THIAGARAJARCOLLEGE OF ENGINEERING

(A Govt. Aided, ISO 9001:2000 Certified Autonomous Institution Affiliated to Anna University)

MADURAI-625 015

B.Tech (Computer Science and Business systems) Programme

TCE/CSBS/BOS **17.04.2026**

MINUTES OF THE ADHOC BOARD OF STUDIES MEETING

The Ad Hoc Board of Studies meeting was convened on 17.04.2026 in the Smart and Secure Environment Lab of Department of Computer Science and Business Systems. The meeting was attended by the undersigned to discuss the modifications required to facilitate the institution's transition from the Relative Grading System to the Absolute Grading System for the students admitted from the academic year 2025–26 as per the directions of Anna University (Letter No. AU/CAC/Absolute Grading/ 02/2025–26, dated 27.03.2026) and the Dean (Academics) Office (TCE/Dean(A&A)/Absolute Grading 2025–26/01, dated 10.04.2026). As per the directions of the Dean (Academics) Office, the Regulation R2021 curriculum, courses of study, and scheme of examinations shall remain unchanged in structure and content for the undergraduate students admitted in the academic year 2025–26. However, modifications at the course-code level are required to facilitate the implementation of the Absolute Grading System within the existing curriculum."

Existing Curriculum R2021 (Relative Grading) (For students admitted in 2021-22, 2022-23, 2023-24, 2024-25)		**R2021-A (Absolute Grading) (For students admitted in 2025-26)**	
REGULAR AND LATERAL ENTRY			
Course Code	**Course Name**	**Course Code**	**Course Name**
Humanities and Social Sciences Courses (HSS)			
21CB430	Introduction to Innovation, IP Management & Entrepreneurship	21CB431	Introduction to Innovation, IP Management & Entrepreneurship
21CB530	Fundamentals of Management	21CB531	Fundamentals of Management
21CB540	Business Strategy	21CB541	Business Strategy
21CB640	Financial & Cost Accounting	21CB641	Financial & Cost Accounting
Basic Science Courses (BS)			
21CB110	Discrete Mathematics	21CB111	Discrete Mathematics
21CB120	Introductory Topics in Statistics, Probability and Calculus	21CB121	Introductory Topics in Statistics, Probability and Calculus
21CB160	Fundamentals of Physics	21CB161	Fundamentals of Physics
21CB210	Linear Algebra	21CB211	Linear Algebra
21CB220	Statistical Methods	21CB221	Statistical Methods
21CB710	Service Operations Management	21CB711	Service Operations Management
Engineering Science Courses (ES)			
21CB130	Fundamentals of Computer Science	21CB131	Fundamentals of Computer Science

21CB140	Principles of Electrical Engineering	21CB141	Principles of Electrical Engineering
21CB170	Fundamentals of Computer Science Lab	21CB171	Fundamentals of Computer Science Lab
21CB180	Principles of Electrical Engineering Lab	21CB181	Principles of Electrical Engineering Lab
21CB240	Principles of Electronics	21CB241	Principles of Electronics
22CB281	Principles of Electronics Lab	22CB282	Principles of Electronics Lab
21ES290	Lateral Thinking	21ES291	Lateral Thinking
21CB250	Fundamentals of Economics	21CB251	Fundamentals of Economics
21CB330	Computational Statistics	21CB331	Computational Statistics
21CB380	Computational Statistics Lab	21CB381	Computational Statistics Lab
21CB470	Design Thinking	21CB471	Design Thinking
21CB720	IT Workshop	21CB721	IT Workshop
Foundation Elective Course (FE)			
21MAFH0	Operations Research	21MAFH1	Operations Research
Professional Core Courses (PC)			
21CB230	Data Structures & Algorithms	21CB231	Data Structures & Algorithms
21CB270	Data Structures and Algorithms Lab	21CB271	Data Structures and Algorithms Lab
21CB311	Computer Organization and Architecture	21CB312	Computer Organization and Architecture
21CB320	Object Oriented Programming	21CB321	Object Oriented Programming
21CB340	Software Engineering	21CB341	Software Engineering
21CB350	Formal Language and Automata Theory	21CB351	Formal Language and Automata Theory
21CB360	Computer Organization and Architecture Lab	21CB361	Computer Organization and Architecture Lab
21CB371	Object Oriented Programming Lab	21CB372	Object Oriented Programming Lab
21CB390	Software Engineering Lab	21CB391	Software Engineering Lab
21CBR10	Operating Systems	21CBR11	Operating Systems
21CB420	Database Management Systems	21CB421	Database Management Systems
21CB460	Software Design with UML	21CB461	Software Design with UML
21CB480	Operating Systems Lab	21CB481	Operating Systems Lab
21CB490	Database Management Systems Lab	21CB491	Database Management Systems Lab
21CB510	Design and Analysis of Algorithms	21CB511	Design and Analysis of Algorithms
21CB520	Compiler Design	21CB521	Compiler Design
21CB570	Design and Analysis of Algorithms Lab	21CB571	Design and Analysis of Algorithm Lab
21CB580	Compiler Design Lab	21CB581	Compiler Design Lab
21CB610	Computer Networks	21CB611	Computer Networks
21CB620	Information Security	21CB621	Information Security
21CB630	Artificial Intelligence	21CB631	Artificial Intelligence
21CB660	Computer Networks Lab	21CB661	Computer Networks Lab
21CB670	Information Security Lab	21CB671	Information Security Lab

21CB680	Artificial Intelligence Lab	21CB681	Artificial Intelligence Lab
Program Electives Courses (PEC)			
21CBPB0	Cloud, Microservices & Applications	21CBPB1	Cloud, Microservices & Applications
21CBPC0	Machine Learning	21CBPC1	Machine Learning
21CBPD0	Modern Web Applications	21CBPD1	Modern Web Applications
21CBPE0	Data Mining and Analytics	21CBPE1	Data Mining and Analytics
21CBPF1	IoT System Design	21CBPF2	IoT System Design
21CBPG0	Financial Management	21CBPG1	Financial Management
21CBPH0	Human Resource Management	21CBPH1	Human Resource Management
21CBPJ0	IT Project Management	21CBPJ1	IT Project Management
21CBPK0	Large scale systems	21CBPK1	Large scale systems
21CBPL0	Big Data Analytics	21CBPL1	Big Data Analytics
21CBPM0	Cloud and Distributed Systems	21CBPM1	Cloud and Distributed Systems
21CBRA0	Usability Design of software Applications	21CBRA1	Usability Design of software Applications
21CBRB0	Image Processing and Pattern Recognition	21CBRB1	Image Processing and Pattern Recognition
21CBRC0	Data Visualization	21CBRC1	Data Visualization
21CBRD0	Logistics Management	21CBRD1	Logistics Management
21CBQA0	Data Mining for Business Intelligence	21CBQA1	Data Mining for Business Intelligence
21CBPN0	Conversational systems	21CBPN1	Conversational systems
21CBPP0	Computational Finance & Modeling	21CBPP1	Computational Finance & Modeling
21CBPQ0	Industrial Robots	21CBPQ1	Industrial Robots
21CBPR0	Enterprise Systems	21CBPR1	Enterprise Systems
21CBPS0	Corporate Finance	21CBPS1	Corporate Finance
21CBPU0	Cryptology	21CBPU1	Cryptology
21CBPV0	Quantum computation and Quantum information	21CBPV1	Quantum computation and Quantum information
21CBPW0	Social, Text and Media Analytics	21CBPW1	Social, Text and Media Analytics
21CBPY0	Mobile computing	21CBPY1	Mobile computing
21CBPZ0	Principles of Cyber Physical System	21CBPZ1	Principles of Cyber Physical System
21CBSA0	Cyber Security Essentials	21CBSA1	Cyber Security Essentials
21CBSB0	Data Center Virtualization	21CBSB1	Data Center Virtualization
21CBSC0	Ethical Hacking	21CBSC1	Ethical Hacking
21CBQB0	Statistics for Management	21CBQB1	Statistics for Management
21CBQC0	Supply Chain Analytics	21CBQC1	Supply Chain Analytics
21CBRE0	Behavioral Economics	21CBRE1	Behavioral Economics
21CBRF0	Industrial Psychology	21CBRF1	Industrial Psychology
21CBRG0	Cognitive science and analytics	21CBRG1	Cognitive science and analytics
21CBRH0	Predictive Analytics	21CBRH1	Predictive Analytics
21CBRJ0	Deep Learning	21CBRJ1	Deep Learning

21CBRK0	Cloud Storage Infrastructures	21CBRK1	Cloud Storage Infrastructures
21CBSD0	Cloud Security	21CBSD1	Cloud Security
21CBSE0	Fog and Edge Computing	21CBSE1	Fog and Edge Computing
21CBSF0	Supply Chain Information Systems	21CBSF1	Supply Chain Information Systems
21CBSG0	Digitalization in Logistics and Supply Chain	21CBSG1	Digitalization in Logistics and Supply Chain
21CBSH0	Intelligent Supply Chain Strategies	21CBSH1	Intelligent Supply Chain Strategies
21CBRL0	Blockchain Technology	21CBRL1	Blockchain Technology
21CBRM0	Mobile Cyber Physical System	21CBRM1	Mobile Cyber Physical System
21CBRN0	Digital Twins in Logistics	21CBRN1	Digital Twins in Logistics
21CBRP0	Graph Algorithms and Complexity Theory	21CBRP1	Graph Algorithms and Complexity Theory
21CBRQ0	Reinforcement Learning	21CBRQ1	Reinforcement Learning
21CBQD0	Human Resource Analytics	21CBQD1	Human Resource Analytics
21CBQE0	Marketing and Social Media Web Analytics	21CBQE1	Marketing and Social Media Web Analytics
21CBQF0	Financial Analytics	21CBQF1	Financial Analytics
21CBQJ0	Digital Business Transformation	21CBQJ1	Digital Business Transformation
21CBQK0	Applied Business Forecasting	21CBQK1	Applied Business Forecasting
21CBQL0	Customer Analytics	21CBQL1	Customer Analytics
General Elective (GE)			
22CBGA0	Business Intelligence & Analytics	22CBGA1	Business Intelligence & Analytics
21CBQG0	Fundamentals of Business Intelligence & Analytics	21CBQG1	Fundamentals of Business Intelligence and Analytics
21CBQH0	Tools for Data Analytics	21CBQH1	Tools for Data Analytics
INDUSTRY SUPPORTED COURSES			
21CB1A0	Devops	21CB1A1	Devops
21CB2A0	Application Security	21CB2A1	Application Security
21CB1B0	Version control system with Git and GitHub.	21CB1B1	Version control system with Git and GitHub.
21CB2B0	MERN Stack	21CB2B1	MERN Stack
21CB1C0	Augmented Reality	21CB1C1	Augmented Reality
21CB1D0	Foundation of NLP	21CB1D1	Foundation of NLP
21CB2C0	Text Analytics and Language Modelling	21CB2C1	Text Analytics and Language Modelling
21CB2D0	Change Data Capture for Bigdata	21CB2D1	Change Data Capture for Bigdata
21CB1E0	Responsible & Safe AI	21CB1E1	Responsible & Safe AI
21CB1F0	Operations Strategy	21CB1F1	Operations Strategy
21CB1G0	AI in Industry 4.0	21CB1G1	AI in Industry 4.0
21CB1H0	GENAI Technologies	21CB1H1	GENAI Technologies
Project Work			
21CB150	Business Communication & Value Science – I	21CB151	Business Communication & Value Science – I

21CB260	Business Communication & Value Science - II	21CB261	Business Communication & Value Science - II
21CB550	Business Communication & Value Science - III	21CB551	Business Communication & Value Science - III
21CB590	Mini Project	21CB591	Mini Project
21CB650	Business Communication & Value Science - IV	21CB651	Business Communication & Value Science - IV
21CB810	Project	21CB811	Project
VALUE ADDED COURSES			
21CBVA0	Linux Administration	21CBVA1	Linux Administration
21CBVB0	Cross Platform Mobile Application Development	21CBVB1	Cross Platform Mobile Application Development
AUDIT COURSES			
21CHAA0	Environmental Sciences	21CHAA1	Environmental Sciences
21CHAB0	Constitution of India	21CHAB1	Constitution of India
21CHAC0	Essence of Indian Knowledge	21CHAC1	Essence of Indian Knowledge
22TAAA0	Heritage of Tamils	22TAAA1	Heritage of Tamils
22TAAB0	Tamils and Technology	22TAAB1	Tamils and Technology
LATERAL ENTRY			
22CB310	Statistical Computing	22CB311	Statistical Computing
22CB350	Business Communication &Value Science – I & II	22CB351	Business Communication &Value Science – I & II
22CB410	Discrete Mathematics and Linear Algebra	22CB411	Discrete Mathematics and Linear Algebra

Thiagarajar College of Engineering, Madurai - 625015

Credit Distribution for B.Tech (Computer Science and Business Systems) Programme – 2025 – 2026 Batch

S.No	Category of Courses	Credits	Credits
A	**Foundation Courses**	**52 - 57**	**24**
	Humanities and Social Sciences (HSS)	09 - 11	6
	Basic Sciences (BS)	21	6
	Engineering Sciences (ES)	23 - 25	12
B	**Professional Core Courses**	**55**	**45**
C	**Elective Courses**	**24 - 48**	**30**
	Program Specific Electives	12 - 24	
	Program Specific Electives for Expanded Scope	6 - 12	
	General Elective	**3 - 6**	**3**
	Foundation Elective	**3 - 6**	**3**
D	**Project work, Seminar, Internship** in Industry or at Higher Learning Institutions	**15**	**15**
E	Mandatory Courses – Environment Science, Induction Programme, Indian Constitution, Essence of Indian Tradition knowledge, Consumer Affairs (as per UGC guidelines)	Non-Credit (Not included for CGPA)	
	Total Credits	**160**	**120**
	Minimum credits to be earned for the award of the Degree	**160 (from A to E and the successful completion of Mandatory Courses)**	**120**

Thiagarajar College of Engineering, Madurai-625015
Department of Computer science and Engineering
Scheduling of Courses – for B.Tech (Computer Science and Business Systems) Programme - join in the year 2025 – 2026

Semester	1	2	3	4	5	6	7	8	9	10	Mandatory Audit Course	Credits
I	21CB111 Discrete Mathematics (4)	21CB121 Introductory Topics in Statistics, Probability and Calculus (3)	21CB131 Fundamentals of Computer Science (3)	21CB141 Principles of Electrical Engineering (2)	21CB151 Business Communication & Value Science - I (2)	21CB161 Fundamentals of Physics (3)	21CB171 Fundamentals of Computer Science Lab (2)	21CB181 Principles of Electrical Engineering Lab (1)			Induction Program	20
II	21CB211 Linear Algebra (4)	21CB221 Statistical Methods (4)	21CB231 Data Structures and Algorithms (4)	21CB241 Principles of Electronics (2)	21CB251 Fundamentals of Economics (2)	21CB261 Business Communication & Value Science - II (2)	21CB271 Data Structures and Algorithms Lab (2)	22CB282 Principles of Electronics Lab (1)	21ES291 Lateral Thinking (1)		21CHAA1 Environmental Sciences	22
III	21CB312 Computer Organization and Architecture (3)	21CB321 Object Oriented Programming (2)	21CB331 Computational Statistics (3)	21CB341 Software Engineering (3)	21CB351 Formal Language and Automata Theory (3)	21CB361 Computer Organization and Architecture Lab (2)	21CB372 Object Oriented Programming Lab (2)	21CB381 Computational Statistics Lab (1)	21CB391 Software Engineering Lab (1)		21CHAB1 Constitution of India	20
IV	21CBR11 Operating Systems (3)	21CB421 Database Management Systems (3)	21CB431 Introduction to Innovation, IP Management & Entrepreneurship (3)	21CB441 Marketing Research & Marketing Management (2)	21YYFX1 *Foundation Elective (3)*	21CB461 Software Design with UML (3)	21CB471 Design Thinking (3)	21CB481 Operating Systems Lab (1)	21CB491 Database Management Systems Lab (1)		21CHAC0 Essence of Indian Knowledge	22
V	21CB511 Design and Analysis of Algorithms (3)	21CB521 Compiler Design (3)	21CB531 Fundamentals of Management (2)	21CB541 Business Strategy (2)	21CB551 Business Communication & Value Science - III (2)	*21YYGX1 General Elective (3)*	*21CBPX1 Program Elective (4)*	21CB571 Design and Analysis of Algorithms Lab (2)	21CB581 Compiler Design Lab (1)	21CB591 Mini Project (1)		23
VI	21B611 Computer Networks (3)	21CB621 Information Security (3)	21CB631 Artificial Intelligence (3)	21CB641 Financial & Cost Accounting (2)	21CB651 Business Communication & Value Science - IV (2)	*21CBPX1 Program Elective (3)*	*21CBPX1 Program Elective (4)*	21CB661 Computer Networks Lab (2)	21CB671 Information Security Lab (1)	21CB681 Artificial Intelligence Lab (1)		24
VII	21CB711 Financial Management (2)	21CB721 Human Resource Management (2)	21CB731 IT Workshop Skylab / Matlab *(3)*	21CB741 Services Science & Service Operational Management (3)	21CB751 IT project Management (4)	21CB761 Usability Design of Software Applications (3)	*21CBPX1 Program Elective (3)*	*21CBPX1 Program Elective (3)*				23
VIII	21CB811 Project Evaluation I (6)											6
											TOTAL	160

BS | HSS | ES | Core | PE | Open Electives | Project | Audit Courses

Passed in Board of Studies Meeting on 17.04.2026

Approved in 71st Academic Council Meeting on 27.06.2026

THIAGARAJAR COLLEGE OF ENGINEERING, MADURAI- 625 015
(A Govt. Aided, ISO 9001:2008 certified Autonomous Institution affiliated to Anna University)

B.Tech (Computer Science and Business Systems) Programme

Categorization of Courses

List of Humanities and Social Science Courses (9)

21CB431 - Introduction to Innovation, IP management and Entrepreneurship (3)
21CB531 - Fundamentals of Management (2)
21CB541 - Business Strategy (2)
21CB641 - Financial & Cost Accounting (2)

List of Basic Science Courses (21)

21CB111 - Discrete Mathematics (4)
21CB121 - Introductory Topics in Statistics, Probability and Calculus (3)
21CB161 - Fundamentals of Physics (3)
21CB211 - Linear Algebra (4)
21CB221 - Statistical Methods (4)
21CB741 - Services Science & Service Operational Management (3)

List of Engineering Science Courses (24)

21CB131 - Fundamentals of Computer Science (3)
21CB141 - Principles of Electrical Engineering (2)
21CB171 - Fundamentals of Computer Science Lab (2)
21CB181 - Principles of Electrical Engineering Lab (1)
21CB241 - Principles of Electronics (2)
21CB251 - Fundamentals of Economics (2)
22CB282 - Principles of Electronics Lab (1)
21ES291 - Lateral Thinking (1)
21CB331 - Computational Statistics (3)
21CB381 - Computational Statistics Lab (1)
21CB471 - Design Thinking (3)
21CB731 - IT Workshop Skylab/Matlab (3)

List of Professional Core Courses (55)

21CB231 - Data Structures and Algorithms (4)
21CB271 - Data Structures and Algorithms Lab (2)
21CB312 - Computer Organization and Architecture (3)
21CB321 - Object Oriented Programming (2)
21CB341 - Software Engineering (3)
21CB351 - Formal Language & Automata Theory (3)
21CB361 - Computer Organization and Architecture Lab (2)
21CB372 - Object Oriented Programming Lab (2)
21CB391 - Software Engineering Lab (1)
21CBR11 - Operating Systems (3)
21CB421 - Database Management Systems (3)
21CB461 - Software Design with UML (3)
21CB481 - Operating Systems Lab (1)
21CB491 - Database Management Systems Lab (1)
21CB511 - Design and Analysis of Algorithms (3)
21CB521 - Compiler Design (3)
21CB571 - Design and Analysis of Algorithms Lab (2)

21CB581 - Compiler Design Lab (1)
21CB611 - Computer Networks (3)
21CB621 - Information Security (3)
21CB631 - Artificial Intelligence (3)
21CB661 - Computer Networks Lab (2)
21CB671 - Information Security Lab (1)
21CB681 - Artificial Intelligence Lab (1)

Programme Electives: (30)
21CB441 - Marketing Research & Marketing Management (2)
21CB711 - Financial Management (2)
21CB721 - Human Resource Management (2)
21CB751 - IT Project Management (4)
21CB761 - Usability Design of Software Applications (3)
Elective II (4)
Elective III (3)
Elective IV (4)
Elective V (3)
Elective VI (3)

General Elective(Elective I) : (3)
Conversational systems / Cloud, Microservices & application / Machine Learning

Foundation Elective: (3)
Operations Research (3)

Project (15)
21CB591 - Mini Project (1)
21CB811 - Project Evaluation I (6)
21CB151 - Business Communication & Value Science – I (2)
21CB261 - Business Communication & Value Science –II (2)
21CB551 - Business Communication & Value Science – III (2)
21CB651 - Business Communication & Value Science –IV (2)

CURRICULUM AND DETAILED SYLLABI

FOR

B.Tech DEGREE (Computer Science and Business Systems) PROGRAMME

FIRST SEMESTER

FOR THE STUDENTS ADMITTED FROM THE

ACADEMIC YEAR 2025 - 2026 ONWARDS

THIAGARAJAR COLLEGE OF ENGINEERING

(A Government Aided ISO 9001-2008 certified
Autonomous Institution affiliated to Anna University)

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THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015
B.Tech (Computer Science and Business systems) Programme
COURSES OF STUDY
(For the candidates admitted from 2025 - 26 onwards)

FIRST SEMESTER

Sl. No.	COURSE CODE	COURSE TITLE	CATEGORY	No.of Hours / Week			Credits
				L	T	P	
THEORY COURSES							
1	21CB111	Discrete Mathematics	BS	3	1	0	4
2	21CB121	Introductory Topics in Statistics, Probability and Calculus	BS	3	0	0	3
3	21CB131	Fundamentals of Computer Science	ES	3	0	0	3
4	21CB141	Principles of Electrical Engineering	ES	2	0	0	2
5	21CB151	Business Communication & Value Science - I	Project	2	0	0	2
THEORY CUM PRACTICAL COURSES							
6	21CB161	Fundamentals of Physics	BS	2	0	2	3
PRACTICAL COURSES							
7	21CB171	Fundamentals of Computer Science Lab	ES	0	0	4	2
8	21CB181	Principles of Electrical Engineering Lab	ES	0	0	2	1
Induction Program (Non Credit)							
TOTAL				**15**	**1**	**8**	**20**

BS : Basic Science
HSS : Humanities and Social Science
ES : Engineering Science
PC : Program Core
PE : Program Elective
OE : Open Elective

L : Lecture
T : Tutorial
P : Practical

Note:
1 Hour Lecture is equivalent to 1 credit
1 Hour Tutorial is equivalent to 1 credit
2 Hours Practical is equivalent to 1 credit

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015
B.Tech (Computer Science and Business systems) Programme

SCHEME OF EXAMINATIONS
(For the candidates admitted from 2025 - 26 onwards)

FIRST SEMESTER

S.No.	Course Code	Name of the Course	Duration of Terminal Exam. in Hrs.	Marks			Minimum Marks for Pass	
				Continuous Assessment	Terminal Exam *	Max. Marks	Terminal Exam	Total
THEORY								
1	21CB111	Discrete Mathematics	3	40	60	100	27	50
2	21CB121	Introductory Topics in Statistics, Probability and Calculus	3	40	60	100	27	50
3	21CB131	Fundamentals of Computer Science	3	40	60	100	27	50
4	21CB141	Principles of Electrical Engineering	3	40	60	100	27	50
5	21CB151	Business Communication & Value Science - I	-	100	-	100	-	50
THEORY CUM PRACTICAL								
6	21CB161	Fundamentals of Physics	3	50	50	100	25	50
PRACTICAL								
7	21CB171	Fundamentals of Computer Science Lab	3	60	40	100	18	50
8	21CB181	Principles of Electrical Engineering Lab	3	60	40	100	18	50

* Terminal Examination will be conducted for maximum marks of 100 and subsequently be reduced to 40 marks for the award of terminal examination marks

21CB111	DISCRETE MATHEMATICS	CATEGORY	L	T	P	CREDIT
		BS	3	1	0	4

Preamble

Discrete Mathematics is the branch of mathematics that provides mathematical framework on discrete objects. Computer Science and Engineering rely mainly on the working principle of discrete objects. This course introduces four modules Boolean Algebra which provides techniques for the minimization of digital circuits, Abstract Algebra which takes vital role in application part of computer science such as cryptography, coding theory etc and also introduces Counting principles such as basic counting, pigeonhole principle & Generating functions, Recurrence relations which are used to determine the complexity of algorithms and to solve counting problems. Combinatorial arguments are made a little easier by the use of pictures of the graphs. The concept of Graph Theory has wide range of applications in Networks, computer architecture, compiling techniques, model checking, artificial intelligence, software engineering, expert systems, software/hardware correctness problem, DBMS, designing concepts, storage methods etc.

Prerequisite

Higher Secondary Level Mathematics

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Demonstrate the given Boolean expression by means of truth table, logic gates and also simplify it into minimum number of literals	15
CO2	Simplify the given Boolean expression/function using Karnaugh maps	10
CO3	Verify the given set with the operations for relations, groups, rings and fields using elementary properties if necessary	15
CO4	Use the principle of basic counting and Pigeonhole on problems related to counting	10
CO5	Solve recurrence relations using generating functions	10
CO6	Illustrate the types of graphs, digraphs and its properties	20
CO7	Obtain PCNF and PDNF of given logical expression	10
CO8	Rephrase real world statements as logical propositions and demonstrate whether the proposition is satisfiable, tautology or a contradiction.	10

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS3	Apply	Value	-	1.1.1, 1.2.7, 2.1.1
CO2	TPS3	Apply	Value	-	1.1.1, 1.2.7, 2.1.1
CO3	TPS3	Apply	Value	-	1.1.1 , 1.2.7, 2.1.1
CO4	TPS3	Apply	Value	-	1.1.1, 1.2.7, 2.1.1
CO5	TPS3	Apply	Value	-	1.1.1, 1.2.7, 2.1.1

CO6	TPS3	Apply	Value	-	1.1.1, 1.2.7, 2.1.1
CO7	TPS3	Apply	Value	-	1.1.1, 1.2.7, 2.1.1
CO8	TPS3	Apply	Value	-	1.1.1, 1.2.7, 2.1.1

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	S	M	M	M								M		
CO2	S	S	S	S								S		
CO3	S	S	S	S								S		
CO4	S	S	S	S								S		
CO5	S	S	S	S								S		
CO6	S	S	S	S								S		
CO7	S	S	S	S								S		
CO8	S	S	S	S								S		

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	**2**	1	2	
Remember	10	10	-	-	-
Understand	30	30	-	-	30
Apply	60	60	100	100	70
Analyze					
Evaluate					
Create					

Sample Questions for Course Outcome Assessment

Course Outcome 1(CO1)

1. Demonstrate by means of truth tables the validity of the following identities.
   i) De Morgan's law for 3 variables: $(xyz)' = x' + y' + z'$
   ii) Second distributive law: $(x + yz) = (x + y)(x + z)$
2. Simplify the following Boolean expression to a minimum number of literals.
   $x'y' + xy + x'y$
3. Given the following Boolean function $F = xy'z + x'y'z + w'xy + wxy$
   i) Obtain the truth table of the function
   ii) Draw the logic diagram using the original Boolean expression
   iii) Simplify the function to minimum number of literals
   iv) Obtain the truth table of the function from the simplified expression and show that it is the same as the one in subdivision i).

Course Outcome 2(CO2)

1. Simplify the following Boolean functions using three variable maps $F(x, y, z) = \sum(1, 2, 3, 6, 7)$
2. Simplify the following Boolean expression using 3-variable maps $xy + x'y'z' + x'yz'$
3. Simplify the following Boolean functions in product of sums $F(w, x, y, z) = \sum(0, 2, 5, 6, 7, 8, 10)$

Course Outcome 3(CO3)

1. Given A = {1,2,3,4} and R ={(1,2),(1,1),(1,3),(2,4)}, S={(1,4),(1,3),(2,3), (3, 1),(4,1)} are relations on A. Find $S \circ R, R \circ S, M_R, M_S, M_{(R \circ S)^{-1}}$ and graph of R & S.
2. Prove that the set of all real numbers of the form $a + b\sqrt{3}$ where $a \& b \in Q$ under usual addition and multiplication is a ring.
3. Verify whether $(Z, +, .)$ is a field or not under usual addition and multiplication.

Course Outcome 4 (CO4)

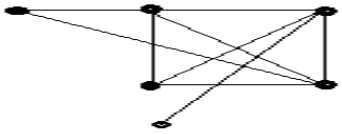
1. How many different license plates can be made if each plate contains a sequence of 3 upper case English letters followed by 3 digits?
2. How many students must be in a class to guarantee that at least 2 students receive the same score on the final exam, if the exam is graded on a scale from 0 to 100 points?
3. Let $a_1, a_2, \ldots . a_n$ be positive real numbers. The arithmetic mean of these numbers is defined by $A = \frac{a_1 + a_2 + \ldots\ldots + a_n}{n}$ and the geometric mean of these numbers is defined by $G = (a_1 a_2 \ldots\ldots . a_n)^{1/n}$. Use mathematical induction to prove that $A \geq G$

Course Outcome 5(CO5)

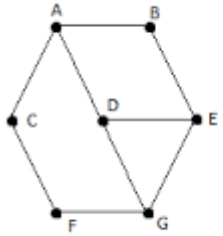
1. Find the generating functions of $(1+x)^{-n}$ & $(1-x)^{-n}$ where n is a positive integer.
2. Solve the recurrence relation $a_k = 3a_{k-1}$ *for* $k = 1,2,\ldots\ldots$ and initial condition $a_0 = 2$
3. Determine the generating function of a numeric function a_r, where $a_r = \begin{cases} 2^r & if\ r\ is\ even \\ -2^r & if\ r\ is\ odd \end{cases}$

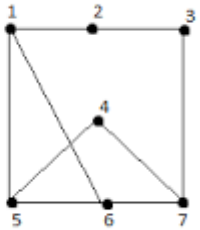
Course Outcome 6(CO6)

1. Verify whether the following graphs are Eulerian or Hamiltonian graphs



2. Determine whether the following graphs are isomorphic or not.





3. What is the procedure to find the chromatic polynomial for the given graph

Course Outcome 7(CO7)

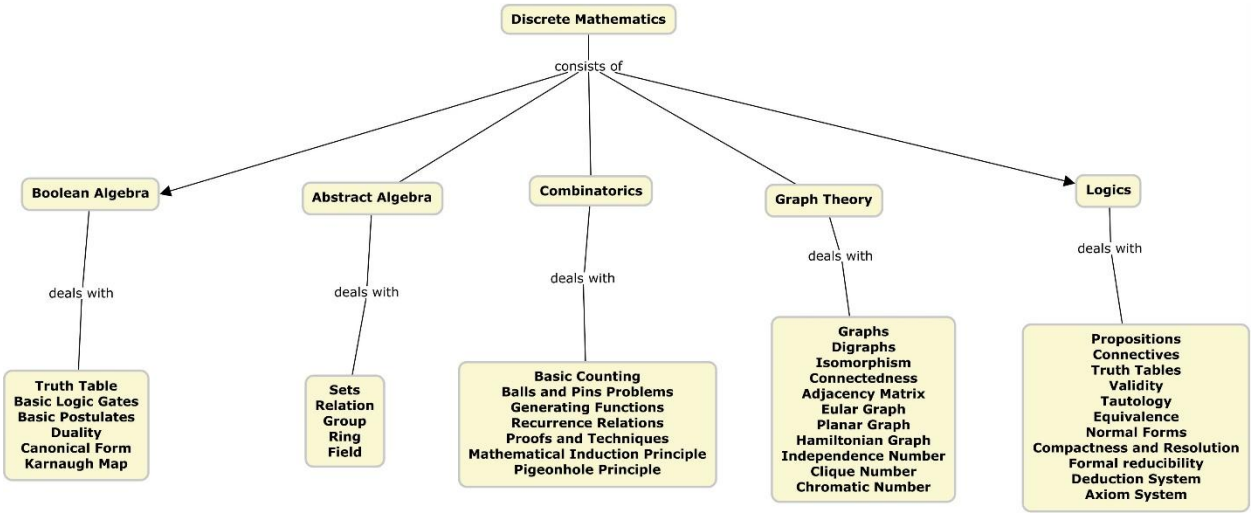
1. Estimate the PCNF and PDNF of the given formula

2. Construct the Truth table of the formula $(7P \vee Q) \wedge (7Q \vee P)$
3. Obtain principal disjunctive normal form of P $\rightarrow$ ((P $\rightarrow$Q) $\wedge$ 7(7Q $\vee$ 7P)) and hence obtain principal conjunctive normal form.

Course Outcome 8(CO8)

1. Prove p $\rightarrow$ (p $\vee$ q) is a Tautology.
2. Check if the following arguments is sound.
   a. All rabbits are mammals.
   b. Bugs Bunny is a rabbit.
   c. Therefore, Bugs Bunny is a mammal.
3. Show that the following set of premises is inconsistent**.**
   If the contract is valid, then john is liable for penalty. If john is liable for penalty, he will go bankrupt. If the bank will loan him money, he will not go bankrupt. As a matter of fact, the contract is valid and the bank will loan him money

Concept Map



Syllabus

Boolean algebra: Introduction of Boolean algebra, truth table, basic logic gate, basic postulates of Boolean algebra, principle of duality, canonical form, Karnaugh map.

Abstract algebra: Set, relation, group, ring, field.

Combinatorics: Basic counting, balls and bins problems, generating functions, recurrence relations. Proof techniques, principle of mathematical induction, pigeonhole principle.

Graph Theory: Graphs and digraphs, complement, isomorphism, connectedness and reachability, adjacency matrix, Eulerian paths and circuits in graphs and digraphs, Hamiltonian paths and circuits in graphs and tournaments, trees; Planar graphs, Euler's formula, dual of a planer graph, independence number and clique number, chromatic number, statement of Four-color theorem.

Logic: Propositional calculus - propositions and connectives, syntax; Semantics - truth assignments and truth tables, validity and satisfiability, tautology; Adequate set of

connectives; Equivalence and normal forms; Compactness and resolution; Formal reducibility - natural deduction system and axiom system; Soundness and completeness.

Learning Resources

1. Topics in Algebra, I. N. Herstein, John Wiley and Sons.
2. Digital Logic & Computer Design, M. Morris Mano, Pearson.
3. Elements of Discrete Mathematics, (Second Edition) C. L. LiuMcGraw Hill, New Delhi.
4. Graph Theory with Applications, J. A. Bondy and U. S. R. Murty, Macmillan Press, London.
5. Mathematical Logic for Computer Science, L. Zhongwan, World Scientific, Singapore.
6. Introduction to linear algebra. Gilbert Strang.
7. Introductory Combinatorics, R. A. Brualdi, North-Holland, New York.
8. Graph Theory with Applications to Engineering and Computer Science, N. Deo, Prentice Hall, Englewood Cliffs.
9. Introduction to Mathematical Logic, (Second Edition), E. Mendelsohn, Van-Nostrand, London.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**BOOLEAN ALGEBRA**		
1.1	Introduction	1	CO1
1.2	Truth Table	1	CO1
1.3	Basic Logic Gates	1	CO1
	Tutorial	1	
1.4	Basic Postulates of Boolean Algebra	1	CO1
1.5	Principle of Duality	1	CO1
1.6	Canonical Forms	1	CO1
	Tutorial	1	
1.7	Karnaugh Map	2	CO2
2.	**ABSTRACT ALGEBRA**		
2.1	Sets	1	CO3
2.2	Relations	1	CO3
2.3	Group	1	CO3
	Tutorial	1	
2.4	Ring	1	CO3
2.5	Field	1	CO3
	Tutorial	1	
3.	**COMBINATORICS**		
3.1	Mathematical Induction	1	CO4
3.2	Balls and Bins Problem	1	CO4
3.3	Pigeonhole Principle	1	CO4
	Tutorial	1	
3.4	Generating Functions	2	CO5
3.5	Recurrence Relations	2	CO5
	Tutorial	1	
4.	**GRAPH THEORY**		
4.1	Graphs and digraphs	1	CO6
4.2	Complement, Isomorphism	1	CO6
4.3	Connectedness and Reachability	1	CO6

	Tutorial	1	
4.4	Adjacency matrix	1	CO6
4.5	Eulerian paths and circuits in graphs and digraphs, Hamiltonian paths and circuits in graphs	1	CO6
4.6	Tournaments, Trees	1	CO6
	Tutorial	1	
4.7	Planar graphs, Euler's formula, dual of a planer graph	1	CO6
4.8	Independence number and clique number	1	CO6
4.9	Chromatic number, statement of Four-color theorem.	1	CO6
	Tutorial	1	
5.	**LOGIC**		
5.1	Propositional calculus - propositions and connectives, syntax	1	CO7
5.2	Semantics - truth assignments and truth tables, validity and satisfiability, tautology	1	CO8
5.3	Adequate set of connectives	1	CO7
	Tutorial	1	
5.4	Equivalence and normal forms	2	CO7
5.5	Compactness and resolution	1	CO8
	Tutorial	1	
5.6	Formal reducibility - natural deduction system and axiom system	1	CO8
5.7	Soundness and completeness	1	CO8
Total		48	

Course Designers:

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21CB121	INTRODUCTORY TOPICS IN STATISTICS, PROBABILITY AND CALCULUS

Category	L	T	P	Credit
BS	3	0	0	3

Preamble

Statistics as a subject is a science of learning from data and provides tools for making decisions when conditions of uncertainty prevail. Statistical techniques are an important tool in these activities because they provide the engineer with both descriptive and analytical methods for dealing with the variability in observed data. The main objective of this course is to provide students with the foundations of statistical and probabilistic analysis mostly used in various applications in engineering and science. It introduces students to cognitive learning in statistics, calculus and develops skills on analyzing the different types of data.

Prerequisite

- Higher secondary level -probability concepts

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Understand the types of data by graphical representation and Frequency curves, central tendency and dispersion, Scatter diagram	15
CO2	Apply the concept of correlation analysis and least square method in fitting regression curves to engineering problems	20
CO3	Apply Bayes theorem to invert conditional probabilities	20
CO4	Determine mass and density functions for discrete and continuous distributions	15
CO5	Identify expected values, moments and moment generating functions	10
CO6	Find areas enclosed between two curves and volumes enclosed between surfaces using integrals of multivariable	20

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond	-	1.1.1, 2.1.1
CO2	TPS3	Apply	Value	-	1.1.1,2.1.1.1, 2.1.4
CO3	TPS3	Apply	Value	-	1.1.1, 2.1.4
CO4	TPS3	Apply	Value	-	1.1.1, 2.1.4
CO5	TPS2	Understand	Respond	-	1.1.1, 2.1.4
CO6	TPS3	Apply	Value	-	1.1.1, 1.2.7, 2.1.1

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	S	S	M	M								S		
CO2	S	M	S	M								S		
CO3	S	S	S	M								S		
CO4	M	S	L	M								M		
CO5	M	S	L	M								S		
CO6	S	S	S	S								S		

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	2	1	2	
Remember	10	10	-	-	-
Understand	30	30	-	-	30
Apply	60	60	100	100	70
Analyse					
Evaluate					
Create					

Assessment Pattern: Psychomotor

Psychomotor Skill	Mini project /Assignment/Practical Component
Perception	
Set	
Guided Response	
Mechanism	
Complex Overt Responses	
Adaptation	
Origination	

Sample Questions for Course Outcome Assessment**

Course Outcome 1(CO1):

1. Define Statistics and state it's objective
2. The following are the number of transistors failing a quality check per hour during 72 observed hours of production:
   2 4 6 8 1 2 1 8 5 4 6 1
   0 1 8 2 3 4 1 2 5 1 1 8
   2 1 9 1 4 2 5 6 8 1 7 1
   4 9 1 8 2 4 1 1 8 5 5 3
   0 9 1 9 7 1 8 8 7 7 7 2
   7 1 2 7 3 5 8 8 5 9 9 0
   Group these data into a frequency distribution showing how often each of the values occurs and draw a bar chart.
3. Find the mean and the standard deviation of the following miles per gallon (mpg) obtained in 20 test runs performed on urban roads with an intermediate-size car:
   19.7 21.5 22.5 22.2 22.6
   21.9 20.5 19.3 19.9 21.7

22.8 23.2 21.4 20.8 19.4
22.0 23.0 21.1 20.9 21.3

Course Outcome 2(CO2):

1. Suppose we have a linear equation through the origin. Estimate the regression line passing through the origin for the following data. Suppose it is not known whether the true regression should pass through the origin. Estimate the regression line.

x	0.5	1.5	3.2	4.2	5.1	6.5
y	1.3	3.4	6.7	8.0	10.0	13.2

2. A study was done on a diesel-powered light-duty pickup truck to see if humidity, air temperature, and barometric pressure influence emission of nitrous oxide (in ppm). Emission measurements were taken at different times, with varying experimental conditions. The data are given in Table 12.2. The model is $yi = \beta 0 + \beta 1x1i + \beta 2x2i + \beta 3x3i + _i, i = 1, 2, \ldots, 20$. Fit this multiple linear regression model to the given data and then estimate the amount of nitrous oxide emitted for the conditions where humidity is 50%, temperature is 76◦F, and barometric pressure is 29.30.

Nitrous Oxide y	Humidity x_1	Temp., x_2	Pressure x_3	Nitrous Oxide y	Humidity x_1	Temp., x_2	Pressure x_3
0.90	72.4	76.3	29.18	1.07	23.3	76.8	29.38
0.91	41.6	70.3	29.35	0.94	47.4	86.6	28.35
0.96	34.3	77.1	29.24	1.10	31.5	76.9	29.63
0.89	35.1	68.0	29.27	1.10	10.6	86.3	29.56
1.00	10.7	79.0	29.78	1.10	11.2	86.0	29.48
1.10	12.9	67.4	29.39	0.91	73.3	76.3	29.40
1.15	8.3	66.8	29.69	0.87	75.4	77.9	29.28
1.03	20.1	76.9	29.48	0.78	96.6	78.7	29.29
0.77	72.2	77.7	29.09	0.82	107.4	86.8	29.03
1.07	24.0	67.7	29.60	0.95	54.9	70.9	29.37

Course Outcome 3(CO3):

1. A system may become infected by some spyware through the internet or e-mail. Seventy percent of the time the spyware arrives via the internet, thirty percent of the time via email. If it enters via the internet, the system detects it immediately with probability 0.6. If via e-mail, it is detected with probability0.8. What percentage of times is this spyware detected?
2. One box contains six red balls and four green balls, and a second box contains seven red balls and three green balls. A ball is randomly chosen from the first box and placed in the second box. Then a ball is randomly selected from the second box and placed in the first box.
   a. What is the probability that a red ball is selected from the first box and a red ball is selected from the second box?

   b**.** At the conclusion of the selection process, what is the probability that the numbers of red and green balls in the first box are identical to the numbers at the beginning?

3. In a certain city, sports bikes are being targeted by thieves. Assume that the probability of a sports bike being stolen is 0.09 while the probability is only 0.5 for a regular bike. Taking, as an approximation for all bikes in that area, the nationwide proportion 0.19 of sports bikes, find (a) the probability that a bike will be stolen. (b) the probability that a stolen bike is a sports bike.

Course Outcome 4 (CO4):

1. If the probability is 0.05 that a certain wide-flange column will fail under a given axial load, what are the probabilities that among 16 such columns
   (a) at most two will fail;
   (b) at least four will fail?
2. The substrate concentration of influent to a reactor is normally distributed with μ =0.30 and $\sigma = 2.8$
   a. Identify the probability that the concentration exceeds 0.25?
   b. Identify the probability that the concentration is at most0 .10?
   c. Characterize the largest 5% of all concentration values?
3. Let X denote the distance (m) that an animal moves from its birth site to the first territorial vacancy it encounters. Suppose that for banner-tailed kangaroo rats, X has an exponential distribution with parameter $\lambda = 0.01386$ (i).Compute the probability that the distance is between 100 and 200 m? (ii). Identify the probability that distance exceeds the mean distance by more than 2 standard deviations? (iii). Calculate the value of the median distance?

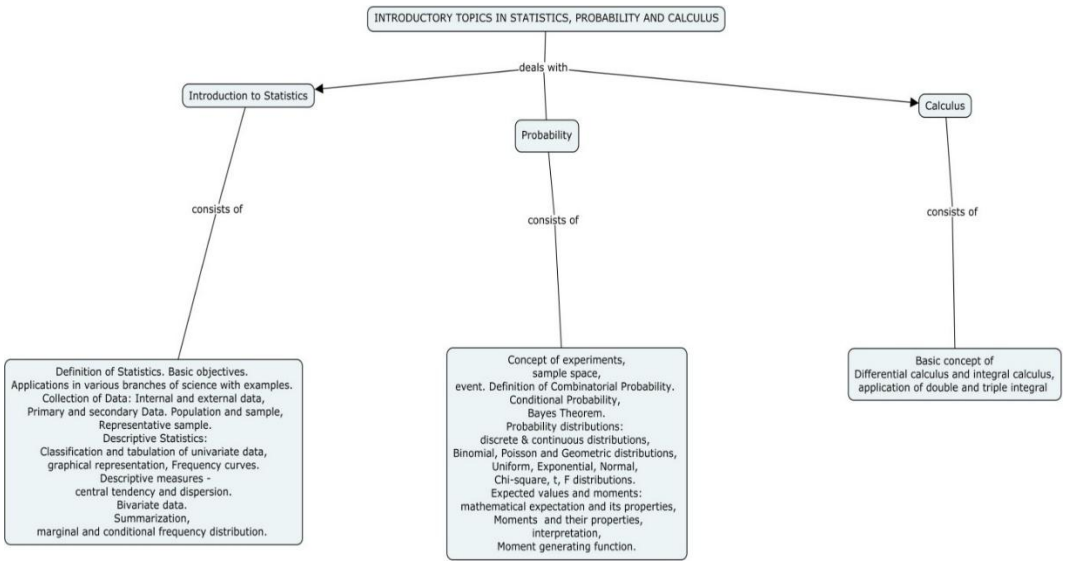
Course Outcome 5 (CO5):

1. If X_1 has mean 8 and variance 2 while X_2 has mean −12.5 and variance 2.25, and the two are independent, find
   (a) $E(X_1 - X_2)$;
   (b) $Var (X_1 - X_2)$.
2. Let $f(x) = 0.2$ for $x = 0, 1, 2, 3, 4$.
   (a) Find the moment generating function
   (b) Obtain $E(X)$ and $E(X^2)$ by differentiating the moment generating function.
3. Let $f(x) = 0.40\binom{4}{x}$ for x = 0, 1, 2, 3, 4
   (a) Find the moment generating function and hence obtain $E(X)$ and $E(X^2)$

Course Outcome 6(CO6):

1. Evaluate the integral $\int_0^1 \int_x^1 e^{\frac{x}{y}} dydx$ by reversing the order of integration
2. Estimate the area enclosed by the curves $y = x^2$ $x + y = 2$
3. Use triple integral to find the volume of the tetrahedron by the planes $x + 2y + z = 2;\ x = 2y; x = 0$ & $z = 0$.

Concept Map



Syllabus

Introduction to Statistics: Definition of Statistics. Basic objectives. Applications in various branches of science with examples. Collection of Data: Internal and external data, Primary and secondary Data. Population and sample, Representative sample. Descriptive Statistics: Classification and tabulation of univariate data, graphical representation, Frequency curves. Descriptive measures - central tendency and dispersion. Bivariate data. Summarization, marginal and conditional frequency distribution.

Probability: Concept of experiments, sample space, event. Definition of Combinatorial Probability. Conditional Probability, Bayes Theorem. Probability distributions: discrete & continuous distributions, Binomial, Poisson and Geometric distributions, Uniform, Exponential, Normal, Chi-square, t, F distributions. Expected values and moments: mathematical expectation and its properties, Moments (including variance) and their properties, interpretation, Moment generating function.

Calculus: Basic concept of Differential calculus and integral calculus, application of double and triple integral.

Learning Resources

1. Introduction of Probability Models, S. M. Ross, Academic Press, N.Y.
2. Fundamentals of Statistics, vol. I & II, A. Goon, M. Gupta and B. Dasgupta, World Press.
3. Higher Engineering Mathematics, B. S. Grewal, Khanna Publication, Delhi.
4. A first course in Probability, S. M. Ross, Prentice Hall.
5. Probability and Statistics for Engineers, (Fourth Edition), I. R. Miller, J.E. Freund and R. Johnson, PHI.
6. Introduction to the Theory of Statistics, A. M. Mood, F.A. Graybill and D.C. Boes, McGraw Hill Education.
7. Advanced Engineering Mathematics, (Seventh Edition), Peter V. O'Neil, Thomson Learning.

8. Advanced Engineering Mathematics, (Second Edition) M. D. Greenberg, Pearson Education.
9. Applied Mathematics, Vol. I & II, P. N. Wartikar and J. N. Wartikar, Vidyarthi Prakashan.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Introduction to Statistics**		
1.1	Definition of Statistics , its objectives and applications	2	CO1
1.2	Collection of Data: Internal and external data, Primary and secondary Data	2	CO1
1.3	Population and sample, Representative sample	1	CO1
1.4	Classification and tabulation of univariate data, graphical representation, Frequency curves.	2	CO1
1.5	central tendency and dispersion	1	CO1
1.6	Summarization, marginal and conditional frequency distribution. Scatter diagram.	2	CO1
1.7	Linear correlation, Rank correlation	2	CO2
1.8	Linear regression- Least squares method	2	CO2
	Case studies in correlation and data analysis – Assignment I	1	
2.	**Probability**		
2.1	Concept of experiments, sample space, event	1	CO3
2.2	Combinatorial Probability and Conditional Probability	1	CO3
2.3	Bayes Theorem	2	CO3
2.4	Discrete distributions- Binomial, Poisson and Geometric	2	CO4
2.5	Continuous Distributions- Uniform, Exponential, Normal	2	CO4
2.6	Continuous Distributions - Chi-square, t, F	2	CO4
2.7	Expected values, variance, covariance, moments, mathematical expectation and its properties	2	CO5
2.8	Moment generating function	1	CO5
	Case studies in Bayesian Application – Assignment II	1	
3.	**Calculus**		
3.1	Basic Concepts of Differential Calculus	2	CO6
3.2	Integral Calculus	1	CO6
3.3	Applications of Double Integral	2	CO6
3.4	Applications of Triple Integral	2	CO6
	Assignment III		
	Total hours	36	

Course Designers:

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21CB131	FUNDAMENTALS OF COMPUTER SCIENCE

Category	L	T	P	Credit
ES	3	0	0	3

Preamble

This course aims to provide exposure to problem solving through programming. It also aims to train the students with basic programming skills. This course enables the students to solve real world computational problems using C-programming language.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Explain the algorithms and draw flowcharts for solving Mathematical and Engineering problems. (Understand)	15
CO2	Develop Computer programs using different types of Operator and Expressions in C (Apply)	20
CO3	Identify the appropriate control structure and interpret modularization, recursion-using functions to solve real time problems. (Apply)	20
CO4	Implement Programs with pointers and arrays.(Apply)	15
CO5	Write programs using Structures ,Unions and files.(Apply)	15
CO6	Illustrate the Unix system Interface using C programs. (Understand)	15

*** Weightage depends on Bloom's Level, number of contact hours

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond	Guided Response	1.2,2.1.2,2.4.6,2.5.2,3.2.3,4.4.3
CO2	TPS3	Apply	Value	-	1.2,2.1.5,3.2.3
CO3	TPS3	Apply	Value	-	1.2,2.1.5, 3.2.3,4.3.2
CO4	TPS3	Apply	Value	-	1.2,2.1.5, 3.2.3,4.5.1
CO5	TPS3	Apply	Value	-	1.2, 2.1.5,3.2.3,4.5.3
CO6	TPS2	Understand	Respond	Guided Response	1.2,2.1.2,2.4.6,4.4.3

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	-	-	-	-	-	-		-	-	-	L		
CO2	S	L	-	-	-	L	-	L	-	L	L	L	L	L
CO3	S	L	-	-	-	L	-	L	-	L	L	L	L	L
CO4	S	L	-	-	-	L	-	L	-	L	L	L	L	L
CO5	S	L	-	-	-	L	-	L	-	L	L	L	L	L
CO6	M	-	-	-	-	L	-	L	-	L	L	L	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	2	1	2	
Remember	10	10	-	-	10
Understand	40	40	-	-	30
Apply	50	50	100	100	60
Analyse	-	-	-	-	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Assessment Pattern: Psychomotor

Psychomotor Skill	Assignment
Perception	-
Set	-
Guided Response	100
Mechanism	-
Complex Overt Responses	-
Adaptation	-
Origination	-

Sample Questions for Course Outcome Assessment**

Course Outcome 1 (CO1):

1. Explain the symbols of Flowchart
2. Write the pseudo code to count the digits of an integer
3. Illustrate the flow chart to exchange the values of variables

Course Outcome 2 (CO2):

1. Explain about the simple data types in C.
2. Determine the values of c and d.

```
int a=18,b=26,c;
float d;
c=(++a)-(b++);d=(c+b)*a+c+b*a;
```

3. Write a C Program to convert temperature in degrees Celsius to degrees Fahrenheit.

Course Outcome 3 (CO3):

1. Explain the conversion of 'while loop' into 'for loop' with the help of flow charts.
2. Draw the flowchart for finding factorial without wit out recursion
3. Construct a C program to read a positive integer, determine the number of digits in it and perform either summation of digits of an integer or reversing the integer value or squaring the value or testing whether it is odd or even based on the number of digits. Assume that the entered value has a maximum of 4 digits. Use Relevant Control Structure

Course Outcome 4 (CO4):

1. Write the importance of pointers? Assume q=20 which is stored in location R=100 and find *R,(q).. Explain call by value and call by reference.
2. Write the algorithm to determine the first two largest elements from the given array. Use pointer notation to access the elements.
3. Develop a C program to multiply two nxn matrices using arrays and pointers.

Course Outcome 5 (CO5):

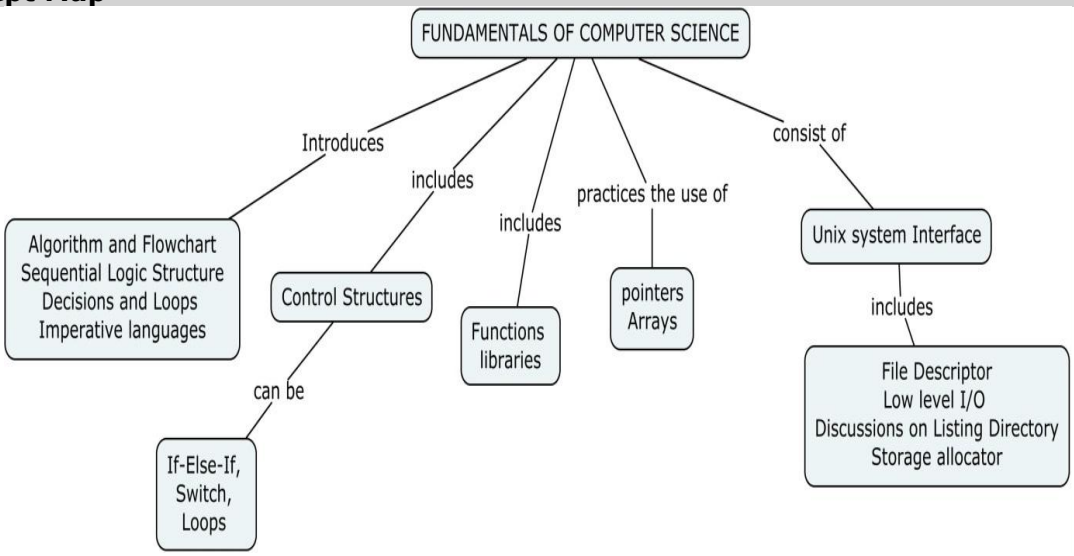
1. Write the syntax for structure type variable within another structure
2. Construct a C program to print the following message:[Use string manipulation functions]

   "Whatsapp or Gmail for communication is preferable.
   St1: I am using Gmail for communication
   St2: People are using Whatsapp or Gmail.
   St3: Any mode of communication is preferable
3. Develop a C program to create a text file to store records of addresses of N persons and retrieve and display the records with status="covid positive".

Course Outcome 6 (CO6):

1. What are the responsibilities of a shell?
2. Specify the difference between absolute path and related path?
3. Describe links and symbolic links in UNIX?

Concept Map



Syllabus

General problem Solving concepts: Algorithm, and Flowchart for problem solving with Sequential Logic Structure, Decisions and Loops- **Problem Solving using Fundamental Algorithms:** Exchanging the values of two variables, counting

Imperative languages: **Introduction to imperative language;** syntax and constructs of a specific language (ANSI C) -**Types Operator and Expressions with discussion of variable naming and Hungarian Notation:** Variable Names, Data Type and Sizes (Little Endian Big Endian), Constants, Declarations, Arithmetic Operators, Relational Operators, Logical Operators, Type Conversion, Increment Decrement Operators, Bitwise Operators,

Assignment Operators and Expressions, Precedence and Order of Evaluation, proper variable naming and Hungarian Notation

Control Flow and Functions - Control Flow with discussion on structured and unstructured programming: Statements and Blocks, If-Else-If, Switch, Loops – while, do, for, break and continue, Go to Labels, structured and un- structured programming - **Functions and Program Structure with discussion on standard library:** Basics of functions, parameter passing and returning type, C main return as integer, External, Auto, Local, Static, Register Variables, Scope Rules, Block structure, Initialisation, Recursion, Pre-processor, Standard Library Functions and return types- Summation of a set of numbers- Reversing Digits of an Integer- Factoring Methods for smallest divisor and prime number - Modularization and recursion –string handling functions

Pointers and Arrays: Pointers and address, Pointers and Function Arguments, Pointers and Arrays, Address Arithmetic, character Pointers and Functions, Pointer Arrays, Pointer to Pointer, Multi-dimensional array and Row/column major formats, Initialisation of Pointer Arrays, Command line arguments, Pointer to functions, complicated declarations –Evaluation - Array order reversal, Array Counting, Finding maximum and the minimum value in a set- Sorting – Searching

Structures: Basic Structures, Structures and Functions, Array of structures, Pointer of structures, Self-referral Structures, Table look up, Typedef, Unions, Bit-fields -**Input and Output:** Standard I/O, Formatted Output – printf, Formated Input – scanf, Variable length argument list, file access including FILE structure, fopen, stdin, sdtout and stderr, Error Handling including exit, perror and error.h, Line I/O, related miscellaneous functions

Unix system Interface: File Descriptor, Low level I/O – read and write, Open, create, close and unlink, Random access – lseek, Discussions on Listing Directory, Storage allocator, **Programming Method:** Debugging, Macro, User Defined Header, User Defined Library Function, makefile utility.

Learning Resources

1. "C: The Complete Reference", Herbert Schildt, Fourth Edition, , McGraw Hill, 2017
2. "Let Us C", YashavantKanetkar , Sixteenth edition, BPB Publication, 2017
3. "Programming in C",B. Gottfried, Third Edition, Schaum Outline Series, 2017
4. "The C Programming Language", B. W. Kernighan and D. M. Ritchi, Second Edition, PHI,1988.
5. "How to solve it by Computer", R.G Dromey, Pearson education, Delhi, 2008.
6. "Simple Program Design", A Step-by-Step Approach, Lesley Anne Robertson, 5th Edition, Thomson, 2007

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1	**General problem Solving concepts**		
1.1	Algorithm, and Flowchart for problem solving with Sequential Logic Structure, Decisions and Loops	3	CO1
1.2	**Problem Solving using Fundamental Algorithms:** Exchanging the values of two variables, counting	2	CO1
2	**Imperative languages**		
2.1	**Introduction to imperative language-** syntax and constructs of a specific language (ANSI C)	1	CO2
2.2	**Types Operator and Expressions with discussion of variable naming and Hungarian Notation:**	2	CO2

	Variable Names, Data Type and Sizes (Little Endian Big Endian), Constants, Declarations		
2.3	Arithmetic Operators, Relational Operators, Logical Operators	1	CO2
2.4	Type Conversion, Increment Decrement Operators, Bitwise Operators	1	CO2
2.5	Assignment Operators and Expressions, Precedence and Order of Evaluation	1	CO2
2.6	Proper variable naming and Hungarian Notation	1	CO2
3	**Control Flow and Functions**		
3.1	**Control Flow with discussion on structured and unstructured programming:** Statements and Blocks, If-Else-If	1	CO3
3.2	Switch , Loops – while, do, for, break and continue, Go-to Labels, structured and un- structured programming	2	CO3
3.3	**Functions and Program Structure with discussion on standard library:** Basics of functions, parameter passing and returning type	1	CO3
3.4	C main return as integer, External, Auto, Local, Static, Register Variables, Scope Rules, Block structure, Initialisation	1	CO3
3.5	Recursion, Pre-processor, Standard Library Functions and return types-Summation of a set of numbers-Reversing Digits of an Integer	1	CO3
3.6	Factoring Methods for smallest divisor and prime number -Modularization and recursion –string handling functions	1	
4	**Pointers and Arrays**		
4.1	Pointers and address, Pointers and Function Arguments ,Pointers and Arrays, Address Arithmetic	1	CO4
4.2	character Pointers and Functions, Pointer Arrays, Pointer to Pointer	1	CO4
4.3	Multi-dimensional array and Row/column major formats, Initialisation of Pointer Arrays	1	CO4
4.4	Command line arguments, Pointer to functions	1	CO4
4.5	Complicated declarations –Evaluation - Array order reversal	1	CO4
4.6	Array Counting, Finding maximum and the minimum value in a set- Sorting - Searching	1	CO4
5	**Structures**		
5.1	Basic Structures, Structures and Functions, Array of structures	1	CO5
5.2	Pointer of structures, Self-referral Structures, Table look up, Type def, Unions, Bit-fields	2	CO5
5.3	**Input and Output:** Standard I/O, Formatted Output – printf, Formated Input – scanf	1	CO5
5.4	Variable length argument list, file access including FILE structure, fopen, stdin, sdtout and stderr,	1	CO5

5.5	Error Handling including exit, perror and error.h, Line I/O, related miscellaneous functions	1	CO5
6	**Unix system Interface**		
6.1	File Descriptor, Low level I/O – read and write, Open, create, close and unlink	2	CO6
6.2	Random access – lseek, Discussions on Listing Directory, Storage allocator	1	CO6
6.3	**Programming Method:** Debugging, Macro, User Defined Header, User Defined Library Function, makefile utility.	2	CO6
	Total Hours	**36**	

Course Designers:

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21CB141	PRINCIPLES OF ELECTRICAL ENGINEERING

Category	L	T	P	Credit
ES	2	0	0	2

Preamble

Principles of electrical engineering are a fundamental course for all the circuit branches in engineering. This course covers the various network theorems to study the behavior of the electrical circuits. In order to find the behavior of AC circuits, the steady state and transient responses are discussed. By applying basic circuit laws, the performance of Electric and Magnetic field is determined in free space and in material space. Students will get an idea about transformer, various measuring instruments and sensors, electrical wiring, earthing and illumination system with some practical applications.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Apply various network theorems and laws to interpret the behavior of the given DC circuits.	20
CO2	Find the steady and transient response of the given AC circuits.	20
CO3	Apply basic circuit laws to find the behavior of Electric and Magnetic field in free space and in material space.	20
CO4	Explain the construction, working principle and applications of transformer.	10
CO5	Explain the construction, working principle and applications of various measuring Instruments and sensors.	15
CO6	Demonstrate the concept of Electrical Wiring, role of earthing, safety devices and system in practical applications.	15

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS3	Apply	Value		1.2.4 , 2.3.1
CO2	TPS3	Apply	Value		1.2.4 , 2.3.1
CO3	TPS3	Apply	Value		1.2.2, 2.3.1
CO4	TPS2	Understand	Respond		1.2.2
CO5	TPS2	Understand	Respond		1.2.2
CO6	TPS3	Apply	Value		1.2.1 , 2.3.1, 3.2.6

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	S	M	M	L	S			M	M			M	L	L
CO2	S	M	M	L	S			M	M			M	L	L

CO3	S	M	M	L	S			M	M			M	L	L
CO4	M	L	L					M	M			L	L	L
CO5	M	L	L					M	M			L	L	L
CO6	S	M	M	L	S			M	M			M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	2	1	2	
Remember	20	20	-	-	20
Understand	30	30	-	-	30
Apply	50	50	100	100	50
Analyse					
Evaluate					
Create					

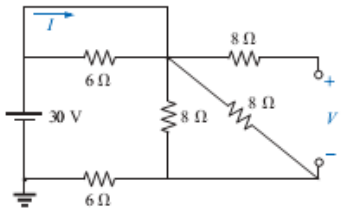
Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject /Assignment/Practical Component
Perception	
Set	
Guided Response	
Mechanism	
Complex Overt Responses	
Adaptation	
Origination	

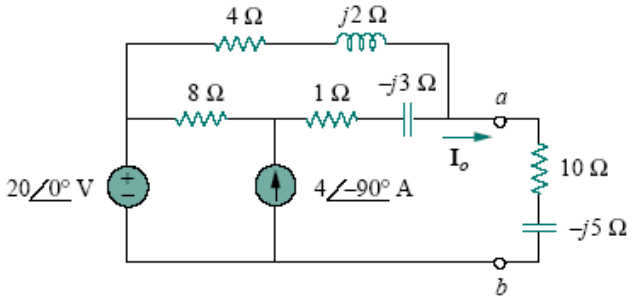
Sample Questions for Course Outcome Assessment

Course Outcome 1(CO1):

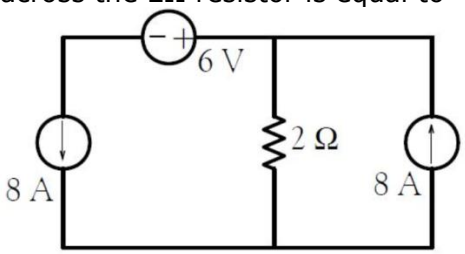
1. Determine the voltage V and current I for the network in figure below using Thevenin's theorem



2. Determine the Norton equivalent of the circuit in Fig. Given as seen from terminals a-b. Use the equivalent to find I_o.



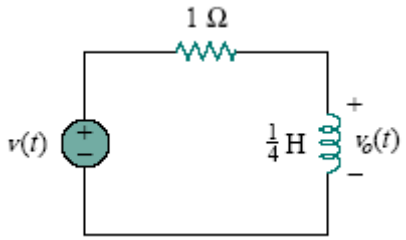
3. The voltage across the 2Ω resistor is equal to



(A) 3V
(B) -3V
(C) 8V
(D) None of the above

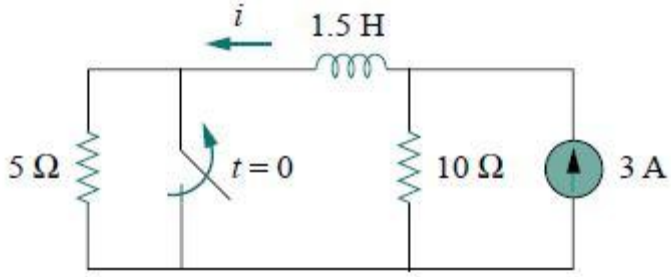
Course Outcome 2(CO2):

1. At what frequency will the output voltage $V_o(t)$ in Fig. below be equal to the input voltage $V(t)$?

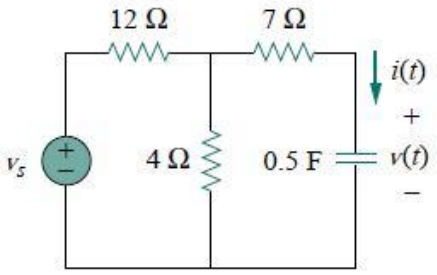


(a) 0 rad/s (b) 1 rad/s (c) 4 rad/s (d) ∞ rad/s (e) none of the above

2. The switch in figure has been closed for a long time. It opens at t = 0. Find $i(t)$ for t >0.



3. Find the step responses $v(t)$ and $i(t)$ to v_s = 5u(t) V in the circuit of figure



Course Outcome 3(CO3):

1. Two point charges - 4 μC and 5 μC are located at (2, - 1, 3) and (0, 4, - 2), respectively. If a third point charge of 3 μC is located at the origin. Find the potential at (-1 , 5, 2) assuming V(∞) = 0
2. Derive the Maxwell's equation for static fields.
3. Given points P(l, - 3 , 5), *Q(2,* 4, 6), and *R(0,* 3, 8), find: (a) the position vectors of *P* and *R,* (b) the distance vector $r_{qr}(c)$ the distance between *Q* and *R.*

Course Outcome 4 (CO4):

1. Derive the EMF equation of single phase transformer.
2. Define the term transformation ratio in Transformer.
3. Mention the advantages of shell type transformer over core type transformer.

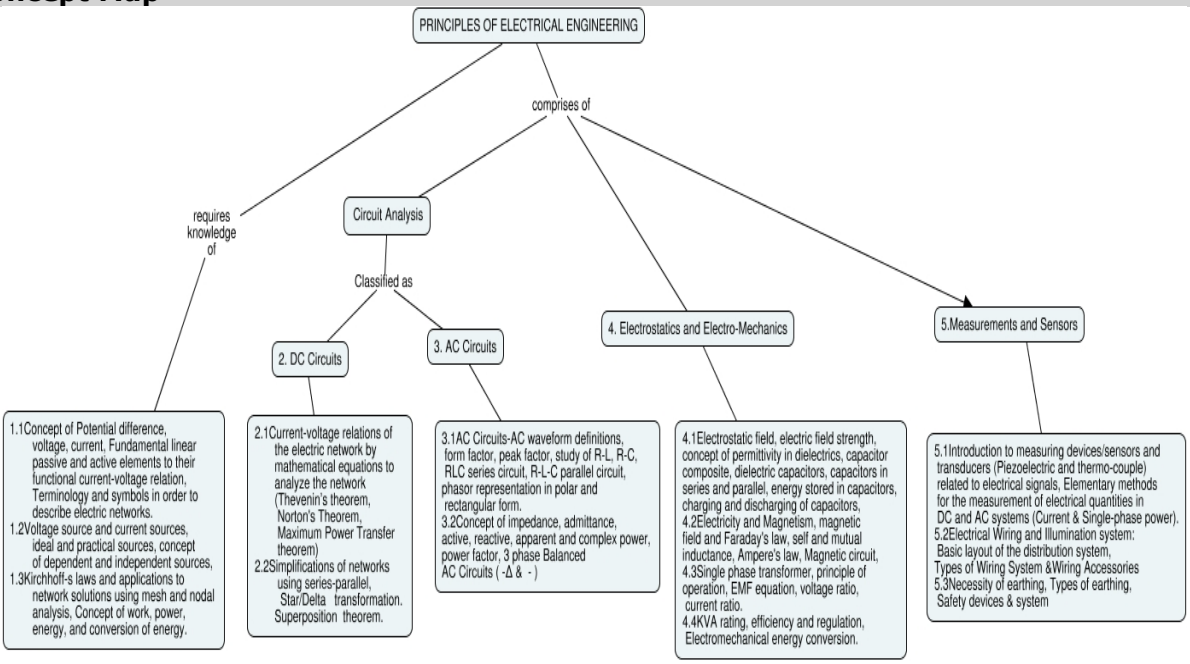
Course Outcome 5 (CO5):

1. Describe the various forces/torques required in the measuring instruments.
2. Name the few static performance characteristics of a measuring instrument.
3. Discuss various methods for the measurement of electrical quantities in AC and DC system.

Course Outcome 6(CO6):

1. Design a lighting layout for a seminar hall having a dimension of 10 meter X 15 meter for an illumination level of 400 Lux. The recommended lamp is 36 watts fluorescent lamp. The depreciation factor is 1.2 and Utilization factor is 0.7. The lumens output of the 36watts fluorescent lamp is 3250 lumens. Also Calculate the number of fittings required.
2. Compare the luminous efficiency of various lamps.
3. Discuss the various earthing techniques used in a house.
4. List the electrical accessories used in a house wiring.

Concept Map



Syllabus

Introduction: Concept of Potential difference, voltage, current, Fundamental linear passive and active elements to their functional current-voltage relation, Terminology and symbols in order to describe electric networks, voltage source and current sources, ideal and practical sources, concept of dependent and independent sources, Kirchhoff-s laws and applications to network solutions using mesh and nodal analysis, Concept of work, power, energy, and conversion of energy.

DC Circuits: Current-voltage relations of the electric network by mathematical equations to analyze the network (Thevenin's theorem, Norton's Theorem, Maximum Power Transfer

theorem) Simplifications of networks using series-parallel, Star/Delta transformation. Superposition theorem.

AC Circuits: AC waveform definitions, form factor, peak factor, study of R-L, R-C,RLC series circuit, R-L-C parallel circuit, phasor representation in polar and rectangular form, concept of impedance, admittance, active, reactive, apparent and complex power, power factor, 3 phase Balanced AC Circuits (ʎ-Δ & ʎ-ʎ).

Electrostatics and Electro-Mechanics: Electrostatic field, electric field strength, concept of permittivity in dielectrics, capacitor composite, dielectric capacitors, capacitors in series and parallel, energy stored in capacitors, charging and discharging of capacitors, Electricity and Magnetism, magnetic field and Faraday's law, self and mutual inductance, Ampere's law, Magnetic circuit, Single phase transformer, principle of operation, EMF equation, voltage ratio, current ratio, KVA rating, efficiency and regulation, Electromechanical energy conversion.

Measurements and Sensors: Introduction to measuring devices/sensors and transducers (Piezoelectric and thermo-couple) related to electrical signals, Elementary methods for the measurement of electrical quantities in DC and AC systems (Current & Single-phase power). Electrical Wiring and Illumination system: Basic layout of the distribution system, Types of Wiring System &Wiring Accessories, Necessity of earthing, Types of earthing, Safety devices & system.

For Further Reading - Principle of batteries, types, construction and application, Magnetic material and B-H Curve, Basic concept of indicating and integrating instruments.

Learning Resources

1. Electric Machinery, (Sixth Edition) A. E. Fitzgerald, Kingsely Jr Charles, D. Umans Stephen, Tata McGraw Hill.
2. A Textbook of Electrical Technology, (vol. I), B. L. Theraja, Chand and Company Ltd., New Delhi.
3. Basic Electrical Engineering, V. K. Mehta, S. Chand and Company Ltd., New Delhi.
4. Theory and problems of Basic Electrical Engineering, (Second Edition), J. Nagrath and Kothari, Prentice Hall of India Pvt. Ltd.
5. Basic of Electrical Engineering, T. K. Nagsarkar and M. S. Sukhija, Oxford University Press.
6. Introduction to Electrodynamics, D. J. Griffiths, (Fourth Edition), Cambridge University Press.
7. Engineering Circuit Analysis, William H. Hayt & Jack E. Kemmerly, McGraw-Hill Book Company Inc.
8. Fundamentals of Electrical and Electronics Engineering, Smarjith Ghosh, Prentice Hall (India) Pvt. Ltd.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Introduction**		
1.1	Concept of Potential difference, voltage, current, Fundamental linear passive and active elements to their functional current-voltage relation, Terminology and symbols in order to describe electric networks.	1	CO1
1.2	Voltage source and current sources, ideal and practical sources, concept of dependent and independent sources,	1	CO1
1.3	Kirchhoff-s laws and applications to network solutions using mesh and nodal analysis, Concept of work, power, energy, and conversion of energy.	2	CO1
2.	**DC Circuits**		

2.1	Current-voltage relations of the electric network by mathematical equations to analyze the network (Thevenin's theorem, Norton's Theorem, Maximum Power Transfer theorem)	2	CO1
2.2	Simplifications of networks using series-parallel, Star/Delta transformation. Superposition theorem.	2	CO1
3.	**AC Circuits**		
3.1	AC Circuits-AC waveform definitions, form factor, peak factor, study of R-L, R-C, RLC series circuit, R-L-C parallel circuit, phasor representation in polar and rectangular form.	2	CO2
3.2	Concept of impedance, admittance, active, reactive, apparent and complex power, power factor, 3 phase Balanced AC Circuits (ʎ-Δ & ʎ-ʎ)	2	CO2
4.	**Electrostatics and Electro-Mechanics**		
4.1	Electrostatic field, electric field strength, concept of permittivity in dielectrics, capacitor composite, dielectric capacitors, capacitors in series and parallel, energy stored in capacitors, charging and discharging of capacitors,	2	CO3
4.2	Electricity and Magnetism, magnetic field and Faraday's law, self and mutual inductance, Ampere's law, Magnetic circuit,	2	CO3
4.3	Single phase transformer, principle of operation, EMF equation, voltage ratio, current ratio.	2	CO4
4.4	KVA rating, efficiency and regulation, Electromechanical energy conversion.	1	CO4
5.	**Measurements and Sensors**		
5.1	Introduction to measuring devices/sensors and transducers (Piezoelectric and thermo-couple) related to electrical signals, Elementary methods for the measurement of electrical quantities in DC and AC systems (Current & Single-phase power).	2	CO5
5.2	Electrical Wiring and Illumination system: Basic layout of the distribution system, Types of Wiring System &Wiring Accessories	2	CO6
5.3	Necessity of earthing, Types of earthing, Safety devices & system	1	CO6
	Total	24	

Course Designers:

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2. Dr.S.Charles Raja charlesrajas@tce.edu

21CB151	BUSINESS COMMUNICATION & VALUE SCIENCE – I

Category	L	T	P	Credit
Project	2	-	-	2

Preamble

This course aims at building up the behavioral performance of the learners. It makes learners Understand what life skills are and their importance in leading a happy and well-adjusted life that motivate students to look within and create a better version of self by introducing them to key concepts of values, life skills and business communication

Prerequisite

Basic Knowledge of high school English

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Recognize the need for life skills and values	10
CO2	Recognize own strengths and opportunities	10
CO3	Apply the life skills to different situations	20
CO4	Explain the basic tenets of communication	20
CO5	Apply the basic communication practices in different types of communication	20
CO6	Design a project based on field work (Community services)	20

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Value	Perception	2.4, 2.5, 3.1
CO2	TPS2	Understand	Respond	Perception	2.4, 2.5, 3.2.6
CO3	TPS3	Apply	Value	Perception	3.1, 3.1.6
CO4	TPS2	Understand	Receive	Perception	3.1.6, 3.2
CO5	TPS3	Apply	Respond	Guided response	3.2.1, 3.2.3, 3.3.1
CO6	TPS6	Create	Characterize	Origination	4.3.4, 4.7.7, 4.7.8

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M					M	M	S	S		M	L	M	M
CO2	M					M	M	M	S			L	L	L
CO3	S								S		S	L	L	L
CO4	M								S		S	L	L	L
CO5	S					M			S		S	L	M	L
CO6	S					M			S		S	L	M	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

No CAT will be conducted.
Summative - Activity Based Evaluation (No External Examination)

Evaluation is done in classroom activities as given below:

Essential Grammar	CO4	APPLY	10
Business Communication	CO5	APPLY	10
Listening Comprehension	CO1	UNDERSTAND	10
Group Assignment	CO3	APPLY	10
Self Introduction	CO2	APPLY	10

Project submission (20) + interview (15) CO6		35
GD (15) CO1		15
	Total	100

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject/Assignment/Practical Component
Perception	
Set	
Guided Response	Micro project
Mechanism	
Complex Overt Responses	
Adaptation	
Origination	

Sample Questions for Course Outcome Assessment**

** (2 to 3 at the cognitive level of course outcome)

Course Outcome 1(CO1): (15 marks)

1. Corona virus Pandemic and its Impact
2. FDI in Retail Sector a Boon or Curse?
3. Digital Education vs Traditional Education

Course Outcome 2(CO2): (10 marks)

Project: Submission and Presentation.

Course Outcome 3 (CO3): : (10 Marks – Time Max 20 mints)
Type of Exercise: Listen to the MP3n/ or MP4 (You Tube Videos) and answer the given MCQs/ Gap -Filling / True or False Exercises

Course Outcome 4 (CO4): Do as Directed (15 Marks)

1.**Choose the correct alternative to fill in the blanks: (3 Marks)**

a. Food prices ---------- again this month.

(i) have raised (ii) have been raising (C) have been rising (D) have arose

b. The team lead, as well as the other members , ---------- present on the occasion.
(A) were (B) was (C) has (D) have
c. Despite the new medicine's ---------- in treating diabetes, it is not ---------- widely.
(A) effectiveness – prescribed (B) availability – used
(C) prescription – available (D) acceptance – proscribed

2. **Do as directed (3 Marks**)
a. Rewrite the following sentence with standard grammatical accuracy.
Epic, the country's first browser, uses very less memory than Google chrome.
b. Which of the above underlined parts of the sentence is not appropriate?
All engineering students (I)/should learn business systems, (II)/ mathematics and (III) how to do computation. (IV).
c. Which of the following options is the closest in meaning to the sentence below?
She enjoyed herself immensely at party
(A) She had a terrible time at the party (B) She had a horrible time at the party
(C) She had a terrific time at the party (D) She had a terrifying time at the party

3. **Do as directed (3 Marks)**
a. Write down the verbs of the following words: i) standard ii) responsive
b. Frame adjectives from the following words: i) news ii) operation
c. Construct a passive using the following prompt, given in brackets.
(It/feel) There is a lack of communication in sales .

4. **Do as directed (3 Marks)**
a. Rearrange the following words to make formal business expressions.
look / meeting / forward / to/ you.
b. Complete the sentence with the correct relative pronoun.
The merger raises a number of HR issues ---------- need to be addressed soon.
c. Complete the sentence with a suitable preposition.
I am working ------- TCS ------- the domain of Business Analytics.

5. **Do as directed (3 Marks)**

a. Frame a sentence in the future perfect, using the prompt given.
network / half our suppliers by / end of this year.
b. Complete the following sentence, using the correct form of the passive.
To asses past performance, and review pay all employees -------- (assess) once a year.
c. Complete the sentence using the correct alternative given in brackets.
d. The number of training organizations ------- (has / have) increasing rapidly.

Course Outcome 5 (CO5): (15 Marks : Time: 20 Minutes)

TCS E Mail Writing: As a recent buyer of their car, write an E-mail to the Manager of XYZ automotive company, Mr Kishore, regarding the poor quality of service facility available in the city. Sign the E-mail as Anil. (Max: 50 words in two Paragraphs)
very few - service centers - complaints - pending problems - maintenance - cost - time - delivery - increase - customer satisfaction

(OR)

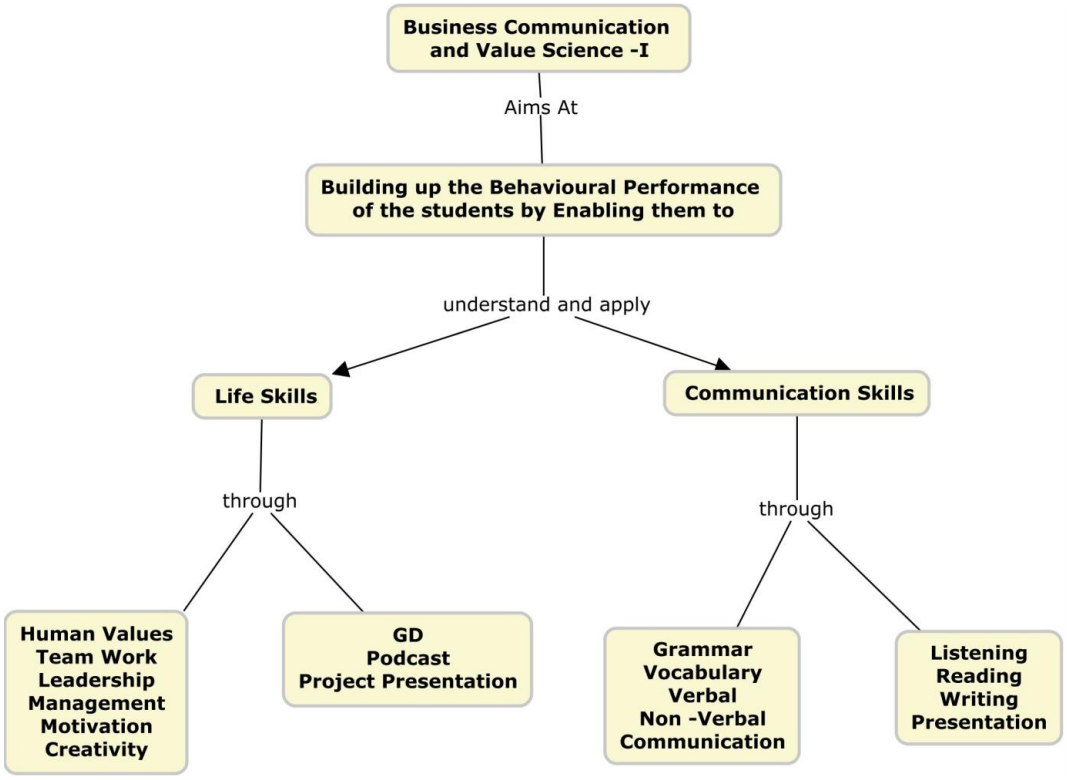
BEC Vantage- Email Writing - Task 1: Your office printer has broken down and you decide to replace it. Write an email to the Head of Purchasing including the following content points: (Words: 40- 50)

- Describing the reason for not repairing the old printer
- Explaining what you need from a new one (colour printing, paper size, etc.)
- Suggesting where to buy a new one

Course Outcome 6 (CO6): (35 Marks – 20+15)

Project Submission and interview.

Concept Map



Syllabus

Overview of LOL (include activity on introducing self), Introduction to critical life skills - Leadership, teamwork, dealing with ambiguity, managing stress, motivating people, creativity, result orientation; Understanding Life Skills: Movie based learning, Self-awareness - identity, body awareness, stress management; Importance of listening skills, Difference between listening and hearing, Types of listening

.

Essential Grammar – Parts of Speech, Applications of tenses in Functional Grammar, Sentence formation, Common errors, Voices; Overview of Business Communication Skills, Barriers of communication, Effective communication, Types of communication- verbal and non–verbal – Role-play based learning, Importance of Questioning, Written Communication: Summary writing, story writing

Business Communication : Formal and informal emails, Verbal communication: Pronunciation, Clarity of speech, Vocabulary Enrichment: Exposure to words from General Service List (GSL) by West, Academic word list (AWL) technical specific terms related to the field of technology, phrases, idioms, formal business vocabulary.

Learning Resources

Text Books:	
There are no prescribed texts for Semester 1 – there will be handouts and reference links shared.	
Reference Books:	
1	English vocabulary in use – Alan Mc'carthy and O'dell
2	APAART: Speak Well 1 (English Language and Communication)
3	APAART: Speak Well 2 (Soft Skills)
4	Business Communication – Dr.SarojHiremath
Web References:	
1	Train your mind to perform under pressure- Simon sinek https://curiosity.com/videos/simon-sinek-on-training-your-mind-to-perform-under-pressure-capture-your-flag/
2	Brilliant way one CEO rallied his team in the middle of layoffs https://www.inc.com/video/simon-sinek-explains-why-you-should-put-people-before-numbers.html
3	Will Smith's Top Ten rules for success https://www.youtube.com/watch?v=bBsT9omTeh0
Online Resources:	
1	https://www.coursera.org/learn/learning-how-to-learn
2	https://www.coursera.org/specializations/effective-business-communication

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.1	Overview of LOL (include activity on introducing self)	1	CO1
1.2	Self-awareness – identity, body awareness, stress management	1	CO1
1.3	Discussion in classroom (Movie based learning – Pursuit of Happiness)	2 1	CO2
1.4	Verbal and non – verbal – Role-play based learning – Activity	1	CO2
1.5	Importance of listening skills - Listen to recording and answer	1 (lab)	CO3
1.6	Writing a newspaper report – Activity	2	CO5
1.7	Presentation on a favourite topic	2	CO5
2.1	Overview - Barriers of communication, Effective communication	1	CO1
2.2	Parts of Speech–Listening to an audio clip and noting down the difference	1 (lab)	CO3
2.3	Sharing words and framing sentence with various parts of speech	1	CO4
2.4	Tenses: Applications of tenses in Functional Grammar	2	CO4
2.5	Sentence formation (general & Technical),	1	CO4
2.6	Common errors, Voices	1	CO4

2.7	Summary writing, story writing	2	CO5
3.1	Overview of business communication	1	CO4
3.2	Formal and informal emails	2	CO5
3.3	Pronunciation, clarity of speech	2 (lab)	CO4
3.4	Reading Economic Times, Reader's Digest and discuss vocabulary	2	CO4
3.5	Exposure to words from General Service List (GSL) by West	1	CO2
3.6	Group discussion using words learnt - Academic word list (AWL) technical specific terms related to the field of technology, phrases, idioms, significant abbreviations formal business vocabulary	2	CO1
3.7	Toastmaster style speech with evaluation	2	CO5
3.8	Creating a podcast on a topic that will interest college students	2	CO5
3.9	Project Preparation - Community Service	2	CO6

Course Designers:

1. Dr.A. Tamilselvi tamilselvi@tce.edu
2. Dr. S. Rajaram sorajaram@gmail.com
3. Mr. R.Vinoth vino@tce.edu
4. Dr.G. Jeya Jeevakani gjjeng@tce.edu
5. Ms. R. Manibala rmaeng@tce.edu

21CB161	FUNDAMENTALS OF PHYSICS

Category	L	T	P	Credit
BS	2	0	2	3

Preamble

The course work aims in imparting fundamental knowledge of oscillations, optics, quantum mechanics, crystal structures and laws of thermodynamics which are essential in understanding and explaining engineering devices

Prerequisite

Basic course (No prerequisite)

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Analyze the behavior of a damped harmonic oscillator	15
CO2	Explain the phenomenon of interference, diffraction and polarization and utilize it for engineering applications	20
CO3	Describe and make use of the Maxwells equation of electromagnetism	10
CO4	Use the basic principles of Quantum mechanics to identify the wave function & understand different crystal structures	25
CO5	Understand the different types of laser ,fiber optic and their applications	15
CO6	Compute the entropy of a given thermodynamic process using the laws of thermodynamics.	15

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS3	Apply	Value		1.1
CO2	TPS3	Apply	Value		1.1
CO3	TPS2	Understand	Respond		1.1
CO4	TPS3	Apply	Value		1.1
CO5	TPS2	Understand	Respond		1.1
CO6	TPS3	Apply	Value		1.1

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	S	M	L	L					L	L		M	L	
CO2	M	L	L	-					L	L		L	L	
CO3	M	L	L	L					L	L		L	L	
CO4	S	M	L	L					L	L		M	L	
CO5	M	L	L	-					L	L		L	L	
CO6	S	M	L	L					L	L		M	L	

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Practical	Terminal Examination Theory
	1	2	1	
Remember	20	20		20
Understand	30	30		30
Apply	50	50	100	50
Analyse				
Evaluate				
Create				

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject /Assignment/Practical Component
Perception	
Set	
Guided Response	
Mechanism	
Complex Overt Responses	
Adaptation	
Origination	

Sample Questions for Course Outcome Assessment**

** (2 to 3 at the cognitive level of course outcome)

Course Outcome 1(CO1):

1. Write any two necessary conditions for body to execute S.H.M
2. Construct the differential equation of a damped harmonic oscillator and deduce the conditions of heavy damping.
3. Explain the different types of damping with suitable displacement-time graph.

Course Outcome 2(CO2):

1. In Newton's ring experiment, the diameter of the fifth ring was 0.3 cm and diameter of twenty fifth ring was 0.8 cm.If the radius of curvature of plano convex lens is 1m, compute the wavelength of light used.
2. Calculate the angles at which the first dark band and next bright band are formed in Fraunhoffer diffraction pattern of slit width 0.3mm wide if wavelength of light used is 5890 A.
3. The critical angle for a clear crystal for green light is 24.4·Identify the angle of Polarisation.

Course Outcome 3(CO3):

1. Briefly explain the Hertz experiment for production of electromagnetic waves
2. Make use of the Maxwells equation to develop the wave equation for a transverse electric field in free space.
3. Recall the maxwells equation in differential form.

Course Outcome 4 (CO4):

1. If the uncertainity in position of electron is $4x10^{-10}$ m,calculate the uncertainity in velocity of electron
2. Calculate the first two energy levels for electron confined to a one dimensional box of 10^{-10} m width.
3. Calculate the interplanar spacing for a (321) plane in a simple cubic lattice where lattice constant is $4.2x10^{-10}$ m

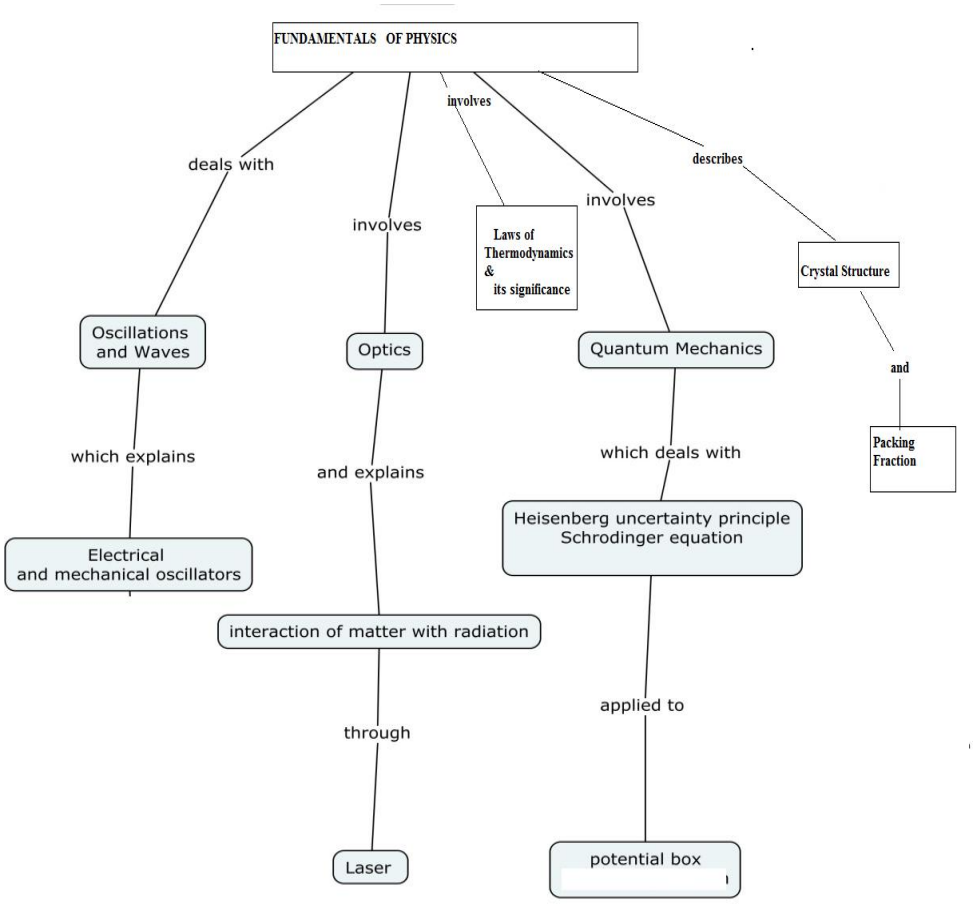
Course Outcome 5 (CO5):

1. Find the ratio of population of two energy states in a Laser the transition between which is responsible for the emission of photons of wavelength6893A at a temperature of 300K.Comment on the type of emission based on the ratio of population.
2. Analyze the role of mixture of gases for a CO_2 laser and predict the working of the laser without Helium gas in the mixture.
3. Differentiate between CO_2 laser and Nd-YAG Laser with respect to their construction and energy level diagram.

Course Outcome 6(CO6):

1. Recall the first law of thermodynamics and its significance.
2. Calculate the change in entropy when 1 g of ice is converted into 1 g of water at 0C.Given that latent heat of fusion is 80 cal/g
3. Cite two examples for irreversible process and prove that entropy increases in irreversible process.

Concept Map



Syllabus

Oscillations

Periodic motion-simple harmonic motion-characteristics of simple harmonic motion-vibration of simple springs mass system. Resonance-definition, damped harmonic oscillator – heavy, critical and light damping, energy decay in a damped harmonic oscillator, quality factor, forced mechanical and electrical oscillators.

Interference

principle of superposition-Young's experiment,Theory of interference fringes-types of interference-Fresnel's prism-Newton's rings, Diffraction-Two kinds of diffraction-Difference between interference and diffraction- Fraunhofer diffraction at single slit-plane diffraction grating. Temporal and Spatial Coherence.

Polarisation of Light

Concept of production of polarized beam of light from two SHM acting at right angle; plane, elliptical and circularly polarized light, Brewster's law, double refraction.

Basic Idea of Electromagnetisms, Maxwell's Equations

Continuity equation for current densities, Maxwell's equation in vacuum and non-conducting medium

Quantum Mechanics

Introduction- Planck's quantum theory- Matter waves, de-Broglie wavelength, Heisenberg's Uncertainty principle, time independent and time dependent Schrödinger's wave equation, Physical significance of wave function, Particle in a one dimensional potential box

Crystallography
Basic terms-types of crystal systems, Bravais lattices, miller indices, d spacing, Atomic packing factor for SC, BCC, FCC and HCP structures, X-ray diffraction

Semiconductor Physics
Conductor, semiconductor and Insulator; Basic concept of Band theory

Laser and Fiber optics:
Einstein's theory of matter radiation interaction and A and B coefficients; amplification of light by population inversion, different types of lasers: Ruby Laser, CO_2 and Nd-YAG (Neodymium-doped Yttrium Aluminium Garnet) Properties of laser beams: mono-chromaticity, coherence, directionality and brightness, laser speckles, applications of lasers in engineering.
Fiber optics and Applications, Types of optical fibers

Thermodynamics
Zeroth law of thermodynamics, first law of thermodynamics, brief discussion on application of 1st law, second law of thermodynamics and concept of Engine, entropy, change in entropy in reversible and irreversible processes.

Laboratory

1) Magnetic field along the axis of current carrying coil – Stewart and Gee
2) Determination of Hall coefficient of semi conductor
3) Determination of Plank constant
4) Determination of wave length of light by Laser diffraction method
5) Determination of wave length of light by Newton's Ring method
6) Determination of laser and optical fiber parameters
7) Determination of Stefan's Constant.

Learning Resources

Text Books:

1. Beiser A, "Concepts of Modern Physics", Fifth Edition, McGraw Hill International.
2. David Halliday, Robert Resnick, Jearl Walker, "Fundamentals of Physics",Seventh Edition Wiley plus

Reference Books:

1. AjoyGhatak, "Optics" Fifth Edition, Tata McGraw Hill.
2. Sears & Zemansky, "University Physics",Eleveth Edition, Addison-Wesley.
3. Jenkins and White, "Fundamentals of Optics", Third Edition, McGraw-Hill

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Oscillations**		
1.1	Periodic motion-simple harmonic motion-characteristics of simple harmonic motion- vibration of simple springs mass system. Resonance-definition.	1	CO1
1.2	Damped harmonic oscillator – heavy, critical and light damping,	1	CO1
1.3	Energy decay in a damped harmonic oscillator, quality factor, forced mechanical and electrical oscillators.	1	CO1
2.	**Interference &Polarization of Light**		
2.1	Principle of superposition-Young's double slit experiment:Theory of interference fringes-types of interference-Fresnel's prism-Newton's rings,	2	CO2
2.2	Diffraction-Two kinds of diffraction-Difference between interference and diffraction-Fresnel's half	2	CO2

	period zone and zone plate-Fraunhofer diffraction at single slit-plane diffraction grating. Temporal and Spatial Coherence.		
2.3	Concept of production of polarized beam of light from two SHM acting at right angle; plane, elliptical and circularly polarized light, Brewster's law, double refraction.	1	CO2
3.	**Basic Idea of Electromagnetisms, Maxwell's Equations**		
3.1	Continuity equation for current densities.	1	CO3
3.2	Maxwell's equation in vacuum and non-conducting medium	1	CO3
4.	**Quantum Mechanics and Crystallography:**		
4.1	Introduction- Planck's quantum theory- Matter waves, de-Broglie wavelength, Heisenberg's Uncertainty principle,	1	CO4
4.2	Time independent and time dependent Schrödinger's wave equation, Physical significance of wave function, Particle in a one dimensional potential box,	2	CO4
4.3	Crystallography- Basic terms-types of crystal systems, Bravais lattices, miller indices, d spacing,	1	CO4
4.4	Atomic packing factor for SC, BCC, FCC and HCP structures.	1	CO4
4.5	X-ray Diffraction	1	CO4
4.6	Semiconductor Physics – conductor, semiconductor and Insulator; Basic concept of Band theory	1	CO4
5.	**Laser and Fiber optics:**		
5.1	Einstein's theory of matter radiation interaction and A and B coefficients; amplification of light by population inversion,	1	CO5
5.2	different types of lasers: Ruby Laser, CO2 and Nd-YAG Laser(Neodymium-doped Yttrium Aluminium Garnet)	1	CO5
5.3	Properties of laser beams: mono-chromaticity, coherence, directionality and brightness, laser speckles, applications of lasers in engineering.	1	CO5
5.4	Fiber optics and Applications, Types of optical fibers	1	CO5
6.	**Thermodynamics**		
6.1	Zeroth law of thermodynamics, first law of thermodynamics, brief discussion on application of 1st law.	1	CO6
6.2	Second law of thermodynamics and concept of Engine.	1	CO6
6.3	Change in entropy in reversible and irreversible processes.	1	CO6
	Theory class	**24hrs**	
7	Practical		
7.1	Introduction to Laboratory Class –Brief Theory of Experiments	3	
7.1	Determination of Plank constant.	2	CO4

7.2	Determination of wave length of light by Laser diffraction method	2	CO5
7.3	Determination of wave length of light by Newton's Ring method	3	CO2
7.4	Determination of laser and optical fiber parameters	2	CO5
7.5	Determination of Stefan's Constant	3	CO6
7.6	Magnetic field along the axis of current carrying coil – Stewart and Gee	3	CO3
7.7	Determination of Hall coefficient of semi conductor	2	CO4
7.8	Additional Practical class (Absentees , Students Joining Late, Repeat Experiments)	2	
7.8	Practical	2	
	Total Practical Hours	**24 hrs**	
	Total hours (Theory 24+Practical 24)	**48 hrs**	

Course Designers:

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21CB171	FUNDAMENTALS OF COMPUTER SCIENCE LAB

Category	L	T	P	Credit
ES	0	0	4	2

Preamble

This course aims to provide exposure to problem solving through C programming. It aims to train the student to design, implement and test the Mathematical and Engineering problems using C-programming language

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Design the algorithms and draw flowcharts for the given Mathematical and Engineering problems	15
CO2	Write Computer programs for the given algorithm.	20
CO3	Implement programs with the relevant control structure and parameter passing using functions.	20
CO4	Develop C programs using derived data types.	15
CO5	Create and use header files and C pre-processor directive as utility.	15
CO6	Use Pattern searching and parsing strategies in problem solving	15

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS3	Apply	Value	-	1.2, 2.1.2 , 2.1.5, 2.4.6, 3.2.4, 3.2.5, 4.4.3
CO2	TPS3	Apply	Value	-	1.2, 2.1.2 , 2.1.5, 2.4.6, 3.2.3, 3.2.4, 4.5.3
CO3	TPS3	Apply	Value	-	1.2, 2.1.2 , 2.1.5, 2.4.6, 3.2.3, 3.2.4, 4.5.3
CO4	TPS3	Apply	Value	-	1.2, 2.1.2 , 2.1.5, 2.4.6, 3.2.3, 3.2.4, 4.5.3
CO5	TPS3	Apply	Value	-	1.2, 2.1.2 , 2.1.5 ,2.4.6, 3.2.3, 3.2.4, 4.5.3
CO6	TPS3	Apply	Value	-	1.2, 2.1.2 , 2.1.5, 2.4.6, 3.2.3, 3.2.4, 4.5.3

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	S	M	L	-	-	L	L	-	-	L	L	M		
CO2	S	M	L	-	-	L	L	-	-	L	L	M	L	L
CO3	S	M	L	-	-	L	L	-	-	L	L	M	L	L
CO4	S	M	L	-	-	L	L	-	-	L	L	M	L	L
CO5	S	M	L	-	-	L	L	-	-	L	L	M	L	L
CO6	S	M	L	-	-	L	L	-	-	L	L	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Model Examination	Terminal Examination
Remember	-	-
Understand	-	-
Apply	100	100
Analyse	-	-
Evaluate	-	-
Create	-	-

Assessment Pattern: Psychomotor

Psychomotor Skill	Observation
Perception	-
Set	-
Guided Response	100
Mechanism	-
Complex Overt Responses	-
Adaptation	-
Origination	-

List of Experiments/Activities with CO Mapping

Ex.No	List of Experiments	CO
1.	Algorithm and flowcharts of small problems like GCD	CO1
	Structured code writing with:	
2.	Small but tricky codes	CO2
3.	Proper parameter passing	CO3
4.	Command line Arguments	CO3
5.	Variable parameter	CO3
6.	Pointer to functions	CO4
7.	User defined header	CO5
8.	Make file utility	CO5
9.	Multi file program and user defined libraries	CO5
10.	Interesting substring matching / searching programs	CO6
11.	Parsing related assignments	CO6

Learning Resources

1. "C: The Complete Reference", Herbert Schildt, Fourth Edition, , McGraw Hill, 2017
2. "Let Us C", Yashavant Kanetkar , Sixteenth edition, BPB Publication, 2017
3. "Programming in C",B. Gottfried, Third Edition, Schaum Outline Series, 2017
4. "The C Programming Language", B. W. Kernighan and D. M. Ritchi, Second Edition, PHI,1988.
5. "How to solve it by Computer", R.G Dromey, Pearson education, Delhi, 2008.
6. "Simple Program Design", A Step-by-Step Approach, Lesley Anne Robertson, 5th Edition, Thomson, 2007

Course Designers:

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21CB181	PRINCIPLES OF ELECTRICAL ENGINEERING LAB

Category	L	T	P	Credit
ES	0	0	2	1

Preamble

The course is designed to provide students a widespread knowledge and understanding of the basic Electrical Systems Components and theorems. The indispensable and pervasive knowledge of various types of circuits and its behavior, two types of connections in AC system and quantities associated in both DC and AC will enhance the practical knowledge about the electrical engineering system.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Practice the use of electrical Elements, sources, measuring devices and transducers related to electrical circuits experimentally.	10
CO2	Determine the resistance temperature coefficient experimentally.	10
CO3	Verify the network theorems for the electric circuit using hardware and simulation software experimentally.	30
CO4	Verify series resonance phenomena in a RLC circuit experimentally.	10
CO5	Analyze the transient behavior of the given RC circuit experimentally.	10
CO6	Verify the relationship between voltage and current in three phase balanced star and delta connected loads experimentally.	20
CO7	Practice electrical quantities measurement in DC and AC systems experimentally.	10

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS3	Apply	Value	Mechanism	1.2.1 ,2.2.3
CO2	TPS3	Apply	Value	Mechanism	1.2.1 ,2.2.3
CO3	TPS3	Apply	Value	Mechanism	1.2.1 ,2.2.3
CO4	TPS3	Apply	Value	Mechanism	1.2.1 ,2.2.3
CO5	TPS4	Analyze	Organize	Complex Overt Responses	1.2.1 ,2.2.3
CO6	TPS3	Apply	Value	Mechanism	1.2.1 ,2.2.3
CO7	TPS3	Apply	Value	Mechanism	1.2.1 ,2.2.3

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	S	M	L	L	M		M	M	M			M	M	L
CO2	S	M	L	L	M		M	M	M			M	M	L
CO3	S	M	L	L	S		M	M	M			M	M	L
CO4	S	M	L	L	S		M	M	M			M	M	L
CO5	S	M	L	L	S		M	M	M			M	M	L
CO6	S	M	L	L	S		M	M	M			M	M	L
CO7	S	M	L	L	L		M	M	M			M	M	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Model Examination	Terminal Examination
Remember		
Understand		
Apply	50	50
Analyse	20	20
Evaluate		
Create		

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject /Practical Component/Observation
Perception	
Set	
Guided Response	
Mechanism	30
Complex Overt Responses	
Adaptation	
Origination	

List of Experiments/Activities with CO Mapping

Experiment List	CO
Familiarization of electrical Elements, sources, measuring devices and transducers related to electrical circuits	CO1
Determination of resistance temperature coefficient	CO2
Verification of Network Theorem (Superposition, Thevenin, Norton, Maximum Power Transfer theorem)	CO3
Simulation of R-L-C series circuits for XL> XC , XL< XC & XL= XC	CO4
Simulation of Time response of RC circuit	CO5
Verification of relation in between voltage and current in three phase balanced star and delta connected loads.	CO6
Demonstration of measurement of electrical quantities in DC and AC systems.	CO7

Learning Resources

1. Electric Machinery, (Sixth Edition) A. E. Fitzgerald, Kingsely Jr Charles, D. Umans Stephen, Tata McGraw Hill.
2. A Textbook of Electrical Technology, (vol. I), B. L. Theraja, Chand and Company Ltd., New Delhi.
3. Basic Electrical Engineering, V. K. Mehta, S. Chand and Company Ltd., New Delhi.
4. Theory and problems of Basic Electrical Engineering, (Second Edition), J. Nagrath and Kothari, Prentice Hall of India Pvt. Ltd.
5. Basic of Electrical Engineering, T. K. Nagsarkar and M. S. Sukhija, Oxford University Press.
6. Introduction to Electrodynamics, D. J. Griffiths, (Fourth Edition), Cambridge University Press.
7. Engineering Circuit Analysis, William H. Hayt & Jack E. Kemmerly, McGraw-Hill Book Company Inc.
8. Fundamentals of Electrical and Electronics Engineering, Smarjith Ghosh, Prentice Hall (India) Pvt. Ltd.

Course Designers:

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2. Dr.S.Charles Raja charlesrajas@tce.edu

CURRICULUM AND DETAILED SYLLABI

FOR

B.Tech DEGREE (Computer Science and Business Systems) PROGRAMME

SECOND SEMESTER

FOR THE STUDENTS ADMITTED FROM THE

ACADEMIC YEAR 2025 - 2026 ONWARDS

THIAGARAJAR COLLEGE OF ENGINEERING

(A Government Aided ISO 9001-2008 certified
Autonomous Institution affiliated to Anna University)

MADURAI – 625 015, TAMILNADU

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THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015
B.Tech (Computer Science and Business systems) Programme

COURSES OF STUDY
(For the candidates admitted from 2025- 26 onwards)

SECOND SEMESTER

Sl. No.	COURSE CODE	COURSE TITLE	CATEGORY	No.of Hours / Week			Credits
				L	T	P	
THEORY COURSES							
1	21CB211	Linear Algebra	BS	3	1	0	4
2	21CB221	Statistical Methods	BS	3	1	0	4
3	21CB231	Data Structures and Algorithms	PC	3	1	0	4
4	21CB241	Principles of Electronics	ES	2	0	0	2
5	21CB251	Fundamentals of Economics	HSS	2	0	0	2
6	21CB261	Business Communication & Value Science - II	Project	2	0	0	2
PRACTICAL COURSES							
7	21CB271	Data Structures and Algorithms Lab	PC	0	0	4	2
8	22CB282	Principles of Electronics Lab	ES	0	0	2	1
9	21ES291	Lateral Thinking	ES	0	0	2	1
10	21CHAA1	Environmental Sciences	AC	1	0	1	-
Total				**16**	**3**	**9**	**22**

BS : Basic Science
HSS : Humanities and Social Science
ES : Engineering Science
PC : Program Core
PE : Program Elective
OE : Open Elective
AC : Audit Course

L : Lecture
T : Tutorial
P : Practical

Note:
1 Hour Lecture is equivalent to 1 credit
1 Hour Tutorial is equivalent to 1 credit
2 Hours Practical is equivalent to 1 credit

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015
B.Tech (Computer Science and Business systems) Programme

SCHEME OF EXAMINATIONS
(For the candidates admitted from 2025 - 26 onwards)

SECOND SEMESTER

S.No.	Course Code	Name of the Course	Duration of Terminal Exam. in Hrs.	Marks			Minimum Marks for Pass	
				Continuous Assessment	Terminal Exam *	Max. Marks	Terminal Exam	Total
THEORY								
1	21CB211	Linear Algebra	3	60	40	100	27	50
2	21CB221	Statistical Methods	3	60	40	100	27	50
3	21CB231	Data Structures and Algorithms	3	60	40	100	27	50
4	21CB241	Principles of Electronics	3	60	40	100	27	50
5	21CB251	Fundamentals of Economics	3	60	40	100	27	50
6	21CB261	Business Communication & Value Science - II	-	100	-	100	-	50
PRACTICAL								
7	21CB271	Data Structures and Algorithms Lab	3	40	60	100	18	50
8	22CB282	Principles of Electronics Lab	3	40	60	100	18	50
9	21ES291	Lateral Thinking	-	40	60	100	18	50
10	21CHAA1	Environmental Sciences	-	40	60	100	18	50

* Terminal Examination will be conducted for maximum marks of 100 and subsequently be reduced to 50 marks for the award of terminal examination marks

21CB211	LINEAR ALGEBRA

Category	L	T	P	Credit
BS	3	1	0	4

Preamble

A general theory of Mathematical systems involving addition and scalar multiplication of vectors has applications in all Engineering field. Mathematical systems of this form are called Vector spaces or linear spaces. Linear systems of equations are associated with many problems in Engineering and Sciences, as well as with applications of mathematics to social sciences, quantitative study of business and economic problems. The modules II and III of this subject deal with the concepts on Vector spaces and orthogonality. SVD & PCA are the two important techniques used for dimensionality reduction in unsupervised learning of machine learning.

Prerequisite

Matrices and Determinants

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Solve the system of linear equations	20
CO2	Verify whether the given set is vector space or not and determine its dimension	15
CO3	Predict an orthonormal basis and decompose a given matrix using QR decomposition	15
CO4	Compute eigen values and eigen vectors for a given matrix	20
CO5	Decompose a matrix using Singular Value Decomposition (SVD)	15
CO6	Perform dimensionality reduction on the given data using SVD and Principal Component Analysis(PCA)	15

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS3	Apply	Value	-	1.1, 2.1,2.2,2.5.1,4.1.2
CO2	TPS3	Apply	Value	-	1.1, 2.1,2.2,2.5.1,4.1.2
CO3	TPS3	Apply	Value	-	1.1, 2.1,2.2,2.5.1,4.1.2
CO4	TPS3	Apply	Value	-	1.1, 2.1,2.2,2.5.1,4.1.2
CO5	TPS3	Apply	Value	-	1.1, 2.1,2.2,2.5.1,4.1.2
CO6	TPS3	Apply	Value	-	1.1, 2.1,2.2,2.5.1,4.1.2

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	S	M	L	L	-	L	-	L	-	-	L	M	L	L
CO2	S	M	L	L	-	L	-	L	-	-	L	M	L	L
CO3	S	M	L	L	-	L	-	L	-	-	L	M	L	L
CO4	S	M	L	L	-	L	-	L	-	-	L	M	L	L
CO5	S	M	L	L	-	L	-	L	-	-	L	M	L	L
CO6	S	M	L	L	-	L	-	L	-	-	L	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	**2**	1	2	
Remember	10	10	-	-	-
Understand	30	30	-	-	30
Apply	60	60	100	100	70
Analyse					
Evaluate					
Create					

Sample Questions for Course Outcome Assessment**

Course Outcome 1(CO1)

1. Compute the rank of the matrix $\begin{pmatrix} 4 & 2 & 1 \\ 2 & 0 & 1 \\ 2 & 0 & -1 \\ 1 & 2 & 1 \end{pmatrix}$
2. Solve by Gauss elimination method: $x + y + z = 3$: $2x - y + 3z = 16$; $3x + y - z = -3$
3. Obtain LU decomposition: $\begin{pmatrix} 2 & 4 & 5 \\ 4 & 10 & 0 \\ 5 & 0 & 7 \end{pmatrix}$

Course Outcome 2(CO2)

1. Verify that $M_3(R)$ is a vector space and identify its dimension.
2. Given the basis $\{1, x, x^2\}$ for C[-1, 1], construct an orthonormal basis for C[-1, 1].
3. Obtain QR decomposition for the matrix $\begin{pmatrix} 2 & 2 & 0 \\ 1 & 0 & 3 \\ 2 & 0 & 1 \\ 4 & 3 & 1 \end{pmatrix}$

Course Outcome 3(CO3)

1. Show that $\left\{ \frac{(1,1,1)^T}{\sqrt{3}}, \frac{(2,1,-3)^T}{\sqrt{14}}, \frac{(4,-5,1)^T}{\sqrt{42}} \right\}$ is an orthonormal set in R^3
2. Construct a QR decomposition for the matrix $A = \begin{pmatrix} 4 & 2 & 1 \\ 2 & 0 & 1 \\ 2 & 0 & -1 \\ 1 & 2 & 1 \end{pmatrix}$
3. Construct a QR decomposition for the matrix $\begin{bmatrix} -4 & 2 & 2 \\ 3 & -3 & 3 \\ 6 & 6 & 0 \end{bmatrix}$

Course Outcome 4 (CO4)

1. Find the eigen values and eigen vectors for the matrix adj A where A= $\begin{pmatrix} 2 & 4 & 5 \\ 4 & 10 & 0 \\ 5 & 0 & 7 \end{pmatrix}$
2. Let L:$R^3 \rightarrow R^3$ be defined by $L(x, y, z) = (x,\ x + y,\ x + y + z)$. Verify whether L is a linear transformation and if so identify its matrix representation.
3. State and prove any two properties of Hermitian and Unitary matrices.

Course Outcome 5 (CO5)

1. Obtain SVD for the matrix i) $\begin{pmatrix} 1 & 1 \\ 1 & 1 \\ 0 & 0 \end{pmatrix}$ ii) $\begin{pmatrix} 2 & 2 & -2 \\ 2 & 2 & -2 \\ -2 & -2 & 6 \end{pmatrix}$
2. Compute pseudo inverse of the matrix $\begin{pmatrix} 1 & 1 \\ 1 & 1 \\ 0 & 0 \end{pmatrix}$

Course Outcome 6(CO6)

1. Calculate PCA for the following data

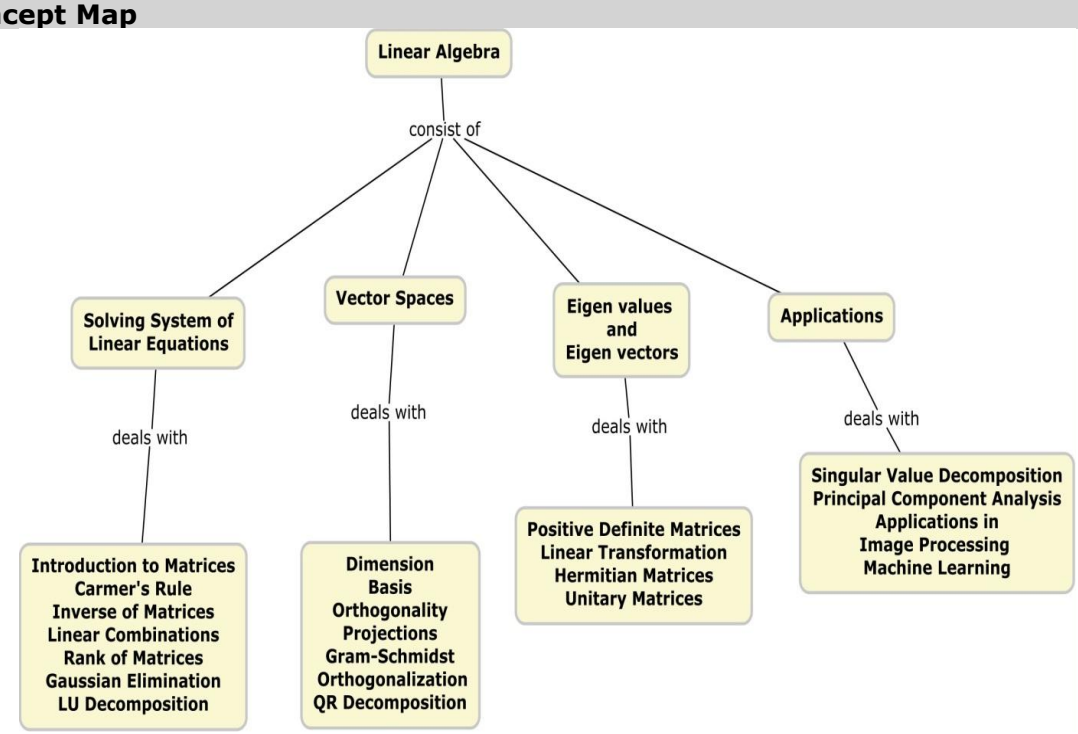
X:	2.5	0.5	2.2	1.9	3.1	2.3	2.0	1.0
Y:	2.4	0.7	2.9	2.2	3.0	2.7	1.6	1.1

2. Calculate PCA for the following trivariate data

X:	60	90	50	30	60
Y:	90	30	50	45	60
Z:	90	90	50	45	90

3. Apply PCA to i) $\begin{pmatrix} 1 & -1 \\ 0 & 1 \\ -1 & 0 \end{pmatrix}$ ii) $\begin{pmatrix} -1 & -2 & 4 \\ 1 & 3 & 0 \\ 2 & 1 & 3 \end{pmatrix}$

Concept Map



Syllabus

Introduction to Matrices and Determinants Introduction to Matrices and Determinants; Solution of Linear Equations; Cramer's rule; Inverse of a Matrix.
Vectors and linear combinations Rank of a matrix; Gaussian elimination; LU Decomposition; Solving Systems of Linear Equations using the tools of Matrices.
Vector Space Vector space; Dimension; Basis; Orthogonality; Projections; Gram-Schmidt orthogonalization and QR decomposition.
Eigen Values and Eigen Vectors Eigenvalues and Eigenvectors; Positive definite matrices; Linear transformations; Hermitian and unitary matrices;
Singular Value Decomposition and Principal component analysis Introduction to their applications in Image Processing and Machine Learning.

Learning Resources

1. Higher Engineering Mathematics, B. S. Grewal.
2. Advanced Engineering Mathematics, 7th Edition, Peter V. O'Neil.
3. Advanced Engineering Mathematics, 2nd Edition, Michael. D. Greenberg.
4. Introduction to linear algebra, 5th Edition, Gilbert Strang.
5. Applied Mathematics (Vol. I & II) , by P. N. Wartikar& J. N. Wartikar.
6. Digital Image Processing, R C Gonzalez and R E Woods
7. https://medium.com/@jonathan_hui/machine-learning-singular-value-decomposition-svd-principal-component-analysis-pca-1d45e885e491
8. https://machinelearningmastery.com/introduction-matrices-machine-learning/

Online course
https://www.coursera.org/lecture/machine-learning/principal-component-analysis-algorithm-ZYIPa

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Solving System of Linear Equations**		
1.1	Introduction to Matrices and Determinants	1	CO1
1.2	Solution of Linear Equations	1	CO1
1.3.	Cramer's Rule and Inverse of a Matrix	1	CO1
	Tutorial	1	CO1
1.4	Vectors and Linear Combinations	1	CO1
1.5	Rank of a Matrix	1	CO1
	Tutorial	1	CO1
1.6	Gaussian Elimination	1	CO1
1.7	LU Decomposition	1	CO1
	Tutorial	1	CO1
1.9	Solving systems of the linear equations using the tools of the matrices(Iterative Methods)	1	CO1
	Tutorial	1	
2.	**Vector Space**		
2.1	Vector Space	2	CO2
2.2	Basis and Dimension	2	CO2
	Tutorial	1	CO2
2.3	Orthogonality	1	CO3
2.4	Projections	1	CO3
	Tutorial	1	CO3
2.5	Gram-Schmidth Orthogonalisation	2	CO3
2.6	QR Decomposition	1	CO3
	Tutorial	1	CO3
3.	**Eigen Values and Eigen Vectors**		

3.1	Eigen values and Eigen vectors	3	CO4
3.2	Positive Definite Matrices	2	CO4
	Tutorial	1	CO4
3.3	Linear Transformation and Matrix Representation	2	CO4
	Tutorial	1	CO4
3.4	Hermitian and Unitary Matrices	2	CO4
	Tutorial	1	CO4
4.	**Applications**		
4.1	Singular Value Decomposition(SVD)	3	CO5
4.2	Pseudo inverse	1	CO5
	Tutorial	1	CO5
4.3	Principal Component Analysis(PCA)	3	CO6
4.4	Applications in Machine Learning	3	CO6
	Tutorial	1	

- Assignment : Google Page Rank Algorithm related to matrices and vector(Case Study)

Course Designers:

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21CB221	STATISTICAL METHODS

Category	L	T	P	Credit
BS	3	1	0	4

Preamble

Statistics as a subject is a science of learning from data and provides tools for making decisions when conditions of uncertainty prevail. Statistical techniques are an important tool in these activities because they provide the engineer with both descriptive and analytical methods for dealing with the variability in observed data. The main objective of this course is to provide students with the foundations of statistical and probabilistic analysis mostly used in various applications in engineering and science as well as which a basic essential mathematics for machine learning. It introduces students to cognitive learning in statistics and develops skills in writing programme language using R.

Prerequisite

- Nil.

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Use several statistical method for the given data to infer the relation among the given variables.	20
CO2	Estimate the population parameters and sufficient statistic.	15
CO3	Identify the right test statistic to test the hypothesis formulated from the given data.	15
CO4	Use the appropriate non parametric hypothesis testing procedures based on inferences	15
CO5	Develop the model for the given time series and estimate the required forecasting.	15
CO6	Explore the features of R language to implement statistical tests for the given data.	20

*** Weightage depends on Bloom's Level, number of contact hours.

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS3	Apply	Value	-	1.1.1, 2.1.4
CO2	TPS3	Apply	Value	-	1.1.1, 2.1.1
CO3	TPS3	Apply	Value	-	1.1.1, 2.1.5, 2.2.1
CO4	TPS3	Apply	Value	-	1.1.1, 2.1.5, 2.2.4
CO5	TPS3	Apply	Value	-	1.1.1, 2.1.1, 2.1.3
CO6	TPS2	Understand	Respond	-	1.1.1, 2.1.1, 4.6.2

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	S	M	L	L	L	L	L			L	L	M	L	L
CO2	S	M	L	L	L	L	L			L	L	M	L	L
CO3	S	M	L	L	L	L	L			L	L	M	L	L
CO4	S	M	L	L	L	L	L			L	L	M	L	L
CO5	S	M	L	L	L	L	L			L	L	M	L	L
CO6	M	L		L		L	L			L	L	L	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	**2**	1	2	
Remember	10	10	-	-	-
Understand	30	30	-	-	30
Apply	60	60	100	100	70
Analyse					
Evaluate					
Create					

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject /Assignment/Practical Component
Perception	
Set	
Guided Response	
Mechanism	
Complex Overt Responses	
Adaptation	
Origination	

Sample Questions for Course Outcome Assessment**

Course Outcome 1(CO1):

1. Suppose we have a linear equation through the origin. Estimate the regression line passing through the origin for the following data. Suppose it is not known whether the true regression should pass through the origin. Estimate the regression line.

x	0.5	1.5	3.2	4.2	5.1	6.5
y	1.3	3.4	6.7	8.0	10.0	13.2

2. A study was done on a diesel-powered light-duty pickup truck to see if humidity, air temperature, and barometric pressure influence emission of nitrous oxide (in ppm). Emission measurements were taken at different times, with varying experimental conditions. The data are given in Table 12.2. The model is $yi = \beta 0 + \beta 1x1i + \beta 2x2i + \beta 3x3i + _i$, $i = 1, 2, \ldots, 20$. Fit this multiple linear regression model to the given data and then estimate the amount of nitrous oxide emitted for the conditions where humidity is 50%, temperature is 76◦F, and barometric pressure is 29.30.

Nitrous Oxide y	Humidity x_1	Temp., x_2	Pressure x_3	Nitrous Oxide y	Humidity x_1	Temp., x_2	Pressure x_3
0.90	72.4	76.3	29.18	1.07	23.3	76.8	29.38
0.91	41.6	70.3	29.35	0.94	47.4	86.6	28.35
0.96	34.3	77.1	29.24	1.10	31.5	76.9	29.63
0.89	35.1	68.0	29.27	1.10	10.6	86.3	29.56
1.00	10.7	79.0	29.78	1.10	11.2	86.0	29.48
1.10	12.9	67.4	29.39	0.91	73.3	76.3	29.40
1.15	8.3	66.8	29.69	0.87	75.4	77.9	29.28
1.03	20.1	76.9	29.48	0.78	96.6	78.7	29.29
0.77	72.2	77.7	29.09	0.82	107.4	86.8	29.03
1.07	24.0	67.7	29.60	0.95	54.9	70.9	29.37

3. Concerns about the increasing friction between some machine parts prompted an investigation of four different types of ball bearings. Five different machines were

available and each type of ball bearing was tried in each machine. Given the observations on temperature, coded by subtracting the smallest value, *Machines* 1 2 3 4 5

Ball bearing 1 10 8 7 4 6
Ball bearing 2 10 7 12 5 11
Ball bearing 3 8 9 11 12 10
Ball bearing 4 12 8 6 11 13

(a) decompose each observation y_{ij} as

$y_{ij} = y_{\bullet\bullet} + (y_{i\bullet} - y_{\bullet\bullet}) + (y_{\bullet j} - y_{\bullet\bullet}) + (y_{ij} - y_{i\bullet} - y_{\bullet j} + y_{\bullet\bullet})$

(b) obtain the sum of squares and the degrees of freedom for each component;

(c) construct the analysis of variance table and test for differences among the bearings using $\alpha = 0.01$.

Course Outcome 2(CO2):

1. Apply least square method to fit an exponential curve of the form $Y = ab^X$ to the following data

X	1	2	3	4	5	6	7	8
Y	1.0	1.2	1.8	2.5	3.6	4.7	6.6	9.1

The two regression lines are 4x – 5y + 53 = 0 and 20x – 9y = 107 and variance of X is

25. Calculate the values correlation coefficient and variance of Y

2. X_1, X_2, and X3 is a random sample of size 3 from a population with mean μ and variance σ^2. T_1, T_2, T_3 are the estimators used to estimate the mean value μ, where $T_1 = X_1 + X_2 - X_3$; $T_2 = 2X_1 + 3X_3 - 4X_2$ and $T_3 = 1/3(\lambda X_1 + X_2 + X_3)$ (i) Are T_1 and T_2 unbiased estimators? Find λ such that T_3 is an unbiased estimator for μ
3. Calculate the maximum likelihood estimator for λ when f (x; λ) is the Poisson distribution

Course Outcome 3(CO3):

1. A shoe manufacturer wants potential customers to compare two types of shoes, one made of the current PVC material *X* and one made of a new PVC material *Y*. Shoes made of both are available. Each person, in a sample of 52, is asked to wear one pair of each type for a whole day. After a walk of 2 km, they are asked to score that day's pair on a scale of 1 to 10, with higher scores being better. The differences in scores (New PVC *Y)* − (Current PVC *X*) have mean 2.6 and variance 3.9. Construct a 90% confidence interval for the mean difference.
2. Two different computer processors are compared by measuring the processing speed for different operations performed by computers using the two processors. If 12 measurements with the first processor had a standard deviation of 0.1 GHz and 16 measurements with the second processor had a standard deviation of 0.15 GHz, can it be concluded that the processing speed of the second processor is less uniform? Use a 0.05 level of significance. What assumptions must be made as to how the two samples are obtained?
3. Transceivers provide wireless communication among electronic components of consumer products. Responding to a need for a fast, low-cost test of Bluetooth-capable transceivers, engineers2 developed a product test at the wafer level. In one set of trials with 60 devices selected from different wafer lots, 48 devices passed. Test the null hypothesis $p = 0.70$ against the alternative hypothesis $p > 0.70$ at the 0.05 level of significance.

Course Outcome 4 (CO4):

1. The following are 42 consecutive pizza breads baked by a newly improved oven model during 6 weeks: 25, 28, 32, 31, 30, 29, 16, 18, 31, 24, 72, 55, 61, 33, 30, 44, 46, 59, 62, 75, 75, 80, 70, 64, 48, 52, 39, 38, 61, 64, 38, 48, 35, 34, 49, 58,

63, 36, 75, 80, 32, and 48. Use the method of runs above and below the median and the 0.01 level of significance to test the null hypothesis of randomness against the alternative that there is a trend.

2. In a vibration study, certain airplane components were subjected to severe vibrations until they showed structural failures. Given the following failure times (in minutes), test whether they can be looked upon as a sample from an exponential population with the mean $\mu = 10$:
   1.5 10.3 3.6 13.4 18.4 7.7 24.3 10.7 8.4
   15.4 4.9 2.8 7.9 11.9 12.0 16.2 6.8 14.7
   Use the Kolmogorov-Smirnov test with a 0.05 level of significance.
3. The following are the self-reported times (hours for month), spent on homework, by random samples of juniors in two different majors.
   Major 1: 63 72 29 58 81 65 79 57 40 76 47 55 60
   Major 2: 41 32 26 43 78 49 39 56 15 54 8 66 64
   Use the *U* test at the 0.05 level of significance to test whether or not students from the 2 groups devote the same amounts of time to homework.

Course Outcome 5 (CO5):

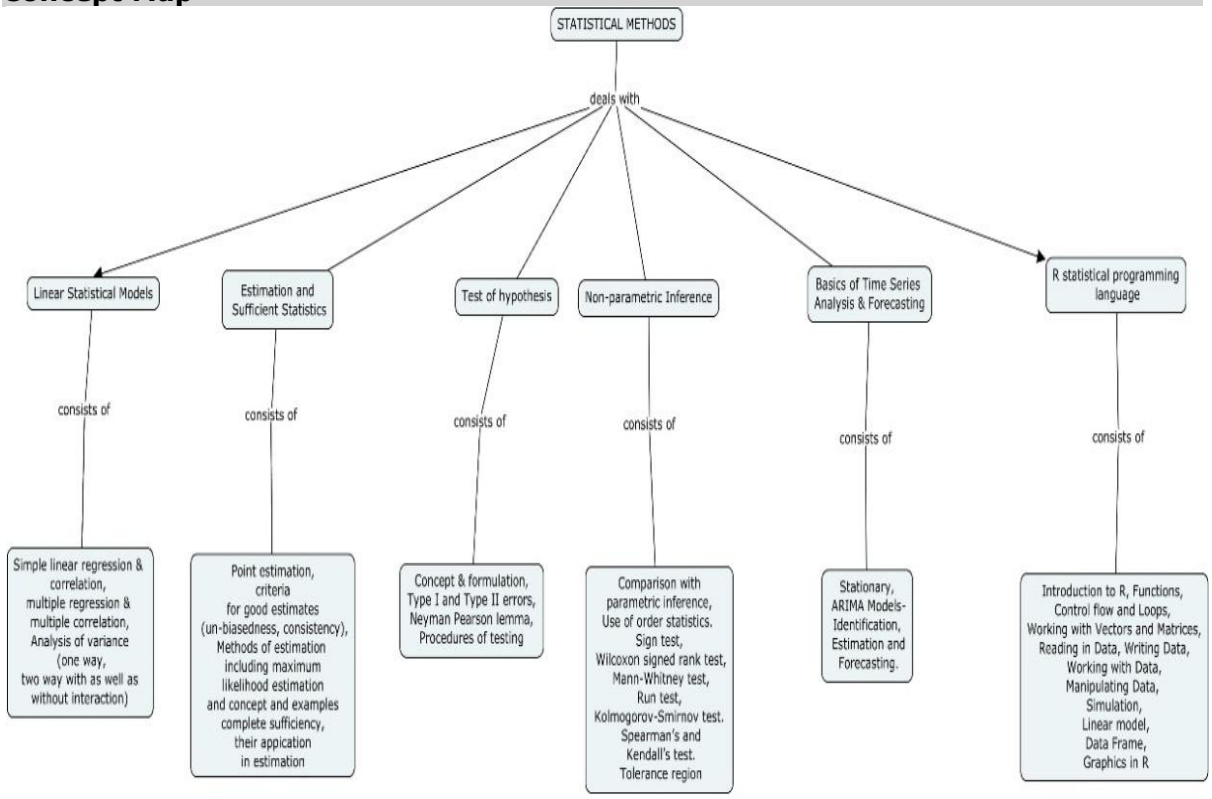
1. For the model (1 -B)(1 -*0.*2B)X_t = (1 -0.5B)Z_t
   (a) Classify the model as an ARIMA (p, *d, q)* process (i.e. find *p, d. q).*
   (b) Determine whether the process is stationary.
2. Suppose that the correlogram of a time series consisting of 100 observations has r1=0.31, r2 = 0.37, r3≈ -0.05, r4=0.06, *r5* = -0.21, r6 = 0.1 li r7 = 0.08, r8 ~0.05, r9=0.12, r10= —0.01
3. For the SARIMA(0, 0, 1)(1, 1, 0)12 model, find forecasts at time # for up to 12 steps ahead in terms of observations and estimated residuals up to time *N.*

Course Outcome 6(CO6):

1. Can you spot the difference between a character string and a number? Which of these are character strings and which are numbers? 1, "1", "one".
2. Create an atomic vector that stores just the face names of the cards in a royal flush, for example, the ace of spades, king of spades, queen of spades, jack of spades, and ten of spades. The face name of the ace of spades would be "ace," and "spades" is the suit. Which type of vector will you use to save the names?
3. Create the following matrix, which stores the name and suit of every card in a royal flush.

```
## [,1] [,2]
 ## [1,] "ace" "spades"
 ## [2,] "king" "spades"
## [3,] "queen" "spades"
## [4,] "jack" "spades"
## [5,] "ten" "spades"
```

Concept Map



Syllabus

Linear Statistical Models: Simple linear regression & correlation, multiple regression & multiple correlation, Analysis of variance (one way, two way with as well as without interaction)

Estimation and Sufficient Statistic: Estimation: Point estimation, criteria for good estimates (un-biasedness, consistency), Methods of estimation including maximum likelihood estimation. Sufficient Statistic: Concept & examples, complete sufficiency, their application in estimation

Test of hypothesis: Concept & formulation, Type I and Type II errors, Neyman Pearson lemma, Procedures of testing.

Non-parametric Inference: Comparison with parametric inference, Use of order statistics. Sign test, Wilcoxon signed rank test, Mann-Whitney test, Run test, Kolmogorov-Smirnov test. Spearman's and Kendall's test. Tolerance region

Basics of Time Series Analysis & Forecasting: Stationary, ARIMA Models: Identification, Estimation and Forecasting.

R statistical programming language: Introduction to R, Functions, Control flow and Loops, Working with Vectors and Matrices, Reading in Data, Writing Data, Working with Data, Manipulating Data, Simulation, Linear model, Data Frame, Graphics in R

Learning Resources

1. I.R. Miller, J.E. Freund and R. Johnson, *"Probability and Statistics for Engineers"* 9th Edition, Pearson.
2. A. Goon, M. Gupta and B. Dasgupta, "Fundamentals of Statistics", vol. I & II, World Press.
3. Chris Chatfield*, "The Analysis of Time Series: An Introduction*", 6th edition, Chapman and Hall/CRC.
4. D.C. Montgomery & E.Peck, *"Introduction to Linear Regression Analysis"*, 5th edition, Wiley.
5. A.M. Mood, F.A. Graybill & D.C. Boes, "*Introduction to the Theory of Statistics*", 3rd edition, McGraw Hill.

6. N. Draper & H. Smith, *"Applied Regression Analysis"*, 3rd edition, Wiley.
7. Garrett Grolemund, *"Hands-on Programming with R", 1st* edition, O'Reilly.
8. Jared P. Lander, *"R for Everyone: Advanced Analytics and Graphics"*, 2nd edition, Addison-Wesley Professional.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Linear Statistical Models**		
1.1	Simple linear regression & correlation	2	CO1
1.2	Multiple regression & Multiple correlation	2	CO1
1.3	Tutorial	1	
1.4	Analysis of variance (one way, two way with as well as without interaction)	2	CO1
1.5	Tutorial	1	
2.	**Estimation and Sufficient Statistic**		
2.1	Estimation: Point estimation, criteria for good estimates (un-biasedness, consistency)	1	CO2
2.2	Methods of estimation including maximum likelihood estimation	2	CO2
2.3	Tutorial	1	
2.4	Sufficient Statistic: Concept & examples	1	CO2
2.5	Sufficient Statistic: complete sufficiency	1	CO2
2.6	Sufficient Statistic: their application in estimation	1	CO2
2.7	Tutorial	1	
	Case study problems in correlation analysis and estimation-Assignment-I		
3.	**Test of hypothesis**		
3.1	Concept & formulation, Type I and Type II errors	2	CO3
3.2	Neyman Pearson lemma	1	CO3
3.3	Tutorial	1	
3.4	Procedures of testing	3	CO3
3.5	Tutorial	1	
4.	**Non-parametric Inference**		
4.1	Comparison with parametric inference, Use of order statistics	1	CO4
4.2	Sign test, Wilcoxon signed rank test	1	CO4
4.3	Mann-Whitney test, V	1	CO4
4.4	Tutorial	1	
4.5	Kolmogorov-Smirnov test	1	CO4
4.6	Spearman's and Kendall's test	1	CO4
4.7	Tolerance region	1	CO4
4.8	Tutorial	1	
	Case study problems in parametric and non-parametric tests- Assignment II		
5.	**Basics of Time Series Analysis & Forecasting:**		
5.1	Stationary, ARIMA Models: Identification, Estimation and Forecasting	3	CO5
5.2	Tutorial	1	
6.	**R statistical programming language**		
6.1	Introduction to R	1	CO6
6.2	Functions, Control flow and Loops	1	CO6
6.3	Working with Vectors and Matrices	1	CO6
6.4	Tutorial	1	
6.5	Reading in Data, Writing Data, Working with Data, Manipulating Data	2	CO6

6.6	Simulation	1	CO6
6.7	Tutorial	1	
6.8	Linear model	1	CO6
6.9	Data Frame, Graphics in R	2	CO6
6.10	Tutorial	1	
	Case study problems in R-tool - Assignment III		
	Total	48	

Course Designers:

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21CB231	DATA STRUCTURES AND ALGORITHMS

Category	L	T	P	Credit
PC	3	1	0	4

Preamble

This course provides an introduction to the basic concepts and techniques of Linear and nonlinear data Structures and analyzes the various algorithms. It also discusses the use of data structures and the algorithm design techniques to provide efficient software solutions.

Prerequisite

- 20CB130-Fundamentals of Computer Science

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Construct algorithms for performing operations on a data structure, with an understanding of the trade-off between the time and space complexity.	20
CO2	Demonstrate how linear data structures like array, stack, queue and linked list are represented in the main memory and manipulated or used by different operations.	20
CO3	Apply non-linear data structures like Binary Tree, Threaded Binary Tree, Binary Search Tree, B & B+ Tree, AVL Tree, Splay Tree and Graphs in different operations.	20
CO4	Identify the computational efficiency of searching algorithms.	10
CO5	Determine the computational efficiency of sorting and hashing algorithms.	15
CO6	Illustrate the organization of files and its accessing schemes	15

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS 3	Apply	Value	Mechanism	1.2, 2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3
CO2	TPS 3	Apply	Value	Mechanism	1.2, 2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3
CO3	TPS 3	Apply	Value	Mechanism	1.2, 2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3
CO4	TPS 3	Apply	Value	Mechanism	1.2, 2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3
CO5	TPS 3	Apply	Value	Mechanism	1.2, 2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3
CO6	TPS 3	Apply	Value	Mechanism	1.2, 2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	S	M	L	L	-	L	L	-	-	L	L	M	L	L
CO2	S	M	L	L	-	L	L	-	-	L	L	M	L	L
CO3	S	M	L	L	-	L	L	-	-	L	L	M	L	L
CO4	S	M	L	L	-	L	L	-	-	L	L	M	L	L
CO5	S	M	L	L	-	L	L	-	-	L	L	M	L	L
CO6	S	M	L	L	-	L	L	-	-	L	L	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	2	1	2	
Remember	10	20	-	-	10
Understand	30	20	-	-	30
Apply	60	60	100	100	60
Analyse					
Evaluate					
Create					

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject /Assignment/Practical Component
Perception	
Set	
Guided Response	
Mechanism	100
Complex Overt Responses	
Adaptation	
Origination	

Sample Questions for Course Outcome Assessment**

** (2 to 3 at the cognitive level of course outcome)

Course Outcome 1(CO1):

1. There are three towers and sixty four disks of different diameters placed on the first tower. The disks are in order of decreasing diameter as one scans up the tower. Monks were reputedly supposed to move the disks from tower 1 to tower 3 obeying the rules: (i) only one disk can be moved at any time; (ii) no disk can be placed on top of a disk with smaller diameter. Write a recursive procedure which prints the sequence of moves which accomplish this task.
2. Is $f(n) = \Theta(n^2)$, where f(n) is defined to be the running time of the program A(n):

```
def A(n): a tuple = tuple(range(0, n))    # a tuple is an immutable version of a
                                          # list, so we can hash it
 S = set()
    for i in range(0, n):
      for j in range(i+1, n):
         S.add(atuple[i:j])               # add tuple (i,...,j-1) to set S.
```

Justify your answer.

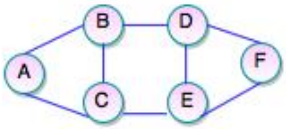
3. Given an array A which stores 0 and 1, such that each entry containing 0 appears before all those entries containing 1. In other words, it is like {0, 0, 0,..., 0, 0, 1, 1,..., 111}. Design an algorithm to find out the small index i in the array A such that A[i] = 1 using c log n instructions in the worst case for some positive constant c.

Course Outcome 2(CO2):

1. Two stacks are to be represented in an array V(1:m) .Write algorithms ADD(i.X) and DELETE(i) to add X and delete an element from stack i, $1 \leq i \leq 2$. Your algorithms should be able to add elements to the stacks so long as there are fewer than m elements in both stacks together.
2. Explain how to implement doubly linked lists using only one pointer value x:np per item instead of the usual two (next and prev). Assume that all pointer values can be interpreted as k-bit integers, and define x:np to be x:np D x:next XOR x:prev, the k-bit "exclusive-or" of x:next and x:prev. (The value NIL is represented by 0.) Be sure to describe what information you need to access the head of the list. Show how to implement the SEARCH, INSERT, and DELETE operations on such a list. Also show how to reverse such a list in O(1) time.
3. Write an algorithm to transform from prefix to postfix. Carefully state any assumptions you make regarding the input. How much time and space does your algorithm take?

Course Outcome 3(CO3):

1. Write an algorithm which inserts a new node T as the left child of node S in a threaded binary tree. The left pointer of S becomes the left pointer of T.
2. Show how the graph below would look if represented by its adjacency matrix, adjacency lists,adjacency multilist.



3. Write algorithm to insert key values into AVL trees, B-trees of order 3, B*-trees of order
3 and B'-trees of order 3. Evaluate the relative performance of these four representations of internal tables.

Course Outcome 4 (CO4):

1. Consider linear search - How many elements of the input sequence need to be checked on the average, assuming that the element being searched for is equally likely to be any element in the array? How about in the worst case? What are the average-case and worst-case running times of linear search ? Justify your answers
2. Consider the searching problem: given an array A[1…n] and a value v output an Index i such that v = A[i] or the special value ϕ if v does not appear in A. If the array J is sorted, we can perform a binary search: compare P with the midpoint of the array and repeat the search on one half of array, eliminating the other half from further consideration.
   (a) Construct a pseudocode for binary search as a recursive procedure.
   (b) Rewrite your binary search procedure in an iterative style.
3. Show that in an undirected graph, classifying an edge (u, v) as a tree edge or a back edge according to whether (u, v)or (v, u) is encountered first during the depth-first search is equivalent to classifying it according to the ordering of the four types in the classification scheme.

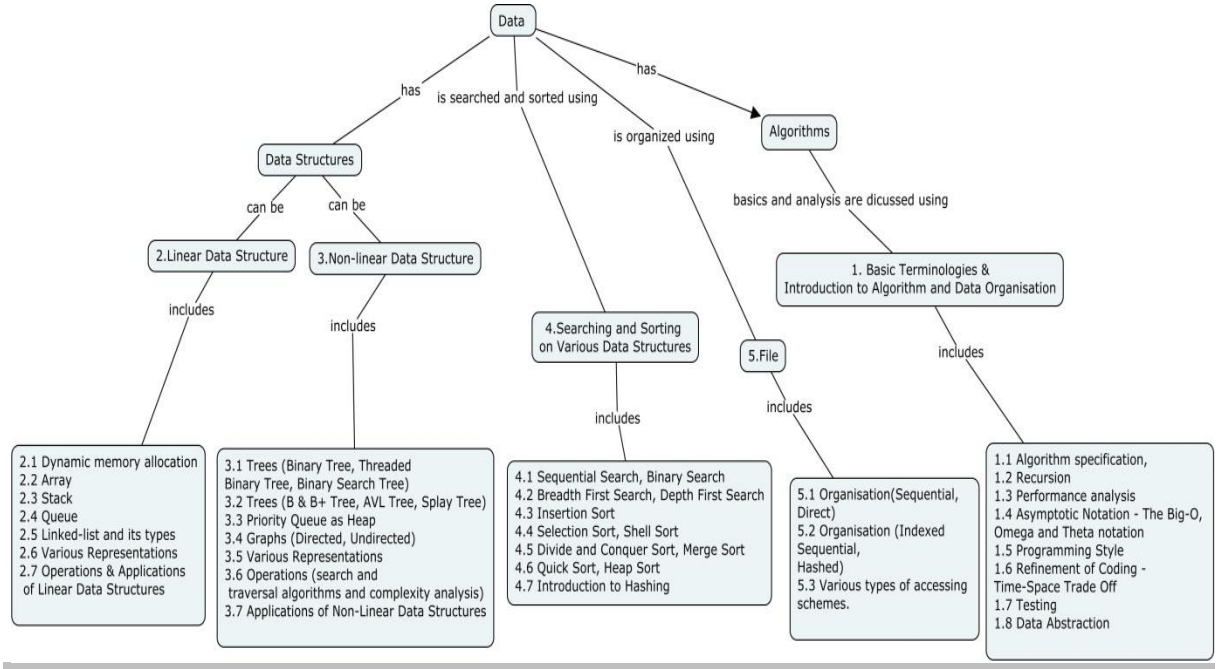
Course Outcome 5 (CO5):

1. Consider sorting n numbers stored in array A by first finding the smallest element of A and exchanging it with the element in AOE1_. Then find the second smallest element of A, and exchange it with AOE2_. Continue in this manner for the first n_1 elements of A. Write pseudocode for this algorithm, which is known as selection sort. What loop invariant does this algorithm maintain? Why does it need to run for only the first n _ 1 elements, rather than for all n elements? Give the best-case and worst-case running times of selection sort in ,-notation
2. Show that the running time of QUICKSORT is θ (n2) when the array A contains distinct elements and is sorted in decreasing order.
3. Consider implementing a hash table for an application in which we will build an initial hash table by inserting a substantial collection of records. After this, we expect that the number of insertions and the number of deletions performed to be roughly the same, although there may be long runs of consecutive insertions or consecutive deletions. Furthermore, the table will use a probe strategy to resolve any collisions that occur during insertion, and therefore we will "tombstone" cells from which a record has been deleted. If we implement the hash table described above, then when we search for a record, we cannot conclude the record is not in the table until we have found an empty cell in the table, not just a tombstone. (We will ensurethat the table never reaches the state that there are no empty cells.) Explain carefully why the search cannot stopwhen a tombstone is encountered

Course Outcome 6(CO6):

1. Write an algorithm to process a tape file in the batched mode. Assume the master file is ordered by increasing primary key value and that all such values are distinct. The transaction file contains transactions labeled: update, delete and insert. Each such transaction also contains the primary key value of the record to be updated, deleted or inserted. A new updated master file is to be created. What is the complexity of your algorithm?
2. Describe briefly how to do the following:
   (i) In a multilist organization: (a) output all records with KEY1 = PROG and KEY2 = NY. How many accesses are needed to carry this out? (b) Output all records with KEY1 = PROG or KEY2 = NY. How many accesses are needed for this. Assume that each access retrieves only one record.
   (ii) If a ring organization is used instead, what complications are introduced into (a) and (b) above?
3. A 105 record file is maintained as an inverted file on a disk with track capacity 5000 characters. This disk has 200 tracks on each of its 10 surfaces. Each record in the file is 50 characters long and has five key fields. Each key is binary (i.e., has only two distinct values) and so the index for each key can be maintained as a binary bit string of length 105 bits. If 1 character is 6 bits long, then each index takes about 4 tracks. How should the 5 indexes be stored on disk so as to minimize total seek time while processing the indexes in order to determine which records satisfy a given boolean query Q? This processing involves reading in 1 track of each index and testing the query against records represented by this track. Then the next set of index tracks is input and so on. How much time does it take to process all the indexes in order to determine which records are to be retrieved? Assume a seek time of 1/10 sec and a latency time of 1/40 sec. Also assume that only the input time is significant. If k records satisfy this query, how much more time is needed to retrieve these k records? Using other file structures it may be necessary to read in the whole file. What is the minimum time needed to read in the entire file of 105 records? How does this compare with the time needed to retrieve k records using an inverted file structure?

Concept Map



Syllabus

Basic Terminologies &Introduction to Algorithm and Data Organisation: Algorithm specification, Recursion, Performance analysis, Asymptotic Notation - The Big-O, Omega and Theta notation, Programming Style, Refinement of Coding - Time-Space Trade Off, Testing, Data Abstraction

Linear Data Structure: Dynamic memory allocation**,**Array, Stack, Queue, Linked-list and its types, Various Representations, Operations & Applications of Linear Data Structures

Non-linear Data Structure: Trees (Binary Tree, Threaded Binary Tree, Binary Search Tree, B & B+ Tree, AVL Tree, Splay Tree) , Priority queue as heap, Graphs (Directed, Undirected), Various Representations, Operations (search and traversal algorithms and complexity analysis) & Applications of Non-Linear Data Structures

Searching and Sorting on Various Data Structures: Sequential Search, Binary Search, Breadth First Search, Depth First Search, Insertion Sort, Selection Sort, Shell Sort, Divide and Conquer Sort, Merge Sort, Quick Sort, Heap Sort, Introduction to Hashing

File: Organisation (Sequential, Direct, Indexed Sequential, Hashed) and various types of accessing schemes.

Learning Resources

1. E. Horowitz and S. Sahni , Fundamentals of Data Structures , Computer Science Press, 1977.
2. AlfredV.Aho, John E.Hopperoft, Jeffrey D.UIlman, Data Structures and Algorithms,Pearson Education,2002.
3. Donald E. Knuth ,The Art of Computer Programming: Volume 1: Fundamental Algorithms, Donald E. Knuth,3rd edition,Pearson Education.
4. Charles E. Leiserson, Thomas H. Cormen, Ronald L. Rivest, Clifford Stein, Introduction to Algorithms, Third edition, PHI, 2010.
5. Pat Morin,Open Data Structures: An Introduction (Open Paths to Enriched Learning), 31st ed. Edition , AU Press,2013

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Basic Terminologies &Introduction to Algorithm and Data Organisation**		
1.1	Algorithm specification,	1	CO1
1.2	Recursion	1	CO1
1.3	Performance analysis	1	CO1
1.4	Asymptotic Notation - The Big-O, Omega and Theta notation	1	CO1
1.5	Programming Style	1	CO1
1.6	Refinement of Coding - Time-Space Trade Off	1	CO1
1.7	Testing	1	CO1
1.8	Data Abstraction	1	CO1
	Tutorial	3	
2	**Linear Data Structure**		
2.1	Dynamic Memory allocation	1	CO2
2.2	Array	1	CO2
2.3	Stack	1	CO2
2.4	Queue	1	CO2
2.5	Linked-list and its types	1	CO2
2.6	Various Representations	1	CO2
2.7	Operations & Applications of Linear Data Structures	1	CO2
	Tutorial	3	
3	**Non-linear Data Structure**		
3.1	Trees (Binary Tree, Threaded Binary Tree, Binary Search Tree)	2	CO3
3.2	Trees (B & B+ Tree, AVL Tree, Splay Tree)	2	CO3
3.3	Priority Queue as Heap	1	CO3
3.4	Graphs (Directed, Undirected)	1	CO3
3.4	Various Representations	1	CO3
3.6	Operations (search and traversal algorithms and complexity analysis)	1	CO3
3.7	Applications of Non-Linear Data Structures	1	CO3
	Tutorial	3	
4	**Searching and Sorting on Various Data Structures**		
4.1	Sequential Search, Binary Search	1	CO4
4.2	Breadth First Search, Depth First Search	1	CO4
4.3	Insertion Sort	1	CO4
4.4	Selection Sort, Shell Sort	1	CO5
4.5	Divide and Conquer Sort, Merge Sort	1	CO5
4.6	Quick Sort, Heap Sort	1	CO5
4.7	Introduction to Hashing	1	CO5
	Tutorial	3	
5	**File**		
5.1	Organisation(Sequential,Direct)	1	CO6
5.2	Organisation (Indexed Sequential, Hashed)	2	CO6
5.3	Various types of accessing schemes.	2	CO6
	Total Hours	48	

Course Designers:

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21CB241	PRINCIPLES OF ELECTRONICS	Category	L	T	P	Credit
		ES	2	0	0	2

Preamble

This course seeks to cover the basics of semiconductor devices including the physics of energy bands, doping and carrier statistics and transport leading up to the understanding of common semiconductor devices including p-n junctions and their applications, BJTs , FETs and MOSFETs. Having learnt the fundamental operating principals of active devices, feedback concept is also introduced to understand the working of amplifiers. The course will also give a flavour of the basics of integrated circuits and to digital electronic fundamentals. The course will ensure that undergraduates, with no background in semiconductors are able to grasp the content. The aim of the course is to develop physics and engineering strategies of semiconductor devices and to discuss their functionalities in modern electronic devices.

Prerequisite

High school physics & math, 10+2 physics

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Summarize the important concepts related to semiconductor Technology	10
CO2	Design and characterization of Diode, BJT and FET devices using specifications from the datasheet.	25
CO3	Categorize the feedback mechanisms	10
CO4	Design op-amp based circuits	20
CO5	Summarize the significance of Digital Systems, how they differ from analog systems and their applications.	10
CO6	Apply the principles of Boolean algebra to manipulate and minimize logic expressions to design simple combinational logic circuits using basic gates.	25

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond	-	1.2.3, 2.4.6
CO2	TPS3	Apply	Value	-	1.2.2, 2.1.1, 2.1.2, 2.1.3, 2.5.1
CO3	TPS2	Understand	Respond	-	1.2.3, 2.4.6
CO4	TPS3	Apply	Value	-	1.2.2, 2.1.1, 2.1.2, 2.5.1
CO5	TPS2	Understand	Respond	-	1.2.3, 2.4.6
CO6	TPS3	Apply	Value	-	1.2.2, 2.1.1, 2.1.2, 2.5.1

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L			S	L	L		L		L	L	L	L
CO2	S	M	L	L	S	L	L	L	L		L	M	L	L
CO3	M	L			S	L	L		L		L	L	L	L
CO4	S	M	L	L	S	L	L	L	L		L	M	L	L
CO5	M	L			S	L	L		L		L	L	L	L
CO6	S	M	L	L	S	L	L	L	L		L	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	**2**	1	2	
Remember	-	-	-	-	-
Understand	40	30		-	20
Apply	60	70	100	100	80
Analyse	-				-
Evaluate					
Create					

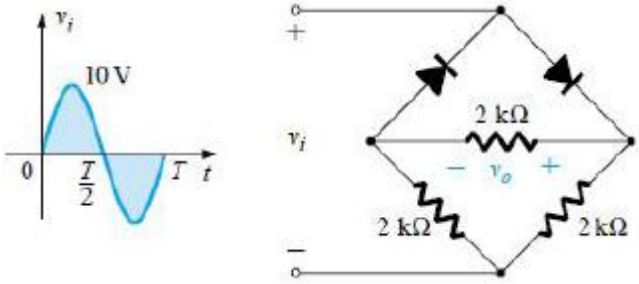
Sample Questions for Course Outcome Assessment**

Course Outcome 1(CO1):

1. Differentiate between intrinsic and extrinsic semiconductors with examples.
2. Calculate the drift velocity of the free electrons in a conductor of area 10-4m2,given the electron density to be 8x1028/m3when a current of 5A flows through it.

Course Outcome 2(CO2):

1. Explain the input and output characteristics of BJT in CE configuration
2. Determine the output waveform for the network of Figure and calculate the output dc level and the required PIV of each diode.



Course Outcome 3 (CO3):

1. Draw the block diagram of feedback amplifier.
2. Determine the voltage gain, input, and output impedance with feedback for voltage series feedback having A=-100, Ri = 10 kΩ, Ro = 20 kΩ for feedback of (a) β=-0.1 and (b) β=-0.5

Course Outcome 4 (CO4):

1. Calculate the maximum frequency for an op-amp with sine wave output voltage of 10 V peak and slew rate is 2 V/μs.
2. Construct an inverting amplifier with gain of 10 and a non-inverting amplifier with gain of 100 using op-amp

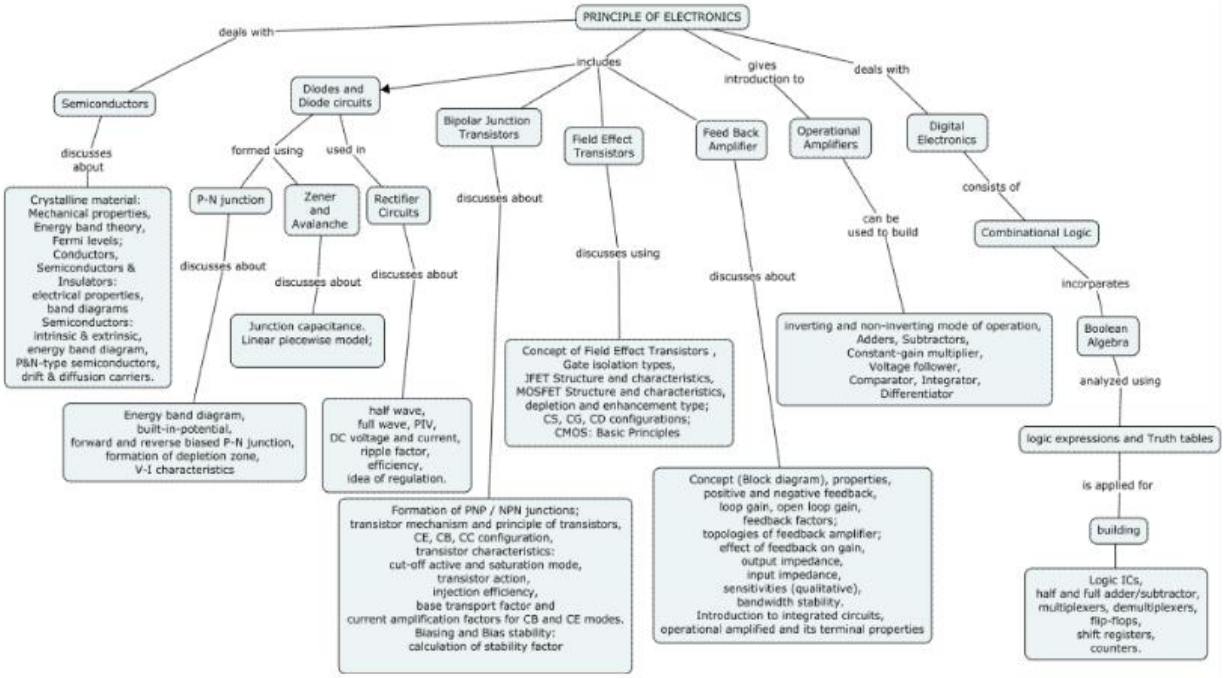
Course Outcome 5(CO5):

1. Discuss the advantages of processing information in digital form.
2. Describe the software aspects of Digital design.

Course Outcome 6(CO6):

1. Simplify the given logic expression using Demorgan's theorem=(A+B+(AB)'+CD)'
2. Prove the commutative and distributive laws in Boolean algebra.

Concept Map



Syllabus

Semiconductors: Crystalline material: Mechanical properties, Energy band theory, Fermi levels; Conductors, Semiconductors & Insulators: electrical properties, band diagrams. Semiconductors: intrinsic & extrinsic, energy band diagram, P&N-type semiconductors, drift & diffusion carriers.

Diodes and Diode Circuits: Formation of P-N junction, energy band diagram, built-in-potential, forward and reverse biased P-N junction, formation of depletion zone, V-I characteristics, Zener breakdown, Avalanche breakdown and its reverse characteristics; Junction capacitance. Linear piecewise model; Rectifier circuits: half wave, full wave, PIV, DC voltage and current, ripple factor, efficiency, idea of regulation.

Bipolar Junction Transistors: Formation of PNP / NPN junctions; transistor mechanism and principle of transistors, CE, CB, CC configuration, transistor characteristics: cut-off active and saturation mode, transistor action, injection efficiency, base transport factor and current amplification factors for CB and CE modes. Biasing and Bias stability: calculation of stability factor

Field Effect Transistors: Concept of Field Effect Transistors (channel width modulation), Gate isolation types, JFET Structure and characteristics, MOSFET Structure and characteristics, depletion and enhancement type; CS, CG, CD configurations; CMOS: Basic Principles

Feed Back Amplifier, and Operational Amplifiers: Concept (Block diagram), properties, positive and negative feedback, loop gain, open loop gain, feedback factors; topologies of feedback amplifier; effect of feedback on gain, output impedance, input impedance, sensitivities (qualitative), bandwidth stability. Introduction to integrated circuits, operational amplified and its terminal properties; Application of operational amplifier; inverting and non-inverting mode of operation, Adders, Subtractors, Constant-gain multiplier, Voltage follower, Comparator, Integrator, Differentiator

Digital Electronics Fundamentals: Difference between analog and digital signals, Boolean algebra, Basic and Universal Gates, Symbols, Truth tables, logic expressions, Logic simplification using K- map, Logic ICs, half and full adder/subtractor, multiplexers, demultiplexers, flip-flops, shift registers, counters.

Learning Resources

1. Adel S. Sedra and Kenneth C. Smith, "Microelectronic Circuits: Theory and Application", 7th Edition, Oxford University Press, 2017.
2. Jacob millman, christos halkias chetan parikh,"Millman's Integrated Electronics "McGraw Hill education (India) private limited,2009
3. M. Morris Mano," *Digital Logic & Computer Design*" Pearson India Educational Services PvT. Limited, 2016
4. Robert L. Boylestad, Louis Nashelsky,*"Electronic Devices and Circuit Theory"*, Pearson India Educational Services PvT. Limited,2015
5. Ben Streetman, Sanjay Banerjee," *Solid State Electronic Devices*",6th Edition, Prentice Hall of India 2005
6. NPTEL online Course on "Fundamentals of Semiconductor devices", Course Link: https://onlinecourses.nptel.ac.in/noc19_ee04/
7. https://www.electronics-tutorials.ws/
8. https://circuitverse.org/

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Semiconductors:** Crystalline material: Mechanical properties, Energy band theory	1	CO1
1.1	Fermi levels; Conductors, Semiconductors & Insulators: electrical properties, band diagrams	1	CO1
1.2	Intrinsic & extrinsic, P&N-type semiconductors	1	CO1
1.3	Drift & diffusion carriers	1	CO1
2	**Diodes and Diode Circuits:** Formation of P-N junction, built-in-potential, forward and reverse biased P-N junction, formation of depletion zone, V-I characteristics	1	CO2
2.1	Zener breakdown, Avalanche breakdown and its reverse characteristics; Junction capacitance. Linear piecewise model;	1	CO2
2.2	Rectifier circuits: half wave, full wave, PIV, DC voltage and current, ripple factor, efficiency, idea of regulation.	2	CO2
3	**Bipolar Junction Transistors:** Formation of PNP / NPN junctions; transistor mechanism and principle of transistors,	1	CO2
3.1	CE, CB, CC configuration, transistor characteristics: cut-off active and saturation mode, transistor action	1	CO2
3.2	Injection efficiency, base transport factor and current amplification factors for CB and CE modes.	1	CO2
3.3	Need for Biasing	1	CO2
4	**Field Effect Transistors:** Concept of Field Effect Transistors (channel width modulation), Gate isolation; CS, CG, CD configurations;	1	CO2
4.1	Types, JFET Structure and characteristics,	1	CO2
4.2	MOSFET Structure and characteristics, depletion and enhancement type	1	CO2
4.3	CMOS: Basic Principles	1	CO2
5	**Feed Back Amplifier, and Operational Amplifiers:** Concept (Block diagram), properties, positive and negative feedback, loop gain, open loop gain, feedback factors	1	CO3

5.1	Topologies of feedback amplifier; effect of feedback on gain, output impedance, input impedance, sensitivities (qualitative), bandwidth stability.	2	CO3
5.2	Introduction to integrated circuits, operational amplified and its terminal properties; Application of operational amplifier; inverting and non-inverting mode of operation, Adders, Subtractors, Constant-gain multiplier	1	CO4
5.3	Voltage follower, Comparator, Integrator, Differentiator	1	CO4
6	**Digital Electronics Fundamentals:** Difference between analog and digital signals, Boolean algebra, Basic and Universal Gates, Symbols	1	CO5
6.1	Truth tables, logic expressions, Logic simplification using K- map	2	CO6
6.2	Logic ICs, half and full adder/ subtractor	1	CO6
6.3	Concept of Multiplexers, flip-flops, shift registers, counters.	2	CO6

Course Designers:

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21CB251	FUNDAMENTALS OF ECONOMICS

Category	L	T	P	Credit
HSS	2	0	0	2

Preamble

The objective of this course is to provide the basic knowledge on micro and macroeconomics to analyse the market structure and demand-supply in real time economy. Further it imparts the knowledge of economic decision making by exploring the performance and behaviour of an economy.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Explain the basic principles and concepts of microeconomics for economic decision making.	8
CO2	Select the appropriate microeconomic demand-supply concepts to solve the business problems.	8
CO3	Develop a strategy that measure, critique and interpret consumer's behavior in decision making.	21
CO4	Make use of the different production and cost functions to derive product decision.	17
CO5	Analyze with the macroeconomics components and Keynesian Multiplier to solve the real time economy problems.	21
CO6	Examine the banking and central bank's monetary policy concepts in economic development of a nation.	25

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond	-	1.1.1,2.1.3
CO2	TPS3	Apply	Value	-	1.1.1,2.1.3,2.1.4
CO3	TPS3	Apply	Value	-	2.1.3,2.1.4,2.1.5
CO4	TPS3	Apply	Value	-	2.2.4
CO5	TPS4	Analyse	Organise	-	2.5.4,4.3.4
CO6	TPS3	Apply	Value	-	2.5.4,3.1.5,3.2.5

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L										L		
CO2	S	M	L									M		
CO3	S	M	L									M		
CO4	S	M	L									M		
CO5	S	S	M	L	L		M	M	M	L	L	M	M	L
CO6	S	M	L				M	L			L	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	**2**	1	2	
Remember	20	20	-	-	20
Understand	30	20	30	20	20
Apply	50	60	70	70	60
Analyse				10	
Evaluate					
Create					

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject /Assignment/Practical Component
Perception	-
Set	-
Guided Response	-
Mechanism	-
Complex Overt Responses	-
Adaptation	-
Origination	-

Sample Questions for Course Outcome Assessment**

Course Outcome 1(CO1):

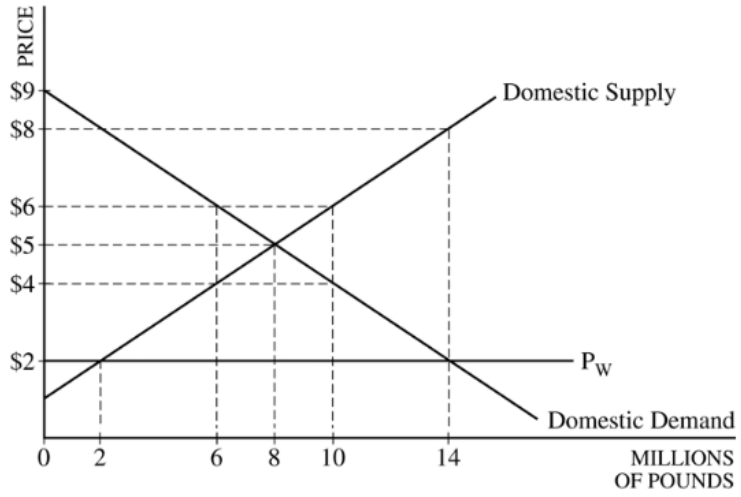
1. State the uses of the study of microeconomics.
2. Differentiate between a firm and industry.
3. Explain various types of price elasticity of demand with the help of diagrams.

Course Outcome 2(CO2):

1. Suppose research shows that the more college education individuals receive, the more responsible citizens they become and the less likely they are to commit crimes.
   (a) Draw a correctly labeled graph for the college education market and show each of the following.
   (i) Private market equilibrium quantity and price of college education, labeled Qm and Pm, respectively
   (ii) Socially optimal quantity of education, labeled Qs
   (iii) Deadweight loss at the market equilibrium, completely shaded
   (b) Assume that the government imposes an effective (binding) price ceiling on the price of college education.
   (i) Show the price ceiling on your graph in part (a), labelling the price ceiling Pc.
   (ii) Does this price ceiling increase, decrease, or have no impact on the deadweight loss in this industry?
2. Assume that the market for avocados is perfectly competitive. The typical firm is earning positive economic profit in the short-run equilibrium. (a) Draw a correctly labeled graph for the typical firm, illustrating the short-run equilibrium and labeling the equilibrium market price and output PE and QE, respectively. (b) Assume there is an increase in the market wage rate for labor, a variable input. Show on your graph in part (a) the effect of the wage increase on the marginal cost curve in the short run. (c) Assume that avocado producers hire workers from a perfectly competitive labor market. Draw a graph of labor supply and demand for the typical firm and label the supply curve MFC and the demand curve MRP. Assume the market wage rate increases from w1 to w2. Show the effect of the wage increase on the graph, labeling the initial quantity of labor hired QL1 and the new quantity of labor hired QL2.

Course Outcome 3(CO3):

1. Assume that the market for good X is perfectly competitive and that the production of good X creates a negative externality. (a) Draw a correctly labelled graph of the market for good X and show each of the following. (i) The marginal private cost and marginal social cost of good X, labeled MPC and MSC, respectively (ii) The market quantity, labeled Qm (iii) The allocatively efficient quantity, labeled Qs (iv) The area of deadweight loss, shaded completely (b) Assume that a lump-sum tax is imposed on the producers of good X. What happens to the deadweight loss? Explain.
2. Sugar is freely traded in the world market. Assume that a country, Loriland, is a price taker in the world market for sugar. Some of the sugar consumed in Loriland is produced domestically while the rest is imported. The world price of sugar is $2 per pound. The graph below shows Loriland's sugar market, and PW represents the world price



(a) At the world price of $2 per pound, how much sugar is Loriland importing?
(b) Suppose that Loriland imposes a per-unit tariff on sugar imports and the new domestic price including the tariff is $4. (i) Identify the new level of domestic production. (ii) Calculate the domestic consumer surplus for Loriland. (iii) Calculate the total tariff revenue collected by the government. (c) Given the world price of $2, what per-unit tariff maximizes the sum of Loriland's domestic consumer surplus and producer surplus?

Course Outcome 4 (CO4):

1. The table below shows the output a firm produces using different amounts of capital (K) and labor (L). The markets for capital and labor are perfectly competitive. The rental rate of capital is $75 per unit, and the wage rate is $200 per unit. In the short run, capital is fixed and labor is variable.

Labor	Output with K=1	Output with K=2
0	0	0
1	10	20
2	25	50
3	38	75

(a) If the firm uses one unit of capital and one unit of labor, will it be operating with constant, increasing, or decreasing returns to scale? Explain using numbers from the table.
(b) Assume, the firm currently has two units of capital and is using three units of labor.

(i) Calculate the marginal product for the third unit of labor.
(ii) Did the firm experience diminishing marginal returns with the addition of the third unit of labor? Explain using numbers from the table.
(iii) Calculate the firm's average total cost for its current level of production.
(iv) If the firm's output is sold in a competitive market, what is the lowest output price at which the third unit of labor would be hired?

2. Camden's Cakery is one of many dessert cafés serving a local community. Each café produces a slightly differentiated product, there are no barriers to entry or exit, and the firm is in long-run equilibrium.
(a) Draw a correctly labeled graph showing Camden's demand curve, marginal revenue curve, marginal cost curve, and long-run average total cost curve. Label Camden's profit-maximizing output Qm and its price Pm.
(b) On your graph in part (a), label the output at which total revenue is maximized QR.
(c) Do firms in this market experience economies of scale, diseconomies of scale, or neither in long-run equilibrium? Explain.

Course Outcome 5 (CO5):

1. Assume a simplified economy where the quantity theory of money holds, with a constant velocity of money circulation *V*, and where all inflation is fully anticipated. Also, this economy does not trade with the rest of the world, and experiences the annual production function $Y=K^{a}L^{1-a}$, where *L* is the total number of worker-hours and *K* is the accumulated capital stock. Assume that all product markets are perfectly competitive and clear instantaneously, that the population is fixed at size *N*, that all individuals work an equal number of hours per year *H*, and that all workers are equally productive. Assume also that the capital stock is fixed for each year, and that there is no depreciation. Finally, assume there is no indirect taxation.
(a) What will the relationship be between gross domestic product (GDP), gross national product (GNP) and national income (NI) for this economy?
(b) By dividing national income *Y* into private consumption spending *C*, government consumption spending *G* and private investment spending *I*, explain how the following macroeconomic variables will be determined in this model. (Assume a constant private savings rate, *s*, and tax burden, *T,* and let the nominal money supply be *M*):
(i) Real GDP (annual)
(ii) Real GDP per capita (annual)
(iii) Real hourly and annual wages.
(iv) Nominal GDP (annual)
(v) Nominal GDP per capita (annual)
(vi) Nominal hourly and annual wages
(vii) Private saving (annual in real terms)
(viii) Private consumption (annual in real terms)
(ix) Private investment (annual in real terms)
(x) The real interest rate.

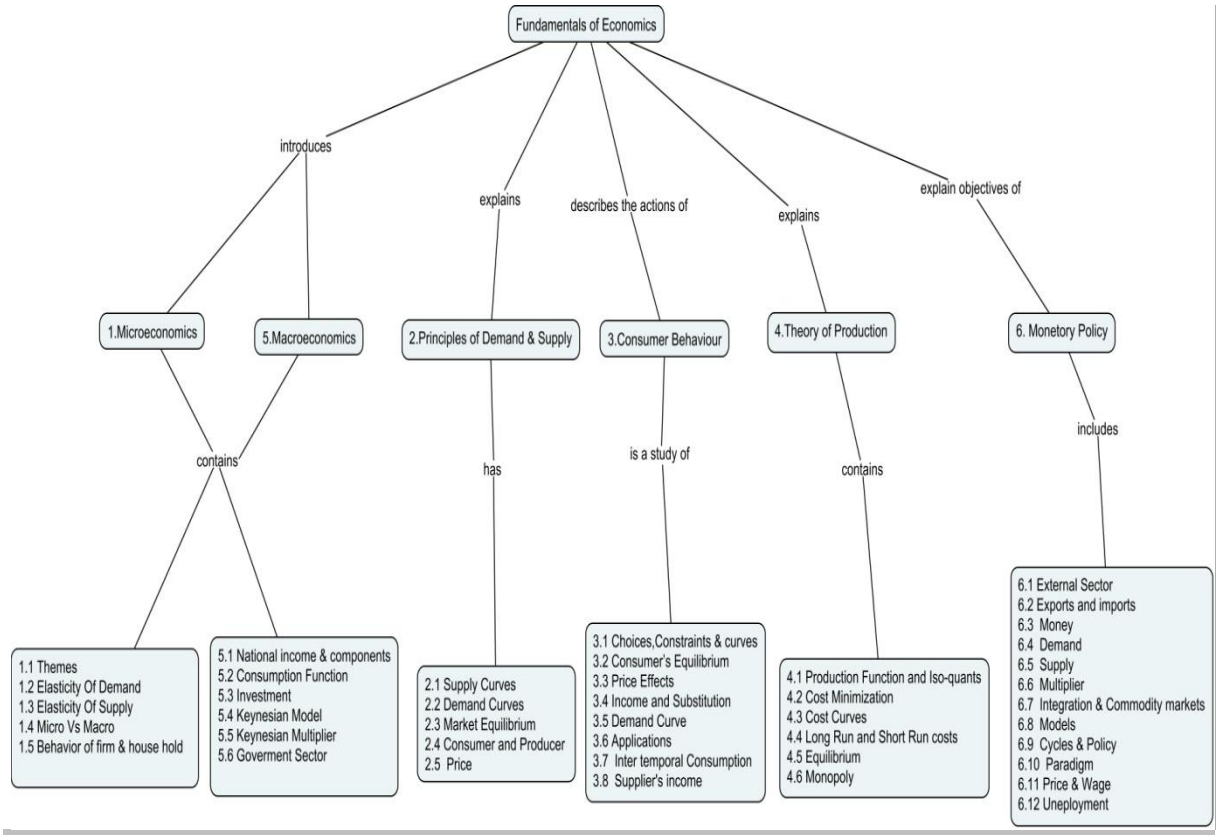
2. Analyse a Keynesian multiplier model for the short run level of aggregate demand in the closed economy which includes a proportional income tax rate *t*, a private saving rate *s*, exogenous government spending *G0*, autonomous consumption *C0* and autonomous investment *I0*. With reference to the role of the Keynesian multiplier and the circular flow model, explain the effect on (i) the equilibrium level of demand, (ii) equilibrium consumption, (iii) the equilibrium government budget deficit and (iv) equilibrium net private savings of the following:
(a) An increase in *G0*.
(b) An increase in *C0*.
(c) An increase in *I0*.
(d) An increase in *s*.
(e) An increase in *t.*

(f) An increase in government spending, where tax intake is raised simultaneously, so as to maintain a balanced budget.

Course Outcome 6(CO6):

1. Use the closed economy IS-LM framework to analyse the impact of each of the following policies on (i) Income/output, (ii) The real interest rate, (iii) Investment, (iv) The government budget deficit.
   Pay particular attention to the role of the slope of the IS and LM curves:
   (a) An increase in government expenditure.
   (b) An increase in the proportional income tax rate.
   (c) An increase in the saving rate.
   (d) An increase in the nominal money supply.
2. Apply the Baumol-Tobin theory of money management to derive the impact of the following on an individual's demand for nominal money balances:
   (a) An increase in the nominal interest rate offered on corporate and government bonds.
   (b) An increase in the riskiness of bonds.
   (c) An increase in real income.
   (d) An increase in the price level.
   (e) A rise in the expected rate of inflation.
   (f) Introduction of charges for withdrawals at cash machines.

Concept Map



Syllabus

Introduction to Microeconomics: The themes of microeconomics, Elasticity of Supply, Elasticity of Demand, Microeconomics versus Macroeconomics, Behavior of firm and House hold.

Principles of Demand and Supply: Supply Curves of Firms — Demand Curves of Households; Equilibrium and Comparative Statics (Shift of a Curve and Movement along the Curve); Welfare Analysis — Consumers' and Producers' Surplus — Price Ceilings and Price Floors.

Consumer Behaviour: Axioms of Choice — Budget Constraints and Indifference Curves; Consumer's Equilibrium — Effects of a Price Change, Income and Substitution Effects — Derivation of a Demand Curve; Applications — Tax and Subsidies — Intertemporal Consumption — Suppliers' Income Effect.

Theory of Production: Production Function and Iso-quants — Cost Minimization; Cost Curves — Total, Average and Marginal Costs — Long Run and Short Run Costs; Equilibrium of a Firm Under Perfect Competition; Monopoly and Monopolistic Competition.

Introduction to Macroeconomics: National Income and its Components — GNP, NNP, GDP, NDP; Consumption Function; Investment; Simple Keynesian Model of Income Determination and the Keynesian Multiplier; Government Sector — Taxes and Subsidies.

Monetary Policy: External Sector — Exports and Imports; Money — Definitions; Demand for Money —Transactionary and Speculative Demand; Supply of Money — Bank's Credit Creation Multiplier; Integrating Money and Commodity Markets — IS, LM Model; Business Cycles and Stabilization — Monetary and Fiscal Policy — Central Bank and the Government; The Classical Paradigm — Price and Wage Rigidities — Voluntary and Involuntary Unemployment.

Learning Resources

1. Pindyck, Robert S., and Daniel L. Rubinfeld, "Microeconomics", 8th Edition, The Pearson Education, Inc., 2013.
2. Dornbusch, Fischer and Startz, "Macroeconomics", 13th Edition, McGraw Hill, 2018.
3. Paul Anthony Samuelson, William D. Nordhaus, "Economics", 19th Edition, McGraw Hill International Edition, 2009.
4. https://data.oecd.org/economy.htm
5. https://www.focus-economics.com
6. https://www.rbi.org.in

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Introduction to Microeconomics**		
1.1	The themes of microeconomics		CO1
1.2	Elasticity of Supply		CO1
1.3	Elasticity of Demand	1	CO1
1.4	Microeconomics versus Macroeconomics		CO1
1.5	Behaviour of firm and House hold	1	CO1
2.	**Principles of Demand and Supply**		
2.1	Supply Curves of Firms		CO2
2.2	Demand Curves of Households	1	CO2
2.3	Market Equilibrium & Comparative Statics		CO2
2.4	Consumers' and Producers' Surplus	1	CO2
2.5	Price Ceilings and Price Floors		CO2
3.	**Consumer Behaviour**		
3.1	Axioms of Choice, Budget Constraints and Indifference Curves	1	CO3
3.2	Consumer's Equilibrium	1	CO3
3.3	Effects of a Price Change		CO3
3.4	Income and Substitution Effects	1	CO3
3.5	Derivation of a Demand Curve		CO3
3.6	Applications: Tax and Subsidies		CO3
3.7	Inter temporal Consumption	1	CO3
3.8	Suppliers' Income Effect	1	CO3

4.	**Theory of Production**		
4.1	Production Function and Iso-quants	1	CO4
4.2	Cost Minimization		CO4
4.3	Cost Curves: Total, Average and Marginal Costs	1	CO4
4.4	Long Run and Short Run Costs	1	CO4
4.5	Equilibrium of a Firm Under Perfect Competition	1	CO4
4.6	Monopoly and Monopolistic Competition		CO4
5.	**Introduction to Macroeconomics**		
5.1	National Income and its Components	1	CO5
5.1.1	GNP, NNP, GDP, NDP		CO5
5.2	Consumption Function	1	CO5
5.3	Investment		CO5
5.4	Simple Keynesian Model of Income Determination	1	CO5
5.5	Keynesian Multiplier	1	CO5
5.6	Government Sector	1	CO5
5.6.1	Taxes and Subsidies		CO5
6.	**Monetary Policy**		
6.1	External Sector	1	CO6
6.2	Exports and Imports		CO6
6.3	Money — Definitions, Demand for Money	1	CO6
6.4	Transactionary and Speculative Demand	1	CO6
6.5	Supply of Money		CO6
6.6	Bank's Credit Creation Multiplier		CO6
6.7	Integrating Money and Commodity Markets	1	CO6
6.8	IS, LM Model		CO6
6.9	Business Cycles and Stabilization, Monetary and Fiscal Policy	1	CO6
6.10	Central Bank and the Government; The Classical Paradigm		CO6
6.11	Price and Wage Rigidities	1	CO6
6.12	Voluntary and Involuntary Unemployment		CO6
	Total Hours	**24**	

Course Designers:

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2. M. Manikandakumar mmrit@tce.edu

21CB261	BUSINESS COMMUNICATION & VALUE SCIENCE – II

Category	L	T	P	Credit
Project	2	-	-	2

Preamble

This course aims at developing effective reading, writing, presentation and group discussion skills and helps students identify personality traits and evolve as a better team player besides introducing them to key concepts of morality, behaviour and beliefs, and diversity and inclusion.

Prerequisite

Basic Knowledge of English and completion of 20CB150

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Understand the basic tools of Reading, Writing and Presentation skills	15
CO2	Use the skills of reading, writing and presentation skills effectively	25
CO3	Comprehend and review the concepts of morality, diversity and inclusion	15
CO4	Identify the personality traits and team work	15
CO5	Organize and document the concepts and theory dedicated to a social cause.	20
CO6	Create an E-Magazine (Morality, diversity and inclusion)	10

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond	Guided Response	1.2, 2.5, 3.1,3.2,3.3.1 3.2.1, 3.2.3,3.2.6,4.2
CO2	TPS3	Apply	Value	Guided Response	1.2, 2.5, 3.1,3.2,3.3.1 3.2.1, 3.2.3,3.2.6,4.2
CO3	TPS2	Understand	Respond	Perception	1.2, 2.5, 3.1,3.2,3.3.1 3.2.1, 3.2.3,3.2.6,4.2
CO4	TPS2	Understand	Respond	Perception	1.2, 2.5, 3.1,3.2,3.3.1 3.2.1, 3.2.3,3.2.6,4.2
CO5	TPS3	Apply	Value	Guided Response	1.2, 2.5, 3.1,3.2,3.3.1 3.2.1, 3.2.3,3.2.6,4.2
CO6	TPS6	Create	Characterize	Origination	4.4.1, 4.4.3, 4.4.6, 4.5

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L				L	M	M	M	M	M	L	M	M
CO2	S	M	L			M	M	M	M	M	M	M	M	M
CO3	M	L				L	M	M	M	M	M	L	M	M
CO4	M	L				M	M	M	M	M	M	L	M	M
CO5	S	M	L			M	M	M	M	M	M	M	M	M
CO6	S					M					S	L		M

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

INTERNALS

No CAT will be conducted.

SUMMATIVE- Activity Based Evaluation (No External Examination)

Evaluation is done in classroom activities as given below

Reading and Writing	CO1	UNDERSTAND	20
Presentation	CO2	APPLY	10
E-magazine	CO6	CREATE	10
Review on movie	CO3	UNDERSTAND	5
Group Discussion/enacting a play	CO4	APPLY	5

Resume Submission	CO1		10
Interview – Immersion	CO5		20
Presentation			20
		Total	100

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject /Assignment/Practical Component
Perception	
Set	
Guided Response	50
Mechanism	50
Complex Overt Responses	
Adaptation	
Origination	

Sample Questions for Course Outcome Assessment**

** (2 to 3 at the cognitive level of course outcome)

Course Outcome 1(CO1): (20 marks + 10 marks)

1. Read the following passage and comprehend it. (10 marks)
2. Resume Writing / Blog Writing / Story writing. (5 marks)
3. **A**) **Spot the error**. **(2 marks)**
   If you lend him book (A) he will lend it to someone else (B) and never you get it back (C) No error (D)
   B) **Punctuate the following. (3 marks)**
   i remember the maps of the holy land coloured they were very pretty the dead sea was pale and blue the very look of it made me thirsty

Course Outcome 2(CO2): (10 marks + 20 marks)

Individual presentation on any one of the topics given:

1. Social media in the classroom
2. Lack of practical knowledge in the education system
3. The history behind the currency

Course Outcome 3(CO3): (5 marks)

Write a review on an English movie that you watched recently (Or) Write a review on your favourite story book.

Course Outcome 4 (CO4): (5 marks)

Group Discussion

1. Digital India: Whom does it Benefit?
2. Future of Crypto currencies.
3. Which is more important creativity or efficiency?

(Or)

Skit

Select any one the topic and enact a play

1. Child right to Education
2. Unemployment
3. Women Empowerment

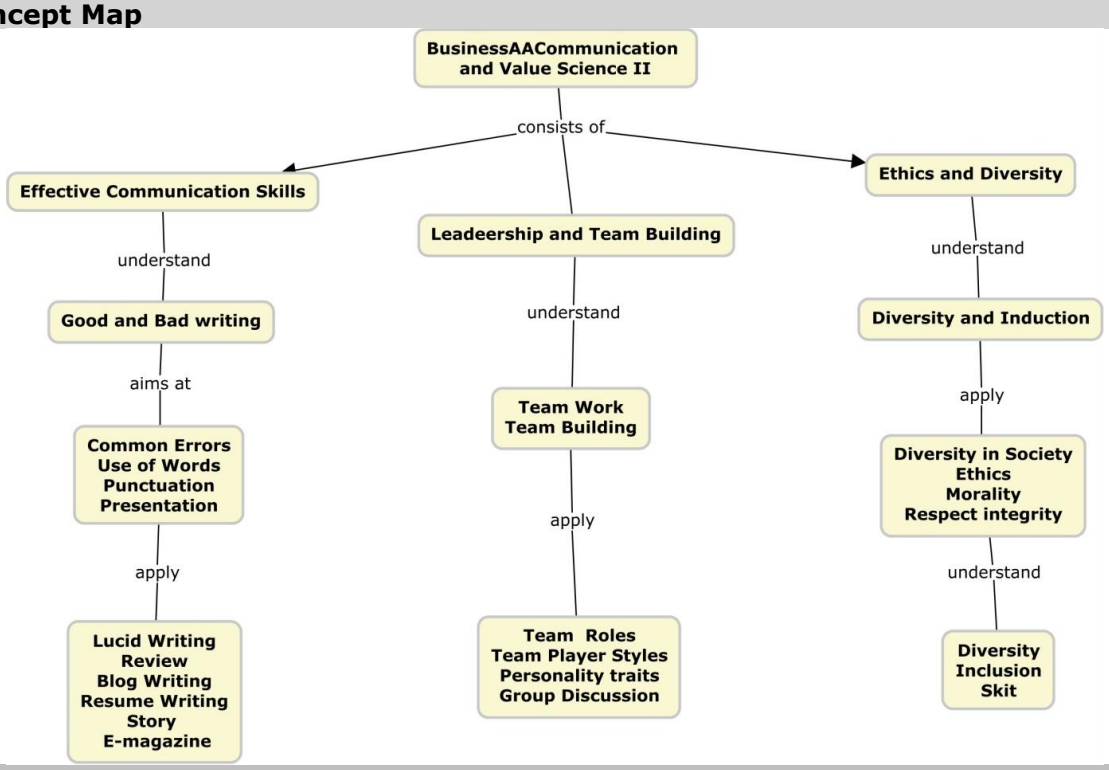
Course Outcome 5 (CO5): (20 Marks)

Interview and Immersion

Course Outcome 6 (CO6): (10 marks)

Create an **E-Magazine** based on the concepts of morality, diversity and inclusion

Concept Map



Syllabus

Effective Communication Skills: Good and Bad Writing – Common Errors, Punctuation rules, Use of Words, Lucid Writing, Speed Reading, Skimming, Scanning, Presentation Techniques, Book/Film/Incident Review, Blog Writing, Resume Writing, Story Writing, E Magazine

Leadership and Team Building: Team Work, Team Building, Introduction to Dr. Meredith Belbin and his 8 Team Roles and Team Player Styles, Lindgren's Big 5 Personality Traits,

Myer Brigg's Questionnaire, Team Falcon Practical to identify individual personality traits, Group Discussion.

Ethics and Diversity: Diversity and Inclusion, Different types of Diversity in Society, Ethics, Morality and respect for individuals, Case study discussion be used to learn Values, Respect for individual and integrity, understanding Diversity inclusion, Skit,

Learning Resources

Text Books: There are no prescribed texts for Semester 2 – there will be handouts and reference links shared	
Reference Books:	
1	Guiding Souls : Dialogues on the purpose of life; Dr. A.P.J Abdul Kalam ;Publishing Year-2005; Co-author—ArunTiwari
2	The Family and the Nation; Dr. A.P.J Abdul Kalam; Publishing year: 2015; Co-author: AcharyaMahapragya
3	The Scientific India: A twenty First Century Guide to the World around Us; Dr. A.P.J Abdul Kalam; Publishing year: 2011; Co-author- Y.S.Rajan
4	Forge Your Future: Candid, Forthright, Inspiring ; Dr. A.P.J Abdul Kalam; Publishing year: 2014
5	Abundance: The Future is Better Than You Think; Peter H. Diamandis and Steven Kotler; Published: 21 Feb, 2012; Publisher: Free Press
6	Start With Why: How Great Leaders Inspire Everyone to Take Action; Simon Sinek; Published: 6 October 2011; Publisher: Penguin
7	Advertising & IMC: Principles and Practice; Sandra Moriarty, Nancy D. Mitchell, William D. Wells; Published: 15 June 2016; Publisher: Pearson Education India
Web References:	
1	ETHICS FUNDAMENTALS AND APPROACHES TO ETHICS https://www.eolss.net/Sample-Chapters/C14/E1-37-01-00.pdf
2	A Framework for Making Ethical Decisions https://www.brown.edu/academics/science-and-technology-studies/framework-making-ethical-decisions
3	Five Basic Approaches to Ethical Decision- http://faculty.winthrop.edu/meelerd/docs/rolos/5_Ethical_Approaches.pdf
Online Resources:	
1	https://youtu.be/CsaTslhSDI
2	https://m.youtube.com/watch?feature=youtu.be&v=IIKvV8_T95M
3	https://m.youtube.com/watch?feature=youtu.be&v=e80BbX05D7Y How To Begin Your Presentation with Simon Sinek
4	https://m.youtube.com/watch?v=dT_D68RJ5T8&feature=youtu.be POWER Writing - Write ANYTHING in English Easily
5	https://m.youtube.com/watch?v=7sLLEdBgYYY&feature=youtu.be

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.1	Introduction, Identification of a social issue for presentation	1	CO2
1.2	Presentation of the social issue in groups	2	CO2
1.3	Good and Bad writing - common errors and punctuation rules	1	CO1
1.4	Elevator pitch	1	CO1
1.5	Discussion on Writing techniques by Catherine Morris & Joanie Mcmahon	2	CO1
1.6	Planning and designing of E magazine with objective & guidelines	1	CO5

1.7	Creating and the launching of E-magazine	2	CO6
2.1	Introduction to basic presentation skills & practice using ORAI app	2 (lab)	CO1
2.2	Introduction and practice to skimming and scanning	2	CO1
2.3	Introducing Dr. Meredith Belbin's research on teamwork	1	CO4
2.4	Watching Belbin's 8 Team roles, 8 team player styles and Lindgren's Big 5 personality traits	1 (lab)	CO4
2.5	Myer Brigg's AVK Method questionnaire	1(lab)	CO4
2.6	Creating a story in groups based on the social issue - feedback	2 1	CO5
2.7	Researching on a book, or film akin to the topic of your social issue and writing about it	2 1	CO3
3.1	Watching a short film on Diversity and discussing in groups	1 (lab)	CO4
3.2	Watching the film "The Fish and I" and debriefing in classroom	2 1 (lab)	CO3
3.3	Introduction to Diversity and Inclusion with reference to our society	1	CO3
3.4	Debating on the topic of diversity with an angle of ethics, morality and respect for individual	2	CO3
3.5	Narrating the challenges faced by a member of a diverse group in 4 minutes	2	CO3
3.6	(Case study discussion be used to learn Values, respect for individual and integrity) Discussing on Values, Respect for individual and integrity using appropriate case study.	2	CO1
3.7	Preparing a CV with the activities done so far	2	CO1

Course Designers:

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5. Ms. R. Manibala rmaeng@tce.edu

21CB271	DATA STRUCTURES AND ALGORITHMS LAB

Category	L	T	P	Credit
PC	0	0	4	2

Preamble

The laboratory course is designed to enable the students to solve simple mathematical, numerical and engineering problems and provide solutions using suitable data structures. The list of experiments includes the implementation of various linear and non-linear data structures and traversal through graphs. These experiments will strengthen the concepts learnt in the corresponding theory course.

Prerequisite

20CB130: Fundamentals of Computer Science

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Construct and Implement the stack and queue functionality for suitable applications.	20
CO2	Implement the operations in linked list data structure for suitable applications	20
CO3	Implement appropriate data structure for string manipulations and text editors	10
CO4	Implement appropriate searching and sorting techniques, with an understanding of the trade-off between the time and space complexity.	20
CO5	Implement graph traversals and manipulate with disjoint sets.	20
CO6	Manipulate files to store and retrieve non-linear data structure.	10

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS3	Apply	Value	Mechanism	1.2, 2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3
CO2	TPS3	Apply	Value	Mechanism	1.2, 2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3
CO3	TPS3	Apply	Value	Mechanism	1.2, 2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3
CO4	TPS3	Apply	Value	Mechanism	1.2, 2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3
CO5	TPS3	Apply	Value	Mechanism	1.2, 2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3
CO6	TPS3	Apply	Value	Mechanism	1.2, 2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	S	M	L	L	L	L	L	M	L	L	L	M	L	L
CO2	S	M	L	L	L	L	L	M	L	L	L	M	L	L
CO3	S	M	L	L	L	L	L	M	L	L	L	M	L	L
CO4	S	M	L	L	L	L	L	M	L	L	L	M	L	L
CO5	S	M	L	L	L	L	L	M	L	L	L	M	L	L
CO6	S	M	L	L	L	L	L	M	L	L	L	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Model Examination	Terminal Examination
Remember		
Understand		
Apply	100	100
Analyse		
Evaluate		
Create		

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject /Practical Component/Observation
Perception	
Set	
Guided Response	
Mechanism	100
Complex Overt Responses	
Adaptation	
Origination	

List of Experiments/Activities with CO Mapping

Module No.	Topic	Course Outcome
1	Implementation of Stack using arrays and linked list.	CO1
2	Implementation of Queue using arrays and linked list.	CO1
3	Implementation of Towers of Hanoi using user defined stacks.	CO1
4	Implementation of Singly Linked List.	CO2
5	Implementation of Doubly Linked List.	CO2
6	Implementation of reading, writing, and addition of polynomials.	CO2
7	Implementation of Line editor.	CO3
8	Implementation of Binary Search Tree operations and traversals	CO4
9	Implementation of AVL Tree.	CO4
10	Implementation of B Tree.	CO4
11	Implementation of Merge sort and Quick sort	CO4
11	Implementation of Disjoint Set.	CO5
12	Implementation of Breadth First Traversal and Depth First Traversal	CO5
13	Saving / retrieving non-linear data structure in/from a file	CO6
	Total sessions	

Learning Resources

1. E. Horowitz and S. Sahni , Fundamentals of Data Structures , Computer Science Press, 1977.
2. AlfredV.Aho, John E.Hopperoft, Jeffrey D.UIlman, Data Structures and Algorithms,Pearson Education,2002.
3. Donald E. Knuth ,The Art of Computer Programming: Volume 1: Fundamental Algorithms, Donald E. Knuth,3rd edition,Pearson Education.
4. Charles E. Leiserson, Thomas H. Cormen, Ronald L. Rivest, Clifford Stein, Introduction to Algorithms, Third edition, PHI, 2010.
5. Pat Morin,Open Data Structures: An Introduction (Open Paths to Enriched Learning), 31st ed. Edition , AU Press,2013

Course Designers:

1. Dr. M.Vijayalakshmi mviji@tce.edu
2. Raja Lavanya rlit@tce.edu

22CB282	PRINCIPLES OF ELECTRONICS LAB	Category	L	T	P	Credit
		ES	0	0	2	1

Preamble

The goal of this course is to supplement the theory course '20CB280 Principles of Electronics' by giving a practical exposure to the students to learn the characteristics of various electronic devices such as diodes, BJT,FET that are used nowadays in most of the electronic circuits. The students also learn the design and the construction of different electronic circuits based on the above electronic devices.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Correctly operate standard electronic test equipment such as digital multi-meters, power supplies to analyze, test, and implement analog and digital circuits	10
CO2	Characterize a PN junction Diodes experimentally and calculate static and dynamic resistance	20
CO3	Analyze the characteristics of the given BJT,FET	20
CO4	Analyze the characteristics of the zener diode as a voltage regulator	10
CO5	Design a diode rectifier circuit	10
CO6	Demonstrate inverting and non-inverting mode of operation of the operational amplifier	10
CO7	Demonstrate minimization of the given Boolean function and realize it using logic gates	20

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS3	Apply	Value	Mechanism	1.2.3, 2.2.3
CO2	TPS3	Apply	Value	Mechanism	1.2.3, 2.2.3
CO3	TPS4	Analyze	Organize	Complex Overt Responses	1.2.3, 2.2.3
CO4	TPS4	Analyze	Organize	Complex Overt Responses	1.2.3, 2.2.3
CO5	TPS4	Apply	Value	Mechanism	1.2.3, 2.2.3
CO6	TPS3	Apply	Value	Mechanism	1.2.3, 2.2.3
CO7	TPS3	Apply	Value	Mechanism	1.2.3, 2.2.3

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	S	M	L	L	S		M	M	M			M	M	L
CO2	S	M	L	L	S		M	M	M			M	M	L
CO3	S	S	S	M	S		M	M	M			S	M	L
CO4	S	S	S	M	S		M	M	M			S	M	L
CO5	S	S	S	M	S		M	M	M			S	M	L
CO6	S	M	L	L	S		M	M	M			M	M	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Model Examination	Terminal Examination
Remember		
Understand		
Apply	20	20
Analyse	50	50
Evaluate		
Create		

Assessment Pattern: Psychomotor

Psychomotor Skill	Practical Component
Perception	
Set	
Guided Response	
Mechanism	30
Complex Overt Responses	
Adaptation	
Origination	

List of Experiments/Activities with CO Mapping

Sl.No.	Name of the Experiment	No. of Sessions	Course Outcome
1.	Familiarization with Laboratory Instruments (Oscilloscope, Function Generator, Digital Multimeter, DC Power Supply, Bread Board) and Data sheet	2	CO1 – CO7
2.	V-I Characteristics of PN junction diode	2	CO1
3.	Characteristics of Zener diode and voltage regulator using Zener diode	1	CO4
4.	Design of Half and full wave Rectifiers	1	CO5
5.	V-I Characteristics of BJT and FET	2	CO3
6.	Verification of Inverting and noninverting operation using op-amps	1	CO6
7.	Study of logic gates and verification of Boolean Laws	2	CO7

Learning Resources

1. Adel S. Sedra and Kenneth C. Smith, "Microelectronic Circuits: Theory and Application", 7th Edition, Oxford University Press, 2017.

2. Jacob millman, christos halkias chetan parikh,"Millman's Integrated Electronics "Macgraw Hill education (india) private limited,2009
3. M. Morris Mano," Digital Logic & Computer Design" Pearson India Educational Services PvT. Limited, 2016
4. Robert L. Boylestad, Louis Nashelsky,"Electronic Devices and Circuit Theory", Pearson India Educational Services PvT. Limited,2015
5. Ben Streetman, Sanjay Banerjee," Solid State Electronic Devices",6th Edition, Prentice Hall of India 2005
6. NPTEL Video Lecture on "Basic Electronics and Lab" , weblink: https://nptel.ac.in/courses/122106025
7. MIT Video Lecture on "Circuits and Electronics" , weblink: https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-002-circuits-and-electronics-spring-2007/index.htm

Course Designers:

1. Dr.S.Kanthamani skmece@tce.edu

CURRICULUM AND DETAILED SYLLABI

FOR

B.Tech DEGREE (Computer Science and Business Systems) PROGRAMME

THIRD SEMESTER

FOR THE STUDENTS ADMITTED FROM THE

ACADEMIC YEAR 2025 - 2026 ONWARDS

THIAGARAJAR COLLEGE OF ENGINEERING

(A Government Aided ISO 9001-2008 certified
Autonomous Institution affiliated to Anna University)

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THIAGARAJAR COLLEGE OF ENGINEERING, MADURAI- 625 015

(A Govt. Aided, ISO 9001:2008 certified Autonomous Institution affiliated to Anna University)

B.Tech Degree (Computer Science and Business systems) Programme

COURSES OF STUDY

(For the candidates admitted from 2025 – 2026 onwards)

THIRD SEMESTER

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT HOURS	No.of Hours / Week			Credits
					L	T	P	
THERORY COURSES								
1	21CB312	Computer Organization and Architecture	PC	3	3	0	0	3
2	21CB321	Object Oriented Programming	PC	2	2	0	0	2
3	21CB331	Computational Statistics	ES	3	3	0	0	3
4	21CB341	Software Engineering	PC	3	3	0	0	3
5	21CB351	Formal Language and Automata Theory	PC	3	3	0	0	3
PRACTICAL COURSES								
6	21CB361	Computer Organization and Architecture Lab	PC	4	0	0	4	2
7	21CB372	Object Oriented Programming Lab	PC	4	0	0	4	2
8	21CB381	Computational Statistics Lab	ES	2	0	0	2	1
9	21CB391	Software Engineering Lab	PC	2	0	0	2	1
AUDIT COURSES								
10	21CHAB1	Constitution of India	AC	2	2	0	0	-
			TOTAL	**28**	**16**	**0**	**12**	**20**

AC : Audit Course
ES : Engineering Science
PC : Program Core
L : Lecture
T : Tutorial
P : Practical

Note:

1 Hour Lecture is equivalent to 1 credit

1 Hour Tutorial is equivalent to 1 credit

2 Hours Practical is equivalent to 1 credit

THIAGARAJAR COLLEGE OF ENGINEERING, MADURAI- 625 015

(A Govt. Aided, ISO 9001:2008 certified Autonomous Institution affiliated to Anna University)

B.Tech Degree (Computer Science and Business systems) Programme

SCHEME OF EXAMINATIONS

(For the candidates admitted from 2025 – 2026 onwards)

THIRD SEMESTER

S.No.	Course Code	Name of the Course	Duration of Terminal Exam. in Hrs.	Marks			Minimum Marks for Pass	
				Continuous Assessment	Terminal Exam *	Max. Marks	Terminal Exam	Total
THEORY								
1	21CB312	Computer Organization and Architecture	3	60	40	100	27	50
2	21CB321	Object Oriented Programming	3	60	40	100	27	50
3	21CB331	Computational Statistics	3	60	40	100	27	50
4	21CB341	Software Engineering	3	60	40	100	27	50
5	21CB351	Formal Language and Automata Theory	3	60	40	100	27	50
PRACTICAL								
5	21CB361	Computer Organization and Architecture Lab	3	50	50	100	18	50
6	21CB372	Object Oriented Programming Lab	3	50	50	100	18	50
7	21CB381	Computational Statistics Lab	3	50	50	100	18	50
8	21CB391	Software Engineering Lab	3	50	50	100	18	50

* Terminal Examination will be conducted for maximum marks of 100 and subsequently be reduced to 40 marks for the award of terminal examination marks

21CB312	COMPUTER ORGANIZATION AND ARCHITECTURE

Category	L	T	P	Credit
PC	3	0	0	3

Preamble

The syllabus is designed for the students to learn and understand the basic organization of computers and the working of its functional components. It gives a brief overview of the organization of a computer, instruction set and basic arithmetic operations. Then memory hierarchy, types of memories, organization of main memory, types of IO buses, and their operation are presented. Then the elements of cache memory design, it's mapping functions and replacement algorithms are emphasized.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Explain the basic principle of digital circuits and components of computers	15
CO2	Explain the various addressing modes, instruction set and data representation of CPU	15
CO3	Perform integer and floating point arithmetic operations on binary numbers and design CPU control unit	20
CO4	Design memory system and perform IO operations, for the given specifications	15
CO5	Estimate the performance improvement through pipelining and Identify the impact of cache coherency in parallel processors	15
CO6	Design the cache memory organization, its mapping functions and replacement algorithms and estimate the performance improvement	20

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond	Guided Response	1.3
CO2	TPS2	Understand	Respond	Guided Response	1.3
CO3	TPS3	Apply	Value	Mechanism	1.3,2.1.1
CO4	TPS3	Apply	Value	Mechanism	1.3,2.1.1
CO5	TPS3	Apply	Value	Mechanism	1.3,2.1.1
CO6	TPS3	Apply	Value	Mechanism	1.3,2.1.1

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L	-									L		
CO2	M	L	-									L		
CO3	S	M	L					L	L	L		M		L
CO4	S	M	L					L	L	L		M		L
CO5	S	M	L					L	L	L		M		L
CO6	S	M	L					L	L	L		M		L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	**2**	1	2	
Remember	20	20		-	10
Understand	20	20			30
Apply	60	60	100	100	60
Analyse					
Evaluate					
Create					

AssessmentPattern: Psychomotor

Psychomotor Skill	~~Miniproject~~/Assignment/~~Practical Component~~
Perception	-
Set	-
Guided Response	-
Mechanism	-
Complex Overt Responses	-
Adaptation	-
Origination	-

Sample Questions for Course Outcome Assessment**

Course Outcome 1(CO1):

1. Differentiate combinational and sequential circuit
2. Distinguish between computer structure and computer function?
3. List the components of computer system.

Course Outcome 2 (CO2):

1. List the different addressing modes.
2. Give an example for direct addressing mode.
3. Discuss the different ways of representing signed numbers.

Course Outcome 3 (CO3):

1. Use the Booth algorithm to multiply 23 (multiplicand) by 29 (multiplier), where each number is represented using 6 bits.

2. Illustrate the steps required for Floating point addition and show the steps for performing addition of 0.8125_{ten} and $-0.0625t_{en}$

Course Outcome 4 (CO4):

1. State the difference between DRAM and SRAM.
2. Why does DMA have priority over CPU when both when both request a memory transfer?

Course Outcome 5 (CO5):

1. Explain why the MEM and the IF stage of a pipeline can potentially have a structural hazard. What can be done to avoid that hazard?
2. What problem can exceptions cause when having a pipelined execution of instruction, and how is the problem typically solved?
3. Define cache coherence.

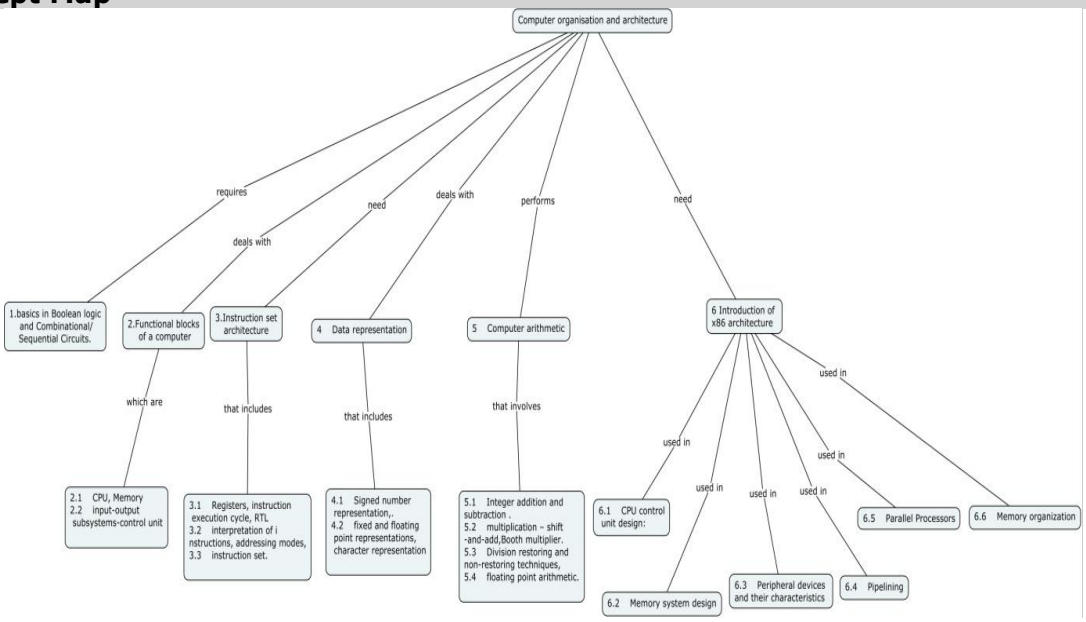
Course Outcome 6 (CO6):

1. For a direct-mapped cache, a main memory address is viewed as consisting of three fields. List and define the three fields.

2. A set-associative cache consists of 64 lines, or slots, divided into four-line sets. Main Memory contains 4K blocks of 128 words each. Show the format of main memory addresses.

3. Given the following specifications for an external cache memory: four-way set associative; line size of two 16-bit words; able to accommodate a total of 4K 32-bit words from main memory; used with a 16-bit processor that issues 24-bit addresses. Design the cache structure with all pertinent information and show how it interprets the processor's addresses.

Concept Map



Syllabus

Functional blocks of a computer: CPU, memory, input-output subsystems, control unit. Instruction set architecture of a CPU: Registers, instruction execution cycle, RTL interpretation of instructions, addressing modes, instruction set. Outlining instruction sets of some common CPUs.

Data representation: Signed number representation, fixed and floating point representations, character representation.

Computer arithmetic: Integer addition and subtraction, ripple carry adder, carry look-ahead adder, etc. multiplication – shift-and-add,Booth multiplier, carry save multiplier, etc. Division restoring and non-restoring techniques, floating point arithmetic, IEEE 754 format.
Introduction to x86 architecture.
CPU control unit design: Hardwired and micro-programmed design approaches, design of a simple hypothetical CPU.
Memory system design: Semiconductor memory technologies, memory organization.
Peripheral devices and their characteristics: Input-output subsystems, I/O deviceinterface, I/O transfers – program controlled, interrupt driven and DMA, privilegedand non-privileged instructions, software interrupts and exceptions. Programs andprocesses – role of interrupts in process state transitions, I/O device interfaces – SCII, USB
Pipelining: Basic concepts of pipelining, throughput and speedup, pipeline hazards.
Parallel Processors: Introduction to parallel processors, Concurrent access to memory and cache coherency.
Memory organization: Memory interleaving, concept of hierarchical memory organization, cache memory, cache size vs. block size, mapping functions, replacement algorithms, write policies.

Learning Resources

1. Computer System Architecture M. M. Mano:, 3rd ed., Pearson Education, 2007.
2. Computer Organization and Design: The Hardware/Software Interface, David A. Patterson and John L. Hennessy., Morgan Kaufmann publishers,2014
3. Computer Organization and Embedded Systems, Carl Hamacher.Mcgeaw Hill, 2002.
4. Computer Architecture and Organization, John P. Hayes,3rddeition, Tata Mcgraw hill , 1998.
5. Computer Organization and Architecture: Designing for Performance, William Stallings, Nineth edition, Prentice Hall, 2013.
6. Computer System Design and Architecture, Vincent P. Heuring and Harry F. Jordan, 3rd ed., Pearson Education, 2004.
7. https://circuitverse.org/

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1	Revision of basics in Boolean logic and Combinational/Sequential Circuits.	1	CO1
2	**Functional blocks of a computer**		
2.1	CPU, Memory	2	CO1
2.2	input-output subsystems-control unit	2	CO1
3	**Instruction set architecture of a CPU**		
3.1	Registers, instruction execution cycle, RTL	1	CO2
3.2	interpretation of instructions, addressing modes,	1	CO2
3.3	instruction set. Outlining instruction sets of some common CPUs.	1	CO2
4	**Data representation**		
4.1	Signed number representation,.	1	CO2
4.2	fixed and floating point representations, character representation	1	CO2
5	**Computer arithmetic**		
5.1	Integer addition and subtraction - ripple carry adder, carry look-ahead adder, etc.	1	CO3
5.2	multiplication – shift-and-add,Booth multiplier, carry	1	CO3

	save multiplier, etc.		
5.3	Division restoring and non-restoring techniques,	1	CO3
5.4	floating point arithmetic, IEEE 754 format.	1	CO3
6	**Introduction to x86 architecture.**		
6.1	**CPU control unit design:**		
6.1.1	Hardwired and micro-programmed design approaches,	1	CO3
6.1.2	design of a simple hypothetical CPU.	1	CO3
6.2	**Memory system design**		
6.2.1	Semiconductor memory technologies	1	CO4
6.2.2	memory organization	1	CO4
6.3	**Peripheral devices and their characteristics**		
6.3.1	Input-output subsystems, I/O device interface, I/O transfers – program controlled, interrupt driven and DMA.,	1	CO4
6.3.2	Privileged and non-privileged instructions, software interrupts and exceptions	1	CO4
6.3.3	Programs and processes – role of interrupts in process state transitions	1	CO4
6.3.4	I/O device interfaces – SCII, USB	1	CO4
6.4	**Pipelining**		
6.4.1	Basic concepts of pipelining, Throughput and speedup,	1	CO5
6.4.2	pipeline hazards	2	CO5
6.5	**Parallel Processors**		
6.5.1	Introduction to parallel processors	1	CO5
6.5.2	Concurrent access to memory and cache coherency	2	CO5
6.6	**Memory organization**		
6.6.1	Memory interleaving, concept of hierarchical memory organization	2	CO6
6.6.2	cache memory, cache size vs. block size	2	CO6
6.6.3	mapping functions,	2	CO6
6.6.4	replacement algorithms, write policies	2	CO6
	Total	36	

Course Designers:

1. Dr.C.Senthilkumar cskcse@tce.edu
2. Dr.K.Narasimma Mallikarjunan arjunkambaraj@tce.edu

21CB321	OBJECT ORIENTED PROGRAMMING

Category	L	T	P	Credit
PC	2	0	0	2

Preamble

This syllabus is intended for the Computer science students and enables them to learn Object Oriented Programming and the design of computer solutions in a precise manner. The syllabus emphasizes on OOP concepts, Functions, Polymorphism, Inheritance and I/O. The intention is to provide sufficient depth in these topics to enable candidates to apply Object Oriented Programming approach to programming. The modules in the syllabus reflect solving general problems via programming solution. Thus, modules collectively focus on programming concepts, strategies and techniques; and the application of these toward the development of programming solutions.

Prerequisite

Programming fundamentals

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Construct object-oriented programs for a given scenario using the concepts of abstraction, encapsulation, message-passing and modularity.	20
CO2	Illustrate the relationships between objects using inheritance.	15
CO3	Develop object-oriented programs for a given application using the concepts of compile-time and run-time polymorphism.	15
CO4	Construct object oriented programs for a given application using Generics and handle exceptions.	15
CO5	Construct object-oriented applications for a given scenario to persist data using files.	15
CO6	Develop object oriented design for the given scenario using UML diagram and evolve object oriented program from the design.	20

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS3	Apply	Value	Mechanism	1.2, 4.5.3
CO2	TPS3	Apply	Value	Mechanism	1.2, 4.5.3
CO3	TPS3	Apply	Value	Mechanism	1.2, 4.5.3
CO4	TPS3	Apply	Value	Mechanism	1.2, 4.5.3
CO5	TPS3	Apply	Value	Mechanism	1.2, 4.5.3
CO6	TPS3	Apply	Value	Mechanism	1.2, 4.5.3

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	S	M	L		M	M			M		M	M	M	L
CO2	S	M	L		M	M			M		M	M	M	L
CO3	S	M	L		M	M			M		M	M	M	L
CO4	S	M	L		M	M			M		M	M	M	L
CO5	S	M	L		M	M			M		M	M	M	L
CO6	S	M	L		M	M			M		M	M	M	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	**2**	1	2	
Remember	20	20			10
Understand	20	40			40
Apply	60	40	100	100	50
Analyse					
Evaluate					
Create					

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject/Assignment/Practical Component
Perception	-
Set	-
Guided Response	20
Mechanism	80
Complex Overt Responses	-
Adaptation	-
Origination	-

Sample Questions for Course Outcome Assessment**

Course Outcome 1(CO1)

1. Assume a class in C++ named Car that keeps track of price of cars. It has member variables carName, price and taxRate. Write a member function that computes the total price(including tax) of the Car object with the values passed as arguments, but which also includes 12.5% as a reasonable default value for taxRate. Create 2 Car objects and display their total price.
2. Write about the benefits of Object oriented Programming.
3. List the difference between inline and non-inline functions.

Course Outcome 2(CO2):

1. Discuss about public and protected derivations with an example program.
2. Consider the scenario in which a class named EBCustomerthat inherits into Domestic and Commercial. Define an interface named calculateTariff that is used both by the Domestic EB customer and the Commercial EB customer in calculating the Nett current consumption

charges. Create a Domestic EB customer object and a Commercial EB customer object and print the Nett current consumption charges of the customers

Course Outcome 3 (CO3):

1. Consider a class called **Dealer** and a class called **PartSupplier**. Multiply inherit them into **DealerPartSupplier**. Now define **LocaldealerPartSuppler** and **OutStationdealerPartSupplier** inheriting from DealerPartSupplier. Use virtual functions in C++ to show the number of parts supplied by LocaldealerPartSupplier and OutStationdealerPartSupplier.
2. Write a C++ program to create 2 overloaded functions named findAtto find the digit / character at the position specified. One function takes a number and position as arguments. Another function takes a string and position as arguments.

Course Outcome 4 (CO4):

1. Write a program to create a class named BirthDay that has date, month and year as members. Write a program to create BirthDay objects of 5 students. Write object oriented exception handling code to validate the month, day and year of thecreatedBirthDay objects.
2. Create a class named Account having Account number, Customer Name and balance as member variables and deposit and withdraw as member functions. Write the exception handling code when the balance of an account drops below Rs.1000.
3. Write a Generic class to sort integers and string.

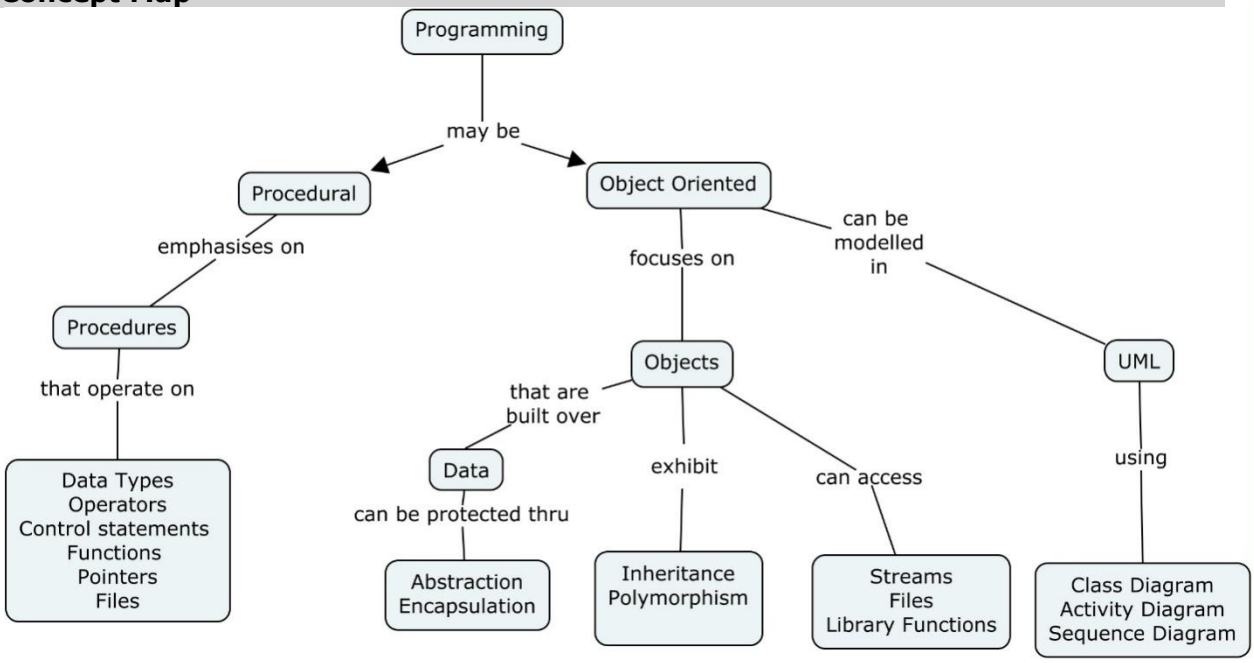
Course Outcome 5(CO5):

1. Consider a class called **UsedCar** which uses an interface called secsalesItem. The UsedCar class has the following fields: vehicleNumber, model, year, kmTravelled, price and the following methods: getVehicleNumber, getModel and getRetailPrice. The interface secsalesItem has only one method called getRetailPrice which calculates price based on the year of manufacture and kilometers travelled. Create 5 usedCar objects and serialize them into a file
2. Write a student database maintenance application using c++
3. Write a program to copy the content of one file to another file.

CourseOutcome6(CO6):

1. PATIENTBASE is a patient management system. The users of this system schedules patient appointment, manages patient admission and can delete any patient record through this system. There are two types of patients in this system. Patients who visit the doctor in the outdoor with an appointment are called Out-Patient. Patients who get admitted in the hospital are called In-Patient. Give the sequence diagram for the given scenario.
2. Determine the user requirements for a web phone-mail product. The primary purpose of this product is to give phone-mail users (e.g., faculty and staff) the ability to access the functionality of the phone-mail system from a web page. In general, the product should enable users of the phone-mail system to do their usual phone-mail activities via a web page. Determine what are those activities, in the form of product requirements and give a Use case diagram for the same.
3. A bank system contains data on customers (identified by name and address) and their accounts. Each account has a balance and there are 2 type of accounts: one for savings which offers an interest rate, the other for investments, used to buy stocks. Stocks are bought at a certain quantity for a certain price (ticker) and the bank applies commission on stock orders. Draw the class diagram and write the corresponding C++ classes.

Concept Map



Syllabus

Procedural programming, An Overview of C: Types Operator and Expressions, Scope and Lifetime, Constants, Pointers, Arrays, and References, Control Flow, Functions and Program Structure, Namespaces, error handling, Input and Output (*C*-way), Library Functions (*string*, *math*, *stdlib*), Command line arguments, Pre-processor directive. Some difference between C and C++:Single line comments, Local variable declaration within function scope, function declaration, function overloading, stronger type checking, Reference variable, parameter passing – value vs reference, passing pointer by value or reference, Operator new and delete, the typecasting operator, Inline Functions in contrast to macro, default arguments. **Fundamentals of Object Oriented Programming:** Necessity for OOP, Data Hiding, Data Abstraction, Encapsulation, Procedural Abstraction, Class and Object. **More extensions to C in C++ to provide OOP Facilities:** Scope of Class and Scope Resolution Operator, Member Function of a Class, private, protected and public Access Specifier, this Keyword, Constructors and Destructors, friend class, error handling (exception). **Essentials of Object Oriented Programming:** Operator overloading, Inheritance – Single and Multiple, Class Hierarchy, Pointers to Objects, Assignment of an Object to another Object, Polymorphism through dynamic binding, Virtual Functions, Overloading, overriding and hiding, Error Handling. Generic Programming: Template concept, class template, function template, template specialization. **Input and Output:** Streams, Files, Library functions, formatted output. **Object Oriented Design and Modelling:** UML concept, Use case for requirement capturing, Class diagram, Activity diagram and Sequence Diagram for design, Corresponding C++&Java code from design

Learning Resources

1. A Tour of C++ (Second edition) ,BjarneStroustrup Addison-Wesley. ISBN 978-0-13-499783-4. July 2018.
2. The C++ Programming Language, BjarneStroustrup, Addison-Wesley Professional ISBN: 9780133522884,2013.
3. C++ and Object-Oriented Programming Paradigm, Debasish Jana, PHI Learning Pvt. Ltd, 2014

4. Programming – Principles and Practice Using C++, BjarneStroustrup, Addison Wesley, 2014.
5. The Design and Evolution of C++, BjarneStroustrup, Addison Wesley,1994

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1	**Procedural programming, An Overview of C and Fundamentals of Object Oriented Programming (5)**		
1.1	Types Operator and Expressions, Scope and Lifetime, Constants, Pointers, Arrays, and References, Control Flow, Functions, Program Structure, Namespaces, error handling, Input and Output (*C*-way), Library Functions (*string*, *math*, *stdlib*), Command line arguments, Pre-processor directive.	1	CO1
1.2	Some difference between C and C++:Single line comments, Local variable declaration within function scope, function declaration, function overloading, stronger type checking, Reference variable, parameter passing – value vs reference, passing pointer by value or reference, Operator new and delete, the typecasting operator, Inline Functions in contrast to macro, default arguments.	1	CO1
1.3	Necessity for OOP, Data Hiding	1	CO1
1.4	Data Abstraction	1	CO1
1.5	Encapsulation, Procedural Abstraction, Class and Object.	1	CO1
2	**Inheritance(3)**		
2.1	Scope of Class and Scope Resolution Operator, Member Function of a Class, private, protected and public Access Specifier,	1	CO2
2.2	this Keyword, Constructors and Destructors, friend classes	1	CO2
2.3	Inheritance – Single and Multiple, Class Hierarchy	1	CO2
3	**Polymorphism(4)**		
3.1	Operator overloading,	1	CO3
3.2	Pointers to Objects, Assignment of an Object to another Object, Polymorphism through dynamic binding	1	CO3
3.3	Virtual Functions, Overloading, overriding and hiding, Inner Classes and Annonymous Classes	1	CO3
3.4	Aggregation and Composition	1	CO3
4.	**Generic Programming and Exception Handling (4)**		
4.1	Generic Programming: Template concept	1	CO4
4.2	class template, function template	1	CO4
4.3	template specialization	1	CO4
4.4	error handling (exception)	1	CO4
5	**Input and Output(3)**		
5.1	Streams	1	CO5
5.2	Files	1	CO5

5.3	Library functions, formatted output	1	CO5
6	**Object Oriented Design and Modelling(5)**		
6.1	UML concept, Use case for requirement capturing	1	CO6
6.2	Class diagram	1	CO6
6.3	Activity diagram	1	CO6
6.4	Sequence Diagram	1	CO6
6.5	Corresponding C++ code from Design	1	CO6
	Total	24	

Course Designers:

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2. Dr.S.Prasanna sprcse@tce.edu

21CB331	COMPUTATIONAL STATISTICS	CATEGORY	L	T	P	CREDIT
		ES	3	0	0	3

Preamble

Computational statistics, or statistical computing, is the interface between statistics and computer science. It is the area of computational science specific to the mathematical science of statistics. The goal of this course is to present essential statistical concepts and introduces students to cognitive learning in computational statistics and develops skills on analyzing the data by using different analysis like discriminant analysis, principal component analysis, factor analysis

Prerequisite

Basic probability concepts

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Understand multivariate Normal Distribution Functions and stochastic processes compute marginal and conditional distributions as well as the parameters in a bivariate distribution	15
CO2	Identify discriminant functions that are the linear combination of independent variables that will discriminate between the categories of the dependent variable	15
CO3	Apply principal component analysis which will help in dimensionality reduction and to Convert set of correlated variables to non-correlated variables.	15
CO4	Understand summarization of data and data reduction and to determine number of factors involved in the analysis	15
CO5	Discover the purpose of clustering, its types and measurements	20
CO6	Solve the problems with the appropriate clustering algorithm	20

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond		1.2.7,1.3.6, 2.1.1
CO2	TPS3	Apply	Value	Mechanism	1.2.7,1.3.6, 2.1.1
CO3	TPS3	Apply	Value	Mechanism	1.2.7,1.3.6, 2.1.1
CO4	TPS2	Understand	Respond		1.2.7,1.3.6, 2.1.1
CO5	TPS3	Apply	Value	Mechanism	1.2.7,1.3.6, 2.1.1, 2.4.6, 4.5.3
CO6	TPS3	Apply	Value	Mechanism	1.2.7,1.3.6, 2.1.1, 2.4.6, 4.5.3

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L									L	L		
CO2	S	M	L								L	M		
CO3	S	M	L								L	M		
CO4	M	L									L	L		
CO5	S	M	L		L	L					L	M	L	
CO6	S	M	L		S	L					L	M	L	

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	2	1	2	
Remember	10	10	-	-	-
Understand	30	30	-	-	30
Apply	60	60	100	100	70
Analyze					
Evaluate					
Create					

Sample Questions for Course Outcome Assessment

Course Outcome 1(CO1)

1.The joint probability mass function of (X, Y) is given byp(x, y) = k(2x + 3y), x =0, 1, 2; y = 1,2,3. Compute all the marginal and conditional probability distributions. Also find the probability distribution of (X+Y)

2. If the joint probability density function of a two-dimensional random variable (x, Y) is given by

f(x, y) = $x^2 + \frac{xy}{3}; fpr\ 0 < x < 1, 0 < y < 2\ and\ 0\ elsewhere$

Find (i) P [X >$\frac{1}{2}$]

(ii) P (Y < X)

(iii) P (Y<$\frac{1}{2}$ / X<$\frac{1}{2}$)

3. Discuss the properties of estimators and maximum likelihood estimator

Course Outcome 2(CO2).

1. How to Perform Discriminant Analysis?
2. Calculate the discriminant function for the following data
   Sample means based on 50 observations each for two species

Character	Iris versicolor	Iris Setosa	Difference
Sepal length	5.936	5.006	0.930
Sepal width	2.7700	3.428	-0.658
Petal length	4.260	1.462	2.789
Petal width	1.326	0.246	1.080

3. Discuss the properties of discriminant analysis

Course Outcome 3(CO3)

1. The feeding pattern of 20 lactating buffaloes adopted in the rural area of Gurgaon district of Haryana is given below. The measured quantity (in kgs.) of feed fed to them are green(X_1), dry fodder(X_2) and concentrate (X_3) as per their lactation number (X_4) Find out the principal components which may account for most of the variation in the data

X_1	X_2	X_3	X_4
30	8	2.0	4
20	11	1.7	4
30	12	2.0	4
22	11	2.0	4
22	12	1.4	4

22	6	0.5	4
20	12	3.5	4
25	12	1.5	5
10	10	.05	5
25	2	0.5	5
15	8	3.0	2
22	8	2.0	2
22	12	2.0	2
8	7	3.2	1
10	12	1.0	1
20	10	1.0	1
3	12	2.0	6
2	12	2.0	6
10	10	0.7	6
23	4	4.5	5

2.Identify the principal components through covariance matrix of the variables
The variables X = (X_1, X_2, X_3) have the covariance matrix as

$$\sum = \begin{bmatrix} 67.629 & -5.871 & 0.318 \\ & 8.787 & -0.287 \\ & & 1.138 \end{bmatrix}$$

3. Define x as 100 linearly spaced values between -2π and 2π. Define y_1 and y_2 as sine and cosine values of x. Create a line plot of both sets of data.

Course Outcome 4 (CO4)

1. What is factor analysis?

2.

Show that the maximum likelihood estimators of Λ and Ψ given $\Phi = I$ are

$$\hat{\Lambda} = C_{xf}^{*} C_{ff}^{*-1},$$

$$\hat{\Psi} = C_{xx}^{*} - C_{xf}^{*} C_{ff}^{*-1} C_{xf}^{*\prime}.$$

3.Discuss about various rotations in factor analysis
4.Distinguish between factor analysis and principal component analysis

Course Outcome 5(CO5)

1. Given Six observations of 2 variables,

Obs.	X_1	X_2
a	3	2
b	4	1
c	2	5
d	5	2
e	1	6
f	4	2

Using the nearest neighbor method and the squared Euclidean distance as a measure the dissimilarity between the data.

2. Describe two methods for validating the results of cluster analysis.
3. Interpret the different types of clustering algorithms with a real time dataset.

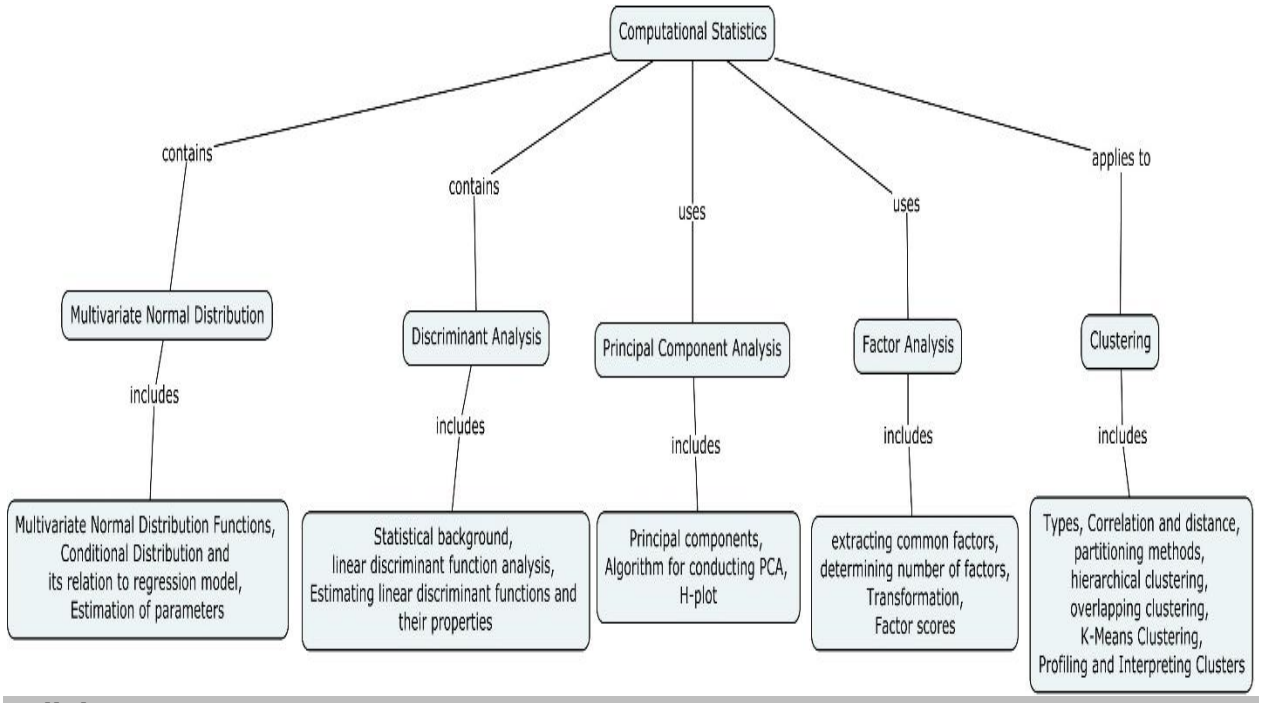
Course Outcome 6(CO6)

1. Based on the given Six observations apply the k-means algorithm and observe the assumptions in both the group that contains a and e.

Obs.	X_1	X_2
a	-1	-2
b	0	0
c	2	2
d	-2	-2
e	1	-1
f	1	2

2. Partial clustering algorithm automatically determines the number of clusters formed. Mention any two situations where this statement fails.
3. Based on the data perform cluster analysis to confirm the results concerning the nearest neighbor, average linkage and k-means method.

Concept Map



Syllabus

Multivariate Normal Distribution: Multivariate Normal Distribution Functions, Conditional Distribution and its relation to regression model, Estimation of parameters, stochastic process-Markov process, Poisson process

Discriminant Analysis: Statistical background, linear discriminant function analysis, Estimating linear discriminant functions and their properties.

Principal Component Analysis: Principal components, Algorithm for conducting principal component analysis, deciding on how many principal components to retain, H-plot.

Factor Analysis: Factor analysis model, extracting common factors, determining number of factors, Transformation of factor analysis solutions, Factor scores.

Clustering: Introduction, Types of clustering, Correlations and distances, clustering by partitioning methods, hierarchical clustering, overlapping clustering, K-Means Clustering-Profiling and Interpreting Clusters

Learning Resources

1. T.W. Anderson, "An Introduction to Multivariate Statistical Analysis", Third Edition, A JOHN WILEY & SONS, INC., PUBLICATION, 2003.
2. J.D. Jobson, "Applied Multivariate Data Analysis, Vol I & II", First Edition, Springer-Verlag New York, 1992.
3. **Kres**, Heinz, "Statistical Tests for Multivariate Analysis", First Edition, Springer-Verlag New York, 1983.
4. Mark Lutz, "Programming Python", 4th Edition, O'Reilly Media, 2010.
5. Tim Hall and J-P Stacey, "Python 3 for Absolute Beginners", Apress, 1st ed. Edition, 2009
6. Magnus Lie Hetland, Beginning Python: From Novice to Professional, APress Edition, 2005
7. J. Neter, W. Wasserman and M.H. Kutner, "Applied Linear Regression Models", Fifth Edition, e McGraw-Hill Companies, Inc., 2005
8. A.S. Mulaik, The Foundations of Factor Analysis, Second Edition, Chapman and Hall/CRC, 2009.
9. D.C. Montgomery and E.A. Peck., "Introduction to Linear Regression Analysis", 5th edition, Wiley, 2012
10. M.R. Anderberg, "Cluster Analysis for Applications", 1st edition, Academic Press, 1973.
11. D .F. Morrison, "Multivariate Statistical Analysis", Brooks/Cole; New edition 2004.
12. Wes Mc Kinney, Python for Data Analysis, O'Reilly Media; 2nd edition, 2017.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Multivariate Normal Distribution**		
1.1	Multivariate Normal Distribution Functions	1	CO1
1.2	Conditional and marginal Distribution	2	CO1
1.3	Relation to regression model	2	CO1
1.4	Estimation of parameters	1	CO1
1.5	Stochastic process-Markov process	1	CO1
1.6	Poisson process	1	CO1
2.	**Discriminant Analysis**		
2.1	Statistical background	1	CO2
2.2	linear discriminant function analysis	2	CO2
2.3	Estimating linear discriminant functions	2	CO2
2.4	Properties of Discriminant Analysis	1	CO2
3.	**Principal Component Analysis**		
3.1	Principal components	1	CO3
3.2	Algorithm for conducting principal component analysis	2	CO3
3.3	deciding on how many principal components to retain	1	CO3
3.4	H-plot.	2	CO3
4.	**Factor Analysis**		
4.1	Factor analysis model	1	CO4
4.2	extracting common factors	1	CO4
4.3	determining number of factors	1	CO4
4.4	Transformation of factor analysis	1	CO4
4.5	Factor scores	1	CO4
5.	**Clustering**		
5.1	Introduction	1	CO5
5.2	Types of clustering	1	CO5
5.3	Correlations and distances	1	CO5
5.4	clustering by partitioning methods	2	CO5

5.5	hierarchical clustering	1	CO6
5.6	overlapping clustering	2	CO6
5.7	K-Means Clustering-Profiling	2	CO6
5.8	Interpreting Clusters	1	CO6
Total		36	

Course Designers:

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21CB341	SOFTWARE ENGINEERING

Category	L	T	P	Credit
PC	3	0	0	3

Preamble

This subject is to promote the practice of software engineering concepts at a higher level of abstraction, in a more engineering-like fashion. This course is to impart knowledge on various software development models and processes that are used by professionals for designing and developing the software.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Explain software engineering methods, practices, and their appropriate application	25
CO2	Compute cost and effort required to complete a given software using the estimation techniques	15
CO3	Explain the metrics and models of Software Quality and Reliability	15
CO4	Analyze the techniques for requirements gathering and modeling	20
CO5	Design the model for the given software requirements using Object Oriented Analysis	10
CO6	Apply various testing methods for real time applications	15

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond	-	1.2, 2.1.1,2.1.2, 4.1.1, 4.1.2
CO2	TPS3	Apply	Value	-	1.2, .1.1,2.1.2, 2.1.3
CO3	TPS2	Understand	Respond	-	1.2, 2.1.1, 2.1.3, 4.1.1, 4.1.2
CO4	TPS3	Apply	Value	-	1.2, 2.1.1, 2.1.2, 2.1.3, 2.1.5,3.2.3, 4.3.1, 4.3.2
CO5	TPS3	Apply	Value	-	1.2, 2.1.1, 2.1.2, 2.1.3, 2.1.5,3.2.3, 4.3.1, 4.3.2, 4.5.1, 4.5.3
CO6	TPS3	Apply	Value	-	1.2, 2.1.1, 2.1.2, 2.1.3, 2.1.5,3.2.3, 4.3.1,4.5.5

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L	-	-	M	M	M	L	M	M	M	L	M	M
CO2	S	M	L	-	S	S	S	M	S	S	S	M	S	S
CO3	S	M	L	-	M	M	M	L	M	M	M	M	M	M
CO4	S	M	L	-	S	S	S	M	S	M	S	M	S	S
CO5	S	M	L	-	S	S	S	M	S	L	S	M	S	S
CO6	M	L	-	-	S	S	S	M	S	L	S	M	S	S

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	**2**	1	2	
Remember	20	20	-	-	-
Understand	20	20	-	-	40
Apply	60	60	100	100	60
Analyse	-	-	-	-	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Assessment Pattern: Psychomotor

Psychomotor Skill	Assignment
Perception	-
Set	-
Guided Response	-
Mechanism	-
Complex Overt Responses	-
Adaptation	-
Origination	-

Sample Questions for Course Outcome Assessment**

Course Outcome 1 (CO1):

1. What is the need for engineering software? (Remember)
2. Explain Evolutionary process models in detail. (Understand)
3. Explain how electronic connectivity between various development teams can support software engineering activities. (Understand)

Course Outcome 2 (CO2):

1. What are the causes for variations in project estimates? (Remember)
2. Describe the difference between process and project metrics. (Understand)
3. Use the COCOMO II model to estimate the effort required to build software for simple ATM that produces 15 screens, 12 reports and will require approximately 60 software components .Assume all weighting factor is 5 and developer/environment maturity is 25. (Apply)

Course Outcome 3 (CO3):

1. List various software Quality metrics. (Remember)
2. Discuss about Capability Maturity Models (Understand)
3. Discuss about risk management in detail. (Understand)

Course Outcome 4 (CO4):

1. Give the structure of SRS and define each one (Remember)
2. Suggest how an engineer responsible for drawing up a system requirements specification might keep track of the relationships between functional and non-functional requirements. (Apply)
3. Develop a SRS for weather monitoring system (Apply)

Course Outcome 5 (CO5):

1. What is meant by refactoring? (Remember)
2. Discuss about encapsulation and its advantages (Understand)
3. Develop CRC model for the inventory control management system with the following requirements, (Apply)
   - Placing and Tracking orders
   - Deliver the orders and Bill the customer
   - Keep track of the stocks in the stores

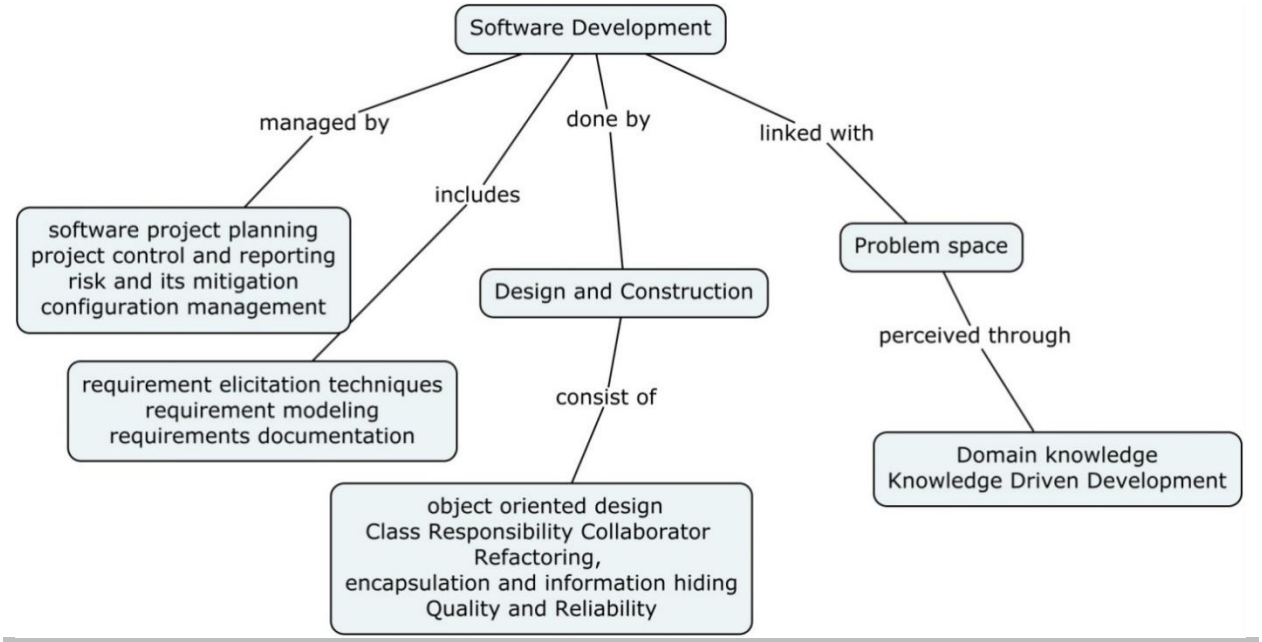
Course Outcome 6 (CO6):

1. Explain the various Black Box Testing Techniques. (Understand)
2. Design a set of test cases for the following program that selects largest of three numbers. (Apply)

```
                main()
                    {
floataa,b,c;
scanf ( "%f%f%f,&a,&b,&c);
                        If (a>b)
{  If (a>c)
printf("%f\n",a);
else
printf("%f\n",c);
                                } else
                                    If (c>b)
printf("%f\n",c);
else
printf("%f\n",b);
                                }}
```

3. Using Boundary value analysis, design the black-box test suite for a software that computes the square root of an input integer which can assume values in the range of 0 to 5000. (Apply)

Concept Map



Syllabus

Introduction: Programming in the small vs. programming in the large; software project failures and importance of software quality and timely availability; engineering approach to software development; role of software engineering towards successful execution of large software projects; emergence of software engineering as a discipline.

Software Project Management: Basic concepts of life cycle models – different models and milestones; software project planning –identification of activities and resources; concepts of feasibility study; techniques for estimation of schedule and effort; software cost estimation models and concepts of software engineering economics; techniques of software project control and reporting; introduction to measurement of software size; introduction to the concepts of risk and its mitigation; configuration management.

Software Quality and Reliability: Internal and external qualities; process and product quality; principles to achieve software quality; introduction to different software quality models like McCall, Boehm, FURPS / FURPS+, Dromey, ISO – 9126; introduction to Capability Maturity Models (CMM and CMMI); introduction to software reliability, reliability models and estimation.

Software Requirements Analysis, Design and Construction: Introduction to Software Requirements Specifications (SRS) and requirement elicitation techniques;techniques for requirement modeling – decision tables, event tables, state transition tables, Petri nets; requirements documentation through use cases; introduction to UML, introduction to software metrics and metrics based control methods; measures of code and design quality.

Object Oriented Analysis, Design and Construction: Concepts -- the principles of abstraction, modularity, specification, encapsulation and information hiding; concepts of abstract data type; Class Responsibility Collaborator (CRC) model; quality of design; design measurements; concepts of design patterns; Refactoring; object oriented construction principles; object oriented metrics.

Software Testing: Introduction to faults and failures; basic testing concepts; concepts of verification and validation; black box and white box tests; white box test coverage – code coverage, condition coverage, branch coverage; basic concepts of black-box tests – equivalence classes, boundary value tests, usage of state tables; testing use cases;

transaction based testing; testing for non-functional requirements – volume, performance and efficiency; concepts of inspection.

Problem Space Understanding: How an industry works, how an IT company works, How IT supports business, Problem Space Understanding, Knowledge Driven Development (KDD), Domain knowledge framework of KDD, usage of domain knowledge framework in Insurance, Banking and Automobile, KDD as a project delivery methodology, Linking domain knowledge to software development, A case study to produce a KDD artifact using Agile.

Learning Resources

1. Ian Sommerville , "Software Engineering" , 10th Edition, John Wiley and sons,2015.
2. Roger S. Pressman, "Software Engineering: A Practitioner's Approach", 7th Edition, McGraw Hill Education, 2017
3. PankajJalote, "Software Engineering: A Precise Approach ",Wiley, 2010
4. Carlo Ghezzi, Jazayeri Mehdi, Mandrioli Dino, "Fundamentals of Software Engineering", 2nd edition,2002
5. Erich Gamma, Richard Helm, Ralph Johnson, John Vlissides, "Design Patterns: Elements of Object-Oriented Reusable Software", 2015
6. Shari Lawrence Pfleeger and Joanne, "M. Atlee Software Engineering: Theory and Practice", 2006
7. Bertrand Meyer, "Touch of Class: Learning to Program Well with Objects and Contracts", 2009
8. Martin Fowler, "UML Distilled: A Brief Guide to the Standard Object Modeling Language", 2018

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1	**Introduction**		
1.1	Programming in the small vs. programming in the large; software project failures and importance of software quality and timely availability	1	CO1
1.2	Engineering approach to software development; role of software engineering towards successful execution of large software projects; emergence of software engineering as a discipline.	1	CO1
2	**Software Project Management**		
2.1	Basic concepts of life cycle models – different models and milestones	2	CO1
2.2	Software project planning –identification of activities and resources; concepts of feasibility study	1	CO2
2.3	Techniques for estimation of schedule and effort; software cost estimation models and concepts of software engineering economics	2	CO2
2.4	Techniques of software project control and reporting; Introduction to measurement of software size	1	CO2
2.5	Introduction to the concepts of risk and its mitigation; configuration management.	2	CO2
3	**Software Quality and Reliability**		
3.1	Internal and external qualities; process and product quality; principles to achieve software quality	1	CO3
3.2	Introduction to different software quality models like McCall, Boehm, FURPS / FURPS+, Dromey, ISO – 9126	2	CO3

3.3	Introduction to Capability Maturity Models (CMM and CMMI)	1	CO3
3.4	Introduction to software reliability, reliability models and estimation.	2	CO3
4	**Software Requirements Analysis, Design and Construction**		
4.1	Introduction to Software Requirements Specifications (SRS) and requirement elicitation techniques	2	CO4
4.2	Techniques for requirement modeling – decision tables, event tables, state transition tables, Petri nets;	2	CO4
4.3	Requirements documentation through use cases; Introduction to UML	1	CO4
4.4	Introduction to software metrics and metrics based control methods; measures of code and design quality.	2	CO4
5	**Object Oriented Analysis, Design and Construction**		
5.1	Concepts - the principles of abstraction, modularity, specification, encapsulation and information hiding; concepts of abstract data type;	1	CO5
5.2	Class Responsibility Collaborator (CRC) model; quality of design; design measurements; concepts of design patterns;	2	CO5
5.3	Refactoring; object oriented construction principles; object oriented metrics.	1	CO5
6	**Software Testing**		
6.1	Introduction to faults and failures; basic testing concepts; concepts of verification and validation; black box and white box tests;	1	CO6
6.2	white box test coverage – code coverage, condition coverage, branch coverage;	1	CO6
6.3	Basic concepts of black-box tests – equivalence classes, boundary value tests, usage of state tables; testing use cases; transaction based testing;	2	CO6
6.4	Testing for non-functional requirements – volume, performance and efficiency; concepts of inspection.	1	CO6
7	**Problem Space Understanding**		
7.1	How an industry works, how an IT company works, How IT supports business, Problem Space Understanding	1	CO1
7.2	Knowledge Driven Development (KDD), Domain knowledge framework of KDD,	1	CO1
7.3	Usage of domain knowledge framework in Insurance, Banking and Automobile, KDD as a project delivery methodology, Linking domain knowledge to software development	1	CO1
7.4	A case study to produce a KDD artifact using Agile.	1	CO1
	Total Hours	**36**	

Course Designers:

1. Dr. A. Malini amcse@tce.edu

21CB351	FORMAL LANGUAGE AND AUTOMATA THEORY

Category	L	T	P	Credit
PC	3	0	0	3

Preamble

This course is to introduce students to the core area of computer science. The course will aid the students to focus on the study of abstract models of computation. These abstract models are needed to assess and solve the computing problems in computer science and engineering via formal reasoning. The students will be exposed to the computability as well as complexity theory. The goal is to aid the students in answering fundamental questions about problems, such as whether they can or not be computed. If the problem can be computed, then what will be its efficiency. The course introduces basic computation models and their properties, and the necessary mathematical techniques to prove the advanced attributes of these models. On successful completion of the course, the students will be able to express computer science problems as mathematical statements and formulate the proof to show the efficiency.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Construct finite state machines and the equivalent regular expressions (Apply)	20
CO2	Construct pushdown automata and the equivalent context free grammars. (Apply)	20
CO3	Construct a linear bound automata for the given context-sensitive language (Apply)	15
CO4	Sketch a turing machine for the given computational problem (Apply)	20
CO5	Demonstrate undecidability for various problems (Apply)	15
CO6	Interpret the characteristics of P, NP and NP Complete problems in the context of Turing machines (Understand)	10

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS3	Apply	Value	Mechanism	1.2,2.3.2,3.2.3,4.4.3
CO2	TPS3	Apply	Value	Mechanism	1.2,2.3.2, 3.2.3,4.4.3
CO3	TPS3	Apply	Value	Mechanism	1.2,2.3.2, 3.2.3,4.4.3
CO4	TPS3	Apply	Value	Mechanism	1.2,2.3.2, 3.2.3,4.4.3
CO5	TPS3	Apply	Value	Mechanism	1.2,2.3.2, 3.2.3,4.4.3
CO6	TPS2	Understand	Respond	Guided Response	1.2,2.3.2, 3.2.3,4.4.3

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	S	M	L		L	L	L	L	L		L	M	L	L
CO2	S	M	L		L	L	L	L	L		L	M	L	L
CO3	S	M	L		L	L	L	L	L		L	M	L	L
CO4	S	M	L		L	L	L	L	L		L	M	L	L
CO5	S	M	L		L	L	L	L	L		L	M	L	L
CO6	M	L				L	L	L	L		L	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	2	1	2	
Remember	20	20	-	-	20
Understand	20	40	30	30	20
Apply	60	40	70	70	60
Analyse					
Evaluate					
Create					

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject /Assignment/Practical Component
Perception	
Set	
Guided Response	30
Mechanism	70
Complex Overt Responses	
Adaptation	
Origination	

Sample Questions for Course Outcome Assessment**

Course Outcome 1(CO1):

1. Construct a right-linear grammar for the language L ((aab*ab)*).
2. Show that for every regular language not containing λ there exists a right-linear grammar whose productions are restricted to the forms

   $A \rightarrow aB$, or $A \rightarrow a$, where $A, B \in V$, and $a \in T$
3. Let G1 = (V2 ,Σ,S2 ,P2) be right-linear and G2= (V2 , Σ,,S2 ,P2) be a left-linear grammar, and assume that V1 and V2 are disjoint. Consider the linear grammar G =({S}∪ V1 ∪ V2 , Σ,S, P), where S is not in V1 ∪ V2 and P = {S → S1 |S2}∪ P1 ∪ P2 . Show that L(G) is regular.

Course Outcome 2(CO2):

1. Construct an LL grammar for the language L (a*ba) ∪ L (abbb*).
2. Show that if G is an LL (k) grammar, then L (G) is a deterministic context-free language.
3. Show that L = $\{a^n b^{2n} : n \geq 0\}$ is a deterministic context-free language

Course Outcome 3(CO3):

1. Find linear bounded automata for the following language, L = $\{a^n : n = m^2, m \geq 1\}$.
2. Find linear bounded automata for the following language, L = $\{a^n : n$ is a prime number$\}$.
3. Find linear bounded automata for the following language, L = $\{a^n : n$ is not a prime number$\}$.

Course Outcome 4 (CO4):

1. Consider the set of machine language instructions for a computer of your choice. Sketch how the various instructions in this set could be carried out by a Turing machine.
2. At one point the Turing machines appear to be more powerful than pushdown automata. Since the tape of a Turing machine can always be made to behave like a stack, it would seem that we can actually claim that a Turing machine is more powerful. What important factor is not taken into account in this argument?
3. Consider a Turing machine with a different decision process in which transitions are made if the current tape symbol is not one of a specified set. For example, $\delta(q_i, \{a, b\}) = (q_j, c, R)$ will allow the indicated move if the current tape symbol is neither a nor b. Formalize this concept and show that this modification is equivalent to a standard Turing machine.

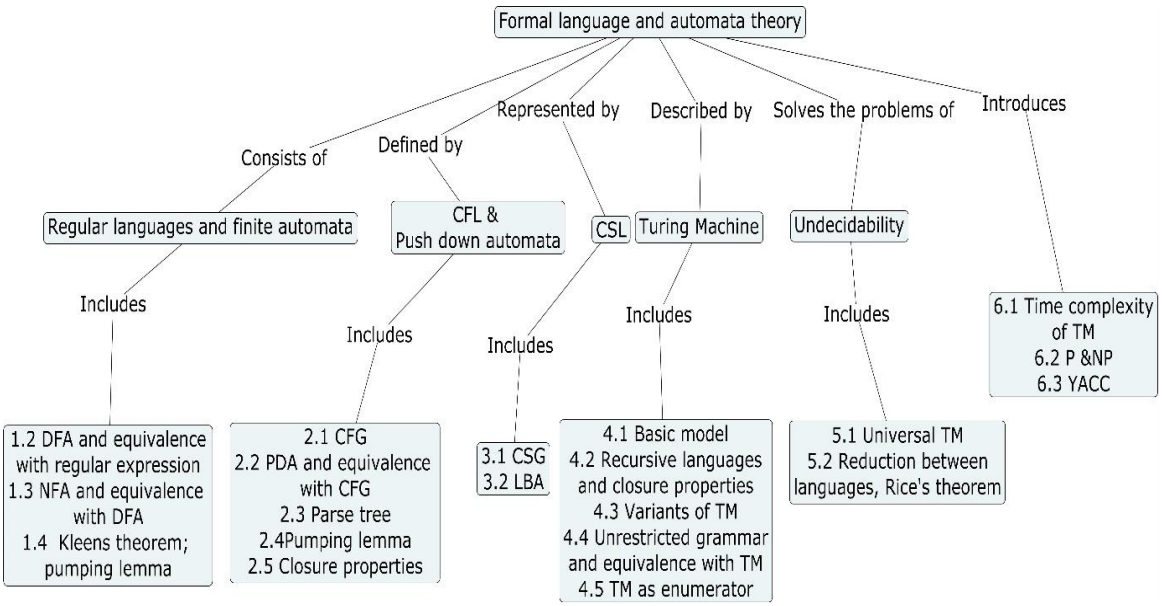
Course Outcome 5 (CO5):

1. Show that the problem of determining whether or not $L(G_i) \subseteq L(G_2)$ is undecidable for context-free grammars G_1 ,G_2 .
2. Show that for arbitrary context-free grammars G1 and G2 , the problem "L(G1) ∩ L (G2) is context-free" is undecidable.
3. Let G1 and G2 be grammars with G1 regular. Is the problem L (G1) = L (G2) decidable when (a) G2 is unrestricted, (b) when G2 is context-free, (c) when G2 is regular?

Course Outcome 6(CO6):

1. Show that TSP is NP-complete.
2. Let G be an undirected graph. An Euler circuit of the graph is a simple cycle that includes all edges. The Euler Circuit Problem (EULER) is to decide if G has an Euler circuit. Show that EULER is not NP-complete
3. Is it possible that P = NP is undecidable?

Concept Map



Syllabus

Introduction: Alphabet, languages and grammars, productions and derivation, Chomsky hierarchy of languages.

Regular languages and finite automata: Regular expressions and languages, deterministic finite automata (DFA) and equivalence with regular expressions, nondeterministic finite automata (NFA) and equivalence with DFA, regular grammars and equivalence with finite automata, properties of regular languages, *Kleene's theorem,* pumping lemma for regular languages, *Myhill-Nerode theorem and its uses,* minimization of finite automata.

Context-free languages and pushdown automata: Context-free grammars (CFG) and languages (CFL), Chomsky and Greibach normal forms, nondeterministic pushdown automata (PDA) and equivalence with CFG, parse trees, ambiguity in CFG, pumping lemma for context-free languages, deterministic pushdown automata, closure properties of CFLs.

Context-sensitive languages: Context-sensitive grammars (CSG) and languages, linear bounded automata and equivalence with CSG.

Turing machines: The basic model for Turing machines (TM), Turing recognizable(recursively enumerable) and Turing-decidable (recursive) languages and their closure properties, variants of Turing machines, nondeterministic TMs and equivalence with deterministic TMs, unrestricted grammars and equivalence with Turing machines, TMs as enumerators.

Undecidability: Church-Turing thesis, universal Turing machine, the universal and diagonalization languages, reduction between languages and Rice's theorem, undecidable problems about languages.

Basic Introduction to Complexity: Introductory ideas on Time complexity of deterministic and nondeterministic Turing machines, P and NP, NP- completeness, Cook's Theorem, other NP -Complete problems.

Laboratory: YACC, the parser-generating tool

Learning Resources

1. "Introduction to Automata Theory, Languages, and Computation", John E. Hopcroft, Rajeev Motwani and Jeffrey D. Ullman, third Edition, Pearson Education, 2008.
2. "An Introduction to Formal Language and Automata", Peter Linz, sixth edition, Jones & Bartlett, 2016.
3. "Elements of the Theory of Computation", Harry R. Lewis and Christos H. Papadimitriou, Second Edition, Pearson Education, 2003.
4. "Automata and Computability", Dexter C. Kozen, Springer, 2012.
5. "Introduction to the Theory of Computation", Michael Sipser, third edition, Cengage, 2014.
6. "Introduction to Languages and the Theory of Computation", John Martin, Third Edition, Tata McGraw Hill, 2007
7. "Computers and Intractability: A Guide to the Theory of NP Completeness", M. R. Garey and D. S. Johnson, W. H. Freeman, 1979.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Introduction &Regular languages and finite automata**		
1.1	Alphabet, languages and grammars, productions and derivation, Chomsky hierarchy of languages.	1	CO1

1.2	Regular expressions and languages, deterministic finite automata (DFA) and equivalence with regular expressions	1	CO1
1.3	Nondeterministic finite automata (NFA) and equivalence with DFA, regular grammars and equivalence with finite automata, properties of regular languages	2	CO1
1.4	*Kleene's theorem,* pumping lemma for regular languages, *Myhill-Nerode theorem and its uses,* minimization of finite automata.	2	CO1
2.	**Context-free languages and pushdown automata**		
2.1	Context-free grammars (CFG) and languages (CFL), Chomsky and Greibach normal forms	2	CO2
2.2	Nondeterministic pushdown automata (PDA) and equivalence with CFG	1	CO2
2.3	Parse trees, ambiguity in CFG	1	CO2
2.4	Pumping lemma for context-free languages, deterministic pushdown automata	1	CO2
2.5	Closure properties of CFLs	1	CO2
3.	**Context-sensitive languages**		
3.1	Context-sensitive grammars (CSG) and languages	2	CO3
3.2	linear bounded automata and equivalence with CSG	2	CO3
4.	**Turing machines**		
4.1	The basic model for Turing machines (TM)	1	CO4
4.2	Turing recognizable(recursively enumerable) and Turing-decidable (recursive) languages and their closure properties	2	CO4
4.3	Variants of Turing machines, nondeterministic TMs and equivalence with deterministic TMs	2	CO4
4.4	Unrestricted grammars and equivalence with Turing machines	2	CO4
4.5	TMs as enumerators	1	CO4
5.	**Undecidability**		
5.1	Church-Turing thesis, universal Turing machine, the universal and diagonalization languages,	3	CO5
5.2	Reduction between languages and Rice's theorem, undecidable problems about languages	3	CO5
6.	**Basic Introduction to Complexity and Laboratory**		
6.1	Introductory ideas on Time complexity of deterministic and nondeterministic Turing machines	2	CO6
6.2	P and NP, NP- completeness, Cook's Theorem, other NP -Complete problems.	2	CO6
6.3	YACC, the parser-generating tool	2	CO6
	TOTAL HOURS	**36**	

Course Designers:

1. Dr. M. K. Kavitha Devi mkkdit@tce.edu
2. Ms. R. Nagarathna nacse@tce.edu

21CB361	COMPUTER ORGANIZATION AND ARCHITECTURE LAB

Category	L	T	P	Credit
PC	0	0	4	2

Preamble

This course provides insight into the working principles of Computer organization and architecture.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Implement the given combinational /sequential circuit	30
CO2	Develop C/C++ programming to understand different data formats	10
CO3	Perform Arithmetic operations using Assembly language programming (ALP)	25
CO4	Perform Accessing of some specific memory locations/port using ALP	10
CO5	Perform Counting odd and even integers from a series of memory locations using ALP	10
CO6	Perform Interrupt handling and displaying register content using ALP	15

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS3	Apply	Value	Mechanism	1.2,3.2.3,4.5.1
CO2	TPS3	Apply	Value	Mechanism	1.2,3.2.3,4.5.1
CO3	TPS3	Apply	Value	Mechanism	1.2,3.2.3,4.5.1,4.5.3
CO4	TPS3	Apply	Value	Mechanism	1.2,3.2.3,4.5.1,4.5.3
CO5	TPS3	Apply	Value	Mechanism	1.2,3.2.3,4.5.1,4.5.3
C06	TPS3	Apply	Value	Mechanism	1.2,3.2.3,4.5.1,4.5.3

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	S	M	L									M		
CO2	S	M	L									M		
CO3	S	M	L		L		L	L	L			M		L
CO4	S	M	L		L		L	L	L			M		L
CO5	S	M	L		L		L	L	L			M		L
CO6	S	M	L		L		L	L	L			M		L

S- Strong; M-Medium; L-Low

AssessmentPattern: Cognitive Domain

Cognitive Levels	Model Examination	Terminal Examination
Remember		
Understand	20	20
Apply	80	80
Analyse		
Evaluate		
Create		

AssessmentPattern: Psychomotor

Psychomotor Skill	~~Miniproject/~~Practical Component/~~Observation~~
Perception	
Set	
Guided Response	
Mechanism	
Complex Overt Responses	
Adaptation	
Origination	

List of Experiments/Activities with CO Mapping

Module No.	Topic	No. of Hours	Course Outcome
1	Implementation of Combinational Digital/Boolean Circuits: Adder, Subtractor, Multiplication Module, Division Module, Multiplexer, Demultiplexer, Encoder, Decoder on breadboard or simulators	12	CO1
2	Implementation of Sequential Circuits: Counters, Linear Feedback Shift Registers (LFSR) on breadboard or simulators	4	CO1
3	Develop C/C++ programming to understand the formats of char, int, float, double, long etc	4	CO2
4	Develop an ALP to Perform Add/subtract/ multiplication/ division/GCD/ LCM on simulator	12	CO3
5	Develop an ALP to Perform Accessing of some specific memory locations/port on simulator	4	CO4
6	Develop an ALP to Perform Counting odd and even integers from a series of memory locations on simulator	4	CO5
7	Develop an ALP to Printing values of selected registers on simulator	4	CO6
8	Develop an ALP to Perform interrupt handling on simulator	4	CO6
	Total	48	

Learning Resources

1. Computer System Architecture M. M. Mano:, 3rd ed., Pearson Education, 2007.
2. Computer Organization and Design: The Hardware/Software Interface, David A. Patterson and John L. Hennessy., Morgan Kaufmann publishers,2014
3. Computer Organization and Embedded Systems, Carl Hamacher.Mcgeaw Hill, 2002.
4. Computer Architecture and Organization, John P. Hayes,3rddeition, Tata Mcgraw hill , 1998.
5. Computer Organization and Architecture: Designing for Performance, William Stallings, Nineth edition, Prentice Hall, 2013.
6. Computer System Design and Architecture, Vincent P. Heuring and Harry F. Jordan, 3rd ed., Pearson Education, 2004.
7. https://circuitverse.org/

Course Designers:

1. Dr.C.Senthilkumar cskcse@tce.edu
2. Dr.K.Narasimma Mallikarjunan arjunkambaraj@tce.edu

21CB372	OBJECT ORIENTED PROGRAMMING LAB

Category	L	T	P	Credit
PC	0	0	4	2

Preamble

This syllabus is intended for the Computer science students and enables them to learn Object Oriented Programming and the design of computer solutions in a precise manner. The experiments emphasize on OOP concepts, Functions, Polymorphism, Inheritance, I/O, event-driven, concurrent and network programming. The intention is to provide sufficient depth in these topics to enable candidates to apply Object Oriented Programming approach to programming.

Prerequisite

Programming fundamentals

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Construct Object oriented programs using methods and passing arrays, objects, and array of objects to them	30
CO2	Demonstrate Compile-time and Run-time polymorphism using object oriented programs	15
CO3	Illustrate the relationships between objects using inheritance hierarchies	10
CO4	Develop Object Oriented programs to demonstrate template functions and Collections	15
CO5	Develop Object Oriented programs to handle data using Files and Object Serialization	10
CO6	Develop object oriented design for the given scenario using UML diagram and evolve object oriented program from the design.	20

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS3	Apply	Value	Mechanism	1.2, 4.5.3
CO2	TPS3	Apply	Value	Mechanism	1.2, 4.5.3
CO3	TPS3	Apply	Value	Mechanism	1.2, 4.5.3
CO4	TPS3	Apply	Value	Mechanism	1.2, 4.5.3
CO5	TPS3	Apply	Value	Mechanism	1.2, 4.5.3
CO6	TPS3	Apply	Value	Mechanism	1.2, 4.5.3

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	S	M	L		L	L	L	L	L	L	M	M	L	L
CO2	S	M	L		L	L	L	L	L	L	M	M	L	L
CO3	S	M	L		L	L	L	L	L	L	M	M	L	L
CO4	S	M	L		L	L	L	L	L	L	M	M	L	L
CO5	S	M	L		L	L	L	L	L	L	M	M	L	L
CO6	S	M	L		L	L	L	L	L	L	M	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Model Examination	Terminal Examination
Remember		
Understand		
Apply	100	100
Analyse		
Evaluate		
Create		

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject/Practical Component/Observation
Perception	-
Set	-
Guided Response	-
Mechanism	100
Complex Overt Responses	-
Adaptation	-
Origination	-

List of Experiments/Activities with CO Mapping

.No.	Experiment	. of Hours	CO
	Parameter passing: passing parameter by value vs by reference, passing array as constant pointer	2	CO1
2.	Function overloading: writing string operations like strcat and strncat, strcpy and strncpy as overloaded functions.	2	CO1
3.	Dynamically allocating space for a pointer depending on input and doing this repeatedly, depending on different inputs and finally de-allocating the pointer.	2	CO1
4.	Define class complex with all possible operations: constructor, destructor, copy constructor, assignment operator with the data members stored as pointer to integers.	2	CO1
5.	Define class vector of integers with all possible operations like constructor, destructor, copy constructor and assignment operators	2	CO1
6.	Define class matrix of integers with all possible operations like constructor, destructor, copy constructor and assignment operators	2	CO1
7.	Define class matrix of integers using vector, with all possible operations like constructor, destructor, copy constructor and assignment operators	2	CO1
8.	Define class stack, queue, linked-list, array, set using some data-type (int) with data members kept as private and functions kept in both protected and public sections.	2	CO1

9.	Define class complex with all possible operators: constructor, destructor, copy constructor, assignment operator and operators >, <, >=, <=, ==, ++ (pre and post), +, +=, ( ), with the data members stored as pointer to integers. Operator Overloading to be used.	2	CO2
10.	Define class vector of integers/float with all possible operations like constructor, destructor, copy constructor and assignment operators>, <, >=, <=, ==, ++ (pre and post), +, +=, ( ) Operator Overloading to be used.	2	CO2
11.	Define class matrix of integers/float with all possible operations like constructor, destructor, copy constructor and assignment operators>, <, >=, <=, ==, ++ (pre and post), +, +=, ( ). Operator Overloading to be used.	1	CO2
12.	Define class matrix of integers/float using vector, with all possible operations like constructor, destructor, copy constructor and assignment operators>, <, >=, <=, ==, ++ (pre and post), +, +=, ( ). Operator Overloading to be used.	2	CO2
13.	Define stack and queue inherited from array class, with standard functions and operators. Demonstrate the use of inner classes and anonymous classes in the application.	3	CO3
14.	Overriding operators <<, >>	2	CO3
15.	Define a class called 'array' with data type passed as template type with constructor, destructor, copy constructor and assignment operators and index operator.	2	CO4
16.	Write a C++ Program and Java Program using Collection Class	3	CO4
17.	Define template functions for compare and use it in the algorithms like bubble sort, insertion sort, merge sort.	2	CO4
18.	Demonstrate Formatted input-output and exceptions using C++ Program and Java Program.	2	CO5
19.	Input manipulators and Thread Safe Classes	2	CO5
20.	Define class model for complex number, student class, book class and show it using UML diagram as well as concrete class. Write the corresponding C++ Program and Java Program	4	CO6
21.	Show behaviouralmodelling through sequence diagram and activity diagram for workflow in a typical log-in, log-out situation. Write the corresponding C++ Program and Java Program	5	CO6
	Total Hours	48	

Learning Resources

1. A Tour of C++ (Second edition) ,BjarneStroustrup Addison-Wesley. ISBN 978-0-13-499783-4. July 2018.
2. The C++ Programming Language, BjarneStroustrup, Addison-Wesley Professional ISBN: 9780133522884,2013.
3. C++ and Object-Oriented Programming Paradigm, Debasish Jana, PHI Learning Pvt. Ltd, 2014
4. Programming – Principles and Practice Using C++, BjarneStroustrup, Addison Wesley, 2014.
5. The Design and Evolution of C++, BjarneStroustrup, Addison Wesley,1994
6. Tony Gaddis, "Starting Out with Java: From Control Structures through Objects", Sixth edition, Pearson Education Limited, 2016.
7. Grady Booch, Robert Maksimchuk, Michael Engel, Bobbi Young, Jim Conallen, Kelli Houston"Object Oriented Analysis and Design with Applications", Third Edition, 2012

Course Designers:

1. Dr.M.Vijayalakshmi mviji@tce.edu
2. Dr.S.Prasanna sprcse@tce.edu

21CB381	COMPUTATIONAL STATISTICS LAB

Category	L	T	P	Credit
ES	0	0	2	1

Preamble

The course focuses on to provide the basic skill in python that helps to explore the data and apply the statistical measures to analyse the data by interpreting them through visualization techniques.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Write a python program using the fundamentals programming concepts such as Flow Controls, Functions, sequences and Class	10
CO2	Write a python program to perform reading / writing data into various file formats	10
CO3	Implement the python program for performing data wrangling concepts and statistical measures	25
CO4	Write a python program to perform Data Aggregation and Grouping operations for dimensionality reduction	20
CO5	Write python program for performing pivot tables and time series operations for probabilistic programming using Bayesian methods	20
CO6	Use the various visualization tools and interpret the results	15

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS3	Apply	Value	Mechanism	1.2, 2.1, 3.2, 4.5.3
CO2	TPS3	Apply	Value	Mechanism	1.2, 2.1, 3.2, 4.5.3
CO3	TPS3	Apply	Value	Mechanism	1.2, 2.1, 3.2, 4.5.3
CO4	TPS3	Apply	Value	Mechanism	1.2, 2.1, 3.2, 4.5.3
CO5	TPS3	Apply	Value	Mechanism	1.2, 2.1, 3.2, 4.5.3
CO6	TPS3	Apply	Value	Mechanism	1.2, 2.1, 3.2, 4.5.3

Mapping with Programme Outcomes and Programme Specific Outcome

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	S	M	L		S			S	S		S	M	L	M
CO2	S	M	L		S			S	S		S	M	L	M
CO3	S	M	L		S	L		S	S		S	M	L	M
CO4	S	M	L		S			S	S		S	M	L	M
CO5	S	M	L		S			S	S		S	M	L	M
CO6	S	M	L		S	L	S	S	S		S	M	M	S

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Model Examination	Terminal Examination
Remember	-	-
Understand	-	-
Apply	100	100
Analyse	-	-
Evaluate	-	-
Create	-	-

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject /Practical Component/Observation
Perception	-
Set	-
Guided Response	-
Mechanism	100
Complex Overt Responses	-
Adaptation	-
Origination	-

List of Experiments/Activities with CO Mapping

Ex. No.	LIST OF EXPERIMENTS	No. of Hours	CO
1.	Basic python program execution with different interpreters and statement expressions a. Various data types b. Type casting c. Control flows	2	CO1
2.	Python program on functions and sequences using Lists, Tuples, Dictionaries, Strings and class	2	CO2
3.	Python program in handling different file formats to perform data acquisition, data cleaning - handling of missing data and descriptive statistical analytics.	2	CO3
4.	Python program to perform inferential statistics – Probability, Central Limit Theorem, Confidence Interval and Hypothesis Testing	2	CO3
5.	Implement a python program to perform data transformation, string manipulations and regular expressions	2	CO3
6.	Write a python program to perform GroupBy operations and transformations	2	CO4
7.	Write a python program to implement the Data Aggregation in dataframe and dimensionality reduction	3	CO4

8.	Develop a python program to perform the pivot operations and cross tabulation in the dataset	1	CO5
9.	Develop a python program to perform Bayesian methods for computational statistics	1	CO5
10.	Develop a python program to forecast the data interpretation using time series operations	1	CO5
11.	Develop a python program to perform sampling and re-sampling using monte-carlo simulation	2	CO5
12.	Use the visualization libraries in python to view and interpret the dataset	4	CO6
	TOTAL HOURS	**24**	

Learning Resources

1. T.W. Anderson, "An Introduction to Multivariate Statistical Analysis", Third Edition, A JOHN WILEY & SONS, INC., PUBLICATION, 2003.
2. J.D. Jobson, "Applied Multivariate Data Analysis, Vol I & II", First Edition, Springer-Verlag New York, 1992.
3. **Kres**, Heinz, "Statistical Tests for Multivariate Analysis", First Edition, Springer-Verlag New York, 1983.
4. Mark Lutz, "Programming Python", 4th Edition, O'Reilly Media, 2010.
5. Tim Hall and J-P Stacey, "Python 3 for Absolute Beginners", Apress, 1st ed. Edition, 2009
6. Magnus Lie Hetland, Beginning Python: From Novice to Professional, APress Edition, 2005
7. J. Neter, W. Wasserman and M.H. Kutner, "Applied Linear Regression Models", Fifth Edition, e McGraw-Hill Companies, Inc., 2005
8. A.S. Mulaik, The Foundations of Factor Analysis, Second Edition, Chapman and Hall/CRC, 2009.
9. D.C. Montgomery and E.A. Peck., "Introduction to Linear Regression Analysis", 5th edition, Wiley, 2012
10. M.R. Anderberg, "Cluster Analysis for Applications", 1st edition, Academic Press, 1973.
11. D .F. Morrison, "Multivariate Statistical Analysis", Brooks/Cole; New edition 2004.
12. Wes Mc Kinney, Python for Data Analysis, O'Reilly Media; 2nd edition, 2017.

Course Designers

1. Dr. N. Chitra ncmat@tce.edu
2. Ms. J. Felicia Lilian jflcse@tce.edu

21CB391	SOFTWARE ENGINEERING LAB

Category	L	T	P	Credit
PC	0	0	2	1

Preamble

This course focuses on providing hands-on experience in designing, developing and testing software systems. Consequently students take up a group project, working through a number of stages for the development of software.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Develop software requirements specification for given software	15
CO2	Perform Structured System Analysis and Structured Design for given requirement specification	10
CO3	Construct object oriented design diagrams based on requirement specification.	15
CO4	Produce efficient, reliable, robust and cost-effective software solutions.	20
CO5	Construct white-box and black-box test cases using various test generation methods	15
CO6	Use of appropriate CASE tools and program analysis tools for a given software	25

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS3	Apply	Value	-	1.2, 2.1.1,2.1.2,2.1.3, 2.1.5, 2.3.1, 2.3.2,2.4.3,2.4.4,3.1.1, 3.1.2, 3.2.3, 3.2.4, 3.2.5,3.2.6, 4.1.1, 4.1.2, 4.4.1, 4.4.3,4.5.1,4.5.3,4.5.5
CO2	TPS3	Apply	Value	-	1.2, 2.1.1,2.1.2,2.1.3, 2.1.5, 2.3.1, 2.3.2,2.4.3,2.4.4,3.1.1, 3.1.2, 3.2.3, 3.2.4, 3.2.5,3.2.6, 4.1.1, 4.1.2, 4.4.1, 4.4.3,4.5.1,4.5.3,4.5.5
CO3	TPS3	Apply	Value	-	1.2, 2.1.1,2.1.2,2.1.3, 2.1.5, 2.3.1, 2.3.2,2.4.3,2.4.4,3.1.1, 3.1.2, 3.2.3, 3.2.4, 3.2.5,3.2.6, 4.1.1, 4.1.2, 4.4.1, 4.4.3,4.5.1,4.5.3,4.5.5
CO4	TPS3	Apply	Value	-	1.2, 2.1.1,2.1.2,2.1.3, 2.1.5, 2.3.1, 2.3.2,2.4.3,2.4.4,3.1.1, 3.1.2, 3.2.3, 3.2.4, 3.2.5,3.2.6, 4.1.1, 4.1.2, 4.4.1, 4.4.3,4.5.1,4.5.3,4.5.5

CO5	TPS3	Apply	Value	-	1.2, 2.1.1,2.1.2,2.1.3, 2.1.5, 2.3.1, 2.3.2,2.4.3,2.4.4,3.1.1, 3.1.2, 3.2.3, 3.2.4, 3.2.5,3.2.6, 4.1.1, 4.1.2, 4.4.1, 4.4.3,4.5.1,4.5.3,4.5.5
CO6	TPS3	Apply	Value	-	1.2, 2.1.1,2.1.2,2.1.3, 2.1.5, 2.3.1, 2.3.2,2.4.3,2.4.4,3.1.1, 3.1.2, 3.2.3, 3.2.4, 3.2.5,3.2.6, 4.1.1, 4.1.2, 4.4.1, 4.4.3,4.5.1,4.5.3,4.5.5

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	S	M	L	-	S	M	S	S	S	M	S	M	S	S
CO2	S	M	L	-	S	M	S	S	S	M	S	M	S	S
CO3	S	M	L	-	S	M	S	S	S	M	S	M	S	S
CO4	S	M	L	-	S	M	S	S	S	M	S	M	S	S
CO5	S	M	L	-	S	M	S	S	S	M	S	M	S	S
CO6	S	M	L	-	S	M	S	S	S	M	S	M	S	S

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Phases	Deliverables	Marks	Course Outcomes
Continuous Assessment			
Review 1 – Requirements specification	Technical Report	10	CO1
Review 2 –Design and implementation	Technical Report	20	CO2,CO3,CO4
Review 3 -Testing and Use of CASE tools	Technical Report	20	CO5 and CO6
End-Semester Examination			
Demonstration	Prototype	60	CO1, CO2, CO3, CO4, CO5 and CO6
Case Study Presentation and viva voce	Poster/PPT	40	

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject /Practical Component/Observation
Perception	-
Set	-
Guided Response	-
Mechanism	-
Complex Overt Responses	-
Adaptation	-
Origination	-

List of Experiments/Activities with CO Mapping

Ex.No	List of Experiments	Hours	CO
1.	Collect the requirements and Identify project scope, Objectives, deliverables	4	CO1
2.	Identify the individual Phases/ modules of the project	2	CO2
3.	Develop Class responsibility collaborator(CRC) Model	4	CO3
4.	Build a Prototype and develop modules of the project	4	CO4
5.	Prepare test plan, perform validation testing, coverage analysis, memory leaks, develop test case hierarchy, Site check and site monitor	4	CO5
6.	Track configuration items and document functional dependencies.	2	CO6
7.	Perform post execution analysis using dynamic program analysis tools	4	CO6

A possible set of applications may be the following:

a. E-Library System
b. Inventory System
c. Course Registration System
d. Quiz System
e. Student Marks Analyzing System
f. Reservation Systems for Airlines, Railways etc.
g. Stock Management System
h. Real-Time Scheduler
i. Simulator Software for Parallel Processing Operation

Learning Resources

1. Ian Sommerville , "Software Engineering" , 10th Edition, John Wiley and sons,2015.
2. Roger S. Pressman, "Software Engineering: A Practitioner's Approach", 7th Edition, McGraw Hill Education, 2017
3. PankajJalote, "Software Engineering: A Precise Approach ",Wiley, 2010
4. Carlo Ghezzi, Jazayeri Mehdi, Mandrioli Dino, "Fundamentals of Software Engineering", 2nd edition,2002
5. Erich Gamma, Richard Helm, Ralph Johnson, John Vlissides, "Design Patterns: Elements of Object-Oriented Reusable Software", 2015
6. Shari Lawrence Pfleeger and Joanne, "M. Atlee Software Engineering: Theory and Practice", 2006
7. Bertrand Meyer, "Touch of Class: Learning to Program Well with Objects and Contracts", 2009
8. Martin Fowler, "UML Distilled: A Brief Guide to the Standard Object Modeling Language", 2018

Course Designers:

1. Dr. A. Malini amcse@tce.edu

CURRICULUM AND DETAILED SYLLABI

FOR

B.Tech DEGREE (Computer Science and Business Systems) PROGRAMME

FOURTH SEMESTER

FOR THE STUDENTS ADMITTED FROM THE

ACADEMIC YEAR 2025- 2026 ONWARDS

THIAGARAJAR COLLEGE OF ENGINEERING

(A Government Aided ISO 9001-2008 certified
Autonomous Institution affiliated to Anna University)

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THIAGARAJAR COLLEGE OF ENGINEERING, MADURAI- 625 015

(A Govt. Aided, ISO 9001:2008 certified Autonomous Institution affiliated to Anna University)

B.Tech Degree (Computer Science and Business systems) Programme

COURSES OF STUDY

(For the candidates admitted from 2025 – 2026 onwards)

FOURTH SEMESTER

Sl. No	COURSE CODE	COURCE TITLE	CATEGORY	CONTACT HOURS	No.of Hours / Week			Credits
					L	T	P	
THERORY COURSES								
1	21CBR11	Operating Systems	PC	3	3	0	0	3
2	21CB421	Database Management Systems	PC	3	3	0	0	3
3	21CB431	Introduction to Innovation, IP Management & Entrepreneurship	HSS	3	3	0	0	3
4	21CBPA1	Marketing Research & Marketing Management	PE	2	2	0	0	2
THEORY CUM PRACTICAL COURSES								
5	21MAFH1	Operations Research	OE	4	2	0	2	3
6	21CB461	Software Design with UML	PC	4	2	0	2	3
7	21CB471	Design Thinking	ES	4	2	0	2	3
PRACTICAL COURSES								
8	21CB481	Operating Systems Lab	PC	2	0	0	2	1
9	21CB491	Database Management Systems Lab	PC	2	0	0	2	1
AUDIT COURSES								
10	21CHAC1	Essence of Indian Knowledge	AC	2	2	0	0	-
			TOTAL	**29**	**19**	**0**	**10**	**22**

AC : Audit Course
ES : Engineering Science
HSS : Humanities and Social Science
PC : Program Core
L : Lecture
T : Tutorial
P : Practical

Note:

1 Hour Lecture is equivalent to 1 credit

1 Hour Tutorial is equivalent to 1 credit

2 Hours Practical is equivalent to 1 credit

THIAGARAJAR COLLEGE OF ENGINEERING, MADURAI- 625 015

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B.Tech Degree (Computer Science and Business systems) Programme

SCHEME OF EXAMINATIONS

(For the candidates admitted from 2025 – 2026 onwards)

FOURTH SEMESTER

S.No.	Course Code	Name of the Course	Duration of Terminal Exam. in Hrs.	Marks			Minimum Marks for Pass	
				Continuous Assessment	Terminal Exam *	Max. Marks	Terminal Exam	Total
THEORY								
1	21CB411	Operating Systems	3	60	40	100	27	50
2	21CB421	Database Management Systems	3	60	40	100	27	50
3	21CB431	Introduction to Innovation, IP Management & Entrepreneurship	3	60	40	100	27	50
4	21CBPA1	Marketing Research & Marketing Management	3	60	40	100	27	50
THEORY CUM PRACTICAL								
5	21MAFH1	Operations Research	3	50	50	100	25	50
6	21CB461	Software Design with UML	3	50	50	100	25	50
7	21CB471	Design Thinking	3	50	50	100	25	50
PRACTICAL								
8	21CB481	Operating Systems Lab	3	40	60	100	18	50
9	21CB491	Database Management Systems Lab	3	40	60	100	18	50

* Terminal Examination will be conducted for maximum marks of 100 and subsequently be reduced to 40 marks for the award of terminal examination marks

21CBR11	OPERATING SYSTEMS

Category	L	T	P	Credit
PC	3	0	0	3

Preamble

Operating systems is a core part of computer-science education. Although this field is undergoing rapid change, as computers are now prevalent in virtually every application, the fundamental concepts remain fairly clear. It provides a clear description of the *concepts* that underlie operating systems. The fundamental concepts and algorithms are based on those used in existing commercial operating systems.

Prerequisite

Basics of Computer Architecture and Organization

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Illustrate the functions Operating System and the types of OS used in different applications	10
CO2	Describe the basics of processes and threads	10
CO3	Construct process scheduling algorithms to schedule the given set of processes	15
CO4	Perform Interprocess communication between concurrently executing processes	10
CO5	Develop solutions to handle deadlock by prevention, avoidance, detection and recovery methods	15
CO6	Perform memory management using contiguous allocation and non-contiguous allocation	20
CO7	Construct storage management solutions to store and retrieve the file system in secondary storage devices	20

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond		1.2,2.3.2
CO2	TPS2	Understand	Respond	Guided Response	1.2,2.3.2
CO3	TPS3	Apply	Value	Mechanism	1.2, 2.3.2,4.3.2
CO4	TPS3	Apply	Value	Mechanism	1.2, 2.3.2,4.3.2
CO5	TPS3	Apply	Value	Mechanism	1.2, 2.3.2,4.3.2
CO6	TPS3	Apply	Value	Mechanism	1.2, 2.3.2,4.3.2
CO7	TPS3	Apply	Value	Mechanism	1.2, 2.3.2,4.3.2

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L										L		
CO2	M	L										L		
CO3	S	M	L		L			M			M	M		L
CO4	S	M	L		L			M			M	M		L
CO5	S	M	L		L			M			M	M		L
CO6	S	M	L		L			M			M	M		L
CO7	S	M	L		L			M			M	M		L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	**2**	1	2	
Remember	30	20	-	-	20
Understand	40	40	10	10	40
Apply	30	40	90	90	40
Analyse	-	-	-	-	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject /Assignment/Practical Component
Perception	-
Set	-
Guided Response	15
Mechanism	85
Complex Overt Responses	-
Adaptation	-
Origination	-

Sample Questions for Course Outcome Assessment**

Course Outcome 1(CO1):

1. What are the functions of Operating System?
2. Define Interrupts.
3. Illustrate the steps taken by the Operating System, when a system call is issued by a user process.

Course Outcome 2(CO2):

1. Give the states and state transition that occurs in a process life cycle.
2. List the differences between processes and threads.
3. Illustrate with an example the concept of Multithreading.
4. What are the various types of Thread? Give Example.

Course Outcome 3(CO3):

1. Consider the given set of processes and apply First Come First Serve Scheduling, Shortest Remaining Time First Scheduling and Non Pre-emptive Priority CPU Scheduling algorithm to schedule the given set of processes.

Process Id	Burst Time (milliseconds)	Arrival Time (milliseconds)	Priority (Low number represents higher priority)
P1	8	0	4
P2	4	0	3
P3	1	2	1
P4	4	4	2
P5	7	6	5

Draw the Gantt chart for each scheduling algorithm and compute the average waiting time and average turn-around time for each of the given algorithms.

2. Illustrate the scheduling parameters used to compare the different scheduling algoritms.
3. Suppose the following jobs arrive for processing at the times indicated, each job

will run the listed amount of time.

Jobs	Arrival time	Burst time (in secs.)
1	0.0	8
2	0.4	4
3	1.0	1

Give Gantt charts illustrating the execution of these jobs using the non preemptive FCFS and SJF scheduling algorithms. Compute the average turn around time and average waiting time of each job for the above algorithms and find the best alternative.

Course Outcome 4 (CO4):

1. Give a solution to the readers-writers problem after explaining its nature?
2. Implement Semaphore solution to the Synchronization of Producer-Consumer problem
3. Discuss how file sharing semantics of unix can be implemented. Can processing of the link and unlink commands of unix lead to deadlocks .Discuss how such deadlocks can be avoided

Course Outcome 5 (CO5):

1. **Considering a system with five processes P_0 through P_4 and three resources of type A, B, C. Resource type A has 10 instances, B has 5 instances and type C has 7 instances. Suppose at time t_0 following snapshot of the system has been taken:**

Process	Allocation	Max	Available
	A B C	A B C	A B C
P_0	0 1 0	7 5 3	3 3 2
P_1	2 0 0	3 2 2	
P_2	3 0 2	9 0 2	
P_3	2 1 1	2 2 2	
P_4	0 0 2	4 3 3	

Question1. What will be the content of the Need matrix?
Question2. Is the system in a safe state? If Yes, then what is the safe sequence?
Question3. What will happen if process P_1 requests one additional instance of resource type A and two instances of resource type C?

2. Illustrate the wait-for graph method of deadlock detection approach?
3. What is Deadlock? Give examples of deadlock?

Course Outcome 6(CO6):

1. Given memory partitions of 100K, 500K, 200K, 300K, and 600K (in order), how would each of the First-fit, Best-fit, and Worst-fit algorithms place processes of 212K, 417K, 112K, and 426K (in order)? Which algorithm makes the most efficient use of memory?
2. Consider the following page reference string 7,0,2,0,3,0,4,2,3,0,3,2,1,2,0,1,7,0,2.
   How many page faults would occur in the case?
   a. LRU
   b. FIFO
   c. Optimal algorithms
   assuming three, five or six frames. Note that initially all frames are empty.

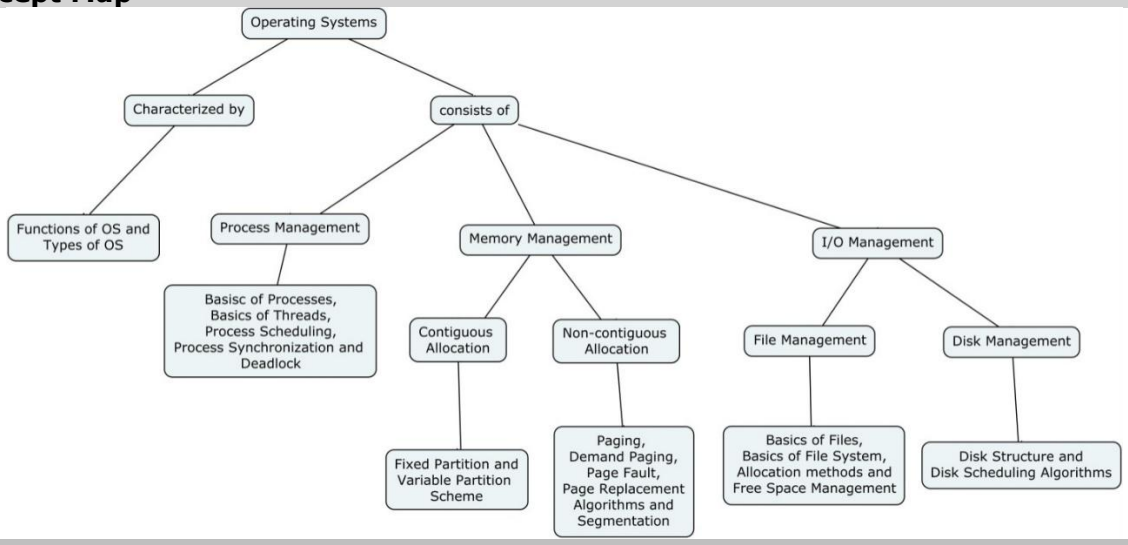
3.. Assume that we have a paging system with page table stored in memory
   a. If a memory reference takes 200 nanoseconds how long does a paged memory reference take? b.
   If we add associative registers and 75% of all page table references are found in the

associative registers, what is the effective memoryreferencetime? Assume that finding a page table entry in the associative registers takes zero time, if the entry is there.

Course Outcome (CO7):

1. Put the following disk scheduling policies in the order that will result in minimum amount of head movement. a. FCFS b. Circular scan c. Elevator algorithm
2. Suppose that a disk drive has 5000 cylinders, numbered from 0 to 4999. The drive is currently serving a request at cylinder 143, and the previous request was at cylinder 125. The queue of pending requests, in FIFO order is 86, 1470, 913, 1774, 948, 1509, 1022, 1750, 130. Starting from the current head position, what is the total distance (in cylinders) that the disk arm moves to satisfy all the pending requests for each of the disk scheduling algorithms. a. FCFS b. SSTF c. SCAN d. LOOK e. C-SCAN f. C-LOOK.
3. Explain the different type of directories in the UNIX system with the directory paths
4. Write the bash shell script to manipulate the contents of the file

Concept Map



Syllabus

Introduction: Concept of Operating Systems (OS), Generations of OS, Types of OS, OS Services, Interrupt handling and System Calls, Basic architectural concepts of an OS, Concept of Virtual Machine, Resource Manager view, process view and hierarchical view of an OS. **Processes**: Definition, Process Relationship, Different states of a Process, Process State transitions, Process Control Block (PCB), Context switching. **Thread**: Definition, Various states, Benefits of threads, Types of threads, Concept of multithreads. **Process Scheduling**: Foundation and Scheduling objectives, Types of Schedulers, Scheduling criteria: CPU utilization, Throughput, Turnaround Time, Waiting Time, Response Time. **Scheduling algorithms**: Pre-emptive and non-pre-emptive, FCFS, SJF, RR; Multiprocessor scheduling: Real Time scheduling: RM and EDF. **Inter-process Communication**: Concurrent processes, precedence graphs, Critical Section, Race Conditions, Mutual Exclusion, Hardware Solution, Semaphores, Strict Alternation, Peterson's Solution, The Producer / Consumer Problem, Event Counters, Monitors, Message Passing, Classical IPC Problems: Reader's & Writer Problem, Dinning Philosopher Problem, Barber's shop problem. **Deadlocks**: Definition, Necessary and sufficient conditions for Deadlock, Deadlock Prevention, Deadlock Avoidance: Banker's algorithm, Deadlock detection and Recovery. **Concurrent Programming:** Critical region, conditional critical region, monitors, concurrent languages and communicating sequential process (CSP). **Memory Management**: Basic concept, Logical and Physical address maps, Memory allocation: Contiguous Memory allocation – Fixed and variable partition–Internal and

External fragmentation and Compaction. **Virtual Memory**: Basics of Virtual Memory – Hardware and control structures – Locality of reference, Page allocation, Partitioning, Paging, Hashed Page table and Inverted Page table,Page fault, Working Set, Segmentation, Demand paging, Page Replacement algorithms: Optimal, First in First Out (FIFO), Second Chance (SC), Not recently used (NRU) and Least Recently used (LRU). **I/O Hardware**: I/O devices, Device controllers, Direct Memory Access, Principles of I/O. **File Management**: Concept of File, Access methods, File types, File operation, Directory structure, File System structure, Allocation methods (contiguous, linked, indexed),Free-space management (bit vector, linked list, grouping), directory implementation(linear list, hash table), efficiency and performance. **Disk Management**: Disk structure, Disk scheduling - FCFS, SSTF, SCAN, C-SCAN, Disk reliability, Disk formatting, Boot-block, Bad blocks. **Case study:** UNIX OS file system, shell, filters, shell programming, programming with the standard I/O, UNIX system calls and Minix Operating System.

Learning Resources

1. Abraham Silberschatz, Peter Baer Galvin and Greg Gagne: Operating System Concepts Essentials, ninth edition, John Wiley and Sons, 2013.
2. Operating Systems: Internals and Design Principles, William Stallings, Pearson Education, 2018.
3. Operating System: A Design-oriented Approach, Charles Patrick Crowley, McGrawHill Eductaion,2017.
4. Operating Systems: A Modern Perspective, Gary J. Nutt, Pearson, 1997.
5. Design of the Unix Operating Systems. Maurice J. Bach. Pearson Education India, 2015.
6. Understanding the Linux Kernel, Daniel Pierre Bovet, Marco Cesati, O'Reilly Media.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1	**Basics of OS and Processes**	**(5)**	
1.1	**Introduction:** Concept of Operating Systems (OS), Generations of OS, Types of OS, OS Services, Interrupt handling and System Calls, Basic architectural concepts of an OS, Concept of Virtual Machine, Resource Manager view, process view and hierarchical view of an OS.	2	CO1
1.2	**Processes**: Definition, Process Relationship, Different states of a Process, Process State transitions, Process Control Block (PCB), Context switching.	2	CO2
1.3	**Thread**: Definition, Various states, Benefits of threads, Types of threads, Concept of multithreads.	1	CO2
2	**Process Scheduling**	**(3)**	
2.1	**Process Scheduling**: Foundation and Scheduling objectives, Types of Schedulers, Scheduling criteria: CPU utilization, Throughput, Turnaround Time, Waiting Time, Response Time.	1	CO3
2.2	**Scheduling algorithms**: Pre-emptive and non-pre-emptive, FCFS, SJF, RR; Multiprocessor scheduling: Real Time scheduling: RM and EDF.	2	CO3
3	**Process Synchronization and Deadlocks**	**(11)**	
3.1	**Inter-process Communication**: Concurrent processes, precedence graphs, Critical Section, Race Conditions, Mutual Exclusion, Hardware Solution	1	CO4

3.2	Synchronization Solutions: Semaphores, Strict Alternation, Peterson's Solution, Event Counters, Monitors, Message Passing and Hardware solutions	3	CO4
3.3	Classical IPC Problems: Reader's & Writer Problem, Dinning Philosopher Problem, Barber's shop problem.	2	CO4
3.4	**Concurrent Programming:** Critical region, conditional critical region, monitors, concurrent languages, Communicating Sequential Process (CSP)	2	CO4
3.5	**Deadlocks**: Definition, Necessary and sufficient conditions for Deadlock, Deadlock Prevention, Deadlock Avoidance: Banker's algorithm, Deadlock detection and Recovery.	3	CO5
4	**Memory Management**	**(8)**	
4.1	**Memory Management**: Basic concept, Logical and Physical address maps, Memory allocation: Contiguous Memory allocation – Fixed and variable partition–Internal and External fragmentation and Compaction.	2	CO6
4.2	**Virtual Memory**: Basics of Virtual Memory – Hardware and control structures – Locality of reference, Page allocation, Partitioning	1	CO6
4.3	Paging, Hashed Page table and Inverted Page table Page fault, Working Set and Segmentation	2	CO6
4.4	Demand paging, Page Replacement algorithms: Optimal, First in First Out (FIFO), Second Chance (SC), Not recently used (NRU) and Least Recently used (LRU).	3	CO6
5	**Storage Management**	**(9)**	
5.1	**I/O Hardware**: I/O devices, Device controllers, Direct Memory Access, Principles of I/O.	1	CO7
5.2	**File Management**: Concept of File, Access methods, File types, File operation, Directory structure, File System structure, Allocation methods (contiguous, linked, indexed)	2	CO7
5.3	Free-space management (bit vector, linked list, grouping), directory implementation (linear list, hash table), efficiency and performance.	2	CO7
5.4	**Disk Management**: Disk structure, Disk scheduling - FCFS, SSTF, SCAN, C-SCAN, Disk reliability, Disk formatting, Boot-block, Bad blocks.	2	CO7
5.5	**Case study:** UNIX OS file system, shell, filters, shell programming, programming with the standard I/O, UNIX system calls and Minix Operating Systems	2	CO7
	Total No of Hours	**36**	

Course Designers:

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21CB421	DATABASE MANAGEMENT SYSTEMS

Category	L	T	P	Credit
PC	3	0	0	3

Preamble

This course helps the students to understand the basic concepts and functionalities of Database Management Systems such as data modelling, data storage and retrieval, data manipulation and effective database design. It also facilitate the students to know about indexing mechanisms used for data retrieval, concurrent access of data, recovery and access control mechanisms. It also makes the students to understand different types of databases and to learn basic concepts of data warehousing and mining.

Prerequisite

Data Structures and Algorithms

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage in %
CO1	Develop different data models such as E-R model, Relational model and object oriented model for a given application	15
CO2	Illustrate the use of relational query languages for data retrieval and manipulation operations	20
CO3	Develop efficient database for a given application using dependency theories and normalization methods	15
CO4	Explain the concepts of query processing and query optimization methods	10
CO5	Construct different data access structures such as indices and hashing for the fast retrieval of data	15
CO6	Illustrate transaction, concurrency and recovery mechanisms to maintain data integrity and consistency in a multi user environment	15
CO7	Describe the need for database security methods and the concepts of different kinds of databases	10

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS3	Apply	Value		1.2, 2.1.1, 2.1.2, 2.1.5, 4.4.3, 4.4.4
CO2	TPS3	Apply	Value		1.2, 2.1.1, 2.1.2, 2.1.5, 4.4.3, 4.4.4
CO3	TPS3	Apply	Value		1.2, 2.1.5, 4.4.3, 4.4.4
CO4	TPS2	Understand	Respond		1.2, 2.1.1
CO5	TPS3	Apply	Value		1.2, 2.1.1, 2.1.5, 4.4.3, 4.4.4
CO6	TPS3	Apply	Value		1.2, 2.1.1, 2.1.2, 2.1.5, 4.4.3, 4.4.4
CO7	TPS2	Understand	Respond		1.2, 2.1.1

Mapping with Programme Outcomes and Programme Specific Outcome

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	S	M	L		M	M	L	M	M		M	M	L	L
CO2	S	M	L		M	M	L	M	M		M	M	L	L
CO3	S	M	L		M	M	L	M	M		M	M	L	L
CO4	M	L										L		
CO5	S	M	L			L		L	L		M	M	L	L
CO6	S	M	L		L	L		L	L		M	M	L	L
CO7	M	L										L		

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	**2**	1	2	
Remember	10	10	-	-	10
Understand	30	40	30	30	30
Apply	60	50	70	70	60
Analyse	-	-	-	-	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject /Assignment/Practical Component
Perception	-
Set	-
Guided Response	-
Mechanism	-
Complex Overt Responses	-
Adaptation	-
Origination	-

Sample Questions for Course Outcome Assessment

Course Outcome1 (CO1):

1. A university registrar's office maintains data about the following entites: (A) courses, including number, title, credits, syllabus, and prerequisites; (b) course offerings, including course number, year, semester, section number, instructor(s), timings and class rooms; (c) students, including student-id, name and program; and (d) instructors, including identification number, name, department, and title. Further, the enrollment of students in courses and grades awarded to students in each course they are enrolled for must be appropriately modeled.
    i. Construct an E-R diagram for the registrar's office. Document all assumptions you make about the mapping constraints.
    ii. Convert the E-R model into a relational model and give equivalent SQL Commands to construct the relational database with appropriate constraints

2. A company database needs to store information about employees (identified by ssn, with salary and phone as attributes), departments (identified by dno, with dname and budget as attributes), and children of employees (with name and age as attributes). Employees work in departments; each department is managed by an employee; a child must be identified uniquely by name when the parent (who is an employee; assume that only one parent works for the company) is known. We are not interested in information about a child once the parent leaves the company.
    i. Draw an ER diagram that captures this information and convert this into an relational model

Course Outcome2 (CO2):

1. LIVES(employee-name, street, city)
WORKS(employee-name, company-name, salary)
LOCATED-IN(company-name, city)
MANAGES(employee-name, manager-name)

Answer the following queries using Relational Algebra.
    i. Find the name of all employees who work for the 'City Bank company '.
    ii. Find the name and city of all employees who work for City Bank.
2. Consider the following tables and give results for the following queries in relational algebra:
Reserves(sid, bid, day)
Sailors (sid, sname, rating, age)
Boats(bid, bname,color)
    i. Find names of sailors who've reserved a green boat
    ii. Find sailors rated > 7 who've reserved boat #103

3. Considering the schema structure given below
CUSTOMER(<u>custno</u>, custname, city, phone)
ITEM (<u>Itemno</u>, Itemname, Itemprice, QtyOnhand)
INVOICE (<u>Invno</u> , Invdate , Custno
INVITEM <u>(Invno , Itemno</u> , Qty)
Answer the following queries in SQL. (Apply)
    i. Find the customers who are not from 'Madurai'
    ii. Display all item name along with the quantity sold.

Course Outcome3 (CO3):

1. Given the following relation instance, list out the functional dependencies holds on this relation.

X	Y	Z
1	4	2
1	5	3
1	6	3
3	2	2

2. Consider the universal relation R = {A,B,C,D,E,F,G,H,I,J} and set of functional dependencies F = {{A,B} -> {C}, {B,D} -> {E,F}, {A,D} -> {G,H}, {A} -> {I}, {H} -> {J}}.
    i. Compute the keys for R.
    ii. Compute the closure of F. List only the non-trivial functional dependencies with single attribute on right hand side.

3. Develop a relational database for the Library Management application by following the various design phases of normalization. (Apply)

Course Outcome4 (CO4):

1. Describe the steps in query processing (Understand)
2. Let relations r1(A,B,C) and r2(C,D,E) have the following properties: r1 has 20,000 tuples, r2 has 45,000 tuples, 25 tuples of r1 fit on one block, and 30 tuples of r2 fit on one block. Estimate the number of block transfers and seeks required using Nested Loop Join strategy for r1 natural joined with r2. (Understand)
3. Consider the query: Find the names of all customers who have an account at some branch located in Brooklyn, Write an efficient relational_algebra expression for this query. (Understand)

Course Outcome5 (CO5):

1. Suppose that we are using extendable hashing on a file that contains records with the following search key values 2, 3, 5, 7, 11, 17, 19, 23, 29, 31. Show the extendable hash structure for this file, if the hash function is h(x)= x mod 5 and buckets can hold 3 records.
2. Construct a B+ Tree with order 3 as follows: Insert sequence : 5, 8, 1, 7, 3, 12, 9, 6 Deletion sequence: 9, 8, 12.

Course Outcome6 (CO6):

1. Consider the following ordering Schedule - S of transactions:
   a. T3: W(X); T2: R(X); T3: commit; T1: W(Y); T1: commit; T2: R(Y);
   b. T2: W(Z); T2: commit; T4: R(X); T4: R(Y); T4:W(Z); T4: commit.

   Identify whether given transactions are view serializable. (Apply)
2. Consider the following schedules involving two transactions. Determine which one is conflict serializable schedule and which is not.

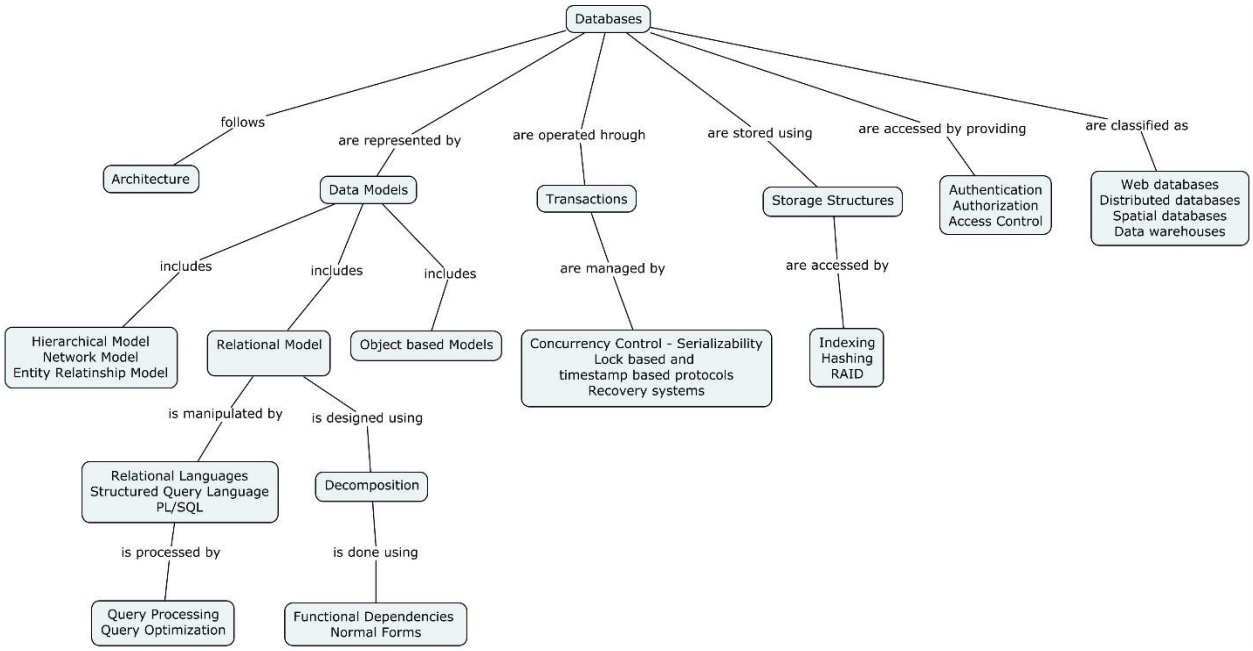
$$S_1 : r_1(X); r_1(Y); r_2(X); r_2(Y); w_2(Y); w_1(X)$$

$$S_2 : r_1(X); r_2(X); r_2(Y); w_2(Y); r_1(Y); w_1(X)$$

Course Outcome7 (CO7):

1. Compare and contrast DBMS with data warehouse systems (understand)
2. Illustrate the different data fragmentation techniques and mention their advantages. (understand)

Concept Map



Syllabus

Introduction: Introduction to Database. Hierarchical, Network and Relational Models.

Database system architecture: Data Abstraction, Data Independence, Data Definition Language (DDL), Data Manipulation Language (DML).

Data models: Entity-relationship model, network model, relational and object oriented data models, integrity constraints, data manipulation operations.

Relational query languages: Relational algebra, Tuple and domain relational calculus,SQL3, DDL and DML constructs, PL/SQL – Sub programs – Procedures, Functions, Triggers, Open source and Commercial DBMS - MYSQL,ORACLE, DB2, SQL server, In-memory Databases.

Relational database design: Domain and data dependency, Armstrong's axioms, Functional Dependencies, Normal forms, Dependency preservation, Lossless design, Denormalization

Query processing and optimization: Evaluation of relational algebra expressions, Query equivalence, Join strategies, Query optimization algorithms.

Storage strategies: Indices, B-trees, Hashing, RAID

Transaction processing: Concurrency control, ACID property, Serializability of scheduling, Locking and timestamp based schedulers, Multi-version and optimistic, Concurrency Control schemes, Database recovery.

Database Security: Authentication, Authorization and access control, DAC, MAC and RBAC models, Intrusion detection, SQL injection.

Advanced topics: Object oriented and object relational databases, Logical databases, Web databases, Distributed databases, Spatial Databases, Data warehousing and data mining.

Learning Resources

1. Avi Silberschatz, Henry F.Korth, S.Sudarshan, "Database System Concepts", 7th Edition, Tata McGrawHill, 2019.
2. Ramez Elmasri and Shamkan tB.Navathe, "Fundamentals of Database System", 7th edition, Pearson Education, 2017.
3. Raghu Ramakrishnan, Johannes Gehrke, "Database Management Systems", 3rd Edition, Tata McGraw Hill, 2002.

4. J. D. Ullman, "Principles of Database and Knowledge – Base Systems", Vol 1, computer science press, 2016.
5. Serge Abiteboul, Richard Hull, Victor Vianu , "Foundations of Databases", Pearson, 1994.
6. https://onlinecourses.nptel.ac.in/noc18_cs15/preview

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures	Course Outcome
1	**Introduction to Database (5)**		
1.1	Introduction to databases – purpose, architecture of database systems	1	CO1
1.2	Data Abstraction, Data Independence, Data Definition Language (DDL), Data Manipulation Language (DML).	1	CO1
1.3	Data Models - Hierarchical, Network, Relational Model and Object oriented data model	1	CO1
1.4	Entity-relationship model – Concepts, integrity constraints, ER model design issues	1	CO1
1.5	ER Diagram - Concepts and notations, extended ER features, Reduction to relational models	1	CO1
2	**Relational Query Languages (7)**		
2.1	Relational Algebra - Selection, Projection, Cross product, Join and Set operators	1	CO2
2.2	Relational Algebra – additional operations, Tuple and domain calculus	1	CO2
2.3	SQL – DDL , DML commands, Set operations	1	CO2
2.4	SQL – DML – Joins, Aggregate functions	1	CO2
2.5	SQL – Sub-queries, TCL and DCL	1	CO2
2.6	PL/SQL – Sub programs – Procedures, Functions, Triggers	1	CO2
2.7	Practice of SQL in open source and commercial data bases, in-memory databases	1	CO2
3	**Relational Database Design (5)**		
3.1	Domain and data dependency	1	CO3
3.2	Functional Dependencies, Armstrong's axioms – Closure sets	1	CO3
3.3	Normal forms	2	CO3
3.4	Decomposition - Dependency preservation, Lossless design, Denormalization	1	CO3
4	**Query Processing and Optimization (4)**		
4.1	Evaluation of relational algebra expressions	1	CO4
4.2	Query equivalence – equivalence rules	1	CO4
4.3	Join strategies	1	CO4
4.4	Query optimization algorithms	1	CO4
5	**Storage Strategies (5)**		
5.1	Indices – Ordered and Hash indices	1	CO5
5.2	B-trees – Indexing and File Organization	2	CO5

5.3	Hashing – static and dynamic hashing	2	CO5
6	**Transaction Processing (5)**		
6.1	ACID property, Concurrency control	1	CO6
6.2	Serializability of scheduling	1	CO6
6.3	Locking and timestamp based schedulers, Multi-version and optimistic	1	CO6
6.4	Concurrency Control schemes	1	CO6
6.5	Database recovery	1	CO6
7	**Database Security(2)**		
7.1	Authentication, Authorization and access control	1	CO7
7.2	DAC, MAC and RBAC models	1	CO7
7.3	Intrusion detection, SQL injection		CO7
8	**Advanced Topics(3)**		
8.1	Object oriented and object relational databases,	1	CO7
8.2	Logical databases, Web databases, Distributed database, Spatial databases	1	CO7
8.3	Data warehousing and data mining	1	CO7
	Total	**36**	

Course Designers:

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21CB431	INTRODUCTION TO INNOVATION, IP MANAGEMENT & ENTREPRENEURSHIP

Category	L	T	P	Credit	Terminal Exam Type
HSS	3	0	0	3	Theory

Preamble

The course covers the various aspects in a business development process based on innovative technological ideas. The course discusses the obstacles that the management and founders will face in a research-oriented company. In addition, the course also analyses and discusses the challenges and opportunities in making an innovative product reach to the large set of users in the market. The course encompasses R&D and innovation processes followed in an established, larger company. The course also covers the development problems of an entrepreneurial start-up enterprise. Besides theoretical knowledge of innovation processes, several sessions are devoted to class discussions to enrich the knowledge of the users.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Explain the different steps in a business development process (Understand)	10
CO2	Demonstrate the requirements and responsibilities put on management, board members and shareholders in different development situations(Apply)	15
CO3	Interpret the market situation to know the opportunities and threats (Apply)	20
CO4	Sketch the needs for financial resources as well as obstacles in the early stages of the development of a business(Apply)	20
CO5	Formulate a business plan based on the innovative idea in technology(Apply)	15
CO6	Sketch the intellectual property rights and legislationto introduce the products in the market (Apply)	20

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond	Guided Response	1.1.1, 2.1.1, 4.6.2
CO2	TPS3	Apply	Value	Mechanism	1.1, 2.1,2.2,2.5.1,4.1.2
CO3	TPS3	Apply	Value	Mechanism	1.1, 2.1,2.2,2.5.1,4.1.2
CO4	TPS3	Apply	Value	Mechanism	1.1, 2.1,2.2,2.5.1,4.1.2
CO5	TPS3	Apply	Value	Mechanism	1.1, 2.1,2.2,2.5.1,4.1.2
CO6	TPS3	Apply	Value	Mechanism	1.1, 2.1,2.2,2.5.1,4.1.2

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L										L		
CO2	S	M	L									M	L	
CO3	S	S	L							L		M		
CO4	M	M	L									M		
CO5	S	S	M	L	L		M	M	M	L	L	M	M	L
CO6	S	M	L				M	L			L	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	**2**	1	2	
Remember	10	10	-	-	10
Understand	30	30	-	-	30
Apply	60	60	100	100	60
Analyse					
Evaluate					
Create					

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject/Assignment/Practical Component
Perception	
Set	
Guided Response	10
Mechanism	90
Complex Overt Responses	
Adaptation	
Origination	

Sample Questions for Course Outcome Assessment**

Course Outcome 1(CO1):

1. How innovation helps in product design? List some of the innovation types. Give example to each type.
2. Explain the dimensions of the innovation. How innovation mapping is done in the product design process?
3. What do you mean by sources of innovation? Explain it with suitable examples.

Course Outcome 2(CO2):

1. Analyse how the situational outlook questionnaire acting as diagnostic tool to decide what kind of innovations might be helpful in establishing the appropriate context for innovation.
2. List the environmental factors which contribute to stifling innovation. Also consider that as an engineer you are going to design on innovative solution for societal problem. How the above list of environmental factors affects your innovative process? Will it affect the efficiency of your innovation?

Course Outcome 3(CO3):

1. "XYZ is planned to become an academic entrepreneurship. But while doing that policies he wants to find some factors which acts as a barriers for his academic entrepreneurship. Institutional policy is one of the factors". Can you analyze each institutional variable and give suitable solution to avoid such a problem?
2. How the family background and religion affect an individual's propensity to establish a new venture? Analyze this factor and give proper alternative to overcome this problem.

Course Outcome 4 (CO4):

1. How venture debt is acting as dominant form of financing for start-ups? Also discuss how long term debt is used by modern companies.
2. Differentiate between the different stages of funding. Analyze the suitable structure of a venture capital firm for start-ups.

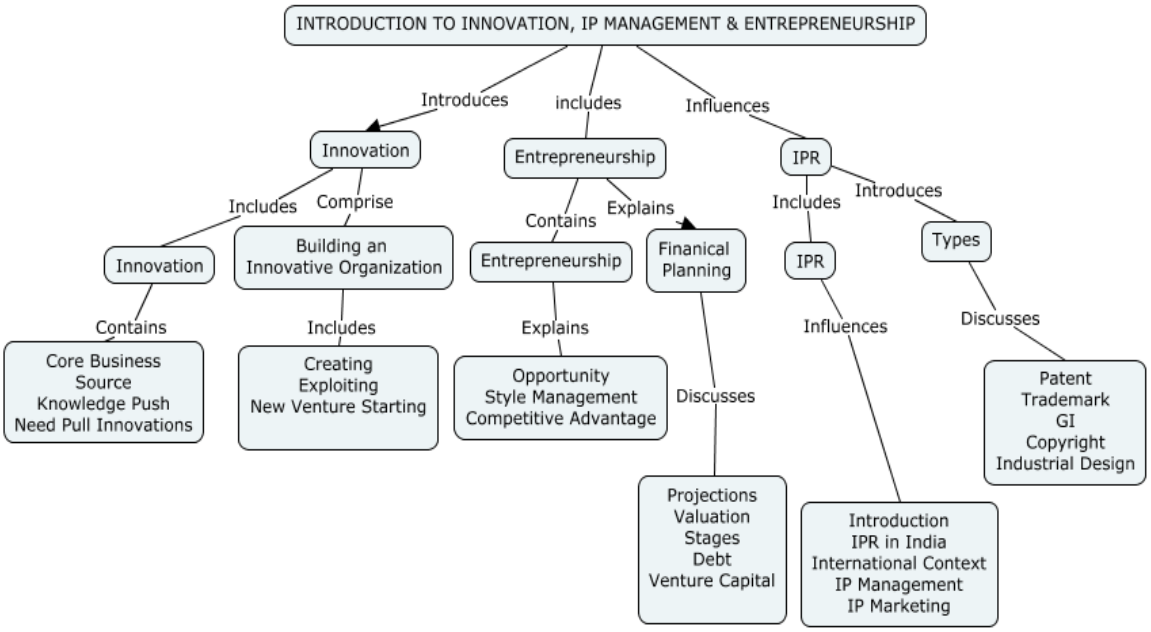
Course Outcome 5 (CO5):

1. "Are intellectual property rights human rights?" Justify your answer.
2. A company XYZ is allocating one patent filing assignment to you. You want to design software for that company and you want to file that. Is it possible to file that patent in India? Give description for your answer.

Course Outcome 6(CO6):

1. "Agricultural university in India is planning to cultivate one new variety of mangos in their field. They want to make that variety as their own variety to avoid others to cultivate it without their permission". If they want to done this which type of IPR is suitable for them. Analyze different types of IPR and choose suitable one.
2. How idea patent differs from product patent.

Concept Map



Syllabus

Innovation: What and Why?

- Innovation as a core business process, Sources of innovation, Knowledge push vs. need pull innovations.
- Class Discussion- Is innovation manageable or just a random gambling activity?

Building an Innovative Organization

- Creating new products and services, Exploiting open innovation and collaboration, Use of innovation for starting a new venture
- Class Discussion- Innovation: Co-operating across networks vs. 'go-it-alone' approach

Entrepreneurship:

- Opportunity recognition and entry strategies
- Entrepreneurship as a Style of Management
- Maintaining Competitive Advantage- Use of IPR to protect Innovation

Entrepreneurship- Financial Planning:

- Financial Projections and Valuation
- Stages of financing
- Debt, Venture Capital and other forms of Financing

Intellectual Property Rights (IPR)

- Introduction and the economics behind development of IPR: Business Perspective
- IPR in India – Genesis and Development
- International Context
- Concept of IP Management, Use in marketing

Types of Intellectual Property

- Patent- Procedure, Licensing and Assignment, Infringement and Penalty
- Trademark- Use in marketing, example of trademarks- Domain name
- Geographical Indications- What is GI, Why protect them?
- Copyright- What is copyright
- Industrial Designs- What is design? How to protect?
- Class Discussion- Major Court battles regarding violation of patents between corporate companies

Home Assignment:

Case study materials book will be given to students. Students are required to meet in groups before coming to class and prepare on the case for the day. Instructor may ask the student groups to present their analysis and findings to the class.
Further, the topic for class discussion will be mentioned beforehand and students should be ready to discuss these topics (in groups) in class. Students are required to meet in groups before coming to class and prepare on the topic. Few topics are mentioned below as examples. Instructor can add or change any topic as per requirement.
Topic 1- Is innovation manageable or just a random gambling activity?
Topic 2- Innovation: Co-operating across networks vs. 'go-it-alone' approach
Topic 3- Major Court battles regarding violation of patents between corporate companies

Learning Resources

1. Joe Tidd, John Bessant. "Managing Innovation: Integrating Technological, Market and Organizational Change", third edition, John Wiley & Sons, 2005.
2. Case Study Materials: To be distributed for class discussion

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Innovation: What and Why?**		
1.1	Innovation as a core business process, Sources of innovation, Knowledge push vs. need pull innovations.	2	CO1
1.2	Class Discussion- Is innovation manageable or just a random gambling activity?	3	CO1
2.	**Building an Innovative Organization**		
2.1	Creating new products and services, Exploiting open innovation and collaboration, Use of innovation for starting a new venture	2	CO2

2.2	Class Discussion- Innovation: Co-operating across networks vs. 'go-it-alone' approach	3	CO2
3.	**Entrepreneurship**		
3.1	Opportunity recognition and entry strategies	2	CO3
3.2	Entrepreneurship as a Style of Management	2	CO3
3.3	Maintaining Competitive Advantage- Use of IPR to protect Innovation	2	CO3
4.	**Entrepreneurship- Financial Planning**		
4.1	Financial Projections and Valuation	2	CO4
4.2	Stages of financing	2	CO4
4.3	Debt, Venture Capital and other forms of Financing	2	CO4
5.	**Intellectual Property Rights (IPR)**		
5.1	Introduction and the economics behind development of IPR: Business Perspective	1	CO5
5.2	IPR in India – Genesis and Development	2	CO5
5.3	International Context	2	CO5
5.4	Concept of IP Management, Use in marketing	1	CO5
6.	**Types of Intellectual Property**		
6.1	Patent- Procedure, Licensing and Assignment, Infringement and Penalty	1	CO6
6.2	Trademark- Use in marketing, example of trademarks- Domain name	1	CO6
6.3	Geographical Indications- What is GI, Why protect them?	1	CO6
6.4	Copyright- What is copyright	1	CO6
6.5	Industrial Designs- What is design? How to protect?	1	CO6
6.6	Class Discussion- Major Court battles regarding violation of patents between corporate companies	3	CO6
	TOTAL HOURS	36	

Course Designers:

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21CBPA1	MARKETING RESEARCH & MARKETING MANAGEMENT

Category	L	T	P	Credit
PE	2	0	0	2

Preamble

This subject covers application of management theories, problem solving methods and different techniques in order to find problems in marketing and suitable solutions for the same. This course is also reviews systematic process and concepts involved in marketing and decision making in marketing process. The course is also explores the concept of communicating tools to bridge the people and industry. Many modern tools and methodologies are included to reach the people to satisfy their needs.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Understand basic marketing concept and application of statistical tools in Marketing research	20
CO2	Comprehend the dynamics of marketing and analyze how its various components interact with each other in the real world	15
CO3	Leverage marketing concepts for effective decision making	10
CO4	Classify different methods of pricing, promotion and distribution strategy	20
CO5	Apply various strategies of Internet Marketing	15
CO6	Analyze the demand in micro economics and statistical tools based on the environment.	20

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS 2	Understand	Respond	Guided Response	1.1.1,2.1.3
CO2	TPS 2	Understand	Respond	Guided Response	1.1.1,2.1.3,2.1.4
CO3	TPS 3	Apply	Value	Mechanism	2.1.3,2.1.4,2.1.5
CO4	TPS 3	Apply	Value	Mechanism	2.2.4
CO5	TPS 3	Apply	Value	Mechanism	2.5.4,4.3.4
CO6	TPS 4	Analyse	Organise	Complex Overt Responses	2.5.4,3.1.5,3.2.5

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L										M		
CO2	M	L										M		
CO3	S	M	L					M	M	M		M		M
CO4	S	M	L	S				M	M	M		M	L	M
CO5	S	M	L					M	M	M		M		M
CO6	S	M	L	S			M	M	M	M	M	M	L	M

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	**2**	1	2	
Remember	40	10	-	-	20
Understand	40	30	60	30	40
Apply	20	60	40	70	40
Analyse					
Evaluate					
Create					

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject/Assignment/Practical Component
Perception	
Set	
Guided Response	30
Mechanism	70
Complex Overt Responses	
Adaptation	
Origination	

Sample Questions for Course Outcome Assessment**

Course Outcome1(CO1):

1. How the customer markets are classified? Give parameter which basically works to classify them in different category. Mention example for each market type.
2. List the strategies which followed in marketing objectives of the product life cycle.
3. "Consumer behaviour is a more function of person's age or generation". Justify your answer.

Course Outcome2(CO2):

1. Examine the product positioning characteristics while designing new product for marketing.
2. Explain the role of customer relationship management in today's competitive business world.
3. List 4 P's of business marketing. How each involved in modern management policies?

Course Outcome3(CO3):

1. How does branding affect the improvement in selling? Is medium of branding related to the popularization ratio?

2. Consider the different means of differentiating products and services. Which ones have the most impact on your choices? Why? Can you think of certain brands that excel on a number of these different means of differentiation?
3. What marketing strategies are appropriate at each stage of the product life cycle if you are developing one billing softwaare?

Course Outcome 4 (CO4):

1. Consider the situation that you are going to open a new start-up. You planned to advertise your company to get more order in short term period. How to implement creative advertising strategy in this situation?
2. As a consumer, which pricing method do you prefer to deal with? Why? If the average price were to stay the same, which would you prefer a firm to do: (1) set one price and not deviate or (2) employ slightly higher prices most of the year but offer slightly discounted prices or specials for certain occasions?

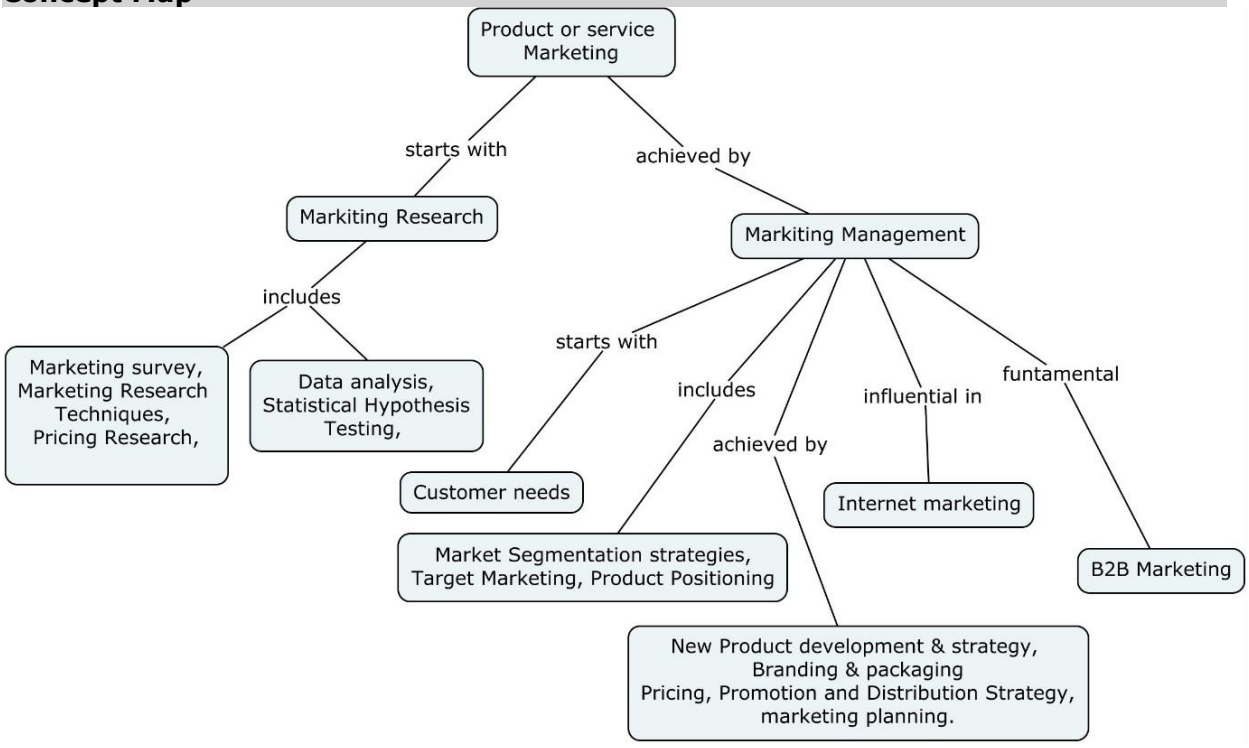
Course Outcome 5 (CO5):

1. Is internet marketing more effective than traditional based on classic media such as TV, radio, magazines, etc.? Analyze your answer and prove it.
2. How internet marketing reach the all levels of the people without spending more cost? Analyze it.

Course Outcome6(CO6):

1. In the given business situation, need to analyse the model based on different aspects. In this case which will be the better tool to get optimal decision? How multivariate helps in this situation.
2. Client is asking the manager to design one questioner related to target audience for his soap product. In that situation if you are the manager how will you design that survey form? How will you allocate weights for each parameter? Design that survey form.

Concept Map



Syllabus

Marketing Concepts and Applications: Introduction to Marketing & Core Concepts, Marketing of Services, Importance of marketing in service sector.

Marketing Planning & Environment: Elements of Marketing Mix, Analyzing needs & trends in Environment - Macro, Economic, Political, Technical & Social

Understanding the consumer: Determinants of consumer behavior, Factors influencing consumer behavior

Market Segmentation: Meaning & Concept, Basis of segmentation, selection of segments, Market Segmentation strategies, Target Marketing, Product Positioning

Product Management: Product Life cycle concept, New Product development & strategy, Stages in New Product development, Product decision and strategies, Branding & packaging

Pricing, Promotion and Distribution Strategy: Policies & Practices – Pricing Methods & Price determination Policies, Sentimental analysis. Marketing Communication – The promotion mix, Advertising & Publicity, 5 M's of Advertising Management. Marketing Channels, Retailing, Marketing Communication, Advertising

Marketing Research: Introduction, Type of Market Research, Scope, Objectives & Limitations Marketing Research Techniques, Survey Questionnaire design & drafting, Pricing Research, Media Research, Analytical attribute approaches-Determinant Gap Maps.

Data Analysis: Use of various statistical tools – Descriptive & Inference Statistics, Statistical Hypothesis Testing, Multivariate Analysis - Discriminant Analysis, Cluster Analysis, Segmenting and Positioning, Factor Analysis

Internet Marketing: Introduction to Internet Marketing. Mapping fundamental concepts of Marketing (7Ps, STP); Strategy and Planning for Internet Marketing

Business to Business Marketing: Fundamental of business markets. Organizational buying process. Business buyer needs. Market and sales potential. Product in business markets. Price in business markets. Place in business markets. Promotion in business markets. Relationship, networks and customer relationship management. Business to Business marketing strategy

Home Assignments:

1. **Written Analyses of Cases** – Students are expected to report on their analysis and recommendations of what to do in specific business situations by applying concepts and principles learned in class (Case Studies to be shared by Faculty) e.g. "Marketing Myopia"
2. Field visit & live project covering steps involved in formulating Market Research Project
3. Measuring Internet Marketing Effectiveness: Metrics and Website Analytics

Learning Resources

1. Philip Kotler, Marketing Management: Analysis, Planning, Implementation, and Control, 9th Edition, Prentice Hall, 1997
2. William J. Stanton, Charles M. Futrell, Fundamentals of Marketing, 8th Edition, McGraw-Hill, 1987
3. V.S. Ramaswamy, Marketing Management: A Strategic Decision Making Approach, 5th Edition, McGraw Hill, 2017
4. RajendraNargundkar, Marketing Research: Text and Cases, 4th Edition, McGraw-Hill, 2019
5. GC Beri, Marketing Research, 5th Edition, Tata McGraw Hill, 2013
6. Donald Cooper, Pamela Schindler, Marketing Research: Concepts And Cases, Tata McGraw Hill, 2005
7. RajanSaxena, Marketing Management, 4th Edition, McGraw Hill, 2009
8. S.A.Sherlekar, Marketing Management, Himalaya Publishing, 2010
9. S.M. Jha, Services Marketing, Himalaya Publishing, 2009

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Marketing Concepts and Applications**		
1.1	Introduction to Marketing & Core Concepts	1	CO1
1.2	Marketing of Services		CO1
1.3	Importance of marketing in service sector		CO1
1.4	Marketing Planning & Environment: Elements of Marketing Mix	1	CO1
1.5	Analyzing needs & trends in Environment		CO1
1.6	Macro, Economic, Political, Technical & Social		CO1
1.7	Understanding the consumer: Determinants of consumer behavior	1	CO1
1.8	Factors influencing consumer behavior		CO1
1.9	Market Segmentation: Meaning & Concept	1	CO1
1.10	Basis of segmentation, selection of segments		CO2
1.11	Market Segmentation strategies		CO2
1.12	Target Marketing	1	CO2
1.13	Product Positioning		CO2
2.	**Product Management**		CO1
2.1	Product Life cycle concept	1	CO3
2.2	New Product development & strategy		CO3
2.3	Stages in New Product development	1	CO3
2.4	Product decision and strategies		CO3
2.5	Branding & packaging		CO3
3.	**Pricing, Promotion and Distribution Strategy**		
3.1	Policies & Practices – Pricing Methods & Price determination Policies, sentimental analysis	1	CO4
3.2	Marketing Communication	1	CO4
3.3	The promotion mix	1	CO4
3.4	Advertising & Publicity		CO4
3.5	5 M's of Advertising Management	1	CO4
3.6	Marketing Channels		CO4
3.7	Retailing, Marketing Communication, Advertising	1	CO4
4.	**Marketing Research**		
4.1	Introduction, Type of Market Research, Scope	1	CO6
4.2	Objectives & Limitations Marketing Research Techniques		CO6
4.3	Survey Questionnaire design & drafting	1	CO6
4.4	Pricing Research, Media Research, Analytical attribute approaches-Determinant Gap Maps.		CO4
4.5	Data Analysis: Use of various statistical tools	1	CO6
4.6	Descriptive & Inference Statistics, Statistical Hypothesis Testing		CO6
4.7	Multivariate Analysis - Discriminant Analysis	1	CO6
4.8	Cluster Analysis, Segmenting and Positioning, Factor Analysis		CO6
5.	**Internet Marketing**		
5.1	Introduction to Internet Marketing	1	CO5
5.2	Mapping fundamental concepts of Marketing (7Ps, STP)	1	CO5

5.3	Strategy and Planning for Internet Marketing	1	CO5
6.	**Business to Business Marketing**		
6.1	Fundamental of business markets	1	CO1
6.2	Organizational buying process. Business buyer needs		CO2
6.3	Market and sales potential	1	CO2
6.4	Product in business markets. Price in business markets	1	CO2
6.5	Place in business markets. Promotion in business markets	1	CO2
6.6	Relationship, networks and customer relationship management	1	CO2
6.7	Business to Business marketing strategy		CO2
	Total	24	

Course Designers:

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21MAFH1	OPERATIONS RESEARCH

Category	L	T	P	Credit
OE	2	0	2	3

Preamble

The course aims to formulate and solve problems using linear programming, transportation problems, assignment problems, inventory control, queueing mechanism and simulation methodology. Eventually, the course provides a thorough understanding towards problem formulation and modelling / solving real world problems by choosing appropriate problem solving techniques.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Interpret the optimization problem using the appropriate mathematical model and derive solutions by validating the model.	15
CO2	Construct and solve problems using linear programming concepts and apply the simplex algorithm	15
CO3	Apply the transportation and assignment problems to various applications and test for optimality	15
CO4	Interpret the project by performing appropriate scheduling techniques and generate the needed time statistical chart along with the inventory cost analysis with the help of quantity discount models.	20
CO5	Construct and solve the queueing model by applying various performance measures.	15
CO6	Apply the simulation methodology for various scheduling, queuing and inventory systems.	20

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS 3	Apply	Value	Mechanism	1.2, 2.1, 4.5.3
CO2	TPS 3	Apply	Value	Mechanism	1.2, 2.1, 4.5.3
CO3	TPS 3	Apply	Value	Mechanism	1.2, 2.1, 4.5.3
CO4	TPS 3	Apply	Value	Mechanism	1.2, 2.1, 4.5.3
CO5	TPS 3	Apply	Value	Mechanism	1.2, 2.1, 4.5.3
CO6	TPS 3	Apply	Value	Mechanism	1.2, 2.1, 4.5.3

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	S	M	L		L			M	M		M		L	
CO2	S	M	L		L			M	M		M		L	
CO3	S	M	L		L			M	M		M		L	
CO4	S	M	L		L			M	M		M		L	
CO5	S	M	L		L			M	M		M		L	
CO6	S	M	L		L			M	M		M		L	

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Practical	Terminal Examination
	1	2	1	
Remember	20	20	-	20
Understand	20	20	-	20
Apply	60	60	100	60
Analyse				
Evaluate				
Create				

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject /Assignment/Practical Component
Perception	
Set	
Guided Response	
Mechanism	100
Complex Overt Responses	
Adaptation	
Origination	

Sample Questions for Course Outcome Assessment**

Course Outcome 1(CO1):

1. How will you construct a mathematical model.
2. Describe the phase formulating the problem
3. A firm manufactures two products A and B on which the profits earned per unit are Rs 3 and Rs 4 respectively. Each product is processed on two machines M1 and M2. Product A requires one minute of processing time on M1 and two minutes on M2 while B requires one minute on M1 and one minute on M2. Machine M1 is available for not more than 7 hours, while machine M2 is available for 10 hours during any working day. Formulate the number of units of products A and B to be manufactured to get maximum profit.

Course Outcome 2(CO2):

1. A company makes two products (X and Y) using two machines (A and B). Each unit of X that is produced requires 50 minutes processing time on machine A and 30 minutes processing time on machine B. Each unit of Y that is produced requires 24 minutes processing time on machine A and 33 minutes processing time on machine B. At the start of the current week there are 30 units of X and 90 units of Y in stock. Available processing time on machine A is forecast to be 40 hours and on machine B is forecast to be 35 hours. The demand for X in the current week is forecast to be 75 units and for Y is forecast to be 95 units. Company policy is to maximise the combined sum of the units of X and the units of Y in stock at the end of the week.
2. Formulate the problem of deciding how much of each product to make in the current week as a linear program. Solve this linear program graphically.
3. A gold processor has two sources of gold ore, source A and source B. In order to kept his plant running, at least three tons of ore must be processed each day. Ore from source A costs $20 per ton to process, and ore from source B costs $10 per ton to process. Costs must be kept to less than $80 per day. Moreover, Federal Regulations require that the amount of ore from source B cannot exceed twice the amount of ore from source A. If ore

from source A yields 2 oz. of gold per ton, and ore from source B yields 3 oz. of gold per ton, how many tons of ore from both sources must be processed each day to maximize the amount of gold extracted subject to the above constraints?

4. The Best Stuffing Company manufactures two types of packing tins- round & flat. Major production facilities involved are cutting and joining. The cutting department can process 200 round tins or 400 flat tins per hour. The joining department can process 400 round tins or 200 flat tins per hour. If the contribution towards profit for a round tin is the same as that of a flat tin, what is the optimal production level? Formulate a linear programming model for this problem and find the optimal solution using simplex method.

Course Outcome 3(CO3):

1. Obtain an initial basic feasible solution to the following transportation problem by using least- cost method.

	D_1	D_2	D_3	Supply
O_1	9	8	5	25
O_2	6	8	4	35
O_3	7	6	9	40
demand	30	25	45	

2. The ICARE Company has three plants located throughout a state with production capacity 50, 75 and 25 gallons. Each day the firm must furnish its four retail shops R1, R2, R3, & R4 with at least 20, 20 , 50, and 60 gallons respectively. The transportation costs (in Rs.) are given below. The economic problem is to distribute the available product to different retail shops in such a way so that the total transportation cost is minimum?

Company	Retail				Supply
	R1	R2	R3	R4	
P1	3	5	7	6	50
P2	2	5	8	2	75
P3	3	6	9	2	25
Demand	20	20	50	60	

3. Obtain an Initial BFS to the following Transportation problem using VAM method?

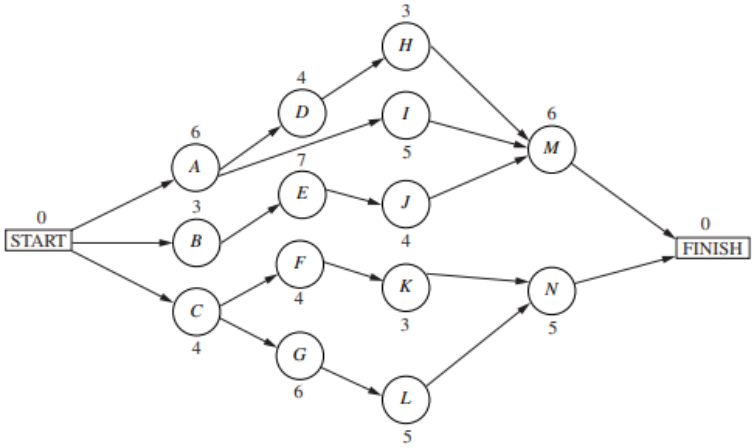
Origin	Destination				Supply
	1	2	3	4	
1	20	22	17	4	120
2	24	37	9	7	70
3	32	37	20	15	50
Demand	60	40	30	110	240

4. Solve the assignment problem:

	1	2	3	4	5
A	6	5	8	11	16
B	1	13	16	1	10
C	16	11	8	8	8
D	9	14	12	10	16
E	10	13	11	8	16

Course Outcome 4 (CO4):

1. Ken Johnston, the data processing manager for Stanley Morgan Bank, is planning a project to install a new management information system. He now is ready to start the project, and wishes to finish in 20 weeks. After identifying the 14 separate activities needed to carry out this project, as well as their precedence relationships and estimated durations (in weeks), Ken has constructed the following project network:



(a) Find all the paths and path lengths through this project network. Which of these paths is a critical path? (b) Find the earliest times, latest times, and slack for each activity. Will Ken be able to meet his deadline if no delays occur? (c) Use the information from part (b) to determine which of the paths is a critical path. What does this tell Ken about which activities he should focus most of his attention on for staying on schedule? (d) Use the information from part (b) to determine what the duration of the project would be if the only delay is that activity I takes 2 extra weeks. What if the only delay is that activity H takes 2 extra weeks? What if the only delay is that activity J takes 2 extra weeks?

2. Using the PERT three-estimate approach, the three estimates for one of the activities are as follows: optimistic estimate 30 days, most likely estimate 36 days, pessimistic estimate 48 days. What are the resulting estimates of the mean and variance of the duration of the activity?
3. Binford Tools manufactures garden tools. It uses inventory, overtime, and subcontracting to absorb demand fluctuations. Expected demand, regular and overtime production capacity, and subcontracting capacity are provided in the following table for the next four quarters for its basic line of steel garden tools:

Quarter	Demand	Regular Capacity	Overtime Capacity	Subcontracting Capacity
1	9,000	9,000	1,000	3,000
2	12,000	10,000	1,500	3,000
3	16,000	12,000	2,000	3,000
4	19,000	12,000	2,000	3,000

The regular production cost per unit is $20, the overtime cost per unit is $25, the cost to subcontract a unit is $27, and the inventory carrying cost is $2 per unit. The company has 300 units in inventory at the beginning of the year. Determine the optimal production schedule for the four quarters that will minimize total costs.

Course Outcome 5 (CO5):

1. Consider a network node that can serve 1 and store 2 packets altogether. Packets arrive to the node according to a Poisson process. Serving a packet involves two independent sequentially performed tasks: the ERROR CHECK and the packet TRANSMISSION to the output link. Each task requires an exponentially distributed time with an average of 30msec. Give, that we observe that the node is empty in 60% of the time, what is the average time spend in the node for one packet?
2. Packets arrive to a communication node with a single output link according to a Poisson Process. Give the Kendall notation for the following cases: 1. the packet lengths are exponentially distributed, the buffer capacity at the node is infinite 2. the packet length is fixed, the buffer can store n packets 3. the packet length is L with probability $p_L$amd l with probability p_l and there is no buffer in the node
3. In a computer network a link has a transmission rate of C bit/s. Messages arrive to this link in a Poisson fashion with rate λ messages per second. Assume that the messages have exponentially distributed length with a mean of 1/μ bits and the messages are queued in a FCFS fashion if the link is busy. a) Determine the minimum required C for given λ and μ such that the average system time (service time + waiting time) is less than a given time T_0.

Course Outcome 6(CO6):

1. Bakery Shop keeps stock of a popular brand of cake. Previous experience indicates the daily demand as given below:

Daily demand	Probability
0	0.01
15	0.15
25	0.20
35	0.50
45	0.12
50	0.02

Consider the following sequence of random numbers: 21, 27, 47, 54, 60, 39, 43, 91, 25, 20. Using this sequence, simulate the demand for the next 10 days. Find out the stock situation, if the owner of the bakery shop decides to

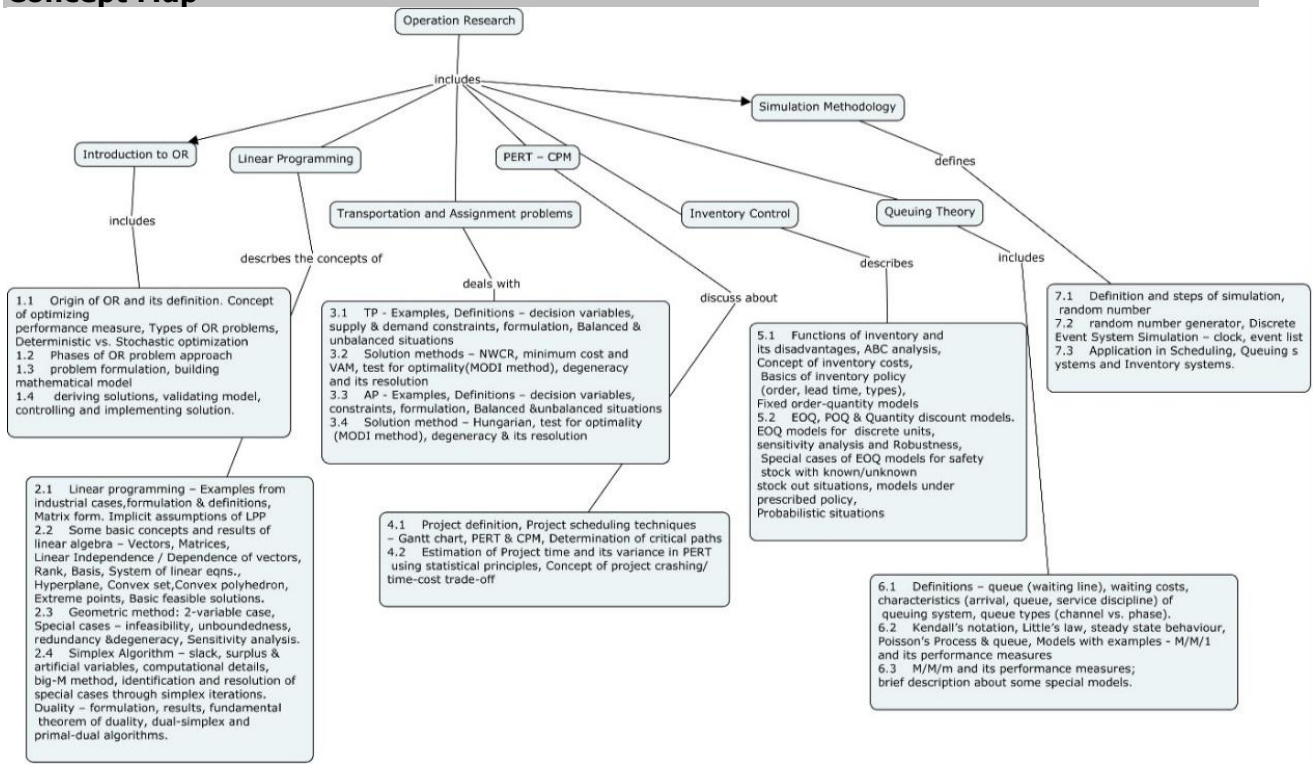
make 30 cakes every day. Also estimate the daily average demand for the cakes on the basis of simulated data.

2. Generate a sequence of 15 random numbers for which seed is 342, constant multiplier is 20, increment is 45 and modulus is 30Question 3
3. People arrive at the New Delhi Railway station to buy tickets according to the following distribution.

Inter-arrival Time (Min.)	Frequency
2	10
3	20
4	40
5	20
6	10

The service time is 5 minutes and there is only one ticket counter. The Railway station incharge is interested in predicting the operating characteristics of this counter during a typical operating day from 10.00 a.m. to 11.00 a.m. Use simulation to determine the average waiting time before service and average time a person spends in the system.

Concept Map



Syllabus

THEORY COMPONENT:

Introduction to OR:

Origin of OR and its definition. Concept of optimizing performance measure, Types of OR problems, Deterministic vs. Stochastic optimization, Phases of OR problem approach –

problem formulation, building mathematical model, deriving solutions, validating model, controlling and implementing solution.

Linear Programming:

Linear programming – Examples from industrial cases, formulation & definitions, Matrix form. Implicit assumptions of LPP.

Some basic concepts and results of linear algebra – Vectors, Matrices, Linear Independence/Dependence of vectors, Rank, Basis, System of linear eqns., Hyperplane, Convex set, Convex polyhedron, Extreme points, Basic feasible solutions.

Geometric method: 2-variable case, Special cases – infeasibility, unboundedness, redundancy &degeneracy, Sensitivity analysis.

Simplex Algorithm – slack, surplus & artificial variables, computational details, big-M method, identification and resolution of special cases through simplex iterations.

Duality – formulation, results, fundamental theorem of duality, dual-simplex and primal-dual algorithms.

Transportation and Assignment problems:

TP - Examples, Definitions – decision variables, supply & demand constraints, formulation, Balanced & unbalanced situations, Solution methods – NWCR, minimum cost and VAM, test for optimality (MODI method), degeneracy and its resolution.

AP - Examples, Definitions – decision variables, constraints, formulation, Balanced &unbalanced situations, Solution method – Hungarian, test for optimality (MODI method), degeneracy & its resolution.

PERT – CPM:

Project definition, Project scheduling techniques – Gantt chart, PERT & CPM, Determination of critical paths, Estimation of Project time and its variance in PERT using statistical principles, Concept of project crashing/time-cost trade-off.

Inventory Control:

Functions of inventory and its disadvantages, ABC analysis, Concept of inventory costs, Basics of inventory policy (order, lead time, types), Fixed order-quantity models – EOQ, POQ & Quantity discount models. EOQ models for discrete units, sensitivity analysis and Robustness, Special cases of EOQ models for safety stock with known/unknown stock out situations, models under prescribed policy, Probabilistic situations.

Queuing Theory:

Definitions – queue (waiting line), waiting costs, characteristics (arrival, queue, service discipline) of queuing system, queue types (channel vs. phase).

Kendall's notation, Little's law, steady state behaviour, Poisson's Process & queue, Models with examples - M/M/1 and its performance measures; M/M/m and its performance measures; brief description about some special models.

Simulation Methodology:

Definition and steps of simulation, random number, random number generator, Discrete EventSystem Simulation – clock, event list, Application in Scheduling, Queuing systems and Inventory systems.

PRACTICAL COMPONENT:

1. Formulation of linear programming problems.
2. Solution of linear programming problem using graphical method with:
    i. Multiple constraints
    ii. Unbounded solution
    iii. Infeasible solution
    iv. Alternative or multiple solution
3. Enumeration of all basic solutions for linear programming problem.
4. Solution of linear programming problem with simplex method.
5. Problem solving using Big M method.
6. Problem solving using two phase method.
7. Solution on primal problem as well as dual problem.

8. Solution based on dual simplex method.
9. Verification of weak duality, strong duality and complementary slackness property.
10. Solution of transportation problem.
11. Solution of assignment problem.
12. Solution of integer programming problem using Branch and Bound method.
13. Solution of integer programming problem using Gomory's cutting plane method.
14. Simulation: Random number generation.
15. Monte Carlo method.
16. Performance measures for M/M/1 queuing model.
17. ABC analysis.
18. Inventory model.

Learning Resources

1. Hamdy A. Taha, "Operations Research - An Introduction", MacMillan Co., Eighth Edition 2010.
2. K.G. Murthy,"Linear Programming",Wiley,1983
3. G. Hadley ,"Linear Programming",Narosa,2002
4. H.M. Wagner,"Principles of Operations Research with Application to Managerial Decisions" ,PHI,Second Edition,1980.
5. Hiller and Lieberman, " Introduction to Operations Research" Tata McGraw Hill, Eighth Edition, 2005
6. Thomas L. Saaty ,"Elements of Queuing Theory", Dover Publications,2000.
7. A. Ravi Ravindran,"Operations Research and Management Science, Hand Book", CRC Press,2007.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures	Course Outcome
1	**Introduction to OR**		
1.1	Origin of OR and its definition. Concept of optimizing performance measure, Types of OR problems, Deterministic vs. Stochastic optimization	1	CO1
1.2	Phases of OR problem approach	1	CO1
1.3	problem formulation, building mathematical model	1	CO1
1.4	deriving solutions, validating model, controlling and implementing solution.	1	CO1
2	**Linear Programming**		
2.1	Linear programming – Examples from industrial cases, formulation & definitions, Matrix form. Implicit assumptions of LPP	1	CO2
2.2	Some basic concepts and results of linear algebra – Vectors, Matrices, Linear Independence / Dependence of vectors, Rank, Basis, System of linear eqns., Hyperplane, Convex set,Convex polyhedron, Extreme points, Basic feasible solutions.	2	CO2
2.3	Geometric method: 2-variable case, Special cases – infeasibility, unboundedness, redundancy &degeneracy, Sensitivity analysis.	1	CO2
2.4	Simplex Algorithm – slack, surplus & artificial variables, computational details, big-M method, identification and resolution of special cases through simplex iterations.	1	CO2

	Duality – formulation, results, fundamental theorem of duality, dual-simplex and primal-dual algorithms.		
3	**Transportation and Assignment problems**		
3.1	TP - Examples, Definitions – decision variables, supply & demand constraints, formulation, Balanced & unbalanced situations	1	CO3
3.2	Solution methods – NWCR, minimum cost and VAM, test for optimality(MODI method), degeneracy and its resolution	1	CO3
3.3	AP - Examples, Definitions – decision variables, constraints, formulation, Balanced &unbalanced situations	1	CO3
3.4	Solution method – Hungarian, test for optimality (MODI method), degeneracy & its resolution	1	CO3
4	**PERT – CPM**		
4.1	Project definition, Project scheduling techniques – Gantt chart, PERT & CPM, Determination of critical paths	1	CO4
4.2	Estimation of Project time and its variance in PERT using statistical principles, Concept of project crashing/time-cost trade-off	1	CO4
5	**Inventory Control**		
5.1	Functions of inventory and its disadvantages, ABC analysis, Concept of inventory costs, Basics of inventory policy (order, lead time, types), Fixed order-quantity models	1	CO4
5.2	EOQ, POQ & Quantity discount models. EOQ models for discrete units, sensitivity analysis and Robustness, Special cases of EOQ models for safety stock with known/unknown stock out situations, models under prescribed policy, Probabilistic situations	2	CO4
6	**Queuing Theory**		
6.1	Definitions – queue (waiting line), waiting costs, characteristics (arrival, queue, service discipline) of queuing system, queue types (channel vs. phase).	2	CO5
6.2	Kendall's notation, Little's law, steady state behaviour, Poisson's Process & queue, Models with examples - M/M/1 and its performance measures	1	CO5
6.3	M/M/m and its performance measures; brief description about some special models.	1	CO5
7	**Simulation Methodology**		
7.1	Definition and steps of simulation, random number	1	CO6
7.2	random number generator, Discrete Event System Simulation – clock, event list	1	CO6
7.3	Application in Scheduling, Queuing systems and Inventory systems.	2	CO6
	TOTAL HOURS	**24**	

Course Contents and Lecture Schedule for Laboratory

Module No.	Topic	No. of Hours	Course Outcome
1	Formulation of linear programming problems	2	CO1
2	Solution of linear programming problem using graphical method with: i. Multiple constraints ii. Unbounded solution iii. Infeasible solution iv. Alternative or multiple solution	2	CO2
3	Enumeration of all basic solutions for linear programming problem with simplex method.	2	CO2
4	Problem Solving using Big M and two-phase method	2	CO2
5	Solution on primal problem as well as dual problem, dual simplex method and Verification of weak duality, strong duality and complementary slackness property	2	CO2
6	Solution of Transportation and Assignment problem	2	CO3
7	Solution of integer programming problem using Branch and Bound method and Gomory's cutting plane method	2	CO3
8	ABC analysis.	2	CO4
9	Monte Carlo method	2	CO5
10	Performance measures for M/M/1 queuing model	2	CO5
11	Simulation: Random number generation.	2	CO6
12	Inventory model	2	CO6
	TOTAL HOURS	**24**	

Course Designers:

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21CB461	SOFTWARE DESIGN WITH UML

Category	L	T	P	Credit
PC	2	0	2	3

Preamble

This course highlights the concept of Object Oriented software design and design patterns to get acquainted with UML diagrams in analysis and design. Focus will be on Object Oriented analysis of the system requirements followed by system design. This course helps in learning software design in a real world perspective.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Explain the concepts of modelling in software development life cycle	10
CO2	Analyze the system requirements for real world problems using use case diagrams	15
CO3	Create sequence and collaboration diagram for finding objects of the process involved	20
CO4	Create logical view design of given software using structural diagrams	20
CO5	Draw State chart and activity diagram to demonstrate the behaviour of the given software	20
CO6	Draw component and deployment models for given software specification	15

*** Weightage depends on Bloom's Level, number of contact hours

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond	-	1.2,2.1.2,2.5.2
CO2	TPS3	Apply	Value	-	1.2,2.1.2, 2.1.5, 3.1.1,3.1.2, 3.2.3,3.2.5, 4.3.1, 4.3.2, 4.3.3,4.4.1,4.4.2,4.4.3,4.4.4,4.5.1, 4.5.3,
CO3	TPS3	Apply	Value	-	1.2,2.1.2, 2.1.5, 3.1.1,3.1.2, 3.2.3,3.2.5, 4.3.1, 4.3.2, 4.3.3,4.4.1,4.4.2,4.4.3,4.4.4,4.5.1, 4.5.3,
CO4	TPS3	Apply	Value	-	1.2,2.1.2, 2.1.5, 3.1.1,3.1.2, 3.2.3,3.2.5, 4.3.1, 4.3.2, 4.3.3,4.4.1,4.4.2,4.4.3,4.4.4,4.5.1, 4.5.3,
CO5	TPS3	Apply	Value	-	1.2,2.1.2, 2.1.5, 3.1.1,3.1.2, 3.2.3,3.2.5, 4.3.1, 4.3.2,

					4.3.3,.4.1,4.4.2,4.4.3,4.4.4, 4.5.1, 4.5.3,
CO6	TPS3	Apply	Value	-	1.2,2.1.2, 2.1.5, 3.1.1,3.1.2, 3.2.3,3.2.5, 4.3.1, 4.3.2, 4.3.3,4.4.1,4.4.2,4.4.3,4.4.4,4.5.1, 4.5.3,

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L								L	-	M		
CO2	S	M	L		S	L	M	S	S	M	S	M	M	M
CO3	S	M	L		S	L	M	S	S	M	S	M	M	M
CO4	S	M	L		S	L	M	S	S	M	S	M	M	M
CO5	S	M	L		S	L	M	S	S	M	S	M	M	M
CO6	S	M	L		S	L	M	S	S	M	S	M	M	M

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests			Practical	Terminal Examination
	1	**2**		1	
Remember	20	20			-
Understand	20	20			20
Apply	60	60		100	80
Analyse	-	-		-	-
Evaluate	-	-		-	-
Create	-	-		-	-

Assessment Pattern: Psychomotor

Psychomotor Skill	Assignment
Perception	-
Set	-
Guided Response	-
Mechanism	-
Complex Overt Responses	-
Adaptation	-
Origination	-

Sample Questions for Course Outcome Assessment**

Course Outcome 1 (CO1):

1. List the factors to consider when selecting an appropriate software development process.

   (Remember)
2. What makes software design different from coding? (Understand)
3. What are the characteristics of a quality software? (Understand)

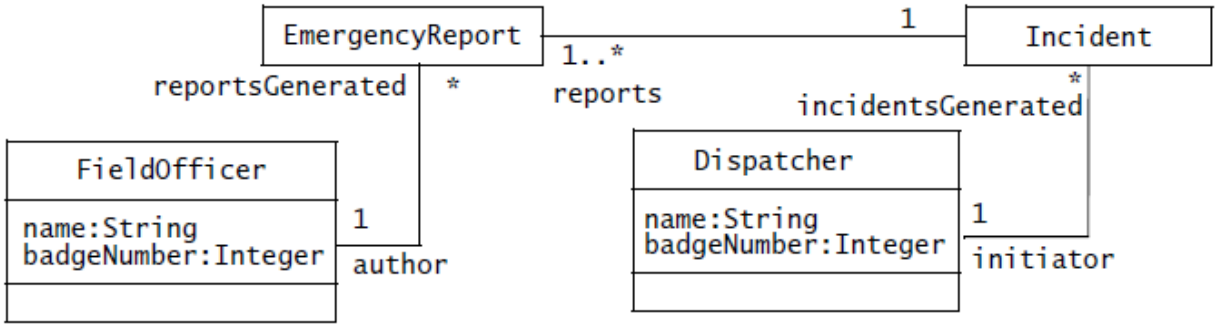
Course Outcome 2 (CO2):

1. What is dependency? Where can it be used? Explain the stereotypes that can be used along with it. (Understand)

2. Create a Use Case Diagram (in UML) with users, Auctions , searching in an Internet auction system (Apply)
3. Draw the Use case diagram for the Traffic control management system (Apply)

Course Outcome 3 (CO3):

1. Give some examples of situations where collaboration diagrams may be beneficial and Explain the relations between collaboration diagram and sequence diagram. (Understand)
2. Draw a sequence diagram for the "warehouseOnFire scenario-report Emergency" given below. Include objects and instances of other classes you may need. Draw only the first five message sends.
   (Apply)



3. Develop Collaboration diagrams for the purchase journey of a consumer on an e-commerce website depicting simplistic interactions between small numbers of objects the user signing in using their unique Id to access an interface of profiles, products, etc.
   (Apply)

Course Outcome 4 (CO4):

1. Briefly describe system's classes, attributes, operations and relationships using Class diagrams (Understand)
2. Distinguish strong and weak aggregations with an example.
   (Understand)
3. Create a class diagram for ATMs system (Ex class-Bank, Customer, ATM, Account-Savings/Current, and ATM Transaction.) (Apply)

Course Outcome 5 (CO5):

1. What is a message? How it will be represented in UML? Mention its types.
   (Understand)
2. Consider the process of ordering a pizza over the phone. Draw an activity diagram representing each step of the process, from the moment you pick up the phone to the point where you start eating the pizza. Do not represent any exceptions. Include activities that others need to perform. (Apply)
3. Add exception handling to the activity diagram you developed in Exercise 2-15. Consider at least three exceptions (e.g., delivery person wrote down wrong address, delivery person brings wrong pizza, store out of anchovies).
   (Apply)

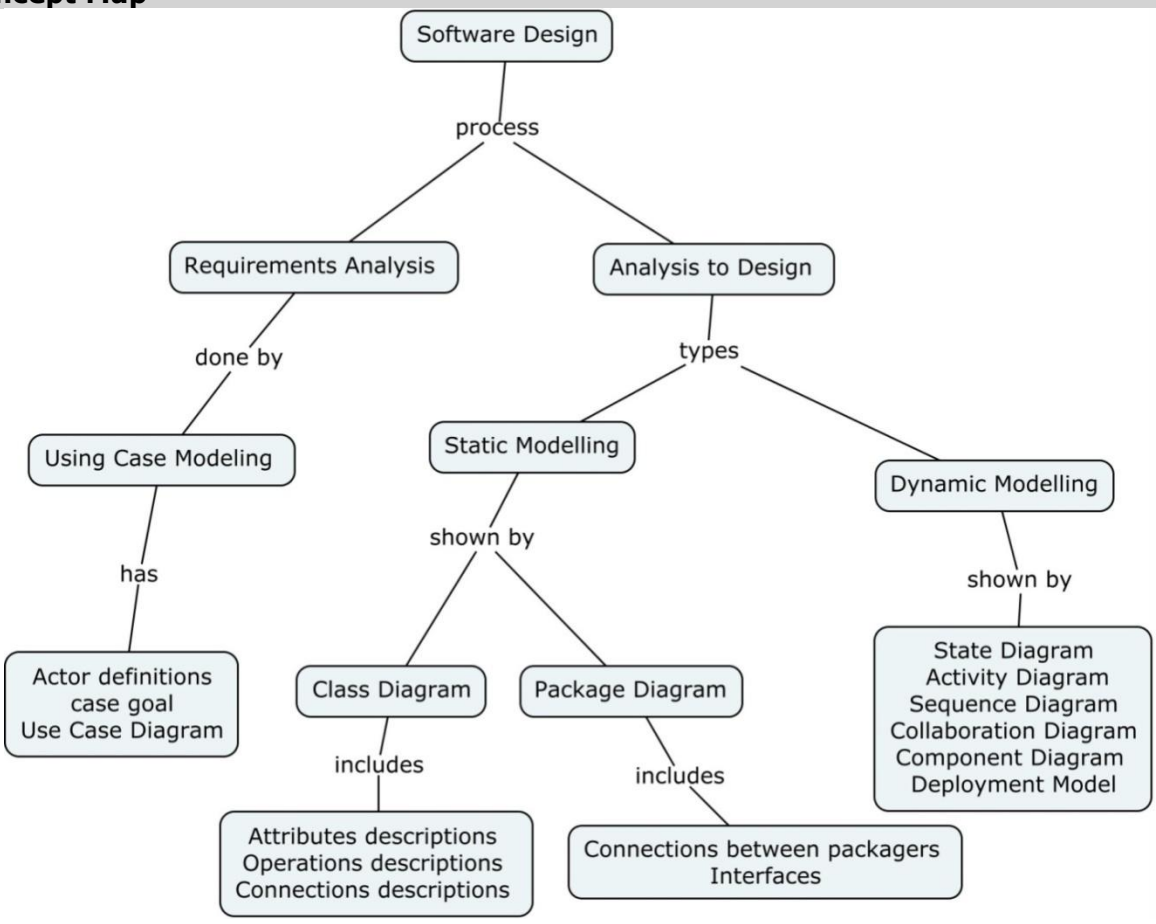
Course Outcome 6 (CO6):

1. Consider a system that includes a Web server and two database servers. Both Database servers are identical: the first acts as a main server, and the second acts as a redundant back-up in case the first one fails. Users use Web browsers to access

data through the Web server. They also have the option of using a proprietary client that accesses the databases directly. Draw a UML deployment diagram representing the hardware/software mapping of this system. **(Apply)**

2. Draw a UML deployment diagram for Client/server architectural style (UML component diagram). Clients request services from one or more Servers. The Server has no knowledge of the Client. **(Apply)**
3. Develop aA UML deployment diagram representing the allocation of components to different nodes. Web browsers on PCs and Macs can access a WebServer that provides information from a Database. **(Apply)**

Concept Map



Syllabus

Introduction to on Object Oriented Technologies and the UML Method.

- Software development process: The Waterfall Model vs. The Spiral Model.
- The Software Crisis, description of the real world using the Objects Model.
- Classes, inheritance and multiple configurations.
- Quality software characteristics.
- Description of the Object Oriented Analysis process vs. the Structure Analysis Model.

Introduction to the UML Language.

- Standards.
- Elements of the language.
- General description of various models.
- The process of Object Oriented software development.

- Description of Design Patterns.
- Technological Description of Distributed Systems.

Requirements Analysis Using Case Modeling

- Analysis of system requirements.
- Actor definitions.
- Writing a case goal.
- Use Case Diagrams.
- Use Case Relationships.

Transfer from Analysis to Design in the Characterization Stage: Interaction Diagrams.

- Description of goal.
- Defining UML Method, Operation, Object Interface, Class.
- Sequence Diagram.
- Finding objects from Flow of Events.
- Describing the process of finding objects using a Sequence Diagram.
- Describing the process of finding objects using a Collaboration Diagram.

The Logical View Design Stage: The Static Structure Diagrams.

- The Class Diagram Model.
- Attributes descriptions.
- Operations descriptions.
- Connections descriptions in the Static Model.
- Association, Generalization, Aggregation, Dependency, Interfacing, Multiplicity.

Package Diagram Model.

- Description of the model.
- White box, black box.
- Connections between packagers.
- Interfaces.
- Create Package Diagram.
- Drill Down.

Dynamic Model: State Diagram / Activity Diagram.

- Description of the State Diagram.
- Events Handling.
- Description of the Activity Diagram.
- Exercise in State Machines.

Component Diagram Model.

- Physical Aspect.
- Logical Aspect.
- Connections and Dependencies.
- User face.
- Initial DB design in a UML environment.

Deployment Model.

- Processors.
- Connections.
- Components.
- Tasks.
- Threads.

- Signals and Events.

Laboratory:
The following UML diagrams will be practiced by the students for applications such as ATM Systems, Stock Maintenance System and Remote Procedure Call Implementation etc.

1. Class Diagram
2. Object Diagram
3. Use Case Diagram
4. Sequence Diagram
5. Collaboration Diagram
6. State Chart Diagram
7. Activity Diagram
8. Component Diagram
9. Deployment Diagram

Learning Resources

1. Grady Booch, James Rumbaugh, Ivar Jacobson, "*The Unified Modelling LanguageUser Guide",* 2005
2. Bernd Bruegge and Allen H. Dutoit*, "Object-Oriented Software Engineering: using UML, Patterns, and Java", 2009*
3. Erich Gamma, Richard Helm, Ralph Johnson, and John M. Vlissides, *"Design Patterns: Elements of Reusable Object-Oriented Software*", 1994

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1	**Introduction to on Object Oriented Technologies and the UML Method**		
1.1	Software development process: The Waterfall Model vs. The Spiral Model, The Software Crisis, description of the real world using the Objects Model	1	CO1
1.2	Classes, inheritance and multiple configurations, Quality software characteristics.	1	CO1
1.3	Description of the Object Oriented Analysis process vs. the Structure Analysis Model	1	CO1
2	**Introduction to the UML Language**		
2.1	Standards, Elements of the language, General description of various models	1	CO1
2.2	The process of Object Oriented software development, Description of Design Patterns	1	CO1
2.3	Technological Description of Distributed Systems	1	CO1
3	**Requirements Analysis Using Case Modeling**		
3.1	Analysis of system requirements, Actor definitions, Writing a case goal	2	CO2
3.2	Use Case Diagrams, Use Case Relationships	2	CO2
4	**Transfer from Analysis to Design in the Characterization Stage: Interaction Diagrams**		
4.1	Description of goal, Defining UML Method, Operation, Object Interface, Class Diagram, Object Diagram	1	CO3
4.2	Sequence Diagram, Finding objects from Flow of Events.	1	CO3

	Describing the process of finding objects using a Sequence Diagram		
4.3	Describing the process of finding objects using a Collaboration Diagram	1	CO3
5	**The Logical View Design Stage: The Static Structure Diagrams**		
5.1	The Class Diagram Model, Attributes descriptions, Operations descriptions, Connections descriptions in the Static Model	1	CO4
5.2	Association, Generalization, Aggregation, Dependency, Interfacing, Multiplicity	2	CO4
6	**Package Diagram Model**		
6.1	Description of the model, White box, black box Connections between packagers, Interfaces	1	CO4
6.2	Create Package Diagram, Drill Down	1	CO4
7	**Dynamic Model: State Diagram / Activity Diagram**		
7.1	Description of the State Diagram, Events Handling, Exercise in State Machines	1	CO5
7.2	Description of the Activity Diagram	1	CO5
8	**Component Diagram Model**		
8.1	Physical Aspect, Logical Aspect, Connections and Dependencies, User face	1	CO6
8.2	Initial DB design in a UML environment.	1	CO6
9	**Deployment Model**		
9.1	Processors, Connections, Components, Tasks	1	CO6
9.2	Threads, Signals and Events.	1	CO6
		24	
Module No.	**Topic**	**No. of Hours**	**Course Outcome**
1	Implementation of Use Case Diagram	2	CO2
2	Implementation of Class Diagram	4	CO4
3	Implementation of Object Diagram	2	CO4
4	Implementation of Sequence Diagram	3	CO3
5	Implementation of Collaboration Diagram	3	CO3
6	Implementation of State Chart Diagram	3	CO5
7	Implementation of Activity Diagram	3	CO5
8	Implementation of Component Diagram	2	CO6
9	Implementation of Deployment Diagram	2	CO6
		24	
	Total Hours	**48**	

Course Designers:

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2. Dr. A. Malini amcse@tce.edu

21CB471	DESIGN THINKING

Category	L	T	P	Credit
ES	2	0	2	3

Preamble

Design Thinking (DT) is a Behavioural oriented course. In this course learners can able to recognize the importance of Design Thinking in Businesses. The Activities such as Doodling and Story Telling is included to present the ideas and prototype. This course also helps to create value proposition statements as part of their presentations. The outcome of the course is to make students recognize how Agile and DT complement each other to deliver customer satisfaction

Prerequisite

Nil

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage in %
CO1	Conduct an immersion activity and fill up the Design Thinking question template	20
CO2	Recognize the steps to create problem statements in the define phase of Design Thinking	10
CO3	Apply the steps in the ideate phase of Design Thinking	15
CO4	Create a prototype to Recognize the importance of service value proposition	15
CO5	Test a prototype created through a Design Thinking process	15
CO6	Demonstrate the design thinking driven project based on customer satisfaction	25

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS3	Apply	Value	Mechanism	1.1, 1.2, 2.1.1, 3.1.2, 3.2.3, 3.2.6, 4.1.2
CO2	TPS3	Apply	Value	Mechanism	1.1, 1.2, 2.1.2, 2.5.1, 2.5.2, 3.1.2, 3.2.3, 3.2.6, 4.1.2
CO3	TPS3	Apply	Value	Mechanism	1.1, 1.2, 2.1.3, 3.1.2, 3.2.3, 3.2.6, 4.1.2, 4.3.1
CO4	TPS3	Apply	Value	Mechanism	1.1, 1.2, 2.1.4, 3.1.2, 3.2.3, 3.2.6, 4.1.2, 4.4.1
CO5	TPS3	Apply	Value	Mechanism	1.1, 1.2, 2.1.5, 3.1.2, 3.2.3, 3.2.6, 4.1.2, 4.4.1
CO6	TPS4	Analyze	Organise	Complex Overt Responses	1.1, 1.2, 2.1.5, 3.1.2, 3.2.3, 3.2.6, 4.1.2, 4.4.1, 4.5.1,4.5.5

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	S	M	L	-		M	M	L	M	M	S	M	L	M
CO2	S	M	L	-		M	M	L	M	M	S	M	L	M
CO3	S	M	L	-		M	M	L	M	M	S	M	L	M
CO4	S	M	L	-	M	M	M	L	M	M	S	M	M	M

CO5	S	M	L	-	M	S	M	L	M	M	S	M	M	M
CO6	S	S	M	L	M	S	S	S	S	M	S	S	M	S

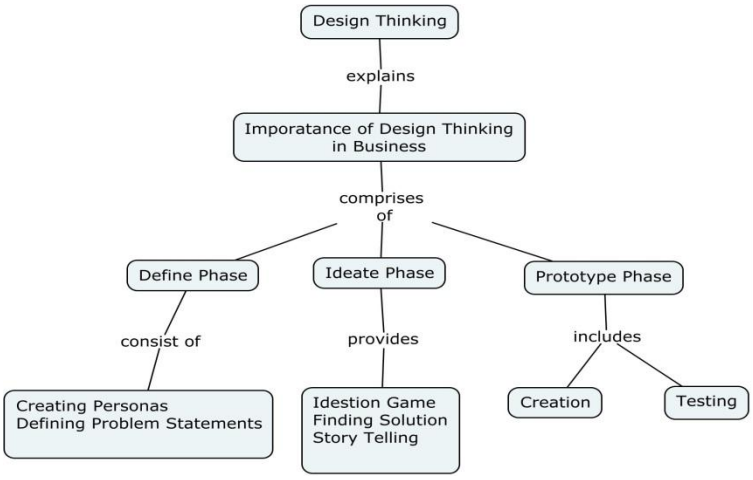
S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Phases	Deliverables	Marks	Course Outcomes
Continuous Assessment			
Review 1 – Problem Identification and Definition	Technical Report	10	CO1 and CO2
Review 2 – Ideating Solutions	Technical Report	20	CO3
Review 3 –Creating a Prototype	Technical Report	20	CO4 and CO5
End-Semester Examination			
Project	Prototype	100	CO6

- The report and presentation will be evaluated based on Rubrics
- Project Demonstration and Poster presentation will be evaluated by two faculty members nominated by their respective Head of the Department.

Concept Map



Syllabus

1.0 Importance of Design Thinking in Business: Needs Assessment, Stakeholder Identification, Stakeholder Requirement Project Time Constraint.

2.0 Define Phase : Creating Personas, Problem Statements, Defining Problem Statements

3.0 Ideate Phase : Introduction, Ideation game, Ideate to find solutions, Story Telling

4.0 Prototype phase: Importance, Creating Prototype, Value Proposition Statement, Testing

Learning Resources

1. NirEyal -Hooked, Portfolio, 2014
2. Rod Judkins -The Art of Creative Thinking ,Hachette Book Publishing,2015
3. Dan Senor and Saul singer-Start Up nation,Twelve Publisher, 2011
4. Simon Sinek -Start with Why, Portfolio, 2011

Online Resources:

1 Understanding Design thinking WF NEN

2 Design Thinking and Innovation at Apple Wei Li

3 Stanford Webinar- Design Thinking = Method, Not Magic

4 Stanford Design Thinking Virtual Crash Course

5 So Many Uses- activity to spark creativity and design

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1	**Importance of Design Thinking in Business (11)**		
1.1	Why is Design Thinking important for business	1	CO1
1.2	Why is Design Thinking important for you?	2	CO1
1.3	What is DT?	1	CO1
1.4	What is empathy?	1	CO1
1.5	How to empathize?	2	CO1
1.6	Intro to Immersion Activity	1	CO1
1.7	Immersion activity	3	CO1
2	**Define Phase (5)**		
2.1	Creating personas	2	CO2
2.2	Problem statements	1	CO2
2.3	Defining problem statements	2	CO2
3	**Ideate Phase (8)**		
3.1	How to Ideate?	1	CO3
3.2	Ideation games	2	CO3
3.3	Ideate to find solutions	2	CO3
3.4	Let's doodle!	1	CO3
3.5	What is Storytelling in DT?	2	CO3
4	**Prototype Phase (12)**		
4.1	Why is a Prototype important in Design Thinking?	1	CO4
4.2	Prototype your idea	3	CO4
4.3	Value Proposition Statement	2	CO4
4.4	Testing in Design Thinking	1	CO5
4.5	Test the Prototype	2	CO5
4.6	Role of DT in your work	1	CO5
4.7	How Agile and DT complement each other to deliver customer satisfaction	1	CO5
4.8	Share your Satori	1	CO5
Project		12	CO6
	Total	**48**	

Course Designers:

1. Dr.R.Leena Sri rlsit@tce.edu
2. TCS Design Thinking Team

21CB481	OPERATING SYSTEMS LAB

Category	L	T	P	Credit
PC	0	0	2	1

Preamble

This practical course enables the students to study and clearly understand the fundamental design and implementation ideas in the engineering of Operating Systems.

Prerequisite

Basics of C Programming and Unix/Linux Operating System

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Develop bash shell scripts using basic Unix/Linux commands (Apply)	10
CO2	Compute the average waiting time and turnaround time for the given set of processes by using CPU scheduling algorithms FCFS, SJFS, Priority and Round Robin (Apply)	20
CO3	Construct Inter Process Communication between processes using shared memory, pipes and message queue method based system calls (Apply)	15
CO4	Construct Semaphore based synchronization solution to the classical synchronization problem (Apply)	10
CO5	Develop solution to handle deadlock with an avoidance and detection approach (Apply)	20
CO6	Construct the First fit and Best fit memory allocation methods used by the memory manager (Apply)	15
C07	Develop solution to allocate files on the secondary storage device (Apply)	10

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS3	Apply	Value	Mechanism	1.2, 2.3.2,4.5.3
CO2	TPS3	Apply	Value	Mechanism	1.2, 2.3.2, 4.5.3
CO3	TPS3	Apply	Value	Mechanism	1.2, 2.3.2, 4.5.3
CO4	TPS3	Apply	Value	Mechanism	1.2, 2.3.2, 4.5.3
CO5	TPS3	Apply	Value	Mechanism	1.2, 2.3.2, 4.5.3
CO6	TPS3	Apply	Value	Mechanism	1.2, 2.3.2, 4.5.3
CO7	TPS3	Apply	Value	Mechanism	1.2, 2.3.2, 4.5.3

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	S	M	L		M			M	M		M	M	M	L
CO2	S	M	L		M			M	M		M	M	M	L
CO3	S	M	L		M			M	M		M	M	M	L
CO4	S	M	L		M			M	M		M	M	M	L

CO5	S	M	L		M			M	M		M	M	M	L
CO6	S	M	L		M			M	M		M	M	M	L
CO7	S	M	L		M			M	M		M	M	M	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Model Examination	Terminal Examination
Remember	-	-
Understand	-	-
Apply	100	100
Analyse	-	-
Evaluate	-	-
Create	-	-

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject /Practical Component/Observation
Perception	-
Set	-
Guided Response	10
Mechanism	90
Complex Overt Responses	-
Adaptation	-
Origination	-

List of Experiments/Activities with CO Mapping

Sl.No	Experiments	No. of hours	CO
1.	Basic Unix/Linux/Minix File system and data manipulation commands.	2	CO1
2.	Implementing bash shell scripting with various control statements	2	CO1
3.	Given the list of processes, their CPU burst times and arrival times print the Gantt chart for the scheduling algorithms FCFS and SJFS. For each of the scheduling policies, compute and print the average waiting time and average turnaround time.	2	CO2
4.	Given the list of processes, their CPU burst times and arrival times print the Gantt chart for Priority scheduling algorithm. Compute and print the average waiting time and average turnaround time.	2	CO2
5.	Given the list of processes, their CPU burst times and arrival times print the Gantt chart for Round Robin scheduling algorithm. Compute and print the average waiting time and average turnaround time.	2	CO2
6.	Develop processes executing and communicating using Shared Memory based Unix/Linux system calls	2	CO3

7.	Develop applications performing Inter Process Communication using pipes or message queues system calls	2	CO3
8.	Implement the Producer – Consumer synchronization problem using semaphores system calls in UNIX/Linux	2	CO4
9.	Implement Bankers Algorithm for Deadlock Avoidance	2	CO5
10.	Implement Deadlock detection approach for single instance and multiple instance resource types.	2	CO5
11.	Implement First fit and Best fit memory management schemes	2	CO6
12.	Implement the Disk Scheduling algorithm and indexing, hashing based allocation method	2	CO7
	Total No. of Hours	24	

Learning Resources

1. Abraham Silberschatz, Peter Baer Galvin and Greg Gagne: Operating System Concepts Essentials, ninth edition, John Wiley and Sons, 2013.
2. Operating Systems: Internals and Design Principles, William Stallings, Pearson Education, 2018.
3. Operating System: A Design-oriented Approach, Charles Patrick Crowley, McGrawHill Eductaion,2017.
4. Operating Systems: A Modern Perspective, Gary J. Nutt, Pearson, 1997.
5. Design of the Unix Operating Systems. Maurice J. Bach. Pearson Education India, 2015.
6. Understanding the Linux Kernel, Daniel Pierre Bovet, Marco Cesati, O'Reilly Media.

Course Designers

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2. Dr.G.MadhuPriya gmadhupriya@tce.edu

21CB491	DATABASE MANAGEMENT SYSTEMS LAB

Category	L	T	P	Credit
PC	0	0	2	1

Preamble

This course helps the students to design database applications using different data models and implement them using Structured Query Language (SQL). This course facilitates the students to perform different database operations such as storage, retrieval and manipulation of data using RDBMS and helps the students to execute procedures, functions, packages and triggers against the databases. Students can develop front end applications in high level languages and these applications can operate with the data on backend databases.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Develop E-R and Relational models for the given real world database application	10
CO2	Build relational schemas using functional dependencies and normal forms	10
CO3	Write SQL queries for data storage, retrieval and manipulation against the relational schemas.	30
CO4	Construct and use different database objects, complex data types using SQL.	10
CO5	Develop sub programs such as Procedures, Functions, Triggers and Packages using PL/SQL and use them for data manipulation.	25
CO6	Develop an application in high level language and make use of APIs to interact with databases	15

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS3	Apply	Value		1.2, 2.1.1, 2.1.2, 2.1.5, 2.2.3, 2.4.3, 3.1, 4.4.3, 4.4.4, 4.5
CO2	TPS3	Apply	Value		1.2, 2.1.1, 2.1.2, 2.1.5, 2.2.3, 2.4.3, 3.1, 4.4.3, 4.4.4, 4.5
CO3	TPS3	Apply	Value		1.2, 2.1.1, 2.1.2, 2.1.5, 2.2.3, 2.4.3, 3.1, 4.4.3, 4.4.4, 4.5
CO4	TPS3	Apply	Value		1.2, 2.1.1, 2.1.2, 2.1.5, 2.2.3, 2.4.3, 3.1, 4.4.3, 4.4.4, 4.5
CO5	TPS3	Apply	Value		1.2, 2.1.1, 2.1.2, 2.1.5, 2.2.3, 2.4.3, 3.1, 4.4.3, 4.4.4, 4.5

CO6	TPS3	Apply	Value		1.2, 2.1.1, 2.1.2, 2.1.5, 2.2.3, 2.4.3, 3.1, 4.4.3, 4.4.4, 4.5

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	S	M	L		L	M	M	M	M		M	M	L	M
CO2	S	M	L		L	M	M	M	M		M	M	L	M
CO3	S	M	L		M	M	M	M	M		M	M	M	M
CO4	S	M	L		M	M	M	M	M		M	M	M	M
CO5	S	M	L		M	M	M	M	M		M	M	M	M
CO6	S	M	L		M	M	M	M	M		M	M	M	M

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Model Examination	Terminal Examination
Remember	-	-
Understand	-	-
Apply	100	100
Analyse	-	-
Evaluate	-	-
Create	-	-

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject /Practical Component/Observation
Perception	-
Set	-
Guided Response	-
Mechanism	-
Complex Overt Responses	-
Adaptation	-
Origination	-

List of Experiments/Activities with CO Mapping

Module No.	Topic	No. of Hours	Course Outcome
1.	Design of database application using E-R model and Relational Model	2	CO1
2.	Identification of functional dependencies and normalization of schemas	2	CO2
3.	Creation of database using SQL – DDL commands along with the integrity constraints(using standard data of reasonable size)	2	CO3

Module No.	Topic	No. of Hours	Course Outcome
4.	Manipulation of database using SQL – DML commands and Practice of DCL and TCL commands (using standard data of reasonable size)	2	CO3
5.	Implementation of Simple Queries involving Date Functions, String Functions , Math Functions, Aggregate Functions (Group by and having clause) - (using standard data of reasonable size)	2	CO3
6.	Implementation of Complex Queries involving Joins, set operators, sub queries, (using standard data of reasonable size) and evaluation of queries	2	CO3
7.	Implementation of Complex queries such as correlated sub queries, hierarchical queries and spatial queries	2	CO3
8.	Creation of various database objects such as index, sequence, synonym, complex data types (LOB,BFILE), collection types, structured types using SQL	2	CO4
9.	Implementation of PL/SQL Procedure, Function along with cursor	2	CO5
10.	Implementation of PL/SQL Trigger (Row and Statement Triggers)	2	CO5
11.	Implementation of Package using PL/SQL	2	CO5
12.	Development of database application in high level language using APIs and Demonstration of a complete database application	2	CO6
	Total	**24**	

Course Designers:

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CURRICULUM AND DETAILED SYLLABI

FOR

B.TECH DEGREE (Computer Science and Business Systems) PROGRAMME

FIFTH SEMESTER

FOR THE STUDENTS ADMITTED FROM THE

ACADEMIC YEAR 2025 – 2026 ONWARDS

THIAGARAJAR COLLEGE OF ENGINEERING

(A Government Aided ISO 9001-2008 Certified

Autonomous Institution affiliated to Anna University)

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THIAGARAJAR COLLEGE OF ENGINEERING, MADURAI- 625 015

(A Govt. Aided, ISO 9001:2008 certified Autonomous Institution affiliated to Anna University)

B.Tech Degree (Computer Science and Business Systems) Programme

COURSES OF STUDY

(For the candidates admitted from 2025 – 2026 onwards)

FIFTH SEMESTER

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	No.of Hours / Week			Credits
				L	T	P	
THEORY COURSES							
1	21CB511	Design and Analysis of Algorithms	PC	3	0	0	3
2	21CB521	Compiler Design	PC	3	0	0	3
3	21CB531	Fundamentals of Management	HSS	2	0	0	2
4	21CB541	Business Strategy	HSS	2	0	0	2
5	21CB551	Business Communication & Value Science - III	Project	2	0	0	2
6	21XXGX0	General Elective – I	GE	3	0	0	3
THEORY CUM PRACTICAL COURSES							
7	21CBPX0	Program Elective – I	PSE	3	0	2	4
PRACTICAL COURSES							
8	21CB571	Design and Analysis of Algorithms Lab	PC	0	0	4	2
9	21CB581	Compiler Design Lab	PC	0	0	2	1
10	21CB591	Mini Project	Project	0	0	2	1
			TOTAL	**18**	**0**	**10**	**23**

PC : Program Core
PSE : Program Specific Elective
HSS : Humanities and Social Science
GE : General Elective
L : Lecture
T : Tutorial
P : Practical

Note:

1 Hour Lecture is equivalent to 1 credit

1 Hour Tutorial is equivalent to 1 credit

2 Hours Practical is equivalent to 1 credit

THIAGARAJAR COLLEGE OF ENGINEERING, MADURAI- 625 015

(A Govt. Aided, ISO 9001:2008 certified Autonomous Institution affiliated to Anna University)

B.Tech Degree (Computer Science and Business Systems) Programme

SCHEME OF EXAMINATIONS

(For the candidates admitted from 2025 – 2026 onwards)

FIFTH SEMESTER

S.No.	Course Code	Name of the Course	Duration of Terminal Exam. in Hrs.	Marks			Minimum Marks for Pass	
				Continuous Assessment	Terminal Exam *	Max. Marks	Terminal Exam	Total
THEORY								
1	21CB511	Design and Analysis of Algorithms	3	60	40	100	27	50
2	21CB521	Compiler Design	3	60	40	100	27	50
3	21CB531	Fundamentals of Management	3	60	40	100	27	50
4	21CB541	Business Strategy	3	60	40	100	27	50
5	21CB551	Business Communication & Value Science - III	-	100	-	100	-	50
THEORY CUM PRACTICAL COURSES								
6	21CBPX0	Program Elective – I	3	50	50	100	25	50
PRACTICAL								
7	21CB571	Design And Analysis of Algorithms Lab	3	40	60	100	18	50
8	21CB581	Compiler Design Lab	3	40	60	100	18	50
9	21CB591	Mini Project	3	40	60	100	27	50

* Terminal Examination will be conducted for maximum marks of 100 and subsequently be reduced to 40 marks for the award of terminal examination marks

21CB511	DESIGN AND ANALYSIS OF ALGORITHMS

Category	L	T	P	Credit	Terminal Exam Type
PC	3	-	-	3	Theory

Preamble

This course enables the students to understand and apply algorithms for solving various computational problems. The different approaches used in algorithms help them to identify clear and efficient ways to solve a problem by increasing the efficiency in regards to time and space complexity with correctness of proof.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Use the asymptotic analysis to identity the performance of algorithm with correctness of proof	15
CO2	Familiarize with various algorithm design techniques and structuring of data	20
CO3	Apply various design algorithms to analyze the problem solving techniques	15
CO4	Illustrate the various graph algorithms to synthesize and model the engineering problems	20
CO5	Solve tractability and Intractability of an algorithm by applying the algorithm techniques	15
CO6	Construct approximation and randomization algorithms to analyse the effectiveness of running time for algorithms	15

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS3	Apply	Value	-	1.2, 2.1.1, 2.1.3
CO2	TPS2	Understand	Respond	-	1.2, 2.1.1, 2.4.6
CO3	TPS3	Apply	Value	-	1.2,2.1.1
CO4	TPS3	Apply	Value	-	1.2, 2.1.1
CO5	TPS3	Apply	Value	-	1.2, 2.1.1
CO6	TPS3	Apply	Value	-	1.2, 2.1.1,2.1.4

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	S	M	L	-	-	-	-	-	L	-	M	M	-	L
CO2	M	L	-	-	-	-	-	-	-	-	L	L	-	-
CO3	S	M	L	-	-	-	-	-	L	-	M	M	-	L
CO4	S	M	L	-	-	-	-	-	L	-	S	M	-	L
CO5	S	M	L	-	-	-	-	-	L	-	S	M	-	L
CO6	S	M	L	-	-	-	-	-	L	-	S	M	-	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	**2**	1	2	
Remember	20	20			20
Understand	20	40			20
Apply	60	40	100	100	60
Analyse	-	-	-	-	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Sample Questions for Course Outcome Assessment**

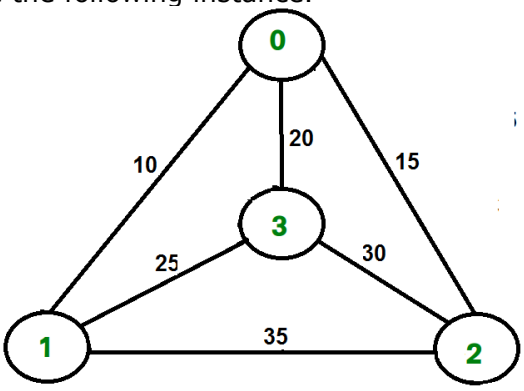
** (2 to 3 at the cognitive level of course outcome)

Course Outcome 1(CO1):

1. Show that if f (n) and g(n) are monotonically increasing functions, then so are the functions f(n)+ g(n) and f (g(n)), and if f(n) and g(n) are in addition nonnegative, then f (n) . g(n) is monotonically increasing.
2. Solve the sorting problems by proving that it terminates / it sorts the set of numbers and determine the time complexity with correctness of proof.
3. For linear / binary search algorithm determine the complexities based on recursive, iterative procedures.

Course Outcome 2(CO2):

1. Suppose we have a stick of length n for some positive integer n. Let p, l ∈ {1, 2, ..., n} denote the utility of a stick of length l. Design a dynamic programming based algorithm which, given n and p1, . . . , pn as inputs, finds a way to break a stick of length n into pieces such that the total utility (the sum of utilities of the pieces) is maximized.
2. Apply the Branch and Bound Method (using the MST-based bounding scheme) seen in class for the TSP to solve the following instance.



3. Solve using dynamic programming to find the optimal parenthesization of a matrix-chain product. Using the algorithm, find the optimal parenthesization of a matrix-chain product whose sequence of dimensions is (5,10,3,12,5)

Course Outcome 3(CO3):

1. Let n denotes the number of vertices in the graph. Prove that if there exists an k^n factor approximation algorithm for the Travelling Salesman problem for any positive integer k, then P = NP.

2. Minimize the usage of bins by defining the n items with different weights {4, 8, 1, 4, 2, 1}
   and the bin capacity is c = 12. Construct an algorithm for bin packing.
3. Give the formulation of modified knapsack problem using branch and bound and find the optimal solution using least cost branch and bound with n=4, m=15, (p1…p4) = (15 15 17 23), (w1…w4) = (3 5 6 9).

Course Outcome 4 (CO4):

1. Let G be an undirected weighted graph. Each edge f in G has a real weight w(f) which could possibly be negative. Let T1 and T2 be two different minimum spanning trees of G. Let e = (u,v) be an edge that is in T1 but not in T2. Let P be the unique path between u and v in T2. Show that P has an edge e 0 such that w(e 0) = w(e).
2. [Hamiltonian path] Let G be an undirected graph with n vertices. A Hamiltonian path of G is a path which visits each vertex of G exactly once. Design a O(poly(n)· 2 n) time algorithm to determine if G has a hamiltonian path, and to find a Hamiltonian path in case G has one, where poly(n) is any polynomial function of n.
3. Let G be a connected, weighted graph. Prove that, if all edge weights in G are distinct, then G has exactly one MST.

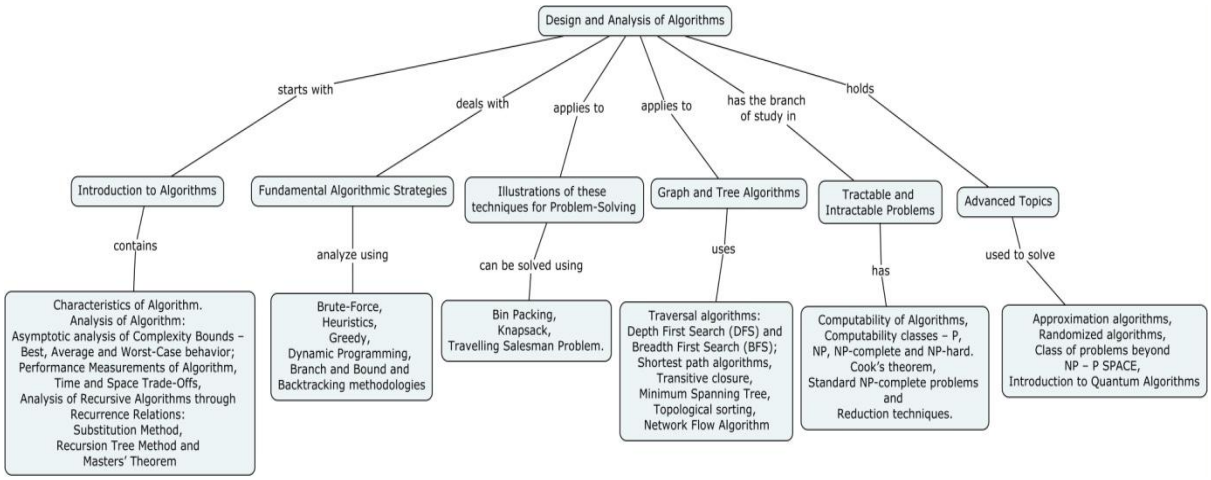
Course Outcome 5 (CO5):

1. Let X be an NP-Complete problem. Consider a decision problem Z Є NP such that X<=Z. Then defend that Z is also NP-Complete.
2. Prove whether 3SAT is NP complete generate the proof of correctness
3. Construct a pseudo-code to implement the naive polynomial-evaluation algorithm that computes each term of the polynomial from scratch. Calculate the running time of this algorithm.

Course Outcome 6(CO6):

1. Solve a O(log n) factor approximation algorithm for the Set Cover problem
2. Construct a 2 factor approximation algorithm for the Vertex Cover problem. [Hint: try to find polynomial time computable lower bound on the size of a minimum vertex cover.]
3. Consider the Quick Sort problem where a Central Pivot is a pivot that divides the array in such a way that one side has at-least 1/4 elements. Determine
   a. How many times while loop runs before finding a central pivot?
   b. Compute the Overall time complexity.

Concept Map



Syllabus

Introduction: Characteristics of Algorithm. Analysis of Algorithm: Asymptotic analysis of Complexity Bounds – Best, Average and Worst-Case behavior; Time and Space Trade-Offs, Analysis of Recursive Algorithms through Recurrence Relations: Substitution Method, Recursion Tree Method and Masters' Theorem.

Fundamental Algorithmic Strategies: Greedy, Dynamic Programming, Branch and Bound and Backtracking methodologies;

Illustrations of these techniques for Problem-Solving, Bin Packing, Knapsack, Travelling Salesman Problem.

Graph and Tree Algorithms: Traversal algorithms: Depth First Search (DFS) and Breadth First Search (BFS); Shortest path algorithms, Minimum Spanning Tree, Topological sorting, Network Flow Algorithm.

Tractable and Intractable Problems: Computability classes – P, NP, NP-complete and NP-hard. Cook's theorem, Standard NP-complete problems and Reduction techniques.

Advanced Topics: Approximation algorithms, Randomized algorithms, Class of problems beyond NP – P SPACE.

Learning Resources

Text Books:

1. Fundamental of Computer Algorithms, E. Horowitz and S. Sahni.
2. The Design and Analysis of Computer Algorithms, A. Aho, J. Hopcroft and J. Ullman.

Reference Books:

1. Introduction to Algorithms, T. H. Cormen, C. E. Leiserson and R. L. Rivest.
2. Computer Algorithms: Introduction to Design and Analysis, S. Baase.
3. The Art of Computer Programming, Vol. 1, Vol. 2 and Vol. 3, .D. E. Knuth.
4. Quantum Computation and Quantum Information, Michael A. Nielsen and Isaac L. Chuang

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Introduction**		
1.1	Characteristics of Algorithm& Analysis of Algorithm	1	CO1
1.2	Asymptotic analysis of Complexity Bounds	1	CO1
1.3	Best, Average and Worst-Case behavior	1	CO1
1.4	Time and Space Trade-Offs	1	CO1
1.5	Analysis of Recursive Algorithms through Recurrence Relations: Substitution Method	1	CO1
1.6	Recursion Tree Method & Masters' Theorem	1	CO1
2.	**Fundamental Algorithmic Strategies**		
2.1	Greedy	2	CO2
2.2	Dynamic Programming	2	CO2
2.3	Branch and Bound	2	CO2
2.4	Backtracking methodologies	1	CO2
3	**Illustrations of these techniques for Problem-Solving**		

3.1	Bin Packing	2	CO3
3.2	Knapsack	2	CO3
3.3	Travelling Salesman Problem	2	CO3
4	**Graph and Tree Algorithms**		
4.1	Traversal algorithms: Depth First Search (DFS) and Breadth First Search (BFS)	1	CO4
4.2	Shortest path algorithms	2	CO4
4.3	Minimum Spanning Tree	1	CO4
4.4	Topological sorting	1	CO4
4.5	Network Flow Algorithm	2	CO4
5	**Tractable and Intractable Problems**		
5.1	Computability classes – P & NP	1	CO5
5.2	Computability classes – NP complete & NP Hard	1	CO5
5.3	Cook's theorem	1	CO5
5.4	Standard NP-complete problems	1	CO5
5.5	Reduction techniques	1	CO5
6	**Advanced Topics**		
6.1	Approximation algorithms	2	CO6
6.2	Randomized algorithms	2	CO6
6.3	Class of problems beyond NP – P SPACE	1	CO6
	TOTAL	36	

Course Designers:

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2. Mrs. J. Felicia Lilian jflcse@tce.edu

21CB521	COMPILER DESIGN

Category	L	T	P	Credit	Terminal Exam Type
PC	3	0	0	3	Theory

Preamble

This course is intended as a primer to this various stages typical in the design of standard compilers, starting with the front-end stages of compilation, and giving a peek into back-end and some recent advancement in the area. At the end of the course, students should be able to appreciate the underlying concepts in compiler design, and be motivated to learn the art of analyzing and transforming programs for performance.

Prerequisite

Data Structures and Algorithms, Formal Languages and Automata Theory

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage in %
CO1	Describe the role of each phase of a compiler; develop a lexical analyzer for recognizing the tokens.	15
CO2	Compute the formal and practical properties of different approaches to parsing	20
CO3	Construct semantic analyzer for type checking	15
CO4	Assemble the symbol table and construct intermediate code generator to translate the source program into intermediate code	15
CO5	Construct code optimizers to optimize the target code generated	20
CO6	Implement a basic compiler for any programming language	15

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond	Guided Response	1.2, 4.3.2
CO2	TPS3	Apply	Value	Mechanism	1.2, 2.1.2, 3.2.3, 4.5.3
CO3	TPS3	Apply	Value	Mechanism	1.2, 2.1.2, 3.2.3, 4.3.2
CO4	TPS3	Apply	Value	Mechanism	1.2, 2.1.2, 3.2.3, 4.5.3
CO5	TPS3	Apply	Value	Mechanism	1.2, 2.1.2, 3.2.3, 4.5.3
CO6	TPS3	Apply	Value	Mechanism	1.2, 2.1.2, 3.2.3, 4.5.3

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L										L		
CO2	S	M	L			L	L		L		L	M	L	L
CO3	S	M	L			L	L		L		L	M	L	L
CO4	S	M	L			L	L		L		L	M	L	L
CO5	S	M	L			L	L		L		L	M	L	L
CO6	S	M	L	L		L	L		L		L	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive levels	Continuous Assessment Tests		Assignments		Terminal examination
	1	2	1	2	
Remember	20	10			20
Understand	20	30	30	30	20
Apply	60	60	70	70	60
Analyse					
Evaluate					
Create					

Assessment Pattern: Psychomotor

Psychomotor Skill	**Miniproject /Assignment/Practical Component**
Perception	
Set	
Guided Response	30
Mechanism	70
Complex Overt Responses	
Adaptation	
Origination	

Sample Questions for Course Outcome Assessment**

Course Outcome 1(CO1):

1. Distinguish between compiler and interpreter
2. What is the role of lexical analyzer?
3. Write the regular expression for the language "All strings of digits with even numbers"
4. Define the term finite automata. Distinguish between NFA and DFA

Course Outcome 2(CO2):

1. Discuss SLR parsing and construct SLR parsing table for the grammar
   E→E+T/T
   T→T*F/F
   F→(E)/id
2. Construct CLR parsing table for the given context free grammar
   S→AA
   A→aA|b
3. Construct the operator precedence relations table for the following grammar and show the parser movements for the given input string i) *id=id ii) id*id=id. The grammar is S→L=R, S→R, L→*R, L→id, R→L

Course Outcome 3(CO3):

1. For the Syntax Directed Definition give annotated parse trees for the following expressions (3+4)*(5+6) and 1*2*3*(4+5)
2. Obtain Syntax Translated Transition for the following grammar

   E -> E+T | T
   T -> T*F | F
   F -> INTLIT

   Draw a parse tree for S=2+3*4

3. Apply the S-attributed definition and constructs syntax tree for a simple expression grammar involving only the binary operations + and -, as usual these operators are at the same precedence level and are jointly left associative. All non terminal have one synthesized attribute node which represents a node of the syntax tree. Production: E→E1+T, E→T, T→(E), T→id/num

Course Outcome 4 (CO4):

1. Apply Back patching to generate intermediate code for the following input
   x:=2+y;
   if x<y then x:=x+y;
   repeat
   y:=y*2;
   while x>10 do x:=x/2
   until x<y
   write the semantic rule and derive the parse tree for the given code
2. How activation record is relevant to the intermediate code generation phase with respect to procedure declarations?
3. Consider the regular expression (a – b) * (c + d) + (a – b) convert the following intermediate forms
   a) infix to postfix b) Three address code c) syntax tree

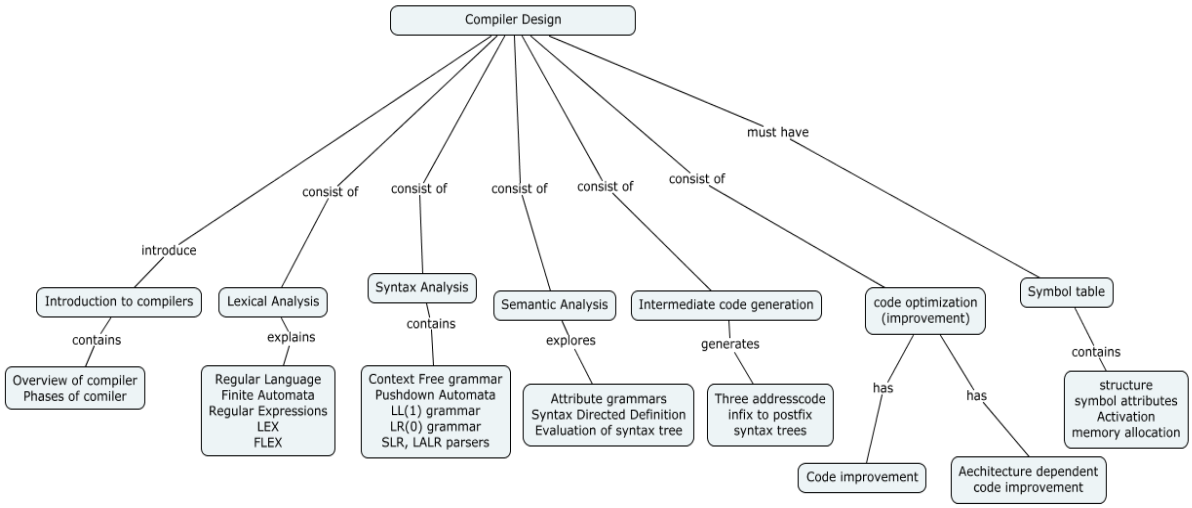
Course Outcome 5 (CO5):

1. *for (i=2; i<=n; i++)*
   a[i] = TRUE;
   count = 0;
   s = sqrt(n);
   for (i=2; i<=s; i++)
   if (a[i]) / i has been found to be a prime */ {*
   count++;
   *for (j=2*i; j<=n; j = j+i)*
   a[j] = FALSE; / no multiple of i is a prime */*
   }
   a) Translate the program into three-address statements of the type we have been using in this section. Assume integers require 4 bytes.
   b) Construct the flow graph for your code from (a).
   c) Identify the loops in your flow graph from (b).
2. Construct an algorithm will do flow – of – control optimizations in a sliding peephole on target machine code
3. Implement various code optimization techniques in a C program of quick sort

Course Outcome 6(CO6):

1. Generate code using code generation algorithm for the sum of prime numbers from 1 to N
2. Devise a register-allocation strategy on the assumption that we automatically store all registers on the stack before each procedure call and restore them after the return.
3. A certain loop requires 5 loads, 7 stores, and 8 arithmetic operations. What is the minimum initiation interval for a software pipelining of this loop on a machine that executes each operation in one clock tick, and has resources enough to do, in one clock tick: a) 3 loads, 4 stores, and 5 arithmetic operations. b) 3 loads, 3 stores, and 3 arithmetic operations.

Concept Map



Syllabus

Introduction: Phases of compilation and overview. Lexical Analysis (scanner): Regular languages, finite automata, regular expressions, relating regular expressions and finite automata, scanner generator (lex, flex).

Syntax Analysis (Parser): Context-free languages and grammars, push-down automata, LL(1) grammars and top-down parsing, operator grammars, LR(O), SLR(1), LR(1), LALR(1) grammars and bottom-up parsing, ambiguity and LR parsing, LALR(1) parser generator (yacc, bison)

Semantic Analysis: Attribute grammars, syntax directed definition, evaluation and flow of attribute in a syntax tree.

Symbol Table: Basic structure, symbol attributes and management Run-time environment: Procedure activation, parameter passing, value return, memory allocation, scope.

Intermediate Code Generation: Translation of different language features, different types of intermediate forms.

Code Improvement (optimization): control-flow, data-flow dependence etc.; local optimization, global optimization, loop optimization, peep-hole optimization etc.

Architecture dependent code improvement: instruction scheduling (for pipeline), loop optimization (for cache memory) etc. Register allocation and target code generation.

Advanced topics: Type systems, data abstraction, compilation of Object Oriented features and non-imperative programming languages

Learning Resources

1. V. Aho, R. Sethi and J. Ullman, 1. Compilers: Principles, Techniques and Tools,, 2nd Edition, Pearson, 2007
2. Randy Allen, Ken Kennedy, "Optimizing Compilers for Modern Architectures: A Dependence-based Approach", Morgan Kaufmann Publishers, 2002.
3. Keith D Cooper and Linda Torczon, "Engineering a Compiler", Morgan Kaufmann Publishers Elsevier Science, 2004.
4. https://onlinecourses.nptel.ac.in › noc22_cs14 › preview

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Introduction (5)**		
1.1	Phases of compilation and overview	1	CO1
1.2	Lexical Analysis (scanner): Regular languages, finite automata, regular expressions	2	CO1
1.3	Relating regular expressions	1	CO1
1.4	Finite automata, scanner generator	1	CO1
2.	**Syntax Analysis (Parser) (8)**		
2.1	Context-free languages and grammars	1	CO2
2.2	push-down automata	1	CO2
2.3	LL(1) grammars and top-down parsing, operator grammars	1	CO2
2.4	LR(O)	1	CO2
2.5	SLR (1)	1	CO2
2.6	LR(1)	1	CO2
2.7	LALR(1) grammars	1	CO2
2.8	Bottom-up parsing		CO2
2.9	Ambiguity and LR parsing	1	CO2
2.10	LALR(1) parser generator (yacc, bison)		CO2
3.	**Semantic Analysis (5)**		
3.1	Attribute grammars, and flow of attribute in a syntax tree.	2	CO3
3.2	Syntax Directed Definition, Evaluation	2	CO3
3.3	Evaluation and flow of attribute in a syntax tree	1	CO3
4.	**Symbol Table & Intermediate Code Generation (5)**		
4.1	Basic Structure, Symbol Attributes and Management	1	CO4
4.2	Run-Time Environment: Procedure Activation	1	CO4
4.3	Parameter Passing, Value Return	1	CO4
4.4	Memory Allocation, Scope.	1	CO4
4.5	Translation of different language features	1	CO4
4.6	Different types of Intermediate forms		CO4
5.	**Code Improvement (optimization) (7)**	5	
5.1	Control-Flow	1	CO5
5.2	Data-Flow Dependence	1	CO5
5.3	Loop Optimization	1	CO5
5.4	Peep-Hole Optimization	2	CO5
5.5	Local Optimization	1	CO5
5.6	Global Optimization	1	CO5
6.	**Architecture dependent code improvement**	4	
6.1	Instruction Scheduling (for Pipeline)	2	CO6
6.2	Loop Optimization (for Cache Memory)	1	CO6
6.3	Register allocation and target code generation	1	CO6
7.	**Advanced topics**	3	
7.1	Type Systems, Data Abstraction,	1	CO6
7.2	Compilation of Object Oriented Features	1	CO6
7.3	Non-Imperative Programming Languages	1	CO6
	Total	**36**	

Course Designers:

1. Dr.P.Chitra pccse@tce.edu
2. Mr.V.Janakiraman vjncse@tce.edu

21CB531	FUNDAMENTALS OF MANAGEMENT

Category	L	T	P	Credit	Terminal Exam Type
HSS	2	-	-	2	Theory

Preamble

This course will teach students the management theories, evolution of management over the years and few basic concepts without going into the details. After studying this course the students will develop an understanding about how organizations work and find it easier to grasp the intricacies of other management areas such as finance, marketing, strategy etc. which will be taken up in future terms.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Understand the role of management responsibilities, its evolution in comparison with traditional and modern approaches	15
CO2	Understand the various functions of a management	15
CO3	Interpret the organization behaviour by balancing the work, handling stress, decision making and diverse culture	20
CO4	Apply the various organizational design and structures to build the value proportion by inheriting the downsides	15
CO5	Apply the ethical principles with social responsibilities	20
CO6	Apply the role of a leader and to lead an organization	15

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond	-	1.1, 4.1
CO2	TPS2	Understand	Respond	-	1.1, 4.2
CO3	TPS3	Apply	Value	-	1.1, 2.5, 3.1,4.2
CO4	TPS3	Apply	Value	-	2.5, 3.1, 4.1
CO5	TPS3	Apply	Value	-	2.5, 3.1, 4.1
CO6	TPS3	Apply	Value	-	2.5, 3.1, 4.1

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L										L		
CO2	M	L										L		
CO3	S	M	L			M		M			L	M	L	L
CO4	S	M	L			M		M			L	M	L	L
CO5	S	M	L			M	S	S			M	M	L	M
CO6	S	M	L			M	S	S			M	M	L	M

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	**2**	1	2	
Remember	40	20	-	-	20
Understand	40	40	30	30	40
Apply	20	40	70	70	40
Analyse	-	-	-	-	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Sample Questions for Course Outcome Assessment**

** (2 to 3 at the cognitive level of course outcome)

Course Outcome 1(CO1):

1. What are the levels of management
2. What do you mean by contingency theory of management what are its implications and relevance? Also state how does this approach differs from systems approach
3. What are the different theories of management
4. Explain a short note on the following a) System theory b) Administrative theory c) Classical theory

Course Outcome 2(CO2):

1. What is creativity ?Explain the role of creativity in decision making also discuss its process and the way an individual can made more creative).
2. What are the different styles of plans? Describe various steps in the planning process
3. Explain any four quantitative techniques used for management decision making
4. Explain Strategic Vs Operations planning.
5. What do you understand by forecasting? how it related with planning

Course Outcome 3(CO3):

1. Discuss the Relationship between the Authority, Power and Influence?
2. What advice would you give to calm down a colleague who's stressed out about a deadline?
3. Define decision- making and explain the process of decision –making that affects the efficiency of the business decisions.

Course Outcome 4 (CO4):

1. Which organizational practices are required to reinforce the organizational intent?
2. What type of leadership and culture are required to achieve the value proposition?
3. Which organization structure should we choose, and how do we overcome its inherent downsides?

Course Outcome 5 (CO5):

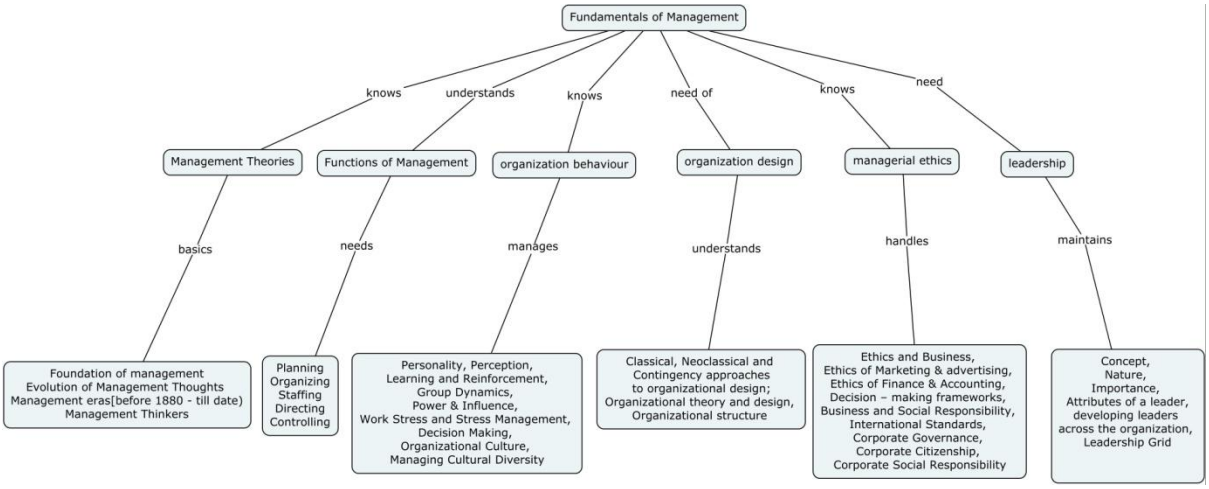
1. Briefly Describe What is Ethical Behavior in a Business Environment
2. What Do You Do When a Valued Customer Behaves in an Unethical Manner?
3. How Do You Handle a Situation Where Something is Not in compliance with the Ethical Standards?

Course Outcome 6(CO6):

4. What do you understand by leadership in business? What should be the qualities of a good business leader?

5. Discuss "A successful leader is not necessarily effective".
6. Explain Herzberg's Two Factor Theory and differentiate it from Maslow's Theory of Need Hierarchy.

Concept Map



Syllabus

Management Theories: Concept and Foundations of Management, Evolution of Management Thoughts [Pre-Scientific Management Era (before 1880), Classical management Era (1880-1930), Neo-classical Management Era (1930-1950), Modern Management era (1950-on word). Contribution of Management Thinkers: Taylor, Fayol, Elton Mayo etc.

Functions of Management Planning, Organizing, Staffing, Directing, Controlling

Organization Behavior: Introduction, Personality, Perception, Learning and Reinforcement, Motivation, Group Dynamics, Power & Influence, Work Stress and Stress Management, Decision Making, Organizational Culture, Managing Cultural Diversity

Organizational Design: Classical, Neoclassical and Contingency approaches to organizational design; Organizational theory and design, Organizational structure (Simple Structure, Functional Structure, Divisional Structure, Matrix Structure)

Managerial Ethics: Ethics and Business, Ethics of Marketing & advertising, Ethics of Finance & Accounting, Decision – making frameworks, Business and Social Responsibility, International Standards, Corporate Governance, Corporate Citizenship, Corporate Social Responsibility

Leadership: Concept, Nature, Importance, Attributes of a leader, developing leaders across the organization, Leadership Grid

Learning Resources

Text Book:

1. Richard L. Daft, *Understanding the Theory and Design of Organizations*

Reference Books:

5. Stephen P. Robbins, Timothy A. Judge, NeharikaVohra, *Organizational Behavior*

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Management Theories**		
1.1	Concept and Foundations of Management, Evolution of Management Thoughts	1	CO1
1.2	Pre-Scientific Management Era (before 1880), Classical management Era (1880-1930), Neo-classical Management Era (1930-1950), Modern Management era (1950-on word)	2	CO1
1.3	Contribution of Management Thinkers: Taylor, Fayol, Elton Mayo etc.	1	CO1
2.	**Functions of Management**		
2.1	Planning, Organizing	1	CO2
2.2	Staffing, Directing	1	CO2
2.3	Controlling	1	CO2
3	**Organization Behavior**		
3.1	Introduction, Personality, Perception	1	CO3
3.2	Learning and Reinforcement, Motivation, Group Dynamics	1	CO3
3.3	Power & Influence, Work Stress and Stress Management	1	CO3
3.4	Decision Making	1	CO3
3.5	Organizational Culture, Managing Cultural Diversity	1	CO3
4	**Organizational Design**		
4.1	Classical, Neoclassical and Contingency approaches to organizational design	2	CO4
4.2	Organizational theory and design,	1	CO4
4.3	Organizational structure (Simple Structure, Functional Structure, Divisional Structure, Matrix Structure)	1	CO4
5	**Managerial Ethics**		
5.1	Ethics and Business, Ethics of Marketing & advertising	1	CO5
5.2	Ethics of Finance & Accounting	1	CO5
5.3	Decision – making frameworks, Business and Social Responsibility	1	CO5
5.4	International Standards, Corporate Governance	1	CO5
5.5	Corporate Citizenship, Corporate Social Responsibility	1	CO5
6	**Leadership**		
6.1	Concept, Nature, Importance	1	CO6
6.2	Attributes of a leader, developing leaders across the organization	1	CO6
6.3	Leadership Grid	1	CO6
	TOTAL	24	

Course Designers:

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2. Mrs. J. Felicia Lilian jflcse@tce.edu

21CB541	BUSINESS STRATEGY

Category	L	T	P	Credit	Terminal Exam Type
HSS	2	0	0	2	Theory

Preamble

This course includes a study of strategic planning including mission statement development, analysis of the external environment and internal organizational factors, development of strategic alternatives, selection of appropriate alternatives, implementation of strategies, and competitive strategies and dynamics. Special emphases are given to the integration and coordination of the functional areas within the enterprise.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage in %
CO1	Know the fundamental concepts of strategic management to analyze business situations and apply these concepts to solve business problems.	20
CO2	Understand how external forces such as social, political/legal, economic, and technological, influence strategic decision-making and firm performance.	15
CO3	Apply External Environments of Firm with Competitive Strategy	20
CO4	Analyze the business portfolio using corporate strategies	20
CO5	Verify Strategic Alliances, Joint Ventures, and Mergers & Acquisitions using growth strategy	15
CO6	Determine the best way to implement a proposed strategy using 7S tools	10

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond	Guided Response	1.2, 4.3.2
CO2	TPS3	Apply	Value	Mechanism	1.2, 2.1.2, 3.2.3, 4.5.3
CO3	TPS3	Apply	Value	Mechanism	1.2, 2.1.2, 3.2.3, 4.3.2
CO4	TPS3	Apply	Value	Mechanism	1.2, 2.1.2, 3.2.3, 4.5.3
CO5	TPS3	Apply	Value	Mechanism	1.2, 2.1.2, 3.2.3, 4.5.3
CO6	TPS3	Apply	Value	Mechanism	1.2, 2.1.2, 3.2.3, 4.5.3

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PSO1	PSO2	PSO3
CO1	M	L										L		
CO2	S	M	L			L	L		L		L	M	L	L
CO3	S	M	L			L	L		L		L	M	L	L
CO4	S	M	L			L	L		L		L	M	L	L
CO5	S	M	L			L	L		L		L	M	L	L
CO6	S	M	L			L	L		L		L	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive levels	Continuous Assessment Tests		Assignments		Terminal examination
	1	2	1	2	
Remember	20	20			20
Understand	20	40	20		20
Apply	60	40	80	100	60
Analyse					
Evaluate					
Create					

Assessment Pattern: Psychomotor

Psychomotor Skill	**Miniproject /Assignment/Practical Component**
Perception	
Set	
Guided Response	30
Mechanism	70
Complex Overt Responses	
Adaptation	
Origination	

Sample Questions for Course Outcome Assessment**

Course Outcome 1(CO1):

1. Define Strategy. How do you consider that strategic management is a process?
2. Explain the conceptual framework of Strategic Management Process.
3. How do the terms mission, objectives, strategies, programs, budgets, procedures differ in the true sense? – Explain.

Course Outcome 2(CO2):

1. If your organization could get accurate answers to 12 questions about its competitive environment, what questions would it ask?
2. Draft a conceptual model for creating a 'strategic plan' for a company.
3. 'The intensity of competition depends on several factors.' Identify these factors and discuss briefly on them

Course Outcome 3(CO3):

1. Discuss Porter's five forces model. How does it help managers to identify the opportunities and threats confronting a company?
2. According to Porter, what determines the level of competitive intensity in an industry?
3. "Companies that fail to develop new products are putting themselves at risk. At the same time, new product developments are risky."
   (a) List the reasons for failure of new products.
   (b) List and briefly explain the factors that hinder the progress of new product development.

Course Outcome 4 (CO4):

1. M/s. XYZ Ltd., is business organized as three divisions and Head Office. The divisions are based on market groupings, which are Retail, Wholesale and Government. The divisions do not trade with each other. The main method of control of the divisions has been the requirement to earn a return on investment (ROI) of 15% per annum. The definition of return and capital employed is provided by Head Office, as is the criterion rate of 15%. The recent experience of M/s. XYZ Ltd., is that the group, as a whole, has been able to earn 15% ROI but there have been wide variations between the results obtained by different divisions. This infringes upon another group policy that forbids cross-subsidization i.e., each and every division must earn the criterion ROI. M/s. XYZ Ltd., is now considering divestment strategies and this could include the closure of one or more of-its divisions. The Head Office is aware that the Boston Product Market Portfolio Matrix (BPMPM) is widely used within the divisions in the formulation and review of marketing strategies. As it is so widely known within the group and is generally regarded by the divisions as being useful, the Head Office is considering employing this approach to assist in the divestment decision.
   (i) Evaluate the use by M/s. XYZ Ltd., of the ROI and its policy that forbids cross-subsidization.
   (ii) Describe the extent to which the BPMPM could be applied by M/s. XYZ Ltd., in its divestment decision. Evaluate the appropriateness of the use of BPMPM for this purpose.
2. Create Port-folio analysis for the above case study.
3. Given below is an extract from the literary supplement of a leading newspaper : An imprint of one's own "Earlier, Publishing houses, focusing on writing by women and books on women-oriented subject, might have been inconceivable. But now such Publishing houses, mostly with a distinct feminist slant to what they publish, have become a reality worldwide. Virago, Women's Press, Kali for Women, Stree, Labyrinth, Attic Press, Minnesota Women's Press, Street Women Press etc., have not only given women a voice long due to them, but have also earned themselves a respectable position in the Publishing Industry. In fact, Seagull Bookstore is possibly the only bookstore in the city of Kolkata that has a separate shelf for books on "gender". Seagull Bookstore has translated a lot a Mahasweta Devi's works into English, which have reached many people all over the world." Does this convey any strategy-related message? If so, write in brief a note on the same.

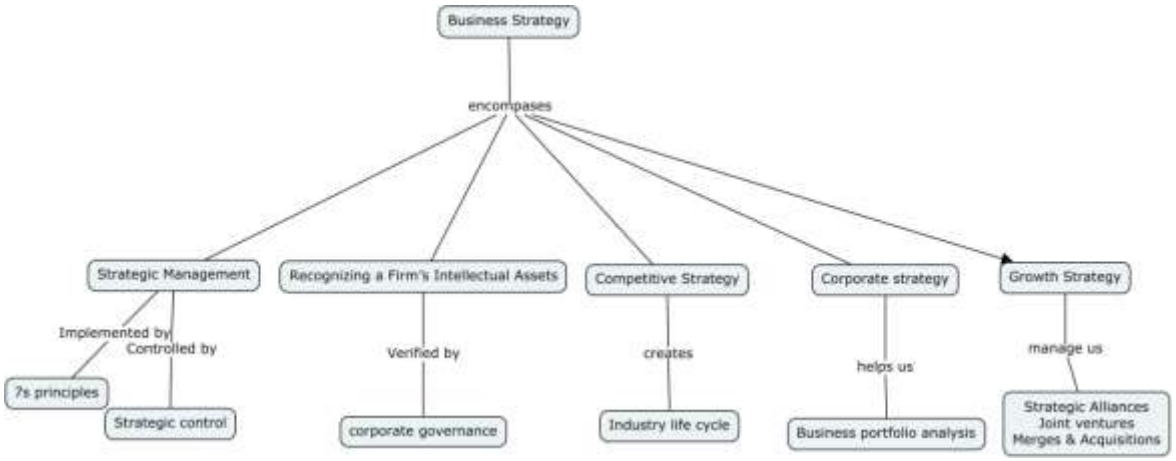
Course Outcome 5 (CO5):

1. "Joint Ventures are emerging as the best tool for reaching new markets". - Comment.
2. "In terms of Strategic Management, how does a new venture's situation differ from that of an ongoing small company?
3. Discuss how a development in a Corporation's societal (Macro) environment can affect the corporation through its task environment.

Course Outcome 6(CO6):

1. Enumerate the different stages of organizational life cycle and highlight the suitable strategies of each stage.
2. If a company which operates in stability strategy in current operations along with related diversification through backward integration. What should be the ideal mix of functional plans and policies? Highlight its features.
3. Discuss the strategies for internet economy

Concept Map



Syllabus

Introduction to Strategic Management: Importance of strategic Management – vision and objectives – schools of thought in Strategic management – Strategy Content, process, and practice – Fit Concept and Configuration Perspective in strategic management.

Internal Environment of firm – Recognizing a Firm's Intellectual Assets: Core Competence as the root of competitive advantage – sources of sustained competitive advantage – Business processes and capabilities based approach to strategy.

External Environments of firm – Competitive strategy: Five forces of industry attractiveness that shape strategy – The concept of strategic groups and industry life cycle – Generic strategies - Generic strategies and the value chain

Corporate Strategy and growth strategies: The motive for diversification- Related and unrelated diversification – Business portfolio Analysis - Expansion, Integration and Diversification - Strategic Alliances, Joint Ventures, and Mergers & Acquisitions

Strategy Implementation: Structure and Systems: The 7S Framework - Strategic Control and Corporate Governance

Learning Resources

1. Robert M. Grant (2012). Contemporary Strategic Management, Blackwell, 7th Edition.
2. M.E. Porter, Competitive Strategy, 1980. M.E. Porter,
3. Competitive Advantage, 1985 Richard Rumelt (2011). Good Strategy Bad Strategy: The Difference and Why It Matters.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Introduction to Strategic Management (5)**		
1.1	Importance of Strategic Management	1	CO1
1.2	Vision and objectives		CO1
1.3	Schools of thought in Strategic management	1	CO1
1.4	Strategy Content, process, and practice	1	CO1
1.5	Fit Concept in strategic management	1	CO1
1.6	Configuration Perspective in strategic management	1	CO1

2	**Internal Environment of firm – Recognizing a Firm's Intellectual Assets (4)**		
2.1	Core Competence as the root of competitive advantage	1	CO2
2.2	sources of sustained competitive advantage	1	CO2
2.3	Business processes	1	CO2
2.4	Capabilities based approach to strategy.	1	CO2
3	**External Environments of firm – Competitive strategy (5)**		
3.1	Five forces of industry attractiveness that shape strategy	1	CO3
3.2	The concept of strategic groups	1	CO3
3.3	Industry life cycle	1	CO3
3.4	Generic strategies	1	CO3
3.5	Generic strategies and the value chain	1	CO3
4	**Corporate Strategy (4)**		
4.1	The motive for diversification	1	CO4
4.2	Related and unrelated diversification	1	CO4
4.3	Business portfolio Analysis – Expansion	1	CO4
4.4	Integration and Diversification	1	CO4
5	**Growth strategies (4)**		
5.1	Expansion, Integration and Diversification	1	CO5
5.2	Strategic Alliances	1	CO5
5.3	Joint Ventures	1	CO5
5.4	Mergers & Acquisitions	1	CO5
6	**Strategy Implementation (2)**		
6.1	Structure and Systems	1	CO6
6.2	The 7S Framework		CO6
6.3	Strategic Control and Corporate Governance	1	CO6
	Total	**24**	

Course Designers:

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21CB551	BUSINESS COMMUNICATION &VALUE SCIENCE – III

Category	L	T	P	Credit	Terminal Exam Type
Project	2	-	-	2	Fully Internal

Preamble

This course aims at building up the cross-cultural communication and behavioral performance of the learners. It makes learners identify their strengths, weakness, opportunities and threats to become successful person in their professional life. It enables the students enhance their technical writing skills. It motivates the students to explore science and modern technology.

Prerequisite

Basic Knowledge of verbal and written English

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Interpret the basic principles of SWOT & life positions (U)	10%
CO2	Comprehend the best practices of Technical Writing and its tools (U)	20%
CO3	Demonstrate cross cultural communication and identify its common mistakes (AP)	10%
CO4	Investigate the concepts of Global, glocal and trans locational culture (AP)	30%
CO5	Apply the role of science in nation building (AP)	10%
CO6	Visualize the future of Artificial Intelligence and its impact in daily life (AP)	20%

CO Mapping with CDIO Curriculum Framework

CO#	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Value	Perception	2.4,2.5,3.1
CO2	TPS2	Understand	Respond	Guided response	3.2.1,3.2.3,3.3.1
CO3	TPS3	Apply	Respond	Perception	3.2.1,3.2.3,3.3.1
CO4	TPS3	Apply	Value	Perception	3.1,3.1.6
CO5	TPS3	Apply	Receive	Perception	3.1.6, 3.2
CO6	TPS3	Apply	Receive	Perception	3.1.6, 3.2

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M					M	M	S	S			L	M	M
CO2	M					M	M	M	S			L	L	L
CO3	S								S			L	L	L
CO4	M								S			L	L	L
CO5	S					M			S		S	L	M	L
CO6	S					M			S		S	L	M	L

S-Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

No CAT will be conducted.

Summative - Activity Based Evaluation (No External Examination)Evaluation is done in classroom activities as given below:

Assignment submission	CO1	UNDERSTAND	10
Written Test	CO2	UNDERSTAND	20
Debate /Role Play	CO3	APPLY	10
Questionnaire, Data Analysis and Report submission	CO4	APPLY	20
Album Submission	CO4	APPLY	10
Individual Presentation	CO5	APPLY	10
Futuristic view of AI	CO6	APPLY	20
		Total	100

Assessment Pattern: Psychomotor

Psychomotor Skill	**Mini project/Assignment/Practical Component**
Perception	
Set	
Guided Response	Assignment
Mechanism	
Complex Overt Responses	
Adaptation	
Origination	

Sample Questions for Course Outcome Assessment**

Course Outcome1(CO1):(10marks)

a. Assignment on SWOT vs TOWS
b. Assignment on Adaptability to VUCA world

Course Outcome2(CO2):(20marks)

Written Test

a. Grammar – Vocabulary, Tense, Voice
b. Paragraph writing – Linking words, Instruction and Recommendation

Course Outcome3(CO3):(10 marks)

Debate / Role play – Topics based on

a. Cross- cultural communication
b. Gender awareness

Course Outcome4(CO4):(10 + 20 Marks)

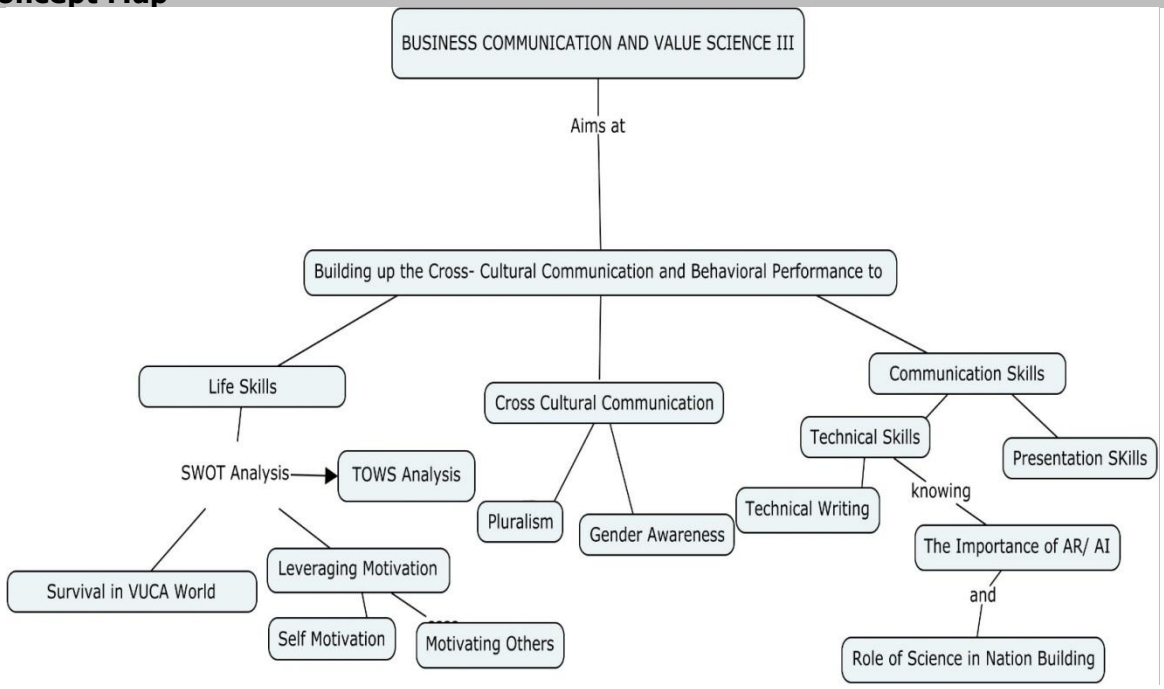
a. Album creation related to different cultures and gender awareness
b. Data Collection using questionnaire and report submission – Global, Glocal and Trans-locational

Course Outcome5(CO5):(10 Marks)
Individual presentation related to Nation Building (Post Independence)

a. Inventors
b. Inventions

Course Outcome 6 (CO6): (20 Marks)
Short film / Any creative visualization representing the future of AI

Concept Map



yllabus

Unit 1 : SWOT – Analysis and application in Life positions, SWOT vs TOWS , Survival in VUCA world, Leveraging Motivation

Unit 2 : Identify and Respect Pluralism in cultural spaces, Definingand Differentiating Global, Glocal, trans locational culture, Implication of Cross cultural communication and its mistakes, Culture shock,Gender Awareness.

Unit 3 : Role of Science in Nation building – Role of Science in post-Independence, Technical Writing – Introduction: Vocabulary,Email Writing (Job Cover letter), Formal Letter writing (Requisition for Internship , IV)

Unit 4 : Defining AI – Importance of AI in everyday life, Applying Technical writing in profession and Real life scenarios – Instruction & Recommendation ,Paragraph Writing.

Learning Resources

Text Books:	
There are no prescribed texts for Semester5– there will be handouts and reference links shared.	
Web References:	
1	**Examples of Technical Writing for Students** https://freelance-writing.lovetoknow.com/kinds-technical-writing
2	11 Skills of a Good Technical Writer https://clickhelp.com/clickhelp-technical-writing-blog/11-skills-of-a-good-technical-writer/

3	**13 benefits and challenges of cultural diversity in the workplace https://www.hult.edu/blog/benefits-challenges-cultural-diversity-workplace/**
Online Resources:	
1	https://youtu.be/CsaTslhSDI
2	https://m.youtube.com/watch?feature=youtu.be&v=IIKvV8_T95M
3	https://m.youtube.com/watch?feature=youtu.be&v=e80BbX05D7Y
4	https://m.youtube.com/watch?v=dT_D68RJ5T8&feature=youtu.be
5	https://m.youtube.com/watch?v=7sLLEdBgYYY&feature=youtu.be

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.1	SWOT and Life positions	1	CO1
1.2	Applying SWOT in real life situations- Survival in VUCA world	1	CO1
1.3	SWOT vs TOWS ((Ted talk on biomimicry-only first 8 minutes) : https://www.youtube.com/watch?v=RHrO4t86phA	1 (Lab)	CO1
1.4	Leveraging Motivation – pat your back activity (You tube videos on Maslow's theory)	2 (Lab)	CO1
2.1	Awareness and respect for pluralism in cultural spaces (Discussion using Phir Miley sur Mera Tumhara)	1	CO3
2.2	Defining and Differentiating Global, Glocal and Trans locational culture	2	CO4
2.3	Implication of Cross-Cultural Communication and its mistakes	2	CO3
2.4	Culture Shock	2	CO3
2.5	Gender Awareness	1	CO3
3.1	Role of science in Nation building and Post-Independence	1	CO5
3.2	Individual Presentation	3	CO5
3.3	Technical writing - Vocabulary	1	CO2
3.4	Technical writing – Formal letter (Permission seeking), Letter writing (Job Cover letter)	1	CO2
4.1	Apply technical writing in real life scenarios and in Profession – Paragraph Writing, Linking words, Instructions and Recommendations	2	CO2
4.2	AI / AR – Introduction and the Importance of AI in everyday life	1	CO6
4.3	Field visit and Data Collection	2	CO4
	Total	24 hours	

Course Designers:

1. Dr.A.Tamilselvi tamilselvi@tce.edu
2. Dr.G. JeyaJeevakani gjjeng@tce.edu
3. Dr.RS.Swarnalakshmi rssleng@tce.edu

21CB571	DESIGN AND ANALYSIS OF ALGORITHMS LAB

Category	L	T	P	Credit	Terminal Exam Type
PC	0	0	4	2	Practical

Preamble

This course provides students with a practical approach to efficiently solve a variety of time and space complexity problems. The students will construct algorithms by using different data structures and implement them to enhance the efficiency of the algorithm.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Identifying the time complexities for various sorting and searching algorithms.	10
CO2	Identify the divide and conquer techniques and solve various recursion problem	15
CO3	Apply the greedy and dynamic programming techniques to solve the problems.	25
CO4	Apply the traversal algorithms for graphs and tree problems and determine their performance	20
CO5	Implement various branch and bound algorithms to solve the real world engineering problems	15
CO6	Design and implement algorithms to find whether they are tractable or in tractable	15

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS3	Apply	Value	-	1.2,2.1.1,2.4.3
CO2	TPS3	Apply	Value	-	1.2,2.1.1,2.4.3
CO3	TPS3	Apply	Value	-	1.2,2.1.1,2.4.3
CO4	TPS3	Apply	Value	-	1.2,2.1.1,2.4.3
CO5	TPS3	Apply	Value	-	1.2,2.1.1,2.4.3
CO6	TPS3	Apply	Value	-	1.2,2.1.1,3.1.1,4.5.1

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	S	M	L				M	M	M		M	M	L	L
CO2	S	M	L				M	M	M		M	M	L	L
CO3	S	M	L				M	M	M		M	M	L	L
CO4	S	M	L				M	M	M		M	M	L	L
CO5	S	M	L				M	M	M		M	M	L	L
CO6	S	M	L				M	M	M		M	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Model Examination	Terminal Examination
Remember		
Understand		
Apply	100	100
Analyse		
Evaluate		
Create		

List of Experiments/Activities with CO Mapping

1. Analyse the exponential and polynomial time complexity of Algorithms
2. Implement the Divide and Conquer algorithms – strings and sequences
3. Implement Prim's and kruskals algorithm using Greedy approach
4. Implement Knapsack problem using Greedy approach
5. Analyze and implement the matrix multiplication problem using dynamic programming
6. Application of DFS – Topological sort/Strongly connected components
7. Implement Ford Fulkerson using maximum flow algorithm
8. Implement TSP using branch and bound techniques
9. Implement Huffman coding and decoding
10. Implement Graph coloring algorithm

Module No.	Topic	No. of sessions	Course Outcome
1.	Analyse the exponential and polynomial time complexity of Algorithms	2	CO1
2.	Implement the Divide and Conquer algorithms – strings and sequences	4	CO2
3.	Implement Prim's and kruskals & Knapsack algorithm using Greedy approach	4	CO3
4.	Analyze and implement the matrix multiplication problem using dynamic programming	2	CO3
5.	Application of DFS – Topological sort/Strongly connected components	4	CO4
6.	Implement Ford Fulkerson using maximum flow algorithm	2	CO5
7.	Implement TSP using branch and bound techniques	2	CO5
8.	Implement Huffman coding and decoding	2	CO6
9.	Implement Graph coloring algorithm	2	CO6
	TOTAL	24	

Learning Resources

1. https://www.hackerrank.com/domains/algorithms
2. https://www.codechef.com/wiki/tutorials
3. Steven S. Skiena, The Algorithm Design Manual, Second Edition, Springer,2010.

Course Designers

1. Dr. A. Malini amcse@tce.edu
2. Mrs. J. Felicia Lilian jflcse@tce.edu

21CB581	COMPILER DESIGN LAB

Category	L	T	P	Credit	Terminal Exam Type
PC	0	0	2	1	Practical

Preamble

The student should be made to be exposed to compiler writing tools. Learn to implement the different Phases of compiler. Be familiar with control flow and data flow analysis. Learn simple optimization techniques

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Develop a lexical analyzer for recognizing the tokens.	15
CO2	Design and convert BNF rules into YACC form to generate various parsers.	15
CO3	Compute the formal and practical properties of different approaches to parsing	15
CO4	Design a symbol table and develop semantic analyzer for type checking	15
CO5	Generation of Intermediate Code and optimizing the target code	20
CO6	Construct a compiler-interpreter for a simple imperative programming language.	20

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS3	Apply	Value	Mechanism	1.2, 4.5.3
CO2	TPS3	Apply	Value	Mechanism	1.2, 4.5.3
CO3	TPS3	Apply	Value	Mechanism	1.2, 4.5.3
CO4	TPS3	Apply	Value	Mechanism	1.2, 4.5.3
CO5	TPS3	Apply	Value	Mechanism	1.2, 4.5.3
CO6	TPS3	Apply	Value	Mechanism	1.2, 4.5.3

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	S	M	L		M	L	L	L	L	L	M	M	L	L
CO2	S	M	L		M	L	L	L	L	L	M	M	L	L
CO3	S	M	L		M	L	L	L	L	L	M	M	L	L
CO4	S	M	L		M	L	L	L	L	L	M	M	L	L
CO5	S	M	L		M	L	L	L	L	L	M	M	L	L
CO6	S	M	L		M	L	L	L	L	L	M	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Model Examination	Terminal Examination
Remember		
Understand		

Apply	100	100
Analyse		
Evaluate		
Create		

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject /Practical Component/Observation
Perception	-
Set	-
Guided Response	-
Mechanism	100
Complex Overt Responses	-
Adaptation	-
Origination	-

List of Experiments/Activities with CO Mapping

S.No	Name of the experiment	Total hours	Course outcome
1.	Implementation of Lexical analyzer using Lex tool	2	CO1
2.	Develop a lexical analyzer to recognize few patterns in C	2	
3.	Generate YACC specification for syntactic categories	2	CO2
4.	Convert BNF rules into YACC form and write code to generate Abstract Syntax Tree	2	
5.	Implement Recursive Descent parser for an expression grammar that generates arithmetic expressions with digits, + and *	4	CO3
6.	Generate Symbol table to store all the characters, digits and symbols	4	CO4
7.	Program to implement Type checking		
8.	Implement various intermediate code generation strategies	2	CO5
9.	Implementation of simple code optimization techniques	2	
10.	Implement the back end of the compiler which takes the three address code and produces the 8086 assembly language instructions that can be assembled and run using a 8086 assembler. The target assembly instructions can be simple move, add, sub, jump. Also simple addressing modes are used.	2 2	CO6
	Total hours	24	

Learning Resources

1. V. Aho, R. Sethi and J. Ullman, 1. Compilers: Principles, Techniques and Tools,, 2nd Edition, Pearson, 2007
2. Randy Allen, Ken Kennedy, "Optimizing Compilers for Modern Architectures: A Dependence-based Approach", Morgan Kaufmann Publishers, 2002.
3. Keith D Cooper and Linda Torczon, "Engineering a Compiler", Morgan Kaufmann Publishers Elsevier Science, 2004.

Course Designers:

1. Dr.P.Chitra pccse@tce.edu
2. Mr.V.Janakiraman vjncse@tce.edu

21CB591	MINI PROJECT

Category	L	T	P	Credit	Terminal Exam Type
Project	0	0	2	1	Viva-Voce

Preamble

The Mini Project is a Phase 1 project for students studying Computer Science and Business Systems. The students as a team of 3 members identify their area of specialization with a defined problem statement. They identify the functional requirements, do analysis and identify the risks that they might encounter. They develop the design for their project using UML diagrams and setup the environment to implement the project.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Identify the problem statement with proper functional and non-functional requirements for complex engineering problems	15
CO2	Plan and construct the requirement analysis by managing the project schedule to ensure time management and within-budget completion	15
CO3	Develop the design based on the design principles to create a next sketch of the interactions between the systems, its lifecycle, resource availability and risks	20
CO4	Develop the environmental setup needed for the project, based on the requirements and professional constraints	15
CO5	Implement the problem with proper bench marked dataset and test the performance with various algorithms	20
CO6	Use proper communication within the team to document the work and analyse the progress	15

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS3	Apply	Value	-	1.1, 1.2, 1.3, 2.1, 2.2, 2.4, 3.1, 3.2, 4.1, 4.2, 4.3, 4.4, 4.5
CO2	TPS4	Analyze	Organize	-	4.3.1, 4.3.2, 4.3.3, 4.3.4
CO3	TPS5	Evaluate	Organize	-	4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.1.5, 4.1.6, 4.2.1, 4.2.2, 4.2.3, 4.2.4
CO4	TPS3	Apply	Value	-	4.4.1, 4.4.2, 4.4.3, 4.4.4, 4.4.5
CO5	TPS5	Analyze	Organize	-	4.5.1, 4.5.2, 4.5.3, 4.5.4, 4.5.5
CO6	TPS3	Apply	Value	-	3.2.1, 3.2.2, 3.2.3, 3.2.4, 3.2.5, 3.2.6

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	S	M	L	-	-	M	S	S	M	M	S	M	M	S
CO2	S	S	M	L	M	M	M	S	M	S	S	M	S	M
CO3	S	S	M	L	S	M	M	S	M	M	S	M	S	M
CO4	S	M	L	-	-	M	M	S	M	M	S	M	M	M
CO5	S	S	M	L	M	M	M	S	M	M	S	M	M	M
CO6	S	M	L	-	-	S	S	S	S	M	S	M	M	S

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Phases	Deliverables	Marks	Course Outcomes
Continuous Assessment			
Review – 1 Identify the problem statement and Requirements	Technical report & Presentation	30	CO1 & CO2
Review - 2 Design and Environmental setup	Technical report & Presentation	40	CO3 & CO4
Review 3 – Implementation & Documentation	Technical report & Presentation	30	CO5 & CO6
End – Semester Examination			
Demonstration	Presentation & Viva-Voce	60	CO1, CO2, CO3, CO4, CO5 and CO6
Documentation	Report	40	

Course Designers

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2. Mrs. J. Felicia Lilian jflcse@tce.edu

CURRICULUM AND DETAILED SYLLABI

FOR

B.TECH DEGREE (Computer Science and Business Systems) PROGRAMME

SIXTH SEMESTER

FOR THE STUDENTS ADMITTED FROM THE

ACADEMIC YEAR 2025 – 2026 ONWARDS

THIAGARAJAR COLLEGE OF ENGINEERING

(A Government Aided ISO 9001-2008 Certified

Autonomous Institution affiliated to Anna University)

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THIAGARAJAR COLLEGE OF ENGINEERING, MADURAI- 625 015

(A Govt. Aided, ISO 9001:2008 certified Autonomous Institution affiliated to Anna University)

B.Tech Degree (Computer Science and Business Systems) Programme

COURSES OF STUDY

(For the candidates admitted from 2025 – 2026 onwards)

SIXTH SEMESTER

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	No.of Hours / Week			Credits
				L	T	P	
THEORY COURSES							
1	21CB611	Computer Networks	PC	3	0	0	3
2	21CB621	Information Security	PC	3	0	0	3
3	21CB631	Artificial Intelligence	PC	3	0	0	3
4	21CB641	Financial & Cost Accounting	HSS	2	0	0	2
5	21CB651	Business Communication & Value Science - IV	Project	2	0	0	2
6	21CBPX1	Program Elective - III	PE	3	1	0	4
THEORY CUM PRACTICAL COURSES							
7	21CBPX1	Program Elective - IV	PE	2	0	2	3
PRACTICAL COURSES							
8	21CB661	Computer Networks Lab	PC	0	0	4	2
9	21CB671	Information Security Lab	PC	0	0	2	1
10	21CB681	Artificial Intelligence Lab	PC	0	0	2	1
			TOTAL	**18**	**1**	**10**	**24**

PC : Program Core
PE : Program Elective
HSS : Humanities and Social Science

L : Lecture
T : Tutorial
P : Practical

Note:

1 Hour Lecture is equivalent to 1 credit

1 Hour Tutorial is equivalent to 1 credit

2 Hours Practical is equivalent to 1 credit

THIAGARAJAR COLLEGE OF ENGINEERING, MADURAI- 625 015

(A Govt. Aided, ISO 9001:2008 certified Autonomous Institution affiliated to Anna University)

B.Tech Degree (Computer Science and Business Systems) Programme

SCHEME OF EXAMINATIONS

(For the candidates admitted from 2025 – 2026 onwards)

SIXTH SEMESTER

S.No.	Course Code	Name of the Course	Duration of Terminal Exam. in Hrs.	Marks			Minimum Marks for Pass	
				Continuous Assessment	Terminal Exam *	Max. Marks	Terminal Exam	Total
THEORY								
1	21CB611	Computer Networks	3	40	60	100	27	50
2	21CB621	Information Security	3	40	60	100	27	50
3	21CB631	Artificial Intelligence	3	40	60	100	27	50
4	21CB641	Financial & Cost Accounting	3	40	60	100	27	50
5	21CB651	Business Communication & Value Science - IV	-	100	-	100	-	50
6	21CBPX1	Program Elective – III	3	40	60	100	27	50
THEORY CUM PRACTICAL COURSES								
7	21CBPX1	Program Elective – IV	3	50	50	100	25	50
PRACTICAL								
8	21CB661	Computer Networks Lab	3	60	40	100	18	50
9	21CB671	Information Security Lab	3	60	40	100	18	50
10	21CB681	Artificial Intelligence Lab	3	60	40	100	18	50

21CB611	COMPUTER NETWORKS

Category	L	T	P	Credit	Terminal Exam Type
PC	3	0	0	3	Theory

Preamble

The syllabus is designed for the students to learn and understand the basic concepts of computer networks and the working of its functional components. It gives a brief overview of the concepts of data communications and functions of different layers of ISO/OSI reference architecture and to understand the error detection and correction methods and types of LAN, Then the concepts of sub netting and routing mechanisms. Then the different types of protocols and network components, configure Switches and Routers.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Understand the fundamentals of data communications and functions of layered architecture	20
CO2	Apply error checking and error correction mechanisms in data Link layer for error free data transmission.	30
CO3	Apply the different protocols and network layer componentsbased on application requirements.	15
CO4	Compare the functionalities of TCP & UDP protocols in the transport layer during data transmission.	10
CO5	Apply a suitable application layer protocol based on application.	15
CO6	Understand the basic concepts of cryptography and network security.	10

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO#	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond	Guided Response	1.2
CO2	TPS3	Apply	Respond	Mechanism	1.2,2.1.1,3.1.1
CO3	TPS3	Apply	Value	Mechanism	1.2, 2.1.5, 2.3.1
CO4	TPS3	Apply	Value	Mechanism	1.2, 2.1.5, 2.2.2, 2.3.1, 2.3.4
CO5	TPS3	Apply	Value	Mechanism	1.2,2.1.1,3.1.1,4.4.1
CO6	TPS2	Understand	Respond	Guided Response	1.2, 2.2.2, 2.3.1

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L										M		
CO2	M	L										M		
CO3	S	M	L		L		L	L	L		M	M		L
CO4	S	M	L		L		L	L	L		M	M		L
CO5	S	M	L		L		L	L	L		M	M		L
CO6	S	M	L		L		L	L	L		M	M		L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	**2**	1	2	
Remember	30	20		-	20
Understand	40	40	30	30	40
Apply	30	40	70	70	40
Analyse	-	-	-	-	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Assessment Pattern: Psychomotor

Psychomotor Skill	**Mini~~project /Assignment/Practical Component~~**
Perception	-
Set	-
Guided Response	30
Mechanism	70
Complex Overt Responses	-
Adaptation	-
Origination	-

Sample Questions for Course Outcome Assessment**

** (2 to 3 at the cognitive level of course outcome)

Course Outcome1(CO1):

1. Distinguish between LAN and WAN.
2. Recall the functionalities of all layers in OSI architecture
3. What is the difference between communication and transmission?

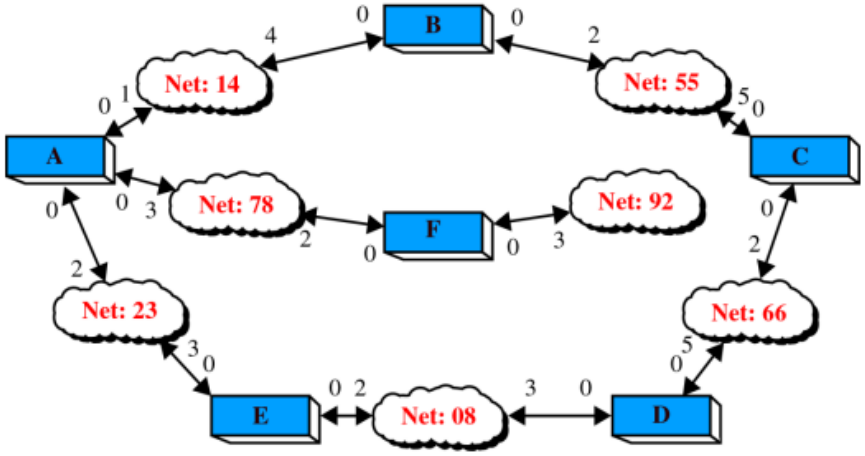
Course Outcome2(CO2):

1. Discuss the principle of stop and wait flow control algorithm. Draw time line diagrams and explain how loss of a frame and loss of an ACK are handled. What is the effect of delay-bandwidth product on link utilization?
2. How is frame order and flow control is achieved using the data link layer?
3. Sixteen-bit messages are transmitted using a Hamming code, using even parity. Determine the number of check bits needed to ensure that the receiver can detect and correct single bit errors? Show the bit pattern transmitted for the message1101001100110101. (Apply) 2. A 12-bit Hamming code whose hexadecimal value is 0xE4F arrives at a receiver. Determine the original transmitted value in hexadecimal, assuming not more than 1 bit is in error. (Apply) 3. A bit stream 10011101 is transmitted using the standard CRC method, with the generator 1001. Show the actual bit string transmitted. Suppose the third bit from the left and the second bit from the right of the transmitted message are inverted during transmission. Show that this error is detected
4. Suppose nodes A and B are on the same 10 Mbps broadcast channel, and the propagation delay between the two nodes is 245 bit times. Suppose A and B send Ethernet frames at the same time, the frames collide, and then A and B choose different values of K in the CSMA/CD algorithm. Assuming no other nodes are active, can the retransmissions from A and B collide? For our purposes, it suffices to work out the following example. Suppose A and B begin transmission at t = 0 bit times. They both detect collisions at t = 245 bit times. Suppose KA

= 0 and KB = 1. At what time does B schedule its retransmission? At what time does A begin transmission? At what time does A's signal reach B? Does B refrain from transmitting at its scheduled time?

Course Outcome3(CO3):

1. Consider the following datagram network. Show the forwarding table in router A, such that all traffic destined to host H3 is forwarded through interface 3.Also write down a forwarding table in router A, such that all traffic from H1 destined to host H3 is forwarded through interface 3, while all traffic from H2 destined to host H3 is forwarded through interface 4.
2. An organization has granted a block of address with the beginning address 25.24.74.0/24.The organization need to have 3 subblocks to be used in 3 subnets: one subblock of 10 addresses, one subblock of 50 addresses and one subblock of 125 addresses. Design the subblocks.



For the subnet shown in the figure calculate the shortest path for all the networks form Router A by using Dijkstra algorithm (Show intermediate steps) and build the routing table for Router A.

Course Outcome 4 (CO4):

1. Consider transferring an enormous file of L bytes from Host A to Host B. Assume an MSS of 536 bytes. What is the maximum value of L such that TCP sequence numbers are not exhausted? For the calculated value of L, find how long it takes to transmit the file. Assume that a total of 66 bytes of transport, network, and link header are added to each segment before the resulting packet is sent out over a 155 Mbps link. Ignore flow control and congestion control so A can pump out the segments back to back and continuously.
2. Suppose Host A sends two TCP segments to Host B over a TCP connection. The first segment has a sequence number 90; the second has a sequence number 110. How much data is in the first segment? If the first segment is lost but the second segment arrives at B. What will be the acknowledgment number in the acknowledgment that Host B sends to Host A.

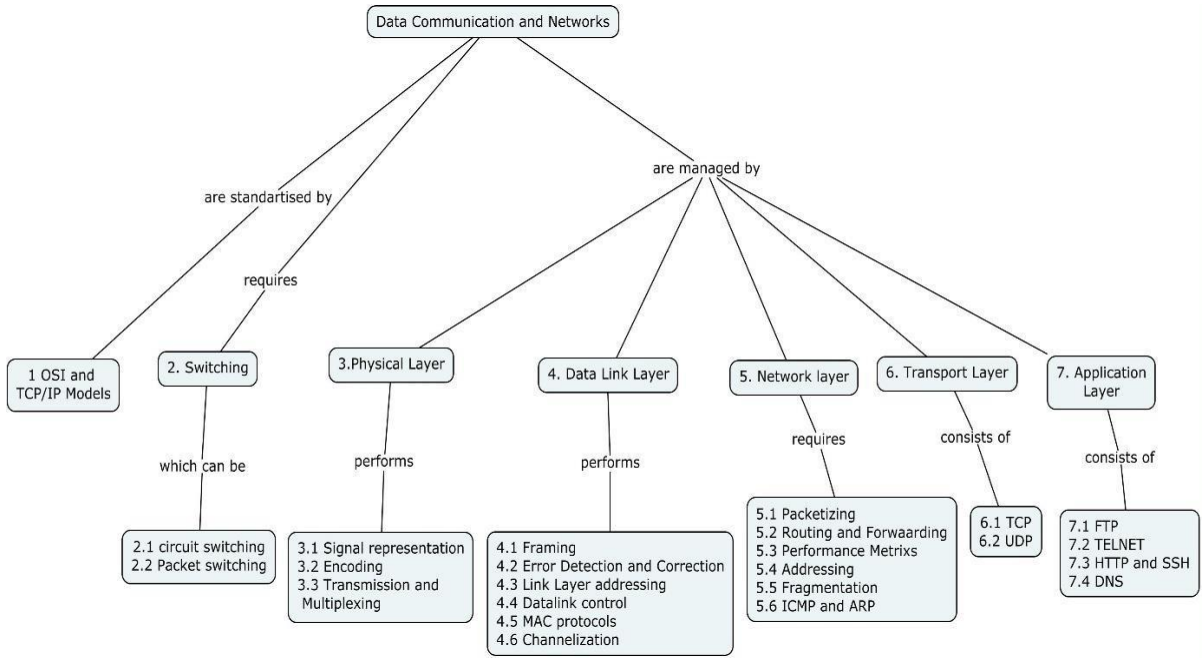
Course Outcome 5 (CO5):

1. List two non proprietary Internet applications and the application-layer protocols that they use.
2. What is the difference between network architecture and application architecture? Question 3
3. Why do HTTP, FTP, SMTP, and POP3 run on top of TCP rather than on UDP?
4. Compare various email protocols like SMTP, IMAP and POP and Outline when it is appropriate to use each.

Course Outcome6(CO6):

1. Describe the concept of Electronic mail
2. Explain the Basic concepts of Cryptography.
3. Illustrate the concept of network management

Concept Map



Syllabus

Introduction: Computer networks and distributed systems, Classifications of computer networks, Preliminaries of layered network structures.

Data communication Components: Representation of data and its flow, VariousConnection Topology, Protocols and Standards, OSI model, Transmission Media.

LAN: Wired LAN, Wireless LAN, Virtual LAN.

Techniques for Bandwidth utilization: Multiplexing – Frequency division, Time division and Wave division, Conceptson spread spectrum.

Data Link Layer and Medium Access Sub Layer: Fundamentals of Error Detection and Error Correction, Block coding, Hamming Distance, CRC; Flow Control and Error control protocols – Stop and Wait, Go-back–N ARQ, Selective Repeat ARQ, Sliding Window,Piggybacking, Random Access, Multiple access protocols –Pure ALOHA,Slotted ALOHA, CSMA/CD,CDMA/CA

Network Layer: Switching, Logical addressing – IPV4, IPV6; Address mapping – ARP,RARP, BOOTP and DHCP–Delivery, Forwarding and Unicast Routing protocols.

Transport Layer: Process to Process Communication, User Datagram Protocol (UDP),Transmission Control Protocol (TCP), SCTP Congestion Control; Quality of Service (QoS), QoSimproving techniques – Leaky Bucket and Token Bucket algorithms.

Application Layer: DNS, DDNS, TELNET, EMAIL, FTP, WWW, HTTP, SNMP, Bluetooth, Firewalls.

Network Security: Electronic mail, directory services and network management, Basic concepts of Cryptography.

Learning Resources

Text Books:

1. A. Tanenbaum, "Computer Networks", 5th Edition, Pearson Education, 2013.
2. BehrouzA.Forouzan, "Data Communication and Networking", 5th Edition, Tata McGraw-Hill,2001

Reference Books:

1. William Stallings, "Data and Computer Communication", 10th Edition, Pearson Education, 2017.
2. Kaufman, R. Perlman and M. Speciner, "Network Security", 2nd edition,Prentice Hall, 2022.

Web References:

1. https://www.udacity.com/course/computer-networking
2. http://www.learnerstv.com/
3. http://freevideolectures.com

Online Resources:

1. https://www.digimat.in/nptel/courses/video/106105081/L01.html
2. https://www.free-online-training-courses.com/networking
3. https://www.youtube.com/watch?v=1eGxPllnj4M
4. http://www.omnisecu.com/basic-networking

Course Contents and Lecture Schedule:

Module No.	Topic	No. of Hours	Course Outcome
1.	**Introduction**		
1.1	Computer networks and distributed systems, Classifications of computer networks, Preliminaries of layered network structures.	1	CO 1
2.	**Data communication Components**		
2.1	Representation of data and its flow, Various Connection Topology, Protocols and Standards	2	CO 1
2.2	OSI model, Transmission Media.	2	CO 1
3.	**LAN:** Wired LAN, Wireless LAN, Virtual LAN.	2	CO 1
4.	**Techniques for Bandwidth utilization**		
4.1	Multiplexing – Frequency division, Time division and Wave division, Conceptson spread spectrum.	1	CO 1
5.	**Data Link Layer and Medium Access Sub Layer**		
5.1	Fundamentals of Error Detection and Error Correction	1	CO 2
5.2	Block coding, Hamming Distance, CRC	2	CO 2
5.3	Flow Control and Error control protocols	1	CO 2
5.4	Stop and Wait, Go-back–N ARQ, Selective Repeat ARQ	2	CO 2
5.5	Sliding Window, Piggybacking, Random Access	2	CO 2
5.6	Multiple access protocols –Pure ALOHA, Slotted ALOHA, CSMA/CD,CDMA/CA	2	CO 2
6.	**Network Layer**		

6.1	Switching, Logical addressing – IPV4, IPV6	2	CO 3
6.2	Address mapping – ARP,RARP, BOOTP and DHCP–Delivery	2	CO 3
6.3	Forwarding and Unicast Routing protocols.	2	CO 3
7.	**Transport Layer**		
7.1	Process to Process Communication, User Datagram Protocol (UDP)	2	CO 4
7.2	Transmission Control Protocol (TCP), SCTP Congestion Control;	2	CO 4
7.3	Quality of Service (QoS), QoS improving techniques – Leaky Bucket and Token Bucket algorithms.	2	CO 4
8.	**Application Layer**		
8.1	DNS, DDNS, TELNET	2	CO 5
8.2	EMAIL, FTP, WWW	2	CO 5
8.3	HTTP, SNMP, Bluetooth, Firewalls.	1	CO 5
9.	**Network Security**		
9.1	Electronic mail, directory services and network management.	2	CO 6
9.2	Basic concepts of Cryptography.	1	CO 6
		36	

Course Designers:

1. Mrs.P.Suganthi psica@tce.edu

21CB621	INFORMATION SECURITY

Category	L	T	P	Credit	Terminal Exam type
PC	3	0	0	3	Theory

Preamble

This course covers information security principles, an area of study that engages in protecting the confidentiality, integrity, and availability of information. Information security is concerned with user identification, authentication and access control based on individual or group privileges.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Understand basic information security goals such as availability, integrity, accuracy, and confidentiality.	10
CO2	Implement the various access control models such as Discretionary, mandatory, roll-based etc.	15
CO3	Design appropriate security policies to protect the data confidentiality in par with international standards.	15
CO4	Develop systems representing flow of information and evaluate assurance using formal methods.	20
CO5	Carrying out detection of malicious logic, vulnerability and intrusion in various applications.	20
CO6	Constructing security architecture in operating systems and databases.	20

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond	-	1.2,1.3,2.2,2.3,2.5.4,4.2
CO2	TPS3	Apply	Value	-	1.2,2.1,2.2,4.1,4.2
CO3	TPS3	Apply	Value	-	1.2, 2.1.2,4.4,4.5,4.6
CO4	TPS3	Apply	Value	-	1.2,2.3,4.2,4.3,4.4,4.5,4.6
CO5	TPS3	Apply	Value	-	1.2,2.1,2.3,4.5
CO6	TPS3	Apply	Value	-	1.2,2.1,2.5,3.1.5,4.3,4.5,4.6

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L		L			L				M	L		L
CO2	S	M	L	L			L				M	M		L
CO3	S	M	L		M		L				M	M	L	L
CO4	S	M	L		M		L				M	M	L	L
CO5	S	M	L				L				M	M		L
CO6	S	M	L		M		L				M	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	2	1	2	
Remember	30	20			20
Understand	30	40	50	50	40
Apply	40	40	50	50	40
Analyse					
Evaluate					
Create					

Sample Questions for Course Outcome Assessment**

** (2 to 3 at the cognitive level of course outcome)

Course Outcome 1(CO1):

1. Elaborate on CIA triad as a guiding principle for information security within health care organization.
2. What arethe differences between the systems development life cycle (SDLC) and the information security life cycle?
3. Design a template for security policy based on Acceptable use policy.

Course Outcome 2(CO2):

1. Find the differences between Bell-LaPadula model and Biba model of security.
2. Why is an access control model important and find the access control best for business?
3. Your organization has become worried about recent attempts to gain unauthorized access to the R&D facility. Therefore, you are asked to implement a system that will require individuals to present a password and enter a PIN at the security gate before gaining access. What is this type of system called?

Course Outcome 3(CO3):

1. In some applications, a passcode consisting of some number of digits is required (for example, a PIN). Using the number-to-letter conversion on a telephone,

a. What passcode corresponds to the password "hello"?

b. Find as many passwords as you can that correspond to the passcode 5465, where each password is an English dictionary word.

2. Develop a construction to show that a system implementing the Chinese Wall model can support the Bell-LaPadula Model.
3. ISO/IEC 27001 is the world's best-known standard for information security management systems (ISMS) and their requirements. Justify the given statement.

Course Outcome 4 (CO4):

1. A common technique for inhibiting password guessing is to disable an account after three consecutive failed login attempts.

a. Discuss how this technique might prevent legitimate users from accessing the system. Why is this action a violation of the principle of least common mechanism?

b. One can argue that this is an example of fail-safe defaults, because by blocking access to an account under attack, the system is defaulting to a known, safe state. Do you agree or disagree with this argument? Justify your answer.

2. Suppose you are the developer of a computer product that can process critical data and will likely run in a hostile environment. You have an outstanding design and development team, and you are very confident in the quality of their work.

a. Explain why you would add assurance steps to your development environment.

b. What additional information (if any) would you need in order to decide whether or not the product should be formally evaluated?

3. Consider the rule of transitive confinement. Suppose a process needs to execute a sub process in such a way that the child can access exactly two files, one only for reading and one only for writing.

a. Could capabilities be used to implement this? If so, how?

b. Could access control lists implement this? If so, how?

Course Outcome 5 (CO5):

1. Tripwire does not encipher the signature blocks. What precautions must installers take to ensure the integrity of the database?
2. An attacker breaks into a Web server running on a Windows 2000–based system. Because of the ease with which he broke in, he concludes that Windows 2000 is an operating system with very poor security features. Is his conclusion reasonable? Why or why not?
3. You have been hired as the security officer for Compute Computers, Inc. Your boss asks you to determine the number of erroneous login attempts that should be allowed before a user's account is locked. She is concerned that too many employees are being locked out of their accounts unnecessarily, but is equally concerned that attackers may be able to guess passwords. How would you determine an appropriate value for the threshhold?

Course Outcome 6(CO6):

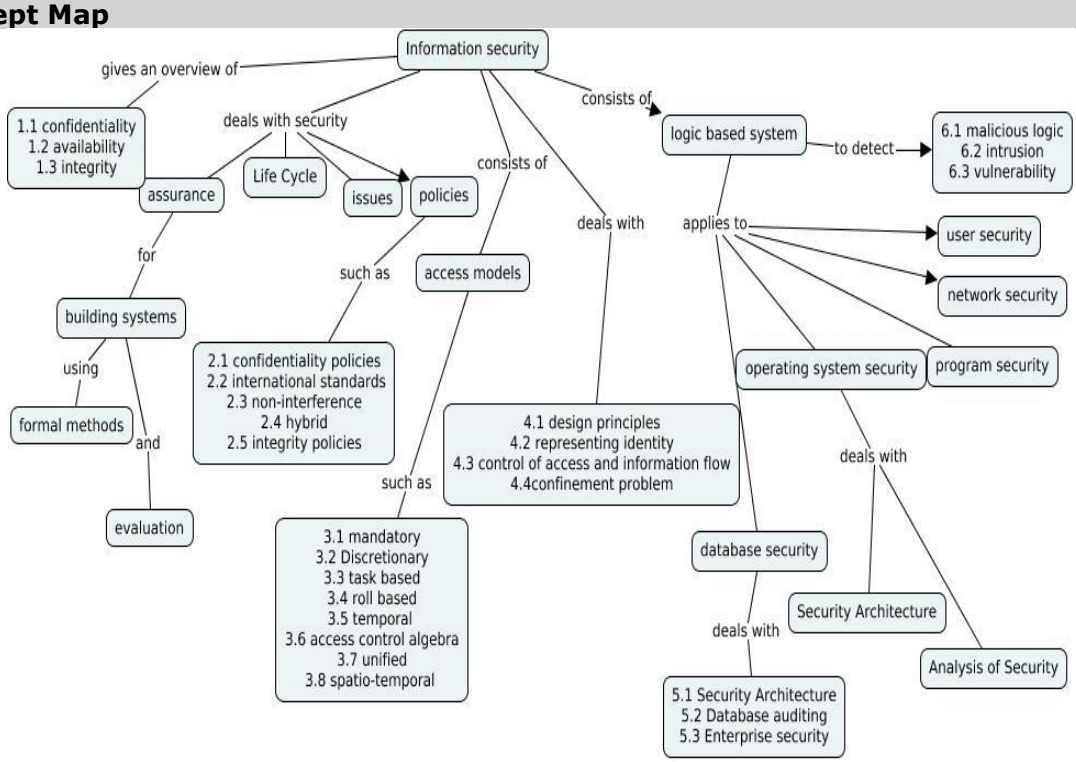
1. What are the significant differences between segmentation and paging? Give one significant security advantage of segmentation over paging.
2. It is sometimes argued that digital rights management (DRM) is, in some sense, the modern incarnation of multilevel security (MLS).

a. List some significant similarities between DRM and MLS.

b. List some significant differences between DRM and MLS.

3. Google's Native Client (NaCl) is a technology designed to allow untrusted code to run securely in a Web browser. The primary advantage is speed, but there are many security issues, some of which are reminiscent of issues faced by NGSCB. Outline the NaCl security architecture.

Concept Map



Syllabus

Overview of Security Parameters: Confidentiality, integrity and availability; Security violation and threats; Security policy and procedure; Assumptions and Trust; Security Assurance, Implementation and Operational Issues; Security Life Cycle.

Access Control Models: Discretionary, mandatory, roll-based and task-based models, unified models, access control algebra, temporal and spatio-temporal models.

Security Policies: Confidentiality policies, integrity policies, hybrid policies, non-interference and policy composition, international standards.

Systems Design: Design principles, representing identity, control of access and information flow, confinement problem. Assurance: Building systems with assurance, formal methods, evaluating systems.

Logic-based System: Malicious logic, vulnerability analysis, auditing, intrusion detection. Applications: Network security, operating system security, user security, program security. Special Topics: Data privacy, introduction to digital forensics, enterprise security specification.

Operating Systems Security: Security Architecture, Analysis of Security in Linux/Windows.

Database Security: Security Architecture, Enterprise security, Database auditing.

Learning Resources

Textbooks:

1. Ross Anderson, "Security Engineering", 3rd Edition, wiley, 2019.
2. Matt Bishop, "Computer Security: Art and Science", 2nd Edition, Pearson Education, 2019.
3. Mark Stamp, "Information Security: Principles and Practice", wiley, 3rd Edition, 2021.

Reference books:

1. C.P. Pfleeger, S.L. Pfleeger, J. Margulies., "Security in Computing", 5th Edition, Pearson Education, 2015.
2. David Wheeler, "Secure Programming HOWTO", 7th Edition, 2015.
3. Michael Zalewski, "Browser Security Handbook", 2008.
4. M. Gertz, S. Jajodia., "Handbook of Database Security", springer, 2008.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Overview of Security Parameters**		
1.1	Confidentiality, integrity and availability	1	CO1
1.2	Security violation and threats	1	CO1
1.3	Security policy and procedure; Assumptions and Trust	1	CO1
1.4	Security Assurance, Implementation, Operational Issues and life cycle.	1	CO1
2.	**Access Control Models**		
2.1	Discretionary, mandatory, roll-based models	2	CO2
2.2	Task-based models, unified models	1	CO2

2.3	Access control algebra, temporal models	1	CO2
2.4	Spatio-temporal models	1	CO2
3.	**Security Policies**		
3.1	Confidentiality policies, integrity policies, Hybrid policies	2	CO3
3.3	Non-interference and policy composition	2	CO3
3.4	International standards.	1	CO3
4.	**Systems Design**		
4.1	Design principles	1	CO4
4.2	representing identity	1	CO4
4.3	control of access and information flow	1	CO4
4.4	confinement problem	2	CO4
4.5	Assurance: Building systems with assurance	1	CO4
4.6	Formal methods, evaluating systems.	1	CO4
5.	**Logic-based System**		
5.1	Malicious logic, vulnerability analysis	1	CO5
5.2	auditing, intrusion detection	1	CO5
5.3	Applications: Network security, operating system security	2	CO5
5.4	user security, program security	1	CO5
5.5	Special Topics: Data privacy	1	CO5
5.6	introduction to digital forensics	1	CO5
5.7	enterprise security specification	1	CO5
6.	**Operating Systems Security**		
6.1	Security Architecture	2	CO6
6.2	Analysis of Security in Linux/Windows	1	CO6
7	**Database Security**		
7.1	Security Architecture	2	CO6
7.2	Enterprise security	1	CO6
7.3	Database auditing	1	CO6
	TOTAL	36	

Course Designers:

1. Subhashni R rsica@tce.edu

21CB631	ARTIFICIAL INTELLIGENCE

Category	L	T	P	Credit	Terminal Exam Type
PC	3	0	0	3	Theory

Preamble

The course is to understand the methods of creating a synergy between the humans and machines by performing real world intellectual tasks such as decision making, planning, problem solving and like using various algorithms.

Prerequisite

Data Structures and Algorithms.

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Summarize different types of AI environments, transform a given real world problem to state space problem.	10
CO2	Apply the relevant uniform search algorithms and heuristics search strategies based on the given state space.	25
CO3	Implement the local search strategies to solve the given Constraint Satisfaction Problem.	10
CO4	Apply the suitable Adversarial search techniques for the given multi-agent environment.	15
CO5	Utilize propositional logics and probabilistic reasoning to apply knowledge representation for the given certain and uncertain problem respectively.	15
CO6	Construct plan graph using planning techniques for the given state space.	15
CO7	Explain the stages and issues in the development of an expert system.	10

*** Weightage depends on Bloom's Level, number of contact hours

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond		1.1,1.2,1.3,2.1.1
CO2	TPS3	Apply	Value		1.1,1.2,1.3,2.1,2.2.1,4.1,4.3.1
CO3	TPS3	Apply	Value		1.1,1.2,1.3,2.1,2.2,4.1,4.2.1,4.3.1,4.3.2, 4.3.3,4.4
CO4	TPS3	Apply	Value		1.1,1.2,1.3,2.1,2.2,4.1,4.2.1,4.3.1,4.3.2, 4.3.3,4.4
CO5	TPS3	Apply	Value		1.1,1.2,1.3,2.1,2.2,4.1,4.2.1,4.3.1,4.3.2, 4.3.3,4.4
CO6	TPS3	Apply	Value		1.1,1.2,1.3,2.1,2.2,4.1,4.2.1,4.3.1,4.3.2, 4.3.3,4.4
CO7	TPS2	Understand	Respond		1.1,1.2,1.3,2.1.1

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L										L		
CO2	S	M	L		M	L	M	L			S	M	L	L
CO3	S	M	L		M	L	S	L			S	M	L	M

CO4	S	M	L		M	L	M	L			S	M	L	L
CO5	S	M	L		L	L	M	L			S	M	L	L
CO6	S	M	L		M	L	M	L			S	M	L	L
CO7	M	L										L		

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	2	1	2	
Remember	30	20	-	-	20
Understand	30	20	30	30	20
Apply	40	60	70	70	60
Analyse	0	0	-	-	-
Evaluate	0	0	-	-	-
Create	0	0	-	-	-

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject /Assignment/Practical Component
Perception	-
Set	-
Guided Response	-
Mechanism	-
Complex Overt Responses	-
Adaptation	-
Origination	-

Sample Questions for Course Outcome Assessment**

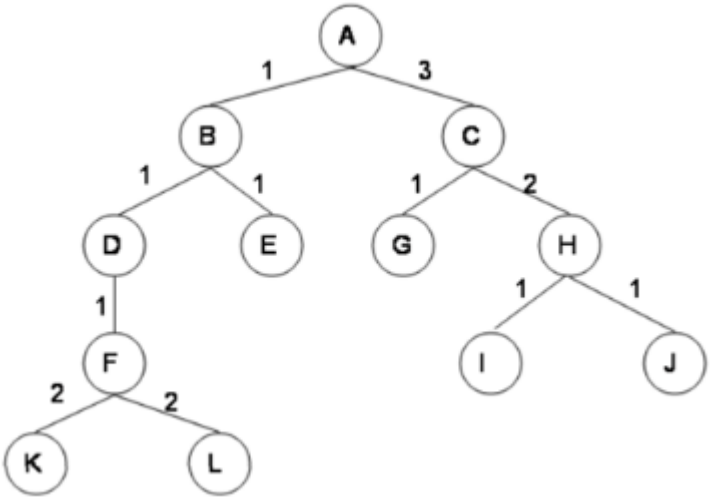
** (2 to 3 at the cognitive level of course outcome)

Course Outcome 1(CO1):

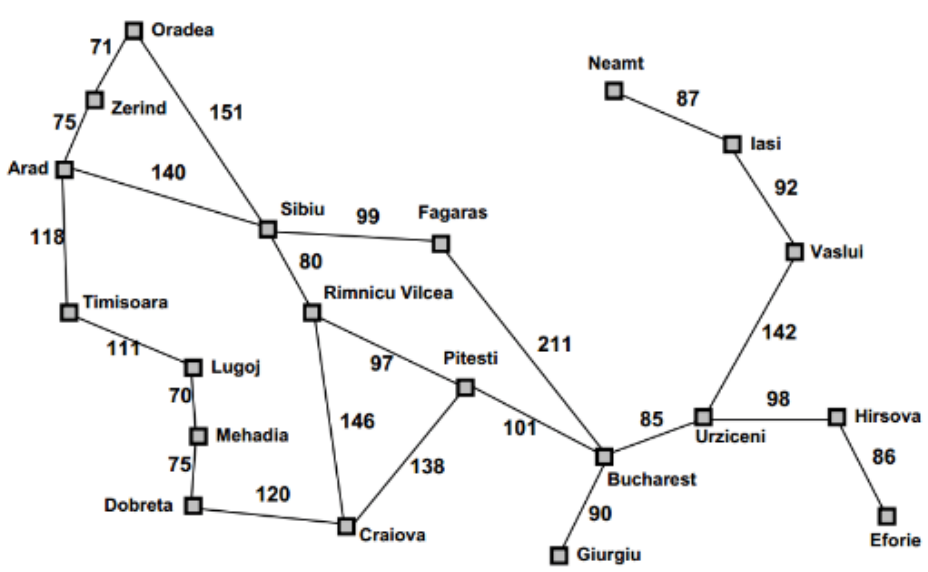
1. List the various types of agents and it's characteristics.
2. Describe in brief an autonomous vehicle as an intelligent agent. Give a **PEAS** specification for the task environment.
3. The water jug problem can be stated as follows: you are given two jugs of capacities litres and 3 litres. You also have a pump that can be used to fill either jug with water, and you can empty the contents of either jug at any time. Your goal is to get exactly 2 litres of water in the 4 litre jug. Formulate this problem as a state-space search describing the state, move-generator and the goal checker.

Course Outcome 2(CO2):

1. Define the state space of the N-queen problem.
2. Consider the tree shown below. The numbers on the arcs are the arc lengths. Assume that the nodes are expanded in alphabetical order when no other order is specified by the search, and that the goal is state G. No visited or expanded lists are used.What order would the states be expanded by each type of Uninformed search? Stop when you expand G.



3. Apply heuristic search, Greedy best first search for the given problem to reach Bucharest.



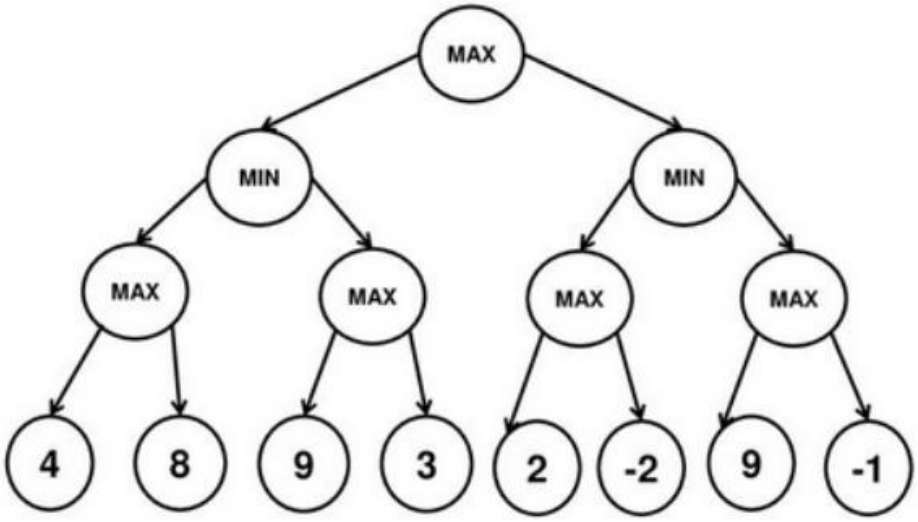
Straight–line distance to Bucharest	
Arad	366
Bucharest	0
Craiova	160
Dobreta	242
Eforie	161
Fagaras	178
Giurgiu	77
Hirsova	151
Iasi	226
Lugoj	244
Mehadia	241
Neamt	234
Oradea	380
Pitesti	98
Rimnicu Vilcea	193
Sibiu	253
Timisoara	329
Urziceni	80
Vaslui	199
Zerind	374

Course Outcome 3(CO3):

1. Consider assigning colors to a checkerboard so that squares that are adjacent vertically or horizontally do not have the same color. We know that this can be done with only two colors, say red (R) and black (B). We will limit our discussion to five squares on a 3x3 board, numbered as follows and If in the initial state (all variables have domains { R, B }), we assign variable 1 to R and do forward checking, what are the resulting domains of the other variables?

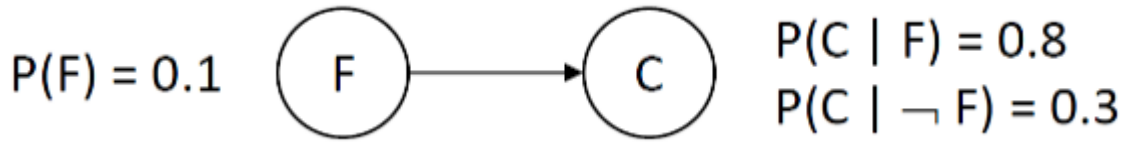
```
1 | 2 | 3
-----------
4 | 5 |
-----------
  |   |
```

2. Consider the CSP with
   Variables = A,B, C
   Domains = {1,2,3,4}
   Constraints = A<B, B<C
   Using the Arc Consistency Algorithm, determine the new domains for A,B and C when the algorithm terminates with all consistent arcs.
3. Find the value returned to the root node (i) without alpha-beta pruning and (ii) alpha-beta pruning.



Course Outcome 4 (CO4):

1. Apply FOL and check which of the following sentences are valid, unsatisfiable, or neither.
a. Smoke ⇒ Smoke
b. Smoke ⇒ Fire
c. Smoke ∨ Fire ∨ ¬ Fire
d. (Smoke ⇒ Fire) ⇒ (¬Smoke ⇒ ¬Fire)
e. (Smoke ⇒ Fire) ⇒ (Smoke ∧ Heat ⇒ Fire)
2. Apply First Order Logic and Encode the following sentences:
a. Jack owns a dog;
b. Every dog owner is an animal lover
c. No animal lover kills an animal
d. Either Jack or Curiosity killed the cat, who is named Tuna
e. Did Curiosity kill the cat?
3. Consider the following Bayesian network, where F = having the flu and C =coughing:



a. Write down the joint probability table specified by the Bayesian network.
b. Are C and F independent in the Bayesian network of Part a?

Course Outcome 5 (CO5):

1. Write the PDDL description of an air cargo transportation planning problem.
2. Consider the following problem - There are two locations C1 and C2, and two containers L1 and L2. If the ship is in the same location as a container, and the ship is empty, the ship can hold the container, as a result of this action, the container is on the ship and the ship is no longer empty. If the ship is in location x, it can move to location y, as a result of this action, the ship is in location y. If the ship has a container on it, and is in location x, then it can

unload, and the effect of the action is that the container is in location x and the ship is empty. In the initial state, both containers and the ship are in L1 and the ship is empty. The goal is to have container C2 in L2. Define the problem as a planning problem. Specify the predicates, objects, initial state, goal specification and the action schemas.

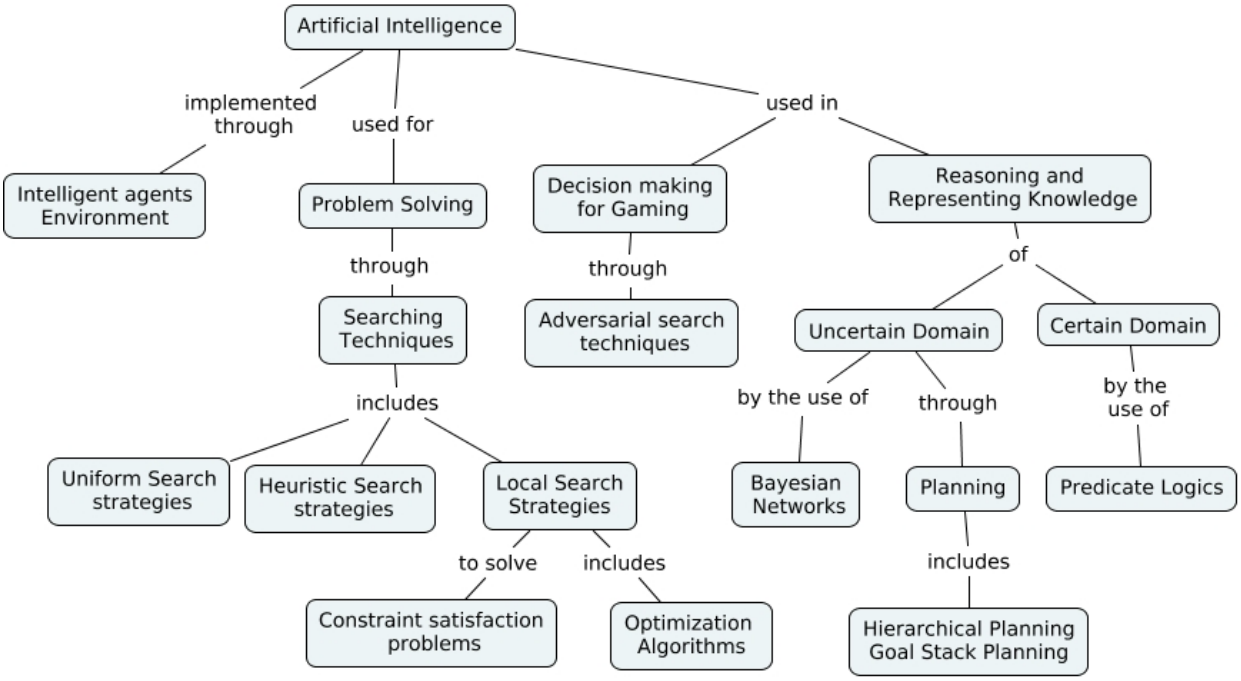
3. The following table of actions describe a planning problem for determining the steps in starting a car. The initial and final states are also indicated. Apply the partial-order planning algorithm to draw the final partial order plan clearly showing the causal links (including the subgoals that they achieve) and ordering links.

Action	Pre-condition	Effects
Turn-Key	¬ Accelerator ∧ ¬ Ignition	Ignition
Press-Clutch	¬ Clutch	Clutch
Release-Clutch	Clutch	¬ Clutch
Press-Accl	¬ Accelerator	Accelerator
Release-Accl	Accelerator	¬ Accelerator
Set-Gear	Clutch	Gear-Set
Engage-Gear	Clutch ∧ Gear-Set ∧ ¬ Accelerator ∧ Ignition	Gear-Engaged ∧ ¬Clutch
START	¬ Clutch ∧ ¬ Accelerator ∧ ¬ Ignition	
FINISH	Gear-Engaged ∧ ¬Clutch ∧ Accelerator ∧ Ignition	

Course Outcome 6(CO6):

1. Describe various components of Expert System Shell.
2. Differentiate the conventional System and an Expert System.
3. Explain the strategies used by Inference Engine for acquiring knowledge from the KB.

Concept Map



Syllabus

Introduction, Overview of Artificial intelligence: Problems of AI, AI technique, Tic - Tac - Toe problem. Intelligent Agents, Agents & environment, nature of environment, structure of agents, goal based agents, utility based agents, learning agents.

Problem Solving: Defining the problem as state space search, production system, problem characteristics, issues in the design of search programs.

Search techniques: Problem solving agents, searching for solutions; uniform search strategies: breadth first search, depth first search, depth limited search, bidirectional search, comparing uniform search strategies. Heuristic search strategies Greedy best-first search, A* search, AO* search, memory bounded heuristic search: local search algorithms & optimization problems: Hill climbing search, simulated annealing search, local beam search.

Constraint satisfaction problems: Local search for constraint satisfaction problems. Adversarial search, Games, optimal decisions & strategies in games, the minimax search procedure, alpha-beta pruning, additional refinements, iterative deepening.

Knowledge & reasoning: Knowledge representation issues, representation & mapping, approaches to knowledge representation. Predicate logic, representing simple fact in logic, representing instant & ISA relationship, computable functions & predicates, resolution, natural deduction. Representing knowledge using rules, Procedural verses declarative knowledge, logic programming, forward verses backward reasoning, matching, control knowledge.

Probabilistic reasoning: Representing knowledge in an uncertain domain, the semantics of Bayesian networks, Dempster-Shafer theory, Planning Overview, components of a planning system, Goal stack planning, Hierarchical planning, other planning techniques.

Expert Systems: Representing and using domain knowledge, expert system shells, and knowledge acquisition.

Learning Resources

Text Book :

1. Stuart J. Russell and Peter Norvig, *"Artificial Intelligence: A Modern Approach"* , 4th edition, Pearson, 2020.
2. Elaine Rich, Kevin Knight and Shivashankar B Nair, *"Artificial Intelligence"*, Third Edition, McGraw Hill Education India, 2010.

Reference Book :

1. Dan W Patterson, *"Introduction To Artificial Intelligence And Expert Systems Online"*,2nd Edition, Prentice-Hall of India,2001.
2. Kaushik, Saroj , *"Logic and Prolog Programming"*, New Age International,2002.
3. Joseph C. Giarratano, Gary D. Riley, *"Expert Systems: Principles and Programming"*, 4th Edition,2005.

Online Resources :

1. https://cse.iitkgp.ac.in/~pallab/course/2022/autumn%202022/Artificial%20Intelligence%20autumn%202022/index.html
2. https://www.ics.uci.edu/~rickl/courses/cs-171/cs171-lecture-slides/

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Introduction, Overview of Artificial intelligence**		
1.1	Problems of AI, AI technique, Tic - Tac - Toe problem.	1	CO1
1.2	Intelligent Agents, Agents & environment, nature of environment, structure of agents, goal based agents, utility based agents, learning agents.	2	CO1
2.	**Problem Solving, Problems, Problem Space & search**		

2.1	Defining the problem as state space search, production system, problem characteristics, issues in the design of search programs. **Search techniques:** Problem solving agents, searching for solutions; uniform search strategies: breadth first search, depth first search,	2	CO2
2.2	Depth limited search, bidirectional search, comparing uniform search strategies.	2	CO2
2.3	Heuristic search strategies : Greedy best-first search	1	CO2
2.4	A* search and AO* search	2	CO2
2.5	Memory bounded heuristic search: local search algorithms & optimization problems: Hill climbing search	2	CO2
2.6	Simulated annealing search, local beam search.	1	CO2
3.	**Constraint satisfaction problems**		
3.1	Local search for constraint satisfaction problems.	4	CO3
3.2	Adversarial search, Games, optimal decisions & strategies in games	3	CO4
3.3	The minimax search procedure, alpha-beta pruning, additional refinements, iterative deepening.	3	CO4
4.	**Knowledge & reasoning**		
4.1	Knowledge representation issues, representation & mapping, approaches to knowledge representation. Predicate logic, representing simple fact in logic, Representing instant & ISA relationship, computable functions & predicates,	1	CO5
4.2	Resolution, natural deduction Representing knowledge using rules, Procedural verses declarative knowledge,	1	CO5
4.3	Logic programming, forward verses backward reasoning, matching, control knowledge.	1	CO5
5.	**Probabilistic reasoning**		
5.1	Representing knowledge in an uncertain domain, the semantics of Bayesian networks,	2	CO5
5.2	Dempster-Shafer theory	1	CO5
5.3	Planning Overview, components of a planning system, Goal stack planning,	2	CO6
5.4	Hierarchical planning, other planning techniques	3	CO6
6.	**Expert Systems**		
6.1	Representing and using domain knowledge	1	CO7
6.2	Expert system shells, and knowledge acquisition.	1	CO7
	Total Hours	36	

Course Designers:

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21CB641	FINANCIAL & COST ACCOUNTING

Category	L	T	P	Credit	Terminal exam type
HSS	2	0	0	2	Theory

Preamble

Accounting is a science which provides all the data by recording, classifying, summarizing and interpreting the various transactions taking place in an organization and thereby helps an engineer in taking vital decisions in an effective manner. Finance is an allied but a separate field relying on accounting and enables engineers in taking useful financial and cost related decisions by providing well defined concepts, tools and techniques

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage in %
CO1	Describe the basic concepts accounting	10
CO2	Interpret the concept of accounting process.	10
CO3	Prepare the financial statements and analyse, interpret the statements	25
CO4	Prepare the cash flow and fund flow Statement	15
CO5	Prepare cost sheet, marginal cost and various types of budgets.,	25
CO6	Prepare the company accounts and annual reports.	15

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Value	Guided response	1.1, 2.3.4, 2.4.6, 2.4.7, 2.5.1
CO2	TPS3	Understand	Value	Mechanism	1.1, 1.2, 2.1.3, 2.1.4, 2.1.5, 2.3, 2.4.3, 2.4.6, 2.4.7
CO3	TPS3	Apply	Value	Mechanism	1.1, 1.2, 2.1.3, 2.1.4, 2.1.5, 2.3, 2.4.3, 2.4.6, 2.4.7
CO4	TPS4	Apply	Value	Mechanism	1.1, 1.2, 2.1, 2.3.2, 2.4.6, 2.4.7, 3.2.3, 4.1.1, 4.1.6, 4.6
CO5	TPS3	Apply	Value	Mechanism	1.1, 1.2, 2.1, 2.4.3, 2.4.4, 2.5.4, 4.1.1, 4.2.1, 4.2.4, 4.3.2, 4.4.6, 4.5.5, 4.6.1
CO6	TPS3	Apply	Value	Mechanism	1.1, 1.2, 2.1.3, 2.1.4, 2.1.5, 2.3, 2.4.3, 2.4.6, 2.4.7

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L	-	-	-	-	M	-	M	S	S	-	-	-
CO2	M	L	-	-	-	-	M	S	M	S	S	-	-	-
CO3	S	M	L	-	-	-	S	S	S	S	S	-	-	L
CO4	S	M	L	-	L	M	S	S	M	S	M	-	-	-
CO5	S	M	L	-	S	M	S	S	M	M	M	-	-	-
CO6	M	M	L	-	-	M	S	M	M	M	S		-	M

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive levels	Continuous Assessment Tests		Assignments		Terminal examination
	1	2	1	2	
Remember	20	20	-	-	20
Understand	30	30	-	-	20
Apply	50	50	100	100	60
Analyse					
Evaluate					
Create					

Assessment Pattern: Psychomotor

Psychomotor Skill	**Miniproject /Assignment/Practical Component**
Perception	-
Set	-
Guided Response	-
Mechanism	Assignment
Complex Overt Responses	-
Adaptation	-
Origination	-

Sample Questions for Course Outcome Assessment**

Course Outcome 1(CO1):

1. Define accounting.
2. Explain the accounting concepts and conventions
3. Explain the process of accounting cycle.

Course Outcome 2(CO2):

1.Define Journalising.

2.Define ledger.

3. Explain the methods of preparation of trial balance.

Course Outcome 3(CO3):

1. Prepare Trading, Profit and Loss Account and Balance Sheet from the following

S.NO	**PARTICULARS**	**Debit balances (in Rs)**	**Credit balances(in Rs)**
1	Capital		300000
2	Bank	15000	
3	Plant and machinery	40000	

4	Land and building	60000	
5	Debtors	20000	
6	Creditors		40000
7	Cash	70000	
8	Purchases and sales	35000	50000
9	Purchase returns and sales returns	7000	4000
10	Bills receivable	3000	
11	Bills payable		5000
12	Wages	40000	
13	Salaries	30000	
14	Discount		4000
15	Stock on Jan 2017	10000	
16	Furniture	7000	
17	Carriage inwards	5000	
18	Carriage outwards	6000	
19	Advertising	10000	
20	Travelling expense	3000	
21	Loans		60000
22	Vans	100000	
23	Telephone	2000	
	Total	**463000**	**463000**

2. From the following particulars, prepare comparative balance sheet of Malar Ltd as on 31st March 2017 and 31st March 2018.

Particulars	**31st March 2017**	**31st March 2018**
I EQUITY AND LIABILITIES		
1. Shareholders' fund		
a) Share capital		
b) Reserves and surplus	2,00,000	2,50,000
2. Non-current liabilities	50,000	50,000
Long-term borrowings		
3. Current liabilities	30,000	60,000
Trade payables		
	20,000	60,000
Total	**3,00,000**	**4,20,000**
II ASSETS		
1. Non-current assets		
a) Fixed assets	1,00,000	1,50,000
b) Non - current investments	50,000	75,000
2. Current assets		
a)Inventories	75,000	1,50,000
b) Cash and cash equivalents	75,000	45,000
Total	**3,00,000**	**4,20,000**

3. Make a statement of Trend Analysis (2019 as base) from the comparative financial statements. Income Statement of Logesh (P) Ltd.

Income Statement

Particulars	**2016**	**2017**	**2018**	**2019**
Sales	300	310	350	450
Cost of Goods Sold	150	170	180	190

Gross Profit	150	140	170	260
Operating Expenses	70	75	75	80
Operating Profit	80	65	95	180

Balance sheet

Particulars	**2016**	**2017**	**2018**	**2019**
Current Assets	70	80	90	90
Fixed Assets	150	70	180	170
Total Assets	220	250	270	260
Current Liabilities	50	55	60	60
Long Term Liabilities & Capital	170	195	210	200
Total Liabilities	220	250	270	260

Course Outcome 4(CO4):

1.From the following balance sheet of Ram & Co Prepare a statement of changes in working capital

Liabilities	1998	1999	**Assets**	1998	1999
Share Capital	150	170	Land & Building	145	170
Debentures	20	30	Machinery	30	20
Reserves & Surplus	35	45	Furniture	40	50
Loans	40	20	Debtors	45	35
Creditors	60	70	Stock	35	45
Bills Payable	20	15	Cash	30	30
Total	**325**	**350**	**Total**	**325**	**350**

2.From the following balance sheets prepare cash flow statement.

Liabilities	1998	1999	**Assets**	1998	1999
Sundry Creditors	2000	3000	Cash	1000	2000
Bills Payable	5000	2000	Debtors	2,500	3000
Share capital	16,000	20,000	Stock	3000	2,500
P & L a/c	4000	5000	Bills receivable	2000	3,500
			Furniture	4000	5,000
			Land & Building	14,500	14,000
Total	**27,000**	**30,000**	**Total**	**27,000**	**30,000**

Additional information

1.There were no sale of fixed assets.

3.From the following balance sheets prepare cash flow statement.

Liabilities	01.01.98	31.12.98	**Assets**	01.01.98	31.12.98
Share capital	60,000	80,000	Land	20,000	25,000
Loans	25,000	20,000	Machinery	25,000	20,000

Creditors	13,000	15,000	Stock	30,000	35,000
Bills Payable	4,000	5,000	Debtors	25,000	35,000
P & L a/c	8,000	10,000	Cash	10,000	15,000
Total	**1,10,000**	**1,30,000**	**Total**	**1,10,000**	**1,30,000**

Course Outcome 5(CO5):

1. Prepare cost sheet in the book of Vimi from the following particulars.

Opening stock: - Raw material = Rs 5,000
Finished goods = Rs 4,000
Closing stock: - Raw material = Rs 4,000
Finished goods = Rs 5,000

Raw material purchased = Rs 50,000
Wages paid to laboures = Rs 20,000
Chargeable expenses = Rs 2,000
Rent and Taxes = Rs 7,400
Power = Rs 3,000
Experimental expenses = Rs 600
Sale of wastage of material = Rs 200
Office management salary = Rs 4,000
Office printing & stationery = Rs 200
Salaries to salesman = Rs 2,000
Commission to traveling agents = Rs 1,000
Sales = Rs 1, 00,000

2. Calculate the cost sheet from the following details given below for the month of October 2019.Total production during the period was 786 units. Identify the sales value and the cost per unit of the product.

Particulars	**Rs**
Raw materials on 1.10.2019	3200
Raw materials on 30.10.2019	1800
Work in Progress on 1.10.2019	2800
Work in Progress on 30.10.2019	2500
Finished goods on 1.10.2019 (Rs 3600)	120 units
Finished goods on 30.10.2019	145 units
Materials Purchased	5000
Direct wages	3000
Direct expenses	2000
Factory expenses	1500
Office and administrative expenses	1800
Selling and distribution expenses	1500
Charge profit 15% on sales	

3. From the forecast of income and expenditure prepare a cash budget for the months from April to June 2019.

Month	Sales Rs	Purchases Rs	Wages Rs	Office expenses Rs	Selling expenses Rs
Feb	70,000	45,000	4,500	2,700	1,800
Mar	72,000	43,000	4,700	3,000	2,000
Apr	75,000	44,000	4,900	2,900	2,200
May	71,000	40,000	5,000	3,000	2,100
Jun	70,000	42,000	5,000	2,800	1,900

- Plant worth Rs25, 000 purchased in June. 40% payable immediately and the remaining in two equal installments in subsequent months.
- Advance tax payable in April Rs 4500
- Period of credit allowed
  - By suppliers 2 months
  - To customer 1 month
- Dividend payable Rs 7000 in June
- Delay in payment of wages and office expenses 1 month and selling expenses 1 month.

Expected cash balance on 1st April Rs 30,000
Machinery expected to sell on May is Rs 20,000

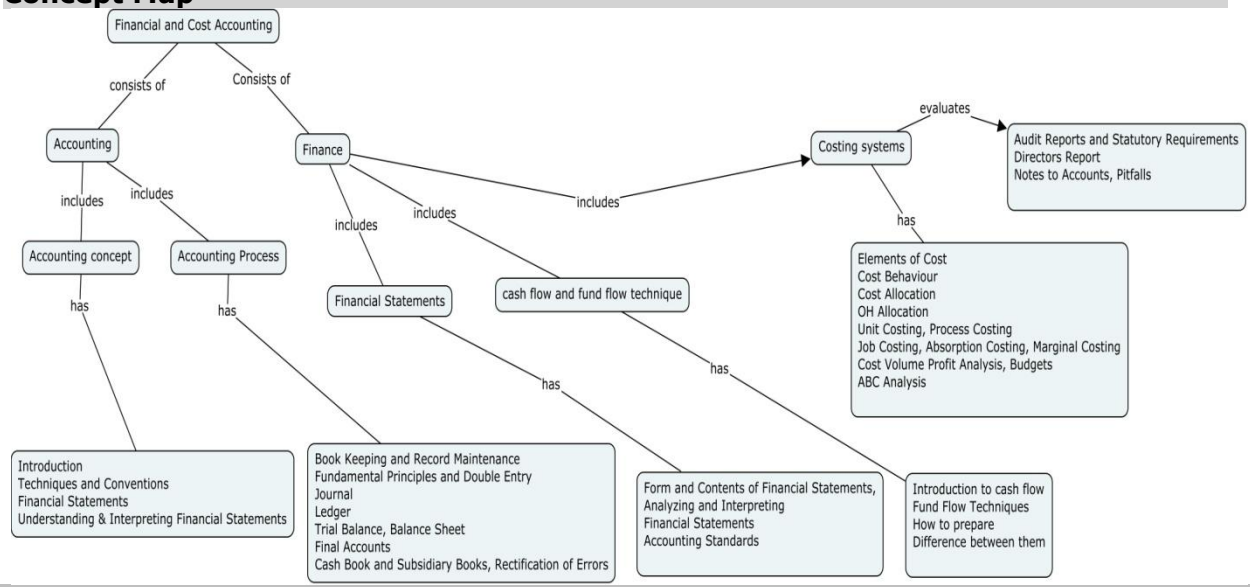
Course Outcome 6 (CO6):

1.ABC Ltd company issued 25,000 shares at Rs 10 per share payable Rs 3 on application, Rs 4 on allotment Rs 3 on first and final call. The public subscribed for 24,000 shares. The directors allotted all the 24,000 shares and received the money duly. Pass the necessary journal entry.

2.Gaja Ltd issued 40,000 shares of ₹ 10 each to the public payable ₹ 2 on the application, ₹ 5 on the allotment, and ₹ 3 on the first and final call. Applications were received for 50,000 shares. The Directors decided to allot 40,000 shares on a pro-rata basis and a surplus of application money was utilized for allotment. Pass journal entries assuming that the amounts due were received.

3.A company forfeited 200 shares of ₹ 10 each fully called up for non – payment of the first call of ₹ 2/- per share and final call of ₹ 3 per share. 120 of these shares were reissued at ₹ 6/- per share fully paid up. Give the necessary entries.

Concept Map



Syllabus

Accounting Concept: Introduction, Techniques and Conventions, Financial Statements-Understanding & Interpreting Financial Statements, **Accounting Process:** Book Keeping and Record Maintenance, Fundamental Principles and Double Entry, Journal, Ledger, Trial Balance, Balance Sheet, Final Accounts, Cash Book and Subsidiary Books, Rectification of Errors. **Financial Statements:** Form and Contents of Financial Statements, Analyzing and Interpreting Financial Statements, Accounting Standards. **Cash Flow and Fund Flow Techniques:** Introduction, How to prepare, Difference between them. **Costing Systems:** Elements of Cost, Cost Behaviour, Cost Allocation, OH Allocation, Unit Costing, Process

Costing, Job Costing, Absorption Costing, Marginal Costing, Cost Volume Profit Analysis, Budgets, ABC Analysis. **Company Accounts and Annual Reports:** Audit Reports and Statutory Requirements, Directors Report, Notes to Accounts, Pitfalls

Learning Resources

1. Robert N Anthony, David Hawkins, Kenneth Marchant, "Accounting: Texts and Cases", McGraw-Hill 2017
2. S P. Jain and K L Narang ,"Corporate Accounting" 9th edition, Kalyani Publishers, New India, 2019.
3. M.C.Shukla,T.S.Grewal,"AdvancedAccounts"- S. Chand & company Ltd.,19th edition ,2017 Reprint, 2010.
4. Prasanna Chandra, "Financial Management-Theory and practice"seventh Reprint,Tata McGraw-Hill publishing company Limited,2010.
5. P.S.BoopathiManickam "Financial and Management Accounting" PSG publications 2009.
6. Michael C .Ehrhardt and Eugene F . Brigham, "Financial Management: Theory and Practice - thirteenth edition" South-Western cengage learning, 2011
7. Paramasivan.C, Subramanian.T, "Financial management" New Age international Publishers, 2014.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Accounting Process (4)**		
1.1	Introduction	1	CO1
1.2	Techniques and Conventions	1	CO1
1.3	Financial Statements	1	CO1
1.4	Understanding & Interpreting Financial Statements	1	CO1
2.	**Accounting Concept (5)**		
2.1	Book Keeping and Record Maintenance	1	CO2
2.2	Fundamental Principles and Double Entry	1	CO2
2.3	Journal	1	CO2
2.4	Ledger		CO2
2.5	Trial Balance, Balance Sheet	1	CO2
2.6	Final Accounts		CO2
2.7	Cash Book and Subsidiary Books, Rectification of Errors	1	CO2
3.	**Financial Statements (4)**		
3.1	Form and Contents of Financial Statements,	1	CO3
3.2	Analyzing and Interpreting	1	CO3
3.3	Financial Statements	1	CO3
3.4	Accounting Standards	1	CO3
4.	**Cash Flow and Fund Flow Techniques (4)**		
4.1	Introduction to cash flow	1	CO4
4.2	Fund Flow Techniques	1	CO4
4.3	How to prepare	1	CO4
4.4	Difference between them	1	CO4
5	**Costing Systems (4)**		
5.1	Elements of Cost	1	CO5
5.2	Cost Behaviour		CO5
5.3	Cost Allocation	1	CO5
5.4	OH Allocation		CO5
5.5	Unit Costing, Process Costing	1	CO5
5.6	Job Costing, Absorption Costing, Marginal Costing		CO5

5.7	Cost Volume Profit Analysis, Budgets	1	CO5
5.8	ABC Analysis		CO5
6	**Company Accounts and Annual Reports (3)**		
6.1	Audit Reports and Statutory Requirements	1	CO6
6.2	Directors Report	1	CO6
6.3	Notes to Accounts, Pitfalls	1	CO6
	Total:	**24 hours**	

Course Designers:

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21CB651	BUSINESS COMMUNICATION & VALUE SCIENCE– IV

Category	L	T	P	Credit	Terminal Exam Type
Project	2	0	0	2	Fully Internal

Preamble

This course aims at enhancing students' corporate communication, developing workplace etiquette, accomplishing time management and stress management techniques. It helps students become emotionally intelligent and learn problem solving skills in personal and professional lives. It creates awareness on the value of corporate social responsibility.

Prerequisite

Basic Knowledge o verbal and written English

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage in %
CO1	Demonstrate Effective Communication in Business Correspondence.	20
CO2	Handle Emotional Intelligence and Conflict Management in both personal and professional lives	15
CO3	Demonstrate Public Speaking skill in real-life scenario	20
CO4	Practice the best Time Management Techniques	15
CO5	Acquire the best practices to Manage Stress.	10
CO6	Relate the importance of Corporate Social Responsibility	20

CO Mapping with CDIO Curriculum Framework

CO#	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Apply	Value	Perception	2.4,2.5,3.1
CO2	TPS2	Apply	Respond	Perception	2.4,2.5,3.2.6
CO3	TPS3	Apply	Respond	Perception	3.1,3.1.6
CO4	TPS2	Apply	Respond	Perception	3.1.6,3.2
CO5	TPS3	Apply	Respond	Guided Response	3.2.1,3.2.3,3.3.1
CO6	TPS6	Apply	Respond	Create (Project)	3.1.6,3.2

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M					M	M	S	S		M	L	M	M
CO2	M					M	M	M	S			L	L	L
CO3	S								S		S	L	L	L
CO4	M								S		S	L	L	L
CO5	S					M		S	S		S	L	M	L
CO6	S					M		S	S		S	L	M	L

S-Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

No CAT will be conducted.
Summative - No Paper based Examination.
Activity Based Evaluation will be done by the Internal and External Examiners

Internal Examination:

Model Test	**CO1&2**	**APPLY**	**20**
Quiz	**CO4&5**	**APPLY**	**10**

External Examination: (External Evaluation is done by the Industry people)

Aptitude Test	**CO1&2**	**APPLY**	**20**		
Speaking	**CO3**	**APPLY**	**10**		
Project & Review	**CO6**	**APPLY**	**30**		
			R1	**R2**	**Final Review & Submission**
			10	**10**	**10**
		Total	**100**		

Assessment Pattern: Psychomotor

Psychomotor Skill	Mini project/Assignment/Practical Component
Perception	
Set	
Guided Response	Project
Mechanism	
Complex Overt Responses	
Adaptation	
Origination	

Sample Questions for Course Outcome Assessment**

Course Outcome1 (CO1):(20marks)

A. Write Business Letters
B. Interpretation of Graphics
C. Frame sentences using business Idioms and Phrases
D. Quiz on Phone etiquettes

Course Outcome2 (CO2):(20marks) Quiz/Questionnaire

Emotional Intelligence/ Intelligence Quotient (IQ)/ Emotional Quotient (EQ)& Conflict Management

Course Outcome**3(CO3):(10 Marks) Speaking Activity**

Public Speaking – Real life scenario and Entrepreneurship

Course Outcome4(CO4):(10 marks) **Listening Activity**

TED Talks - Time management and Etiquettes

Course **Outcome4(CO5):(10 Marks) Case Study**

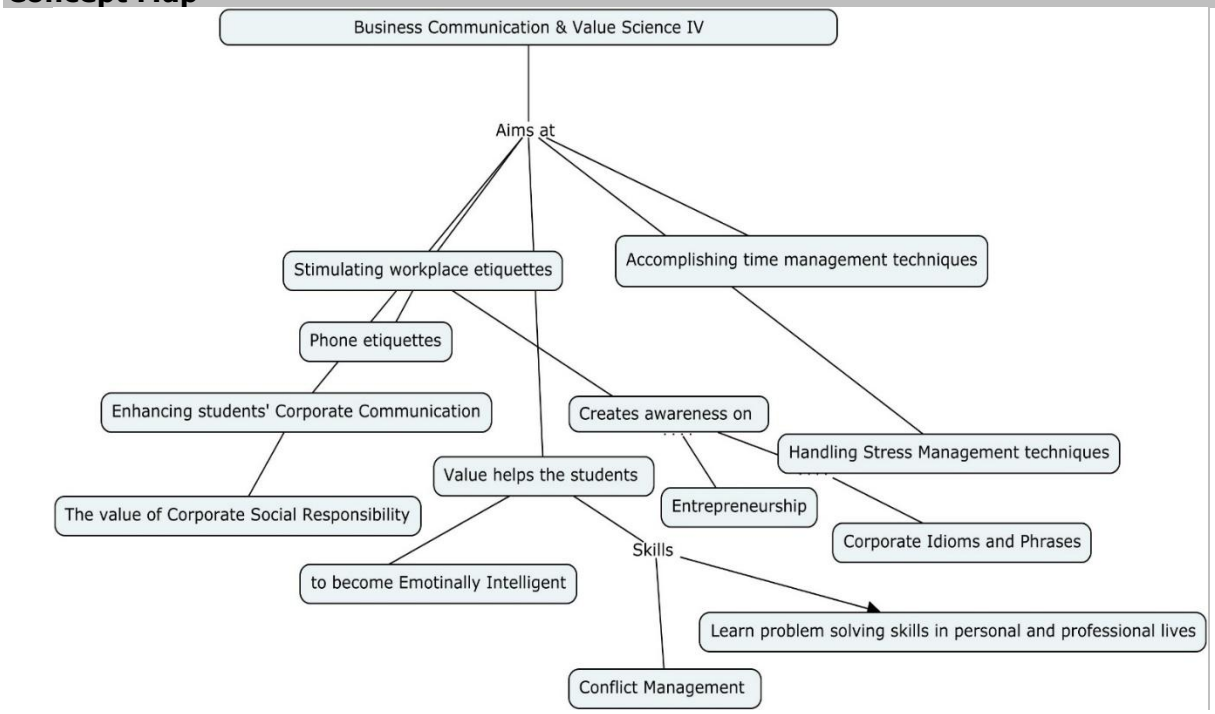
Case Study on Stress Management

Course Outcome 6 (CO6): (30) Project + Review

Startup related project and its review will be based on -

1. Topic selection 2. Preparation (synopsis) 3. Full project submission

Concept Map



Syllabus

Principles of Communicative writing and Corporate Etiquettes

Identify the key aspects of communicative Writing - Business Letters, Writing Proposals - startups, Graphical interpretation, Business Idioms and Corporate terms, Features of Corporate etiquettes, Cellphone and telephone etiquettes.

Emotional Intelligence and Conflict Management

Difference between Emotional Quotient and Intelligence Quotient, Importance of Emotional Intelligence in personal and professional lives, Meaning and Definition of Conflict, Reasons of Conflict, impacts of Conflicts, Tips to Manage Conflicts.

Public Speaking Skills and Time Management Skill

Public Speaking at your workplace, Best practices of public speaking in real life scenarios, Extempore, Listening - Ted-Talk videos

Time and Stress Management Skills

Time Management for better life style, Basic practices to Manage Stress, 4As of Stress Management, Relaxation Techniques.

Corporate Social Responsibility

Attributes needed to function and grow in a corporate environment, Ubuntu story, Attributes and Qualities required for Work - Resilience, Flexibility, Strategic Thinking and Planning, Resolving Conflicts and Decision Making.

Learning Resources

Text Books:	
There are no prescribed texts for Semester1–there will be hand-outs and reference links shared.	
Reference Books:	
1	Emotional Intelligence: Why it Can Matter More Than IQ by Daniel Goleman
2	Putting Emotional Intelligence to Work by Ryback David

3	How to Develop Self Confidence and Improve Public Speaking - Time - Tested Methods of Persuasion by Dale Carnegie
4	TED Talks: The official TED guide to public speaking: Tips and tricks for giving unforgettable speeches and presentations
Web References:	
1	**https://www.tata.com/about-us/tata-group-our-heritage**
2	**https://economictimes.indiatimes.com/tata-success-story-is-based-on-humanityphilanthropy-and-ethics/articleshow/41766592.cms**
Online Resources:	
1	https://youtu.be/reu8rzD6ZAE
2	https://youtu.be/Wx9v_J34Fyo
3	https://youtu.be/F2hc2FLOdhI
4	https://youtu.be/wHGqp8lz36c
5	https://youtu.be/hxS5He3KVEM
6	https://youtu.be/nMPqsjuXDmE

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.1	Identify the key aspects of communicative Writing	1	CO1
1.2	Business Letters	1	CO1
1.3	Writing Proposals – Start ups	1	CO1
1.4	Graphical Interpretation	1	CO1
1.5	Business Idioms and Corporate Terms	1	CO1
1.6	Features of Corporate Etiquettes and Phone Etiquettes	1	CO1
2.1	Difference between Emotional Quotient and Intelligence Quotient	2	CO2
2.2	Importance of Emotional Intelligence in Personal and Professional lives	1	CO2
2.3	Meaning and Definition of Conflict, Reasons of Conflict, impacts of Conflicts, Tips to Manage Conflicts	1	CO2
3.1	Public Speaking at your Workplace	3	CO3
3.2	Best practices of Public Speaking in Real Life Scenarios	2	CO3
3.3	Extempore	1	CO3
3.4	Listening - Ted-Talk videos	2 (LAB)	CO3
4.1	Time Management for better life style	1	CO4
4.2	Basic Practices to Manage Stress, 4As of Stress Management	1	CO5
4.3	Relaxation Techniques	1	CO5
5.1	Attributes needed to function and grow in a Corporate Environment, Ubuntu story	1	CO6
5.2	Attributes and Qualities required for Work - Resilience, Flexibility, Strategic Thinking and Planning, Resolving Conflicts and Decision Making	2	CO6
	TOTAL	24	

CourseDesigners:

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3. Dr.RS.Swarnalakshmi rssleng@tce.edu

21CB661	COMPUTER NETWORKS LAB

Category	L	T	P	Credit	Terminal Exam Type
PC	0	0	4	2	Practical

Preamble

Universal connectivity is realized through Computer Networks. It is important to gain knowledge on the hardware requirements and functioning of Computer Networks. This course provides insight into the working of network protocols and their characteristics.

Prerequisite

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Configuration of networking components and installing device drivers and build a Local Area Network.	10
CO2	Implement client server communication using socket programming.	15
CO3	Implement Sliding window protocol and stop and wait protocol.	15
CO4	Implement File transfer, Remote Method Invocation.	15
CO5	Develop a DNS client server to resolve the given host name or IP address.	20
CO6	SimulateanetworktopologyusingNS3.	25

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO#	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS3	Apply	Value	Mechanism	1.2,3.2.3,4.5.1
CO2	TPS3	Apply	Value	Mechanism	1.2,3.2.3,4.5.1,4.5.3
CO3	TPS3	Apply	Value	Mechanism	1.2,3.2.3,4.5.1,4.5.3
CO4	TPS3	Apply	Value	Mechanism	1.2,3.2.3,4.5.1,4.5.3
CO5	TPS3	Apply	Value	Mechanism	1.2,3.2.3,4.5.1,4.5.3
CO6	TPS3	Apply	Value	Mechanism	1.2,2.1.2,3.2.3,4.5.1,4.5.3

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	S	M	L		L	L	L	L			L	M	L	L
CO2	S	M	L		L	L	L	L			L	M	L	L
CO3	S	M	L		L	L	L	L			L	M	L	L
CO4	S	M	L		L	L	L	L			L	M	L	L
CO5	S	M	L		L	L	L	L			L	M	L	L
CO6	S	M	L		L	L	L	M			L	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Model Examination	Terminal Examination
Remember		
Understand	20	20
Apply	80	80
Analyse		
Evaluate		
Create		

Assessment Pattern: Psychomotor

Psychomotor Skill	~~Mini~~project /Practical Component~~/Observation~~
Perception	
Set	
Guided Response	20
Mechanism	80
Complex Overt Responses	
Adaptation	
Origination	

List of Experiments/Activities with CO Mapping

Module No.	Topic	No.of Hours	Course Outcome
1.	Implementation of system administration and network administration	2	CO1
2.	Implementation of socket programming and client server model using UDP and TCP	4	CO2
3.	Implementation of Sliding window protocol and stop and wait protocol	2	CO3
4.	Simulate PING and TRACEROUTE commands	2	CO3
5.	Applications using TCP Sockets like File transfer Remote command execution Chat Concurrent server	4	CO4
6.	Create a socket for HTTP for webpage upload and download	2	CO5
7.	Implementation of Subnetting Applications DNS SNMP	2	CO5
8.	Simulation of any one of routing protocol using NS3	2	C06
9.	Implement Network File Transfer Application using PUTTY	2	C06
10.	Perform a case study about ETTERCAP (NETWORK SECURITY TOOL).	2	C06
	Total	24	

Course Designers:

1. Mrs.P.Suganthi psica@tce.edu

21CB671	INFORMATION SECURITY LAB

Category	L	T	P	Credit	Terminal Exam type
PC	0	0	2	1	Practical

Preamble

The objective of an information security lab is to protect information from unauthorized release and ensure that the appropriate level of confidentiality is preserved. It has three fundamental objectives, namely confidentiality, integrity, and availability.Students will get hands-on experience on password cracking and authentication, computer vulnerability scan and network security monitoring (intrusion detection).

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Implementation of authentication methods in Unix/Linux systems by using passwords.	25
CO2	Implementation of vulnerabilities in database security and multi factor authentication in Unix/Linux systems.	15
CO3	Demonstrate file systems access control policy in Unix/ Linux systems.	10
CO4	Apply hashing algorithm for encryption and data integrity.	15
CO5	Identify the interfaces of the Wireshark application and perform network analysis.	20
CO6	Demonstrate network intrusion detection system using network security tool.	10

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS3	Apply	Value	-	1.2,1.3,2.2,4.3
CO2	TPS3	Apply	Value	-	1.2,2.2,2.3,4.2,4.3
CO3	TPS3	Apply	Value	-	1.2,1.3,4.3,4.4,4.5
CO4	TPS3	Apply	Value	-	1.2,1.3,4.2,4.3
CO5	TPS3	Apply	Value	-	1.2,1.3,4.2,4.3,4.4,4.5,4.6
CO6	TPS3	Apply	Value	-	1.2,1.3,4.2,4.3,4.4,4.5,4.6

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	S	M	L				M	M	M		M	M	L	L
CO2	S	M	L				M	M	M		M	M	L	L
CO3	S	M	L				M	M	M		M	M	L	L
CO4	S	M	L				M	M	M		M	M	L	L
CO5	S	M	L		L		M	M	M		M	M	L	L
CO6	S	M	L		L		M	M	M		M	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Model Examination	Terminal Examination
Remember		
Understand		
Apply	100	100
Analyse		
Evaluate		
Create		

List of Experiments/Activities with CO Mapping

Module No.	Topic	No. of Hours	Course Outcome
1	Manage user identityof Unix/Linux systems in groups and depict administrator policies for adding/deleting user accounts.	1	CO1
2	Create, edit and manage passwords and expiration limits by Viewing group level password policies.	1	CO1
3	Implementation of standard password manager for adding and retrieving the passwords from store using GPG key.	1	CO1
4	Apply software vulnerabilities such as SQL injection and provide solutions for prevention and detection.	1	CO2
5	Apply two-factor authentication for SSH In Linux/Unix systems.	1	CO2
6	Implementation of file permission/access modes and change it using symbolic method and absolute form.	1	CO3
7	Implementation of SHA-I algorithm and MD5 algorithm for generating hashed passwords.	2	CO4
8	Study the steps for installing Wireshark, the packet-sniffing tool for performing Network analysis.	1	CO5
9	Implementations of the various wireshark filter and perform malware traffic analysis.	2	CO5
10	Apply snort tool fornetwork intrusion detection.	1	CO6
	TOTAL	12	

Learning Resources

1. https://access.redhat.com/products
2. https://www.wireshark.org/docs/wsug_html/
3. David Wheeler, "*Secure Programming HOWTO*", 7th Edition, 2015.

Course Designers:

1. Subhashni R rsica@tce.edu

21CB681	Artificial Intelligence Lab

Category	L	T	P	Credit	Terminal Exam type
PC	0	0	2	1	Practical

Preamble

The experiments are designed to provide problem-solving abilities that can be applied to a variety of real-world issues. Students can discover how Artificial Intelligence algorithms can reason, interact, apply knowledge, and learn.

Prerequisite

Basic knowledge of programming language like python,c or c++

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Develop solutions using relevant uninformed search strategies to solve the given state space problem.	15
CO2	Construct a solution using suitable heuristic searching algorithms for the given problem statement	15
CO3	Implement a suitable optimization algorithm for the real-world problem.	15
CO4	Apply an adversarial search strategy for the given gaming environment and the CSP problem.	25
CO5	Construct a planning graph to solve the considered real world problem.	15
CO6	Apply various probabilistic decision-making algorithms on considering a real time dataset for evaluation.	15

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS3	Apply	Value		1.2, 2.3.2,3.2.3, 4.4.3, 4.5.3
CO2	TPS3	Apply	Value		1.2, 2.3.2,3.2.3, 4.4.3, 4.5.3
CO3	TPS3	Apply	Value		1.2, 2.3.2,3.2.3, 4.4.3, 4.5.3
CO4	TPS3	Apply	Value		1.2, 2.3.2,3.2.3, 4.4.3, 4.5.3
CO5	TPS3	Apply	Value		1.2, 2.3.2,3.2.3, 4.4.3, 4.5.3
CO6	TPS3	Apply	Value		1.2, 2.3.2,3.2.3, 4.4.3, 4.5.3

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	S	M	L		S	S		S	L		S	M	M	L
CO2	S	M	L		S	S		S	L		S	M	M	L
CO3	S	M	L		S	S		S	L		S	M	M	L
CO4	S	M	L		S	S		S	L		S	M	M	L
CO5	S	M	L		S	S		S	M		S	M	M	L
CO6	S	M	L		S	S	M	S	M	L	S	M	M	M

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Model Examination	Terminal Examination
Remember	-	-
Understand	-	-

Apply	100	100
Analyse	-	-
Evaluate	-	-
Create	-	-

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject /Practical Component/Observation
Perception	-
Set	-
Guided Response	-
Mechanism	100
Complex Overt Responses	-
Adaptation	-
Origination	-

List of Experiments/Activities with CO Mapping

S.No	Name of the Experiment	No. of Hours	Course Outcome
1.	Implement a solution for the Tic-Tac-Toe problem with O and X	1	CO1
2.	Implement an uninform searching strategy to detect a cycle and the strongly connected components in a directed graph using BFS and DFS respectively.	1	CO1
3.	Implement a program to find the shortest path between the source and the destination node using A* and AO* heuristic searching algorithms.	1	CO2
4.	Implement a Greedy Heuristic solution for the travelling salesman problem.	1	CO2
5.	Implement an Optimization Algorithm, Hill Climbing algorithm for the N-Queen Problem.	1	CO3
6.	Implement a program to solve the crypt arithmetic puzzle, a CSP problem using Backtracking.	2	CO4
7.	Implement the adversarial search MinMax algorithm with and without alpha beta pruning for a two-player gaming environment.	1	CO4
8.	Implement a program to solve the Block World Problem using goal stack planning.	1	CO5
9.	Implement Bayesian Belief Network for a given large dataset	1	C06
10.	Implement a k-means clustering algorithm for given data set	1	C06
11.	Implement Decision Tree for any considered application of decision making.	1	C06
	Total	12	

Learning Resources

1. Stuart Russell and Peter Norvig. "*Artificial Intelligence: A Modern Approach*", 4th Edition, Prentice Hall, 2020.
2. Deepak Khemani. "*A First Course in Artificial Intelligence*", McGraw Hill Education ,2013.

Course Designers

1. Mrs.J.Felicia Lilian jflcse@tce.edu
2. Ms.M.Mahalakshmi mmica@tce.edu

CURRICULUM AND DETAILED SYLLABI

FOR

B.TECH DEGREE (Computer Science and Business Systems) PROGRAMME

SEVENTH AND EIGHTH SEMESTER

FOR THE STUDENTS ADMITTED FROM THE

ACADEMIC YEAR 2025– 2026 ONWARDS

THIAGARAJAR COLLEGE OF ENGINEERING

(A Government Aided ISO 9001-2008 Certified

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THIAGARAJAR COLLEGE OF ENGINEERING, MADURAI- 625 015

(A Govt. Aided, ISO 9001:2008 certified Autonomous Institution affiliated to Anna University)

B.Tech Degree (Computer Science and Business Systems)

Programme COURSES OF STUDY

(For the candidates admitted from 2025– 2026 onwards)

SEVENTH SEMESTER

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	No.of Hours / Week			Credits
				L	T	P	
THEORY COURSES							
1	21CB711	Service Operations Management	BS	3	0	0	3
2	21CBPX1	Program Elective - V	PE	2	0	0	2
3	21CBPX1	Program Elective – VI	PE	2	0	0	2
4	21CBPX1	Program Elective – VII	PE	3	1	0	4
5	21CBPX1	Program Elective - VIII	PE	3	0	0	3
6	21CBPX1	Program Elective - IX	PE	3	1	0	4
7	21CBPX1	Program Elective - X	PE	2	0	2	3
THEORY CUM PRACTICAL COURSES							
8	21CB721	IT Workshop	ES	2	0	2	3
			TOTAL	**20**	**2**	**4**	**24**

EIGHTH SEMESTER

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	No.of Hours / Week			Credits
				L	T	P	
PRACTICAL COURSES							
1	21CB811	Project	Project	0	0	12	6
			TOTAL	**0**	**0**	**12**	**6**

BS : Basic Sciences
PE : Program Elective
ES : Engineering Sciences
L : Lecture
T : Tutorial
P : Practical

Note:

1 Hour Lecture is equivalent to 1 credit

1 Hour Tutorial is equivalent to 1 credit

2 Hours Practical is equivalent to 1 credit

THIAGARAJAR COLLEGE OF ENGINEERING, MADURAI- 625 015

(A Govt. Aided, ISO 9001:2008 certified Autonomous Institution affiliated to Anna University)

B.Tech Degree (Computer Science and Business Systems) Programme

SCHEME OF EXAMINATIONS

(For the candidates admitted from 2025 – 2026 onwards)

SEVENTH SEMESTER

S.No.	Course Code	Name of the Course	Duration of Terminal Exam. in Hrs.	Marks			Minimum Marks for Pass	
				Continuous Assessment	Terminal Exam *	Max. Marks	Terminal Exam	Total
THEORY								
1	21CB711	Service Operations Management	3	40	60	100	27	50
THEORY CUM PRACTICAL COURSES								
2	21CB721	IT Workshop	3	50	50	100	25	50

EIGHTH SEMESTER

S.No.	Course Code	Name of the Course	Duration of Terminal Exam. in Hrs.	Marks			Minimum Marks for Pass	
				Continuous Assessment	Terminal Exam *	Max. Marks	Terminal Exam	Total
PRACTICAL								
1	21CB811	Project	-	40	60	100	27	50

21CB711	Service Operations Management

Category	L	T	P	Credit	Terminal Exam Type
PC	3	0	0	3	Theory

Preamble

The objective of the course is to understand the growing significance and impact of services on the growth and economy and the scientific ways to run the operations so as to optimize the business and brand returns. The main concern of Operations Management is to convert the materials into goods and services efficiently. This course would help the students understand service Operations Management which comprises planning, implementing, and also supervising the production of goods and management.

Prerequisite

Fundamentals of Management, Operations Research

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Understand the services and service operations management concepts.	15
CO2	Improve services from Goods-Dominant logic to Service-Dominant logic by adding values.	15
CO3	Develop a new service and generate a blueprint for service delivery system.	15
CO4	Apply the principles, tools and techniques of service design such as Huff's retail model, thinking model.	20
CO5	To demonstrate the strategies for service supply relationship of goods and after sales service.	25
CO6	Implement the service operation strategies on any service organization around with the perspective of: nature, classification, design and quality of service.	10

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond		1.2,1.3,2.2,2.3,2.5.4,4.2
CO2	TPS3	Apply	Value		1.2,2.1,2.2,4.1,4.2
CO3	TPS3	Apply	Value		1.2, 2.1.2,4.4,4.5,4.6
CO4	TPS3	Apply	Value		1.2,2.3,4.2,4.3,4.4,4.5,4.6
CO5	TPS3	Apply	Value		1.2,2.1,2.3,4.5
CO6	TPS3	Apply	Value		1.2,2.1,2.5,3.1.5,4.3,4.5,4.6

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO 1	PSO 2	PSO 3
CO1	M	L	L	L			L				M	L		L
CO2	S	M	M	L			L				M	L		L
CO3	S	M	M		L		L				M	M		L
CO4	S	S	M		M		L				M	M	L	L
CO5	S	M	M				L				M	M		L
CO6	S	S	M		M		L				M	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	2	1	2	
Remember	30	30			20
Understand	30	40	50	50	40
Apply	40	30	50	50	40
Analyse					
Evaluate					
Create					

Sample Questions for Course Outcome Assessment**

** (2 to 3 at the cognitive level of course outcome)

Course Outcome 1(CO1):

1. Illustrate how the type of work he or she does influences a person's lifestyle. For example, contrast a farmer, a factory worker, and a school teacher.
2. Determine if the service sector is currently expanding or contracting based upon the Non-Manufacturing Index (NMI) found at the ISM Report on Business on the Institute of Supply Management.
3. Is it possible for an economy to be based entirely on services, analyse?

Course Outcome 2(CO2):

1. Critique the "Distinctive Characteristics of Service Operations" by arguing that the characteristics of customer participation, simultaneity, perishability, intangibility, and heterogeneity may apply to goods as well.
2. Illustrate the "distinctive characteristics of service operations" for a service with which you are familiar.
3. Could firms in the "world-class service delivery" stage of competitiveness be described as "learning organizations"?

Course Outcome 3(CO3):

1. Give an example of a service in which isolation of the technical core would be inappropriate.
2. Prepare a service blueprint for Golfsmith.
3. What generic approach to service system design is illustrated by Commuter Cleaning, and what competitive advantages does this design offer?

Course Outcome 4 (CO4):

1. Will Amazon continue to be successful against "click-and mortar" competitors, such as Barnes & Noble? Is Amazon.com a model for the future of retailing?

as Barnes & Noble? Is Amazon.com a model for the future of retailing?
2. What features of the 7-Eleven Japan distribution system illustrate the "Value Net Integrator" e-business model?
3. Illustrate the four components in the cost of quality for a service of your choice.

Course Outcome 5 (CO5):

1. The CRAFT program is an example of a heuristic programming approach to problem solving. Why might CRAFT not find the optimal solution to a layout problem?
2. The architect for the new undergraduate library is interested in a floor plan that would be viewed as convenient by users. Based on survey data from the old library, student movements between different areas in hundreds of trips per month are noted in the flow matrix below. Prepare a good initial rectangular layout that minimizes total flow distance between nonadjacent areas; then use operations sequence analysis to improve the layout.

Library Area	A	B	C	D	E	F
A Reserve Room	—	5	9	3	7	1
B Reference Room	3	—	8	2	6	2
C Copy Room	1	1	—	7	2	3
D Stacks	2	2	10	—	2	5
E Periodical Room	1	2	6	3	—	2
F Computer Room	1	1	1	4	2	—

3. Passengers arriving at an airport departure gate must first wait for their row to be called before proceeding to the gate to have their boarding pass authenticated. If the boarding pass does not match the departing flight, the passenger is directed to the appropriate gate. A passenger attempting to carry on an excessively large bag is directed to check the luggage piece and return. Passengers with the proper boarding pass and appropriate sized carry-on are allowed to enter the jet way and board the plane. Draw a process flow diagram of the departure gate process. How might this process be improved to avoid delays?

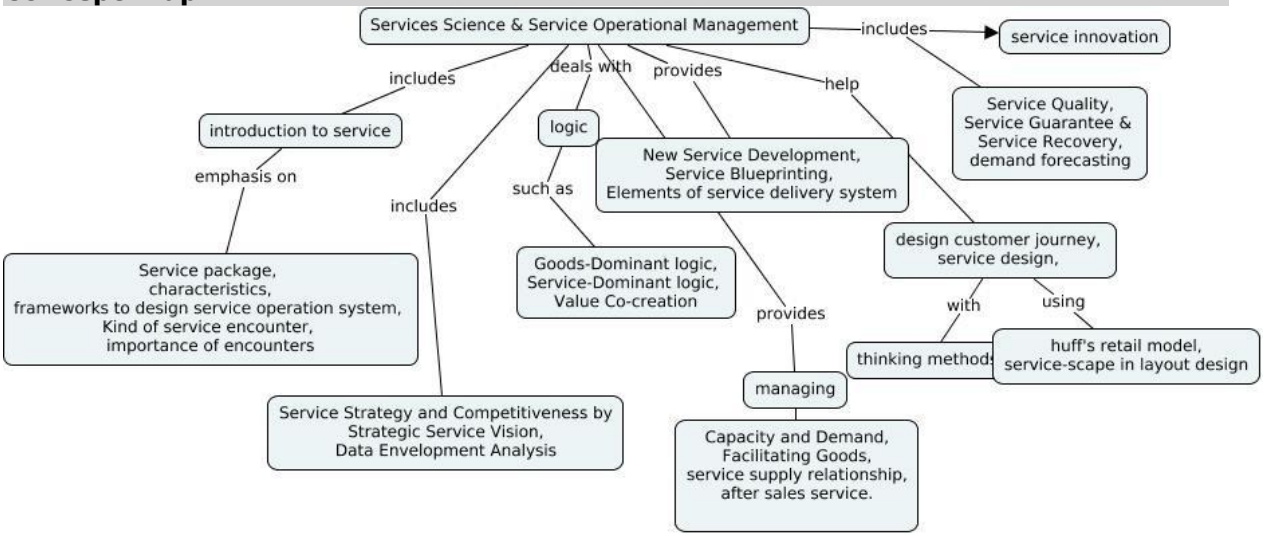
Course Outcome 6(CO6):

1. Sunset Airlines is reviewing its check-in procedures in anticipation of its "two for the price of one" fare promotion. Presently, a single clerk spends an average of 3 minutes per passenger checking luggage and issuing boarding passes. Service times have a negative exponential distribution, and passenger arrivals are Poisson distributed, with an anticipated mean of 15 per hour during flight operations. What is the probability that an arriving passenger will be served immediately without waiting?
2. Sea Dock, a private firm, operates an unloading facility in the Gulf of Mexico for super tankers delivering crude oil for refineries in the Port Arthur area of Texas. Records show that, on average, 2 tankers arrive per day, with a Poisson distribution. Super tankers are unloaded one at a time on a first-come, first-served (FCFS) basis. Unloading requires approximately 8 hours of a 24-hour working day, and unloading times have a negative exponential distribution.
    a. Sea Dock has provided mooring space for 3 tankers. Is this sufficient to meet the U.S. Coast Guard requirement that at least 19 of 20 arrivals should find mooring space available?
    b. Sea Dock can increase its unloading capacity to a rate of 4 ships per day through additional labour at a cost of $480 per day. Considering the

$1,000- per-day demurrage fee charged to Sea Dock for keeping a super tanker idle (this includes unloading time as well as time spent waiting in queue), should management consider this expansion opportunity?

3. A resort hotel is planning to install a computerized inventory system to manage the complementary guest toilet items such as soap and shampoo. The daily usage rate for bars of soap appears to be distributed normally, with mean 16 and standard deviation 3. Once an order is placed, it takes a full week before delivery is made.
   The effort to place an order and receive the shipment is approximately one hour's time for a staff person who is paid $10 per hour. The opportunity cost of capital is 20 percent per year. A bar of soap is valued at approximately $0.25. The hotel is
   concerned about stockouts of such a basic item and, thus, desires a 94 percent service level. Recommend an order quantity (*Q*) and reorder point (*r*) for a continuous review system.

Concept Map



Syllabus

Introduction: Introduction to service operations, Role of service in economy and society, Introduction to Indian service sector. Nature of Services and Service Encounters: Differences between services and operations, Service package, characteristics, various frameworks to design service operation system, Kind of service encounter, importance of encounters

Service-Dominant Logic: From Goods- Dominant logic to Service-Dominant logic, Value Co-creation. Service Strategy and Competitiveness: Development of Strategic Service Vision (SSV), Data Envelopment Analysis

New Service Development: NSD cycle, Service Blueprinting, Elements of service delivery system.

Service Design: Customer Journey and Service Design, Design Thinking methods to aid Service Design. Locating facilities and designing their layout: models of facility locations (Huff's retail model), Role of service- scape in layout design. Service Quality: SERVQUAL, Walk through Audit, Dimensions of Service quality & other quality tools

Service Guarantee & Service Recovery: Provide Service guarantee and recover from Service failure. Forecasting Demand for Services: A review of different types of forecasting methods for demand forecasting. Managing Capacity and Demand: Strategies for matc hing capacity and demand, Psychology of waiting, Application of various tools used in managing waiting line in services. Managing Facilitating Goods: Review of inventory models, Role of inventory in services. Managing service supply relationship: Understanding the supply chain/hub of service, Strategies for managing suppliers of service. Vehicle Routing Problem: Managing after sales service, Understanding services that involve transportation of people and vehicle, Techniques for optimizing vehicle routes

Service Innovation: Services Productivity, Need for Services Innovation.

Case Study:

Case 1: Choose any service organization around and present it from the perspective of: nature of service, classification of service, blueprint or service design analysis, service quality, and any additional perspective you would like to add.

Case 2: Choose any latest research paper in services and explain your understanding and feedback on the same.

Learning Resources

TEXTBOOK:

1. Fitzsimmons & Fitzsimmons, Service Management: Operations, Strategy, Informat ion Technology, Mc Graw Hill publications,7th edition,2019.

REFERENCE BOOK:

1. Reason, Ben, and Lovlie, Lavrans, Service Design for Business: A Practical Guide to Optimizing the Customer Experience, Pan Mac millan India, 2016.
2. Wilson, A., Zeithaml, V. A., Bitner, M. J., & Gremler, D. D. *Services marketing: Integrating customer focus across the firm*. Mc Graw Hill,2012
3. Lovelock, C.*Services Marketing, 7/e*. Pearson Education India,2011
4. Chesbrough. H, Open services innovation: Rethinking your business to grow and compete in a new era. John Wiley & Sons, 2010.

Course Contents and Lecture Schedule

Modul e No.	Topic	No. of Hours	Course Outcome
1	**Introduction**		
1.1	Introduction to the course, Introduction to service operations	1	CO1
1.2	Role of service in economy and society, Introduction to Indian service sector	2	CO1
1.3	**Nature of Services and Service Encounters:** Differences between services and operations, Service package, characteristics	2	CO1
1.4	various frameworks to design service operation system, Kind of service encounter, importanc e of encounters	1	CO1
2	**Service-Dominant Logic:**		
2.1	From Goods-Domina nt logic to Service-Domina nt logic, Value Co-creation	2	CO2

2.2	**Service Strategy and Competitiveness:** Development of Strategic Service Vision (SSV)	2	CO2
2.3	Data Envelopment Analysis	1	CO2
3	**New Service Development**:		
3.1	NSD cycle	2	CO3
3.2	Service Blueprinting	2	CO3
3.3	Elements of service delivery system	1	CO3
4	**Service Design:**		
4.1	Customer Journey and Service Design	1	CO4
4.2	Design Thinking methods to aid Service Design	1	CO4
4.3	**Locating facilities and designing their layout:** models of facility locations (Huff's retail model)	2	CO4
4.4	Role of service-scape in layout design	1	CO4
4.5	**Service Quality:** SERVQUAL, Walk through Audit	1	CO4
4.6	Dimensions of Service quality & other quality tools	1	CO4
5	**Service Guarantee & Service Recovery:**		
5.1	Provide Service guarantee and recover from Service failure	1	CO5
5.2	**Forecasting Demand for Services**: A review of different types of forecasting methods for dema nd forecasting.	1	CO5
5.3	**Managing Capacity and Demand**: Strategies for matching capacity and demand, Psychology of waiting	1	CO5
5.4	Application of various tools used in managing waiting line in services.	1	CO5
5.5	**Managing Facilitating Goods**: Review of inventory models, Role of inventory in services	1	CO5
5.6	**Managing service supply relationship:** Understanding the supply chain/hub of service, Strategies for managing suppliers of service	1	CO5
5.7	**Vehicle Routing Problem:** Managing after sales service, Understanding services that involve transportation of people and vehicle	2	CO5
5.8	Techniques for optimizing vehicle routes	1	CO5
6	**Service Innovation:**		
6.1	Services Productivity, Need for Services Innovation	1	CO6
6.2	**Case Study:** **CASE 1:** Choose any service organization around and present it from the perspective of: nature of service, classification of service, blueprint or service design analysis, service quality, and any additional perspective you would like to add. **CASE 2:** Choose any latest research paper in services and explain your understanding and feedback on the same.	3	CO6
	TOTAL	**36**	

Course Designers:

1. Subhashni.R rsica@tce.edu

21CB721	IT WORKSHOP

Category	L	T	P	Credit	**Terminal Exam Type**
ES	2	0	2	3	Theory

Preamble

This course enables the students to become familiar with the MATLAB/SCILAB software that helps them to solve application problems. It integrates computation, visualization and programming environment. It helps the students to conduct numeric al experiments and to tackle realistic and more complicated mathematical problems.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Explain the fundamental features of MATLAB for problem solving.	10
CO2	Perform the basic mathematical operations as well as matrix generation and array representations.	15
CO3	Draw the graphs, plot multiple data, perform line styles and change colors using the plotting features.	20
CO4	Develop scripting programs to build an interactive computational environment.	20
CO5	Demonstrate control flow and operators using loops and structures.	20
CO6	Solve the problems by debugging the code interactively in M-files.	15

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framewo

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond		1.2,2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3
CO2	TPS2	Understand	Respond		1.2,2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3
CO3	TPS3	Apply	Value		1.2,2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3
CO4	TPS3	Apply	Value		1.2,2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3
CO5	TPS3	Apply	Value		1.2,2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3
CO6	TPS3	Apply	Value		1.2,2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L	L	L		L		L		L	L	L	L	L
CO2	M	L	L	L		L		L		L	L	L	L	L
CO3	S	M	L	L		L		L		L	L	M	L	L
CO4	S	M	L	L		L		L		L	L	M	L	L
CO5	S	M	L	L		L		L		L	L	M	L	L
CO6	S	M	L	L		L		L		L	L	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Test		Model Examination	Terminal Examination
	I	II		
Remember	40	20		20
Understand	40	20		30
Apply	20	60	100	50
Analyse				
Evaluate				
Create				

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject /Practical Component/Observation
Perception	
Set	
Guided Response	
Mechanism	
Complex Overt Responses	
Adaptation	
Origination	

Sample Questions for Course Outcome Assessment**

Course Outcome 1(CO1):

1. Write fundamental programs in MATLAB, creating variables and mathematical functions.
2. Brief about the history of MATLAB its strengths and weaknesses.
3. Find the precedence of operators and perform basic algebraic operations.

Course Outcome 2(CO2):

1. Write a program to perform matrix operations and array operations
2. Write a program to solve the system of linear equations.
3. Perform SVD for the given data.

Course Outcome 3(CO3):

1. Program the fundamentals concepts of basic Plotting consisting of simple and multiple data sets in one plot.
2. Write a program to plot the function sin (x) on the interval [0, 2π].
3. Plot three related functions of x: y1 = 2 cos(x), y2 = cos(x), and y3 = 0.5 ∗ cos(x), in the interval $0 \leq x \leq 2\pi$.

Course Outcome 4(CO4):

1. Write a program to perform Input –output Arguments in M-Scirpt files using functions.
2. Write a function file that converts temperature in degrees Fahrenheit (◦F) to degrees Centigrade (◦C). Use input and fprintf commands to display a mix of text and numbers . Recall the conversion formulation, C = 5/9 ∗ (F − 32).
3. Write a user- defined MATLAB function, with two input and two output arguments that determines the height in centimeters (c m) and mass in kilogra ms (kg)of a person from his height in inches (in.) and weight in pounds (lb). (a) Determine in SI units the height and mass of a 5 ft.15 in. person who weight 180 lb. (b) Determine your own height and weight in SI unit

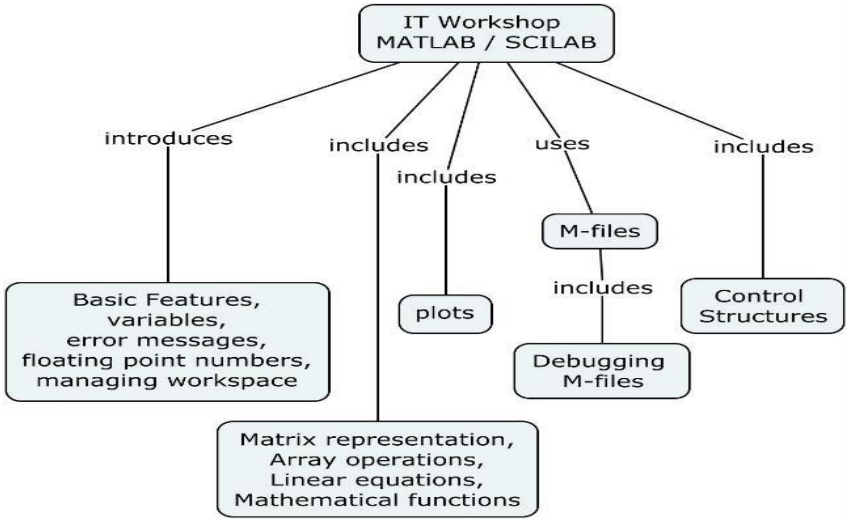
Course Outcome 5(CO5):

1. Write a program to find the quadratic roots
2. Develop a matlab coding for solving simultaneous equations consisting of three variables and there by finding the variables.
3. Explain the control structures that cause specific group of instructions to be repeated for a fixed no of times or until the specified condition is met.

Course Outcome 6(CO6):

1. Explain the debugging process.
2. Create breakpoints and test with a help of a simple MATLAB program
3. What is the use the debugging process and debugging M-files.

Concept Map



Syllabus

Introduction to MATLAB

History, basic features, strengths and weaknesses, good programming practices and plan your code *Working with variables, workspace and miscellaneous commands:* Creating MATLAB variables, overwriting variable, error messages, making corrections, controlling the hierarchy of operations or precedence, controlling the appearance of floating point number, managing the workspace, keeping track of your work session, entering multiple statements per line, miscellaneous commands.

Matrix, array and basic mathematical functions

Matrix generation, entering a vector, entering a matrix, matrix indexing, colon operator, linear spacing, creating a sub-matrix, dimension, matrix operations and functions matrix generators, special matrices, array and array operations, solving linear equations, other mathematical functions.

Basic plotting

Overview, creating simple plots, adding titles, axis labels, and annotations, multiple data sets in one plot, specifying line styles and colours.

Introduction to programming

Introduction, M- File Scripts, script side-effects, M-File functions, anatomy of a M-File function, input and output arguments, input to a script file, output commands

Control flow and operators

``if ... end'' structure, relational and logical operators, ``for ... end'' loop, ``while ... end'' loop, other flow structures, operator precedence, saving output to a file

Debugging M-files

Debugging process, preparing for debugging, setting breakpoints, running with breakpoints, examining values, correcting and ending debugging, correcting an M-file

Learning Resources

Text Books:

1. 'Digital Image Processing using MATLAB', Rafael C. Gonzalez, Richard E. Woods, Steven Eddins, McGraw Hill Education; 2nd edition, 2017.
2. 'MATLAB: A Practical Introduction to Programming and Problem Solving', Stormy Attaway, Butterworth-Heinemann; 5th edition, 2018.

Reference Link:

1. Experiments with MATLAB, Cleve Moler, 2011, https://www.mathworks.com/content/dam/mathworks/mathworks-dot-com/moler/exm/book.pdf

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1	**Introduction to MATLAB**		
1.1	History, basic features, strengths and weaknesses, good programming practices and plan your code *Working with variables, workspace and miscellaneous commands:* Creating MATLAB variables, overwriting variable	1	CO1
1.2	Error messages, making corrections, controlling the hierarchy of operations or precedence, controlling the appearance of floating point number	1	CO1
1.3	Managing the workspace, keeping track of your work session, entering multiple statements per line, miscellaneous commands,	1	CO1
2	**Matrix, array and basic mathematical functions**		
2.1	Matrix generation, entering a vector, entering a matrix, matrix indexing, colon operator, linear spacing	1	CO2
2.2	creating a sub-matrix, dimension, matrix operations	1	CO2
2.3	functions matrix generators, special matrices, array and array operations	1	CO2
2.4	solving linear equations, other mathematical functions.	1	CO2
3	**Basic plotting**		
3.1	Overview, creating simple plots, adding titles, axis labels, and annotations	2	CO3
3.2	multiple data sets in one plot, specifying line styles and colours	2	CO3
4	**Introduction to programming**		
4.1	Introduction, M-File Scripts, script side-effects	1	CO4

4.2	M-File functions,	1	CO4
4.3	anatomy of a M-File function, input and output arguments,	2	CO4
4.4	input to a script file, output commands	1	CO4
5	**Control flow and operators**		
5.1	``if ... end'' structure, relational and logical operators,	2	CO5
5.2	``for ... end'' loop, ``while ... end'' loop,	1	CO5
5.3	other flow structures, operator precedence, saving output to a file	2	CO5
6	**Debugging M-files**		
6.1	Debugging process, preparing for debugging	1	CO6
6.2	setting breakpoints, running with breakpoints	1	CO6
6.3	examining values, correcting and ending debugging, correcting an M-file	1	CO6
	TOTAL	**24**	

Expt. No.	**Laboratory Exercises**	**No. of hours**	**Course Outcome**
1	Introduction to MATLAB: Programs using mathematical and relational expressions and the operators.	2	CO1
2	Introduction to MATLAB Programming: Programs on input and output.	2	CO1
3	Vectors and Matrices: Programs using array operations and matrix operations (such as matrix multiplication).	2	CO2
4	Data Structures: Cell Arrays and Structures: Experiments based on two main data structures: cell arrays and structures	2	CO2
5	Visualization by plotting data and adding features	2	CO3
6	Experiments based on Advanced Plotting Techniques.	2	CO3
7	MATLAB Programs: More experiments based on scripts and user-defined functions	2	CO4
8	Experiments based on Advanced Functions.	2	CO4
9	Selection Statements: Experiments on if statements, with else and elseif clauses and switch statements.	2	CO5
10	Loop Statements and Vectorizing Code: Programs based on the concepts of counted (for) and conditional (while) loops.	2	CO5
11	Experiments based on Debugging and breakpoints	2	CO6
12	Examining the M-files	2	CO6
	SUBTOTAL	**24**	
	TOTAL	**48**	

Course Designer:

1. Mrs. J. Felicia Lilian jflcse@tce.edu

CURRICULUM AND DETAILED SYLLABI

FOR

B.TECH DEGREE (Computer Science and Business Systems) PROGRAMME

PROGRAMME ELECTIVES

FOR THE STUDENTS ADMITTED FROM THE

ACADEMIC YEAR 2025 – 2026 ONWARDS

THIAGARAJAR COLLEGE OF ENGINEERING

(A Government Aided ISO 9001-2008 Certified

Autonomous Institution affiliated to Anna University)

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B.Tech Degree (Computer Science and Business systems) Programme

PROGRAMME ELECTIVES

(For the candidates admitted from 2025 – 2026 onwards)

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	No. of Hours / Week			Credits
				L	T	P	
THEORY CUM PRACTICAL COURSES							
1	21CBPB1	Cloud, Microservices & Application	PSE	2	0	2	3
2	21CBPC1	Machine Learning	PSE	2	0	2	3
3	21CBPD1	Modern Web Applications	PSE	3	0	2	4

L : Lecture
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				Continuous Assessment	Terminal Exam *	Max. Marks	Terminal Exam	Total
THEORY								
1	21CBPB1	Cloud, Microservices & Application	3	50	50	100	25	50
2	21CBPC1	Machine Learning	3	50	50	100	25	50
3	21CBPD1	Modern Web Applications	3	50	50	100	25	50

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Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	No.of Hours / Week			Credits
				L	T	P	
THEORY COURSES							
1	21CBPE1	Data Mining and Analytics	PSE	3	1	0	4
THEORY CUM PRACTICAL COURSES							
2	21CBPF2	IoT System Design	PEES	2	0	2	3

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				Continuous Assessment	Terminal Exam *	Max. Marks	Terminal Exam	Total
THEORY								
1	21CBPE1	Data Mining and Analytics	3	40	60	100	27	50
THEORY CUM PRACTICAL COURSES								
2	21CBPF2	IoT System Design	3	50	50	100	25	50

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Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	No.of Hours / Week			Credits
				L	T	P	
THEORY COURSES							
1	21CBPG1	Financial Management	PSE	2	0	0	2
2	21CBPH1	Human Resource Management	PSE	2	0	0	2
3	21CBPJ1	IT Project Management	PSE	3	1	0	4
4	21CBPK1	Large scale systems	PSE	3	0	0	3
5	21CBPL1	Big Data Analytics	PSE	3	0	0	3
6	21CBPM1	Cloud and Distributed Systems	PSE	3	0	0	3
7	21CBRA1	Usability Design of software Applications	PEES	3	0	0	3
8	21CBRB1	Image Processing and Pattern Recognition	PEES	3	1	0	4
9	21CBRC1	Data Visualization	PEES	3	0	0	3
10	21CBRD1	Logistics Management	PEES	3	0	0	3
11	21CBQA1	Data Mining for Business Intelligence	PEES	3	0	0	3

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				Continuous Assessment	Terminal Exam *	Max. Marks	Terminal Exam	Total
THEORY								
1	21CBPG1	Financial Management	3	40	60	100	27	50
2	21CBPH1	Human Resource Management	3	40	60	100	27	50
3	21CBPJ1	IT Project Management	3	40	60	100	27	50
4	21CBPK1	Large scale systems	3	40	60	100	27	50
5	21CBPL1	Big Data Analytics	3	40	60	100	27	50
6	21CBPM1	Cloud and Distributed Systems	3	40	60	100	27	50
7	21CBRA1	Usability Design of software Applications	3	40	60	100	27	50
8	21CBRB1	Image Processing and Pattern Recognition	3	40	60	100	27	50
9	21CBRC1	Data Visualization	3	40	60	100	27	50
10	21CBRD1	Logistics Management	3	40	60	100	27	50
11	21CBQA1	Data Mining for Business Intelligence	3	40	60	100	27	50

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				L	T	P	
THEORY CUM PRACTICAL COURSES							
1	21CBPN1	Conversational systems	PSE	2	0	2	3
THEORY COURSES							
2	21CBPP1	Computational Finance & Modeling	PSE	4	0	0	4
3	21CBPQ1	Industrial Robots	PSE	3	0	0	3
4	21CBPR1	Enterprise Systems	PSE	3	0	0	3
5	21CBPS1	Corporate Finance	PSE	4	0	0	4
6	21CBPU1	Cryptology	PSE	3	1	0	4
7	21CBPV1	Quantum computation and Quantum information	PSE	3	0	0	3
8	21CBPW1	Social, Text and Media Analytics	PSE	2	1	0	3
9	21CBPY1	Mobile computing	PSE	3	0	0	3
10	21CBPZ1	Principles of Cyber Physical System	PSE	3	0	0	3
11	21CBSA1	Cyber Security Essentials	PSE	3	0	0	3
12	21CBSB1	Data Center Virtualization	PSE	3	0	0	3
13	21CBSC1	Ethical Hacking	PSE	3	0	0	3
14	21CBQB1	Statistics for Management	PSE	3	0	0	3
15	21CBQC1	Supply Chain Analytics	PSE	3	0	0	3
16	21CBRE1	Behavioral Economics	PEES	4	0	0	4
17	21CBRF1	Industrial Psychology	PEES	4	0	0	4
18	21CBRG1	Cognitive science and analytics	PEES	3	0	0	3
19	21CBRH1	Predictive Analytics	PEES	3	0	0	3
20	21CBRJ1	Deep Learning	PEES	2	1	0	3
21	21CBRK1	Cloud Storage Infrastructures	PEES	3	0	0	3

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				Continuous Assessment	Terminal Exam *	Max. Marks	Terminal Exam	Total
THEORY CUM PRACTICAL COURSES								
1	21CBPN1	Conversational systems	3	50	50	100	22.5	50
THEORY COURSES								
2	21CBPP1	Computational Finance & Modeling	3	40	60	100	27	50
3	21CBPQ1	Industrial Robots	3	40	60	100	27	50
4	21CBPR1	Enterprise Systems	3	40	60	100	27	50
5	21CBPS1	Corporate Finance	3	40	60	100	27	50
6	21CBPU1	Cryptology	3	40	60	100	27	50
7	21CBPV1	Quantum computation and Quantum information	3	40	60	100	27	50
8	21CBPW1	Social, Text and Media Analytics	3	40	60	100	27	50
9	21CBPY1	Mobile computing	3	40	60	100	27	50
10	21CBPZ1	Principles of Cyber Physical System	3	40	60	100	27	50
11	21CBSA1	Cyber Security Essentials	3	40	60	100	27	50
12	21CBSB1	Data Center Virtualization	3	40	60	100	27	50
13	21CBSC1	Ethical Hacking	3	40	60	100	27	50
14	21CBQB1	Statistics for Management	3	40	60	100	27	50
15	21CBQC1	Supply Chain Analytics	3	40	60	100	27	50
16	21CBRE1	Behavioral Economics	3	40	60	100	27	50
17	21CBRF1	Industrial Psychology	3	40	60	100	27	50
18	21CBRG1	Cognitive science and analytics	3	40	60	100	27	50
19	21CBRH1	Predictive Analytics	3	40	60	100	27	50
20	21CBRJ1	Deep Learning	3	40	60	100	27	50
21	21CBRK1	Cloud Storage Infrastructures	3	40	60	100	27	50

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S. No	COURSE CODE	COURSE TITLE	CATEGORY	No.of Hours / Week			Credits
				L	T	P	
THEORY COURSES							
1	21CBSD1	Cloud Security	PSE	3	0	0	3
2	21CBSE1	Fog and Edge Computing	PSE	3	0	0	3
3	21CBSF1	Supply Chain Information Systems	PSE	3	0	0	3
4	21CBSG1	Digitalization in Logistics and Supply Chain	PSE	3	0	0	3
5	21CBSH1	Intelligent Supply Chain Strategies	PSE	3	0	0	3
6	21CBRL1	Blockchain Technology	PEES	3	0	0	3
7	21CBRM1	Mobile Cyber Physical System	PEES	3	0	0	3
8	21CBRN1	Digital Twins in Logistics	PEES	3	0	0	3
9	21CBRP1	Graph Algorithms and Complexity Theory	PEES	3	0	0	3
10	21CBRQ1	Reinforcement Learning	PEES	3	0	0	3
11	21CBQD1	Human Resource Analytics	PSE	3	0	0	3
12	21CBQE1	Marketing and Social Media Web Analytics	PSE	3	0	0	3
13	21CBQF1	Financial Analytics	PSE	3	0	0	3

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B.Tech Degree (Computer Science and Business Systems) Programme

SCHEME OF EXAMINATIONS

(For the candidates admitted from 2025 – 2026 onwards)

PROGRAMME ELECTIVES

S.No.	Course Code	Name of the Course	Duration of Terminal Exam. in Hrs.	Marks			Minimum Marks for Pass	
				Continuous Assessment	Terminal Exam *	Max. Marks	Terminal Exam	Total
THEORY COURSES								
1	21CBSD1	Cloud Security	3	40	60	100	27	50
2	21CBSE1	Fog and Edge Computing	3	40	60	100	27	50
3	21CBSF1	Supply Chain Information Systems	3	40	60	100	27	50
4	21CBSG1	Digitalization in Logistics and Supply Chain	3	40	60	100	27	50
5	21CBSH1	Intelligent Supply Chain Strategies	3	40	60	100	27	50
6	21CBRL1	Blockchain Technology	3	40	60	100	27	50
7	21CBRM1	Mobile Cyber Physical System	3	40	60	100	27	50
8	21CBRN1	Digital Twins in Logistics	3	40	60	100	27	50
9	21CBRP1	Graph Algorithms and Complexity Theory	3	40	60	100	27	50
10	21CBRQ1	Reinforcement Learning	3	40	60	100	27	50
11	21CBQD1	Human Resource Analytics	3	40	60	100	27	50
12	21CBQE1	Marketing and Social Media Web Analytics	3	40	60	100	27	50
13	21CBQF1	Financial Analytics	3	40	60	100	27	50

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PROGRAMME ELECTIVES
(For the candidates admitted from 2025 – 2026 onwards)

S. No	COURSE CODE	COURSE TITLE	CATEGORY	No.of Hours / Week			Credits
				L	T	P	
THEORY COURSES							
1	21CBQG1	Fundamentals of Business Intelligence & Analytics	PSE	1	0	0	1
2	21CBQH1	Tools for Data Analytics	PSE	1	0	0	1

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S. No	COURSE CODE	COURSE TITLE	CATEGORY	No.of Hours / Week			Credits
				L	T	P	
THEORY COURSES							
1	21CBQJ1	Digital Business Transformation	PSE	3	0	0	3
2	21CBQK1	Applied Business Forecasting	PSE	3	0	0	3
	21CBQL1	Customer Analytics	PSE	3	0	0	3

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2 Hours Practical is equivalent to 1 credit

21CBPB1	Cloud, Microservices & Application

Category	L	T	P	Credit	Terminal Exam Type
PSE	2	0	2	3	Theory

Preamble

This course intends to introduce students to the fundamentals of developing application on cloud, specifically public clouds such as AWS, AZURE and Google. Apply Micro services principles to specific business requirements to build a scalable & performing solution.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Explain the key technologies of delivery and deployment models of cloud	15
CO2	Acquire the various cloud components to guide the applications of public cloud	15
CO3	Develop and design an application using various tools in cloud environment	20
CO4	Deploy the cloud micro services using native cloud tools	25
CO5	Maximize scalability in micro services-based applications using Devops	15
CO6	Analyze the issues of cloud such as security, monitoring etc	10

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond	-	1.2, 4.3.2
CO2	TPS3	Apply	Value	-	1.2, 2.1.2, 3.2.3, 4.5.3
CO3	TPS3	Apply	Value	-	1.2, 2.1.2, 3.2.3, 4.3.2
CO4	TPS3	Apply	Value	-	1.2, 2.1.2, 3.2.3, 4.5.3
CO5	TPS3	Apply	Value	-	1.2, 2.1.2, 3.2.3, 4.5.3
CO6	TPS3	Apply	Value	-	1.2, 2.1.2, 3.2.3, 4.5.3

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L										L		
CO2	S	M	L		M	L	L		L		L	M	L	L
CO3	S	M	L		M	L	L		L		L	M	L	L
CO4	S	M	L		M	L	L		L		L	M	L	L
CO5	S	M	L		S	L	L		L		L	M	L	L
CO6	S	M	L		M	L	L		L		L	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive levels	Continuous Assessment Tests		Practical	Terminal examination
	1	2		
Remember	10	10		10
Understand	30	30		30
Apply	60	60	100	60
Analyse				
Evaluate				
Create				

Sample Questions for Course Outcome Assessment**

Course Outcome 1(CO1):

1. Name the essential characteristics of cloud computing.
2. Elaborate the most important advantages of cloud technologies for social networking application
3. Explain in detail about cloud service models.

Course Outcome 2(CO2):

1. Explain the services provided by the Amazon infrastructure cloud from a user perspective.
2. How to deploy a web application in a Google App Engine? Explain.
3. Give an overview of Open Stack Services.

Course Outcome 3(CO3):

1. Identify when to use cloud application and explain how architecture affects the performance.
2. Deploy cloud application with user interface that to be used on a smart phone.
3. Adapt suitable data component for E-Governance applications.
4. Design an interface for rural development system using suitable cloud platform.

Course Outcome 4 (CO4):

1. Assume that a company ABC wants to offer services such as starting a policy and payment of policy on a service oriented architecture over the cloud. Explain the implementation details of this scenario.
2. Consider online shop with separate micro services for user-accounts, product-catalogue order-processing and shopping carts, setting up micro services system using spring boot and spring cloud.
3. To compare and contrast micro service implementations. Setting up micro services for NETFLIX play lists using spring boot.

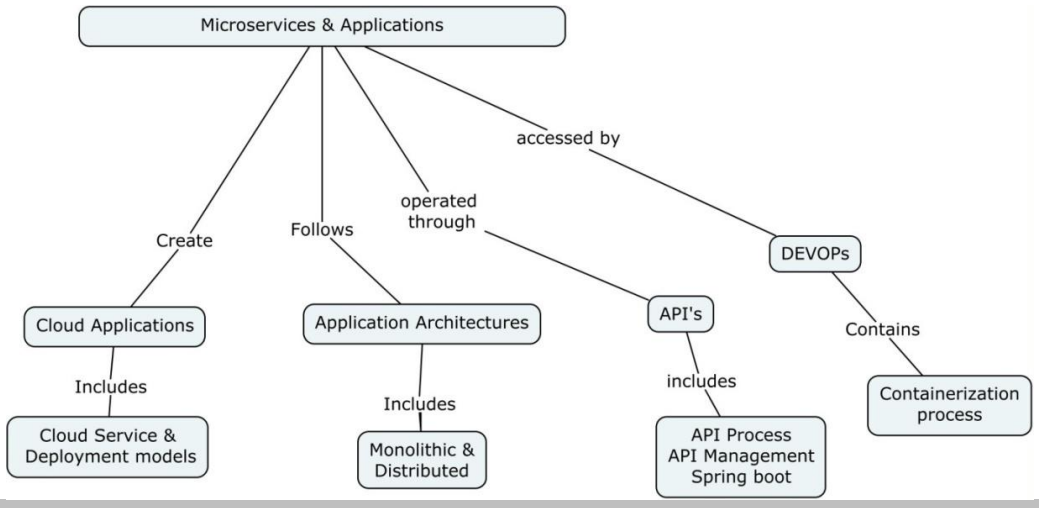
Course Outcome 5 (CO5):

1. Explain with a use case where DevOps can be used in industry / real life.
2. Explain the use of Git commands. In Git, how do you revert a commit that has already been pushed and made public?
3. Explain your understanding and expertise on both the software development side and the technical operations side of an organization you have worked with in the past?

Course Outcome 6(CO6):

1. Analyze the various cloud computing tools to improve security through automation.
2. Explain IBM application services for cloud security.
3. How to secure your data for transport in cloud?

Concept Map



Syllabus

Cloud Fundamentals: Introduction, Cloud Service Components, Cloud Service / Deployment models, Application of Cloud computing

Cloud components: Guiding Principle with respect to utilization, security, pricing and the applications of cloud, public cloud platforms overview and their usage
Application Architectures: Monolithic & distributed, Micro service fundamental and design approach, Cloud native applications – 12 Factors App
Application Integration process, Apification process, API fundamental, Micro service, API management, Spring boot, fundamental and design of micro service, API tools, Developer portal, Applications of micro services and APIFICATION.
Devops: Fundamentals, Tools and applications, containerization process and application.
Advanced topics: Python refresher, use cases, cloud security and monitoring tools
Laboratory:

- Choose a real life example of Business application that you have used and apply these technologies and concepts to solution it.
- Cloud Architecture Design
- Microservice Architecture Design
- API development use case and deployment
- Microservice development and deployment
- Devops tools usages for automation in development / Testing / Deployment
- AWS features use cases – ex, Lambda Functions
- Azure features use cases
- GCP Features use cases
- Creating an API and API Documentation
- Cloud scaling

Learning Resources

1. Rittinghouse, John W., and James F. Ransome, "Cloud Computing: Implementation, Management and Security", CRC Press, 2017.
2. Rajkumar Buyya, Christian Vecchiola, S. ThamaraiSelvi, "Mastering Cloud Computing", Tata Mcgraw Hill, 2013.
3. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing - A Practical Approach", Tata Mcgraw Hill, 2009.Online courses
4. https://onlinecourses.nptel.ac.in › noc21_cs14 › preview

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Fundamentals (4)**		
1.1	Cloud fundamentals	1	CO1
1.2	Cloud service components	1	CO1
1.3	Cloud service / deployment models	1	CO1
1.4	Applications of cloud computing	1	CO1
2.	**Components of cloud (4)**		
2.1	Cloud components	1	CO2
2.2	Guiding Principle with respect to utilization	1	CO2
2.3	Guiding Principle with respect to security and pricing	1	CO2
2.3	Public Cloud Platforms overview and their usage	1	CO2
3.	**Cloud Architectures (5)**		
3.1	Application architectures	1	CO3
3.2	Monolithic & Distributed architecture	1	CO3
3.3	Micro service fundamentals and design approach	1	CO3
3.4	Cloud Native applications	1	CO3
3.5	12 Factors App	1	CO3
4.	**Application Integrated Process and Apification (6)**		
4.1	Application Integrated Process	1	CO4
4.2	Apification Process	1	CO4
4.3	API fundamentals	1	CO4
	Microservice, API management		
	Spring boot	1	

	fundamental and design of micro service		
4.4	API Tools	2	CO4
4.5	Developer portal		CO4
4.6	Applications of Micro service and APIFICATION		CO4
5.	**Devops (3)**		
5.1	Devops Fundamentals	1	CO5
5.2	Tools and applications	1	CO5
5.3	Containerization Process, Applications of Devops	1	CO5
6.	**Advanced topics (2)**		
6.1	Python – Refresher, use cases	1	CO6
6.2	Cloud security, Monitoring tools	1	CO6
		24	

Laboratory

Module No.	**Topic**	**No. of Hours**	**Course Outcome**
1	Cloud Architecture Design	2	CO2
2	Microservice Architecture Design	3	CO2
3	API development use case and deployment	2	CO3
4	Microservice development and deployment	2	CO2
5	Devops Tools usages for automation in development / Testing / Deployment	4	CO5
6	AWS features use cases	2	CO6
7	Azure features use cases	2	CO6
8	GCP Features use cases	2	CO3
9	Creating an API and API Documentation	3	CO4
10	Cloud scaling	2	CO4
		24	
	Total hours	**48**	

Course Designers:

1. Dr.A.Malini amcse@tce.edu
2. Mr.V.Janakiraman vjncse@tce.edu

21CBPC1	MACHINE LEARNING

Category	L	T	P	Credit	Terminal Exam Type
PSE	2	0	2	3	Theory

Preamble

This course introduces the fundamentals of machine learning to the students and it also enables them to understand the classification, regression and clustering algorithms to apply them to various real-time problems. The course also guides them in finding the correct evaluation metrics to quantify the efficiency of the algorithm.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Understand the basics of machine learning and their need using WEKA and R	10
CO2	Familiarize with various classification algorithms and evaluation metric to apply them for various problems	20
CO3	Interpret the significance of using Support Vector Machines and Hidden Markov Models	20
CO4	Apply the regression algorithms for various applications	15
CO5	Apply the association rule mining and expectation – maximization algorithms	15
CO6	Apply the clustering algorithms with clear understanding in detecting anomalies and outliers.	20

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond	-	1.1, 1.2, 1.3, 2.1.1
CO2	TPS3	Apply	Value	-	1.3, 2.1.1, 2.1.1, 2.1.2
CO3	TPS3	Apply	Value	-	1.3, 2.1.1, 2.1.2, 2.4.6, 4.5.1, 4.5.3
CO4	TPS3	Apply	Value	-	1.3, 2.1.1, 2.1.2, 2.4.6, 4.5.1, 4.5.3
CO5	TPS3	Apply	Value	-	1.3, 2.1.1, 2.1.2, 2.4.6, 4.5.1, 4.5.3
CO6	TPS3	Apply	Value	-	1.3, 2.1.1, 2.1.2, 2.4.6, 4.5.1, 4.5.3

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L	-	-	-	-	-	-	L	-	L	L	-	L
CO2	S	M	L	-	L	-	-	-	L	-	L	L	-	-
CO3	S	M	L	-	M	-	-	-	L	-	L	L	-	L
CO4	S	M	L	L	M	L	-	-	L	-	L	M	-	L
CO5	S	M	L	L	M	-	-	-	L	-	L	M	-	L
CO6	S	M	L	L	M	L	-	-	L	-	L	M	-	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Practical	Terminal Examination
	1	2		
Remember	20	20		20
Understand	40	40		20
Apply	40	40	100	60
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject /Assignment/Practical Component
Perception	-
Set	-
Guided Response	-
Mechanism	-
Complex Overt Responses	-
Adaptation	-
Origination	-

Sample Questions for Course Outcome Assessment**

** (2 to 3 at the cognitive level of course outcome)

Course Outcome 1(CO1):

1. Explain the terms in Machine Learning. Discuss why Machine Learning is important.
2. Discuss the issues in Machine Learning
3. "When the feature space is larger, overfitting is less likely", Justify the statement.

Course Outcome 2(CO2):

1. Define (i) Prior Probability (ii) Conditional Probability (iii) Posterior Probability. What are the relevance and features of Bayesian theorem? Explain the practical difficulties of the Bayesian theorem.
2. Explain Naïve Bayes Classifier with an Example.
3. List the issues in Decision Tree Learning. Interpret the algorithm with respect to overfitting the data

Course Outcome 3(CO3):

1. Explain the concept of Viterbi algorithm and its role using hidden markov model.
2. A hypothetical SVM model has the following values of lagrange multipliers α and support vectors: Suppose that the linear kernel is used. Compute the output y of this SVM model when the input feature vector is (0.3, 0.8, 0.6).

α	Support Vector	y
1	(1,-1,1)	+1
0.5	(0,2,-1)	-1
1	(-1,0,2)	-1

3. What are the basic problems in HMM? Derive the solutions to the problems using forward, viterbi, and baum-welch algorithms?

Course Outcome 4 (CO4):

1. The sales of the company for each year is shown below

X(year)	2018	2019	2020	2021
Y(sales improved in %)	12	19	30	35

   a) Find the regression line y = ax+b
   b) Predict the sales in 2020 based on the regression obtained.
2. In logistic regression, what do you mean by loss and prediction functions. Explain with the help of co-variance and posterior distribution functions.
3. Fit the logistic regression model for the given dataset {(-,1,-5)), (+,(5,-1)), (+,(3,3)), (+,(-1,5)), (-,(-5,2)), (-,(-2,-2))}

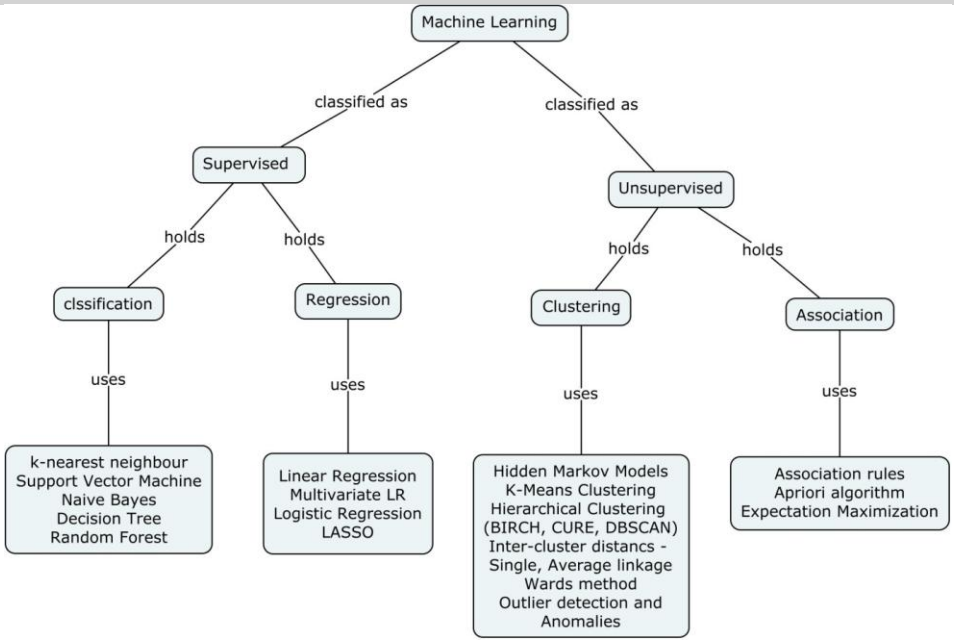
Course Outcome 5 (CO5):

1. What is the need of Association Rule Mining? Mention the roles of support and confidence in Association Rule Mining.
2. Now you want to learn your friend's transition model, based on this utterance. Zero pseudocounts. Since there's missing data, you must use the EM algorithm. Show the results of one step of the EM algorithm, where the previous question was the first E-step. So just do an M-step and show the resulting parameters. For this question, don't bother with START and END transitions. Use zero pseudocounts.
3. At first, you guess that your friend was generating words from this bigram LM: p(hi|hi) = 0.7 p(yo|hi) = 0.3 p(hi|yo) = 0.5 p(yo|yo) = 0.5 Given these parameters, what is the posterior probability of whether the missing word is "hi" or "yo"?

Course Outcome 6(CO6):

1. We are given the following four data points in two dimension: X1 = (2, 2), X2 = (8, 6), X3 = (6, 8), X4 = (2, 4). We want to cluster the data points into two clusters C1 and C2 using the K-Means algorithm. Manhattan distance is used for clustering. To initialize the algorithm we consider C1 = {X1, X3}, and C2 = {X2, X4}. After two iteration of the K-Means algorithm, the cluster memberships are – C1={X1,X4} and C2={X2, X3}
2. We would like to cluster the natural numbers from 1 to 1024 into two clusters using hierarchical agglomerative clustering. We will use Euclidean distance as our distance measure. We break ties by merging the clusters in which the lowest natural number resides. For example, if the distance between clusters A and B is the same as the distance between clusters C and D, we would choose A and B as the next clusters to merge if min{A, B} < min{C, D} , where {A, B} are the set of natural numbers assigned to clusters A and B. For each of the clustering methods mentioned below, specify the number of elements assigned to each of the two clusters obtained by cutting the dendogram at the root for Single, Complete and Average Linkage
3. How is Entropy used as a Clustering Validation Measure?

Concept Map



Syllabus

Introduction to Machine Learning (ML); Relationship between ML and human learning; A quick survey of major models of how machines learn; Example applications of ML. Introduction to WEKA and R. **Classification**: Supervised Learning; Feature engineering; Training and testing classifier models; Cross-validation; Model evaluation (precision, recall, F1-mesure, accuracy, area under curve); Statistical decision theory; Naive Bayes classification; Bayesian networks; Decision Tree and Random Forests; k-Nearest neighbor classification; **Support Vector Machines**; Artificial neural networks including backpropagation; Applications of classifications; Ensembles of classifiers including bagging and boosting. **Hidden Markov Models (HMM)** with Viterbi algorithms; Sequence classification; Conditional random fields; **Regression**: Multi-variable regression; Model evaluation; Least squares regression; Regularization; LASSO; Applications of regression. **Association rule mining** algorithms including apriori. Expectation-Maximization(EM) algorithm for unsupervised learning. **Clustering**: average linkage; Ward's algorithm; Minimum spanning tree clustering; K-nearest neighbors clustering; BIRCH; CURE; DBSCAN Anomaly and outlier detection methods.

Lab Sessions:

(1) Introduction to WEKA and R
(2) Classification of some public domain datasets in UCI ML repository

Mini projects in the Lab:

(1) Implementation of one clustering algorithm
(2) Implementation of one anomaly detection algorithms
(3) Implementation of EM algorithm for some specific problem

Learning Resources

Text Books:

1. R.O. Duda, P.E. Hart, D.G. Stork, Pattern Classification, 2/e, Wiley, 2001.
2. C. Bishop, Pattern Recognition and Machine Learning, Springer, 2007.
3. E. Alpaydin, Introduction to Machine Learning, 3/e, Prentice-Hall, 2014.
4. A. Rostamizadeh, A. Talwalkar, M. Mohri, Foundations of Machine Learning, MIT Press.
5. Webb, Statistical Pattern Recognition, 3/e, Wiley, 2011

Course Contents and Lecture Schedule

THEORY COMPONENT			
Module No.	**Topic**	**No. of Hours**	**Course Outcome**
1.	**Introduction to Machine Learning**		
1.1	Relationship between ML and human learning	1	CO1
1.2	Example applications of ML	1	CO1
1.3	Introduction to WEKA and R	1	CO1
2.	**Classification**		
2.1	Supervised Learning: Feature engineering; Training and testing classifier models	1	CO2
2.3	Cross-validation; Model evaluation (precision, recall, F1-mesure, accuracy, area under curve)	1	CO2
2.4	Statistical decision; Naive Bayes classification; Bayesian networks	1	CO2
2.6	Decision Tree and Random Forests; k-Nearest neighbor classification	1	CO2
3	**Support Vector Machines**		
3.1	Artificial neural networks including backpropagation	1	CO3
3.2	Applications of classifications; Ensembles of classifiers including bagging and boosting	1	CO3
3.3	**Hidden Markov Models** (HMM) with Viterbi algorithms	2	CO3
3.4	Sequence classification using HMM; Conditional random	1	CO3

	fields		
4	**Regression**		
4.1	Multi-variable regression	1	CO4
4.2	Model evaluation; Least squares regression	1	CO4
4.3	Regularization; LASSO; Applications of regression	1	CO4
5	**Association rule mining**		
5.1	Association rule mining algorithms including apriori	3	CO5
5.2	Expectation-Maximization (EM) algorithm for unsupervised learning	2	CO5
6	**Clustering**		
6.1	average linkage; Ward's algorithm	1	CO6
6.2	Minimum spanning tree clustering; K-nearest neighbors clustering	1	CO6
6.3	BIRCH; CURE; DBSCAN Anomaly and outlier detection methods	2	CO6
	TOTAL	**24**	

PRACTICAL COMPONENT

Module No.	Topic	No. of Hours	Course Outcome
1	Introduction to WEKA and R	**2**	CO1
2	Classification of some public domain datasets in UCI ML repository	**6**	CO2
3	Implementation of SVM	**4**	CO3
4	Implementation of regression algorithm	**4**	CO4
5	Implementation of EM algorithm for some specific problem	**2**	CO5
6	Implementation of Clustering algorithm	**4**	CO6
7	Implementation of anomaly detection algorithms	**2**	CO6
	TOTAL	**24**	
	TOTAL HOURS	**48**	

Course Designers:

1. Dr. P Chitra pccse@tce.edu
2. Mrs. J. Felicia Lilian jflcse@tce.edu

21CBPD1	MODERN WEB APPLICATIONS

Category	L	T	P	Credit	Terminal Exam Type
PSE	3	0	2	4	Theory

Preamble

This course covers the design, implementation, and testing of web-based applications including related software, database and interfaces. The students will learn about mark-up languages, scripting languages, interactive graphics and databases. It also covers social, ethical and security issues arising from the web and social software. The concepts will be illustrated with appropriate examples and tools.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage in %
CO1	Demonstrate the basic principles of web components and understand the standards required for the development of web environment.	10
CO2	Apply the design tools and styles to develop web pages using mark-up language HTML and CSS	15
CO3	Illustrate the scripting language and apply them to develop high quality dynamic web client application	20
CO4	Use the interchange language XML to develop web applications for distributed environment	15
CO5	Construct dynamic web pages by applying the validation and verification conditions using PHP	20
CO6	Apply server side languages using My-SQL & PHP platforms for manipulating data in a web application	20

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond	-	1.1,1.2,4.3.2
CO2	TPS3	Apply	Value	-	1.2, 2.1.1,2.1.2,3.2.3,4.3.2
CO3	TPS3	Apply	Value	-	1.2, 2.1.2, 3.2.3,4.3.2
CO4	TPS3	Apply	Value	-	1.2, 2.1.2, 3.2.3,4.5.3
CO5	TPS3	Apply	Value	-	1.2, 2.1.2,2.4.3,3.2.3,4.5.3
CO6	TPS3	Apply	Value	-	1.2, 2.1.2,2.4.6,3.2.3,4.5.3

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2	PSO3
CO1	M	L												
CO2	S	M	L		M	L		L	L		L	L	L	
CO3	S	M	L		M	L		L	L		L	L	L	
CO4	S	M	L		M	L		L	L		L	L	L	
CO5	S	M	L		S	L		L	L		L	L	L	
CO6	S	M	L		M	L		L	L		L	L	L	

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive levels	Continuous Assessment Tests		Practical	Terminal examination
	1	2		
Remember	20	20		20
Understand	40	40		20
Apply	40	40	100	60
Analyse				
Evaluate				
Create				

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject /Assignment/Practical Component
Perception	-
Set	-
Guided Response	-
Mechanism	-
Complex Overt Responses	-
Adaptation	-
Origination	-

Sample Questions for Course Outcome Assessment**

Course Outcome 1(CO1):

1. Explain web browser architecture.
2. List out the types of web pages.
3. List out the Characteristics of web applications

Course Outcome 2(CO2):

1. Create HTML forms for ticket booking system.
2. Write a CSS Rule to change colour of all elements containing attribute class = "green move" to green and shift them down to 25 pixels and right 15 pixels?
3. Write a HTML program to insert "India Map" and fix the hot spots in the map.

Course Outcome 3(CO3):

1. Write a client server application using JSP to get radius sent by browser and find area of circle
2. Develop three tier application for online registration of a course using JSP.
3. Develop client server application using JSP for calculating factorial of a number which is sent from client.
4. Write a Java Script to get input from the user in XHTML and convert to lowercase and uppercase?

Course Outcome 4 (CO4):

1. Write an XML and DTD for Storing Recipes.
2. Construct the book's XML document using cascading style sheets
3. Illustrate the principles of XSLT

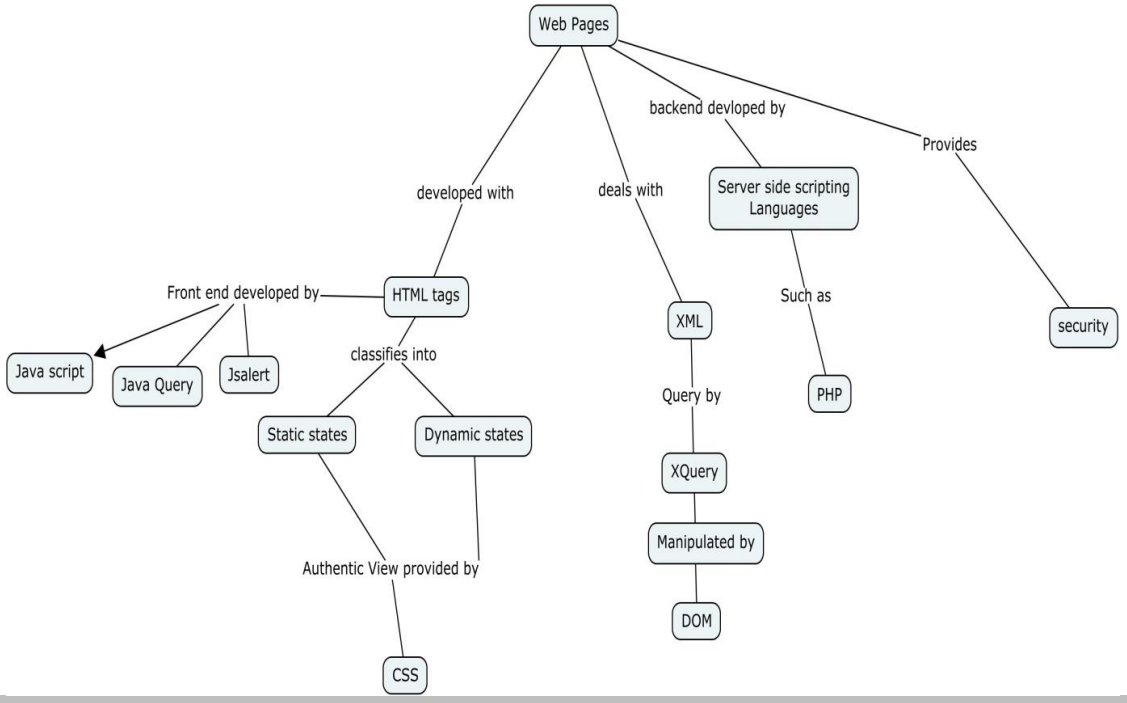
Course Outcome 5 (CO5):

1. Model the database for Employee Details System and do the following queries using PHP. a. Insert a new employee into the database.
   b. Delete the 2nd record for the particular employee.
   c. Make search provision.
   d. Provide view for the whole table.
2. Create dynamic web application for College Management system using PHP.
   a. Perform the following task by using jQuery UI
   b. Click Toggle colors
   c. Click Add a New Box
3. Write a PHP program to retrieve the HTML Form information by using POST command

Course Outcome 6(CO6):

1. Create cookie information to identify the visitors for the web pages.
2. Construct 2 user id's and password and write these to cookies. Read the information entered in the Login form and authenticate with the values (user id and passwords) available in the cookies and check the validity of the user.
3. Identify different types of attacks in web security.

Concept Map



Syllabus

Introduction to Internet & World Wide Web:−History of the Internet & World- Wide Web, Web Browsers, −Web Servers, Uniform Resource Locator, Tools and Web Programming Languages. Web Standards, Categories of Web Applications, Characteristics of Web Applications, Tiered Architecture

Hypertext Mark Up Language (HTML) Revision: Basic HTML page, Text Formatting, Table, Headers, Linking, Images, List, Meta Elements

Cascading Style Sheets (CSS) Revision: Inline, Internal and External Style Sheet, Bootstrap- CSS Text , CSS forms , CSS components drop down .

Java Script: Introduction to Java Scripts, Objects in Java Script, Dynamic HTML with Java Script, Bootstrap- JS Alert, JS Button, JS popover

Extensible Markup Language (XML): Introduction, Structuring Data, Document Type Definition, XML Vocabularies, Document Object Model DOM) with Java Script, Extensible Style sheet Language Transforms (XSL)

Writing Basic PHP Programs : Creating PHP Programs, Numbers and Strings, Literals and Variables, Operators and Functions

Form & PHP: Creating Form Controls, Using Values Returned From, Forms Using PHP

PHP Database Connectivity: Connecting to MySQL Server, Selecting Databases, Checking for Errors, Closing the MySQL Server Connection

Manipulating Data in MySQL Using PHP: Inserting, Viewing Updating and Deleting Records, Manipulating joined tables. **User Authentication:** Creating Session, Authorization Level

Learning Resources

1. Deitel P.J., Deitel H.M and Deitel A (2012) Internet and World wide web : How to program, fifth edition, Pearson Prentice Hall.
2. HTML & CSS: Design and Build Websites, Jon Duckett, John Wiley and sons.
3. Naramore E., Gerner J., Scouarnec Y.L., et al., (2005) Beginning PHP5, Apache, MySQL Web Development: Programmer to Programmer, John Wiley & Sons Inc.

4. SebestaR.W.(2014)ProgrammingtheWorldWideWeb,8thedition,Pearson.
5. PressmanR.andLoweD.(2008)Web Engineering: apractitioner's approach, FirstEdition, Mc GrawHill
6. Kappel G., et al. (2006) Web Engineering: The Discipline of systematic Development of Web Applications, First Edition, John Wiley & Sons.
7. SuhW.(2005) Web Engineering: Principles and Techniques, Idea GroupInc.
8. UllmanL (2016) PHP for the Web:Visual Quick Start Guide, Fifth Edition, Peach pit Press

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Introductionto Internet & World Wide Web (3)**		
1.1	History of the Internet & World- Wide Web, Web Browsers, Web Servers	2	CO1
1.2	Uniform Resource Locator, Tools and Web Programming Languages. Web Standards, Categories of Web Applications	1	CO1
1.3	Characteristics of Web Applications, Tiered Architecture	1	CO1
2	**Hypertext Mark Up Language (4)**		
2.1	Basic HTML page, Text Formatting, Table, Headers, Linking, Images, List, Meta Elements	2	CO2
3	**Cascading Style Sheets(CSS) Revision**		
3.1	Inline, Internal and External Style Sheet Bootstrap-CSS Text	2	CO2
3.2	CSS forms , CSS components drop down	1	CO2
4	**Java Script (3)**		
4.1	Introduction to Java Scripts, Objects in Java Script	2	CO3
4.2	Dynamic HTML with Java Script, Bootstrap- JS Alert	3	CO3
4.3	JS Button, JS popover	2	CO3
5	**Extensible Markup Language(XML) (3)**		
5.1	Introduction, Structuring Data	1	CO4
5.2	Document Type Definition, XML Vocabularies,	2	CO4
5.3	Document Object Model (DOM)with Java Script	2	CO4
5.4	Extensible Style sheet Language Transforms(XSL)		CO4
6	**Writing Basic PHP Programs, Form & PHP, PHP Database Connectivity (6)**		
6.1	Creating PHP Programs	2	CO5
6.2	Numbers and Strings		CO5
6.3	Literals and Variables	2	CO5
6.4	Operators and Functions		CO5
6.5	Creating Form Controls, Using Values Returned From, Forms Using PHP	2	CO5
6.6	Connecting to MySQL Server, Selecting Databases, Checking for Errors, Closing the MySQL Server Connection	2	CO5
7	**Manipulating Data in MySQL Using PHP, User Authentication (5)**		
7.1	Inserting, Viewing, Updating and Deleting Records,	3	CO6
7.2	Manipulating joined tables	2	CO6
7.3	Creating Session, Authorization Level	2	CO6
	Total	**36**	

Laboratory			
Module No.	**Topic**	**No. of Hours**	**Course Outcome**
1	Basic HTML tags and its use	2	CO1
2	Design the following static web pages for your application a) Home page b) Login Page c) Catalogue Page	2	CO2
3	Design the following static web pages for your application a) Cart page b) Registration page	2	CO2
4	Write a Java script to perform validation and verification of forms for your application	6	CO3
5	Develop an XML file by using all the XML components for the application that you have designed.	4	CO4
6	Write Program in PHP to demonstrate basics of PHP and convert all the previous forms that are developed for your application to PHP forms. Make sure that you establish database connection using MySQL.	2	CO5
7	Write a program in PHP to perform CRUD (Create, Insert, Update, Delete operations) and also design a page that can upload & display image in PHP	2	CO5
8	Write a PHP code to connect the database and extract data from the tables and display them.	2	CO6
9	Work on any case study.	2	CO6
	Total	24	
	Total Hours	**60**	

Course Designers:

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21CBPE1	DATA MINING AND ANALYTICS

Category	L	T	P	Credit	Terminal exam type
PSE	3	1	0	4	Theory

Preamble

The course provides an emphasis on data processing techniques, rule mining, classification, clustering and in the development of prediction models. It facilitates the student by interpreting the real world problems by examining with appropriate mining tools. Also provides an in-depth knowledge on managing, handling and analysing structured or unstructured data.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage in %
CO1	Describe the fundamental concepts of data mining	15
CO2	Apply appropriate data pre-processing techniques for the given dataset.	15
CO3	Interpret and apply data-mining techniques such as association rule mining, classification and prediction for given scenario.	20
CO4	Apply descriptive modelling using linear regression analysis and perform various tests using forecasting models for categorical data.	15
CO5	Implement linear and non linear model for solving real world data.	20
CO6	Apply time series analysis and prescriptive analytics methods for solving the real world problems	15

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond	-	1.2,2.3.1,2.3.2
CO2	TPS3	Apply	Value	Mechanism	1.2, 2.2, 2.3.1, 2.3.2, 3.1.4, 3.1.5
CO3	TPS3	Apply	Value	Mechanism	1.2, 2.3.1, 2.3.2, 2.3.3, 4.4.1, 4.5.3, 4.5.5
CO4	TPS4	Apply	Organize	Complex overt Responses	1.3,2.2.3,2.2.4
CO5	TPS4	Apply	Organize	Complex overt Responses	1.3,2.2.3,2.2.4
CO6	TPS3	Apply	Value	Mechanism	1.2, 2.3.1, 2.3.2, 2.3.3, 4.4.1, 4.5.3, 4.5.5

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	M	L											L		
CO2	S	M	L										M		
CO3	S	M	L		L							L	M	L	L
CO4	S	S	M	L	S	S		M	M			M	M	S	L
CO5	S	S	M	L	S	S		M	M			M	M	S	L
CO6	S	M	L		L							L	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive levels	Continuous Assessment Tests		Assignments		Terminal examination
	1	2	1	2	
Remember	20	20			10
Understand	20	20	30	30	20
Apply	60	60	70	70	70
Analyse					
Evaluate					
Create					

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject /Assignment/Practical Component
Perception	-
Set	-
Guided Response	-
Mechanism	-
Complex Overt Responses	-
Adaptation	-
Origination	-

Sample Questions for Course Outcome Assessment**

Course Outcome 1(CO1):

1. Discuss the Issues and challenges in Data Mining.
2. Describe different types of data and give an example for each.
3. Explain various stages of KDD.

Course Outcome 2(CO2):

1. Suppose that the data for analysis includes the attribute age. The age values for the data tuples are 75, 63, 55, 47, 77, 48, 63, 54, 60, 38, and 54.
   a. Find the mean, median and mid-range of the data.
   b. Can you find (roughly) the first quartile (Q1) and the third quartile (Q3) of the data?
   c. What is the mode of the data? Comment on the data"s modality (i.e., bimodal, trimodal, etc.).
   d. Show a boxplot of the data. e. How is a quantile-quantile plot different from a quantile plot?
2. Normalize 23, -23, 27, 39, 41, 47, 50, 52, 54, 60 using the decimal scaling method.
3. Suppose a group of 12 sales price records has been stored as follows: 5, 10, 11, 13, 15, 35, 50, 55, 72, 92, 204, 215. Partition them into 3 bins by equal width binning

Course Outcome 3(CO3):

1. Illustrate the significance of candidate set generation step of level wise algorithm.
2. For the given database find all the frequent item sets using Apriori method and list all the strong association rules that match the metarule

$\forall$ x € transaction , buys(X,item1) ^ buys(X,item2) $\Rightarrow$ buys(X,item3).

TID	Items bought
100	{f, a, c, d, g, i, m, p}
200	{a, b, c, f, l, m, o}
300	{b, f, h, j, o, w}
400	{b, c, k, s, p}
500	{a, f, c, e, l, p, m, n}

Minimum Support = 30%

Minimum Confidence = 70%

3. For the given database, using the Apriori algorithm finds all the Strong association rules which is used for deciding the profit level of the company. Assume the min support=30% and min confidence=70%

S.NO	Age	Credit rating
1.	25	Fair
2.	29	Excellent
3.	35	Fair
4.	42	Excellent
5.	47	Fair
6.	49	Excellent

Course Outcome 4 (CO4):

Consider the assumptions of linearity for a curvature using various plots. Scatter plot of residuals versus the fitted values• Scatter plot for residuals versus each predictor•The plot for residuals versus the predictor suggests that there is a non-linear relationship.

1. Identify the type of regression analysis model that suits best for the above problem
2. Differentiate Hierarchical and non-hierarchical segmentation models with an illustrative example.
3. Elaborate the algorithmic steps of the regression model.
4. Consider there are about 1000 tuples of record with binary class labels. Out of 1000 data tuples 580 belongs to class A and 420 data tuples belongs to class B. The data records have been trained and tested over Neural Network algorithm. The confusion matrix shows that out of 1000 tuples of records only 620 records has been correctly classified by the classifier which then corresponds 341 of class A and 279 of class B.

Calculate the following:

- Classification Accuracy
- Error Rate
- Sensitivity
- Specificity
- Precision

Course Outcome 5 (CO5):

1. Apply the following data for non-parametric maximum likelihood estimator for the variable S(t). Incorporate the concepts of censoring and no censoring with respect to the total number of individuals dj, for an event to occur. Suppose there are 10 customers of a certain type who were tracked over a a period of time to determine how many have churned, censored and at risk t(nt). out of 10 customers at the beginning of the study, the following conditions holds with respect to the time of the event S(t):

Time	Customers at risk $t(n_i)$	Customers churned $t(d_i)$	Customers censored at t
0	10	0	0
3	?	1	1
6	?	1	0
9	?	0	1
12	?	3	0
15	?	1	1
18	?	0	1

(i) Derive the KM estimator for S(t).

(ii) Find the total number of customers who are at risk at the end of the time period, say 18.

2. Relate the concept of product limit estimator for s(t) with censoring for churn prediction with 10 individuals and compute the following for the data provided: (i) Examine when the customers churn. (ii) Interpret the data when customers make next purchase. (iii) Solve for s(t) when customers are in default state

Customer	Time of churn	Churn or censored
C1	6	Churn
C2	3	Censored
C3	12	Churn
C4	15	Censored
C5	18	Censored
C6	12	Churn

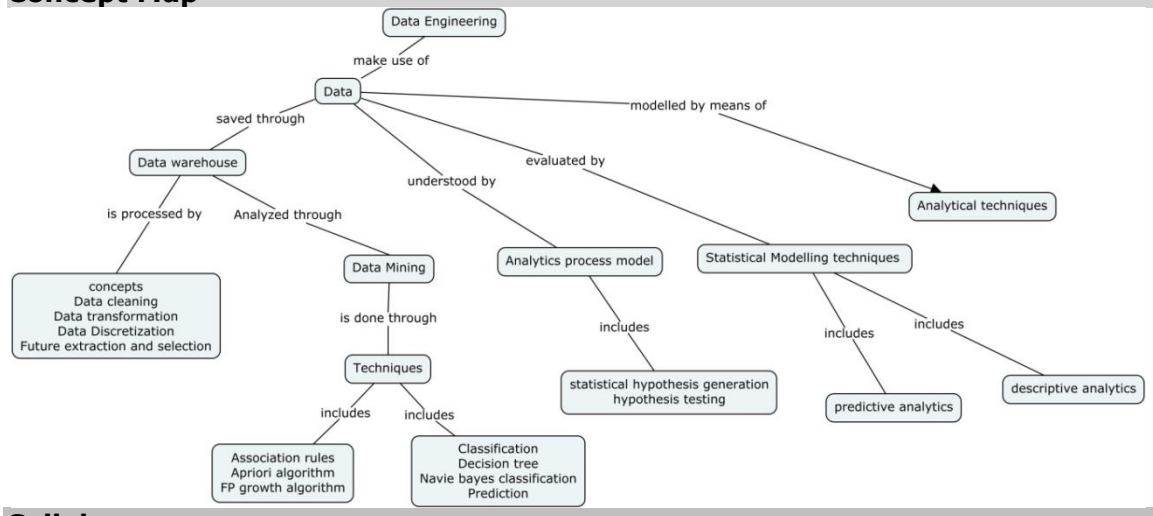
Course Outcome 6(CO6):

1. Consider a set of unstructured textual data given for analysis. Summarize the sub tasks and components in which a text analysis process must contain. Make use of tagging and annotation for the textual data analysis process.

2. Consider the logical view of a document from a full text to a set of index terms and compute the following for text processing: (a) Parts of speech tagging (b) Tokenization (c) Stemming
3. Produce the pseudo code for computing tokenization, stemming using any text processing language for the below.

I love this movie! It's sweet, but with satirical humor. The dialogue is great and the adventure scenes are fun… It manages to be whimsical and romantic while laughing at the conventions of the fairy tale genre. I would recommend it to just about anyone. I've seen it several times, and I'm always happy to see it again whenever I have a friend who hasn't seen it yet!

Concept Map



Syllabus

Introduction and Knowledge Representation

Introduction - Related technologies - Machine Learning, DBMS, OLAP, Statistics, Stages of the Data Mining Process, Data Mining Techniques, Knowledge Representation Methods, Task relevant data, Background knowledge, Representing input data and output knowledge, Visualization techniques, Applications.

Data Pre-processing

Data pre-processing: Data cleaning, Data transformation, Data reduction, Discretization and generating concept hierarchies. Attribute-oriented analysis: Attribute generalization, Attribute relevance, Class comparison, Statistical measures

Data Mining Methods

Association rules: Motivation and terminology, Basic idea: item sets, Generating item sets and rules efficiently, Correlation analysis. Classification: Basic learning/mining tasks, Inferring rudimentary rules: 1R, algorithm, Decision trees, covering rules. Prediction: The prediction task, Statistical (Bayesian) classification, Bayesian networks, Instance based methods (nearest neighbor), linear models.

Descriptive analytics: Data Modeling, Trend Analysis, Simple Linear Regression Analysis

Forecasting models: Heuristic methods, predictive modeling and pattern discovery, Logistic Regression: Logit transform, ML estimation, Tests of hypotheses, Wald test, LR test, score test, test for overall regression, multiple logistic regression, forward, backward method, interpretation of parameters, relation with categorical data analysis. Interpreting Regression Models, Implementing Predictive Models

Linear Models and Non Linear Model

Introduction to linear model - Link functions such as Poisson, binomial, inverse binomial, inverse Gaussian, Gamma.

Introduction to Non Linear Regression (NLS) - Linearization transforms, their uses & limitations, examination of non-linearity, initial estimates, iterative procedures for NLS, grid search, steepest descent. Introduction to semiparametric regression models, additive regression models. Introduction to nonparametric regression methods

Time Series Analysis: Auto - Covariance, Auto-correlation and their properties. Exploratory time series analysis, Test for trend and seasonality, Exponential and moving average smoothing, Holt – Winter smoothing, forecasting based on smoothing.

Linear time series models: Autoregressive, Moving Average, Autoregressive Moving Average and Autoregressive Integrated Moving Average models; Estimation of ARIMA models such as Yule-

Walker estimation for AR Processes, Maximum likelihood and least squares estimation for ARIMA Processes, Forecasting using ARIMA models.

Prescriptive Analytics: Mathematical optimization, Networks modeling-Multi-objective optimization-Stochastic modelling.

Learning Resources

1. Jiawei Han and MichelineKamber, "Data Mining: Concepts and Techniques", 3rd Edition, Morgan Kaufmann Publishers, 2010.
2. LiorRokach and OdedMaimon, "Data Mining and Knowledge Discovery Handbook", 2nd edition Springer, 2010
3. Trevor Hastie and Robert Tibshirani and Friedman, "The Elements of Statistical Learning: Data Mining, Inference, and Prediction", 2nd edition, Springer, 2017
4. George E. P. Box, Gwilym M. Jenkins, Gregory C. Reinsel, Greta M. Ljung "Time Series Analysis: Forecasting and Control", 5th edition Wiley, 2015
5. https://nptel.ac.in/courses/106/105/106105174/ - Data Mining by Prof. PabitraMitra, IIT Kharagpur.
6. https://www.edx.org/learn/data-analysis
7. https://www.coursera.org/browse/data-science/data-analysis

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Introduction and Knowledge Representation (6)**		
1.1	Introduction - Related technologies	1	CO1
1.2	Machine Learning, DBMS, OLAP, Statistics	1	CO1
1.3	Stages of the Data Mining Process, Data Mining Techniques	1	CO1
1.4	Knowledge Representation Methods, Task relevant data, Background knowledge	1	CO1
1.5	Representing input data and output knowledge, Visualization techniques, Applications	1	CO1
1.6	**Case Study:** Study about WEKA tool and WEKA explorer	1	CO1
2.	**Data Pre-processing (7)**		
2.1	Data cleaning, Data transformation, Data reduction	1	CO2
2.2	Attribute generalization	1	CO2
2.3	Attribute relevance	1	CO2
2.4	Class comparison,	1	CO2
2.5	Statistical measures	1	CO2
2.6	**Case study:** Perform data pre-processing techniques for real world data sets (Weather / Medical / banking)	2	CO2
3.	**DATA MINING METHODS (9)**		
3.1	Association rules: Motivation and terminology	1	CO3
3.2	Basic idea: item sets, Generating item sets and rules efficiently	1	CO3
3.3	Correlation analysis	1	CO3
3.4	Classification: Basic learning/mining tasks	1	CO3
3.5	Inferring rudimentary rules: 1R, algorithm		CO3
3.6	Decision trees, covering rules	1	CO3
3.7	The prediction task, Statistical (Bayesian) classification	1	CO3
3.8	Bayesian networks		CO3
3.9	Instance-based methods (nearest neighbour), linear models	1	CO3
3.10	**Case study 1:** Frequent item sets mining using Apriori and FP growth algorithm	1	CO3
3.11	**Case study 2:** Classification- Implement Decision Tree, Naïve Bayesian Classifier, NN classifier and SVM.	1	CO3
4.	**Descriptive Analytics and Forecasting models (8)**		

4.1	Data Modeling, Trend Analysis, Simple Linear Regression Analysis	1	CO4
4.2	Forecasting models: Heuristic methods, predictive modeling and pattern discovery	1	CO4
4.3	Logistic Regression: Logit transform, ML estimation, Tests of hypotheses, Wald test, LR test, score test, test for overall regression	2	CO4
4.4	multiple logistic regression, forward, backward method, interpretation of parameters, relation with categorical data analysis	2	CO4
4.5	Interpreting Regression Models, Implementing Predictive Models	1	CO4
4.6	**Case study:** Statistical model using a sample dataset – pre-processing, hypothesis building, model fitting, model validation and interpretation of results.	1	CO4
5	**Linear and Non-linear Models (10)**		
5.1	Introduction to Linear model	1	CO5
5.2	Generalized Linear model: link functions such as Poisson, binomial, inverse binomial, inverse Gaussian, Gamma.	1	CO5
5.3	Linearization transforms, their uses & limitations, examination of non-linearity, initial estimates.	2	CO5
5.4	iterative procedures for NLS Grid search, steepest descent methods	2	CO5
5.5	Introduction to semi-parametric regression models, additive regression models. Introduction to nonparametric regression method	2	CO5
5.6	**Case study1:** Linear regression technique for statistical model building.	2	CO5
6	**Time Series Analysis (8)**		
6.1	Auto - Covariance, Auto-correlation and their properties. Exploratory time series analysis, Test for trend and seasonality	1	CO6
6.2	Exponential and moving average smoothing, Holt – Winter smoothing, forecasting based on smoothing	1	CO6
6.3	Autoregressive, Moving Average, Autoregressive Moving Average and Autoregressive Integrated Moving Average models	1	CO6
6.4	Estimation of ARMA models such as Yule-Walker estimation for AR Processes	1	CO6
6.5	Maximum likelihood and least squares estimation for ARMA Processes, Forecasting using ARIMA models	1	CO6
6.6	Mathematical optimization		CO6
6.7	Networks modeling-Multi-objective optimization-Stochastic modelling	1	CO6
6.8	Decision and Risk analysis, Decision trees.		CO6
6.9	**Case Study 1**:Perform forecasting using any time series data with help of ARIMA model	2	CO6
		Total: 48 hours	

Course Designers:

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21CBPF2	IOT SYSTEM DESIGN

Category	L	T	P	Credit	Terminal Exam Type
PEES	2	0	2	3	Theory

Preamble

The course will enable the students to understand the basic concepts of IoT with its use cases and applications. It helps the students to identify the technologies to make the things to communicate through the internet that interacts with the real world. It also gives an overview of designing the prototype and connecting with appropriate tools to store data for future analysis.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Understand the building blocks of IoT and the IoT architecture to connect the data and process them for various applications.	10
CO2	Implement domain-specific IoT sensors to collect data that fulfils the required specifications.	10
CO3	Use an appropriate network protocol to connect the IoT architecture for transmitting data.	10
CO4	Employ the security and privacy mechanism to leverage communication with data.	10
CO5	Implement data analytical methods to examine patterns and trends in time-series data.	10
CO6	Employ VLSI and System on Chip design principles to construct and integrate energy-efficient IoT devices with embedded intelligence.	10
CO7	Analyze the interfacing and data integration of sensors with Arduino and Raspberry Pi to evaluate and optimize real-time IoT data acquisition	20
CO8	Build a cloud environment to store the acquired data using the network protocols.	20

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO#	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond	-	1.2,2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3
CO2	TPS3	Apply	Value	-	1.2,2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3
CO3	TPS3	Apply	Value	-	1.2,2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3
CO4	TPS3	Apply	Value	-	1.2,2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3
CO5	TPS3	Apply	Value	-	1.2,2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3
CO6	TPS3	Apply	Value	-	1.2,2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3
CO7	TPS4	Analyze	Organize	-	1.2,2.1.5,2.2.3,2.5.1, 3.1, 3.2.3, 4.5.1, 4.5.3
CO8	TPS4	Analyze	Organize	-	1.2,2.1.5,2.2.3,2.5.1, 3.1, 3.2.3, 4.5.1, 4.5.3

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L	L	L		L	L			L	L	L	L	L
CO2	S	M	L	L		L	L			L	L	M	L	L
CO3	S	M	L	L		L	L			L	L	M	L	L
CO4	S	M	L	L		L	L			L	L	M	L	L

CO5	S	M	L	L		L	L			L	L	M	L	L
CO6	S	M	L	L		L	L			L	L	M	L	L
CO7	S	S	M	L		L	L			L	L	S	L	L
CO8	S	S	M	L		L	L			L	L	S	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Practical	Terminal Examination
	1	2		
Remember	30	20	-	20
Understand	30	30	-	40
Apply	40	50	100	40
Analyse				
Evaluate				
Create				

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject /Assignment/Practical Component
Perception	-
Set	-
Guided Response	-
Mechanism	-
Complex Overt Responses	-
Adaptation	-
Origination	-

Course Level Assessment Questions CO7 & CO8 are assessed through Mini-Project.
Mini-project Details

- Team formation (Team size: 3)
- Problem Identification – real world problems focused on societal and environment need
- Identification of appropriate components needed to build the microcontroller board
- Assemble the components and program the board
- Test the board with sample input

Sample Questions for Course Outcome Assessment**

** (2 to 3 at the cognitive level of course outcome)

Course Outcome 1(CO1):

1. Draw a neat sketch and label the IoT architecture.
2. Illustrate the implementation of edge analytics on wearable devices.
3. Explain in detail about the flow of data in an centralized alarm system through IoT devices.

Course Outcome 2(CO2):

1. Explain the interfacing of sensors and actuators to the controllers.
2. Write a program to calculate the humidity in a particular place.
3. Illustrate on the use of sensors and transducers in an Industrial Application.

Course Outcome 3 (CO3):

1. Discuss on the network layers in respective to IoT levels.
2. Discuss on the protocols used for IoT in an commercial environment.
3. Construct an alternate design for using 801.2 Wi-Fi communications for distributed communication over the sensor nodes.

Course Outcome 4 (CO4):

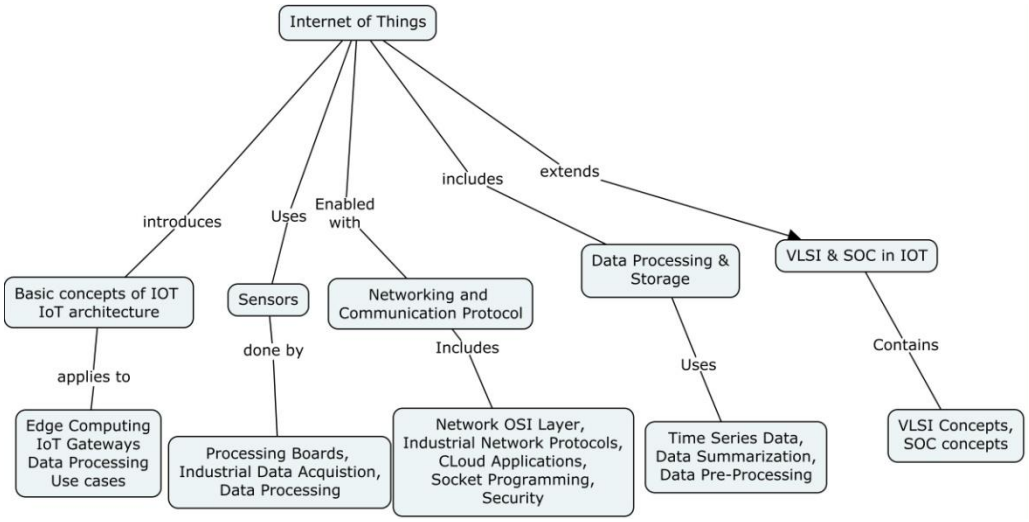
1. Discuss on MQTT, CoAP as IoT protocols for resource-constrained devices?
2. Construct Secure Development of IoT applications.

3. Explain how the connection is established with a microcontroller such as Bluetooth and USB

Course Outcome 5 (CO5):
1. Develop an IoT application to solve anomaly detection issue
2. Discuss about the role, features and characteristics of a Time Series Data.
3. Explain in detail on how to handle noisy and missing data to produce an effective environment.

Course Outcome 6 (CO6):
1. Apply the VLSI design flow to outline the development process of an IoT-enabled sensor node SoC.
2. Demonstrate how System-on-Chip architecture can be customized to meet the low-power requirements of wearable IoT devices.
3. Illustrate how embedded SoCs enable edge processing in real-time industrial IoT applications.

Concept Map



Syllabus

Introduction to IoT and Use cases: Consumer IoT vs Industrial Internet, Fundamental building blocks, IoT reference architectures, Industrial Internet Reference Architecture, Edge Computing, IoT Gateways, Data Ingestion and Data Processing Pipelines, Data Stream Processing**,** Use Cases.

Sensors and Industrial Systems: Introduction to sensors and transducers, integrating sensors to sensor processing boards, introduction to industrial data acquisition systems, industrial control systems and their functions

Networking and Communication for IoT: Recap of OSI 7 layer architecture and mapping to IoT architecture, Introduction to proximity networking technologies (ZigBee, Bluetooth, Serial Communication), Industrial network protocols (Modbus, CANbus), Communicating with cloud applications (web services, REST, TCP/IP and UDP/IP sockets, MQTT, Web Sockets, protocols. Message encoding (JSON, Protocol Buffers)

IoT Data Processing and Storage: Time Series Data and their characteristics, time series databases, basic time series analytics, data summarization and sketching, dealing with noisy and missing data, anomaly and outlier detection

VLSI and SOC in IOT: Introduction to VLSI concepts, VLSI design flow and their role in IoT hardware. Overview of System on Chip architecture. Embedded System on Chip. Emerging technology- AI on chip.

Students can write as an assignment on any 2 topics listed below:

a. IoT Applications
- Smart Cities
- Connected Vehicles and Telematics
- Smart Grids
- Smart Homes

b. IoT data visualization

- Survey of cloud based IoT platforms
- Low power wide area networks for IoT
- IoT device management
- Survey of chips, embedded modules and development boards for IoT devices
- Embedded and real-time operating systems for IoT
- IoT Security
    - Security risks in IoT
    - Securing IoT endpoint devices and secure communication protocols for IoT
    - Security and Privacy of IoT data

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1	**Introduction to IoT and Use cases**:		
1.1	Fundamental building blocks, IoT Architecture	**1**	CO1
1.2	Edge Computing, IoT Gateways,	**1**	CO1
1.3	Data Ingestion and Data Processing Pipelines	**1**	CO1
1.4	Data Stream Processing, Use Cases	**1**	CO1
2	**Sensors and Industrial Systems:**		
2.1	Introduction to sensors and transducers,	**1**	CO2
2.2	Integrating sensors to sensor processing boards,	**1**	CO2
2.3	Introduction to industrial data acquisition systems,	**1**	CO2
2.4	Industrial control systems and their functions	**1**	CO3
3	**Networking for IoT:**		
3.1	Recap of OSI 7 layer architecture and mapping to IoT architecture,	**1**	CO3
3.2	Introduction to proximity networking technologies (ZigBee, Bluetooth, Serial Communication),	**2**	CO3
3.3	Industrial network protocols (Modbus, CANbus),	**1**	CO3
4	**Communication for IoT**		
4.1	Communicating with cloud applications (web services, REST, TCP/IP and UDP/IP)	**2**	CO4
4.2	sockets, MQTT, WebSockets, protocols.	**1**	CO4
4.3	Message encoding (JSON, Protocol Buffers)	**1**	CO4
5	**IoT Data Processing and Storage**		
5.1	Time Series Data and their characteristics,	**1**	CO5
5.2	time series databases,	**1**	CO5
5.3	basic time series analytics,		CO5
5.4	data summarization and sketching,	**1**	CO5
5.5	dealing with noisy and missing data, anomaly and outlier detection,	**1**	CO5
6	**VLSI and SOC in IOT:**		
6.1	Introduction to VLSI concepts,	**1**	CO6
6.2	VLSI design flow and their role in IoT hardware.	**1**	CO6
6.3	Overview of System on Chip architecture.	**1**	CO6
6.4	Embedded System on Chip. Emerging technology- AI on chip. Design of a custom IoT SoC. Applications in wearables, autonomous vehicles and IIoT	**1**	CO6
	TOTAL	**24 Hours**	
Exp. No.	**Laboratory Exercises**	**No. of Hours**	**Course Outcome**
1	Setting up the Arduino Development Environment, connecting analog sensors to an Arduino Boarding and reading analog sensor data	**2**	CO7
2	Digital Input and Output reading using and Arduino board and Arduino Development Environment	**2**	CO7

3	Interfacing Sensors with Arduino	**2**	CO7
4	Introduction to Raspberry Pi: GPIO Programming and Sensor Integration	**4**	CO7
5	Interfacing Sensors with Raspberry PI	**2**	CO7
6	Uploading Data to the cloud using Arduino Development Environment	**2**	CO8
7	Retrieving Data from the cloud to Arduino Development Environment	**2**	CO8
8	Implement cloud to device connectivity using HTTP communication protocol	**2**	CO8
9	Implement cloud to device connectivity using MQTT protocol with MQTT Browser.	**2**	CO8
10	Create a Rule Chain in ThingsBoard cloud platform and design an interactive dashboard	**4**	CO8
	SUB TOTAL	**24**	
	TOTAL	**48 Hours**	

Learning Resources

Text Books:

1. Qusay F. Hassan (Ed.), Internet of Things A to Z: Technologies and Applications, 2nd Edition, Wiley-IEEE Press, 2025
2. Sébastien Ziegler, Renáta Radócz, Adrian Quesada Rodriguez & Sara Nieves Matheu Garcia (Eds.), Springer Handbook of Internet of Things, Springer, 2024.
3. Sneh Saurabh, Introduction to VLSI Design Flow, Cambridge University Press, 2023.

Reference Books:

1. Samuel Greengard, "The Internet of Things (The MIT Press Essential Knowledge series)", MIT Press, 2015.
2. CharalamposDoukas, "Building Internet of Things with the Arduino", CreateSpace Independent Publishing Platform , 2012.
3. Yuan Taur & Tak H. Ning, *Fundamentals of Modern VLSI Devices*, 3rd Edition, Cambridge University Press, 2022.
4. Andrew K Dennis , "Raspberry Pi Computer Architecture Essentials", 2016.
5. M. Banzi, "Getting Started with Arduino", O Reilly Media, 2009.

Links:

1. Industrial Internet Reference Architecture - http://www.iiconsortium.org/IIRA.htm
2. World Economic Forum Report on Industrial Internet of Things - https://www.weforum.org/reports/industrial-internet-things
3. 50 Sensor Applications for a Smarter World - http://www.libelium.com/resources/top_50_iot_sensor_applications_ranking/
4. GSMA IoT Security Guidelines & Assessment - https://www.gsma.com/iot/future-iot-networks/iot-security-guidelines/

Course Designers:

1. Ms. Raajalakshmi Ramanathan, Senior Manager, IoTDE, TCS — raajalakshmi.r@tcs.com
2. Mrs. Yuvasini. D — dyica@tce.edu
3. Mrs. Priya Thiagarajan — ptca@tce.edu

21CBPG1	FINANCIAL MANAGEMENT

Category	L	T	P	Credit	Terminal exam type
PSE	2	0	0	2	Theory

Preamble

This course is intended to develop skills for the interpretation of business information and the application of financial theory in financing-related decisions. Also, the students will be able to make better portfolio management, dividend decisions, inventory management, and long-term financing decisions.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage in %
CO1	Understand the financial management concepts to make financial decisions.	15
CO2	Apply the cash flow techniques to find the value of firm or industry.	20
CO3	Apply capital asset pricing model to minimize the risk and return.	20
CO4	Apply financial leverage concepts to maximize the wealth of the shareholders	15
CO5	Estimate the effectiveness and efficiency of an organization's operating and cash cycles.	15
CO6	Apply cash and account receivable management techniques to maximize the cost savings	15

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond	Guided Response	1.2, 4.3.2
CO2	TPS3	Apply	Value	Mechanism	1.2, 2.1.2, 3.2.3, 4.5.3
CO3	TPS3	Apply	Value	Mechanism	1.2, 2.1.2, 3.2.3, 4.3.2
CO4	TPS3	Apply	Value	Mechanism	1.2, 2.1.2, 3.2.3, 4.5.3
CO5	TPS3	Apply	Value	Mechanism	1.2, 2.1.2, 3.2.3, 4.5.3
CO6	TPS3	Apply	Value	Mechanism	1.2, 2.1.2, 3.2.3, 4.5.3

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	M	L											L		
CO2	S	M	L			L	L	L		L		L	M	L	L
CO3	S	M	L			L	L	L		L		L	M	L	L
CO4	S	M	L			L	L	L		L		L	M	L	L
CO5	S	M	L			L	L	L		L		L	M	L	L
CO6	S	M	L	L		L	L	L		L		L	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive levels	Continuous Assessment Tests		Assignments		Terminal examination
	1	2	1	2	
Remember	20	10			20
Understand	20	30	30		20
Apply	60	60	70	100	60
Analyse					
Evaluate					
Create					

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject /Assignment/Practical Component
Perception	
Set	
Guided Response	30
Mechanism	70
Complex Overt Responses	
Adaptation	
Origination	

Sample Questions for Course Outcome Assessment**

Course Outcome 1(CO1):

1. Explain the various functions of financial management.
2. Define Annuity factor
3. Explain Time value of Money. What is its relevance in financial decision making?

Course Outcome 2(CO2):

1. Calculate the minimum current price needed to make selling the bond the best financial choice?
2. Illustrate the various probability distribution to measures the risk.
3. Consider a portfolio of 300 shares of firm A worth $10/share and 50 shares of firm B worth

$40/share. You expect a return of 8% for stock A and a return of 13% for stock B.
(a) What isthe total value of the portfolio, what are the portfolio weights and what is the expected return?
(b) Suppose firm A's share price goes up to $12 and firm B's share price falls to $36. What is the new value of the portfolio? What return did it earn? After the price change, what are the new portfolio weights?

Course Outcome 3(CO3):

1. On the basis of expected Rate, Standard Deviation, Variance and Coefficient of variation decided which of the following company is best for investment (Single company Risk analysis).

Possible outcomes	Probability	Rate of Return	
		Company G	Company H
Bullish Trend	0.3	50%	25%
Normal Trend	0.4	20%	15%
Bearish Trend	0.3	(10)%	15%

2. FANNIE MAE is one of the famous brands trading in the US market. The government of the US now wants to issue a 20 year fixed semi-annually paying bond for their project. The price of the bond is $1,101.79, and the face value of the bond is $1,000. The coupon rate is 7.5% on the bond. Based on this information, you are required to calculate the approximate yield to maturity on the bond.

3. You can borrow and lend at the risk-free rate of 8%. The return on the optimal risky portfolio is16%. What investment strategy will provide you with an expected return of 22%?

Course Outcome 4 (CO4):

1. Explain the following: (i) Combined Leverage (ii) Asset Leverage (iii) ROI Leverage
2. The following are the details

Selling price per unit	Rs. 20
Variable cost per unit	Rs. 12
Actual sales	200 units
Installed capacity	300 units

Calculated operating leverage in each of the following two situations. (i) when fixed costs are Rs. 1000 (ii) when fixed costs are Rs. 800.

3. A Ltd. has the following capital structure :

	Rs.
Equity share capital (of Rs. 100 each)	1,00,000
10% Preference share capital (of Rs. 100 each)	2,00,000
10% debentures (of Rs. 100 each)	2,00,000

If EBIT is (i) Rs. 1,00,000 (ii) Rs. 80,000 and (iii) Rs. 1,20,000,
Calculate financial leverage under three situations. Assume 50% tax rate.

Course Outcome 5 (CO5):

1. The following information is available for Swagat Ltd.: (`. '000)

Average stock of raw materials and stores	200	
Average WIP inventory		300
Average finished goods inventory	180	
Average accounts receivable		300
Average accounts payable	180	
Average raw materials and stores purchase on credit and consumed per day		10
Average WIP value of raw materials committed per day		12.5
Average cost of goods sold per day		18
Average sales per day		20

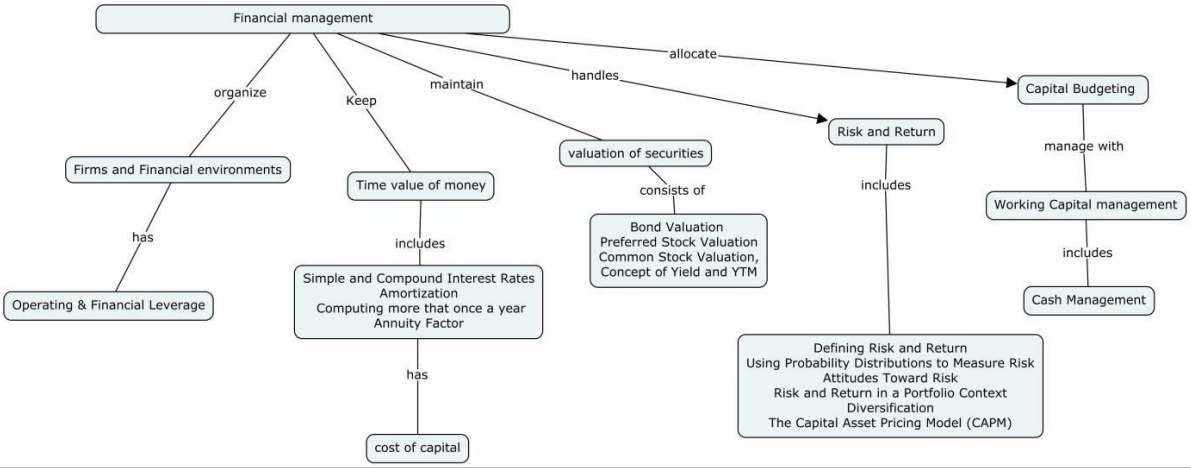
You are require to calculate: (i) Duration of raw material stage (ii) Duration of WIP stage (iii) Duration of Finished goods stage (iv) Duration of accounts receivable stage (v) Duration of accounts payable stage, and (vi) Duration of operating cycle.

2. Illustrate the various determinants of working capital.

Course Outcome 6(CO6):

1. Illustrate the various determinants of cash flows.
2. Illustrate the different methods of cash forecasting.
3. Draw an activity chart that speeds up the process of depositing the cheque in the bank accountfrom the time of receipt?

Concept Map



Syllabus

Introduction: Introduction to Financial Management - Goals of the firm - Financial Environments. **Time Value of Money:** Simple and Compound Interest Rates, Amortization, Computing more than once a year, Annuity Factor.

Capital Budgeting: The Capital Budgeting Concept & Process - An Overview, Generating Investment Project Proposals, Estimating Project, After Tax Incremental Operating Cash Flows, Capital Budgeting Techniques, Project Evaluation and Selection - Alternative Methods

Valuation of Securities: Bond Valuation Preferred Stock Valuation, Common Stock Valuation, Concept of Yield and YTM. **Risk & Return:** Defining Risk and Return, Using Probability Distributions to Measure Risk, Attitudes Toward Risk, Risk and Return in a Portfolio Context, Diversification, The Capital Asset Pricing Model (CAPM)

Operating & Financial Leverage: Operating Leverage, Financial Leverage, Total Leverage, and Indifference Analysis in leverage study. **Cost of Capital:** Concept, Computation of Specific Cost of Capital for Equity - Preference – Debt, Weighted Average Cost of Capital – Factors affecting Cost of Capital

Working Capital Management: Overview, Working Capital Issues, Financing Current Assets (Short Term and Long Term- Mix), Combining Liability Structures and Current Asset Decisions, Estimation of Working Capital.
Cash Management: Motives for holding cash, speeding up Cash Receipts, Slowing Down Cash Payouts, Electronic Commerce, Outsourcing, Cash Balances to maintain, Factoring.
Accounts Receivable Management: Credit & Collection Policies, Analyzing the Credit Applicant, Credit References, Selecting optimum Credit period

Learning Resources:
Text Books:

1. Timothy J. Gallagher, "Financial Management: Principles and Practice 9th Edition", Textbook Media Press, 2022.
2. Shashi K. Gupta, R. K. Sharma, Neeti Gupta," Financial Management Theory and Practice", 9th edition, Kalyani Publishers,2019.

Reference books:

1. Van Horne and Wachowicz, "Fundamentals of Financial Management", Prentice Hall,Pearson education 12th edition, 2016.
2. Srivastava, Misra," Financial Management", 2nd edition Oxford university press

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Introduction**		
1.1	Introduction to Financial Management	1	CO1
1.2	Goals of the firm - Financial Environments	1	CO1
1.3	**Time Value of Money:** Simple and Compound Interest Rates,	1	CO1
1.4	Amortization, Computing more than once a year, Annuity Factor.	1	CO1
2	**Capital Budgeting**		
2.1	The Capital Budgeting Concept & Process - An Overview, Generating Investment Project Proposals	1	CO2
2.2	Estimating Project, After Tax Incremental Operating Cash Flows	1	CO2
2.3	Capital Budgeting Techniques	1	CO2
2.4	Project Evaluation and Selection - Alternative Methods	1	CO2
3	**Valuation of Securities and Risk & Return**		
3.1	Bond Valuation Preferred Stock Valuation, Common Stock Valuation	1	CO3
3.2	Concept of Yield and YTM	1	CO3
3.3	Defining Risk and Return, Using Probability Distributions to Measure Risk, Attitudes Toward Risk	1	CO3
3.4	Risk and Return in a Portfolio Context, Diversification	1	CO3
3.5	The Capital Asset Pricing Model (CAPM)	1	CO3
4	**Operating & Financial Leverage**		
4.1	Operating Leverage, Financial Leverage, Total Leverage, and Indifference Analysis in leverage study.	1	CO4
4.2	**Cost of Capital:** Concept, Computation of Specific Cost of Capital for Equity	1	CO4
4.3	Preference – Debt, Weighted Average Cost of Capital	1	CO4
4.4	Factors affecting Cost of Capital	1	CO4
5	**Working Capital Management**		
5.1	Overview, Working Capital Issues	1	CO5
5.2	Financing Current Assets (Short Term and Long Term-Mix)	1	CO5
5.3	Combining Liability Structures and Current Asset Decisions, Estimation of Working Capital.	1	CO5
6	**Cash Management**		
6.1	Motives for holding cash, Speeding up Cash Receipts, Slowing Down Cash Payouts,	1	CO6
6.2	Electronic Commerce, Outsourcing, Cash Balances to maintain, Factoring.	1	CO6
6.3	**Accounts Receivable Management:** Credit & Collection Policies, Analyzing the Credit Applicant,	1	CO6
6.4	Credit References, Selecting optimum Credit period.	1	CO6
	Total hours	**24**	

Course Designer:

1. Mr.V.Janakiraman vjncse@tce.edu

21CBPH1	Human Resource Management

Category	L	T	P	Credit	Terminal Exam Type
PSE	2	0	0	2	Theory

Preamble

This course is to understand the basic concepts and importance of Human Resources Management and learn Various Human Resources Applications and Practices. Apply HRM concepts in organisational context and understand how HRM activities lead to performance and sustainability of the organisation.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Explain the basic concepts and importance of Human Resource Management	10
CO2	Select appropriate manpower resources using various activities and functions.	20
CO3	Develop action plans, train and appraise the performance of employees.	15
CO4	Understand the system design of Human Resource Management	15
CO5	Choose the appropriate Business strategies to improve the growth of organization.	20
CO6	Identify the impact of HR activities on different service sectors.	20

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond	Guided Response	1.1,4.1
CO2	TPS3	Apply	Value	Mechanism	1.1,2.5,3.1,4.2
CO3	TPS3	Apply	Value	Mechanism	2.5,3.1,4.1,4.2
CO4	TPS2	Understand	Respond	Guided Response	1.1,4.2
CO5	TPS3	Apply	Value	Mechanism	2.5,3.1,4.1,4.2
CO6	TPS3	Apply	Value	Mechanism	2.5,3.1,4.1,4.2

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	M	L		M		L			M	M			M	L	L
CO2	M	M	S	M	L	L			L	M			M	L	L
CO3	S	M	L	M	M	L			M	M			M	L	L
CO4	S	M	L	M	M	L			M	M			S	M	L
CO5	S	M	M	S	S	M			S	S			S	S	M
CO6	S	S	M	S	S	M			S	S			S	S	M

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	2	1	2	
Remember	20	20	-	-	20
Understand	40	40	50	50	40
Apply	40	40	50	50	40
Analyse	-	-	-	-	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Sample Questions for Course Outcome Assessment**

** (2 to 3 at the cognitive level of course outcome)

Course Outcome 1(CO1):

1. What is HRM?
2. What is meant by HR policy?
3. Discuss the impact of culture and technology on Human Resource Practices.
4. Elucidate the factors affecting HR policies.
5. Explain the process of formulating HR Policies and analyze the scope of human resource policies.

Course Outcome 2(CO2):

1. Define recruitment and Staffing.
2. What is meant by HRIS?
3. For a startup small scale restaurant, design the content of HRIS and HR portal. What are the common issues the company would face with respect to employee privacy and suggest ways to overcome it?
4. Identify the functions of Human Resource Information Systems.
5. Determine the various internal factors in the organization which affect the recruitment programme.

Course Outcome 3 (CO3):

1. Write some of the Major Stumbling blocks in HRP.
2. What is mean by Retention
3. "Human Resource Planning is more than matching demand and supply gaps." Do you Agree?
4. Describe the process of HRP.
5. "Human Resource Planning is a basic business premise & is necessary for organizational effectiveness" please evaluate the statement
6. Discuss the problems in HRP. Explain also how can you plan for Human resources in an effective manner?

Course Outcome 4(CO4):

1. What are the objectives of an HR Audit?
2. Define HR Accounting.
3. Write short note on HR accounting? Discuss the approaches of HR accounting. Also explain how it is different from HR auditing.

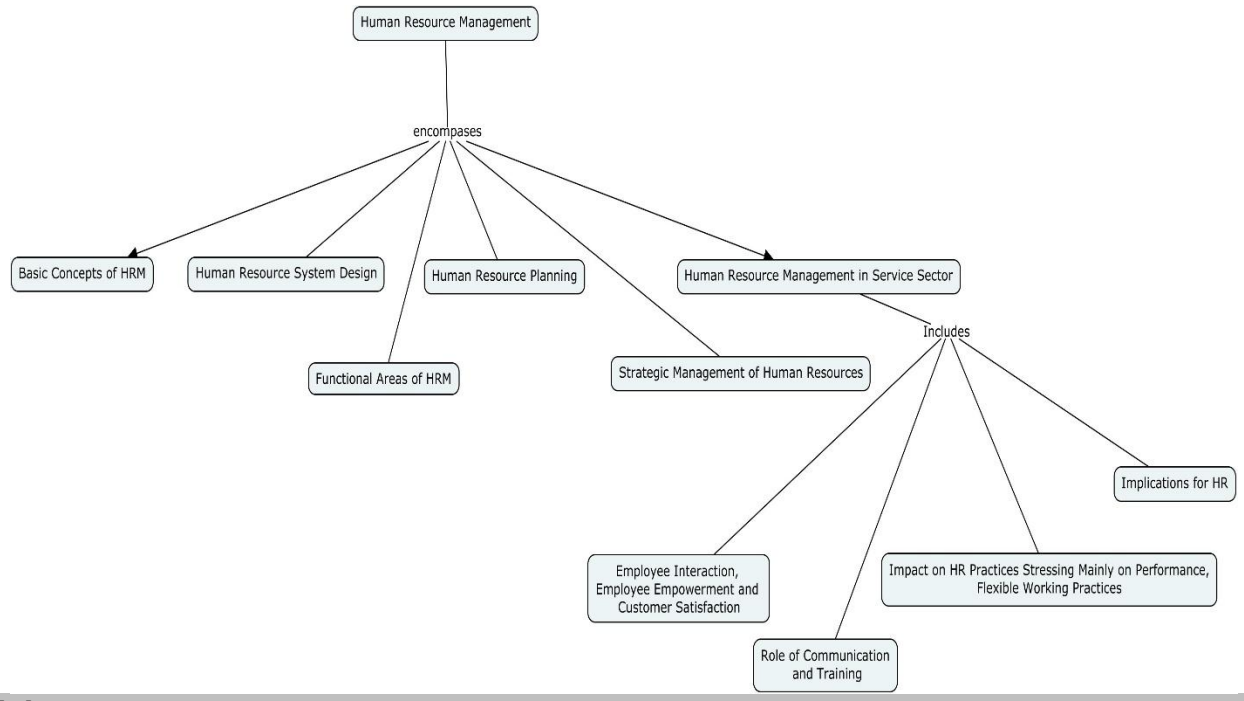
Course Outcome 5 (CO5):

1. List the relationship between HR strategy and corporate strategy
2. What are the barriers to strategic HRM?
3. What is strategic capability?
4. What are the various Models of SHRM? Explain In detail
5. Elaborate on the various SHRM challenges faced by an organization with suitable examples.
6. Explain the framework of Strategic HR Management Process

Course Outcome 6 (CO6):

1. How you measure the Customer Satisfaction
2. List the Role of Communication and Training
3. Describe any two theories of motivation which you find the most suitable to motivate the employees of your organization.
4. Identify the Impact on HR Practices Stressing Mainly on Performance

Concept Map



Syllabus

Human Resource Management: Concept and Challenges, HR Philosophy, Policies, Procedures and Practices.

Functional Areas of HRM: recruitment and staffing, benefits, compensation, employee relations, HR compliance, organizational design, training and development, human resource information systems (H.R.I.S.) and payroll.

Human Resource Planning: Demand Forecasting, Action Plans– Retention, Training, Redeployment & Staffing, Succession Planning

Human Resource System Design: HR Profession, and HR Department, Line Management Responsibility in HRM, Measuring HR, Human resources accounting and audit; Human resource information system

Strategic Management of Human Resources: SHRM, relationship between HR strategy and overall corporate strategy, HR as a Factor of Competitive Advantage, Managing Diversity in the Workplace

Human Resource Management in Service Sector- Special considerations for Service Sector including Managing the Customer – Employee Interaction, Employee Empowerment and Customer Satisfaction, Service Failure and Customer Recovery – the Role of Communication and Training, Similarities and Differences in Nature of Work for the Frontline Workers and the Backend, Support Services - Impact on HR Practices Stressing Mainly on Performance, Flexible Working Practices – Implications for HR

Learning Resources

Text Book

1. Dessler G, Varrkey B. "Human Resource Management", 16th edition. Pearson Education India, 2020.

Reference Books

1. Mathis RL, Jackson JH. "Human resource management", 15th edition, Jakarta: Salemba Empat.), 2021.
2. Joseph J. Martocchio, "Human Resource Management", 15th edition, Pearson Education Champaign, 2019.

Online courses

1. https://archive.nptel.ac.in/courses/110/105/110105069/
2. https://www.digimat.in/nptel/courses/video/122105020/

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Human Resource Management:**		CO1
1.1	Concept and Challenges	1	CO1
1.2	HR Philosophy, Policies	1	CO1
1.3	Procedures and Practices.	1	CO1
3.	**Functional Areas of HRM:**		CO2
3.1	recruitment and staffing, benefits, compensation	1	CO2
3.2	employee relations, HR compliance	1	CO2
3.3	organizational design, training and development	1	CO2
3.4	Human Resource Information Systems (H.R.I.S.) and payroll.	1	CO2
4	**Human Resource Planning:**		CO3
4.1	Demand Forecasting, Action Plans	1	CO3
4.2	Retention, Training	1	CO3
4.3	Redeployment & Staffing	1	CO3
4.5	Succession Planning	1	CO3
2	**Human Resource System Design:**		CO4
2.2	HR Profession and HR Department	1	CO4
2.3	Line Management Responsibility in HRM, Measuring HR	1	CO4
2.4	Human resources accounting and audit	1	CO4
2.5	Human resource information system	1	CO4
5	**Strategic Management of Human Resources:**		CO5
5.1	SHRM	1	CO5
5.2	relationship between HR strategy and overall corporate strategy	1	CO5
5.3	HR as a Factor of Competitive Advantage	1	CO5
5.4	Managing Diversity in the Workplace	1	CO5
6.	**Human Resource Management in Service Sector**		CO6
6.1	Managing the Customer – Employee Interaction, Employee Empowerment and Customer Satisfaction	1	CO6
6.2	Service Failure and Customer Recovery– the Role of Communication and Training	1	CO6
6.3	Similarities and Differences in Nature of Work for the Frontline Workers and the Backend	1	CO6
6.4	Support Services - Impact on HR Practices Stressing Mainly on Performance	1	CO6
6.5	Flexible Working Practices – Implications for HR	1	CO6
	TOTAL	**24**	

Course Designer:

1. Mrs.P.Suganthi psica@tce.edu

21CBPJ1	IT Project Management

Category	L	T	P	Credit	Terminal Exam Type
PSE	3	1	0	4	Theory

Preamble

This course develops the competencies and skills for planning, organizing and controlling projects within time and cost targets. Students will also learn agile project management techniques such as Scrum and DevOps.

Prerequisite

-

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Explain the various activities for resource management, risk assessment and project closure	10
CO2	Understand best practices followed in agile project management	10
CO3	Apply appropriate project planning and tracking tools for the given specification	20
CO4	Perform cost benefit analysis for the successful implementation of a project plan	20
CO5	Identify various agile methods to manage software projects effectively	20
CO6	Apply suitable software project management technique for the given scenario	20

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psycho motor	
CO1	TPS2	Understand	Respond		1.2, 2.1.1, 4.1.1, 4.1.2, 4.1.3
CO2	TPS2	Understand	Respond		1.2, 2.1.1, 4.1.1, 4.1.2, 4.1.3
CO3	TPS3	Apply	Value		1.2, 2.1.1, 2.1.3, 2.1.4, 4.1, 4.2, 4.3.1,4.3.4
CO4	TPS3	Apply	Value		1.2, 2.1.1, 2.1.3, 2.1.4, 4.1, 4.2, 4.3.1,4.3.4
CO5	TPS3	Apply	Value		1.2, 2.1.1, 2.1.3, 2.1.4, 4.1, 4.2
CO6	TPS3	Apply	Value		1.2, 2.1.1, 2.1.3, 2.1.4, 2.5, 3.1, 3.2, 3.3, 4.1, 4.2, 4.3.1,4.3.4

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L			L			M	M	M	L	L	M	
CO2	M	L			L			M	M	M	L	L	M	
CO3	S	M	L		M	L	M	S	S	S	M	M	S	M
CO4	S	M	L		M	L	M	S	S	S	M	M	S	M
CO5	S	M	L		M	L	M	S	S	S	M	M	S	M
CO6	S	M	L		M	L	M	S	S	S	M	M	S	M

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment/Mini Project		Terminal Examination
	1	2	1	2	
Remember	20	20			20
Understand	40	40			30
Apply	40	40	100	100	50
Analyse					
Evaluate					
Create					

Sample Questions for Course Outcome Assessment**

** (2 to 3 at the cognitive level of course outcome)

Course Outcome 1(CO1):

1. List the software management principles in modern project profile?
2. What is the difference between mitigating a risk and contingency planning?
2. Develop a risk breakdown structure and describe the process involved in Risk management.

Course Outcome 2(CO2):

1. List the benefits of agile modelling.
2. Explain about agile manifesto and principles.
3. Choose an agile methodology which preserves customer values with less work to implement online shopping system.

Course Outcome 3(CO3):

1. Explain the guidelines for estimating times, costs and resources and explain the methods for estimating the project costs by Top Down Approach
2. Explain how organizing projects are deployed within the dedicated project teams. State its pros and cons.
3. Develop a WBS for a project in which you are going to build shopping application. Try to identify all of the major components and provide three levels of detail.

Course Outcome 4 (CO4):

1. What are the causes for variations in project estimates?
2. How will you select a suitable cost estimation model for a given project?
3. Estimate the cost associated with the project using bottom up technique

Course Outcome 5(CO5):

1. Recall about task boards.
2. Explain about project scheduling and tracking using burn down charts.
3. Create backlogs and burn down chart to monitor the progress of the project.

Course Outcome 6 (CO6):

1. Create a customer database for the Modesto league baseball team. Draw a project network Complete the forward and backward pass, compute activity slack, and identify the critical path. How long will this project take? How sensitive is the network schedule? Calculate the free slack and total slack for all noncritical activities.

2. Your roommate is about to submit a scope statement for a spring concert sponsored by the entertainment council at Western Evergreen State University (WESU). WESU is a residential university with over 22,000 students. This will be the first time in six years since WESU sponsored a spring concert. The entertainment council has budgeted $40,000 for the project. The event is to occur on June 5th. Since your roommate knows you are taking a class on project management she has asked you to review her scope statement and make suggestions for improvement. She considers the concert a resume building experience and wants to be as professional as possible. Below is a draft of her scope statement. What suggestions would you make and why?

3. You work for LL Company, which manufactures high-end optical scopes for hunting rifles. LL Company has been the market leader for the past 20 years and has decided to diversify by applying its technology to develop a top-quality binocular. What kind of project management structure would you recommend they use for this project? What information would you like to have to make this recommendation, and why?

Syllabus

Project Overview and Feasibility Studies- Identification, Market and Demand Analysis, Project Cost Estimate, Financial Appraisal

Project Scheduling: Project Scheduling, Introduction to PERT and CPM, Critical Path Calculation, Precedence Relationship, Difference between PERT and CPM, Float Calculation and its importance, Cost reduction by Crashing of activity.

Cost Control and Scheduling: Project Cost Control (PERT/Cost), Resource Scheduling & Resource Leveling

Project Management Features: Risk Analysis, Project Control, Project Audit and Project Termination

Agile Project Management: Introduction, Agile Principles, Agile methodologies, Relationship between Agile Scrum, Lean, DevOps and IT Service Management (ITIL).

Scrum: Sprint, product backlog, sprint backlog, sprint review, retro perspective, various roles (Roles in Scrum), Best practices of Scrum.

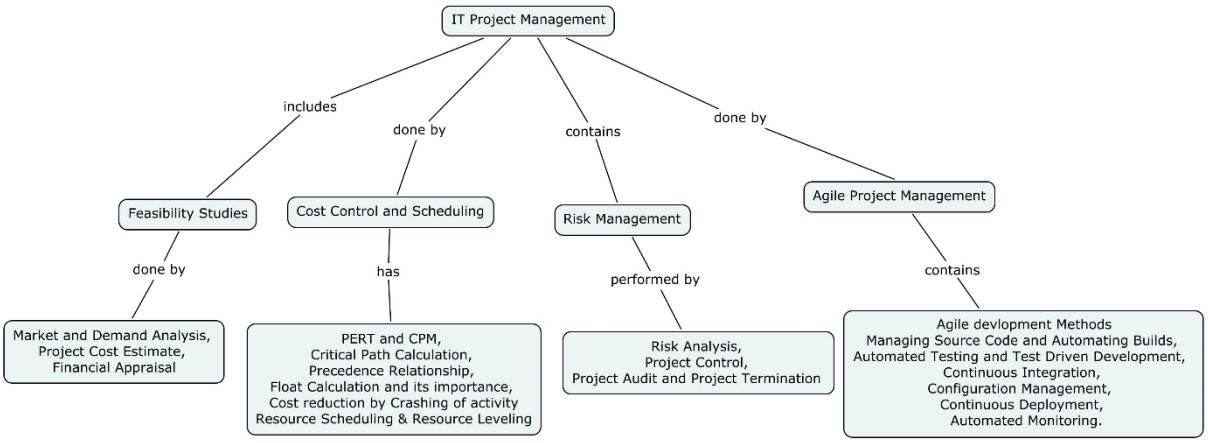
DevOps: Overview and its Components, Containerization Using Docker, Managing Source Code and Automating Builds, Automated Testing and Test Driven Development, Continuous Integration, Configuration Management, Continuous Deployment, Automated Monitoring.

Other Agile Methodologies: Introduction to XP, FDD, DSDM, Crystal

Assignment:

Case studies will be distributed to students beforehand and students should prepare and try to solve these cases before coming to class. Students will be asked submit and present their understanding of the cases and solutions before the class.

Concept Map



Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1	**Project Overview and Feasibility Studies**		
1.1	Identification, Market and Demand Analysis,	1	CO1
1.2	Project Cost Estimate	2	CO3
1.3	Financial Appraisal	1	CO1
2	**Project Scheduling**		
2.1	Introduction to PERT and CPM	1	CO3
2.2	Critical Path Calculation, Precedence Relationship	2	CO3
2.3	Difference between PERT and CPM, Float Calculation and its importance,	1	CO3
2.4	Cost reduction by Crashing of activity	2	CO3
3	**Cost Control and Scheduling**		
3.1	Project Cost Control (PERT/Cost)	2	CO4
3.2	Resource Scheduling & Resource Leveling	2	CO4
4	**Project Management Features**		

Module No.	Topic	No. of Hours	Course Outcome
4.1	Risk Analysis	2	CO1
4.2	Project Control	1	CO1
4.3	Project Audit and Project Termination	1	CO1
5	**Agile Project Management**		
5.1	Agile Principles, Agile methodologies	1	CO2
5.2	Relationship between Agile Scrum	1	CO2
5.3	Lean software development	1	CO2
5.4	DevOps and IT Service Management (ITIL)	1	CO5
6	**Agile Methodologies**		
6.1	Extreme Programing	1	CO2
6.2	FDD, DSDM, Crystal	2	CO2
7	**Scrum**		
7.1	Sprint, product backlog, sprint backlog, sprint review, retro perspective	2	CO5
7.2	Roles in Scrum	1	CO5
7.3	Best practices of Scrum	1	CO5
8	**DevOps**		
8.1	Overview and its Components	1	CO2
8.2	Containerization Using Docker	2	CO2
8.3	Managing Source Code and Automating Builds	1	CO5
8.4	Automated Testing and Test Driven Development	1	CO5
8.5	Continuous Integration, Configuration Management	1	CO5
8.6	Continuous Deployment, Automated Monitoring	1	CO5
	Case Study		
1	Students should solve the case studies and present their understanding of the cases and solutions before the class. Collect functional and non-functional requirements for the chosen problem	4	CO6
2	Estimate the effort, development time and resources	2	CO6
3	Create a schedule to organize the tasks, deliverables and milestones of a project on a timeline.	4	CO6
4	Prepare RMMM plan	2	CO6
	Total Hours	48	

Learning Resources:

1. Warburton. R &Kanabar. V, The Art and Science of Project Management, RW Press, RI, Second Edition, 2016.
2. 2. Bob Hughes, Mike Cotterell, Software Project Management, Tata McGraw Hill, Third Edition, 2011.
3. Mike Cohn, "Succeeding with Agile: Software Development Using Scrum", Pearson Addison-Wesley Professional, 1st Edition, 2015.
4. Roman Pichler, "Agile Product Management with Scrum", Addison-Wesley publisher, 1st Edition, 2011.
5. Ken Schwaber, "Agile Project Management with Scrum (Microsoft Professional)", Microsoft Press US publisher, 1st Edition, 2014.

Course Designers:

1. Dr. A. Malini amcse@tce.edu

21CBPK1	LARGE SCALE SYSTEMS

Category	L	T	P	Credit	Terminal Exam Type
PSE	3	0	0	3	Theory

Preamble

This course is to understand the architecture and fundamentals of large scale distributed computing and various scheduling algorithms for resource management. Identify the special requirements for Fault Tolerance in modern large scale systems and apply the appropriate monitoring Tools for control and optimization of large scale system.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Explain the architecture and fundamentals of large scale distributed computing.	20
CO2	Analyze various high performance communication methods in large scale distributed computing.	15
CO3	Apply the appropriate scheduling algorithm for Resource Managements	20
CO4	Apply the appropriate monitoring Tools for control and optimize Large scale system using control monitoring Tools.	20
CO5	Understand the special requirements for Fault Tolerance in modern large scale distributed systems.	10
CO6	Develop the Secure Application using appropriate development tools and framework.	15

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond	Guided Response	1.1,4.1
CO2	TPS3	Apply	Value	Mechanism	2.5,3.1,4.1,4.2
CO3	TPS3	Apply	Value	Mechanism	1.1,2.5,3.1,4.2
CO4	TPS3	Apply	Value	Mechanism	2.5,3.1,4.1,4.2
CO5	TPS2	Understand	Respond	Guided Response	1.1,4.1
CO6	TPS3	Apply	Value	Mechanism	2.5,3.1,4.1,4.2

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	S	M	M		M			M	L			S	M	L
CO2	S	S	M	L								S	L	L
CO3	S	M	L		L	L	L					M	L	L
CO4	S	M	M		S	M	L	L			L	S	S	M
CO5	S	M	M		S	M	M	L			L	S	S	M
CO6	S	M	M		S	M	M	L			L	S	S	M

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	2	1	2	
Remember	20	20	-	-	20
Understand	40	40	50	50	40
Apply	40	40	50	50	40
Analyse	-	-	-	-	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Sample Questions for Course Outcome Assessment**

** (2 to 3 at the cognitive level of course outcome)

Course Outcome 1(CO1):

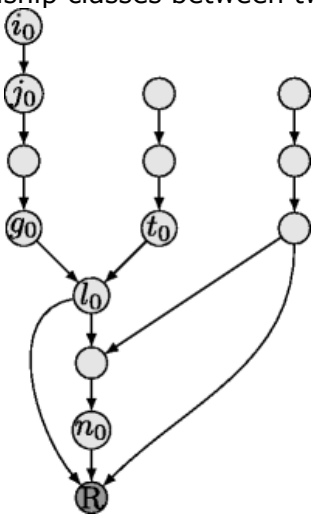
6. Until OGSA is truly stable, the Globus Toolkit remains the de facto standard, and one of the most important pieces of software in Grid system development. Justify.
7. Elaborate the importance of Architectural Models Client Server architectures
8. Analyse the need for pattern oriented software architecture in building large software applications. Give an example with neat sketch.

Course Outcome 2(CO2):

4. What is a hierarchical and what is a flat client-server model?
5. Explain how the reliability of smart grid can be enhanced by integrating intelligent electronic devices (IED) into it.
6. What are the data and functional requirements of grid computing? Explain the layered architecture of grid with a neat diagram?

Course Outcome 3(CO3):

6. Identify possible hierarchical relationship classes between two arbitrary genes i,j of DAG



2. Given the "Energy Situation" represents a complex subnet representing the hive storage. Give an example of a Petri Net for a multi-agent simulation of bee recruitment.

Course Outcome 4 (CO4):

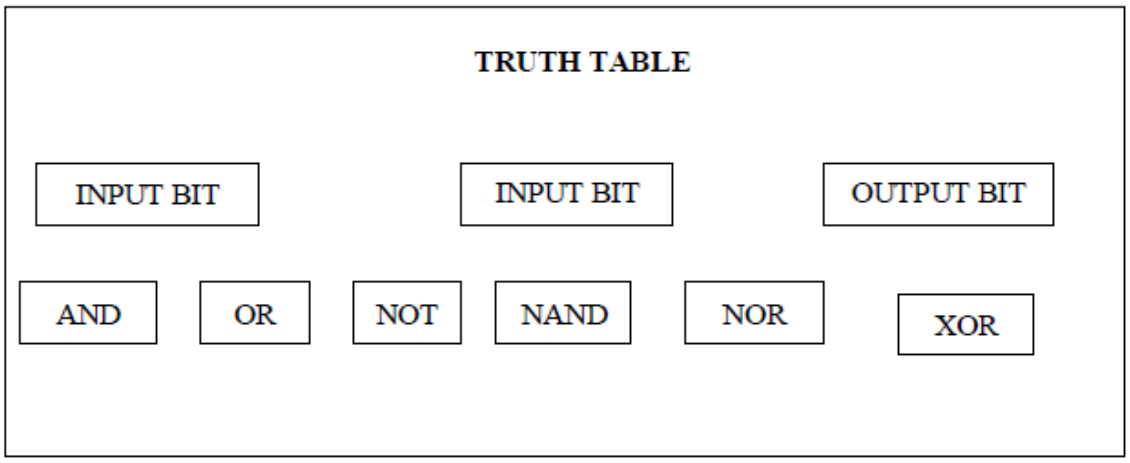
7. Proxies can support replication transparency by invoking each replica, as explained in the text. Can (the server side of) an application be subject to a replicated calls?
8. Explain server virtualization with respect to logical and physical partitioning.
9. Ricart and Agrawala's algorithm has the problem that if a process has crashed and does not reply to a request from another process to access a resources, the lack of response will be interpreted as denial of permission. We suggested that all requests be answered immediately to make it easy to detect crashed processes. Are there any circumstances where even this method is insufficient? Discuss.

Course Outcome 5 (CO5):

7. Why is the fault tolerance problem a greater challenge in collaborative p2p systems than in file sharing p2p systems?
8. Design a fault tolerant system and depict the needed elements and working of the syste,.
9. Why is it sometimes so hard to hide the occurrence and recovery from failures in a distributed system?

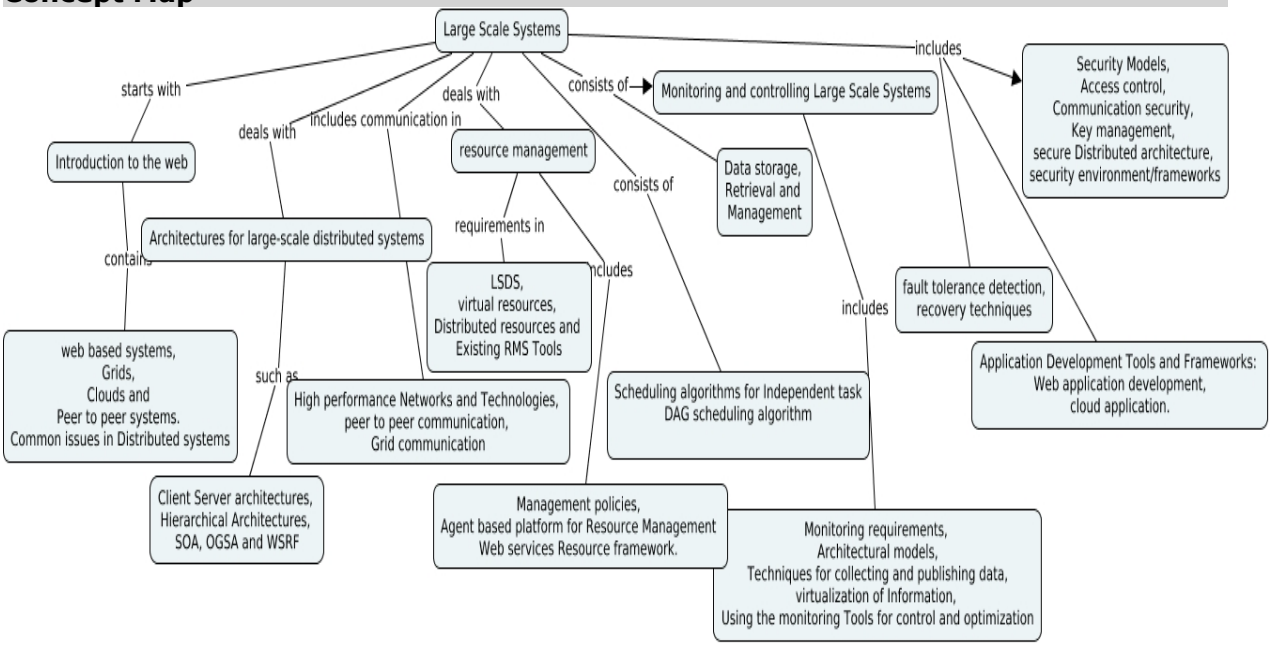
Course Outcome 6(CO6):

5. Design an ER diagram for a Banking system that allows its customers to open and manage bank accounts. You should clearly identify the entities, relationships, cardinality and the key constraints in your answer. You must also add proper attributes for each entity. The description of the Banking system is given below:
    a. A Bank allows its customers to open accounts with itself. There are three kinds of accounts, which are Savings account, Current Account and Salary account. In savings accounts Bank give an interest rate of 3%. The minimum balance for the savings account is INR 2000/-. In the salary account also, the bank gives an interest rate of 3% but allows the customer to have zero balance. In the Current account the bank changes the customer a fixed amount (say INR 1000 per year) and no interest is given. However, a customer can avail an overdraft of Rs 1 lakh at an interest rate of 7%. A customer is assigned a customer ID and can open multiple accounts with the Bank. An account may be single person account or joint account with a maximum of 4 customer in a joint account. A customer can perform different transactions using his/her account. S/he can deposit money, withdraw money, transfer money from one account to another. In addition, at the end of each month bank pays/charges the interest to the accounts, using the average balance of that month.
6. Design the Relational Schema for the E-R diagram that you have drawn for part Question 1. The relations must be at least in 3NF. Perform the following on the relations:
    a. Enter about 5 sets of meaningful data in each of the relations.
    b. Identify the domain of various attributes.
    c. Identify the Primary keys of all the relations.
    d. Identify the Foreign keys and referential integrity constraints in the relations.
7. Develop a GUI (details given below)by Using Tkinter and wxPython, compare the code complexity of both and give your observation



Details of GUI : the GUI for Truth table should accept two bits (0 or 1) as input and produce the Output as per the Logical operation to be chosen by pressing the button of that particular logical operation i.e. AND, OR, NOT,NAND, NOR, XOR. You may use other suitable components like text box, combo box, list, Radio Button, Check Box, Buttons etc. to implement the GUI.

Concept Map



Syllabus

Introduction – Basic concepts –The web –web based systems, Grids, Clouds and Peer to peer systems. Common issues in Distributed systems.

Architectures for large-scale distributed systems: Importance of Architectural Models Client Server architectures, Hierarchical Architectures, SOA, OGSA and WSRF. **Communication:** High performance Networks and Technologies, peer to peer communication, Grid communication

Resource Managements: Requirements of RM in LSDS, virtual resources, Distributed resources and Existing RMS Tools, Resource Management policies, Agent based platform for Resource Management Web services Resource framework. **Scheduling:** Scheduling methods, Scheduling algorithms for Independent task. DAG scheduling algorithms,

Data storage, Retrieval and Management: Data storage, Data Retrieval, Data Transfer, Replication and managements. **Monitoring and controlling Large Scale Systems:** Monitoring requirements, Architectural models for Monitoring systems, Techniques for collecting and publishing data, virtualization of monitoring Information, Using the monitoring Tools for control and optimization

Fault Tolerance: Fault Tolerance Models, Failure Detection and Recovery, Fault Tolerance Techniques.

Security: Security Models, Access control, Communication security, Key management, secure Distributed architecture, security environment/frameworks. **Application Development Tools and Frameworks:** Web application development, environment and Tools for cloud application.

Assignment:
Students should prepare and try to solve cases studies on Fault Tolerance, Resource Managements, Web application development, etc. Students will be asked submit and present their Understanding of the cases and solutions before the class.

Learning Resources

Text Book

1. Valentin Cristea, ciprain Dobre, Varrkey B. "Large-scale Distributed Computing and Applications: Models and Trends", Information science reference New York, 2010.

2. Dominique Luzeaux, Jean-René Ruault, Jean-Luc Wippler, "Large-scale Complex System and Systems of Systems Hardcover", Wiley-ISTE, 2011.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Introduction**		CO1
1.1	Basic concepts –The web –web based systems, Grids, Clouds and Peer to peer systems. common issues in Distributed systems	1	CO1
1.2	**Architectures for large-scale distributed systems**: Importance of Architectural Models Client Server architectures, Hierarchical Architectures	2	CO1
1.3	SOA, OGSA and WSRF	2	CO1
2	**Communication**		CO2
2.1	High performance Networks and Technologies	2	CO2
2.2	peer to peer communication	1	CO2
2.3	Grid communication	2	CO2
3	**Resource Managements:**		
3.1	Requirements of RM in LSDS, virtual resources	2	CO3
3.2	Distributed resources and Existing RMS Tools	2	CO3
3.3	Resource Management policies, Agent based platform for Resource Management Web services Resource framework.	2	CO3
3.4	**Scheduling:** Scheduling methods, Scheduling algorithms for Independent task.	2	CO3
3.5	DAG scheduling algorithms	1	CO3
4	**Data storage, Retrieval and Management:**		CO4
4.1	Data storage, Data Retrieval, Data Transfer, Replication and managements.	2	CO4
4.2	**Monitoring and controlling Large Scale Systems:** Monitoring requirements, Architectural models for Monitoring systems	2	CO4
4.3	Techniques for collecting and publishing data	1	CO4
4.4	virtualization of monitoring Information and monitoring Tools for control and optimization	2	CO4
5	**Fault Tolerance:**		CO5
5.1	Fault Tolerance Models, Failure Detection and Recovery	2	CO5
5.2	Fault Tolerance Techniques	2	CO5
6.	**Security**		CO6
6.1	Security Models, Access control, Communication security	2	CO6
6.2	Key management, secure Distributed architecture, security environment/frameworks	2	CO6
6.3	**Application Development Tools and Frameworks:** Web application development environment and Tools for cloud application	2	CO6
	TOTAL	**36**	

Course Designers:

1. P. Suganthi psica@tce.edu
2. R.Subhashni rsica@tce.edu

21CBPL1	BIG DATA ANALYTICS

Category	L	T	P	Credit	**Terminal Exam Type**
PSE	3	0	0	3	Theory

Preamble

This course enables the students to familiarize with big data platform and its business implications. It also provides an overview of Hadoop framework, Map Reduce, PIG and HIVE. The course guides them to store, analyse and manipulate data by using the data analytics tools which helps them to gain a comprehensive knowledge on big data analytics.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Explain the role and characteristics of big data analytics in the real-world.	15
CO2	Describe the underlying concepts of Hadoop framework in distributed environment	15
CO3	Develop applications to handle big data in Hadoop environment	20
CO4	Solve data intensive problems using map reduce techniques	20
CO5	Demonstrate the efficient storage and processing of large datasets using HIVE	15
CO6	Write queries to perform data manipulation operations using PIG data flow system	15

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond		1.2,2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3
CO2	TPS2	Understand	Respond		1.2,2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3
CO3	TPS3	Apply	Value		1.2,2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3
CO4	TPS3	Apply	Value		1.2,2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3
CO5	TPS3	Apply	Value		1.2,2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3
CO6	TPS3	Apply	Value		1.2,2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L	L	L		L	L			L	L	L	L	L
CO2	M	L	L	L		L	L			L	L	L	L	L
CO3	S	M	L	L		L	L			L	L	M	L	L
CO4	S	M	L	L		L	L			L	L	M	L	L
CO5	S	M	L	L		L	L			L	L	M	L	L
CO6	S	M	L	L		L	L			L	L	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	**Continuous Assessment Test**		**Assignment**		**Terminal Examination**
	I	**II**	**I**	**II**	
Remember	20	20			20
Understand	40	20	50		20
Apply	40	60	50	100	60
Analyse					
Evaluate					
Create					

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject /Practical Component/Observation
Perception	
Set	
Guided Response	
Mechanism	
Complex Overt Responses	
Adaptation	
Origination	

Sample Questions for Course Outcome Assessment**

Course Outcome 1(CO1):

1. Discuss in detail about the characteristics of Big Data.
2. Explain in detail about Nature of Data and its applications.
3. What is big data analytics? Explain four 'V's of Big data. Briefly discuss applications of big Data.

Course Outcome 2(CO2):

1. Explain core architecture of Hadoop with suitable block diagram. Discuss role of each component in detail.
2. List various configuration files used in Hadoop Installation. What is use of mapred-site.xml.
3. What is Name node & Data node in Hadoop Architecture.

Course Outcome 3(CO3):

1. Illustrate with an example of Hadoop HDFS architecture with an example.
2. How would you show your understanding of the tools, trends and technology in big data?
3. Analyze the NameNode recovery process. What will happen with a NameNode that doesn"t have any data?

Course Outcome 4(CO4):

1. Exhibit the following query: If reducers do not start before all mappers finish then why does the progress on MapReduce job shows something like Map(50%) Reduce(10%)? Why reducers progress percentage is displayed when mapper is not finished yet?

2. Solve using MAP REDUCE. Count the number of companies in each state

a.	REDMI-Kerela	UNILIVER-Odisha
b.	ACER-Delhi	ACER-Assam
c.	TITAN- Maharastra	REDMI-Delhi
d.	HP-Karnataka	ANGEL-Delhi
e.	SAMSUNG-Delhi	FEMINA-Delhi
f.	JIO-Haryana	BECON-Telangana
g.	REALME-DELHI	NOKIA- Tamilnadu
h.	ACER-Odisha	JIO -DELHI

3. Discuss Hadoop YARN in detail with failures in classic MapReduce.

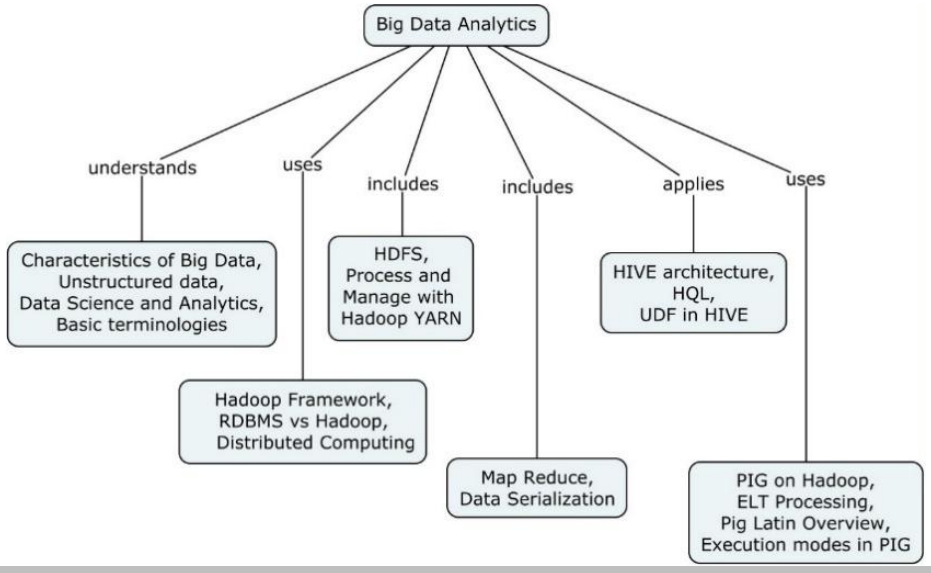
Course Outcome 5(CO5):

1. Sketch a neat diagram that showcase the working of Hive.
2. Explain Metastore in Hive.
3. Illustrate HiveQL Data Definition Language? Explain any three HiveQL DDL command with its syntax and example.

Course Outcome 6(CO6):

1. Explain the uses of Map Reduce in Pig..
2. Interpret the role of scalar data type and complex data types in Pig.
3. Demonstrate the usage of 'filters', 'group', 'orderBy', 'distinct' keywords in pig scripts.

Concept Map



Syllabus

ESSENTIALS OF BIG DATA ANALYTICS: Data, Characteristics of data and Types of digital data, Sources of data, Working with unstructured data, Evolution and Definition of big data, Need of big data, Challenges of big data; Overview of business intelligence, Data science and Analytics, Classification of analytics, Challenges to big data analytics, Importance of big data analytics, Basic terminologies in big data environment.

OVERVIEW OF HADOOP FRAMEWORK: Introducing Hadoop, Need of Hadoop, limitations of RDBMS, SPARK, RDBMS versus Hadoop, Distributed computing challenges, History of Hadoop, Hadoop overview, Use case of Hadoop.

HADOOP DISTRIBUTORS: HDFS (Hadoop Distributed File System), Processing data with Hadoop, managing resources and applications with Hadoop YARN (Yet another Resource Negotiator), Interacting with Hadoop Ecosystem.

MAPREDUCE PROGRAMMING: Introduction, Mapper, Reducer, Combiner, Partitioner, Searching, Sorting, Compression, Real time applications using MapReduce, Data serialization and Working with common serialization formats, Big data serialization formats.

Apache HIVE Fundamentals: Hive architecture, Hive data types, Hive file format, Hive Query Language (HQL), User-Defined Function (UDF) in Hive.

Apache PIG Fundamentals: The anatomy of Pig, Pig on Hadoop, Pig Philosophy, Use case for Pig; ETL Processing, Pig Latin overview, Data types in Pig, Running Pig, Execution modes of Pig, HDFS commands, Relational operators, Piggy Bank, Word count example using Pig**.**

Learning Resources

Text Books:

1. Seema Acharya, Subhashini Chellappan, "Big Data Analytics", 2nd Edition, Wiley, 2019.
2. Boris lublinsky, Kevin t. Smith, Alexey Yakubovich, "Professional Hadoop Solutions", 1st Edition, Wrox, 2013.
3. Chris Eaton, Dirk Deroos et. al., "Understanding Big data", Indian Edition, McGraw Hill, 2015.
4. Tom White, "HADOOP: The definitive Guide", 3rd Edition, O Reilly, 2012.
5. Vignesh Prajapati, "Big Data Analytics with R and Hadoop", 1st Edition, Packet Publishing Limited, 2013

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1	**ESSENTIALS OF BIG DATA ANALYTICS**:		
1.1	Data, Characteristics of data and Types of digital data, Sources of data, Working with unstructured data.	1	CO1
1.2	Evolution and Definition of big data, and Need of big data, Challenges of big data.	1	CO1
1.3	Overview of business intelligence, Data science and Analytics, Classification of analytics, Challenges to big data analytics.	2	CO1
1.4	Importance of big data analytics, Basic terminologies in big data environment	1	CO1
2	**OVERVIEW OF HADOOP FRAMEWORK:**		
2.1	Introducing Hadoop, Need of Hadoop, limitations of RDBMS - SPARK.	1	CO2
2.2	RDBMS versus Hadoop, Distributed computing challenges.	2	CO2
2.3	History of Hadoop, Hadoop overview.	1	CO2
2.4	Use case of Hadoop	2	CO2
3	**HADOOP DISTRIBUTORS:**		
3.1	HDFS (Hadoop Distributed File System), Processing data with Hadoop.	2	CO3
3.2	Managing resources and applications with Hadoop YARN (Yet another Resource Negotiator)	3	CO3
3.3	Interacting with Hadoop Ecosystem.	2	CO3
4	**MAPREDUCE PROGRAMMING**:		
4.1	Introduction, Mapper, Reducer, Combiner, Partitioner	1	CO4
4.2	Searching, Sorting, Compression	1	CO4
4.3	Real time applications using MapReduce	2	CO4
4.4	Data serialization	1	CO4
4.5	Working with common serialization formats	1	CO4
4.6	Big data serialization formats.	1	CO4
5	**Apache HIVE Fundamentals:**		
5.1	Hive architecture, Hive data types	2	CO5
5.2	Hive file format, Hive Query Language (HQL)	2	CO5
5.3	User-Defined Function (UDF) in Hive.	1	CO5
6	**Apache PIG Fundamentals**:		
6.1	The anatomy of Pig, Pig on Hadoop, Pig Philosophy, Use case for Pig.	2	CO6
6.2	ETL Processing, Pig Latin overview, Data types in Pig, Running Pig, Execution modes of Pig	2	CO6
6.3	HDFS commands, Relational operators, Piggy Bank, Word count example using Pig**.**	2	CO6
	TOTAL	**36**	

Course Designer:

1. Dr. A. Malini amcse@tce.edu
2. Mrs. J. Felicia Lilian jflcse@tce.edu

21CBPM1	CLOUD AND DISTRIBUTED SYSTEMS

Category	L	T	P	Credit	Terminal Exam Type
PSE	3	0	0	3	Theory

Preamble

This course is to understand the basic concepts of distributed systems and distributed resource management also learns the basics of cloud computing, the services offered by the cloud, Virtualization, Cloud Storage and Cloud Security.

Prerequisite

Operating Systems, Computer Networks

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Explain the concepts of distributed computing and resource management.	10
CO2	Perform Mutual Exclusion and Deadlock detection using various distributed algorithms.	10
CO3	Illustrate the architecture, deployment and service models of cloud computing.	25
CO4	Identify the various virtualization technological concepts of Cloud Computing.	25
CO5	Solve the core issues of cloud computing such as cloud management, storage and security.	15
CO6	Develop cloud environment using different Cloud software and computing platforms.	15

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond	Guided Response	1.2, 2.3.1, 2.4.6
CO2	TPS3	Apply	Value	Mechanism	1.2, 2.3.1, 2.3.2, 2.3.4
CO3	TPS2	Understand	Respond	Guided Response	1.2, 2.3.1, 2.4.6
CO4	TPS3	Apply	Value	Mechanism	1.2, 2.3.1, 2.3.2, 2.3.4
CO5	TPS3	Apply	Value	Mechanism	1.2, 2.4.5, 2.4.6, 2.5.1, 3.1.1, 3.2.1 – 3.2.6, 4.5.3, 4.5.5
CO6	TPS3	Apply	Value	Mechanism	1.2, 2.4.5, 2.4.6, 2.5.1, 3.1.1, 3.2.1 – 3.2.6, 4.5.3, 4.5.5

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	S	M	M		M			M	L			S	L	L
CO2	S	S	M	L								S	L	L
CO3	S	M	L		L	L	L					M	L	L
CO4	S	M	M		S	M	L	L			L	S	S	M
CO5	S	M	M		S	M	M	L			L	S	S	M
CO6	S	M	M		S	M	M	L			L	S	S	M

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	2	1	2	
Remember	20	20	-	-	20
Understand	40	40	40	40	40
Apply	40	40	60	60	40
Analyse	-	-	-	-	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject /Assignment/Practical Component
Perception	-
Set	-
Guided Response	30
Mechanism	70
Complex Overt Responses	-
Adaptation	-
Origination	-

Sample Questions for Course Outcome Assessment**

** (2 to 3 at the cognitive level of course outcome)

Course Outcome 1(CO1):

9. List out the characteristics of Distributed Computing
10. Compare various models of distributed computations
11. Discuss briefly key challenges that one needs to address in the design and development of distributed applications.
12. Recall models of Distributed computations
13. Classify Distributed Systems
14. Write a simple RMI program that demonstrates the invocation of remote object services. For example, when a client sends a message "Ping", the server responds with "Pong".
15. Illustrate the remote procedure call with a suitable example

Course Outcome 2(CO2):

7. Identify the requirements of a mutual exclusion algorithms
8. Consider the following simple method to enforce mutual exclusion: all sites are arranged in a logical ring fashion and a unique token circulates around the ring hopping from a site to another site. When a site needs to executes its CS, it waits for the token, grabs the token, executes the CS, and then dispatches the token to the next site on the ring. If a site does not need the token on its arrival, it immediately dispatches the token to the next site (in zero time).
    a. What is the response time when the load is low?
    b. What is the response time when the load is heavy?

   Assume there are N sites, the message/token delay is T, and the CS execution time is E.
3. Explain global state detection based algorithms
4. Demonstrate the various models of deadlocks

Course Outcome 3(CO3):

1. Discuss the Layers and types of cloud
2. Discuss the IaaS cloud service model.
3. Explain the desired features of cloud
4. I am starting a new company to analyze videos. I'll need a lot of storage as videos consume quite a bit of disk. Additionally, I'll need ample computational power, possibly running

applications concurrently. I have discovered some very good tools to facilitate development in Windows but the deployment will be more effiicently handled in the Linux environment. All the pointers say that I need to move to cloud. I have found that SaaS is the most attractive service, followed by PaaS and IaaS, in that order. Given the above information, which service do you recommend? Why?

5. Evaluate and contrast the merits and demerit of Cloud deployment models: public, private, hybrid, community

Course Outcome 4 (CO4):

10. Demonstrate the type of virtualization that is supported by the virtualization tool named PlateSpin Power Recon".
11. Illustrate the steps to add the OpenSolaris Guest OS to Sun xVM VirtualBox.
12. Define Virtualization.
13. Explain the concept of SOA.
14. Illustrate in detail about the compiler support for para virtualization architecture.
15. Examine in detail about hardware support for virtualization and CPU virtualization.

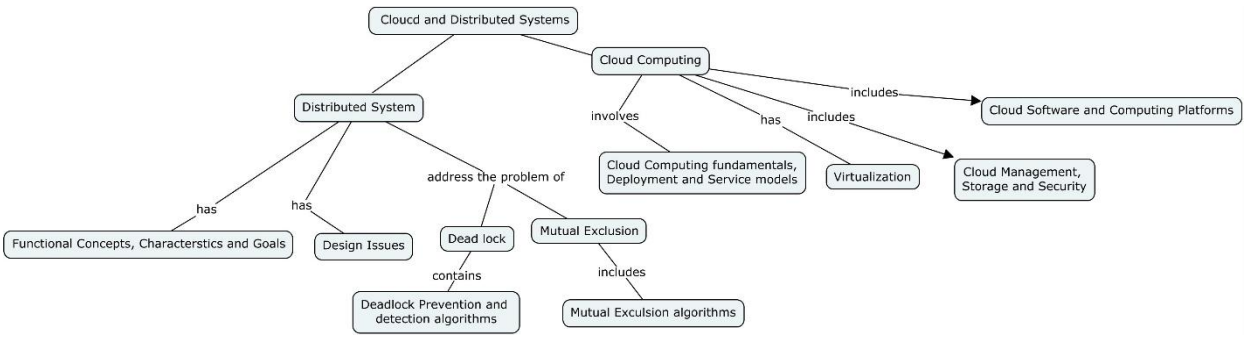
Course Outcome 5 (CO5):

10. Identify the Challenges in Cloud Security
11. Explain the use of cloud-based security groups that are used to counter and prevent the cloud security threats and attacks.
12. Evaluate about the architectural design of compute and storage clouds.
13. Generalize about the IAM.

Course Outcome 6(CO6):

8. Give some of the Applications of GAE
9. Define the MapReduce function
10. State and Explain the basic of Google App Engine infrastructure programming model.
11. Construct the design of OpenStack Nova system architecture and describe detail about it
12. Discuss model architecture of distributed file system and its components

Concept Map



Syllabus

Distributed Systems: Characteristics – Issues in Distributed Systems – Distributed System Model – Request/Reply Protocols – RPC – RMI – Logical Clocks and Casual Ordering of Events – Election Algorithm – Distributed Mutual Exclusion –Distributed Deadlock Detection Algorithms.

Cloud Computing: Evolution of Cloud Computing – Cloud Characteristics – Elasticity in Cloud – On-demand Provisioning – NIST Cloud Computing Reference Architecture– Architectural Design Challenges – Deployment Models: Public, Private and Hybrid Clouds – Service Models: IaaS – PaaS – SaaS – Benefits of Cloud Computing

Cloud Enabling Technologies: Introduction to Web Service and Service Oriented Architecture – SOAP – REST – Basics of Virtualization – Full and Para Virtualization– Implementation Levels of Virtualization – Tools and Mechanisms – Virtualization of CPU – Memory – I/O Devices – Desktop Virtualization – Server Virtualization.

Cloud Management, Storage and Security: Resource Provisioning and Methods – Cloud Management Products – Cloud Storage – Provisioning Cloud Storage – Managed and Unmanaged

Cloud Storage – Cloud Security Overview – Cloud Security Challenges –Security Architecture design – Virtual Machine Security – Application Security –Data Security.

Cloud Software and Computing Platforms: DFS – Map Reduce – Google App Engine (GAE) – Programming Environment for GAE – Architecture of GFS – Case Studies: Openstack, Heroku, and Docker Containers –Amazon EC2, AWS, Microsoft Azure, Google Compute Engine.

Learning Resources

Text Book

1. Andrew S. Tanenbaum, Maarten Van Steen, "Distributed Systems - Principles and Paradigms", Second Edition, Pearson, 2016.
2. George Coulouris, Jean Dollimore and Tim Kindberg, "Distributed Systems Concepts and Design", Fifth Edition, Pearson Education, 2017.
3. Kai Hwang, Geoffrey C Fox, Jack G Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2013.

Reference Books

1. Mukesh Singhal, "Advanced Concepts In Operating Systems", McGraw Hill Series in Computer Science, 1994.
2. Buyya R., Broberg J., Goscinski A., "Cloud Computing: Principles and Paradigm", John Wiley, 2011.
3. John W. Rittinghouse, James F. Ransome, "Cloud Computing: Implementation "Management and Security", CRC Press, 2010.

Online courses

3. https://www.digimat.in/nptel/courses/video/106105167
4. https://www.mooc-list.com/course/cloud-application-security-coursera
5. https://www.digimat.in/nptel/courses/video/106106168

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Distributed Systems**		CO1
1.1	Introduction, Characteristics, Issues in Distributed Systems	1	CO1
1.2	Distributed System Model, Request/Reply Protocols, RPC, RMI	2	CO1
1.3	Logical Clocks and Casual Ordering of Events	1	CO1
2	**Mutual Exclusion and Deadlock Detection Algorithms**		CO2
2.1	Election Algorithm , Distributed Mutual Exclusion	2	CO2
2.2	Distributed Deadlock Detection Algorithms.	2	CO2
3	**Cloud Computing**		CO3
3.1	Introduction, Evolution of Cloud Computing, Cloud Characteristics, NIST	2	CO3
3.2	Elasticity in Cloud, On-demand Provisioning	1	CO3
3. 3	Cloud Computing Reference Architecture, Architectural Design Challenges	1	CO3
3.4	Deployment Models: Public, Private and Hybrid Clouds	2	CO3
3.5	Service Models: IaaS – PaaS – SaaS – Benefits of Cloud Computing	2	CO3
4	**Cloud Enabling Technologies**		CO4
4.1	Introduction to Web Service and Service Oriented Architecture, SOAP, RES	2	CO4
4.2	Basics of Virtualization, Full and Para Virtualization, Implementation Levels of	2	CO4

	Virtualization		
4.3	Tools and Mechanisms, Virtualization of CPU, Memory, I/O Devices.	2	CO4
4.4	Desktop Virtualization, Server Virtualization.	2	CO4
5	**Cloud Management, Storage and Security**		CO5
5.1	Resource Provisioning and Methods, Cloud Management Products	1	CO5
5.2	Cloud Storage, Provisioning Cloud Storage, Managed and Unmanaged Cloud Storage	2	CO5
5.3	Cloud Security Overview, Cloud Security Challenges, Security Architecture design	1	CO5
5.4	Virtual Machine Security, Application Security, Data Security.	2	CO5
6	**Cloud Software and Computing Platforms**		CO6
6.1	DFS, Map Reduce	1	CO6
6.2	Google App Engine (GAE), Programming Environment for GAE, Architecture of GFS	2	CO6
6.3	**Case Studies**: Openstack, Heroku, Docker Containers, Amazon EC2, AWS, Microsoft Azure, Google Compute Engine.	3	CO6
	TOTAL	**36**	

Course Designers:

1. Mrs.P.Suganthi psica@tce.edu

21CBRA1	USABILITY DESIGN OF SOFTWARE APPLICATIONS

Category	L	T	P	Credit	Terminal Exam Type
PEES	3	0	0	3	Theory

Preamble

The course emphasizes creating user-friendly software applications by incorporating the principles of smart design and user experience design. Through this course, learners will get acquainted with user- friendly and interactive user interfaces for software applications. This course provides a deep understanding of how users of a software application can achieve the specified goals easily.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage in %
CO1	Understand the basic concepts of user-centered software design process	15
CO2	Describe the various aspects of user-centered design for real world problems.	15
CO3	Apply the heuristic principles to evaluate the interactive design for software applications.	25
CO4	Perform usability testing to redesign projects during the design life cycle.	15
CO5	Apply user experience (UX) design to digital artifacts.	15
CO6	Apply the design thinking technique for product development.	15

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond	Guided Response	1.2, 4.3.2
CO2	TPS3	Understand	Respond	Guided Response	1.2, 4.3.2
CO3	TPS3	Apply	Value	Mechanism	1.2, 2.1.2, 3.2.3, 4.3.2
CO4	TPS3	Apply	Value	Mechanism	1.2, 2.1.2, 3.2.3, 4.5.3
CO5	TPS3	Apply	Value	Mechanism	1.2, 2.1.2, 3.2.3, 4.5.3
CO6	TPS3	Apply	Value	Mechanism	1.2, 2.1.2, 3.2.3, 4.5.3

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L										L		
CO2	S	M	L			L	L		L		L	M	L	L
CO3	S	M	L			L	L		L		L	M	L	L
CO4	S	M	L			L	L		L		L	M	L	L
CO5	S	M	L			L	L		L		L	M	L	L
CO6	S	M	L	L		L	L		L		L	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive levels	Continuous Assessment Tests		Assignments		Terminal examination
	1	2	1	2	
Remember	20	10			10
Understand	20	30	30		30
Apply	60	60	70	100	60
Analyse					
Evaluate					
Create					

Sample Questions for Course Outcome Assessment**

Course Outcome 1(CO1):

1. What are the elements of user centered design?
2. Briefly explain UCD Process.
3. Explain in detail about Agile aspects of user centered design

Course Outcome 2(CO2):

1. Explain User Cantered design Process to evaluate the following case study

Consider a system that includes a Web server and two database servers. Both Database servers are identical: the first acts as a main server, and the second acts as a redundant back-up in case the first one fails. Users use Web browsers to access data through the Web server. They also have the option of using a proprietary client that accesses the databases directly.

2. Explain the Ergonomics for mobile for the left hand side user.
3. "User Centered Design is a Multi Disciplinary Process" Comment your answers with an example.

Course Outcome 3(CO3):

1. Illustrate the various principles of Heuristic evaluation.
2. Examine the importance of Heuristic Evaluation for OS development
3. Experiment the frustrating experiences and error messages for the devices you have discussed and list the ways to improvise it for customer need

Course Outcome 4 (CO4):

1. Look at the entire competitive landscape to find all the mousetraps that exist and document what makes them tick. Conduct comparative research on other companies to see if there are products that achieve a similar goal in a different way.
2. How do we adapt and model all of our old design patterns to this new design system?
3. Illustrate the look and feel effect in Mac OS and Windows OS

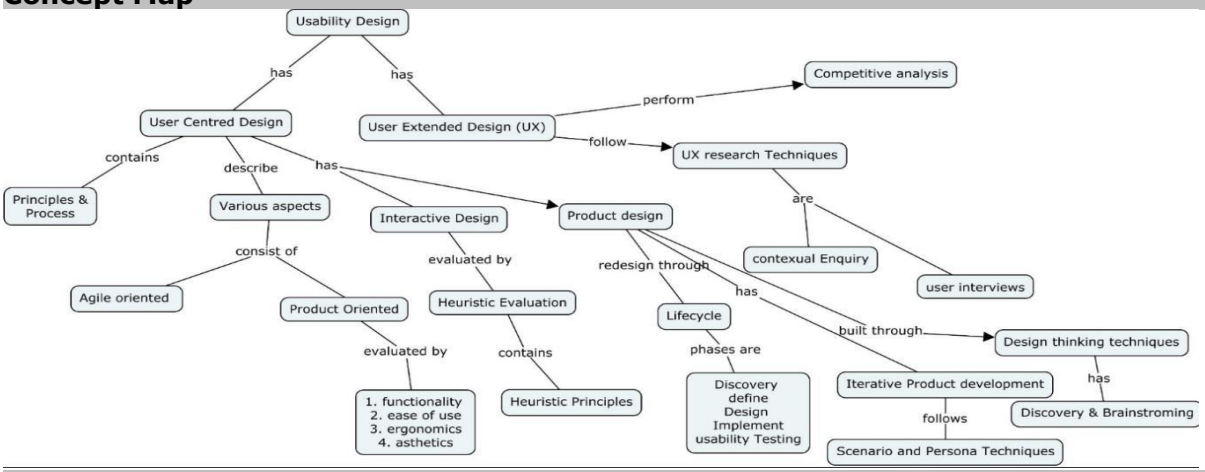
Course Outcome 5 (CO5):

1. Design a User Interface for hand gestures as a mode of interaction for children with cognitive challenges
2. How to conduct UX research with usability testing?
3. If tasked to perform a UX evaluation of a product, what would your process look like to accomplish this? Can you tell me about a project you did this for and what the outcome of the evaluation was?

Course Outcome 6(CO6):

1. Apply the story board for the game console you are developing
2. Illustrate the Speech Based Mobile Interface for the Textually Low Literate
3. Practice Interactive Information Platform for Remote Health Care
4. Illustrate with an example how to create user personas.

Concept Map



Syllabus

Introduction to User Centered Design

Basics of User Centered Design – Elements – Models and approaches – User Centered Design Principles – Usability – UCD Process – Agile Aspects of User Centered Design

Aspects of User Centered Design

Product Appreciation Assignment – Evaluating the product from user centered design aspects such as functionality, ease of use, ergonomics and aesthetics

Interactive Design Evaluation

Introduction to Interactive design process – Interactive design in practice – Introducing evaluation – Evaluation: Inspection, Analysis and Models – Heuristic Evaluation: 10 Heuristic principles, Examples – Group Assignment initiation (Website and App) – Evaluation for key tasks of the app or website for heuristic principles, severity, recommendations.

Project Design Life Cycle

Redesign project through the design lifecycle – Discovery – Define – Design – Implement – usability Testing

User Experience Design

Understanding user – their goals – context of use and environment of use Research Techniques: Contextual Enquiry, User Interviews – Competitive Analysis of UX

Product Development

Scenarios and Persona Technique – Overview of Design Thinking Techniques – Discovery and Brainstorming – Concept Development – Task flow detailing for the project – Prototyping Techniques – Paper, Electronic and Prototyping tools.

Learning Resources

1. Jenny Preece, Helen Sharp and Yvonne Rogers, "Interaction Design: Beyond Human-Computer Interaction", 5th Edition Wiley publications, 2019.
2. Elizabeth Goodman, Mike Kuniavsky, Andrea Moed, "Observing the User Experience A Practitioner's Guide to User Research", 2nd Edition Morgan Kaufmann publications, 2012.
3. Jesse James Garrett, "The Elements of User Experience: User-Centered Design for theWeb and Beyond", 2nd Edition, Pearson Education, 2010.
4. Jonny Schneider, "Understanding Design Thinking, Lean, and Agile", 3rd edition, Oriellv publications, 2014.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Introduction to User Centred Design**		
1.1	Basics of User Centred Design	1	CO1
1.2	Elements – Models and approaches	1	CO1
1.3	Usability – UCD Process	1	CO1
1.4	User Centred Design Principles	1	CO1
1.5	Agile Aspects of User Centred Design	1	CO1

2.	**Aspects of User Centred Design**		
2.1	Product Appreciation Assignment	1	CO2
2.2	Evaluating the product from user centered design	1	CO2
2.3	Evaluating the product from user centered design aspects : ease of use	1	CO2
2.4	Evaluating the product from user centered design aspects : ergonomics	1	CO2
2.5	Evaluating the product from user centered design aspects : aesthetics	1	CO2
3.	**Interactive Design Evaluation**		
3.1	Introduction to Interactive design process	1	CO3
3.2	Interactive design in practice	1	CO3
3.3	Introducing evaluation – Evaluation: Inspection, Analysis and Models	2	CO3
3.4	Heuristic Evaluation: 10 Heuristic principles	2	CO3
3.5	Examples – Group Assignment initiation (Website and App) – Evaluation for key tasks of the app or website for heuristic principles,severity, recommendations.	2	CO3
4.	**Project Design Life Cycle**		
4.1	Redesign project through the design lifecycle – Discovery – Define – Design – Implement	2	CO4
4.2	Usability Testing	2	CO4
5.	**User Experience Design**		
5.1	Understanding user	1	CO5
5.2	Understanding their goals	1	CO5
5.3	context of use	1	CO5
5.4	environment of use Research Techniques	1	CO5
5.5	Contextual Enquiry	1	CO5
5.6	User Interviews	1	CO5
5.7	Competitive Analysis of UX	1	CO5
6.	**Product Development**		
6.1	Scenarios and Persona Technique	1	CO6
6.2	Overview of Design Thinking Techniques	1	CO6
6.3	Discovery and Brainstorming	1	CO6
6.4	Concept Development	1	CO6
6.5	Task flow detailing for the project	1	CO6
6.6	Prototyping Techniques – Paper, Electronic and Prototyping tools.	2	CO6
	Total	**36**	

Course Designer:

1. Mr.V.Janakiraman vjncse@tce.edu

21CBRB1	IMAGE PROCESSING AND PATTERN RECOGNITION

Category	L	T	P	Credit	Terminal Exam Type
PEES	3	1	0	4	Theory

Preamble

This course on Image Processing and Pattern Recognition is designed to provide students with a comprehensive understanding of digital image processing techniques and their practical applications. The course covers the fundamental concepts of image formation and registration, image transformation and filtering, image segmentation and morphological operations, color models and processing, feature extraction techniques, and real-time applications in industries, medicine, and remote sensing.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Explain the basics of image formation and registration techniques	10%
CO2	Perform image transformation functions and filtering operations on images	15%
CO3	Demonstrate the various image segmentation and morphological operations for partition of objects	25%
CO4	Apply the knowledge of different color models and its processing techniques on images	20%
CO5	Illustrate various feature extraction techniques and recognize the images for real world applications	20%
CO6	Implement the image processing techniques for various real-time applications such as industry, medicine and remote sensing	10%

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond	Guided Response	1.2, 4.3.2
CO2	TPS3	Apply	Value	Mechanism	1.2, 2.2, 2.3.1, 2.3.2, 3.1.4, 3.1.5
CO3	TPS3	Apply	Value	Mechanism	1.2, 2.3.1, 2.3.2, 2.3.3, 4.4.1, 4.5.3, 4.5.5
CO4	TPS3	Apply	Value	Mechanism	1.2, 2.2, 2.3.1, 2.3.2, 3.1.4, 3.1.5
CO5	TPS3	Apply	Value	Mechanism	1.2, 2.2, 2.3.1, 2.3.2, 3.1.4, 3.1.5
CO6	TPS3	Apply	Value	Mechanism	1.2, 4.3.4, 4.5.3, 4.5.6, 4.6.1

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L										L		
CO2	S	M	L			L	L		L		L	M	L	L
CO3	S	M	L			L	L		L		L	M	L	L
CO4	S	M	L			L	L		L		L	M	L	L

CO5	S	M	L			L	L		L		L	M	L	L
CO6	S	M	L	L	L	L	L		L		L	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive levels	Continuous Assessment Tests		Assignments		Terminal examination
	1	2	1	2	
Remember	20	20			20
Understand	30	30	30		30
Apply	50	50	70	100	50
Analyse					
Evaluate					
Create					

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject /Assignment/Practical Component
Perception	
Set	
Guided Response	30
Mechanism	70
Complex Overt Responses	
Adaptation	
Origination	

Guidelines for the Mini-Project: Group formation: Students are split into project groups with around 3 members in each group. A team can execute the project using appropriate Image processing technique

At the end of the semester, the team members have to present their project, submit their report and share their lessons learnt/best practices with other teams. Some of the activities may include: (but not limited to)

- Application identification and data set collection
- Perform feature selection and other image processing techniques such as filtering, segmentation and color processing
- Reporting the results and performance analysis for the chosen techniques
- Documentation

Some of the Mini-project titles may include: (but not limited to) • Face recognition Number plate recognition • Posture recognition • Precision Agriculture • Disease Identification • Wound detection • Cancer detection

Sample Questions for Course Outcome Assessment**

Course Outcome 1(CO1):

1.What is Quantization?

2.What is meant by image formation, and how do different registration techniques affect it?

3.Explain the difference between geometric and photometric models used in image registration. Discuss their strengths and weaknesses.

Course Outcome 2(CO2):

1.Write detailed note on Sharpening Spatial Filters

2.Describe the benefits of Histogram in Image processing.

Course Outcome 3(CO3):

1.Explain the role of image transformation functions in filtering operations. Give examples of spatial filtering techniques.

2.What are the different edge detection techniques used in image segmentation, and how do they link and detect edges?

Course Outcome 4 (CO4):

1.Define colour models used in image processing. What are the differences between RGB, CMY, HSI, YCbCr, and Lab models?
2.Differentiate false colour and pseudo colour

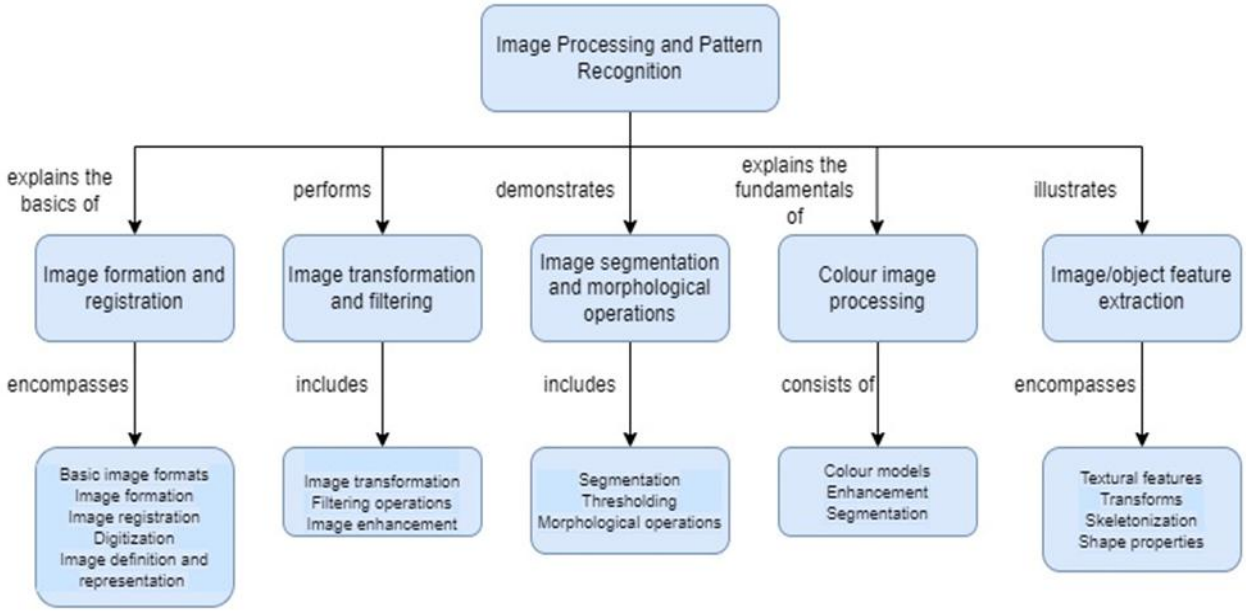
Course Outcome 5 (CO5):

1. Describe the different textural features used in image processing. How are they used for feature extraction? Give examples of their applications.
2.What is meant by skeletonization?

Course Outcome 6(CO6):

1. Explain in detail the image processing techniques used for various real-time applications such as industry, remote sensing and medicine.
2. Illustrate the various image processing techniques.

Concept Map



Syllabus

Introduction Basics of image formation and registration techniques Image processing systems and its applications. Basic image file formats. Image formation- Image Registration- Geometric and photometric models; Digitization - sampling, quantization; Image definition and its representation, neighbourhood metrics.

Image transformation functions and filtering operations Intensity transformations and spatial filtering: Enhancement, contrast stretching, histogram specification, local contrast enhancement; Smoothing, linear and order statistic filtering, sharpening, spatial convolution, Gaussian smoothing, DoG, LoG.

Image segmentation and morphological operations Segmentation: Pixel classification; Grey level thresholding, global/local thresholding; Optimum thresholding - Bayes analysis, Otsu method; Derivative based edge detection operators, edge detection/linking, Canny edge detector; Region growing, split/merge techniques, line detection, Hough transform. Morphological Filtering Basics: Dilation and Erosion Operators, Top Hat Filters.

Colour image processing: Fundamentals of different colour models - RGB, CMY, HSI, YCbCr, Lab; False colour; Pseudo colour; Enhancement; Segmentation.

Image/Object features extraction: Textural features - gray level co-occurrence matrix; Moments; Connected component analysis; Convex hull; Distance transform, medial axis transform, skeletonization/thinning, shape properties.

Learning Resources

Text Books:

1. R. C. Gonzalez and R. E. Woods, "Digital Image Processing", Prentice Hall, 4th Edition,2017

Reference Books:

1. Pitas, "Digital Image Processing - Algorithms and Applications", John Wiley,2010.

2. Frank Y. Shih, "Image Processing and Pattern Recognition: Fundamentals and Techniques", Wiley-IEEE Press, 2010
3. Anil K Jain, "Fundamentals of Digital Image Processing", Prentice Hall of India (PHI).

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1	**Introduction - Basics of image formation and registration techniques**		CO1
1.1	Image processing systems and its applications-Basic image file formats.	1	
1.2	Image formation- Image Registration-Geometric and photometric models	2	
1.3	Digitization - sampling, quantization	2	
1.4	Image definition and its representation-neighbourhood metrics	1	
2	**Image transformation functions and filtering operations**		CO2
2.1	Intensity transformations and spatial filtering	2	
2.2	Enhancement-contrast stretching-histogram specification-local contrast enhancement	2	
2.3	Smoothing, linear and order statistic filtering	1	
2.4	Sharpening-spatial convolution-Gaussian smoothing	2	
2.5	DoG-LoG	1	
3	**Image segmentation and morphological operations**		CO3
3.1	Segmentation-Pixel classification-Grey level thresholding-global/local thresholding	3	
3.2	Optimum thresholding - Bayes analysis, Otsu method-Derivative based edge detection operators- edge detection/linking-Canny edge detector	4	
3.3	Region growing-split/merge techniques-line detection-Hough transform	3	
3.4	Morphological Filtering Basics-Dilation and Erosion Operators-Top Hat Filters.	2	
4	**Colour image processing**		CO4
4.1	Fundamentals of different colour models - RGB, CMY, HSI, YCbCr, Lab	3	
4.2	False colour-Pseudo colour	3	
4.3	Enhancement- Segmentation.	3	
5	**Image/Object features extraction**		CO5
5.1	Textural features - gray level co-occurrence matrix-Moments	3	
5.2	Connected component analysis-Convex hull-Distance transform- medial axis transform	3	
5.3	Skeletonization/thinning- shape properties	3	
6.	Applying image processing techniques for an application	5	CO6
	Total No of Hours	**48**	

Course Designer:

1. Dr.P.Chitra pccse@tce.edu

21CBRC1	DATA VISUALIZATION

Category	L	T	P	Credit	**Terminal Exam Type**
PEES	3	0	0	3	Theory

Preamble

This course will help the students to understand the need of data visualization and guide them to represent an abstract view of data. To learn the various tools that provides an easy way to understand the trends, outliers and patterns in the data. To analyse a massive volume of data, the data visualization techniques are considered as an essential tool.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Explain the foundations and characteristics of data representation	15
CO2	Illustrate the basic concepts of data visualization and the levels of validation	20
CO3	Explore the data for analysing the knowledge through 2D data visualization	15
CO4	Develop a 3D visualization by interpreting the given data	15
CO5	Analyse the given data using various visualization tools such as rank analysis, Trend Analysis, etc.	20
CO6	Interpret various forms of data such as tables, spatial data, geometric data, etc.	15

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond		1.2,2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3
CO2	TPS2	Understand	Respond		1.2,2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3
CO3	TPS3	Apply	Value		1.2,2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3
CO4	TPS3	Apply	Value		1.2,2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3
CO5	TPS3	Apply	Value		1.2,2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3
CO6	TPS3	Apply	Value		1.2,2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L	L	L		L	L			L	L	L	L	L
CO2	M	L	L	L		L	L			L	L	L	L	L
CO3	S	M	L	L		L	L			L	L	M	L	L
CO4	S	M	L	L		L	L			L	L	M	L	L
CO5	S	M	L	L		L	L			L	L	M	L	L
CO6	S	M	L	L		L	L			L	L	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	**Continuous Assessment Test**		**Assignment**		**Terminal Examination**
	I	**II**	**I**	**II**	
Remember	20	20			20
Understand	40	20	50		20
Apply	40	60	50	100	60
Analyse					
Evaluate					
Create					

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject /Practical Component/Observation
Perception	
Set	
Guided Response	
Mechanism	
Complex Overt Responses	
Adaptation	
Origination	

Sample Questions for Course Outcome Assessment**

Course Outcome 1(CO1):

1. Write a Python program to display grid and draw line charts of the closing value of Alphabet Inc.between October 3, 2016 to October 7, 2016. Customized the grid lines with linestyle -, width .5.and color blue**.**
2. Define data visualization. Illustrate how data visualization is better than the traditional text based data methods.
3. Which types of features can can the human eye easily pick out of a time series plot?

Course Outcome 2(CO2):

1. Explain visualization purpose and factors influencing a visual perception?
2. How does edges, contrast and colors affect Visual Perception?
3. Explain the following: i. Matplotlib ii. Seaborn iii. Plotly iv. ggplot

Course Outcome 3(CO3):

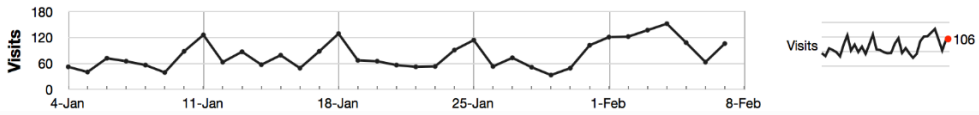
1. Write and explain in detail a python program for the following data x = [1,2,3,4,5,6]y =[2,4,1,5,2,6] .Customize the line with green coloured dashed line ,blue marker with size 12.
2. Write a Python program to display a horizontal bar chart of the popularity of programmingLanguages.Sample data:Programming languages: Java, Python, PHP, JavaScript, C#, C++Popularity: 22.2, 17.6, 8.8, 8, 7.7, 6.7
3. Explain plotting a sine wave using Matplotlib

Course Outcome 4(CO4):

1. How gridlines can be used in Matplotlib. Explain it with the function and different options available
2. This question is an extension to visualizing more than 3 variables. Investigate on your own the term "scatterplot matrix", and draw one for the Food texture data set. Create an effective scatterplot matrix with the scatterplotMatrix function. List some bullet-points that interpret the plot.
3. Create a chart that shows the variability in website traffic for each day of the week.

Course Outcome 5(CO5):

1. Construct a correlation matrix using the core function of the data frame?
2. How can we visualize more than three dimensions of data in a single chart?
3. The data shown here are the number of visits to a university website for a particular statistics course. There are 90 students in the class.



a. What are the names (type) of the 2 plots shown?

b. List any 2 interesting features in these data.

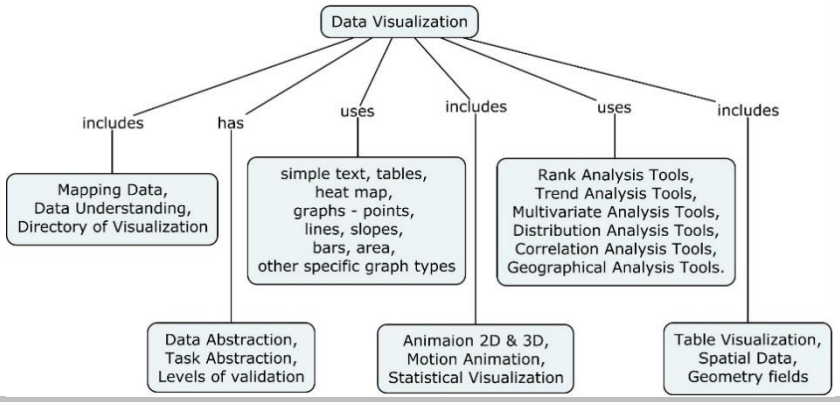
Course Outcome 6(CO6):

1. Construct a visualization graph to capture the track of a cab using GPS track logger**.**
2. With an example demonstrate different line style in a single graph.

3. Compare the defect types (number of defects) for different product grades (categories) given in the table. Which defects cost us the most money?

	Total defects	A	B	C	D	E
A4636	131	37	21	28		45
A2524	86	20	24	21	1	20
A3713	75	17	13	18		27
A4452	73	5	33	17		18
A4088	72	14	16	12	2	28
A2103	68	14	13	14	1	26
A2156	68	16	13	19	2	18
A3681	66	12	16	9	1	28
A1366	50	11	15	12		12
A2610	39	5	7	12		15
Total	728	151	171	162	7	237

Concept Map



Syllabus

From Data to Visualization - Mapping Data onto Aesthetics, Coordinate System and Axes Applications, Color Scales, Directory of Visualization – Amounts, Distribution, Proportions, x-y relationships, Geospatial Data, Uncertainity.

Foundation of data visualization – Need of visualization– understand the context, exploratory vs explanatory analysis, Difficulty in Validation. *Data Abstraction*: Dataset types, Attribute types, Semantics. *Task Abstraction*: Analyze, Produce, Search, Query. *Four levels of validation*: Validation approaches, Validation examples, Marks and Channel.

Visualization Techniques- simple text, tables, heat map, graphs - points, lines, slopes, bars, area, other specific graph types – pie, donut, Interactive Visualizations and Animations - Dynamic charts - Dynamic maps - Animation types - 2D, 3D, Motion Animation - Animation Principles - Altair Package - Statistical Visualizations – Data Stories.

Data Visualization Tools: Rank Analysis Tools- Trend Analysis Tools- Multivariate Analysis Tools- Distribution Analysis Tools- Correlation Analysis Tools- Geographical Analysis Tools.

Visualize Tables and Spatial Data: Categorical regions - Spatial axis orientation - Spatial layout density. Arrange spatial data: Geometry - Scalar fields - Vector fields - Tensor fields.

Assessment for Assignment:
Students can for a team of 2 and perform visualization for various real time data analytics case studies using visualization tools such as Tableau, Zoho Analytics/Reports, Visual.ly, IBM Watson etc.

Learning Resources

Text Books:

1. Claus Wilke, 'Fundamentals of Data Visualization:A Primer on Making Informative and Compelling Figures", O'Reilly Media, 2019.
2. Alexandru Telea, 'Data Visualization:Principles and Practice, Second Edition', Taylor & Francis, 2015.

Reference Books:

1. Kyran Dale, 'Data Visualization with Python and JavaScript Scrape, Clean, Explore & Transform Your Data', O'Reilly Media, 2016.
2. Ware C and Kaufman M, 'Visual thinking for design', Morgan Kaufmann Publishers, 2008.
3. Chakrabarti S, 'Mining the web: Discovering knowledge from hypertext data', Morgan Kaufman Publishers, 2003.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1	**From Data to Visualization**		
1.1	Mapping Data onto Aesthetics, Coordinate System and Axes Applications, Color Scales,	2	CO1
1.2	Directory of Visualization – Amounts, Distribution, Proportions,	2	CO1
1.3	x-y relationships, Geospatial Data, Uncertainity.	1	CO1
2	**Foundation of data visualization**		
2.1	Need of visualization– understand the context, exploratory vs explanatory analysis, Difficulty in Validation.	2	CO2
2.2	Data Abstraction: Dataset types, Attribute types, Semantics.	2	CO2
2.3	Task Abstraction: Analyze, Produce, Search, Query.	2	CO2
2.4	Four levels of validation: Validation approaches, Validation examples, Marks and Channel.	1	CO2
3	**Visualization Techniques**		
3.1	Simple text, tables, heat map, graphs	2	CO3
3.2	Points, lines, slopes, bars, area, other specific graph types	2	CO3
3.3	Pie, donut, Interactive Visualizations	2	CO3
4	**Animations**		
4.1	Dynamic charts - Dynamic maps	2	CO4
4.2	Animation types - 2D, 3D, Motion Animation - Animation Principles	2	CO4
4.3	Altair Package - Statistical Visualizations – Data Stories	2	CO4
5	**Data Visualization Tools**:		
5.1	Rank Analysis Tools- Trend Analysis Tools-	2	CO5
5.2	Multivariate Analysis Tools	2	CO5
5.3	Distribution Analysis Tools	1	CO5
5.4	Correlation Analysis Tools	1	CO5
5.5	Geographical Analysis Tools.	1	CO5
6	**Visualize Tables and Spatial Data**:		
6.1	Categorical regions	1	CO6
6.2	Spatial axis orientation - Spatial layout density	1	CO6
6.3	Arrange spatial data: Geometry	1	CO6
6.4	Scalar fields - Vector fields - Tensor fields	2	CO6
	TOTAL	**36**	

Course Designer:

1. Dr. A. Malini amcse@tce.edu
2. Mrs. J. Felicia Lilian jflcse@tce.edu

21CBRD1	LOGISTICS MANAGEMENT

Category	L	T	P	Credit	Terminal Exam Type
PEES	3	0	0	3	Theory

Preamble

This course emphasis on students to create the role of logistics in a market-oriented society and examine the major functions of logistics, and also students will improve the employability and open up career paths such as inventory planning, distribution plans, warehouse management.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage in%
CO1	Understand the fundamental concepts of logistics and its management	10
CO2	Apply the various principles & concepts of logistics management to help and manage supply chain operations.	15
CO3	Apply the logistics KPI metrics & strategies against industry benchmark.	20
CO4	Apply collaborative planning, forecasting, and replenishment for supply chain integration.	20
CO5	Apply the global logistics strategies for improving the performance of a company.	15
CO6	Apply the sustainable logistic principles for environmental sustainability, procurement and supplier management.	20

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond	Guided Response	1.2, 4.3.2
CO2	TPS3	Apply	Value	Mechanism	1.2,2.1.2,3.2.3,4.5.3
CO3	TPS3	Apply	Value	Mechanism	1.2,2.1.2,3.2.3,4.3.2
CO4	TPS3	Apply	Value	Mechanism	1.2,2.1.2,3.2.3,4.5.3
CO5	TPS3	Apply	Value	Mechanism	1.2,2.1.2,3.2.3,4.5.3
CO6	TPS3	Apply	Value	Mechanism	1.2,2.1.2,3.2.3,4.5.3

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L										L		
CO2	S	M	L			L	L		L		L	M	L	L
CO3	S	M	L			L	L		L		L	M	L	L
CO4	S	M	L			L	L		L		L	M	L	L
CO5	S	M	L			L	L		L		L	M	L	L
CO6	S	M	L	L		L	L		L		L	M	L	L

S-Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive levels	Continuous Assessment Tests		Assignments		Terminal examination
	1	2	1	2	
Remember	20	10			20
Understand	20	30	30		20
Apply	60	60	70	100	60
Analyze					
Evaluate					
Create					

Assessment Pattern: Psychomotor

Psychomotor Skill	**Mini project/Assignment/Practical Component**
Perception	
Set	
Guided Response	30
Mechanism	70
Complex Overt Responses	
Adaptation	
Origination	

Sample Questions for Course Outcome Assessment**

Course Outcome 1(CO1):

1. Define logistics.
2. Describe about Current trends and challenges in logistics management.
3. Explain the key objectives of logistic management.

Course Outcome 2(CO2):

1. The following are monthly costs incurred by Transport Company. Identify the basic costs of transportation. Rent of container Rs. 1,20,00,000, Rent of office Rs. 27,500, Diesel cost Rs.80,000,Driversalary Rs. 15,000, Cleaner salary 5,000, Vehicle repairs Rs.45,000, LoadingandunloadingcostsRs.25,000
2. Indian Oil Company wish supply LP gas to its customers for cooking purpose at cheaper rate by minimizing its transport costs? What is best means of transport?
3. Examine the need for inventory management.
4. Illustrate the concept of warehouse and examine its functions.

Course Outcome 3(CO3):

1. Illustrate how to achieve integration in logistics.
2. Develop are sources and logistics required in setting up a therapeutic drug monitoring services?
3. Illustrate the various strategies involved in logistics management.

Course Outcome 4(CO4):

1. Draw a graph illustrating the bullwhip effect and discuss its impact on the measures of supply chain performance.
2. Construct a unified view of Vendor-managed inventory (VMI) in automobile industries.
3. Illustrate the role of logistics in supply chain strategies

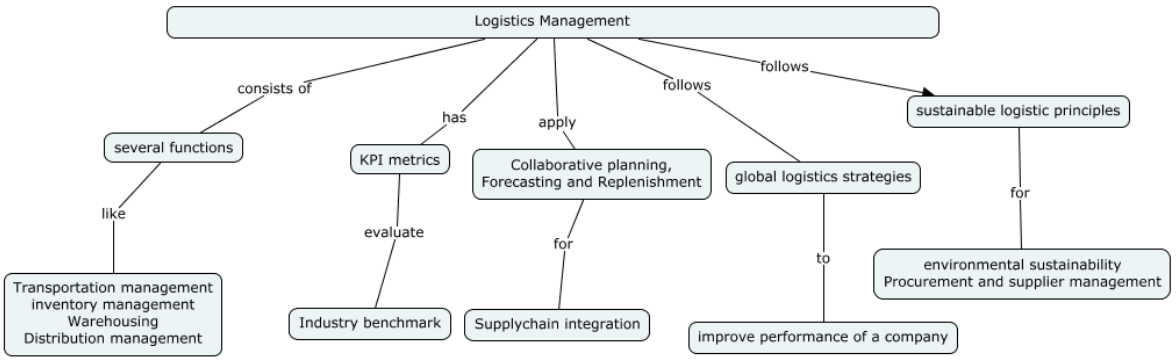
Course Outcome 5(CO5):

1. Illustrate with an example for Inco terms and international shipping terms
2. Explain in detail about trading.
3. Demonstrate the role of global logistics in SCM.

Course Outcome 6(CO6):

1. Expose the massive importance of Green Logistics and its major drivers.
2. Explain the feasible methods to achieve Supply chain Sustainability?
3. Elaborate the different stages in EIA.

Concept Map



Syllabus

Introduction to Logistics and Logistics Management

Definition and scope of logistics - Key objectives of logistics management - Evolution of logistics management- Current trends and challenges in logistics management

Transportation, Inventory, Warehousing, and Distribution Management

Transportation Management: Modes of transportation (land, sea, air)-Carrierselectionandnegotiation-Routingandscheduling-Transportationcostmanagement

Inventory Management: Types of inventories - Inventory costs and trade-offs - Inventory control policies (e.g., EOQ, safety stock, JIT)-Inventory performance metrics

Warehousing and Distribution: Types of warehouses and distribution centers - Design and layout of warehouses-Warehouse operations (e.g., receiving, put away, picking, packing)-Warehouse performance metrics

Logistics Performance, Strategy

Logistics Performance Measurement: Key performance indicators (KPIs) in logistics – Balanced score card approach to logistics performance measurement- Benchmarking and continuous improvement- Linking logistics performance to overall business performance

Logistics Strategy: Strategic role of logistics – Definition-role of logistics managers in strategic decisions-Strategy options, Lean Strategy, Agile Strategies & Other strategies-Designing & implementing a logistical strategy

Logistics Integration

Supply Chain Integration: Role of logistics in supply chain management - Collaborative planning, forecasting, and replenishment (CPFR) -Vendor-managed inventory (VMI)-Electronic data interchange (EDI) and other supply chain technologies

Global Logistics and Trade

International trade regulations and compliance-Inco terms and international shipping terms - Customs clearance and documentation - Global logistics strategies and challenges, Emerging Topics in Logistics Management - E-commerce logistics - Omni-channel logistics –Artificial intelligence and automation in logistics

Sustainable Logistics

Sustainability in Logistics - Overview of sustainable logistics - Importance of sustainable logistics Key sustainability challenges in logistics-Environmental Sustainability in Logistics-Greenhouse gas emissions and carbon footprint of logistics operations-Sustainable transportation modes (e.g., electric vehicles, bicycles)-Sustainable packaging and materials handling - Labor rights and ethical considerations in logistics operations - Workforce diversity and inclusion-Health and safety in logistics operations Sustainable procurement and supplier management-Sustainable logistics network design and optimization - Return on investment (ROI) of sustainable logistics initiatives.

Learning Resources

1. SL.Ganapathi, SK.Nandhi," Logistics Management", 1st edition oxford university press, 2016.

2. Ram Singh, "International trade Logistics", 1st edition oxford university press, 2018.
3. Vinod.V.Sople "Logistics Management –The Supply Chain Imperative", 3rd edition, Pearson Education, 2016.

Course Contents and Lecture Schedule

Module No.	Topic	No.of Hours	Course Outcome
1	**Introduction to Logistics and Logistics Management**		
1.1	Definition and scope of logistics	1	CO1
1.2	Key objectives of logistics management	1	CO1
1.3	Evolution of logistics management	1	CO1
1.4	Current trends and challenges in logistics management	1	CO1
	Transportation, Inventory, Warehousing, and Distribution Management		
2.1	Transportation Management: Modes of transportation (land, sea, air)	1	CO2
2.2	Carrier selection and negotiation - Routing and scheduling - Transportation cost management	1	CO2
2.3	Inventory Management: Types of inventories	1	CO2
2.4	Inventory costs and trade-offs		
2.5	Inventory control policies (e.g., EOQ, safety stock, JIT)- Inventory Performance metrics	1	CO2
2.6	**Warehousing and Distribution:** Types of warehouses and distribution centers	1	CO2
2.7	Design and layout of warehouses	1	CO2
2.8	Warehouse operations e.g.,receiving,putaway,picking,packing)- Warehouse performance metrics	1	CO2
	Logistics Performance, Strategy, and Integration		
3.3	Logistics Performance Measurement: Key performance indicators(KPIs) in logistics	1	CO3
3.2	Balanced scorecard approach to logistics performance measurement	1	CO3
3.3	Benchmarking and continuous improvement		CO3
3.4	Linking logistics performance to overall business performance	1	CO3
3.5	Logistics Strategy: Strategic role of logistics–Definition-role of logistics managers in strategic decisions	1	CO3
3.6	Strategy options, Lean Strategy, Agile Strategies &Other strategies	1	CO3
3.7	Designing &implementing a logistical strategy	1	CO3
	Supply Chain Integration		
4.1	Role of logistics in supply chain management	1	CO4
4.2	Collaborative planning, forecasting, and replenishment(CPFR)	1	CO4
4.3	Vendor-managed inventory(VMI)	1	CO4
4.4	Electronic data interchange (EDI) and other supply chain Technologies	2	CO4
	Global Logistics and Trade		
5.1	International trade regulations and compliance	1	CO5
5.2	Inco terms and international shipping terms	1	CO5
5.3	Customs clearance and documentation	1	CO5
5.4	Global logistics strategies and challenges	1	CO5

5.5	Emerging Topics in Logistics Management-E-commerce logistics	1	CO5
5.6	Omni-channel logistics		
5.7	Artificial intelligence and automation in logistics	1	CO5
	Sustainable Logistics		
6.1	Sustainability in Logistics-Overview of sustainable logistics	1	CO6
6.2	Importance of sustainable logistics Key sustainability challenges in logistics	1	CO6
6.3	Environmental Sustainability in Logistics-Green house gas emissions and carbon foot print of logistics operations	1	CO6
6.4	Sustainable transportation modes(e.g., electric vehicles, bicycles)- Sustainable packaging and materials handling	1	CO6
6.5	Labor rights and ethical considerations in logistics operations	1	CO6
6.6	Workforce diversity and inclusion-Health and safety in logistics Operations	1	CO6
6.7	Sustainable procurement and supplier management-Sustainable logistics network design and optimization	1	CO6
6.8	Return on investment (ROI)of sustainable logistics initiatives.	1	CO6
	Total	**36**	

Course Designer:

1. Dr.P.Chitra pccse@tce.edu
2. Mr.V.Janakiraman vjncse@tce.edu

21CBQA1	DATA MINING FOR BUSINESS INTELLIGENCE

Category	L	T	P	Credit	Terminal Exam Type
PEES	3	0	0	3	Theory

Preamble

Students will learn key quantitative techniques essential for analysing and improving business operations. Learn to apply important quantitative methods developed in the fields of data mining and business intelligence that are commonly used to solve business related problems. At the end of this course, students will better understand the need and appropriate place for data mining, the major techniques used in data mining, and the important pitfalls to avoid.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage** in %
CO1	Understand the principles of data mining, data pre-processing and data visualization techniques.	15
CO2	Identify an appropriate data mining technique for a given problem.	20
CO3	Apply various classification and clustering techniques using WEKA tool.	25
CO4	Apply common methods used in business intelligence by identifying Key Performance Indicators (KPI's), dashboards, reports and CRM concepts and solutions.	15
CO5	Implementation of a BI system by planning the resources and choosing the right size, shape, cost of architecture.	15
CO6	Solve practical problems using BI and provide needed decision support.	10

** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond		1.2,1.3,2.2,2.3,2.5.4,4.2
CO2	TPS3	Apply	Value		1.2,2.1,2.2,4.1,4.2
CO3	TPS3	Apply	Value		1.2, 2.1.2,4.4,4.5,4.6
CO4	TPS3	Apply	Value		1.2,2.3,4.2,4.3,4.4,4.5, 4.6
CO5	TPS3	Apply	Value		1.2,2.1,2.3,4.5
CO6	TPS3	Apply	Value		1.2,2.1,2.5,3.1.5,4.3,4.5,4.6

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L	L	L			L				M	M		L
CO2	S	M	M	L			L				M	S		L
CO3	S	M	S		M		L				M	S	L	L
CO4	S	S	M		M		L				M	M	L	L
CO5	S	S	M				L				M	M		L
CO6	S	S	M		M		L				M	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	2	1	2	
Remember	30	30			20
Understand	30	30	50	50	30
Apply	40	40	50	50	50
Analyse					
Evaluate					
Create					

Sample Questions for Course Outcome Assessment**

** (2 to 3 at the cognitive level of course outcome)

Course Outcome 1(CO1):

1. Define each of the following data mining functionalities: characterization, discrimination, association and correlation analysis, classification, regression, clustering, and outlier analysis. Give examples of each data mining functionality, using a real-life database that you are familiar with.
2. Present an example where data mining is crucial to the success of a business. What data mining functionalities does this business need (e.g., think of the kinds of patterns that could be mined)? Can such patterns be generated alternatively by data query processing or simple statistical analysis?
3. Suppose that the data for analysis includes the attribute age. The age values for the data tuples are (in increasing order) 13, 15, 16, 16, 19, 20, 20, 21, 22, 22, 25, 25, 25, 25, 30, 33, 33, 35, 35, 35, 35, 36, 40, 45, 46, 52, 70.
   - **a.** What is the mean of the data? What is the median?
   - **b.** What is the mode of the data? Comment on the data's modality (i.e., bimodal, trimodal, etc.).
   - **c.** What is the midrange of the data?
   - **d.** Can you find (roughly) the first quartile (Q1) and the third quartile (Q3) of the data?
   - **e.** Give the five-number summary of the data.
   - **f.** Show a boxplot of the data.
   - **g.** How is a quantile–quantile plot different from a quantile plot?

Course Outcome 2(CO2):

1. Explain the process of mining the World Wide Web.
2. Quantitative association rules may disclose exceptional behaviours within a data set, where "exceptional" can be defined based on statistical theory. Given the association rule
   Sex = female ⇒ mean wage = $7.90/hr (overall mean wage = $9.02/hr),
   Which suggests an exceptional pattern? The rule states that the average wage for females is only $7.90 per hour, which is a significantly lower wage than the overall average of $9.02 per hour. Discuss how such quantitative rules can be discovered systematically and efficiently in large data sets with quantitative attributes.
3. You are given the transaction data shown in the Table below from a fast food restaurant. There are 9 distinct transactions (order: 1 – order: 9) and each transaction involves between 2 and 4 meal items. There are a total of 5 meal items that are involved in the transactions. For simplicity we assign the meal items short names (M1 – M5) rather than the full descriptive names (e.g., Big Mac)

Metal Item	List of item IDs	Metal Item	List of item IDs
Order 1	M1, M2. M5	Order 6	M2, M3
Order 2	M2. M4	Order 7	M1, M3
Order 3	M2, M3	Order 8	M1, M2. M3, M5
Order 4	M1, M2, M4	Order 9	M1, M2, M3
Order 5	M1, M3		

For all of the parts below the minimum support is 2/9 (.222) and the minimum confidence is 7/9 (.777). Note that you only need to achieve this level, not exceed it. Show your work for full credit (this mainly applies to part a).

a. Apply the Apriori algorithm to the dataset of transactions and identify all frequent k itemset. Show all of your work. You must show candidates but can cross them off to show the ones that pass the minimum support threshold.
b. Find all strong association rules of the form: X ^ Y ^ Z and note their confidence values.

Course Outcome 3(CO3):

1. Discuss the key issues of Hierarchical clustering methods.
2. Design an efficient method that performs effective naive Bayesian classification over an infinite data stream (i.e., you can scan the data stream only once). If we wanted to discover the evolution of such classification schemes (e.g., comparing the classification scheme at this moment with earlier schemes such as one from a week ago), what modified design would you suggest?
3. For the following medical diagnosis data, create a decision tree

Sore throat	**Fever**	**Swollen glands**	**Congestion**	**Headache**	**Diagnosis**
Yes	Yes	Yes	Yes	Yes	Strep throat
No	No	No	Yes	Yes	Allergy
Yes	Yes	No	Yes	No	Cold
Yes	No	Yes	No	No	Strep throat
No	Yes	No	Yes	No	Cold
No	No	No	Yes	No	Allergy
No	No	Yes	No	No	Strep throat
Yes	No	No	Yes	Yes	Allergy
No	Yes	No	Yes	Yes	Cold
Yes	Yes	No	Yes	Yes	Cold

Course Outcome 4 (CO4):

1. Create a visual to show the weather pattern in your city. Could you show together temperature, humidity, wind, and rain/snow over a period of time.
2. Businesses need a "two-second advantage" to succeed. What does that mean to you?
3. Assuming that data mining techniques are to be used in the following cases, identify whether the task required is supervised or unsupervised learning.
   i) Deciding whether to issue a loan to an applicant based on demographic and financial data (with reference to a database of similar data on prior customers).
   ii) In an online bookstore, making recommendations to customers concerning additional items to buy based on the buying patterns in prior transactions.
   iii) Identifying a network data packet as dangerous (virus, hacker attack) based on comparison to other packets whose threat status is known.

Course Outcome 5 (CO5):

1. How Optimization models are used for calls and product presentations planning?
2. Scenario: You are a new analyst for Acell, a company selling laptops. You have been provided with data about products and sales. Your task is to help the company to plan product strategy and pricing policies that will maximize Acell's projected revenues in 2009. Using an interactive visualization tool, answer the following questions.

   Price Questions

   a. At what prices are the laptops actually selling?
   b. Does price change with time? (Hint: Make sure that the date column is recognized as such. The software should then enable different temporal

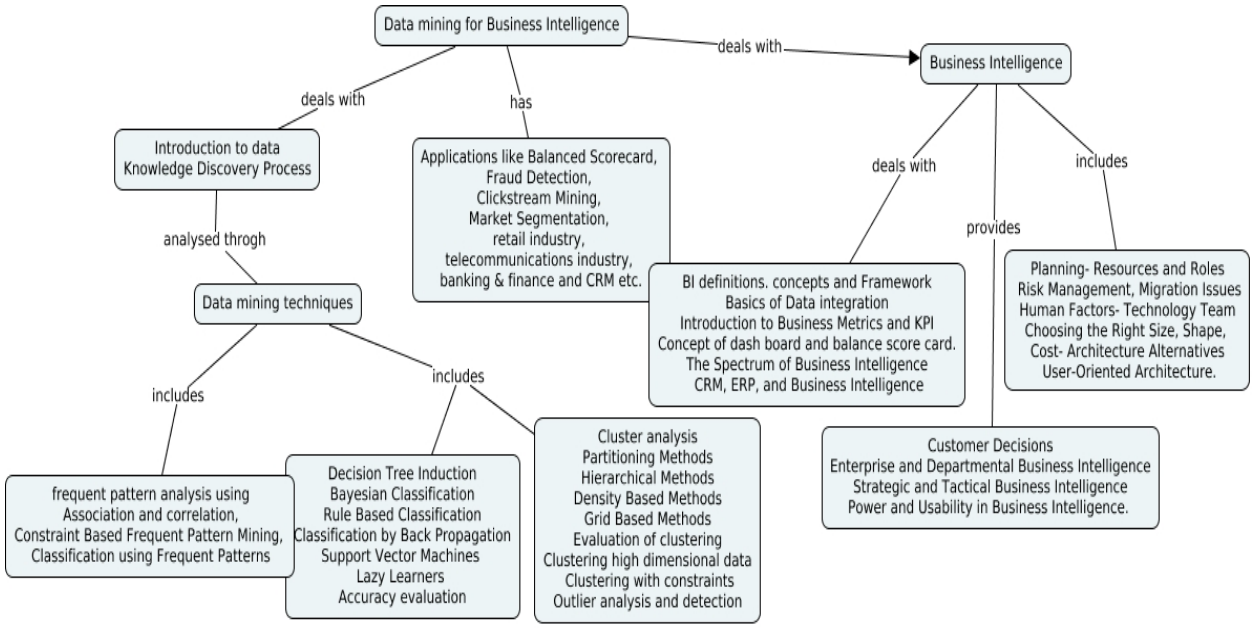
aggregation choices, e.g., plotting the data by weekly or monthly aggregates, or even by day of week.)

c. Are prices consistent across retail outlets?
d. How does price change with configuration?

Course Outcome 6(CO6):

1. How does big data impact the business models?
2. Here are a few comments from customer service calls received by Liberty.
   a. I loved the design of the shirt. The size fitted me very well. However, the fabric seemed flimsy. I am calling to see if you can replace the shirt with a different one. Or please refund my money.
   b. I was running late from work, and I stopped by to pick up some groceries. I did not like the way the manager closed the store while I was still shopping.
   c. I stopped by to pick up flowers. The checkout line was very long. The manager was polite but did not open new cashiers. I got late for my appointment.
   d. The manager promised that the product will be there, but when I went there the product was not there. The visit was a waste. The manager should have compensated me for my trouble.
   e. When there was a problem with my catering order, the store manager promptly contacted me and quickly got the kinks out to send me replacement food immediately. They are very courteous.
   Create a TDM with not more than six key terms. [Hint: Treat each comment as a document.

Concept Map



Syllabus

Data Mining Systems

Introduction to Data Mining Systems – Knowledge Discovery Process – Data Mining Techniques – Issues – applications- Data Objects and attribute types, Statistical description of data, Data Pre-processing – Cleaning, Integration, Reduction, Transformation and discretization, Data Visualization, Data similarity and dissimilarity measures.

Frequent Pattern Analysis

Mining Frequent Patterns, Associations and Correlations – Mining Methods- Pattern Evaluation Method – Pattern Mining in Multilevel, Multi-Dimensional Space – Constraint Based Frequent Pattern Mining, Classification using Frequent Patterns

Classification and Clustering
Decision Tree Induction - Bayesian Classification – Rule Based Classification – Classification by Back Propagation – Support Vector Machines – Lazy Learners – Model Evaluation and Selection-Techniques to improve Classification Accuracy. Clustering Techniques – Cluster analysis-Partitioning Methods - Hierarchical Methods – Density Based Methods - Grid Based Methods – Evaluation of clustering – Clustering high dimensional data- Clustering with constraints, Outlier analysis-outlier detection methods- Weka tool.

Business performance management -BI definitions and concepts- BI Framework- Basics of Data integration- Introduction to Business Metrics and KPI – Concept of dash board and balance score card. The Spectrum of Business Intelligence- CRM, ERP, and Business Intelligence- Customer Decisions- Enterprise and Departmental Business Intelligence- Strategic and Tactical Business Intelligence- Power and Usability in Business Intelligence.

Business Intelligence Project Plan- Planning- Resources and Roles- Risk Management- Data Migration Issues- Human Factors- The Business Intelligence Technology Team- Choosing the Right Size, Shape, and Cost- Architecture Alternatives- User-Oriented Architecture.

Business Intelligence Applications: Data mining for business Applications like Balanced Scorecard, Fraud Detection, Clickstream Mining, Market Segmentation, retail industry, telecommunications industry, banking & finance and CRM etc.

Learning Resources

1. Jiawei Han, Micheline Kamber and Jian Pei, "Data Mining Concepts and Techniques", Third Edition, Elsevier Publisher, 2011.
2. Galit Shmueli, Nitin R. Patel, and Peter C. Bruce, Data Mining for Business Intelligence, 2nd Edition, Wiley, 2010.
3. Carlo Vercellis, Business Intelligence: Data Mining and Optimization for Decision Making,Wiley India Publications,2009.
4. Loshin D, "Business Intelligence", First Edition, Elsevier Science, 2003.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Data Mining Systems**		
1.1	Introduction to Data Mining Systems – Knowledge Discovery Process	1	CO1
1.2	Data Mining Techniques – Issues	1	CO1
1.3	applications- Data Objects and attribute types, Statistical description of data	1	CO1
1.4	Data Pre-processing – Cleaning, Integration, Reduction, Transformation and discretization,	1	CO1
1.5	Data Visualization, Data similarity and dissimilarity measures.	1	CO1
2	**Frequent Pattern Analysis**		
2.1	Mining Frequent Patterns, Associations and Correlations	1	CO2
2.2	Mining Methods- Pattern Evaluation Method	1	CO2
2.3	Pattern Mining in Multilevel, Multi-Dimensional Space	2	CO2
2.4	Constraint Based Frequent Pattern Mining	1	CO2
2.5	Classification using Frequent Patterns	2	CO2
3	**Classification and Clustering**		
3.1	Decision Tree Induction	1	CO3
3.2	Bayesian Classification – Rule Based Classification	1	CO3
3.3	Classification by Back Propagation – Support Vector Machines	1	CO3

3.4	Lazy Learners – Model Evaluation and Selection- Techniques to improve Classification Accuracy.	1	CO3
3.5	Clustering Techniques – Cluster analysis-Partitioning Methods	1	CO3
3.6	Hierarchical Methods – Density Based Methods - Grid Based Methods	1	CO3
3.7	Evaluation of clustering – Clustering high dimensional data	1	CO3
3.8	Clustering with constraints, Outlier analysis-outlier detection methods- Weka tool.	2	CO3
4	**Business performance management**		
4.1	BI definitions and concepts- BI Framework- Basics of Data integration	1	CO4
4.2	Introduction to Business Metrics and KPI – Concept of dash board and balance score card.	1	CO4
4.3	**The Spectrum of Business Intelligence-** CRM, ERP, and Business Intelligence- Customer Decisions	2	CO4
4.4	Enterprise and Departmental Business Intelligence	1	CO4
4.5	Strategic and Tactical Business Intelligence- Power and Usability in Business Intelligence.	1	CO4
5	**Business Intelligence Project Plan**		
5.1	Planning- Resources and Roles- Risk Management	1	CO5
5.2	Data Migration Issues- Human Factors- The Business Intelligence Technology Team	2	CO5
5.3	Choosing the Right Size, Shape, and Cost-Architecture Alternatives- User-Oriented Architecture	2	CO5
6	**Business Intelligence Applications**		
6.1	Balanced Scorecard, Fraud Detection, Clickstream Mining, Market Segmentation	2	CO6
6.2	Retail industry, telecommunications industry, banking & finance and CRM etc.	2	CO6
	TOTAL	**36**	

Course Designers:

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21CBPN1	CONVERSATIONAL SYSTEMS

Category	L	T	P	Credit	Terminal Exam Type
PSE	2	0	2	3	Theory

Preamble

This course focuses on providing students with a foundational understanding of conversational systems, including chatbots and their terminologies which helps them to explore machine learning concepts and algorithms for custom ML model development. Additionally, it emphasizes the improvement of conversational experiences for enhanced customer interactions

Prerequisite

Nil

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Explain the fundamental concepts of conversational systems.	15
CO2	Apply foundational programming skills of python for text extraction and classification.	10
CO3	Apply the principles of Natural Language Processing (NLP) and do sentiment analysis using NLP toolkits.	20
CO4	Develop a voice / Chatbot using various frameworks such as Google Dialog flow, Microsoft Bot etc.	20
CO5	Create an effective conversational agent using ML technologies, Advanced Dialog management, virtual agents etc.	20
CO6	Understand current methods in conversational analytics with insights into future trends.	15

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond		1.2,2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3
CO2	TPS3	Apply	Value		1.2,2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3
CO3	TPS3	Apply	Value		1.2,2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3
CO4	TPS3	Apply	Value		1.2,2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3
CO5	TPS3	Apply	Value		1.2,2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3
CO6	TPS2	Understand	Respond		1.2,2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L										L		
CO2	S	M	L		M	L	L		L		L	L	L	L
CO3	S	M	L		M	L	L		L		L	M	L	L
CO4	S	M	L		M	L	L		L		L	M	L	L
CO5	S	M	L		M	L	L		L		L	M	L	L
CO6	S	M	L		M	L	L		L		L	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Model Examination	Terminal Examination
	1	2		
Remember	30	20		20
Understand	30	40	50	40
Apply	40	40	50	40
Analyse				
Evaluate				
Create				

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject /Assignment/Practical Component
Perception	
Set	
Guided Response	
Mechanism	
Complex Overt Responses	
Adaptation	
Origination	

Sample Questions for Course Outcome Assessment**

** (2 to 3 at the cognitive level of course outcome)

Course Outcome 1(CO1):

1. What are the series of steps performed to understand the intent and entity of input?
2. Write a program to produce KWIC displays from a text file. Have the user be able to select the word of interest and the size of the surrounding context.
3. S: What kind of food would you like? U: What are my choices? Interpreting and responding to clarification requests from the user are usually handcrafted into slot-filling dialogues in current systems as special cases that have been predicted at design time.

Course Outcome 2(CO2):

1. Write a python program to create polls and get responses using emojis.
2. Show the steps involved in combining stemming with lemmatization.
   Explain the methods of Text classification to categorize documents or pieces of text. Choose on the classifiers class label to assign to it.

Course Outcome 3(CO3):

1. Write a finite-state automaton for a dialogue manager for checking your bank balance and withdrawing money at an automated teller machine.
2. NLP is structured data. Justify?
3. Show ways to Deal with Sequence Labelling and perform vanilla forward, backward and bidirectional pass.

Course Outcome 4 (CO4):

1. Implement a small air-travel help system based on text input. Your system should get constraints from users about a particular flight that they want to take, expressed in natural language, and display possible flights on a screen. Make simplifying assumptions. You may build in a simple flight database or you may use a flight information system on the Web as your backend.
2. Chatbot, conversational agent and dialogue system all these terms are the same . State whether this statement is true or false.
3. Analyze each of the errors in the incorrectly recognized transcription of "um the phone is I left the. . . ". For each one, give your best guess as to whether you think it is caused by a problem in signal processing, pronunciation modeling, lexicon size, language model, or pruning in the decoding search.

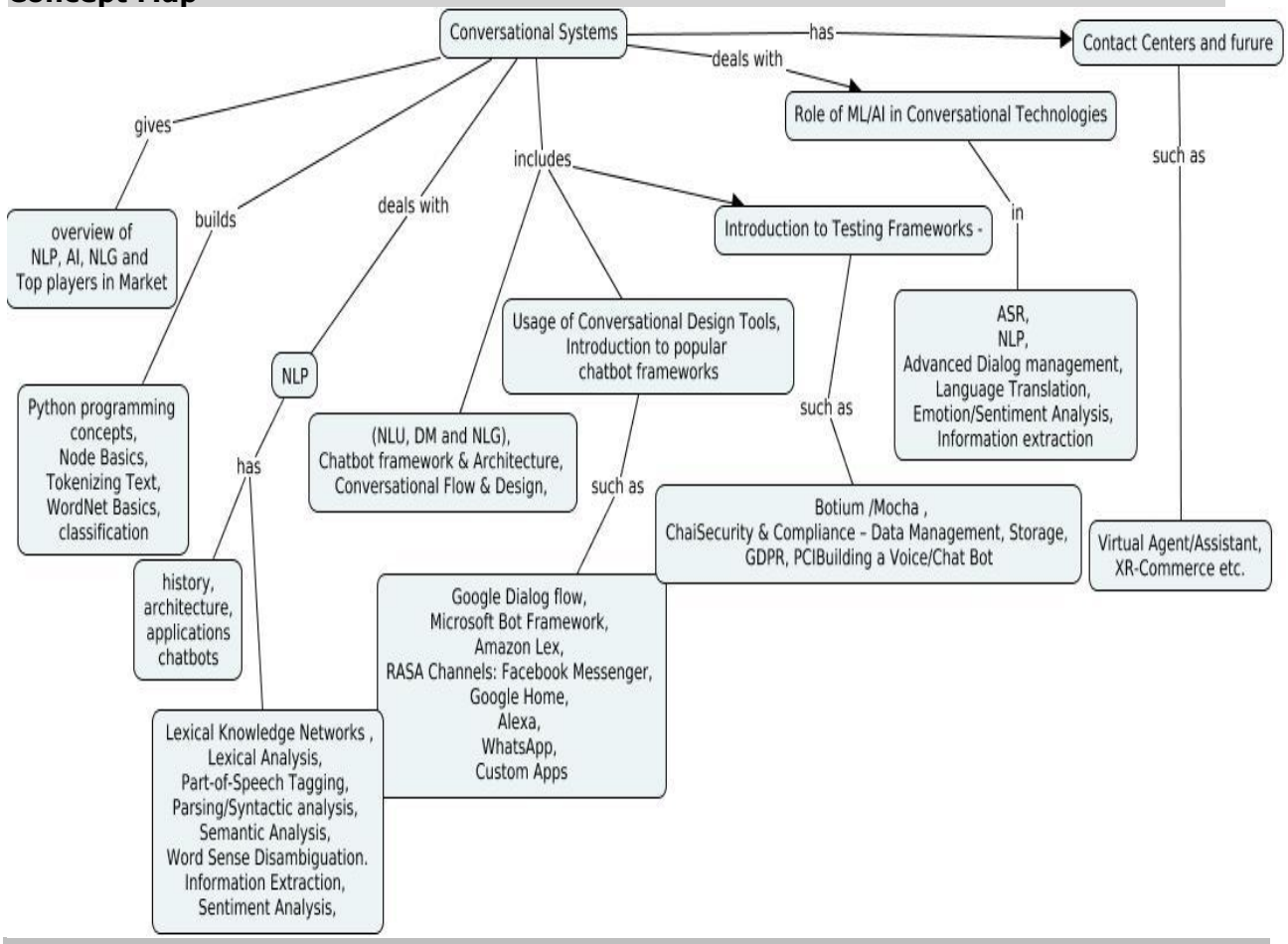
Course Outcome 5 (CO5):

1. Draw a Recurrent Neural Network For Image Generation.
2. Explain the role of the forget gate in an LSTM cell?
3. Give an example of a practical LSTM implementation, such as text generation?

Course Outcome 6(CO6):

1. Explain XR standard in E Commerce with example
2. Design an effective dialogue between an AI system and user with re-prompting features.

Concept Map



Syllabus

Fundamentals of Conversational Systems-Introduction: Overview, Case studies, Explanation about different modes of engagement for a human being, History and impact of AI, Underlying technologies: Natural Language Processing, Artificial Intelligence and Machine Learning, NLG, Speech-To-Text, Text-To-Speech, Computer Vision etc. Introduction to Top players in Market – Google, MS, Amazon & Market trends, Messaging Platforms (Facebook, WhatsApp) and Smart speakers – Alexa, Google Home and other new channels, Ethical and Legal Considerations in AI Overview

Foundational Blocks for Programming-Basic Python programming concepts, Node Basics, Coding Best Practices, Tokenizing Text and WordNet Basics, Extracting Chunks, classification.

Natural Language Processing-Introduction: Brief history, Basic Concepts, Phases of NLP, Application of chatbots etc, General chatbot architecture, Basic concepts in chatbots: intents, Entities, Utterances, Variables and Slots, Fulfillment Lexical Knowledge Networks (WordNet, Verbnet, PropBank, etc), Lexical Analysis, Part-of-Speech Tagging, Parsing/Syntactic analysis, Semantic Analysis, Word Sense Disambiguation.Information Extraction, Sentiment Analysis, NLP using Python - NLP libraries like NLTK, spaCy, StanfordNLP etc, Affective NLG

Building a chatbot/Conversational AI Systems-Fundamentals of Conversational Systems (NLU, DM and NLG), Chatbot framework & Architecture, Conversational Flow & Design, Intent Classification (ML and DL based techniques), Dialogue Management Strategies, Natural Language Generation, UX design, APIs and SDKs, Usage of Conversational Design Tools, Introduction to popular chatbot frameworks – Google Dialog flow, Microsoft Bot Framework,

Amazon Lex, RASA Channels: Facebook Messenger, Google Home, Alexa, WhatsApp, Custom Apps,Overview of CE Testing techniques, A/B Testing, Introduction to Testing Frameworks - Botium /Mocha ,ChaiSecurity & Compliance – Data Management, Storage, GDPR, PCIBuilding a Voice/Chat Bot -Case Study to build a learning chatbot

Role of ML/AI in Conversational Technologies – Brief Understanding on how Conversational Systems uses ML technologies in ASR, NLP, Advanced Dialog management, Language Translation, Emotion/Sentiment Analysis, Information extraction, etc. to effectively converse
Project 2: Case Study to build a ML Model using LSTM/any RNN and integrate with chatbot

Contact Centers- Introduction to Contact centers – Impact & Terminologies, Case studies & Trends, Virtual Agent/Assistant
Overview on Conversational Analytics-Conversation Analytics : The need of it
Introduction to Conversational Metrics
Future –Summary, Robots and Sensory Applications overview, XR Technologies in Conversational Systems , XR-Commerce, Future technologies and market innovations overview.

Learning Resources

1. Michael McTear, "Conversational AI: Dialogue Systems, Conversational Agents, and Chatbots",Morgan & Claypool,2020.
2. Christopher D. Manning and HinrichSchutze, " Foundations of Natural Language Processing" , 6 th Edition, The MIT Press Cambridge, Massachusetts London, England, 2003
3. Daniel Jurafsky and James H. Martin "Speech and Language Processing", 3rd edition, Prentice Hall, 2009.
4. Jacob Perkins, Python Text Processing with NLTK 2.0 Cookbook, Packt Publishing, 2010.
5. Wolfgang Ertel," Introduction to Artificial Intelligence", Second Edition, Springer, 2017.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Fundamentals of Conversational Systems**		
1.1	Overview, Case studies, Explanation about different modes of engagement for a human being, History and impact of AI, Underlying technologies: Natural Language Processing	1	CO1
1.2	Artificial Intelligence and Machine Learning, NLG, Speech-To-Text, Text-To-Speech, Computer Vision etc. Introduction to Top players in Market – Google, MS, Amazon & Market trends	1	CO1
1.3	Messaging Platforms (Facebook, WhatsApp) and Smart speakers – Alexa, Google Home and other new channels, Ethical and Legal Considerations in AI Overview	1	CO1
2	**Foundational Blocks for Programming**		
2.1	Basic Python programming concepts	1	CO2
2.2	Node Basics, Coding Best Practices	1	CO2
2.3	Tokenizing Text and WordNet Basics, Extracting Chunks, classification	1	CO2
3.	**Natural Language Processing**		
3.1	Introduction: Brief history, Basic Concepts, Phases of NLP, Application of chatbots etc	1	CO3

3.2	General chatbot architecture, Basic concepts in chatbots: intents, Entities, Utterances, Variables and Slots, Fulfillment	1	CO3
3.3	Lexical Knowledge Networks (WordNet, Verbnet, PropBank, etc)	1	CO3
3.4	Lexical Analysis, Part-of-Speech Tagging, Parsing/Syntactic analysis, Semantic Analysis, Word Sense Disambiguation	1	CO3
3.5	Information Extraction, Sentiment Analysis, NLP using Python - Make use of any of the NLP libraries like NLTK, spaCy, StanfordNLP etc. Affective NLG	1	CO3
4	**Building a chatbot/Conversational AI Systems-**		
4.1	Fundamentals of Conversational Systems (NLU, DM and NLG), Chatbot framework & Architecture	1	CO4
4.2	Conversational Flow & Design, Intent Classification (ML and DL based techniques)	1	CO4
4.3	Dialogue Management Strategies, Natural Language Generation, UX design, APIs and SDKs, Usage of Conversational Design Tools	1	CO4
4.4	Introduction to popular chatbot frameworks – Google Dialog flow, Microsoft Bot Framework, Amazon Lex, RASA Channels: Facebook Messenger, Google Home, Alexa, WhatsApp, Custom Apps,Overview of CE Testing techniques A/B Testing	1	CO4
4.5	Introduction to Testing Frameworks - Botium /Mocha, ChaiSecurity & Compliance – Data Management, Storage, GDPR, PCI Building a Voice/Chat Bot, Case Study to build a learning chatbot	1	CO4
5	**Role of ML/AI in Conversational Technologies**		
5.1	Brief Understanding on how Conversational Systems uses ML technologies in ASR, NLP, Advanced Dialog management	1	CO5
5.2	Language Translation, Emotion/Sentiment Analysis, Information extraction, etc. to effectively converse	1	CO5
5.3	Case Study to build a ML Model using LSTM/any RNN and integrate with chatbot	2	CO5
5.4	Contact Centers- Introduction to Contact centers – Impact & Terminologies, Case studies & Trends, Virtual Agent/Assistant	1	CO5
6	**Overview on Conversational Analytics**		
6.1	Conversation Analytics : The need of it Introduction to Conversational Metrics	1	CO6
6.2	Future –Summary, Robots and Sensory Applications overview	1	CO6
6.3	XR Technologies in Conversational Systems, XR-Commerce, Future technologies and market innovations overview.	1	CO6
	SUBTOTAL	**24**	
Expt. No.	**Laboratory Exercises**	**No. of hours**	**Course Outcome**
1	Analyse a specific case study of a conversational system application and Identify the challenges, benefits, and potential improvements.	2	CO1
2	Construct the python program to perform basic operations	2	CO2

3	Construct the python program to handle collection of data objects	2	CO2
4	Create a Python program that functions as a simple calculator, allowing users to perform basic arithmetic operations with functions.	2	CO2
5	Develop a Node.js application that serves a webpage with dynamic content. Include a form for user interaction.	2	CO2
6	Implement sentiment analysis in Python using an NLP library. Analyse the sentiment of a set of text documents.	2	CO3
7	Construct a Basic Chatbot in a web page	2	CO3
8	Design and build a chatbot that can answer questions and provide information on a specific topic, such as weather forecasting or restaurant recommendations.	2	CO3
9	Explore WordNet and apply word sense disambiguation techniques to disambiguate word senses in a given text passage.	2	CO4
10	Create a Python program that extracts key information (e.g., headlines, dates) from a set of news articles using NLP techniques.	2	CO4
11	Develop a system that can remember and reference past interactions in chatbot conversation.	2	CO5
12	Integrate a machine learning model into your chatbot to provide personalized recommendations based on user preferences.	2	CO5,CO6
	SUBTOTAL	**24**	
	TOTAL	**48**	

Course Designers:

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21CBPP1	COMPUTATIONAL FINANCE & MODELING

Category	L	T	P	Credit	Terminal Exam Type
PSE	4	0	0	4	Theory

Preamble

The course is intended to provide a reasonable understanding of various calculations involved in finance and statistics with insights into various methodologies used in it. It also involves black-scholes frameworks for pricing, financial product and markets, pricing and statistical analysis.

Prerequisite

-

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Understand the Numerical methods relevant to integration and differentiation	15
CO2	Apply the Black-Scholes framework for pricing commodities and show the use of Monte Carlo simulation in solving applied problems for derivation of Greeks.	25
CO3	Analyse the financial markets and the products traded based on contracts and speculation strategies	15
CO4	Use various pricing methods in various financial applications.	15
CO5	Illustrate various methods related to in statistical analysis in financial returns	15
CO6	Apply limit risk strategies to reduce the risk in investment	15

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond		1.2,1.3,2.2,2.3,2.5.4,4.2
CO2	TPS3	Apply	Value		1.2,2.1,2.2,4.1,4.2
CO3	TPS3	Apply	Value		1.2, 2.1.2, 4.4, 4.5, 4.6
CO4	TPS3	Apply	Value		1.2,2.3,4.2,4.3,4.4, 4.5,4.6
CO5	TPS3	Apply	Value		1.2,2.1,2.3,4.5
CO6	TPS3	Apply	Value		1.2,2.1,2.5,3.1.5,4.3,4.5,4.6

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	S	M	L						L		M	M		L
CO2	M	L	-						-		L	L		-
CO3	S	M	L						L		M	M		L
CO4	S	M	L						L		S	M		L
CO5	S	M	L						L		S	M		L
CO6	S	M	L						L		S	M		L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	2	1	2	
Remember	40	20	-	-	20
Understand	40	40	-	-	40
Apply	20	40	100	100	40
Analyse					
Evaluate					
Create					

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject /Assignment/Practical Component
Perception	
Set	
Guided Response	
Mechanism	
Complex Overt Responses	
Adaptation	
Origination	

Sample Questions for Course Outcome Assessment**

** (2 to 3 at the cognitive level of course outcome)

Course Outcome 1(CO1):

1. Discuss about the examples of exact solutions including Black Scholes and its relatives.
2. Explain about the connection with binomial models.
3. Give a brief introduction to numerical methods for solving multi-factor models.

Course Outcome 2(CO2):

1. Discuss about the PDE for pricing commodity and currency options.
2. An organization is producing a car with various production cost, using Monte Carlo method predict correct prize for the car.
3. In an organization is producing a burger with various production cost, using Monte Carlo method predict correct prize for the car.

Course Outcome 3(CO3):

1. Explain in detail about Equities, indices, foreign exchange, and commodities.
2. Analyze an organization's foreign exchange to predict future trend.
3. Analyze an organization's Equities to predict future trend

Course Outcome 4 (CO4):

1. Discuss about the various Application areas include the pricing of Europian options.
2. An organization is producing a car with various production cost, using sampling Monte Carlo method predict correct prize for the car.
3. A person plans to inverts a money of Rs.1,00,000 guide him to invest in appropriate techniques.

Course Outcome 5 (CO5):

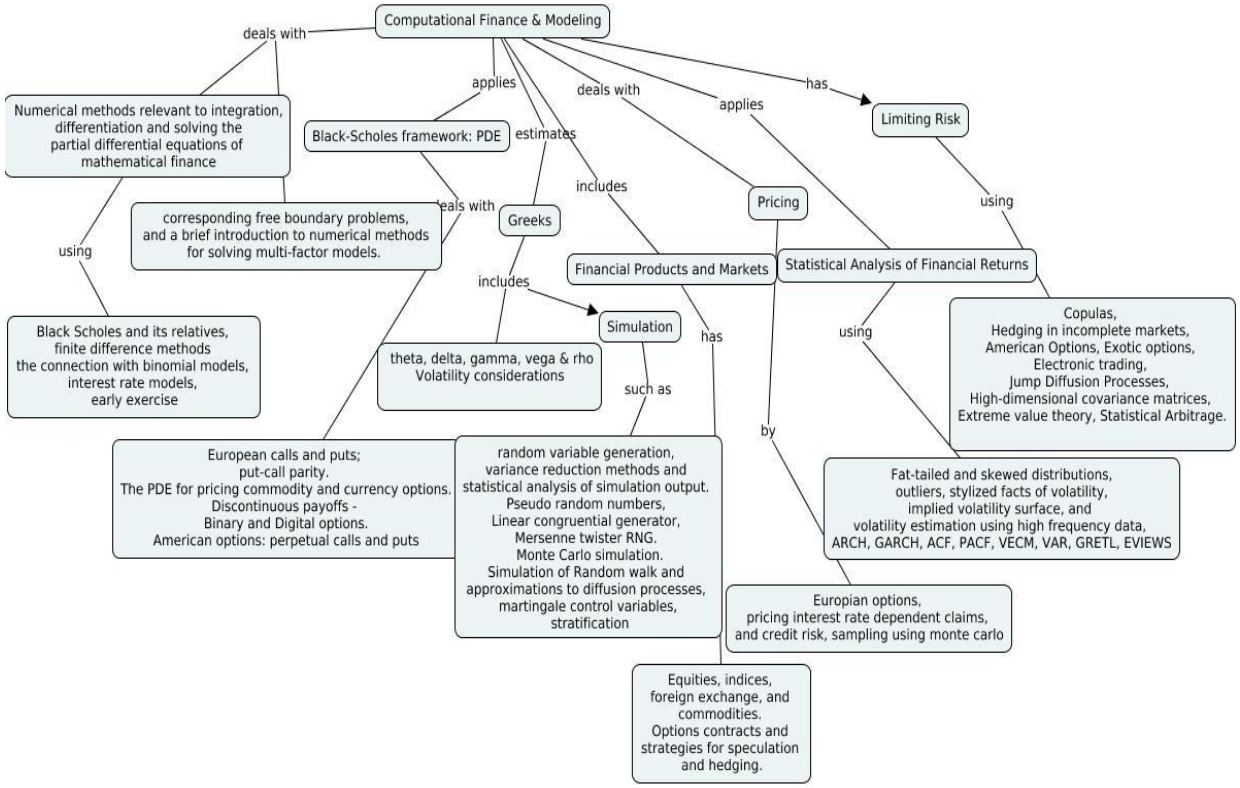
1. Discuss about Fat-tailed and skewed distributions.
2. Analyze various statistics and predict the best returns using ARCH method.
3. Analyze various statistics and predict the best returns using ACF method.

Course Outcome 6(CO6):

1. Explain about Hedging in incomplete markets.
2. In an investment of an amount predict the best investment method using Jump Diffusion Processes.

3. In an investment of an amount predict the best investment method using High-dimensional covariance matrices Processes.

Concept Map



Syllabus

Numerical methods relevant to integration, differentiation and solving the partial differential equations of mathematical finance: examples of exact solutions including Black Scholes and its relatives, finite difference methods including algorithms and question of stability and convergence, treatment of near and far boundary conditions, the connection with binomial models, interest rate models, early exercise, and the corresponding free boundary problems, and a brief introduction to numerical methods for solving multi-factor models.

Black-Scholes framework: Black-Scholes PDE: simple European calls and puts; put-call parity. The PDE for pricing commodity and currency options.Discontinuous payoffs - Binary and Digital options.

The Greeks: theta, delta, gamma, vega & rho and their role in hedging. The mathematics of early exercise - American options: perpetual calls and puts; optimal exercise strategy and the smooth pasting condition. Volatility considerations - actual, historical, and implied volatility; local vol and volatility surfaces.Simulation including random variable generation, variance reduction methods and statistical analysis of simulation output. Pseudo random numbers, Linear congruential generator, Mersenne twister RNG. The use of Monte Carlo simulation in solving applied problems on derivative pricing discussed in the current finance literature. Importance sampling, Monte Carlo integration, Simulation of Random walk and approximations to diffusion processes, martingale control variables, stratification, and the estimation of the "Greeks".

Financial Products and Markets: Introduction to the financial markets and the products which are traded in them: Equities, indices, foreign exchange, and commodities. Options contracts and strategies for speculation and hedging.

Pricing: Application areas include the pricing of European options, pricing interest rate dependent claims, and credit risk. The use of importance sampling for Monte Carlo simulation of VaR for portfolios of options.

Statistical Analysis of Financial Returns: Fat-tailed and skewed distributions, outliers, stylized facts of volatility, implied volatility surface, and volatility estimation using high frequency data, ARCH, GARCH, ACF, PACF, VECM, VAR, GRETL, EVIEWS

Limiting Risk: Copulas, Hedging in incomplete markets, American Options, Exotic options, Electronic trading, Jump Diffusion Processes, High-dimensional covariance matrices, Extreme value theory, Statistical Arbitrage.

Learning Resources

1. Cornelis W Oosterlee, Lech A Grzelak, "Mathematical Modeling And Computation In Finance", World Scientific Publishing Company, 2019.
2. R. Seydel: Tools for Computational Finance, 6th edition, Springer-Verlag, New York, 2017.
3. P. Glasserman: Monte Carlo Methods in Financial Engineering, Springer-Verlag, New York,2007.
4. W. Press, S. Teukolsky, W. Vetterling and B. Flannery, Numerical Recipes in C: The Art of Scientific Computing, 1997. Cambridge University Press, Cambridge, UK. Available on-line at: http://www.nr.com/
5. A. Lewis: Option Valuation under Stochastic Volatility, Finance Press, Newport Beach,California, 2000.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Numerical methods relevant to integration, differentiation and solving the partial differential equations of mathematical finance**		
1.1	Examples of exact solutions including Black Scholes and its relatives	1	CO1
1.2	Finite difference methods including algorithms and question of stability and convergence	1	CO1
1.3	Treatment of near and far boundary conditions, the connection with binomial models, interest rate models, early exercise, and the corresponding free boundary problems,	2	CO1
1.4	Brief introduction to numerical methods for solving multi-factor models	1	CO1
2	**Black-Scholes framework: Black-Scholes PDE:**		
2.1	simple European calls and puts; put-call parity	1	CO2
2.2	The PDE for pricing commodity and currency options. Discontinuous payoffs - Binary and Digital options.	1	CO2
2.3	**The Greeks:** theta, delta, gamma, vega & rho and their role in hedging.	1	CO2
2.4	The mathematics of early exercise - American options: perpetual calls and puts; optimal exercise strategy and the smooth pasting condition.	1	CO2
2.5	Volatility considerations - actual, historical, and implied volatility; local vol and volatility surfaces	1	CO2
2.6	Simulation including random variable generation, variance reduction methods and statistical analysis of simulation output.	1	CO2

2.7	Pseudo random numbers, Linear congruential generator, Mersenne twister RNG.	1	CO2
2.8	The use of Monte Carlo simulation in solving applied problems on derivative pricing discussed in the current finance literature.	1	CO2
2.9	importance sampling, Monte Carlo integration, Simulation of Random walk and approximations to diffusion processes, martingale control variables, stratification, and the estimation of the "Greeks".	2	CO2
3	**Financial Products and Markets:**		
3.1	Introduction to the financial markets and the products which are traded in them	2	CO3
3.2	Equities, indices, foreign exchange, and commodities	2	CO3
3.3	Options contracts and strategies for speculation and hedging.	1	CO3
4	**Pricing**		
4.1	Application areas include the pricing of Europian options,	2	CO4
4.2	pricing interest rate dependent claims, and credit risk.	2	CO4
4.3	The use of importance sampling for Monte Carlo simulation of VaR for portfolios of options.	2	CO4
5	**Statistical Analysis of Financial Returns:**		CO5
5.1	Fat-tailed and skewed distributions, outliers	1	CO5
5.2	stylized facts of volatility, implied volatility surface, and volatility estimation using high frequency data.	2	CO5
5.3	ARCH, GARCH, ACF,	1	CO5
5.4	PACF, VECM, VAR, GRETL, EVIEWS	1	CO5
6	**Limiting Risk:**		
6.1	Copulas, Hedging in incomplete markets, American Options, Exotic options	2	CO6
6.2	Electronic trading, Jump Diffusion Processes, High-dimensional covariance matrices	2	CO6
6.3	Extreme value theory, Statistical Arbitrage.	1	CO6
	TOTAL	**36**	

Course Designers:

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21CBPQ1	INDUSTRIAL ROBOTS

Category	L	T	P	Credit	Terminal exam type
PSE	3	0	0	3	Theory

Preamble

The course is intended to provide a reasonable understanding of robotics, how they function, what are technologies used in it. It also includes the usage of big data in the field of robotics and embedded system.

Prerequisite

Artificial Intelligence Concepts

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Understand the basic concepts of Industry 4.0 and Industrial Robots	15
CO2	Automate business processes using RPA tool	20
CO3	Develop computer vision applications using machine learning and deep learning techniques	20
CO4	Apply several statistical analysis techniques and business analytics for cognitive robotics	20
CO5	Demonstrate the role of Data Science and their working principles in robotics	15
CO6	Explain the various failure handling mechanisms for industrial robots	10

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond		1.2, 1.3
CO2	TPS3	Apply	Value		1.2, 1.3, 2.1.1, 2.1.2
CO3	TPS3	Apply	Value		1.2, 1.3, 2.1.1, 2.1.2
CO4	TPS3	Apply	Value		1.2, 1.3, 2.1.1, 2.1.2
CO5	TPS3	Apply	Value		1.2, 1.3, 2.1.1, 2.1.2
CO6	TPS2	Understand	Respond		1.2, 1.3

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L									L	L		
CO2	S	M	L		S	L	M				M	M	L	M
CO3	S	M	L		S	L	M				M	M	L	M
CO4	S	M	L		S	L	M				M	M	L	M
CO5	S	M	L		S	L	M				M	M	L	M
CO6	M	L									L	L		

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	2	1	2	
Remember	20	20	-	-	20
Understand	30	20			20
Apply	50	60	100	100	60
Analyse					
Evaluate					
Create					

Sample Questions for Course Outcome Assessment**

** (2 to 3 at the cognitive level of course outcome)

Understand the basic concepts of Industry 4.0 and Industrial Robots (CO1):

1. Discuss in detail about Industry 4.0. **[Understand]**
2. Explain about the evolution of Industrial Robots and their Applications. **[Understand]**
3. Discuss about the various types of robotics in various applications. **[Understand]**

Automate business processes using RPA tool (CO2):

1. Discuss about the Robotic Process Automation. **[Understand]**
2. Design a simple robot that will move according to the path available. **[Apply]**
3. In a vehicle robot apply the methods of Analysis, Control. **[Apply]**

Develop computer vision applications using machine learning and deep learning techniques (CO3):

1. Explain the concepts of computer vision and the how vision systems are becoming essential part of Robotics? **[Understand]**
2. Design a simple robot model using computer vision to automate the movement of a vehicle. **[Apply]**
3. Design a 3 D robot which enables movement in all the 3 dimensions. **[Apply]**

Apply several statistical analysis techniques and business analytics for cognitive robotics (CO4):

1. Discuss about the Foundation for Advanced Robotics and AI. **[Understand]**
2. Design a practical robot. **[Apply]**
3. Do a demo on training a robot using Artificial Intelligence. **[Apply]**

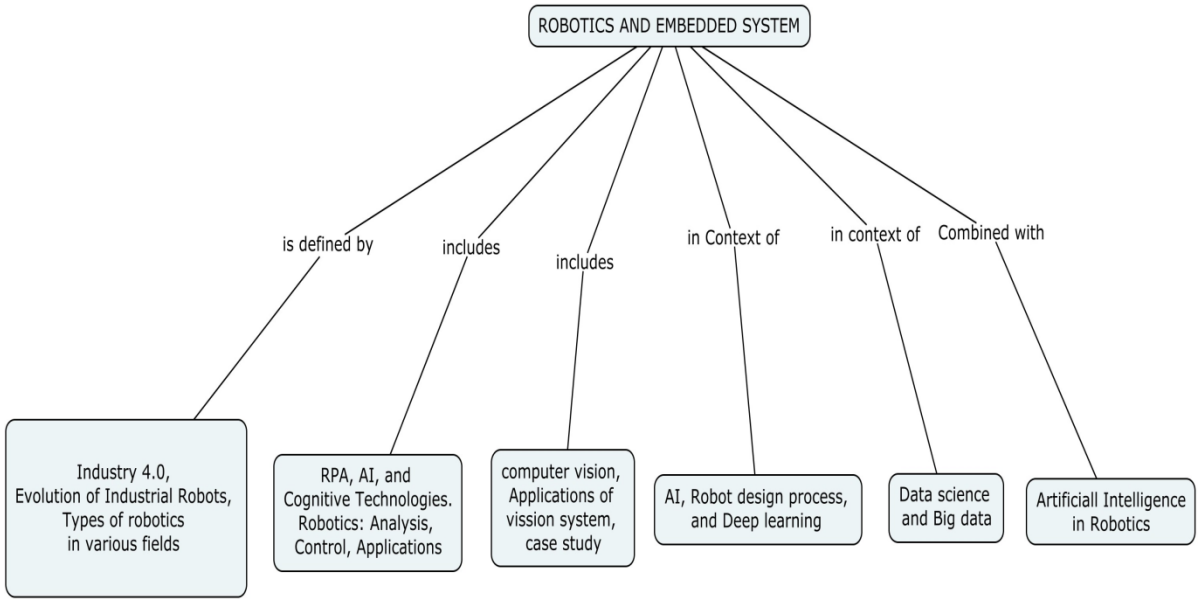
Demonstrate the role of Data Science and their working principles in robotics (CO5):

1. Discuss about the Cognitive Technologies for data and Analytics in robotics. **[Understand]**
2. Develop a Big Data Cognitive to Assistant Robots Using Cognitive Deep Learning Technology for Reducing Variability in Industrial Human Robot Activities. **[Apply]**
3. Develop a Big Data Cognitive to Assistant Robots Using Cognitive Deep Learning Technology for Reducing Variability in vehicle robot activities. **[Apply]**

Explain the various failure handling mechanisms for industrial robots (CO6):

1. Discuss about the failure analysis of mature robots in automated production. **[Understand]**
2. Explain various Reliability Factors Related to Industrial Robots. **[Understand]**
3. Discuss about the Failure analysis of mature robots in automated production. **[Understand]**

Concept Map



Syllabus

Introduction to Modern Day Robotics and their industrial applications: Introduction to ROS Topics, Services, Actions and Nodes, Industry 4.0 Concept: Background and Overview-Industry 4.0 technologies: implementation patterns in manufacturing companies-Evolution of Industrial Robots and their Applications-Advancements in Robotics and Its Future Uses-Types of robotics in various fields for applications

Technologies essential for Cognitive Robotics: Computer systems and Technologies relevant to modern day robotics-Robotic Process Automation: Overview of RPA and its applications-RPA, AI, and Cognitive Technologies for Leaders-Introduction to Robotics: Analysis, Control, Applications

Introduction to computer vision and application of Vision Systems in Robotics: Concepts of computer vision and the how vision systems are becoming essential part of Robotics-Computer Vision: Models, Learning, and Inference -Mastering Computer Vision with TensorFlow 2.x: Build advanced computer vision applications using machine learning and deep learning techniques- Machine Vision Applications-Application areas for vision systems-Robot inspection case study-Autonomous driving using 3D imaging case study.

AI in the context of Cognitive Robotics and Role of AI in Robotics: Foundation for Advanced Robotics and AI- A Concept for a Practical Robot Design Process- Demo to train A Robot Using AI - Deep learning core applications-Deep learning business applications

Data Science and Big Data in the context of Cognitive Robotics: Cognitive Technologies: The Next Step Up for Data and Analytics in robotics-Cognitive Deep Learning Technology for Big Data Cognitive Assistant Robots for Reducing Variability in Industrial Human-Robot Activities

Artificial Intelligence and Robotics: The Review of Reliability Factors Related to Industrial Robots -Failure analysis of mature robots in automated production- Data Analytics for Predictive Maintenance of Industrial Robots - Failure Is an Option: How the Severity of Robot Errors Affects Human-Robot Interaction- Sentiment analysis.

Case Study:
Design a simple robot which analyses facial expression of a human and predict the emotion

Learning Resources

1. Saeed Benjamin Niku, "Introduction to Robotics: Analysis, Control, Applications", Wiley Publishers, 2 nd edition,2011
2. Simon J. D. Prince, "Computer Vision: Models, Learning, and Inference", Cambridge University Press, 2012
3. Francis X. Govers," Artificial Intelligence for Robotics: Build Intelligent Robots that Perform Human Tasks Using AI Techniques", Packt publishing,2018
4. KrishnenduKar, "Mastering Computer Vision with TensorFlow 2.x: Build Advanced Computer Vision Applications Using Machine Learning and Deep Learning Techniques", Packt publishing,2020.
5. Armando Vieira, Bernardete Ribeiro," Introduction to Deep Learning Business Applications for Developers from Conversational Bots in Customer Service to Medical Image processing",Apress,2018

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Introduction to Modern Day Robotics and their industrial applications:**		
1.1	Industry 4.0 Concept: Background and Overview	1	CO1
1.2	Industry 4.0 technologies: implementation patterns in manufacturing companies-	1	CO1
1.3	Evolution of Industrial Robots and their Applications	2	CO1
1.4	Advancements in Robotics and Its Future Uses- Types of robotics in various fields for applications	2	CO1
2.	**Technologies essential for Cognitive Robotics:**		
2.1	Computer systems and Technologies relevant to modern day robotics	1	CO2
2.2	Robotic Process Automation: Overview of RPA and its applications-RPA	1	CO2
2.3	AI, and Cognitive Technologies for Leaders	2	CO2
2.4	Introduction to Robotics: Analysis, Control, Applications	2	CO2
3	**Introduction to computer vision and application of Vision Systems in Robotics:**		
3.1	Concepts of computer vision and the how vision systems are becoming essential part of Robotics-	2	CO3
3.2	Computer Vision: Models, Learning, and Inference	1	CO3
3.3	Mastering Computer Vision with TensorFlow 2.x: Build advanced computer vision applications using machine learning and deep learning techniques	1	CO3
3.4	Machine Vision Applications	1	CO3
3.5	Application areas for vision systems- Robot inspection case study	1	CO3
3.6	Autonomous driving using 3D imaging case study	1	CO3
4	**AI in the context of Cognitive Robotics and Role of AI in Robotics:**		
4.1	Foundation for Advanced Robotics and AI	1	CO4
4.2	A Concept for a Practical Robot Design Process-	1	CO4
4.3	Demo to train A Robot Using AI	2	CO4
4.4	Deep learning core applications-Deep learning business applications	2	CO4
5	**Data Science and Big Data in the context of Cognitive Robotics:**		
5.1	Cognitive Technologies: The Next Step Up for Data and Analytics in robotics	2	CO5

5.2	Cognitive Deep Learning Technology for Big Data Cognitive Assistant Robots for Reducing Variability in Industrial Human	2	CO5
5.3	Cognitive Deep Learning Technology for Big Data Cognitive Assistant Robots for Reducing Variability in Industrial Human-Robot Activities	2	CO5
6	**Artificial Intelligence and Robotics**:		
6.1	The Review of Reliability Factors Related to Industrial Robots -Failure analysis of mature robots in automated production	1	CO6
6.2	Data Analytics for Predictive Maintenance of Industrial Robots	2	CO6
6.3	Failure Is an Option: How the Severity of Robot Errors Affects Human-Robot Interaction- Sentiment analysis	2	CO6
	Total Hours	36	

Course Designers:

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2. T.Siva tcsa@tce.edu

21CBPR1	ENTERPRISE SYSTEMS

Category	L	T	P	Credit	Terminal Exam Type
PSE	3	0	0	3	Theory

Preamble

This course is designed to understand the basic elements and characteristics of Enterprise systems and future trends in Enterprise architectures. Learn the non-functional requirements for enterprise systems and design an application using various tools in a cloud environment.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage *** in %
CO1	Explain the basic elements of enterprise systems, enterprise architectures and sample enterprise application systems like Enterprise Resource Planning (ERP), Product Life cycle management (PLM), HR Systems (HRM), etc.	25
CO2	Identify the suitable key characteristics and enterprise system architectures of ecommerce, service oriented, microservice and cloud architecture.	15
CO3	Examine the enterprise application architectures of layer architecture, event driven architecture, plug-in architecture, etc and Patterns.	10
CO4	Identify the suitable enterprise integration patterns techniques WSDL, SOAP, RESTFul web services for a given scenario.	15
CO5	Develop and deploy a continuous integration/continuous delivery enterprise application using Dockers, Micro services, Kubernetes and Serverless..	20
CO6	Design an enterprise application using various enterprise architecture models Zachman framework and TOGAF framework.	15

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO#	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond	Guided Response	1.3, 2.3.1
CO2	TPS3	Apply	Value	Mechanism	1.1, 1.3, 2.1.1, 2.1.2
CO3	TPS3	Apply	Value	Mechanism	1.1, 1.3, 2.1.1, 2.1.2
CO4	TPS3	Apply	Value	Mechanism	1.1, 1.3, 2.1.1, 2.1.2
CO5	TPS3	Apply	Value	Mechanism	1.1, 1.3, 2.1.1, 2.1.2
CO6	TPS3	Apply	Value	Mechanism	1.1, 1.3, 2.1.1, 2.1.2

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	S	L										L		
CO2	M	M	L		M	L	L		L		L	M	L	L
CO3	M	M	L		M	L	L		L		L	M	L	L
CO4	M	M	L		M	L	L		L		L	M	L	L
CO5	M	M	L		M	L	L		L		L	M	L	L
CO6	M	M	L		M	L	L		L		L	M	L	L

S- Strong; M-Medium; L-Low

AssessmentPattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	2	1	2	
Remember	20	20	-	-	20
Understand	20	20	30	30	20
Apply	60	60	70	70	60
Analyse	-	-	-	-	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

AssessmentPattern: Psychomotor

Psychomotor Skill	Miniproject/Assignment/Practical Component
Perception	-
Set	-
Guided Response	30
Mechanism	70
Complex Overt Responses	-
Adaptation	-
Origination	-

Sample Questions for Course Outcome Assessment**

** (2 to 3 at the cognitive level of course outcome)

Course Outcome 1(CO1):

1. Define enterprise systems and explain their fundamental elements.
2. Describe the key features and functions of Enterprise Resource Planning (ERP) systems.
3. Discuss the role of Product Life Cycle Management (PLM) systems in managing product development and lifecycles.
4. You are an IT consultant for a medium-sized manufacturing company. How would you recommend implementing an ERP system to streamline their business operations? Provide a step-by-step plan.
5. Imagine you are the IT manager of a software development company. How could you use HR Systems (HRM) to manage employee records and performance evaluations effectively?

Course Outcome 2(CO2):

1. Define the key characteristics of modern enterprise systems and their significance.
2. Compare and contrast the key characteristics of ecommerce, service-oriented, microservice, and cloud architectures.

3. Explain how each of these architectures can benefit an organization in terms of scalability and flexibility.
4. You are tasked with building an e-commerce platform for a retail business. Discuss the key characteristics and advantages of e-commerce architecture. How would you implement it for the business?
5. Suppose you are the CTO of a startup, and you need to decide between a microservices and a monolithic architecture for your application. Explain the key characteristics of both and recommend the best fit for your project.

Course Outcome 3(CO3):

1. Explain the concept of layer architecture in enterprise applications and its advantages.
2. Describe the principles of event-driven architecture and its role in real-time data processing.
3. Discuss the benefits and use cases of plug-in architecture in enterprise systems.
4. You are a software architect working on a project that involves real-time data processing. How would you design an event-driven architecture for this project? What are the benefits?
5. Your team is developing a complex enterprise application. Explain how you would use the plug-in architecture to make it extensible and easy to maintain.

Course Outcome 4 (CO4):

1. Define Enterprise Application Integration (EAI) and its importance in modern organizations.
2. Compare and contrast WSDL, SOAP, and RESTful web services for integrating enterprise applications.
3. Given a specific business scenario, recommend the most suitable integration technique (WSDL, SOAP, or RESTful web services) and justify your choice.
4. You are working on a project that involves integrating multiple systems with different data formats. Explain which integration technique (WSDL, SOAP, or RESTful web services) you would choose for this scenario and justify your decision.
5. Imagine you are the lead developer on a project that requires real-time communication between different components. Discuss how you would use WebSocket and RESTful web services to achieve this.

Course Outcome 5 (CO5):

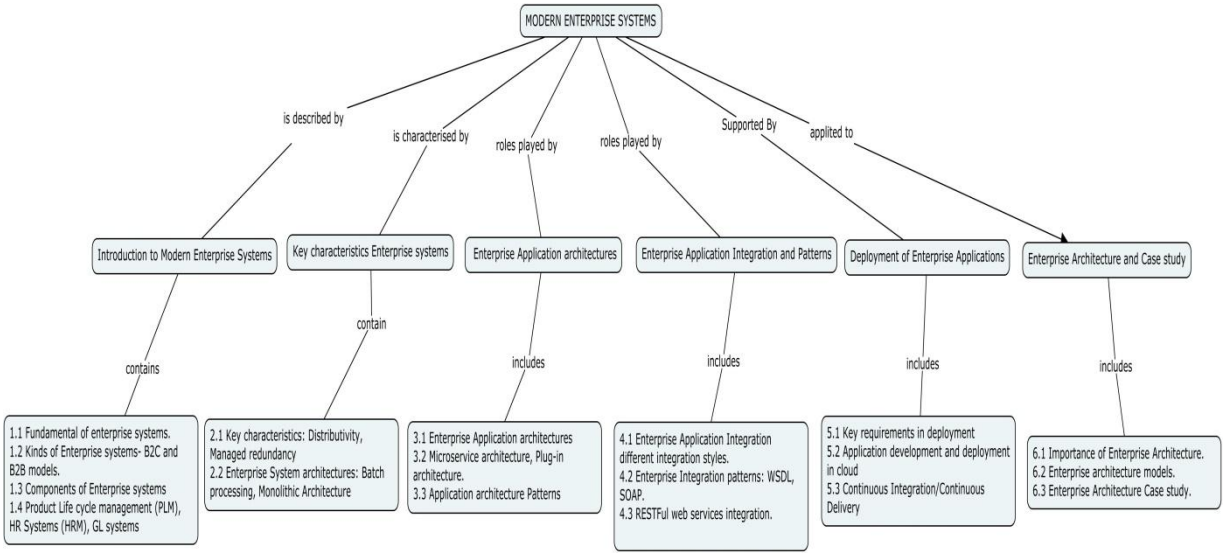
1. Explain the significance of Continuous Integration (CI) and Continuous Delivery (CD) in modern software development.
2. Describe the role of Docker containers in packaging and deploying applications.
3. Discuss the principles and benefits of microservices architecture in application development.
4. You are responsible for developing a cloud-native application. Describe how you would use Docker containers and Kubernetes to deploy and manage the application's scalability and resilience.
5. Your team is building a serverless application for a startup. Explain how the serverless architecture can reduce costs and improve flexibility for the business.

Course Outcome 6 (CO6):

1. Explain the importance of Enterprise Architecture (EA) in aligning business objectives with IT strategy.
2. Describe the components and perspectives of the Zachman Framework for EA.
3. Discuss the principles and components of the TOGAF Framework and how it can be applied in EA development.

4. As an enterprise architect, you are assigned to design a new system for a large corporation. Explain how you would apply the Zachman Framework to ensure alignment with business objectives.
5. Your organization is adopting the TOGAF framework for enterprise architecture. Create a hypothetical case study where TOGAF principles are applied to streamline IT processes and enhance business agility.

Concept Map



Syllabus

Introduction to Modern Enterprise Systems: Introduction to enterprise systems. Elements of enterprise systems – Business Information system, Decision support systems, Knowledge management systems, Financial and human resource systems. Kinds of Enterprise systems- B2C and B2B models. **Components of Enterprise systems:** Channels (Mobile, web, desktop, partner integration), Data management, workflow, Controlling and Auditing, Accounting etc. **Sample Enterprise systems:** ERP, SCM, CRM, Product Life cycle management (PLM), HR Systems (HRM), GL systems.

Key characteristics Enterprise systems: Distributivity, Managed redundancy, Exception processing, Collaboration, Data transformation. **Enterprise System architectures**: Batch processing, Monolithic, client server, ecommerce, service oriented, microservice, and cloud architectures.

Introduction to Enterprise Application architectures: Layer Architecture, Event driven Architecture, Service oriented Architecture, Microservice architecture, Plug-in architecture. **Application architecture Patterns:** Layering, Organizing domain logic, Mapping to database, Web Presentation, Concurrency.

Enterprise Application Integration: Introduction to Enterprise Integration, different integration styles. Elements of messaging-based Integration. **Enterprise Integration patterns:** Modern service integration techniques. Introduction to WSDL, SOAP. Introduction RESTFulwebservices integration. Differences between SOAP and REST.

Deployment of Enterprise applications: Key requirements in deployment - Stability, capacity, Security, availability, Network, Availability, and Transparency.

Application development and deployment in cloud – Dockers, micro services, Kubernetes, Serverless. Continuous Integration/Continuous Delivery

Introduction to Enterprise Architecture: Importance of Enterprise Architecture. Enterprise architecture models. Zachman Framework, TOGAF Framework. Enterprise Architecture Case study.

Learning Resources

Text Books:

1. Alexis Leon, "Enterprise Resource Planning", 4th edition, Tata McGraw Hill, 2019.
2. Ralph Stair, George Reynold, "Principle of Information Systems", 13th edition, CENGAGE Learning Custom Publishing, 2016.

Reference Books:

1. David Farley, Jez Humble, "Continuous Delivery: Reliable Software Releases through Build, Test, and Deployment Automation", 1st edition, Addison-Wesley, 2016.
2. Martin Fowler et al, "Pattern of Enterprise Application Architecture", 1st edition, Addison Wesley, 2012.
3. Gregor Hohpe, Bobby Woolf, "Enterprise Integration Patterns: Designing, Building, and Deploying Messaging Solutions", 1st edition, Addison-Wesley Professional, 2012.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Introduction to Enterprise Application architectures**		**CO 1**
1.1	Introduction to enterprise systems. Elements of enterprise systems	1	CO 1
	Business Information system, Decision support systems	1	CO 1
	Knowledge management systems, Financial and human resource systems.	1	CO 1
1.2	Kinds of Enterprise systems- B2C and B2B models.	1	CO 1
1.3	**Components of Enterprise systems:** Channels (Mobile, web, desktop, partner integration), Data management, workflow, Controlling and Auditing, Accounting etc.	2	CO1
1.4	**Sample Enterprise systems:** ERP, SCM, CRM	2	CO1
	Product Life cycle management (PLM), HR Systems (HRM), GL systems.	2	CO1
2.	**Key characteristics and Architectures of Enterprise systems**		**CO2**
2.1	**Key characteristics:** Distributivity, Managed redundancy, Exception processing, Collaboration, Data transformation.	2	CO2
2.2	**Enterprise System architectures**: Batch processing, Monolithic, client server,	2	CO2
	ecommerce, service oriented, microservice, and cloud architectures.	2	CO2
3	**Introduction to Enterprise Application architectures and Patterns**		**CO3**
3.1	**Enterprise Application architectures:** Layer Architecture, Event driven Architecture, Service oriented Architecture.	1	CO3
	Microservice architecture, Plug-in architecture.	1	CO3

3.2	**Application architecture Patterns:** Layering, Organizing domain logic, Mapping to database, Web Presentation, Concurrency.	1	CO3
4	**Enterprise Application Integration and Patterns**		**CO4**
4.1	**Enterprise Application Integration:** Introduction to Enterprise Integration, different integration styles. Elements of messaging-based Integration.	2	CO4
4.2	**Enterprise Integration patterns:** Modern service integration techniques. Introduction to WSDL, SOAP.	2	CO4
	Introduction RESTFul web services integration. Differences between SOAP and REST.	2	CO4
5	**Deployment of Enterprise applications**		**CO5**
5.1	Key requirements in deployment - Stability, capacity, Security, availability, Network and Transparency.	2	CO5
5.2	**Application development and deployment in cloud** – Dockers, micro services, Kubernetes.	2	CO5
	Serverless. Continuous Integration/Continuous Delivery	2	CO5
6.	**Introduction to Enterprise Architecture and Case study**:		**CO6**
6.1	Importance of Enterprise Architecture.	1	CO6
	Enterprise architecture models. Zachman Framework, TOGAF Framework	2	CO6
6.2	Enterprise Architecture Case study	2	CO6
	TOTAL	**36**	

Course Designers:

1. Mrs.P.Suganthi psica@tce.edu
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21CBPS1	CORPORATE FINANCE

Category	L	T	P	Credit	Exam type
PSE	4	0	0	4	Theory

Preamble

This course will help students to develop in-depth knowledge about the financial techniques and instruments to develop skills for interpretation business information and application of financial theory in corporate investment decisions, with special emphasis on working capital management.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage in %
CO1	Explain the concept of Equity and Debt Market.	15
CO2	Retain all the profits in business to keep a part of profits in the business and distribute others among shareholders by applying dividend decision concept.	25
CO3	Identify the role of restructuring and mergers &acquisitions in the context of corporate finance.	20
CO4	Describe the effectiveness and efficiency of an organization's operating and cash cycles.	10
CO5	Evaluate the optimum utilization of the firm's liquid resources by using inventory and cash management.	15
CO6	Evaluate the financial performance of trades in order to reduce counterparty risk, increase market liquidity.	15

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Value	Guided response	1.1, 2.3.4, 2.4.6, 2.4.7, 2.5.1
CO2	TPS3	Apply	Value	Mechanism	1.1, 1.2, 2.1.3, 2.1.4, 2.1.5, 2.3, 2.4.3, 2.4.6, 2.4.7
CO3	TPS3	Apply	Value	Mechanism	1.1, 1.2, 2.1.3, 2.1.4, 2.1.5, 2.3, 2.4.3, 2.4.6, 2.4.7
CO4	TPS3	Understand	Value	Guided response	1.1, 1.2, 2.1.3, 2.1.4, 2.1.5, 2.3, 2.4.3, 2.4.6, 2.4.7
CO5	TPS3	Apply	Value	Mechanism	1.1, 1.2, 2.1.3, 2.1.4, 2.1.5, 2.3, 2.4.3, 2.4.6, 2.4.7
CO6	TPS3	Apply	Value	Mechanism	1.2, 2.1.2, 3.2.3, 4.5.3

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L										L		
CO2	S	M	L			L	L		L		L	M	L	L
CO3	S	M	L			L	L		L		L	M	L	L
CO4	S	M	L			L	L		L		L	M	L	L
CO5	S	M	L			L	L		L		L	M	L	L
CO6	S	M	L	L		L	L		L		L	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive levels	Continuous Assessment Tests		Assignments		Terminal examination
	1	2	1	2	
Remember	20	10			20
Understand	20	30			20
Apply	60	60	100	100	60
Analyse					
Evaluate					
Create					

Assessment Pattern: Psychomotor

Psychomotor Skill	Mini-project/Assignment/Practical Component
Perception	
Set	
Guided Response	30
Mechanism	70
Complex Overt Responses	
Adaptation	
Origination	

Sample Questions for Course Outcome Assessment**

Course Outcome 1(CO1):

1. Explain briefly about IPO process.
2. Describe with an example Equity market.
3. How debt market helps for stocks and bonds?

Course Outcome 2(CO2):

1. ABC Ltd earned profits after tax of INR 50 crore in the year 2019-20. The firm has growth plans for diversification and needs INR 25 crore. The firm traditionally pays 30-50% of its profits as dividends. Shareholders prefer stable and uniform returns over time.
2. Illustrate How Does the Dividend Decision Impact Shareholders?
3. ABC leased a machine from XYZ for three years for $2,500 per month, a total of $90,000. Using ABC's 6% incremental borrowing rate, the PV of ABC's rental payments is $82,588. Since the PV of the lease is significantly less than the machine's fair market value ($100,000), the lease is categorized as an operating lease. Under ASC 842, ABC reports the machine as a right-of-use asset with a corresponding lease liability on its balance sheet.

Course Outcome 3(CO3):

1. Outline for Post-Merger Integration (PMI) by Senior Task Force or Senior Project Team
    1. Assess current situation - where do we stand?
    2. Collect information and identify critical issues for integration.
    3. Develop plans to resolve critical issues.
    4. Obtain consensus and agree on PMI Plan.

2. The following information is provided related to the acquiring firm A Ltd. and the target firm T Ltd:

Particulars	Firm A	Firm T
EAT (Rs lakh)	1,000	200
Number of shares outstanding (in lakh)	100	50
EPS (Rs.)	10	5
MPS (Rs.)	100	20

(a) What is the swap ratio based on current market prices?
(b) What is the EPS of A Ltd after acquisition?

(c) What is the expected market price per share (MPS) of A Ltd after acquisition, assuming P/E ratio ofFirm A remains unchanged.
(d) Determine the market value of the merged firm.
(e) Calculate gain/loss for shareholders of the two independent companies, after acquisition.
(f) Determine the upper and lower limits for swap ratio beyond which the two firms would not go for theacquisition/merge

Course Outcome 4 (CO4):

1. Explain the various process involved in Inventory Management.
2. Describe briefly about cash management techniques
3. How does Capital financing works?

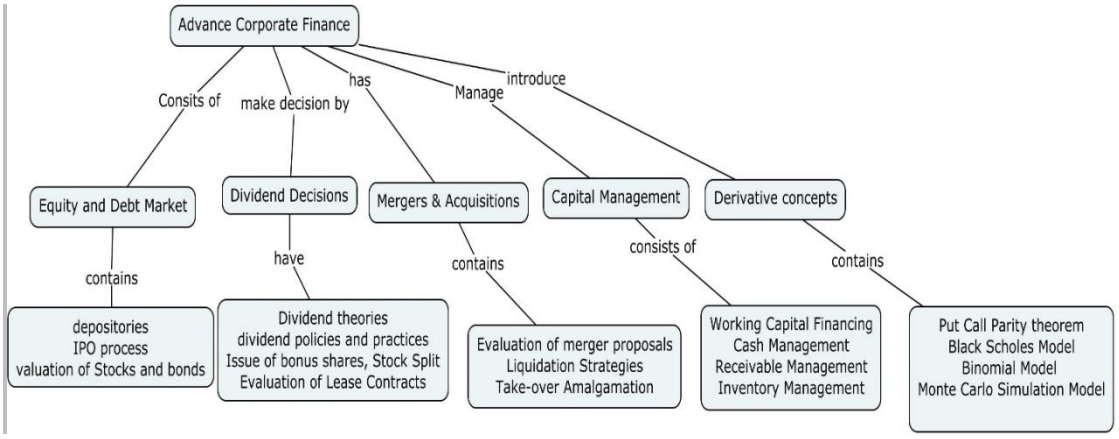
Course Outcome 5 (CO5):

1. Conduct an interview with a manager responsible for inventory management in a medium or large scale organization and try to get the answers to following questions. (a) Why inventories are kept in his organization? (b) How inventories are classified in his organization?
2. Apply the inventory situation in an organization for one to two years' period in respect of ABC and VED classification. What type of control activities do you propose for each type of items?
3. For the organisation you are working or you know, collect the relevant information regarding various elements of ordering cost, carrying cost and shortage cost and then calculate these costs.

Course Outcome 6(CO6):

1. The current value of XYZ stock is 75.38 per share. XYZ stock does not pay any dividends. The premium of a nine–month 80–strike call is 5.737192 per share. The premium of a nine–month 80–strike put is 7.482695 per share. Find the annual effective rate of interest.
2. XYZ stock does not pay any dividends. The price of a one year forward for one share of XYZ stock is 47.475. The premium of a one year 55–strike put option of XYZ stock is 9.204838 per share. The annual effective rate of interest is 5.5%. Calculate the price of a one year 55–strike call option for one share of XYZ stock.
3. Suppose the stock price is 40 and we need to price a call option with a strike of 45 maturing in 4 months. The stock is not expected to pay dividends. The continuously-compounded riskfree rate is 3%/year, the mean return on the stock is 7%/year, and the standard deviation of the stock return is 40%/year.
   a. Find our S and B value.
   b. Find out X and Y value.
   c. N(x1) = 0.3627026 and N(x2) = 0.2802213 (confirm for yourself if you like). Find the Black-Scholes call price.

Concept Map



Syllabus

Equity and Debt Market: Overview of primary& secondary equity markets and their operations. Stock market regulations, depositories. IPO process & book building process Valuation of Stocks and bonds.

Dividend Decisions: Dividend theories, dividend policies and practices. Traditional Approach, Dividend Discount Models, Miller and Modigliani Dividend policy of firms, Stability of Dividends, Forms of Dividends, Issue of bonus shares, Stock Split, Stock repurchases cancellation of paid-up capital, Evaluation of Lease Contracts

Mergers and Acquisitions: Overview of Mergers& acquisitions, Evaluation of Merger Proposal, Take-over Amalgamation, Leveraged buy-out, Management buy-out, Corporate Failure and Liquidation Strategic factors arising during course of restructuring. Offensive & defensive practices for hostile takeovers.

Working Capital Management: Working Capital Planning, Monitoring and Control of Working Capital, Working Capital Financing

Components of Working Capital Management: Managing the Components of Working Capital, Cash Management, Receivable Management, and Inventory Management

Introduction to derivatives: Basics of Futures, Forwards, Options, Swaps, Interest rate swaps, Options Payoff Diagrams, Pricing of Futures, Put Call Parity theorem, Option Pricing using Black Scholes Model, Binomial Model and Monte Carlo Simulation Model, Hedging concepts &Use of Derivatives for Risk-Return Management- Credit Default Swaps& total return swaps

Home Assignment:

Case study materials book will be given to students. Students are required to meet in groups before coming to class and prepare on the case for the day. Instructor may ask the student groups to present their analysis and findings to the class.

Further, the topic for class discussion will be mentioned beforehand and students should be prepared to discuss these topics in class. Few topics are mentioned below as examples. Instructor can add or change any topic as per requirement.

- Topic: Historical perspectives of markets like major boom and busts, bull and bear cycles, major market crashes, bubbles
- Topic: Major scams in the market, e.g. Satyam case

Learning Resources

1. Brealey, Myers and Allen,Principles of Corporate Finance, New Delhi: McGraw Hill Education, 2017

2. I.M.Pandey, Financial Management, New DelhiVikas Publishing House Pvt. Ltd., 2016.

3. M.Y. Khan and P. K.Jain, Financial Management- Text, Problems and Cases, New Delhi Tata McGraw Hill Publishing Company Ltd, 2018.

4. Dr S. Gurusamy, Merchant Banking and Financial Services, New Delhi: Tata McGraw Hill, 2017.

5. Bhalla V K, Working Capital Management, New Delhi: S. Chand Publishing, 2014.

6. S. L. Gupta, Financial Derivatives Theory Concepts and Problems, New Delhi: PHI Learning, 2017

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1	**Equity and Debt Market**		
1.1	Overview of primary& secondary equity markets and their operations	1	CO1
1.2	Stock market regulations	1	CO1
1.3	Depositories	1	CO1
1.4	IPO process	1	CO1
1.5	Book building process	2	CO1
1.6	Valuation of Stocks and bonds	2	CO1

2	**Dividend Decisions**		
2.1	Dividend theories	2	CO2
2.2	Dividend policies and practices	1	CO2
2.3	Traditional Approach	1	CO2
2.4	Dividend Discount Models	2	CO2
2.5	Miller and Modigliani Dividend policy of firms	1	CO2
2.6	Stability of Dividends	1	CO2
2.7	Forms of Dividends - Issue of bonus shares, Stock Split	1	CO2
2.8	Stock repurchases cancellation of paid-up capital	1	CO2
2.9	Evaluation of Lease Contracts	1	CO2
3	**Mergers and Acquisitions**		
3.1	Overview of Mergers & Acquisitions	1	CO3
3.2	Evaluation of Merger Proposal	1	CO3
3.3	Take-over Amalgamation	2	CO3
3.4	Leveraged buy-out	1	CO3
3.5	Management buy-out	1	CO3
3.6	Corporate Failure and Liquidation	1	CO3
3.7	Strategic factors arising during course of restructuring.	1	CO3
3.8	Offensive & defensive practices for hostile takeovers	1	CO3
4	**Working Capital Management**		
4.1	Working Capital Planning,	1	CO4
4.2	Monitoring and Control of Working Capital	1	CO4
4.3	Working Capital Financing	2	CO4
5	**Components of Working Capital Management**		
5.1	Managing the Components of Working Capital	2	CO5
5.2	Cash Management	2	CO5
5.3	Receivable Management	2	CO5
5.4	Inventory Management	1	CO5
6	**Introduction to derivatives**		
6.1	Basics of Futures, Forwards, Options	1	CO6
6.2	Swaps, Interest rate swaps, Options	1	CO6
6.3	Payoff Diagrams, Pricing of Futures	1	CO6
6.4	Put Call Parity theorem	1	CO6
6.5	Option Pricing using Black Scholes Model	1	CO6
6.6	Binomial Model	1	CO6
6.7	Monte Carlo Simulation Model	1	CO6
6.8	Hedging concepts & Use of Derivatives for Risk-Return Management	1	CO6
6.9	Credit Default Swaps& total return swaps	1	CO6
	Total	**48**	

Course Designers:

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21CBPU1	CRYPTOLOGY

Category	L	T	P	Credit	Terminal Exam Type
PSE	3	1	0	4	Theory

Preamble

This course describes the emerging concepts of cryptography and algorithms, security attacks on information systems and the authentication process. The focus of the course is on confidentiality, data integrity and non-repudiation. It also imparts knowledge of the key concepts of cryptanalysis and quantum cryptography.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Explain the concepts of number theory and Infer the need of security to introduce strong cryptosystems.	10
CO2	Describe the network security issues, challenges, mechanisms and the need for Security Services.	10
CO3	Apply the symmetric key algorithms such as stream cipher and block cipher to secure a message over an insecure channel.	25
CO4	Implement public key algorithms, hash functions and digital signatures to ensure data security and data integrity.	20
CO5	Identify the requirements for secure communication and challenges related to the secure applications.	20
CO6	Design a secure application using Lattice-based, Hash-based and Multivariate post quantum cryptographic algorithms.	15

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO#	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond	Guided Response	1.3, 2.3.1
CO2	TPS2	Understand	Respond	Guided Response	1.3, 2.3.1
CO3	TPS3	Apply	Value	Mechanism	1.1, 1.3, 2.1.1, 2.1.2
CO4	TPS3	Apply	Value	Mechanism	1.3, 2.1.1, 4.5.1
CO5	TPS3	Apply	Value	Mechanism	1.3, 2.1.1, 4.5.1
CO6	TPS3	Apply	Value	Mechanism	1.3, 2.1.1, 4.5.1

Mapping with Programme Outcomes and Programme Specific Outcome

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	S	M	M	M	M					L	L	M	L	L
CO2	M	M	M	M	M					L	L	M	L	L
CO3	M	M	M	M	M			L		L	L	M	L	L
CO4	M	M	M	M	M			L		L	L	M	L	L
CO5	M	M	M	M	M			L		L	L	M	L	L
CO6	M	M	M	M	M					L	L	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	2	1	2	
Remember	20	20	-	-	20
Understand	40	20	30	30	20
Apply	40	60	70	70	60
Analyse	-	-	-	-	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject/Assignment/Practical Component
Perception	-
Set	-
Guided Response	20
Mechanism	80
Complex Overt Responses	-
Adaptation	-
Origination	-

Sample Questions for Course Outcome Assessment**

** (2 to 3 at the cognitive level of course outcome)

Course Outcome 1 (CO1):

1. Why do networks need security?
2. Define number theory?
3. Explain the concept of Pseudo-random bit generation with example.

Course Outcome 2 (CO2):

1. Explain different methods used to maintain confidentiality
2. List the characteristics of Integrity
3. Differentiate Privacy and Security
4. Define Non-Repudiation security service. Explain a mechanism to achieve the same.

Course Outcome 3 (CO3):

1. Apply the next round of DES cipher which takes the following values as input. [Assume your own key]: L7: E967CD69 R7: 064ABA10
2. What is the difference between a block cipher and a stream cipher?
3. State the five modes of operation of block cipher?

Course Outcome 4 (CO4):

1. In RSA, given e=13 and n=143 encrypt and decrypt the message 'BECSE'.
2. Using Public Key Cryptography solve the problem of secure secret key sharing for Symmetric Ciphers.
3. For any two points P and Q (such that P≠Q) in the curve E11(1 , 6), find (P + Q) and 2P.\
4. Illustrate the usage of RSA for digital signature with a working example.

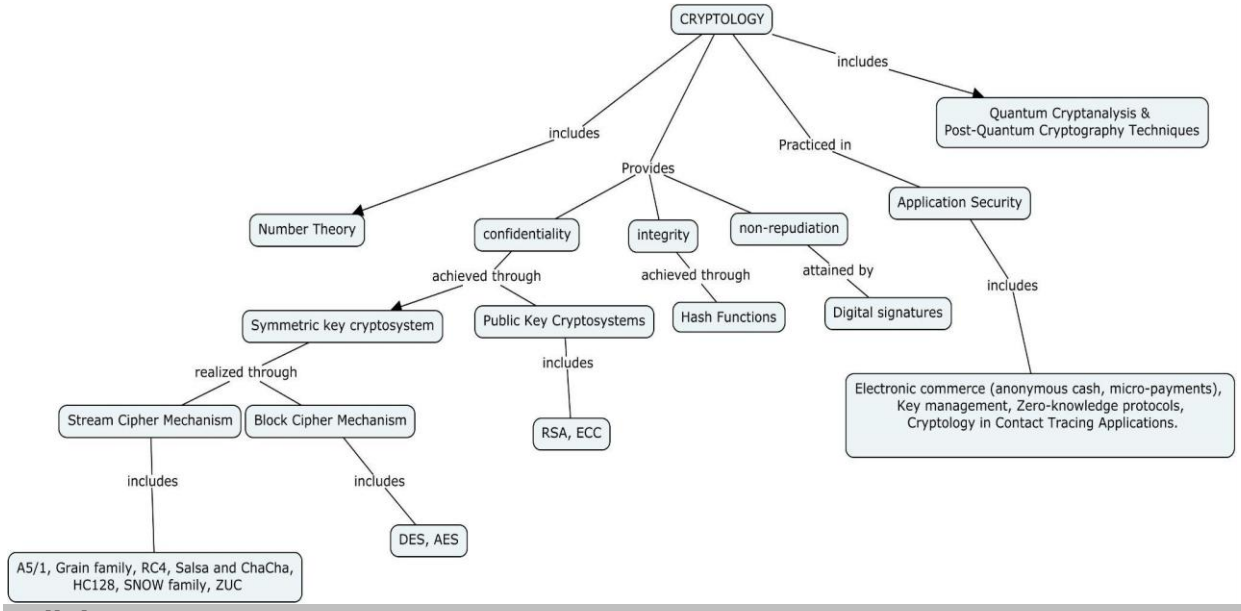
Course Outcome 5 (CO5):

1. Write short note on Key management.
2. Identify the characteristics of Zero-knowledge protocols.
3. Demonstrate the working principles of micro-payments systems.

Course Outcome 6 (CO6):

1. Identify the **i**ssues related to Quantum Cryptanalysis
2. Define Quantum cryptography
3. Demonstrate the working principles of the Multivariate cryptography method for your own scenario.

Concept Map



Syllabus

Introduction to Cryptography: Elementary number theory, Pseudo-random bit generation, Elementary cryptosystems.

Basic security services: confidentiality, integrity, availability, non-repudiation, privacy

Symmetric key cryptosystems: Stream Cipher: Basic Ideas, Hardware and Software Implementations, Examples with some prominent ciphers: A5/1, Grain family, RC4, Salsa and ChaCha, HC128, SNOW family, ZUC; **Block Ciphers:** DES, AES, Modes of Operation;
Public Key Cryptosystems and Authentication: Hash Functions; Authentication, RSA, ECC; Digital signatures

Security Applications: Electronic commerce (anonymous cash, micro-payments), Key management, Zero-knowledge protocols, Cryptology in Contact Tracing Applications.

Quantum Cryptanalysis & Post-Quantum Cryptography: Quantum cryptography, quantum encryption, Issues related to Quantum Cryptanalysis. Post-Quantum Cryptography: Lattice-based cryptography: NTRU, Hash-based cryptography: SPHINCS, Multivariate cryptography: Rainbow.

Learning Resources

Text Books:

1. W. Stallings, "Cryptography and Network Security- Principles and Practice". 7th edition, Pearson Education, 2017.
2. D. R. Stinson, "Cryptography - Theory and Practice.", 4th Edition, Chapman and Hal/CRC press, 2018.

Reference Books:

1. A. J. Menezes, P. C. van Oorschot, and S. A. Vanstone, "Handbook of Applied Cryptography", 5th edition, Chapman and Hal/CRC press, 2020.
2. G. Paul and S. Maitra, "RC4 Stream Cipher and Its Variants", CRC Press, Taylor & Francis Group, A Chapman & Hall Book, 2012.
3. Behrouz A.Forouzan, "Data Communication and Networking", 5th Edition, Tata McGraw-Hill,2017.

Online Resources:

1. http://www.theory.caltech.edu/~preskill/ph229/

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Introduction to Cryptography:**		**CO1**
1.1	Elementary number theory, Pseudo-random bit generation	2	CO1
1.2	Elementary Cryptosystems	2	CO1
2.	**Basic security services:**		**CO2**
2.1	confidentiality, integrity	2	CO2
2.2	availability, non repudiation, privacy	2	CO2
3.	**Symmetric key cryptosystems:**		**CO3**
3.1	**Stream Cipher:** Basic Ideas, Hardware and Software Implementations	2	CO3
3.2	prominent ciphers: A5/1, Grain family, RC4	2	CO3
	Salsa, ChaCha, HC128	2	CO3
	SNOW family, ZUC	1	CO3
3.3	**Block Ciphers:** DES, AES, Modes of Operation	2	CO3
	Implement the DES, AES algorithms (Tutorial 1)	2	CO3
	Implement the any two Substitution and Transposition Techniques (Tutorial 2)	2	CO3
4.	**Public Key Cryptosystems:**		**CO4**
4.1	Hash Functions; Authentication	2	CO4
4.2	RSA, ECC	2	CO4
4.3	Digital signatures	1	CO4
	Implement the RSA, ECC algorithms. (Tutorial 3)	2	CO4
	Demonstrate how to provide secure data storage, secure data transmission and for creating digital signatures. (Tutorial 4)	2	CO4
5	**Security Applications:**		**CO5**
5.1	Electronic commerce (anonymous cash, micro-payments)	2	CO5
5.2	Key management	1	CO5
5.3	Zero-knowledge protocols	1	CO5
5.4	Cryptology in Contact Tracing Applications	2	CO5
	Set Up a honey pot and monitor the honeypot on network (Tutorial 5)	2	CO5
	Install and Configure Firewalls for a variety of options (Tutorial 6)	2	CO5
6	**Introductory topics in Post-Quantum Cryptography:**		**CO6**
6.1	Quantum cryptography, quantum encryption, Issues related to Quantum Cryptanalysis	2	CO6
6.2	Post-Quantum Cryptography: Lattice-based cryptography : NTRU	2	CO6
6.3	Hash-based cryptography :SPHINCS	2	CO6
6.4	Multivariate cryptography: Rainbow	2	CO6
	TOTAL	**48**	

Course Designers:

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21CBPV1	QUANTUM COMPUTATION & QUANTUM INFORMATION	Category	L	T	P	Credit	Terminal Exam Type
		PSE	3	0	0	3	Theory

Preamble

This course provides knowledge on quantum information and computing, by exploring various principles of quantum algorithms, random number generator algorithms and key distribution methodologies. It also includes the basics of cipher techniques that are applied in post quantum cryptography.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Explain the basic terminologies and concepts of quantum information used in devising the quantum process	20%
CO2	Construct the various algorithms for computing information, searching and factorization of number	20%
CO3	Use the potential of quantum computing algorithms in exploring cryptosystems.	15%
CO4	Demonstrate the quantum number generator methods for commercial products and applications.	10%
CO5	Employ suitable Quantum key distribution methods for secure communication in real world applications.	15%
CO6	Discuss the methods of ciphers used in post quantum cryptography for preventing cryptanalytic attacks by quantum computers	20%

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond		1.1, 1.2, 2.1.1
CO2	TPS2	Apply	Value		1.2, 2.1.2, 2.1.3, 4.3, 4.5.3
CO3	TPS3	Apply	Value		1.2, 2.1.2, 2.1.3, 4.3, 4.5.3
CO4	TPS3	Apply	Value		1.2, 2.1.2, 2.1.3, 4.3, 4.5.3
CO5	TPS3	Apply	Value		1.2, 2.1.4, 2.1.5, 4.3, 4.5.3
CO6	TPS3	Understand	Respond		1.3, 2.1.4, 4.3.2

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L	L		M	L					L	L		
CO2	S	M	L		S						M	L		
CO3	S	M	L		S						S	L		
CO4	S	M	L		S						S	L		
CO5	S	M	L		S						S	L		
CO6	M	L	L	L	M						L	L		

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	2	1	2	
Remember	20	20			20
Understand	30	30			30
Apply	50	50	100	100	50
Analyse					
Evaluate					
Create					

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject /Assignment/Practical Component
Perception	
Set	
Guided Response	
Mechanism	
Complex Overt Responses	
Adaptation	
Origination	

Sample Questions for Course Outcome Assessment**

** (2 to 3 at the cognitive level of course outcome)

Course Outcome 1(CO1):

1. Interpret the key concept of quantum states and operators used in quantum mechanics.
2. Summarize the concept of superdense coding and quantum teleportation with suitable examples.
3. Explain in detail about quantum gates and circuits?

Course Outcome 2(CO2):

1. Illustrate a suitable quantum algorithm for solving a black box problem by a quantum computer.
2. Develop a quantum algorithm for finding prime factors of a number in O(log N).
3. Utilize a quantum algorithm for solving simon's problem that requires O(n) queries.

Course Outcome 3(CO3):

1. Identify a suitable quantum algorithm for searching a number in an unordered set in $O(\sqrt{N})$.
2. Apply shor's algorithm for solving discrete logarithm problems and find how it is simpler than the factoring method.
3. Identify the generalized simon problem and apply the simon algorithm for finding hidden strings.

Course Outcome 4 (CO4):

1. Apply the principle behind generating quantum numbers by Quantis QRNG PCIe for implementing quantum draws to secure lotteries.
2. Identify the hardware components and physical principles of TRNG used by commercial products and applications.
3. Identify the random number generator method used by IBM in their cloud as not predetermined.

Course Outcome 5 (CO5):

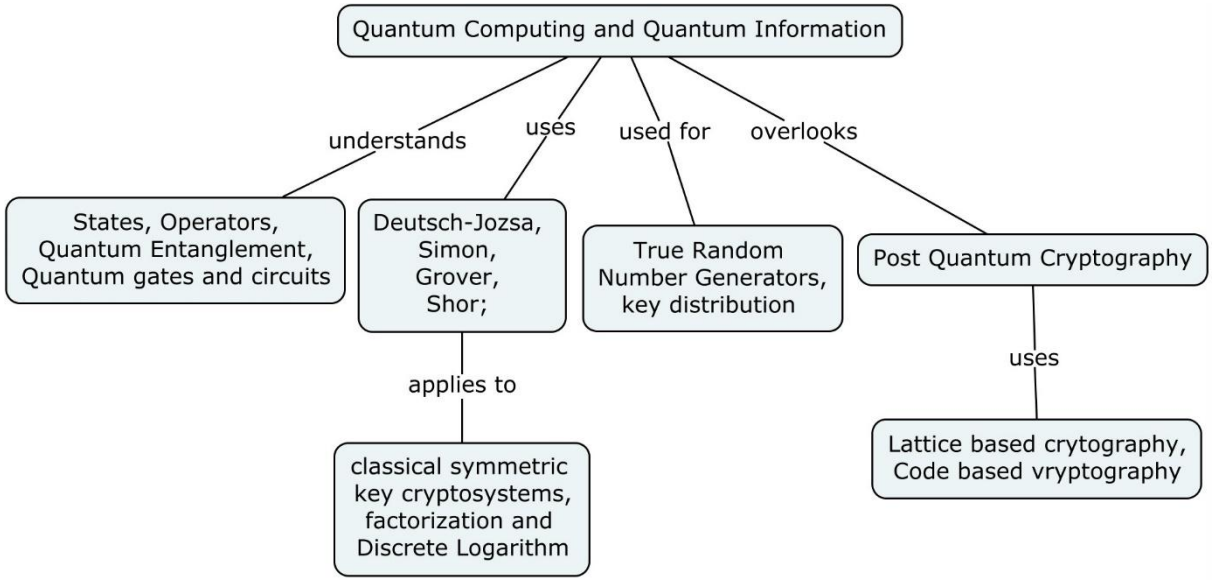
1. Identify suitable conditional requirements and design in BB84 quantum key distribution protocol for securely communicating key from one party to another.
2. Apply the concept of Ekert protocol for identifying secure key generation between set of analyzers.

3. Apply the Semi-Quantum QKD protocols for key generation between a classical party and quantum party and also between two classical parties.

Course Outcome 6(CO6):

1. Explain on the role of enhancing security through Post Quantum Algorithms using lattice method.
2. How Does Post Quantum Cryptography Work?
3. What do you mean by security reduction and discuss on the ways for proving security?

Concept Map



Syllabus

Introduction to Quantum Information: States, Operators, Measurements, Quantum Entanglement: Quantum Teleportation, Super-dense coding, CHSH Game, Quantum gates and circuits

Quantum Algorithms: Problem statement- Complexity Analysis-Deutsch-Jozsa, Simon, Grover, Shor;

Implications of Quantum Algorithms - Implication of Grover's and Simon's algorithms towards classical symmetric key cryptosystems, Implication of Shor's algorithm towards factorization and Discrete Logarithm based classical public key cryptosystems

Quantum True Random Number Generators : Detailed design and issues of quantumness, Commercial products and applications

Quantum key distribution: BB84, Ekert, Semi-Quantum QKD protocols and their variations, Issues of Device Independence, Commercial products

Introductory topics in Post-Quantum Cryptography:

Introduction to **lattice based cryptography**, Useful Lattice Problems. Learning with Errors and Short Integer Solution problem. Connection to dihedral hidden subgroup problem - Public key encryption and fully homomorphic encryption - Basic of **Code Based Cryptography** – Error Correcting codes.

Assignments on Quantum Algorithms

Quantum Algorithm Zoo. https://quantumalgorithmzoo.org/

Learning Resources

Text Books

1. Bergou, János A., Mark Hillery, and Mark Saffman. Quantum information processing. Springer International Publishing, 2021.
2. M. A. Nielsen and I. L. Chuang, "Quantum Computation and Quantum Information", Cambridge University Press, 10th edition, 2012.
3. Steeb, Willi-Hans, and Yorick Hardy. Problems and solutions in quantum computing and quantum information. 2004
4. Daniel J. Bernstein, Johannes Buchmann and Erik Dahmen,"Post-Quantum Cryptography", Springer, 2009

Reference Books

1. SAPV Tharrmashastha, D. Bera, A. Maitra and S. Maitra, "Quantum Algorithms for Cryptographically Significant Boolean Functions - An IBMQExperience", Springer 2020
2. P. Kaye, R. Laflamme, and M. Mosca, "An Introduction to Quantum Computing", Oxford University Press, New York, 2007.
3. N. David Mermin, "Quantum Computer Science", Cambridge University Press, 2007.
4. LaPierre, Ray. Introduction to quantum computing. Springer Nature, 2021

Online Courses

1. *Post Quantum Cryptography.* D. Unruh: Available online: https://courses.cs.ut.ee/2023/pqc/fall
2. Presskil Lecture notes: Available online: http://theory.caltech.edu/~preskill/ph219/ph219_2021-22.html

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Introduction to Quantum Information:**		
1.1	States, Operators, Measurements,	1	CO1
1.2	Quantum Entanglement: Quantum Teleportation, Super-dense coding,	2	CO1
1.3	CHSH Game	2	CO1
1.4	Quantum gates and circuits	2	CO1
2.	**Quantum Algorithms:**		
2.1	Problem statement - Complexity Analysis-Deutsch-Jozsa	1	CO2
2.2	Simon	2	CO2
2.3	Grover	2	CO2
2.4	Shor	2	CO2
3.	**Implications of Quantum Algorithms**		
3.1	Implication of Grover's and Simon's algorithms towards classical symmetric key cryptosystems,	2	CO3
3.2	Implication of Shor's algorithm towards factorization and	2	CO3
3.3	Discrete Logarithm based classical public key cryptosystems	2	CO3
4.	**Quantum True Random Number Generators :**		
4.1	Detailed design and issues of quantumness,	2	CO4
4.2	Commercial products and applications	2	CO4
5.	**Quantum key distribution:**		
5.1	BB84, Ekert,	2	CO5
5.2	Semi-Quantum QKD protocols and their variations,	2	CO5

5.3	Issues of Device Independence, Commercial products	1	CO5
6.	**Introductory topics in Post-Quantum Cryptography:**		
6.1	Introduction to **lattice based cryptography**, Useful Lattice Problems.	1	CO6
6.2	Learning with Errors and Short Integer Solution problem.	2	CO6
6.3	Connection to dihedral hidden subgroup problem -	1	CO6
6.4	Public key encryption and fully homomorphic encryption	2	CO6
6.5	Basic of **Code Based Cryptography** – Error Correcting codes.	1	CO6
	TOTAL	36	

Course Designers:

1. Dr.J.FeliciaLilian jflcse@tce.edu
2. Mr.M.Venkatesh mvhca@tce.edu

21CBPW1	Social, Text And Media Analytics

Category	L	T	P	Credit	Terminal Exam Type
PSE	2	1	0	3	Theory

Preamble

This course presents the concepts of NLP text processing technologies, approaches and methods. It also helps them to find out the ways of extracting information and analyse the data over real time text and social media networks.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage* ** in %
CO1	Identify the pre-processing techniques and information extraction methods for real world textual data	15
CO2	Examine the unstructured data to extract insights using NLP techniques such as content analysis, topic detection, prediction etc.	20
CO3	Implement sentiment and context based analysis on real time media data	15
CO4	Demonstrate search engine optimization and web document ranking for real time problem	20
CO5	Identify the graph and matrices methods for social media and web analytics	15
CO6	Analyze the different social contexts in media sites such as Twitter, Facebook, and YouTube using social network analysis techniques	15

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS3	Apply	Value		1.1, 1.2, 4.3.2
CO2	TPS3	Apply	Value		1.2, 2.1, 4.3.1, 4.3.3,
CO3	TPS3	Apply	Value		1.2, 2.1, 4.3.1
CO4	TPS3	Apply	Value		1.2, 1.3, 2.1, 4.3.1, 4.3.3,
CO5	TPS3	Apply	Value		1.3, 2.1, 4.3.1
CO6	TPS3	Apply	Value		1.3, 2.1, 4.3.1, 4.3.3

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	S	M	L		M						M	L		
CO2	S	M	L		S						M	L		
CO3	S	M	L		S						S	L		
CO4	S	M	L		S						S	L		
CO5	S	M	L		S						S	L		
CO6	S	M	L	L	S						S	L		

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	2	1	2	
Remember	20	20			15
Understand	30	30			25
Apply	50	50	100	100	60
Analyse					
Evaluate					
Create					

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject /Assignment/Practical Component
Perception	
Set	
Guided Response	
Mechanism	
Complex Overt Responses	
Adaptation	
Origination	

Sample Questions for Course Outcome Assessment**

** (2 to 3 at the cognitive level of course outcome)

Course Outcome 1(CO1):

1. In customer support applications, how can text preprocessing techniques enhance the efficiency of chatbot responses by understanding and generating human-like responses?
2. Discuss the role of text preprocessing in analyzing and categorizing customer emails for effective customer relationship management in a service-oriented business.
3. How can core text mining operations be employed in the finance sector to extract key information from financial reports and news articles for investment decision-making?

Course Outcome 2(CO2):

1. In digital marketing, explain how content analysis can be employed to optimize website content for better search engine visibility and user engagement.
2. Discuss the use of content analysis in journalism to automatically categorize and prioritize news articles

Course Outcome 3(CO3):

1. How can context analysis be applied in political science to analyze speeches and social media content, providing insights into public opinion and political trends?
2. How can natural language processing be used in the legal domain to automate the analysis of legal documents and contracts, ensuring compliance and mitigating legal risks?
3. In the healthcare industry, discuss how NLP techniques can contribute to extracting valuable information from electronic health records for clinical decision support.

Course Outcome 4 (CO4):

1. Discuss the application of web analytics tools in the travel industry to analyze website traffic and user interactions, leading to personalized marketing strategies.
2. How can web analytics tools assist educational institutions in tracking and improving the online learning experience for students?
3. Explain the significance of web search and retrieval in the real estate industry for users searching for properties based on specific criteria.

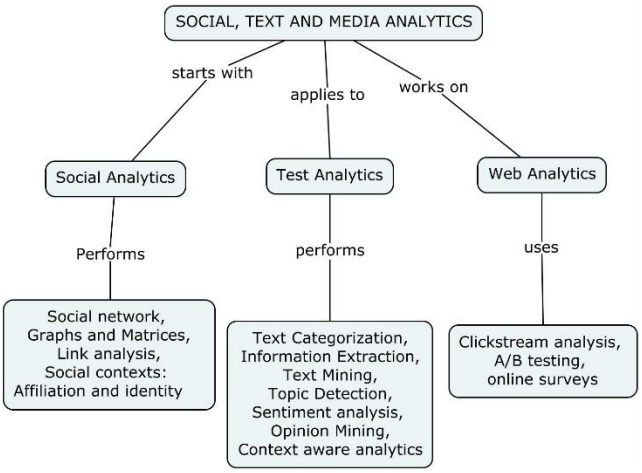
Course Outcome 5 (CO5):

1. Explain how basic measures for individuals and networks can be utilized in the analysis of online gaming communities to identify influential players and encourage community engagement.
2. How can social network and web data analysis contribute to identifying and combating misinformation and fake news on social media platforms?

Course Outcome 6(CO6):

1. In cybersecurity, discuss how link analysis can be employed to trace and investigate the sources of cyber threats and attacks.
2. In e-commerce, how can the analysis of network evolution be employed to identify changes in customer preferences and adapt marketing strategies accordingly.
3. In social media platforms, how can the analysis of random graphs and network evolution contribute to predicting the spread of viral content?

Concept Map



Syllabus

Text Mining: Introduction, Core text mining operations, Pre-processing techniques, Categorization, Clustering, Information extraction, Probabilistic models for information extraction, Text mining applications.

Methods & Approaches: Content Analysis; Natural Language Processing; Clustering & Topic Detection; Simple Predictive Modeling; Sentiment Analysis; Sentiment Prediction; *Opinion Mining; Context aware text analysis.*

Web Analytics: Web analytics tools, Clickstream analysis, A/B testing, online surveys; Web search and retrieval, Search engine optimization, Web crawling and Indexing, Ranking algorithms, Web traffic models.

Social Media & Web Methods: Social network and web data and methods. Graphs and Matrices. Basic measures for individuals and networks. Information visualization.

Social Media Analytics Making connections: Link analysis. Random graphs and network evolution. Social contexts: Affiliation and identity; Social network analysis

Learning Resources

1. Dipanjan Sarkar, Text Analytics with Python, Second Edition, Apress, 2019
2. Benjamin Bengfort, Rebecca Bilbro, and Tony Ojeda, Applied Text Analytics with Python, First Edition, O'Reilly Media, June 2018.
3. Hansen, Derek, Ben Sheiderman, Marc Smith. Analyzing Social Media Networks with NodeXL: Insights from a Connected World, Morgan Kaufmann, 2011
4. Avinash Kaushik, Web Analytics 2.0: The Art of Online Accountability, 2009

5. Ronen Feldman and James Sanger, The Text Mining Handbook: Advanced Approaches in Analyzing Unstructured Data, Cambridge University Press, 2006.
6. Hanneman, Robert and Mark Riddle, Introduction to Social Network Method, 2005

Reference Books:

1. Monge, P. R. & Contractor, N. S., Theories of communication networks. New York: Oxford University Press. http://nosh.northwestern.edu/vita.html, (2003).
2. Wasserman, S. & Faust, K. Social network analysis: Methods and applications. New York: Cambridge University Press, 1994.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**TEXT MINING**		
1.1	Introduction, Core text mining operations, Pre-processing techniques, Categorization, Clustering,	3	CO1
1.2	Information extraction, Probabilistic models for information extraction, Text mining applications.	3	CO1
2.	**METHODS & APPROACHES**		
2.1	Content Analysis	2	CO2
2.2	Natural Language Processing	1	CO2
2.3	Clustering	1	CO2
2.4	Topic Detection	1	CO2
2.5	Simple Predictive Modeling	1	CO2
3.			
3.1	Sentiment Analysis; Sentiment Prediction	3	CO3
3.2	Opinion Mining; Context aware text analysis.	3	CO3
4.	**WEB ANALYTICS**		
4.1	Web analytics tools, Clickstream analysis	1	CO4
4.2	A/B testing, online surveys	1	CO4
4.3	Web search and retrieval, Search engine optimization	1	CO4
4.4	Web crawling and Indexing	1	CO4
4.5	.Ranking algorithms	1	CO4
4.6	Web traffic models	1	CO4
5.	**SOCIAL MEDIA AND WEB METHODS**		
5.1	Social network and web data and methods..	2	CO5
5.2	Graphs and Matrices.	1	CO5
5.3	Basic measures for individuals and networks	1	CO5
5.4	Information visualization.	2	CO5
6.	**SOCIAL MEDIA ANALYTICS**		
6.1	Making connections: Link analysis.	2	CO6
6.2	Random graphs and network evolution. Social contexts:	2	CO6
6.3	Affiliation and identity; Social network analysis	2	CO6
	TOTAL	**36**	

Course Designers:

1. Dr. J. Felicia Lilian jflcse@tce.edu
2. Ms. Priya Thiagarajan ptca@tce.edu

21CBPY1	MOBILE COMPUTING

Category	L	T	P	Credit	Terminal exam type
PSE	3	0	0	3	Theory

Preamble

This course describes the mobile computing paradigm through study of architecture, infrastructure, location management, handoff management and data transmission in mobile and wireless communication networks. It also imparts the knowledge of various types of networks such as adhoc, wireless sensor, radio and 5G cellular networks.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage in %
CO1	Explain the concepts of architecture, performance metrics and various generations of mobile networks.	20
CO2	Apply the various location management techniques and handoff strategies in mobile networks	20
CO3	Apply the various data transmission methods in MIMO, OFDM, WLAN and WPAN systems.	20
CO4	Identify suitable architecture and routing methods for mobile adhoc & wireless sensor networks.	20
CO5	Identify the various techniques applicable for accessing and sharing sensor data in cognitive radio networks.	10
CO6	Apply resource management techniques for device communication in 5G cellular networks.	10

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond		1.2
CO2	TPS3	Apply	Value		1.2, 2.1.1
CO3	TPS3	Apply	Value		1.2, 2.1.1
CO4	TPS3	Apply	Value		1.2, 2.1.1, 2.1.2
CO5	TPS3	Apply	Value		1.2, 2.1.1, 2.1.2
CO6	TPS3	Apply	Value		1.2, 2.1.1

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L										L		
CO2	S	M	L		M						L	M	L	L
CO3	S	M	L		M						L	M	L	L
CO4	S	M	L		M						L	M	L	L
CO5	S	M	L		M						L	M	L	L
CO6	S	M	L		M						L	M	L	L

S-Strong;M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive levels	Continuous Assessment Tests		Assignments		Terminal examination
	1	2	1	2	
Remember	20	20			20
Understand	20	20	30	30	20
Apply	60	60	70	70	60
Analyze					
Evaluate					
Create					

Assessment Pattern:Psychomotor

Psychomotor Skill	Miniproject/Assignment/PracticalComponent
Perception	
Set	
Guided Response	
Mechanism	
Complex Overt Responses	
Adaptation	
Origination	

Sample Questions for Course Outcome Assessment**

Course Outcome 1(CO1):

1. Explain in detail about the architecture of cellular networks.
2. Summarize various propagation and path loss models in wireless communication.
3. Classify various generations in mobile computing environments with suitable examples.

Course Outcome2(CO2):

1. Apply the different types of dynamic location management schemes that help mobile stations for keeping track of location in cellular networks.
2. Utilize various paging strategies used for notifying the mobile station of incoming messages or calls in cellular networks.
3. Identify suitable types of handoff detection strategies applicable in wireless networks.

Course Outcome3(CO3):

1. Identify suitable access protocol for supporting data transmission in wireless communication networks.
2. Apply various technologies used for sending and receiving the radio signals in personal area networks.
3. Develop a OFDM modulated MIMO scheme for signal transmission in wireless networks.

Course Outcome4(CO4):

1. Identify various types of routing protocols for a new node entering into mobile ad hoc networks.
2. Apply various method of clustering of sensor nodes for supporting network scalability in wireless sensor networks
3. Build a routing protocol for identifying suitable paths for transmission of data in wireless sensor networks.

Course Outcome5(CO5):

1. Apply various types of techniques followed in sensing the spectrum in cognitive radio networks.
2. Identify suitable sharing methods for accessing the spectrum with the consideration of

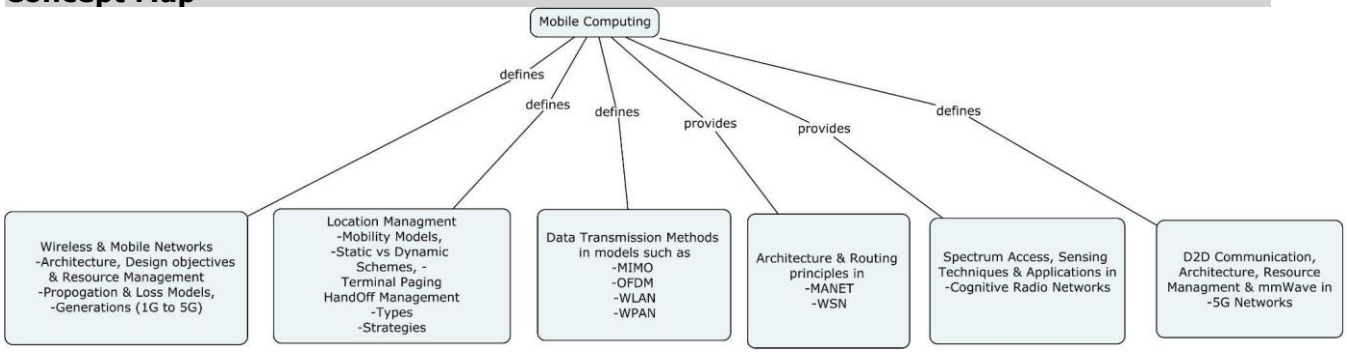
minimal transmission power.

3. Develop an application that resolves the interoperability and coexistence issues in radio cognitive networks.

Course Outcome6(CO6):

1. Utilize the architecture of 5G and identify how components are associated with each other for D2D communications.
2. Identify various challenges in radio resource management for developing learning architectures in 5G.
3. Apply the characteristics of the mmWave communication in 5G networks and identify suitable use cases in real world applications.

Concept Map



Syllabus

Introduction: Overview of wireless and mobile infrastructure; Preliminary concepts on cellular architecture; Design objectives and performance issues; Radio resource management and interface; Propagation and path loss models; Channel interference and frequency reuse; Cell splitting; Channel assignment strategies; Overview of generations:- 1G to 5G.

Location and handoff management: Introduction to location management (HLR and VLR); Mobility models characterizing individual node movement (Random walk, Fluid flow, Markovian,Activity based); Mobility models characterizing the movement of groups of nodes (Reference point based group mobility model, Community based group mobility model); Static (Always vs. Never update, Reporting Cells, Location Areas) and Dynamic location management schemes (Time, Movement, Distance, Profile Based); Terminal Paging (Simultaneous paging, Sequential paging); Location management and Mobile IP; Overview of handoff process; Factors affecting handoffs and performance evaluation metrics; Handoff strategies; Different types of handoffs (soft, hard, horizontal, vertical).

Wireless transmission fundamentals: Introduction to narrow and wideband systems; Spread spectrum; Frequency hopping; Introduction to MIMO; MIMO Channel Capacity and diversity gain; Introduction to OFDM; MIMO-OFDM system; Multiple access control (FDMA, TDMA,CDMA, SDMA); Wireless local area network; Wireless personal area network (Bluetooth and zigbee).

Mobile Ad-hoc networks: Characteristics and applications; Coverage and connectivity problems; Routing in MANETs.

Wireless sensor networks: Concepts, basic architecture, design objectives and applications; Sensing and communication range; Coverage and connectivity; Sensor placement; Data relaying and aggregation; Energy consumption; Clustering of sensors; Energy efficient Routing (LEACH).

Cognitive radio networks: Fixed and dynamic spectrum access; Direct and indirect spectrum sensing; Spectrum sharing; Interoperability and co-existence issues; Applications of cognitive radio networks.

D2D communications in 5G cellular networks: Introduction to D2D communications; High level requirements for 5G architecture; Introduction to the radio resource management, power control and mode selection problems; Millimeter wave communication in 5G.

Assignment:
Development and implementation of different network protocols using network simulators such as NS-3 and OMNET++.

A Discrete-Event Network Simulator. https://www.nsnam.org/docs/manual/html/index.html

Learning Resources

Text Books:

1. Andrea Goldsmith,"Wireless Communication", Cambridge University Press, Second Edition, 2020.

2. JochenSchiller,"Mobile Communications", Second Edition, Pearson Education, 2012.

Reference Books:

3. Lingyang Song, DusitNiyato, Zhu Han, and Ekram Hossain, "Wireless Device-to- Device Communications and Networks",Cambridge University Press, 2015.
4. EzioBiglieri, Andrea J. Goldsmith, Larry J. Greenstein, Narayan Mandayam and H. Vincent Poor, "Principles of Cognitive Radio", Cambridge University Press, 2013.

Course Contents and Lecture Schedule

Module No.	Topic	No.of Hours	Course Outcome
1.	**Introduction**		
1.1	Overview of wireless and mobile infrastructure	1	CO1
1.2	Preliminary concepts on cellular architecture, Design objectives and performance issues	2	CO1
1.3	Radio resource management and interface, Propagation and path loss models	1	CO1
1.4	Channel interference and frequency reuse- Cell splitting; Channel assignment strategies	2	CO1
1.5	Overview of generations:- 1G to 5G.	1	CO1
2	**Location and handoff management**		
2.1	Introduction to location management (HLR and VLR), Mobility models characterizing individual node movement (Random walk, Fluid flow, Markovian, Activity based);	1	CO2
2.2	Mobility models characterizing the movement of groups of nodes (Reference point based group mobility model, Community based group mobility model);	1	CO2
2.3	Static (Always vs. Never update, Reporting Cells, Location Areas) and Dynamic location management schemes (Time, Movement, Distance, Profile Based);;	2	CO2
2.4	Terminal Paging (Simultaneous paging, Sequential paging); Location management and Mobile IP	2	CO2
2.5	Overview of handoff process; Factors affecting handoffs and performance evaluation metrics; Handoff strategies; Different types of handoffs (soft, hard, horizontal, vertical).	2	CO2
3	**Wireless transmission fundamentals**		
3.1	Introduction to narrow and wideband systems; Spread spectrum; Frequency hopping;	1	CO3
3.2	Introduction to MIMO; MIMO Channel Capacity and diversity gain	2	CO3
3.3	Introduction to OFDM; MIMO-OFDM system; Multiple access control (FDMA, TDMA,CDMA, SDMA);	2	CO3

3.4	Wireless local area network; Wireless personal area network (Bluetooth and zigbee). Measure Risk, Attitudes Toward Risk	2	CO3
4	**Mobile Ad-hoc networks & Wireless sensor networks**		
4.1	**Mobile Ad-hoc networks-** Characteristics and applications, Coverage and connectivity problems; Routing in MANETs	2	CO4
4.2	**Wireless sensor networks-** Concepts, basic architecture, design objectives and applications	1	CO4
4.3	Sensing and communication range; Coverage and connectivity; Sensor placement; Data relaying and aggregation;	2	CO4
4.4	Energy consumption; Clustering of sensors; Energy efficient Routing (LEACH).	1	CO4
5	**Cognitive radio networks**		
5.1	Fixed and dynamic spectrum access;	1	CO5
5.2	Direct and indirect spectrum sensing	1	CO5
5.3	Spectrum sharing; Interoperability and co-existence issues	1	CO5
5.4	Applications of cognitive radio networks	1	CO5
6	**D2D communications in 5G cellular networks**		
6.1	Introduction to D2D communications;	1	CO6
6.2	High level requirements for 5G architecture	1	CO6
6.3	Introduction to the radio resource management, power control and mode selection problems	1	CO6
6.4	Millimeter wave communication in 5G	1	CO6
	Total hours	**36**	

Course Designer

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21CBPZ1	PRINCIPLES OF CYBER PHYSICAL SYSTEM

Category	L	T	P	Credit	Terminal Exam Type
PSE	3	0	0	3	Theory

Preamble

This course describes about the basic concepts, requirements, principles and techniques in cyber physical systems and provide students hands-on experience in prototyping a cyber-physical system. Examine the challenges in implementing a cyber-physical system from a computational perspective.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Explain the need and purpose of the different components of cyber physical systems.	10
CO2	Illustrate the cyber physical systems design recommendations and cyber physical system application.	15
CO3	Identify the hardware platforms and wireless technologies for cyber physical systems	15
CO4	Analyze the Dynamics Behaviours of a Continuous Dynamics, Discrete dynamics and Hybrid Systems.	15
CO5	Implement the Concurrent Models of computation such as Structure of Models, Synchronous Reactive models, Dataflow models and Timed models.	20
CO6	Examine the design of Embedded Systems, Internet of Things Architecture, CPS Architecture and Identify the Security and Privacy issues in Cyber Physical Systems.	25

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO#	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond	Guided Response	1.3,1.2,2.1.1,2.1.2,2.2.1, 2.5.1
CO2	TPS2	Understand	Respond	Guided Response	1.3,2.1.1,4.4.1,2.3.1, 2.5.1
CO3	TPS3	Apply	Value	Mechanism	1.3,2.1.1,2.1.2,2.5.1, 4.1.2, 4.4.1,4.4.2,4.4.3
CO4	TPS3	Apply	Value	Mechanism	1.3,2.1.1,2.1.2,2.5.1, 4.1.2, 4.4.1,4.4.2,4.4.3
CO5	TPS3	Apply	Value	Mechanism	1.3,2.1.1,2.1.2,2.5.1, 4.1.2, 4.4.1,4.4.2,4.4.3
CO6	TPS2	Apply	Value	Mechanism	1.3,2.1.1,2.1.2,2.5.1, 4.1.2, 4.4.1,4.4.2,4.4.3

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	S	M									L	L		L
CO2	M	M									L	L		L
CO3	M	M	L								L	L		L
CO4	M	M	L	M	M			M	M		M	M	M	L
CO5	S	M	M	M	M			M	M		M	M	M	L
CO6	S	M	M	M	M			M	M		M	M	M	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	2	1	2	
Remember	20	20	-	-	20
Understand	40	40	30	30	20
Apply	40	40	70	70	60
Analyse	-	-	-	-	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Assessment Pattern: Psychomotor

Psychomotor Skill	~~Mini~~project/Assignment~~/Practical Component~~
Perception	-
Set	-
Guided Response	20
Mechanism	80
Complex Overt Responses	-
Adaptation	-
Origination	-

Sample Questions for Course Outcome Assessment**

** (2 to 3 at the cognitive level of course outcome)

Course Outcome 1(CO1):

1.fundamental concept of a Cyber-Physical System (CPS)
2.Describe the concept of data integration and its significance in Industry 4.0.
3.Clarify the benefits of real-time data monitoring in IIoT applications

Course Outcome 2(CO2):

1.Describe a specific scenario where CPS Design can improve manufacturing processes.
2.Propose an IIoT solution for optimizing energy usage in a factory
3.Can you design a control algorithm for a simple CPS using a specific sensor and actuator configuration?

Course Outcome 3(CO3):

1.How would you choose the appropriate CPS hardware components and architecture to ensure reliable and efficient operation?
2.What potential challenges and vulnerabilities can arise in CPS hardware systems, and how can they be mitigated or addressed?
3.Develop a comprehensive CPS hardware architecture for an autonomous drone delivery system, considering all the necessary hardware components, redundancy, and safety measures.

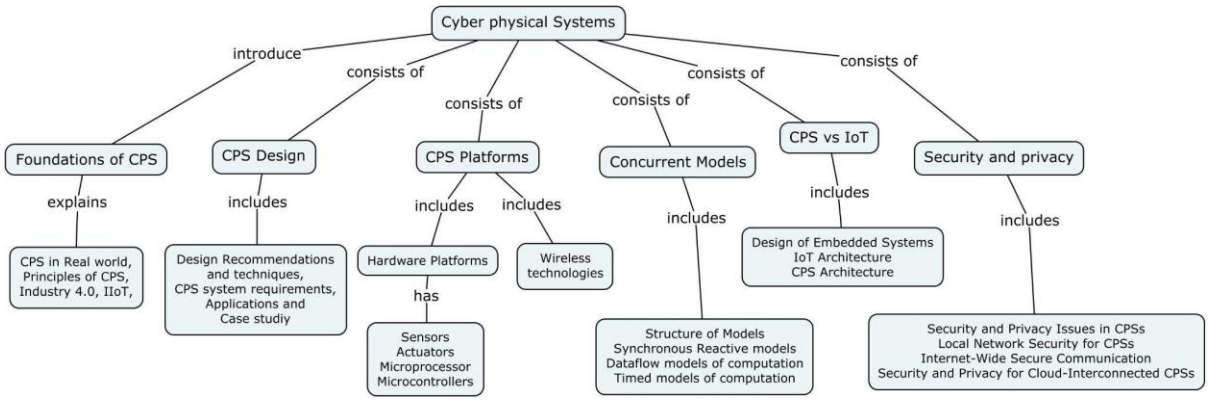
Course Outcome 4 (CO4):

1.Analyze the effect of parameter variations in a continuous dynamics model and how they impact the system's behavior.
2.Investigate the transient response of a continuous-time system and identify key performance metrics, such as rise time and settling time.
3.Develop a state-transition model for a discrete-event system, such as an elevator control system, to manage passenger requests efficiently.
4.Apply a finite state machine (FSM) to model the operation of a traffic signal at an intersection, considering various traffic flow scenarios.

Course Outcome 5 (CO5):
1.Simulate the dataflow model to analyze performance and identify bottlenecks
2.Analyze the Timed model to ensure that it meets timing constraints and performs as expected in real-time scenarios
3.Create a model that represents the structure and interactions of various components and their models of computation

Course Outcome 6(CO6):
1.Design a simple Cyber-Physical System for monitoring temperature and humidity in a greenhouse.
2.Mitigate the main challenges in ensuring the security and privacy of data in Cyber-Physical Systems.
3. Analyze the impact of a security breach in Internet-wide CPS on critical infrastructure or public safety.

Concept Map



Syllabus

Computational foundation of Cyber Physical Systems: Cyber Physical Systems in Real world, Basic Principle of Cyber Physical Systems, Industry 4.0, IIoT

Cyber Physical System Design and system requirements: Cyber Physical Systems Design Recommendations, CPS system requirements, Cyber Physical System Application, Case study of Cyber Physical Systems

Cyber Physical System Platforms: Hardware platforms for Cyber Physical Systems (Sensors/Actuators, Microprocessor/Microcontrollers), Wireless Technologies for Cyber Physical Systems

Cyber Physical System – Models and Dynamics Behaviours: Continuous Dynamics, Discrete dynamics, Hybrid Systems

Concurrent Models of computation: Structure of Models, Synchronous Reactive models, Dataflow models of computation, Timed models of computation

Study of Embedded Systems vs Internet of Things vs Cyber Physical System: Design of Embedded Systems (I/O Units, Multitasking and Scheduling), Internet of Things Architecture, CPS Architecture.

Security and Privacy in Cyber Physical Systems: Security and Privacy Issues in CPSs, Local Network Security for CPSs, Internet-Wide Secure Communication, Security and Privacy for Cloud-Interconnected CPSs, Case Study: Cybersecurity in Digital Manufacturing/Industry 4.0

Learning Resources

Text Books:

1. E. A. Lee and S. A. Seshia, "Introduction to Embedded Systems: A Cyber-Physical Systems Approach", 2nd edition, MIT Press, 2017.
2. R. Alur, "Principles of Cyber-Physical Systems", MIT Press, 2015.

Reference Books:

1. T. D. Lewis "Network Science: Theory and Applications", 1st edition, Wiley, 2009.
2. P. Tabuada, "Verification and control of hybrid systems: a symbolic approach", 1st edition, Springer-Verlag, 2010.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Computational foundation of Cyber Physical Systems**		**CO1**
1.1	Cyber Physical Systems in Real world, Basic Principle of Cyber Physical Systems	2	CO1
1.2	Industry 4.0, IIoT	2	CO1
2.	**Cyber Physical System Design and system requirements**		**CO2**
2.1	Cyber Physical Systems Design Recommendations, CPS system requirements	2	CO2
2.2	Cyber Physical System Application, Case study of Cyber Physical Systems	2	CO2
3.	**Cyber Physical System Platforms**		**CO3**
3.1	Hardware platforms for Cyber Physical Systems (Sensors/Actuators,Microprocessor/Microcontrollers)	2	CO3
3.2	Wireless Technologies for Cyber Physical Systems	2	CO3
4.	**Cyber Physical System – Models and Dynamics Behaviours**		**CO4**
4.1	Continuous Dynamics	1	CO4
4.2	Discrete dynamics	1	CO4
4.3	Hybrid Systems	2	CO4
5	**Concurrent Models of computation**		**CO5**
5.1	Structure of Models	2	CO5
	Synchronous Reactive models	2	CO5
5.2	Dataflow models of computation	2	CO5
	Timed models of computation	2	CO5
6	**Study of Embedded Systems vs Internet of Things vs Cyber Physical System**		**CO6**
6.1	Design of Embedded Systems (I/O Units, Multitasking and Scheduling),	2	CO6
6.2	Internet of Things Architecture, CPS Architecture	2	CO6
6.3	**Security and Privacy in Cyber Physical Systems**		**CO6**
6.3.1	Security and Privacy Issues in CPSs, Local Network Security for CPSs	2	CO6
	Internet-Wide Secure Communication	2	CO6
6.3.2	Security and Privacy for Cloud-Interconnected CPSs	2	CO6
6.3.3	Case Study: Cybersecurity in Digital Manufacturing/ Industry 4.0.	2	CO6
	TOTAL	**36**	

Course Designers:

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21CBSA1	CYBER SECURITY ESSENTIALS

Category	L	T	P	Credit	Terminal Exam Type
PSE	3	0	0	3	Theory

Preamble

This course describes the basic principles of cyber security and explores the basics of cyber trends, threats, attacks and exploitation. It also imparts knowledge of various defense mechanisms and tools used for preventing cyberattacks.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage *** in %
CO1	Explain the key components and types of attacks in the cyber security system.	15
CO2	Implement the enterprise information security policy (EISP), Information System Security Policy (ISSP), System-Specific Security Policy (SYSSP) security policies and risk management techniques to solve security problems	10
CO3	Identify the suitable data attacker techniques such as Anti forensics using Tunneling, Botnets, Fast Flux and Fraud Techniques for networks systems	20
CO4	analyze software vulnerabilities and security solutions using cyber attack methods and Malware techniques to reduce the risk of exploitation.	25
CO5	Implement the analysis and defense techniques such as cyber security defenses, firewall and antivirus software to prevent security threats.	15
CO6	Design a secured real world application using cyber security tools snort, NetFlow Analyzer, etc..	15

CO Mapping with CDIO Curriculum Framework

CO#	TCE	Learning Domain Level			CDIO
	Proficiency Scale	Cognitive	Affective	Psychomotor	Curricular Components (X.Y.Z)
CO1	TPS2	Understand	Respond	Guided Response	1.3,1.2,2.1.1,2.1.2,2.2.1, 2.5.1,4.1.2
CO2	TPS3	Apply	Value	Mechanism	1.3,2.1.1,4.4.1,2.3.1,2.5.1, 4.1.2
CO3	TPS3	Apply	Value	Mechanism	1.3,2.1.1,2.1.2,2.5.1,4.1.2, 4.4.1,4.4.2, 4.4.3,4.5
CO4	TPS3	Apply	Value	Mechanism	1.3,2.1.1,2.1.2,2.5.1,4.1.2, 4.4.1,4.4.2, 4.4.3,4.5
CO5	TPS3	Apply	Value	Mechanism	1.3,2.1.1,2.1.2,2.5.1,4.1.2, 4.4.1,4.4.2, 4.4.3,4.5
CO6	TPS3	Apply	Value	Mechanism	1.3,2.1.1,2.1.2,2.5.1,4.1.2, 4.4.1,4.4.2, 4.4.3,4.5

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	S	M	L	M	M	L	M				L	M	L	L
CO2	S	M	L	M	M	L	M				L	M	L	L
CO3	S	M	M	M	S	M	M				M	M	L	M
CO4	S	M	M	M	S	M	M				M	M	L	M
CO5	S	M	M	M	S	M	M				M	M	L	M
CO6	S	M	M	M	S	M	M				M	M	L	M

S-Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive levels	Continuous Assessment Tests		Assignments		Terminal examination
	1	2	1	2	
Remember	20	20			20
Understand	40	40	30	30	20
Apply	40	60	70	70	60
Analyze					
Evaluate					
Create					

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject/Assignment/Practical Component
Perception	
Set	
Guided Response	20
Mechanism	80
Complex Overt Responses	
Adaptation	
Origination	

Sample Questions for Course Outcome Assessment**

Course Outcome 1 (CO1):

1. Classify the various types of attacks that are possible in affecting the cybersecurity environment?
2. Explain in detail about various types of active attacks in the cybersecurity environment?
3. Show the concept of difference between Denial of Service and Distributed Denial of Service attacks with examples.

Course Outcome 2 (CO2):

1. Identify various components of EISP for developing the strategic vision of an organization?
2. Identify suitable risk assessment procedures for preventing the organization'sinformation asset with examples.
3. Apply various methods of control strategies that help the project team in an organization to overcome the risk identified as a security threat.

Course Outcome 3 (CO3):

1. Identify suitable tunneling techniques that are applicable in various network protocols in cyber security systems.
2. Apply various fraud techniques in mobile devices that are risks to user personal information.
3. Identify various click fraud models applicable in the advertising world of

network systems.

Course Outcome 4 (CO4):

1. Identify various categories of web exploit tools for providing awareness for security personnel to prevent data hacking in cyber security environments.
2. Apply various protection mechanisms for preventing SQL injection attacks in social websites.
3. Organize various malware attacks to provide awareness for students in preventing exploitation.

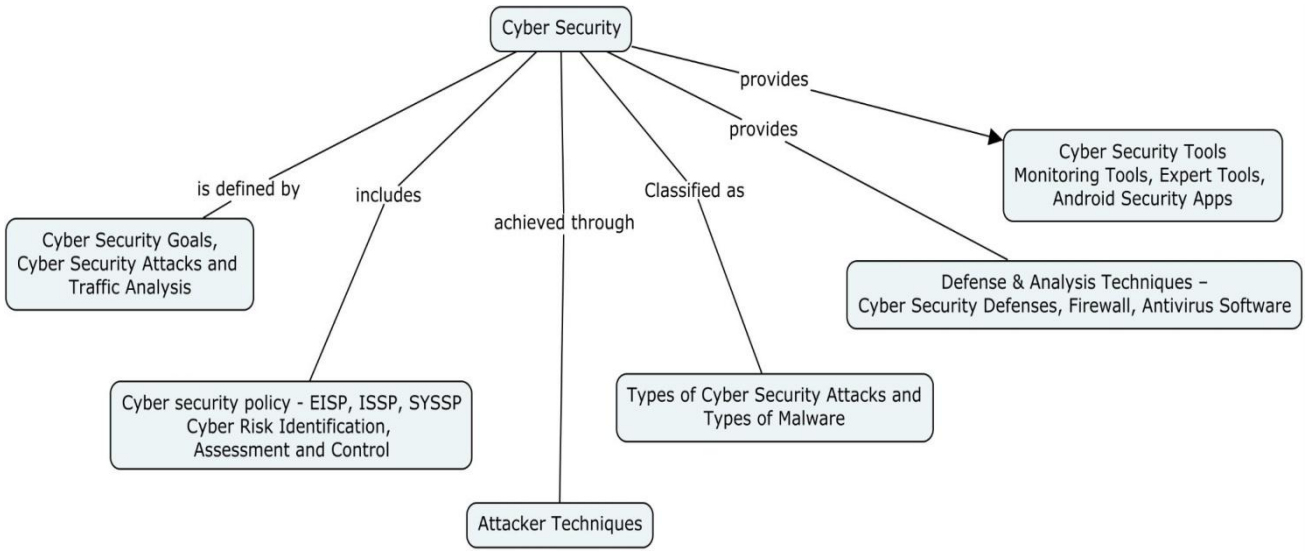
Course Outcome 5 (CO5):

1. Apply various categories of firewall processing modes for securing information flow from trusted to untrustworthy networks and vice versa.
2. Identify suitable intrusion detection mechanisms for monitoring and detecting the network traffic in a wireless area network.
3. Develop an automated malicious code analysis system comprising various techniques to provide active defense for malicious code in network systems.

Course Outcome 6 (CO6):

1. Identify various basic tools for administering, monitoring and troubleshooting that every cybersecurity specialist should have in their toolbox.
2. Apply various tools for preventing port, firewall analysis and operating systems for host systems in cyber security systems.
3. Identify suitable packet analysis tools for capturing data to examine various traffic and protocols in a network systems.

Concept Map



Syllabus

Introduction: Cyber Security Goals - Security Attacks - Passive Attacks – Release of Message Contents – Traffic Analysis - Active Attacks – Masquerade – Replay – Modification of Messages – Denial of Service - Examples.

Policy & Risk Management: Cyber security policy - EISP, ISSP, SYSSP- Cyber Risk Identification, Assessment, and Control

Attacker Techniques: Introduction - Anti forensics – Using Proxies – Using Tunneling – Using Botnets – Using Fast Flux - Fraud Techniques – Phishing – Rogue Antivirus – Click Fraud - Cyber Security Statistics

Exploitation: Introduction - Malware - Types of Malware – VIRUS – Computer Worm – Trojan Horse - Ransomware - Cyber Attacks - Denial of Service Attacks - Man-in-the-Middle Attacks- SQL Injection Attacks

Defense & Analysis Techniques: Introduction - The Power of Active Defense - Cyber Security Defenses – Firewall – Antivirus Software

Cyber Security Tools: Basic Tools - Monitoring Tools - Expert Tools - Android Security Apps

Learning Resources

Text Books:

1. Charles J. Brooks, Christopher Grow, Philip Craig & Donald Short, "Cyber Security Essentials", 1st edition, Sybex, 2018.
2. James Graham, Richard Howard & Ryan Olson, "Cyber Security Essentials", 1st edition, CRC Press, 2016.

Reference Book:

1. Michael E. Whitman, Herbert J. Mattord, "Principles of Information Security", 6th edition, Course Technology Inc, 2018

Course Contents and Lecture Schedule

Module No.	Topic	No.of Hours	Course Outcome
1.	**Introduction**		**CO1**
1.1	Cyber Security Goals - Security Attacks - Passive Attacks –- Active Attacks	2	CO1
1.2	Release of Message Contents – Traffic Analysis –Masquerade	2	CO1
1.3	Replay – Modification of Messages – Denial of Service - Examples.	2	CO1
2	**Policy & Risk Management**		**CO2**
2.1	Cyber security policy - ESSP, ISSP, SYSSP	2	CO2
2.2	Cyber Risk Identification, Assessment, and Control	1	CO2
3	**Attacker Techniques**		**CO3**
3.1	Introduction - Antiforensics – Using Proxies	2	CO3
3.2	Using Tunneling – Using Botnets – Using Fast Flux	2	CO3
3.3	Fraud Techniques – Phishing – Rogue Antivirus	2	CO3
3.4	Click Fraud - Cyber Security Statistics	1	CO3
4	**Exploitation**		**CO4**
4.1	Introduction - Malware - Types of Malware	1	CO4
4.2	VIRUS – Computer Worm – Trojan Horse - Ransomware	2	CO4
4.3	Cyber Attacks	1	CO4
4.4	Denial of Service Attacks	1	CO4
4.5	Man-in-the-Middle Attacks	2	CO4
4.6	SQL Injection Attacks	2	CO4
5	**Defense & Analysis Techniques**		**CO5**
5.1	Introduction - The Power of Active Defense	1	CO5
5.2	Cyber Security Defenses	2	CO5
5.3	Firewall – Antivirus Software	2	CO5
6	**Cyber Security Tools**		**CO6**
6.1	Basic Tools - Monitoring Tools	2	CO6
6.2	Expert Tools	2	CO6
6.3	Android Security Apps	2	CO6
	Total hours	**36**	

Course Designers:

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21CBSB1	DATA CENTER VIRTUALIZATION

Category	L	T	P	Credit	Terminal exam type
PSE	3	0	0	3	Theory

Preamble

This course introduces the concept of data center and its virtualization using related technologies. Techniques for virtualizing data, storage, network elements and servers for automating data center virtualization along with the tools used have been described for better understanding and knowledge sharing.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage in %
CO1	Understand the basics of data centers, virtualization and its types.	15
CO2	Identify suitable requirements and management issues in designing data centers for automation with example case study.	20
CO3	Construct various techniques in virtualizing the storage devices and identify key challenges in integration and management of storage devices.	20
CO4	Apply various techniques in virtualizing the servers for better utilization of resources such as operating systems, processors and physical servers in data center automation	10
CO5	Identify suitable approaches in virtualizing the network for improving security within the data center.	15
CO6	Employ various techniques in migrating virtual machine and identify its support for live migration	20

CO Mapping with CDIO Curriculum Framework

CO#	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Component (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond		1.2, 2.1.5, 2.2.3, 2.5.1, 3.2.
CO2	TPS3	Apply	Value		1.2,2.3.2,3.2.3,4.4.3
CO3	TPS3	Apply	Value		1.2,2.3.2,3.2.3,4.4.3
CO4	TPS3	Apply	Value		1.2,2.1.5, 2.2.3, 2.5.1, 3.2. 4.5.3
CO5	TPS3	Apply	Value		1.2,2.1.5, 2.2.3, 2.5.1, 3.2. 4.5.3
CO6	TPS3	Apply	Value		1.2,2.1.5, 2.2.3, 2.5.1, 3.2. 4.5.3

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	S	M	L						L		M	M	L	L
CO2	M	L	-						-		L	L	-	L
CO3	S	M	L						L		M	M	L	L
CO4	S	M	L						L		S	M	L	L
CO5	S	M	L						L		S	M	L	L
CO6	S	M	L						L		S	M	L	L

S-Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive levels	Continuous Assessment Tests		Assignments		Terminal examination
	1	2	1	2	
Remember	20	20			20
Understand	20	40	50	50	20
Apply	60	40	50	50	60
Analyze					
Evaluate					
Create					

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject/Assignment/PracticalComponent
Perception	-
Set	-
Guided Response	-
Mechanism	-
Complex Overt Responses	-
Adaptation	-
Origination	-

Sample Questions for Course Outcome Assessment **

** (2 to 3 at the cognitive level of course outcome)

Course Outcome1(CO1):

1. Compare and contrast physical and virtual data center with examples.
2. Classify various types of virtualization models in the domain of cloud computing.
3. Interpret the concept of hypervisor with neat examples.

Course Outcome2(CO2):

1. Identify requirements and challenges in designing a data center for better support of automation in cloud computing.
2. Identify the server access models and topology of fabric extender and apply it for a known example.
3. Organize the feature of fabric extender technology used in CISCO Nexus 2000.

Course Outcome3(CO3):

1. Apply the RAID concept for virtualizing the physical storage and identify its key benefits.
2. Identify various methods of virtualizing the storage device and its key challenges.
3. Identify the architecture of virtualization that is applicable for a pool of storage devices.

Course Outcome4(CO4):

1. Identify various methods of virtualization of servers in data centers with examples.
2. Apply the concept of dockers in virtualizing physical machines in a data center.
3. Apply the concept of Linux containers in virtualizing host OS in physical machines.

Course Outcome5(CO5):

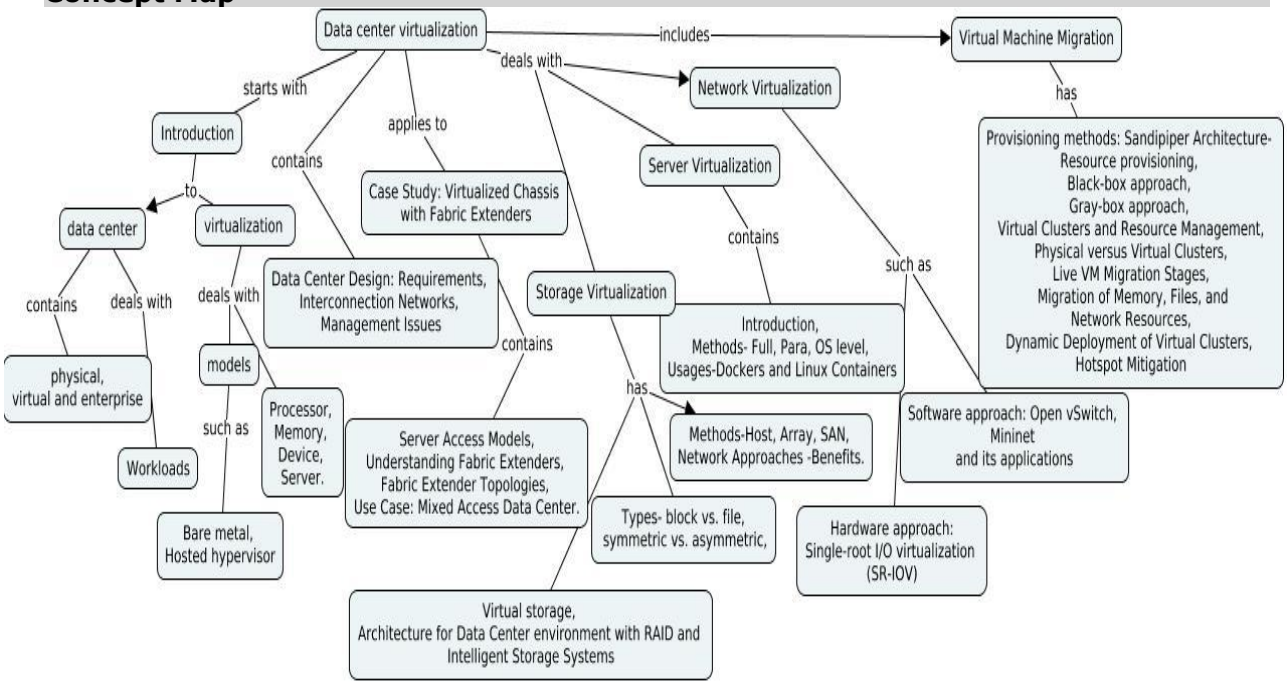
1. Identify the working principle of virtualizing network for automation of data center

2. Identify the suitable approaches suitable for virtualizing network in data center.
3. Identify the architectural approach used in VMware NSX Data center.

Course Outcome6(CO6):

1. Organize the steps involved in live migration of virtual machines from one host to another with diagram.
2. Apply the concept of sandpiper architecture to detect and mitigate hostspots for migration.
3. Identify the working principle of migrating memory, files and network resources with examples.

Concept Map



Syllabus

Introduction: Data Center- physical and virtual data centers, Enterprise Data Centers, Data Center Workloads, Virtualization-Models-Bare metal, Hosted hypervisor-Types-Processor, Memory, Device, Server.

Data Center Design: Requirements, Interconnection Networks, Management Issues, Case Study: Virtualized Chassis with Fabric Extenders, Server Access Models, Understanding Fabric Extenders, Fabric Extender Topologies, Use Case: Mixed Access Data Center.

Storage Virtualization: Virtual storage, Architecture for Data Center environment with RAID and Intelligent Storage Systems- Types- block vs. file, symmetric vs. asymmetric, Methods-Host, Array, SAN, Network Approaches -Benefits.

Server Virtualization : Introduction, Methods- Full, Para, OS level, Usages-Dockers and Linux Containers

Network Virtualization: Approaches for Networking of VMs: Hardware approach: Single-root I/O virtualization (SR-IOV), Software approach: Open vSwitch, Mininet and its applications.

Virtual Machine Migration: Provisioning methods: Sandipiper Architecture-Resource provisioning, Black-box approach, Gray-box approach, Virtual Clusters and Resource Management, Physical versus Virtual Clusters, Live VM Migration Stages, Migration of Memory, Files, and Network Resources, Dynamic Deployment of Virtual Clusters, Hotspot Mitigation

Home Assignments:

1. Virtualizing OS for Data Center using Vsphere.
2. Management of VM host, virtual network and scheduling using openNebula.

Learning Resources

Text Books:

1. Kai Hwang, Jack Dongarra, Geoffrey Fox," Distributed and Cloud Computing From Parallel Processing to the Internet of Things", Morgan Kaufmann, First Edition, 2013.

2. Mauricio Arregoces and Maurizio Portolani, "Data Center Fundamentals", Cisco Press, 2004.

Reference Books:

1. Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, "Cloud Computing: Principles and Paradigms", Wile, 2011
2. Tom Clark," Storage virtualization : technologies for simplifying data storage and management", Second Edition, Addison Wesley, 2005.

Online Courses

1. NPTEL course on "Cloud Computing and Distributed Computing" by Prof.Rajiv Misra, IIT Patna.
2. URL: https://onlinecourses.nptel.ac.in/noc21_cs15/preview

Course Contents and Lecture Schedule

Module No.	Topic	No.of Hours	Course Outcome
1.	**Introduction:**		
1.1	Data Center- physical and virtual data centers, Enterprise Data Centers	1	CO1
1.2	Data Center Workloads	1	CO1
1.3	Virtualization-Models-Bare metal, Hosted hypervisor	1	CO1
1.4	Types-Processor, Memory, Device, Server.	1	CO1
2	**Data Center Design:**		
2.1	Requirements, Interconnection Networks, Management Issues	2	CO2
2.2	Case Study: Virtualized Chassis with Fabric Extenders, Server Access Models	2	CO2
2.3	Understanding Fabric Extenders, Fabric Extender Topologies	2	CO2
2.4	Use Case: Mixed Access Data Center	1	CO2
3	**Storage Virtualization:**		
3.1	Virtual storage	1	CO3
3.2	Architecture for Data Center environment with RAID	2	CO3
3.3	Intelligent Storage Systems	1	CO3
3.4	Types- block vs. file, symmetric vs. asymmetric	2	CO3
3.5	Methods-Host, Array, SAN,	1	CO3
3.6	Network Approaches -Benefits.	1	CO3
4	**Server Virtualization** :		CO4
4.1	Introduction, Methods- Full, Para, OS level	2	CO4
4.2	Usages-Dockers and Linux Containers	2	CO4
5	**Network Virtualization:**		CO5
5.1	Approaches for Networking of VMs	1	CO5
5.2	Hardware approach: Single-root I/O virtualization (SR-IOV),	2	CO5

5.3	Software approach: Open vSwitch, Mininet and its applications.	2	CO5
6	**Virtual Machine Migration**:		
6.1	Provisioning methods: Sandipiper Architecture	1	CO6
6.2	Resource provisioning, Black-box approach, Gray-box approach,	1	CO6
6.3	Virtual Clusters and Resource Management	1	CO6
6.4	Physical versus Virtual Clusters	1	CO6
6.5	Live VM Migration Stages	1	CO6
6.6	Migration of Memory, Files, and Network Resources	1	CO6
6.7	Dynamic Deployment of Virtual Clusters	1	CO6
6.8	Hotspot Mitigation	1	CO6
	Total hours	**36**	

Course Designers:

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21CBSC1	ETHICAL HACKING

Category	L	T	P	Credit	Terminal Exam Type
PSE	3	0	0	3	Theory

Preamble

This course includes a study of ethical hacking starting from the basic terminologies, data collection and various hacking techniques in system and web using various tools. At the end, students will be proficient in securing digital systems and networks against security threats.

Prerequisite

-

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	To Understand Networking terminologies and phases involved in hacking.	20
CO2	Interpret various aspects of data collection practices using tools such as NMAP.	15
CO3	Explore the fundamentals of port scanning and essentials of cryptography	15
CO4	Apply advanced system hacking techniques such as Active and Passive Sniffing- ARP Spoofing etc.	20
CO5	Create a hacking environment through the utilization of various tools such as wireshark and provide measures to overcome it.	15
CO6	Identify and mitigate web application vulnerabilities such as SQL injection, Cross-site scripting etc.	15

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond		1.2,1.3,2.2,2.3,2.5.4, 4.2
CO2	TPS3	Apply	Value		1.2,2.1,2.2,4.1,4.2
CO3	TPS3	Apply	Value		1.2, 2.1.2,4.4,4.5,4.6
CO4	TPS3	Apply	Value		1.2,2.3,4.2,4.3,4.4,4. 5,4.6
CO5	TPS3	Apply	Value		1.2,2.1,2.3,4.5
CO6	TPS3	Apply	Value		1.2,2.1,2.5,3.1.5,4.3, 4.5,4.6

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L	L	L			L				M	L		
CO2	S	M	M	L			L				M	M	L	L
CO3	S	M	M		L		L				M	M	L	L
CO4	S	S	M		M		L				M	M	L	L
CO5	S	M	M				L				M	M	L	L
CO6	S	S	M		M		L				M	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	2	1	2	
Remember	20	20			20
Understand	30	20	50	50	30
Apply	50	60	50	50	50
Analyse					
Evaluate					
Create					

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject /Assignment/Practical Component
Perception	
Set	
Guided Response	
Mechanism	
Complex Overt Responses	
Adaptation	
Origination	

Sample Questions for Course Outcome Assessment**

** (2 to 3 at the cognitive level of course outcome)

Course Outcome 1(CO1):

1. Explain the phases involved in hacking.
2. Explain the need for Vulnerability Scanners and write the commands for implementing it in linux os.
3. Depict the network components that are communicating at each layer of the five-layer internet protocol stack with example.

Course Outcome 2(CO2):

1. Explain footprinting in ethical hacking.
2. Differentiate types of footprinting and enumerate its steps.
3. Illustrate the methods of Identifying IP addresses using whois database.

Course Outcome 3(CO3):

1. Write a Python program and deepen your understanding of the Scapy library.
2. Write a kernel module called a keylogger that logs everything a user types, including usernames and passwords.
3. Show how the DES block cipher can be used to build a 64-bit hash function. Is the result collision resistant?

Course Outcome 4 (CO4):

1. Discuss the limitations and challenges of relying solely on keystroke loggers for password cracking, and explore alternative methods that attackers might use.
2. Design a network security policy to prevent ARP spoofing incidents.
3. Compare and contrast the differences between passive and active IP sniffing techniques.
4. How can organizations protect their network against Https sniffing attacks?

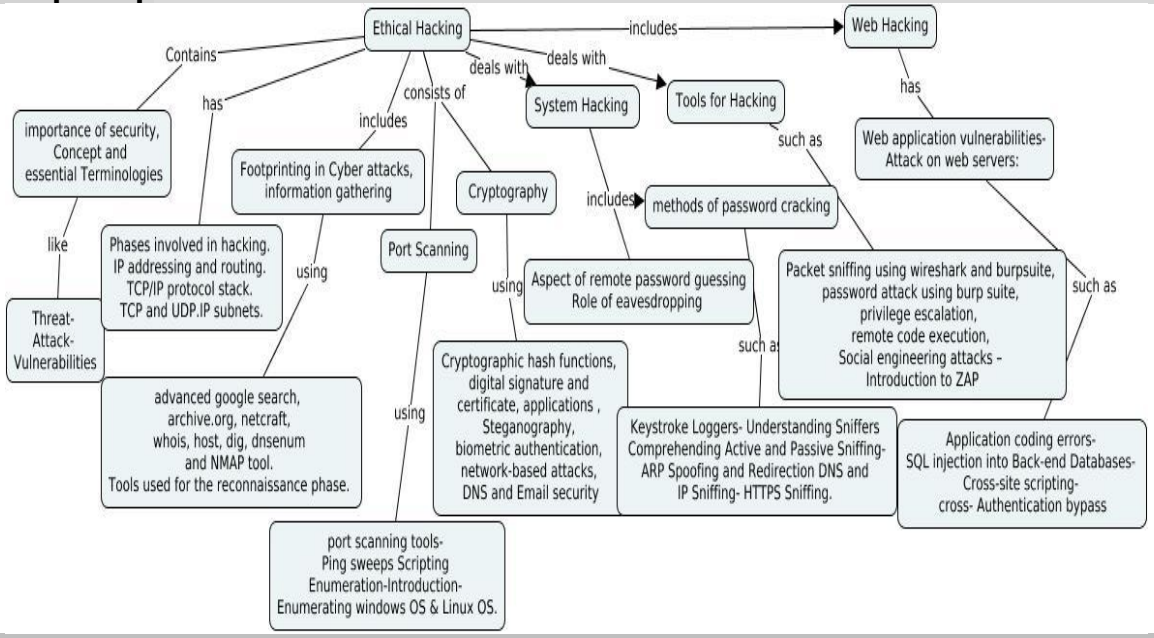
Course Outcome 5 (CO5):

1. Using Wireshark, describe the process of capturing and analyzing packets on a local network.
2. Outline a real-world scenario where packet sniffing with Burp Suite might be used for security testing
3. How would you protect a web application from remote code execution security breach?
4. Evaluate the potential consequences of a successful social engineering attack on a government agency's information systems.

Course Outcome 6(CO6):

1. Develop a list of security best practices that can help mitigate common web application vulnerabilities
2. How would you test a web application for SQL injection vulnerabilities?
3. Provide an example of a simple web page vulnerable to XSS and suggest a mitigation strategy.
4. Evaluate the impact of an authentication bypass on the reputation and trustworthiness of an online service

Concept Map



Syllabus

Overview of Ethical Hacking & Network fundamentals

Understanding the importance of security - Concept of ethical hacking and essential Terminologies Threat- Attack- Vulnerabilities- Phases involved in hacking. IP addressing and routing. TCP/IP protocol stack. TCP and UDP.IP subnets.

Footprinting in Cyber attacks

Information gathering using advanced google search, archive.org, netcraft, whois, host, dig, dnsenum and NMAP tool. -Tools used for the reconnaissance phase.

Port Scanning & Cryptography

Port Scanning - Introduction- using port scanning tools- Ping sweeps Scripting Enumeration-Introduction- Enumerating windows OS & Linux OS. Cryptographic hash functions, digital signature and certificate, applications , Steganography, biometric authentication, network-based attacks, DNS and Email security

System Hacking

Aspect of remote password guessing- Role of eavesdropping -Various methods of password cracking- Keystroke Loggers- Understanding Sniffers - Comprehending Active and Passive Sniffing- ARP Spoofing and Redirection DNS and IP Sniffing- HTTPS Sniffing.

Tools for Hacking

Packet sniffing using wireshark and burpsuite, password attack using burp suite, privilege escalation, remote code execution, Social engineering attacks – Introduction to ZAP

Web Hacking

Web application vulnerabilities-Attack on web servers: Application coding errors- SQL injection into Back-end Databases- Cross-site scripting- cross- Authentication bypass

Learning Resources

1. Daniel G. Graham, "Ethical Hacking: A Hands-on Introduction to Breaking In", 2021.
2. Michael T. Simpson, "Hands-on Ethical Hacking & Network Defense", Course Technology, 2010
3. Patrick Engebretson,The Basics of Hacking and Penetration Testing, SYNGRESS, Elsevier, 2013.
4. https://www.coursera.org/specializations/ethical-hacking
5. https://onlinecourses.nptel.ac.in/noc22_cs13

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Overview of Ethical Hacking & Network fundamentals**		
1.1	Understanding the importance of security - Concept of ethical hacking and.	1	CO1
1.2	essential Terminologies Threat- Attack- Vulnerabilities	2	CO1
1.3	Phases involved in hacking.	1	CO1
1.4	IP addressing and routing. TCP/IP protocol stack	2	CO1
1.5	TCP and UDP.IP subnets.	1	CO1
2	**Footprinting in Cyber attacks**		
2.1	Information gathering using advanced google search	2	CO2
2.2	archive.org, netcraft, whois	1	CO2
2.3	host, dig, dnsenum and NMAP tool.	1	CO2
2.4	Tools used for the reconnaissance phase.	1	CO2
3	**Port Scanning & Cryptography**		
3.1	Port Scanning - Introduction- using port scanning tools- Ping sweeps Scripting	1	CO3
3.2	Enumeration-Introduction- Enumerating windows OS & Linux OS.	2	CO3
3.3	Cryptographic hash functions, digital signature and certificate, applications	1	CO3
3.4	Steganography, biometric authentication, network-based attacks	1	CO3
3.5	DNS and Email security	1	CO3
4	**System Hacking**		
4.1	Aspect of remote password guessing	1	CO4
4.2	Role of eavesdropping	1	CO4
4.3	Various methods of password cracking- Keystroke Loggers	2	CO4
4.4	Understanding Sniffers - Comprehending Active and Passive Sniffing	2	CO4
4.5	ARP Spoofing and Redirection DNS and IP Sniffing- HTTPS Sniffing.	2	CO4
5	**Tools for Hacking**		
5.1	Packet sniffing using wireshark and burpsuite	2	CO5
5.2	password attack using burp suite	1	CO5
5.3	privilege escalation, remote code execution	1	CO5
5.4	Social engineering attacks – Introduction to ZAP	1	CO5
6.	**Web Hacking**		
6.1	Web application vulnerabilities	1	CO6
6.2	Attack on web servers: Application coding errors	1	CO6
6.3	SQL injection into Back-end Databases	1	CO6
6.4	Cross-site scripting- cross- Authentication bypass	2	CO6
	TOTAL	**36**	

Course Designers:

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21CBQB1	STATISTICS FOR MANAGEMENT

Category	L	T	P	Credit	Terminal Exam Type
PSE	3	0	0	3	Theory

Preamble

The students will be able to learn statistics, or the application of statistics in the workplace. Students will able to gathering, analyzing, and interpreting data, also explore basic probability concepts, including measuring and modeling uncertainty, and use various data distributions, along with the Linear Regression Model, to analyze and inform business decisions.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage in %
CO1	Illustrate probability, joint and marginal probability, conditional probability and apply Bayes rule to invert probabilities on a decision tree	15
CO2	Describe the basic concepts of distributions, charts and various types of measures to summarize the data	15
CO3	Estimate the uncertainty while making decisions based on population parameters using statistical inference.	15
CO4	Implement statistical tests such as the t-test, F-test, z-test, and chi-square test to illustrate hypothesis testing in both small and large samples.	20
CO5	Use statistical techniques like multiple regression and correlation to make conclusions about population-level variables.	20
CO6	Evaluate variations across the means of distinct groups by using Analysis of Variance on real-time data	15

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Apply	Value	Mechanism	1.1, 2.3.4, 2.4.6, 2.4.7, 2.5.1
CO2	TPS3	Understand	Value	Guided response	1.1, 2.3.4, 2.4.6, 2.4.7, 2.5.1
CO3	TPS3	Apply	Value	Mechanism	1.1, 1.2, 2.1.3, 2.1.4, 2.1.5, 2.3, 2.4.3, 2.4.6, 2.4.7
CO4	TPS3	Apply	Value	Mechanism	1.1, 1.2, 2.1.3, 2.1.4, 2.1.5, 2.3, 2.4.3, 2.4.6, 2.4.7
CO5	TPS3	Apply	Value	Mechanism	1.1, 1.2, 2.1.3, 2.1.4, 2.1.5, 2.3, 2.4.3, 2.4.6, 2.4.7
CO6	TPS3	Apply	Value	Mechanism	1.2, 2.1.2, 3.2.3, 4.5.3

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L										L		
CO2	S	M	L			L	L		L		L	M	L	L
CO3	S	M	L			L	L		L		L	M	L	L
CO4	S	M	L			L	L		L		L	M	L	L
CO5	S	M	L			L	L		L		L	M	L	L
CO6	S	M	L	L		L	L		L		L	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive levels	Continuous Assessment Tests		Assignments		Terminal examination
	1	2	1	2	
Remember	20	10			20
Understand	20	30			20
Apply	60	60	100	100	60
Analyse					
Evaluate					
Create					

Assessment Pattern: Psychomotor

Psychomotor Skill	**Miniproject/Assignment/Practical Component**
Perception	
Set	
Guided Response	30
Mechanism	70
Complex Overt Responses	
Adaptation	
Origination	

Sample Questions for Course Outcome Assessment**

Course Outcome 1(CO1):

1. Two competing software companies are after an important contract. Company A is twice as likely to win this competition as company B. What is the probability to win the contract?
2. (Reliability of backups) There is a 1% probability for a hard drive to crash. Therefore, it has two backups, each having a 2% probability to crash, and all three components are independent of each other. The stored information is lost only in an unfortunate situation when all three devices crash. What is the probability that the information is saved?
3. (Diagnostics of computer codes) A new computer program consists of two modules. The first module contains an error with probability 0.2. The second module is more complex; it has a probability of 0.4 to contain an error, independently of the first module. An error in the first module alone causes the program to crash with probability 0.5. For the second module, this probability is 0.8. If there are errors in both modules, the program crashes with probability 0.9. Suppose the program crashed. What is the probability of errors in both modules?

Course Outcome 2(CO2):

1. The article "Viral load and heterosexual transmission of human immunodeficiency virus type 1" (New England Journal of Medicine, 2000, 342:921-929) studied the question of whether the people with high levels of HIV-1 are significantly more likely to transmit HIV to their uninfected partners.

Measurements follow the amount of HIV-1 RNA levels in the group whose partners who were initially uninfected became HIV-positive during the course of the study. Values are given in units of RNA copies/mL.

79725, 12862, 18022, 76712, 256440, 14013, 46083, 6808, 85781, 1251, 6081, 50397, 11020, 13633, 1064, 496433, 25308, 6616, 11210, 13900

a) Determine the mean, median, and standard deviation.

b) Find the 25th, 50th, and 75th percentiles.

2. Student grades on a chemistry exam were: 77, 78, 76, 81, 86, 51, 79, 82, 84, 99
   - Construct a stem-and-leaf plot of the data.
   - Are there any potential outliers? If so, which scores are they? Why do you consider them outliers?

3. The median age for U.S. blacks currently is 30.9 years; for U.S. whites it is 42.3 years. Based upon this information, give two reasons why the black median age could be lower than the white median age.Does the lower median age for blacks necessarily mean that blacks die younger than whites? Why or why not?How might it be possible for blacks and

whites to die at approximately the same age, but for the median age for whites to be higher?

Course Outcome 3(CO3):

1. The average annual amount the n = 1593 families paid for college was $24,164. If the population standard deviation is $8500, give the 95% confidence interval for μ, the average annual amount a family pays for a college undergraduate

2.If X is a population variable that follows a binomial distribution of parameters κ and η, and X = (X1,...,Xn) is a simple random sample: (a) Apply the method of the moments to obtain an estimator of the parameter η. (b) Apply the maximum likelihood method to obtain an estimator of the parameter η. (c) When κ = 10 and x = (x1,...,x5) = (4, 4, 3, 5, 6), use the estimators obtained in the two previous sections to construct final estimates of the parameter η and the measures μ and σ2

3. A random quantity X is supposed to follow a geometric distribution. Let X be a simple random sample. A) Apply the method of the moments to find an estimator of the parameter η. B) Apply the maximum likelihood method to find an estimator of the parameter η. C) Given a sample such that $\sum_{j=1}^{27} x_j = 134$, apply the formulas obtained in the two previous sections to give final estimates of η. Finally, give estimates of the mean and the variance of X.

Course Outcome 4 (CO4):

1. A Telecom service provider claims that individual customers pay on an average 400 rs. per month with standard deviation of 25 rs. A random sample of 50 customers' bills during a given month is taken with a mean of 250 and standard deviation of 15. What to say with respect to the claim made by the service provider?

2. Analyze the below data and tell whether you can conclude that smoking causes cancer or not?

Category	Diagnosed as Cancer	Without Cancer	Total
Smokers	400	300	700
Non-Smokers	300	500	800
Total	700	800	1500

3. An automobile tyre manufacturer claims that the average life of a particular grade of tyre is more than 20,000 km. A random sample of 16 tyres is having mean 22,000 km with a standard deviation of 5000 km. Validate the claim of the manufacturer at 5% LoS.

Course Outcome 5 (CO5):

1. The values of y and their corresponding values of y are shown in the table below

X	0	1	2	3	4
y	2	3	5	4	6

- Find the least square regression line y=ax+b.
- Estimate the **value of y** when x=10.

2. Given the past data as shown, how much loan a customer of age 30 will apply for? Apply Linear Regression to create a model with the past data. Use the model to make predictions.

Age	Loan Amount
60	2000
36	8000
28	12000
55	5000
40	10000
45	3000

3.The coefficient of rank correlation of the marks obtained by 10 students in statistics and accountancy was found to be 0.8. It was later discovered that the difference in ranks in the two subjects obtained by one of the students was wrongly taken as 7 instead of 9. Find the correct coefficient of rank correlation.

Course Outcome 6(CO6):

1**.** Three types of fertilizers are used on three groups of plants for 5 weeks. We want to check if there is a difference in the mean growth of each group. Using the data given below apply a one-way ANOVA test at 0.05 significant level.

Fertilizer 1	Fertilizer 2	Fertilizer 3
6	8	13
8	12	9
4	9	11
5	11	8
3	6	7
4	8	12

2. The International Air Transport Association surveys business travelers to develop quality ratings for transatlantic gateway airports. The maximum possible rating is 10. Suppose a simple random sample of 50 business travelers is selected and each traveler is asked to provide a rating for the Miami International Airport. The ratings obtained from the sample of 50 business travelers follow. 6 4 6 8 7 7 6 3 3 8 10 4 8 7 8 7 5 9 5 8 4 3 8 5 5 4 4 4 8 4 5 6 2 5 9 9 8 4 8 9 9 5 9 7 8 3 10 8 9 6 Develop a 95% confidence interval estimate of the population mean rating for Miami.

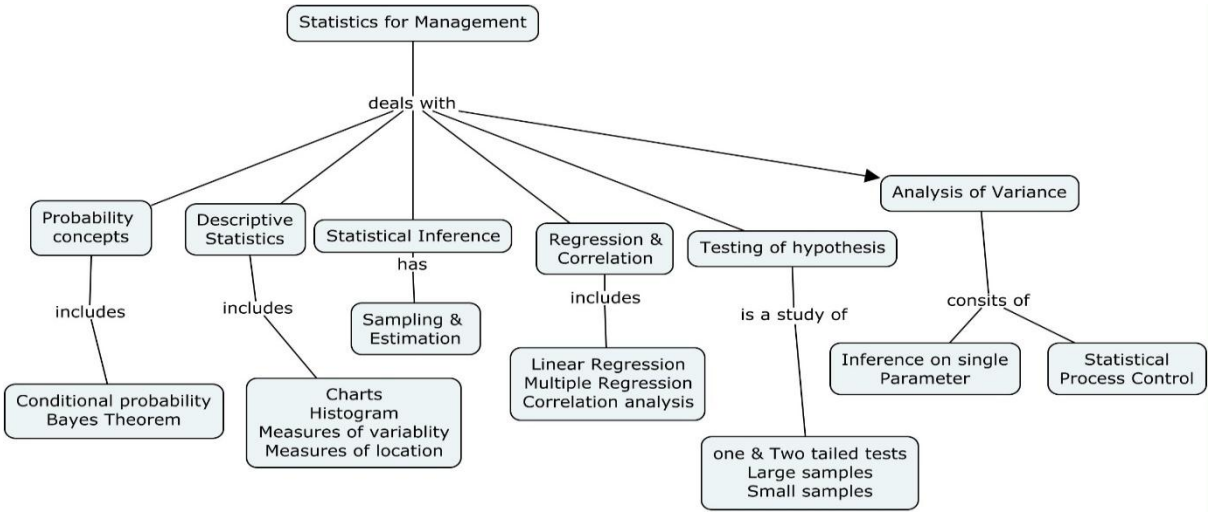
3. The manager ofan automobile dealership is considering a new bonus plan designed to increase sales volume. Currently, the mean sales volume is 14 automobiles per month. The manager wants to conduct a research study to see whether the new bonus plan increases sales volume. To collect data on the plan, a sample of sales personnel will be allowed to sell under the new bonus plan for a one-month period.

a. Develop the null and alternative hypotheses most appropriate for this research situation.

b. Comment on the conclusion when H0 cannot be rejected.

c. Comment on the conclusion when H0 can be rejected

Concept Map



Syllabus

INTRODUCTION: Basic definitions and rules for probability, conditional probability independence of events, Baye‘s theorem, and random variables, Probability distributions: Binomial, Poisson, Uniform and Normal distributions.

DESCRIPTIVE STATISTICS: Frequency distribution – Bar graphs and Pie charts – Histogram- Ogive – Simpson’s paradox – Measures of Location – Measures of Variability –

Measures of distribution shape, relative location and detecting outliers – Exploratory Data analysis, Stem-and-leaf display – Measures of Association between two variables.

STATISTICAL INFERENCE: Sampling distribution - Estimation: Point estimation, interval estimation - Criteria of a good estimator – Interval estimation of mean, proportion, and variance (single sample and two samples).

HYPOTHESIS TESTING: General concepts - Errors in Hypothesis testing - One-and twotailed tests (t-test, F-test, z-test), chi-square test - Tests concerning mean, proportion, and variance - Tests for Goodness of fit and independence of attributes.

CORRELATION AND REGRESSION: introduction - Estimation using the regression line - Correlation analysis -Limitations, errors, and caveats of using regression and correlation Analyzes - Multiple regression and correlation analysis - Inferences about population parameters – Modeling techniques.

ANALYSIS OF VARIANCE: Introduction to design of experiments, Analysis of variance. Quality control, statistical process control (SPC) - decision analysis - uncertainty vs. risk, utility theory, game theory

Learning Resources

1. Richard I. Levin. David S. Rubin, "Statistics for Management", Pearson Education, 2017.
2. Ronald E. Walpole, Raymond H. Meyers and Sharon L. Meyers, "Probability and Statistics for Engineers and Scientists", Pearson Education, 2019.
3. L. Devore, "Probability and Statistics for Engineering and Sciences", Cengage Learning, 2018.
4. Anderson, Sweeney and Williams, "Statistics for business and economics", Cengage Learning, 2014.
5. Saeed Ghahramani, "Fundamentals of Probability with Stochastic Processes", Pearson Education, 2018.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1	**INTRODUCTION**		
1.1	Basic definitions and rules for probability	1	CO1
1.2	Conditional probability independence of events	1	CO1
1.3	Baye's theorem, and random variables	2	CO1
1.4	Probability distributions: Binomial, Poisson	1	CO1
1.5	Uniform and Normal distributions.	1	CO1
2	**DESCRIPTIVE STATISTICS**		
2.1	Frequency distribution – Bar graphs and Pie charts	1	CO2
2.2	Histogram- Ogive – Simpson's paradox	1	CO2
2.3	Measures of Location – Measures of Variability		CO2
2.4	Measures of distribution shape, relative location and detecting outliers	1	CO2
2.5	Exploratory Data analysis, Stem-and-leaf display	1	CO2
2.6	Measures of Association between two variables.		CO2
3	**STATISTICAL INFERENCE**		
3.1	Sampling distribution	1	CO3
3.2	Estimation: Point estimation, interval estimation	2	CO3
3.3	Criteria of a good estimator	1	CO3
`3.4	Interval estimation of mean, proportion, and variance (single sample and two samples).	2	CO3
4	**HYPOTHESIS TESTING**		

4.1	General concepts	1	CO4
4.2	Errors in Hypothesis testing	1	CO4
4.3	One-and two tailed tests	2	CO4
4.4	Tests concerning mean, proportion, and variance	2	CO4
4.5	Tests for Goodness of fit and independence of attributes.	1	CO4
5	**CORRELATION AND REGRESSION**		
5.1	Introduction , Estimation using the regression line	1	CO5
5.2	Correlation analysis	1	CO5
5.3	Limitations, errors, and caveats of using regression and correlation Analyzes	1	CO5
5.4	Multiple regression and correlation analysis	2	CO5
5.5	Inferences about population parameters	1	CO5
5.6	Modelling techniques.	1	CO5
6	**ANALYSIS OF VARIANCE**		
6.1	Introduction to design of experiments	1	CO6
6.2	Analysis of variance	1	CO6
6.3	Quality control	1	CO6
6.4	statistical process control (SPC)	1	CO6
6.5	decision analysis	1	CO6
6.6	uncertainty vs. risk, utility theory, game theory	1	CO6
	Total	**36**	

Course Designers:

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21CBQC1	SUPPLY CHAIN ANALYTICS

Category	L	T	P	Credit	Terminal Exam Type
PSE	3	0	0	3	Theory

Preamble

This course helps to gain the knowledge about collect, clean, and analyse supply chain data using supply chain analytics techniques to improve the performance of their organizations. It will give technical understanding of supply chain analytics technique in different business model, the data and tools that are used, and how to apply analytics to real-world problems.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage *** in %
CO1	Understand the philosophy and approach in data-driven for Supply Chain Management.	10
CO2	Comprehend the emerging trends in AI and ML for supply chain analytics	10
CO3	Explain the key principles of warehousing decision, and end-to-end planning process flow.	20
CO4	Perform inventory optimization by identifying the main inputs that affect the inventory level.	20
CO5	Use machine learning algorithms to develop predictive models for supply chain forecasting.	20
CO6	Assess various cost drivers for supply chain network, and develop a realistic model to optimize supply chain network to minimize the total delivered costs	20

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond		1.2,2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3
CO2	TPS3	Apply	Value		1.2,2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3
CO3	TPS3	Apply	Value		1.2,2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3
CO4	TPS3	Apply	Value		1.2,2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3
CO5	TPS3	Apply	Value		1.2,2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3
CO6	TPS2	Understand	Respond		1.2,2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	S	M	L		M	L						L	L	L
CO2	S	M	L		S	L					L	L	L	L
CO3	S	M	L		S						L	M	L	L
CO4	S	M	L		S						L	M	L	L
CO5	S	M	L		S						L	M	L	L
CO6	S	M	L	L	S						L	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	2	1	2	
Remember	10	10			10
Understand	20	20			20
Apply	40	40	100	100	40
Analyse	30	30			30
Evaluate					
Create					

Assessment Pattern: Psychomotor

Psychomotor Skill	Mini project /Assignment/Practical Component
Perception	
Set	
Guided Response	
Mechanism	
Complex Overt Responses	
Adaptation	
Origination	

Sample Questions for Course Outcome Assessment**

** (2 to 3 at the cognitive level of course outcome)

Course Outcome 1(CO1):

1. What is the philosophy of data-driven supply chain management, and why is it important in today's business environment?
2. How can data-driven approaches enhance supply chain decision-making and overall performance?
3. Give an example of a company that successfully implemented data-driven supply chain management and describe the benefits they achieved.

Course Outcome 2(CO2):

1. Describe the key skills and strategies that supply chain professionals should possess to effectively manage and implement change.
2. Provide an example of a company that underwent a significant change in its supply chain processes and explain how they managed the transition.
3. How can technology and data analytics support change management in supply chain operations?

Course Outcome 3(CO3):

1. Describe the typical steps involved in an end-to-end supply chain planning process from demand forecasting to distribution.
2. How does effective supply chain planning contribute to cost reduction and improved customer satisfaction?
3. Give an example of a supply chain planning challenge and explain how it can be addressed using best practices.

Course Outcome 4 (CO4):

1. How can organizations set appropriate inventory targets to balance costs and customer demand effectively?
2. Discuss the role of demand forecasting in inventory optimization and its impact on supply chain performance.
3. You are the supply chain manager of a retail company, and you've noticed that your company is experiencing excessive inventory levels, leading to increased carrying costs. Identify the main inputs that are contributing to this problem and outline a plan to perform inventory optimization. Provide specific steps and strategies to set inventory targets that reduce carrying costs while ensuring product availability.
4. You manage a food distribution company that faces challenges in accurately forecasting demand for perishable products. Propose a machine learning-based

solution to improve demand forecasting. Describe the specific machine learning techniques you would use, the data you need, and the steps involved in building a predictive model that can better predict demand for perishable goods.

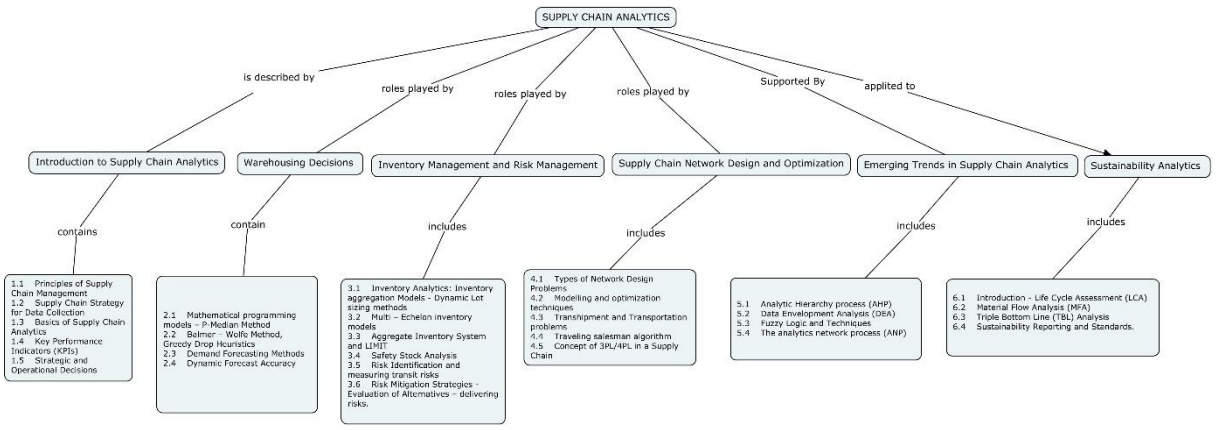
Course Outcome 5 (CO5):

1. How can machine learning algorithms be applied to supply chain forecasting, and what advantages do they offer over traditional methods?
2. Provide examples of supply chain data that can benefit from machine learning-based forecasting models.
3. Your e-commerce company has been struggling with inaccurate demand forecasting, resulting in understocked and overstocked products. Implement a machine learning-based solution to improve demand forecasting accuracy. Describe the machine learning algorithms you would use, the data sources required, and the steps involved in developing and validating predictive models to address this issue.
4. Discuss the potential risks and limitations associated with using machine learning in supply chain forecasting.

Course Outcome 6(CO6):

1. What data and analytics are typically used in supply chain network optimization models?
2. Discuss the trade-offs and challenges involved in minimizing total delivered costs while maintaining service levels in a supply chain network.
3. Your company operates a complex supply chain network, and you've been tasked with reducing transportation and distribution costs while maintaining service levels. Assess the various cost drivers in your supply chain network, such as transportation, warehousing, and inventory carrying costs. Develop a realistic optimization model that minimizes total delivered costs. Provide a step-by-step plan, including data sources, tools, and key performance indicators to evaluate the success of the optimization strategy.

Concept Map



Syllabus

INTRODUCTION TO SUPPLY CHAIN ANALYTICS

Principles of Supply Chain Management - Supply Chain Strategy for data Collection - Basics of Supply Chain Analytics - Key Performance Indicators (KPIs) in Supply Chain - Strategic and Operational Decisions - Benefits and Challenges of Analytics.

WAREHOUSING DECISIONS

Mathematical programming models – P-Median Method – Guided LP approach – Balmer – Wolfe Method, Greedy Drop Heuristics, Dynamic Location Models, Space Determination and Layout Methods – Demand Forecasting Methods – Dynamic Forecast Accuracy.

INVENTORY AND RISK MANAGEMENT THROUGH ANALYTICS

Inventory Analytics: Inventory aggregation Models - Dynamic Lot sizing methods - multi – Echelon inventory models - Aggregate Inventory System and LIMIT - Safety Stock Analysis.

Managing Supply Chain Risks through Analytics: Risk Identification and measuring transit risks - Risk Mitigation Strategies - Evaluation of Alternatives – delivering risks.

SUPPLY CHAIN NETWORK DESIGN AND OPTIMIZATION

Introduction: supply chain network design and optimization - Types of supply chain network design problems.

Modelling and optimization techniques: Notion of Graphs - Minimal Spanning Tree - Shortest Path Algorithms - Maxim flow problems.

Transportation: Transhipment and Transportation problems – Set covering and Set Partitioning Problems – Traveling salesman algorithm – Advance routing problem - Heuristics/optimization - Concept of 3PL/4PL in a Supply Chain.

EMERGING TRENDS IN SUPPLY CHAIN ANALYTICS (AI/ML)

Analytic Hierarchy process (AHP) - Data Envelopment Analysis (DEA) - Fuzzy Logic and Techniques - the analytics network process (ANP) - TOPISIS Application in SCM.

Sustainability Analytics – Introduction - Life Cycle Assessment (LCA) - Material Flow Analysis (MFA) - Triple Bottom Line (TBL) Analysis - Sustainability Reporting and Standards.

Learning Resources

Text Books:

1. Supply Chain Management by Pearson Seventh Edition, Kindle Edition by Sunil Chopra (Author), Peter Meindl (Author), Dharam Vir Kalra (Author) Kumar by Pearson Education , 2017.
2. Supply Chain Analytics Paperback – 1 September 2021 by T. A. S. Vijayaraghavan (Author) by Wiley, 2021.
3. Supply Chain Analytics: Strategies, Models and Solutions Paperback – Import, 4 July 2022 by Rabindranath Bhattacharya (Author), Anindita Maitra Bhattacharyya (Author) first edition , SAGE Publications Pvt. Ltd by 2022.
4. Nada R. Sanders, Big data driven supply chain management: A framework for implementing analytics and turning information into intelligence, Pearson Education, 2014.
5. Michael Watson, Sara Lewis, Peter Cacioppi, Jay Jayaraman, Supply Chain Network Design: Applying Optimization and Analytics to the Global Supply Chain, Pearson Education, 2013.
6. Anna Nagurney, Min Yu, Amir H. Masoumi, Ladimer S. Nagurney, Networks Against Time: Supply Chain Analytics for Perishable Products, Springer, 2013.

Reference Books:

1. Casella, George, and Roger L. Berger. *Statistical inference*. Cengage Learning, 2021.
2. Larose, Daniel T. Data mining and predictive analytics. John Wiley & Sons, 2015.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1	Introduction to Supply Chain Analytics		
1.1	Principles of Supply Chain Management,	1	CO1
1.2	Supply Chain Strategy for Data Collection	1	CO1
1.3	Basics of Supply Chain Analytics	1	CO1
1.4	Key Performance Indicators (KPIs)	1	CO1
1.5	Strategic and Operational Decisions, Benefits and Challenges of Analytics	1	CO1
2	Warehousing Decisions		
2.1	Mathematical programming models – P-Median Method – Guided LP approach	2	CO3
2.2	Balmer – Wolfe Method, Greedy Drop Heuristics, Dynamic Location Models, Space Determination and Layout Methods	2	CO3

2.3	Demand Forecasting Methods	2	CO2,CO5
2.4	Dynamic Forecast Accuracy	1	CO2,CO5
3	Inventory Management and Risk Management		
3.1	Inventory Analytics: Inventory aggregation Models - Dynamic Lot sizing methods	2	CO4
3.2	Multi – Echelon inventory models	1	CO4
3.3	Aggregate Inventory System and LIMIT	1	CO4
3.4	Safety Stock Analysis	1	CO4
3.5	Risk Identification and measuring transit risks	1	CO4
3.6	Risk Mitigation Strategies - Evaluation of Alternatives – delivering risks.	1	CO4
4	Supply Chain Network Design and Optimization		
4.1	Types of Network Design Problems	1	CO6
4.2	Modelling and optimization techniques: Notion of Graphs - Minimal Spanning Tree -Shortest Path Algorithms - Maxim flow problems.	2	CO6
4.3	Transportation: Transhipment and Transportation problems – Set covering and Set Partitioning Problems	2	CO6
4.4	Traveling salesman algorithm – Advance routing problem - Heuristics/optimization	2	CO6
4.5	Concept of 3PL/4PL in a Supply Chain	1	CO6
5	Emerging Trends in Supply Chain Analytics (AI/ML)		
5.1	Analytic Hierarchy process (AHP)	2	CO2, CO5
5.2	Data Envelopment Analysis (DEA)	1	CO2, CO5
5.3	Fuzzy Logic and Techniques	1	CO2, CO5
5.4	The analytics network process (ANP)	1	CO2, CO5
6	Sustainability Analytics		
6.1	Introduction - Life Cycle Assessment (LCA)	1	CO2, CO5
6.2	Material Flow Analysis (MFA)	1	CO2, CO5
6.3	Triple Bottom Line (TBL) Analysis	1	CO2, CO5
6.4	Sustainability Reporting and Standards.	1	CO2, CO5
	Total Hours	**36**	

Course Designers:

1. Dr. P. Chithra pccse@tce.edu
2. A. Indirani aiica@tce.edu

21CBRE1	BEHAVIORAL ECONOMICS

Category	L	T	P	Credit	Terminal Exam type
PEES	4	0	0	4	Theory

Preamble

To impart knowledge on current ideas and concepts regarding decision making in Economics, particularly from a behavioral science perspective, which can affect choices and behavior of firms, households and other economics entities

Prerequisite

To Know the fundamental knowledge of economics

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage in %
CO1	Make rational by applying neo classical and standard economic models.	15
CO2	Explain the fundamentals of choice theory	20
CO3	Evaluate the impact of psychological and social factors on both macro and micro-economics by applying behavioral science concepts	15
CO4	To be conversant decision-making in complex and uncertain environment using utility theory and decision analysis.	10
CO5	Make decisions about savings, work, effort and discounting in multiple time periods by using the intertemporal choice method.	15
CO6	Illustrate the concept of game theory and how it relates to strategic interactions.	25

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS3	Apply	Value	Mechanism	1.2, 2.1.2, 3.2.3, 4.5.3
CO2	TPS2	Understand	Respond	Guided Response	1.2, 4.3.2
CO3	TPS3	Apply	Value	Mechanism	1.2, 2.1.2, 3.2.3, 4.3.2
CO4	TPS3	Apply	Value	Mechanism	1.2, 2.1.2, 3.2.3, 4.5.3
CO5	TPS3	Apply	Value	Mechanism	1.2, 2.1.2, 3.2.3, 4.5.3
CO6	TPS3	Apply	Value	Mechanism	1.2, 2.1.2, 3.2.3, 4.5.3

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L										L		
CO2	S	M	L			L	L		L		L	M	L	L
CO3	S	M	L			L	L		L		L	M	L	L
CO4	S	M	L			L	L		L		L	M	L	L
CO5	S	M	L			L	L		L		L	M	L	L
CO6	S	M	L	L		L	L		L		L	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive levels	Continuous Assessment Tests		Assignments		Terminal examination
	1	2	1	2	
Remember	20	20			20
Understand	20	20	30		20
Apply	60	60	70	100	60
Analyse					
Evaluate					
Create					

Assessment Pattern: Psychomotor

Psychomotor Skill	Mini-project/Assignment/Practical Component
Perception	
Set	
Guided Response	30
Mechanism	70
Complex Overt Responses	
Adaptation	
Origination	

Sample Questions for Course Outcome Assessment**

CO1:

1. Explain Theory and evidence in the social sciences and in behavioral economics
2. Apply the Behavioral economics in an organization where various levels of employees are working. In an organization which comprises of various employees how behavioural economics factors like gains and losses, money illusion does affects.

CO2:

1. Explain Policy analysis related to choice theory.
2. Discuss about neoclassical model in choice theory.
3. Discuss in detail about the Environmental protection in detail.

CO3:

1. Explain different kinds of biases and beliefs.
2. Calculate the probability estimation of various believes in an organization which produce various sweets.
3. In an organization do Self-evaluation and self-projection to evaluate the current position.

CO4:

1. Discuss about Marginal Utility.
2. Decide on a strategy among various strategies to be used to develop the organization's growth.
3. In an organization analyze the growth related to the consumption of resources.

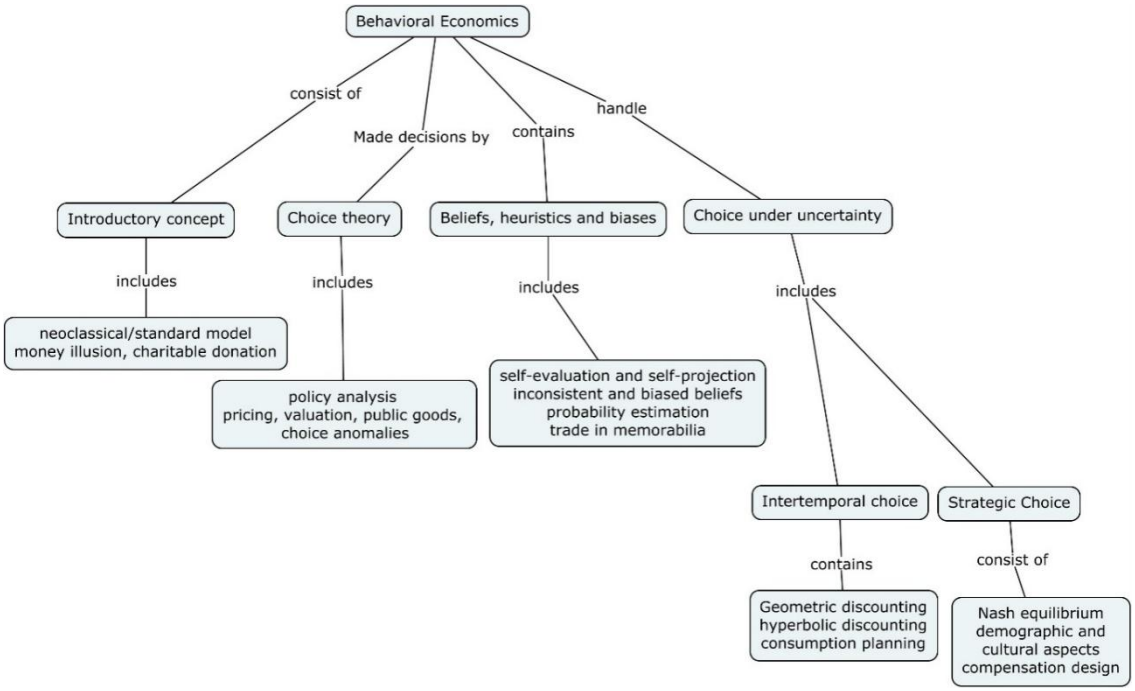
CO5:

1. Discuss about the anomalies of inter-temporal decisions.
2. In an credit card company they develop a strategy to make the customer to use their credit card more. Develop an effective strategy to do so.
3. Consider a scenario that a customer is planning to buy a credit card from any organization, there are many credit card company available, device an effective decision and choose the best suited organization among various methods.

CO6:

1. Discuss about the Voluntary contribution.
2. Analyze the game theory and Nash equilibrium in various aspects like strategies, information, and equilibrium in pure and mixed strategies and provide effective report.
3. Do analysis of Individual preferences; choice anomaliesand inconsistencies in a credit card company and provide effective feedback.

Concept Map



Syllabus

Introduction

The neoclassical/standard model and behavioural economics in contrast; historical background; behavioural economics and other social sciences; theory and evidence in the social sciences and in behavioural economics; applications – gains and losses, money illusion, charitable donation.

Basics of choice theory

Revisiting the neoclassical model; utility in economics and psychology; models of rationality; connections with evolutionary biology and cognitive neuroscience; policy analysis – consumption and addiction, environmental protection, retail therapy; applications – pricing, valuation, public goods, choice anomalies

Beliefs, heuristics and biases

Revisiting rationality; causal aspects of irrationality; different kinds of biases and beliefs; self-evaluation and self-projection; inconsistent and biased beliefs; probability estimation; trading applications – trade in counterfeit goods, financial trading behavior, trade in memorabilia

Choice under uncertainty

Background and expected utility theory; prospect theory and other theories; reference points; loss aversion; marginal utility; decision and probability weighting; applications – ownership and trade, income and consumption, performance in sports.

Intertemporal choice

Geometric discounting; preferences over time; anomalies of inter-temporal decisions; hyperbolic discounting; instantaneous utility; alternative concepts – future projection, mental accounts, heterogeneous selves, procedural choice; policy analysis – mobile calls, credit cards, organization of government; applications – consumption and savings, clubs and membership, consumption planning

Strategic choice

1. Review of game theory and Nash equilibrium – strategies, information, equilibrium in pure and mixed strategies, iterated games, bargaining, signaling, learning; applications – competitive sports, bargaining and negotiation, monopoly and market entry
2. Individual preferences; choice anomalies and inconsistencies; social preferences; altruism; fairness; reciprocity; trust; learning; communication; intention; demographic and cultural aspects; social norms; compliance and punishment; inequity aversion; policy analysis – norms and markets, labor markets, market clearing, public goods; applications – logic and knowledge, voluntary contribution, compensation design

Learning Resources

1. Philip Corr, AnkePlagnol, Behavioural Economics the Basics, 2019, 1st Edition Routledge.
2. Orrell David, Behavioural Economics, 2018, Icon Books Ltd
3. Behavioral Economics 3Rd Edition 2018 by Edward Cartwright, Taylor and Francis
4. ParthaDasgupta, Economics: A Very Short Introduction, Oxford University Press, 2017
5. N. Wilkinson and M. Klaes, "An Introduction to Behavioral Economics", 2017, 3rd Edition, Red Globe Press.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Introduction**		
1.1	The neoclassical/standard model and behavioural economics in contrast	2	CO1
1.2	Historical background	1	CO1
1.3	Behavioural economics and other social sciences	1	CO1
1.4	Theory and evidence in the social sciences and in behavioural economics	1	CO1
2.	**Basics of choice theory**		
2.1	Revisiting the neoclassical model	1	CO2
2.2	Utility in economics and psychology	1	CO2
2.3	Models of rationality	1	CO2
2.4	Connections with evolutionary biology and cognitive neuroscience	1	CO2
2.5	Policy analysis	1	CO2
2.6	Consumption and addiction	1	CO2
2.7	Environmental protection	1	CO2
2.8	Retail therapy	1	CO2
2.9	Applications – pricing	1	CO2
2.10	Valuation, public goods, choice anomalies	1	CO2
3.	**Beliefs, heuristics and biases**		
3.1	Revisiting rationality	1	CO3
3.2	Causal aspects of irrationality	1	CO3
3.3	Different kinds of biases and beliefs	1	CO3
3.4	Self-evaluation and self-projection	1	CO3
3.5	Inconsistent and biased beliefs	2	CO3
3.6	Probability estimation	1	CO3
3.7	Trading applications	1	CO3
3.8	Trade in counterfeit goods	1	CO3
3.9	Financial trading behaviour, trade in memorabilia		
4.	**Choice under uncertainty**		
4.1	Background And Expected Utility Theory	1	CO4
4.2	Prospect Theory And Other Theories	1	CO4
4.3	Reference Points; Loss Aversion	1	CO4
4.4	Marginal Utility	1	CO4
4.5	Decision And Probability Weighting, Applications	2	CO4
4.6	Ownership And Trade		
4.7	Income And Consumption	1	CO4
4.8	Performance In Sports		
5.	**Intertemporal choice**		
5.1	Geometric discounting; preferences over time	1	CO5
5.2	anomalies of inter-temporal decisions	1	CO5
5.3	hyperbolic discounting; instantaneous utility	1	CO5

5.4	alternative concepts – future projection, mental accounts	1	CO5
5.5	heterogeneous selves, procedural choice	1	CO5
5.6	policy analysis – mobile calls, credit cards	1	CO5
5.7	organization of government; applications	1	CO5
5.8	consumption and savings, clubs and membership, consumption planning	1	CO5
6.	**Strategic choice**		
6.1	Review of game theory and Nash equilibrium	1	CO6
6.2	Strategies, information, equilibrium in pure and mixed strategies	1	CO6
6.3	Iterated games, bargaining, signalling, learning; applications	1	CO6
6.4	Competitive sports, bargaining and negotiation, monopoly and market entry	1	CO6
6.5	Individual preferences; choice anomalies and inconsistencies; social preferences	1	CO6
6.6	Altruism; fairness; reciprocity; trust; learning; communication; intention; demographic and cultural aspects	1	CO6
6.7	Social norms; compliance and punishment;	1	CO6
6.8	Public goods; applications – logic and knowledge,	1	CO6
6.9	Voluntary contribution, compensation design	1	CO6
	Total	**48**	

Course Designers:

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21CBRF1	INDUSTRIAL PSYCHOLOGY

Category	L	T	P	Credit	Terminal Exam Type
PEES	4	0	0	4	Theory

Preamble

Introduces students to the application of psychological theory for industrial processes, work culture and enhance employee work life. This course will inculcate skills to help prepare themselves for their roles as employees and managers.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Understand the basics of industrial psychology	15
CO2	Apply advanced screening to select effective employee	15
CO3	Evaluate employee performance by training and appraisals	20
CO4	Apply strategies to foster employee motivation to enhance satisfaction and commitment	15
CO5	Apply leadership principles effectively within professional environments	20
CO6	Manage Stress for Work Life balance	15

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond		1.2, 2.1.1 , 2.2.1 , 2.5.1
CO2	TPS3	Apply	Value		1.2, 2.1.1 , 2.5.1, 2.5.1
CO3	TPS3	Apply	Value		1.2, 2.1.1, 2.5.1, 2.5.1
CO4	TPS3	Apply	Value		1.3, 2.1.1, 2.5.1, 2.5.2, 3.2.1, 3.3.3
CO5	TPS3	Apply	Value		2.1.1, 2.5.1, 2.5.2, 3.1.1, 3.1.2, 3.1.3, 3.1.4
CO6	TPS3	Apply	Value		2.1.1, 2.5.1, 2.5.2

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L						L	L			L	L	
CO2	S	S	L	M	M			M	M		L	S	M	
CO3	S	M	L	M	M			M	M		L	M	M	
CO4	S	S	M	M	M	M	L	M	M		L	S	M	L
CO5	M	S	M	M	M	M	L	M	M		L	S	M	L
CO6	M	M	L	M	M	M		M	M		L	M	M	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	2	1	2	
Remember	10	20	-	-	20
Understand	30	20	30	30	20
Apply	60	60	70	70	60
Analyse	-	-	-	-	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject /Assignment/Practical Component
Perception	-
Set	-
Guided Response	30
Mechanism	70
Complex Overt Responses	-
Adaptation	-
Origination	-

Sample Questions for Course Outcome Assessment**

** (2 to 3 at the cognitive level of course outcome)

Course Outcome 1(CO1):

1.Recall the key pioneers in the field of Industrial Psychology and their contributions
2.What is the primary purpose and key components typically included in a job analysis report?
3.How does job analysis contribute to effective human resource management?
4.Summarize the importance of job descriptions in an organization
5.Given a specific job position, create a step-by-step plan for conducting a job analysis, including the methods you would use.

Course Outcome 2(CO2):

1.What is the purpose of a job interview in the selection process?
2.How does an intensive interview process differ from a standard one-round interview?
3.Compare different interview screening techniques and their effectiveness in the job selection process.
4.Given a job description, outline a multi-stage interview process that includes skills tests, behavioral interviews, and reference checks

Course Outcome 3(CO3):

1.How does performance coaching contribute to employee development and growth?
2.How do different leadership styles influence employee motivation in the workplace?
3.Compare and contrast different methods for assessing employee performance, such as 360-degree feedback and performance appraisals.

Course Outcome 4 (CO4):

1.Identify common factors that can affect employee motivation.
2.Describe the impact of leadership styles on employee motivation
3.Assess the potential consequences of a lack of recognition and appreciation in the workplace.
4.Analyze the ethical considerations in conducting psychological assessments in the workplace. How can potential biases be minimized?

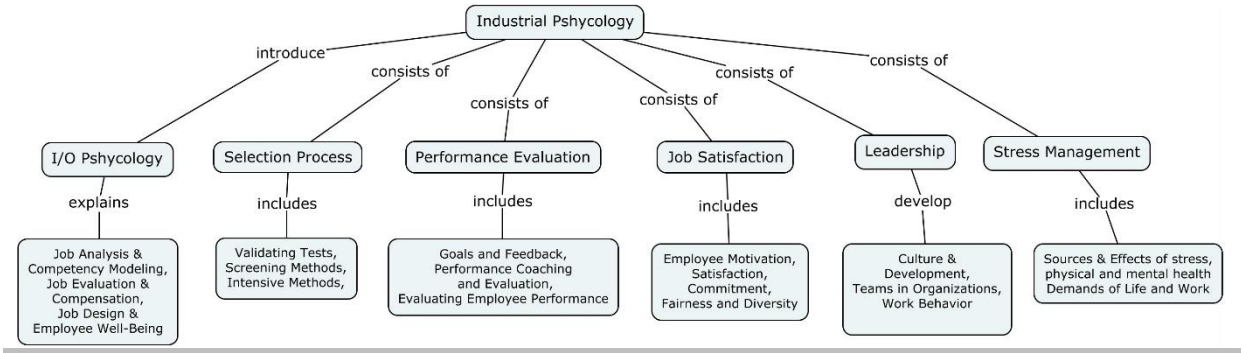
Course Outcome 5 (CO5):

1.How do leaders influence organizational culture, and why is it important?
2.How does effective team communication contribute to team success?
3.Propose strategies for resolving a leadership conflict within a team.
4.Develop a plan to address a specific workplace issue, such as reducing turnover or enhancing teamwork, using principles from Industrial Psychology.

Course Outcome 6(CO6):

1.What are some common sources of stress in everyday life?
2.Propose strategies for coping with workplace stress, such as time management and setting boundaries.
3.Assess the potential consequences of prolonged stress on physical health
4.Propose strategies to address demotivation caused by work-related stress.

Concept Map



Syllabus

Introduction to Industrial psychology

What is I/O Psychology? Research Methods, Statistics, and Evidence-based Practice , Introduction & Legal Context of Industrial Psychology, Job Analysis & Competency Modeling, Job Evaluation & Compensation, Job Design & Employee Well-Being, Recruitment

Selection Process

Identifying Criteria & Validating Tests and Measures, Screening Methods, Intensive Methods,

Performance Evaluation

Performance Goals and Feedback, Performance Coaching and Evaluation, Evaluating Employee Performance,

Employee Job satisfaction and Motivation

Employee Motivation, Satisfaction and Commitment, Fairness and Diversity

Leadership

Leadership, Organizational Climate, Culture, and Development, Teams in Organizations, The Organization of Work Behavior

Stress management

Stress Management: Nature, Sources, Effects of stress on physical and mental health , Demands of Life and Work

Learning Resources

Text Books

1. Anoiko's wikis , Industrial and organizational psychology , 2014
2. Baron, R. & Misra. G. (2013). Psychology. Pearson
3. Chadha, N.K. & Seth, S. (2014). The Psychological Realm: An Introduction. Pinnacle Learning,

References

1. Carr, A. (2004). Positive Psychology: The science of happiness and human strength.UK: Routledge
2. Baron, R.A., Nyla R. Branscombe , (2017).Social Psychology (14th Ed).New Delhi: Pearson
3. Frank J Landy , Jefrey , Work in 21st century , 5th edition , Wiley
4. Organizational Behaviour, Robbins, Judge & Vohra, Pearson Education Publication, 16th Edition.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Introduction to Industrial psychology**	**7**	**CO1**
1.1	What is I/O Psychology? , Research Methods	1	CO1
1.2	Statistics, Evidence-based Practice	1	CO1
1.3	Introduction & Legal Context of Industrial Psychology	1	CO1
1.4	Job Analysis & Competency Modeling	1	CO1
1.5	Job Evaluation & Compensation	1	CO1
1.6	Job Design & Employee Well-Being,	1	CO1
1.7	Job Recruitment	1	CO1

2.	**Selection Process**	**9**	**CO2**
2.1	Identifying Criteria	1	CO2
2.2	Validating Tests and Measures	2	CO2
2.3	Screening Methods	3	CO2
2.4	Intensive Methods	3	CO2
3.	**Performance Evaluation**	**8**	**CO3**
3.1	Performance Goals and Feedback	2	CO3
3.2	Performance Coaching and Evaluation	3	CO3
3.3	Evaluating Employee Performance	3	CO3
4.	**Employee Job satisfaction and Motivation**	**7**	**CO4**
4.1	Employee Motivation	2	CO4
4.2	Employee Satisfaction	2	CO4
4.3	Commitment	1	CO4
4.4	Fairness and Diversity	2	CO4
5.	**Leadership**	**9**	**CO5**
5.1	Leadership	1	CO5
5.2	Organizational Climate, Culture, and Development	3	CO5
5.3	Teams in Organizations	3	CO5
5.4	The Organization of Work Behavior	2	CO5
6.	**Stress management**	**7**	**CO6**
6.1	Stress management	1	CO6
6.2	Nature and sources of Stress	2	CO6
6.3	Effects of Stress on physical health	1	CO6
6.4	Effects of Stress on mental health	1	CO6
6.5	Demands of Life and work	2	CO6

Course Designers:

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2. Mrs. A.Indirani aiica@tce.edu

21CBRG1	COGNITIVE SCIENCE AND ANALYTICS

Category	L	T	P	Credit	Terminal Exam Type
PEES	3	0	0	3	Theory

Preamble

This course aims to provide a comprehensive understanding of cognitive science and analytics, from the fundamental concepts and advanced interdisciplinary relationships. It explores the intersection of artificial intelligence, psychology, and philosophy, and to provide experience with brain imaging techniques. It aims to equip the learner with skills to apply cognitive science principles in real-world scenarios.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Explain the practical applications of cognitive science concepts, integrating artificial intelligence, psychology, and philosophy to address real-world challenges.	15
CO2	Develop real-world computational solutions by applying advanced knowledge about the organization and operations of the human brain	15
CO3	Demonstrate proficiency in identifying and using various brain imaging techniques to analyze and interpret neural activity.	20
CO4	Utilize concept hierarchies and memory processes to relate brain signals for the development of computing applications..	15
CO5	Apply practical information of computational concepts of code duality, information fusion and processing skills for real world scenarios	15
CO6	Apply the connection between cognitive science and robotics - concepts of affordance and attention and explore solutions for real world problems.	20

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS3	Understand	Respond		1.1.1,2.1.3,2.1.4
CO2	TPS3	Apply	Value		1.2, 1.3, 2.1, 2.2.1
CO3	TPS3	Apply	Value		1.2, 1.3, 2.1, 2.2.1
CO4	TPS3	Apply	Value		1.2, 1.3, 2.1, 2.2.1
CO5	TPS3	Apply	Value		1.2, 1.3, 2.1, 2.2.1
CO6	TPS3	Apply	Value		1.2, 1.3, 2.1, 2.2.1

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L			S	M						M	L	M
CO2	S	M	L		S	M						M	L	M
CO3	S	M	L		S	M						M	L	M
CO4	S	M	L		S	M						M	L	M
CO5	S	M	L		S	M						M	L	M
CO6	S	M	L		S	M						M	L	M

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	**2**	1	2	
Remember	20	20			20
Understand	20	20			20
Apply	60	60	100	100	60
Analyse					
Evaluate					
Create					

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject /Assignment/Practical Component
Perception	
Set	
Guided Response	20
Mechanism	80
Complex Overt Responses	
Adaptation	
Origination	

Sample Questions for Course Outcome Assessment**

** (2 to 3 at the cognitive level of course outcome)

Course Outcome 1(CO1):

1. Explore the historical evolution of cognitive science. What pivotal moments mark the development of cognitive science, particularly in the integration of artificial intelligence and psychology, and how have these influenced its trajectory?
2. Define the role of language in machine learning and artificial intelligence. How does the definition of language impact the development and application of neural network models?
3. Investigate the relationship between artificial intelligence and neural network models. How do these models contribute to language processing, considering the nuances of linguistic knowledge, syntax, semantics, and pragmatics?

Course Outcome 2(CO2):

1. Investigate the phenomenon of multisensory integration in the cortex. How does the brain integrate information from different senses, and what role does this play in language processing?
2. Explore how disruptions in multisensory integration may lead to language disorders and discuss the concept of lateralization in the context of language functions.

Course Outcome 3(CO3):

1. Examine the methods and applications of brain imaging technologies such as fMRI, MEG, PET, and EEG in the study of the human brain. How do these tools contribute to unraveling the mysteries of multisensory integration, sensory information processing, and language-related functions?
2. Investigate the significance of brain lateralization and its role in language disorders. How do insights into the structure and constituents of the brain contribute to our understanding of cognitive functions and neurological conditions?

Course Outcome 4 (CO4):

1. Explore the process of sensory information processing in the brain and its role in the generation of concept hierarchies. How does linguistic knowledge influence the formation of these hierarchies?
2. Discuss the concept of generative linguistics in the context of discretization and the creation of concept hierarchies. How do mathematical models contribute to understanding sensory memory, explicit vs. implicit memory, and short-term vs. long-term memory in the context of constructing memories?
3. Explain how sensory memory and explicit vs. implicit memory contribute to the overall construct of concept hierarchies?

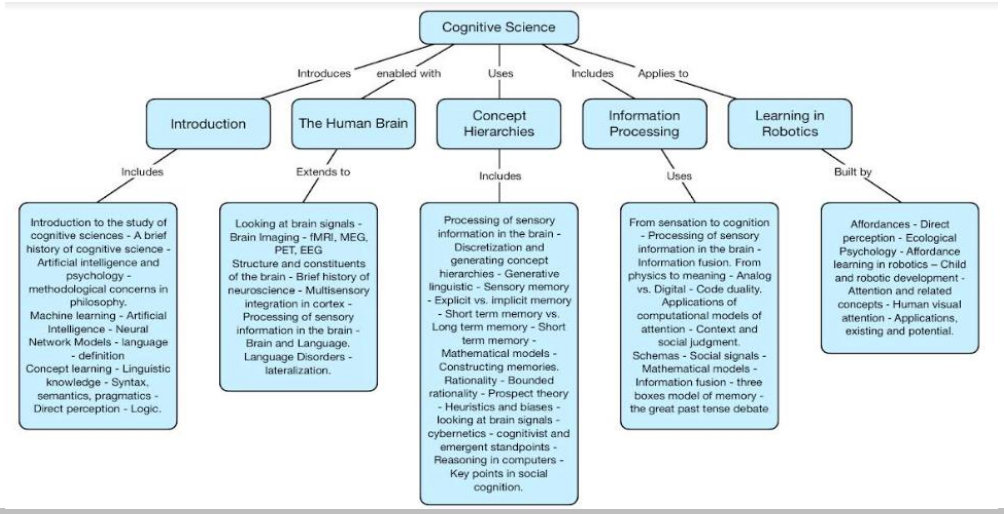
Course Outcome 5 (CO5):

1. Contrast analog and digital information processing in the context of the brain. Explore the concept of code duality and its role in translating physical signals into meaningful information from both a philosophical and computational perspective.
2. Explore the applications of computational models of attention in information processing. How does context influence social judgment, and how are computational models utilized to understand and enhance attention in various settings?

Course Outcome 6(CO6):

1. Explore the concept of affordances in the context of robotics. How does direct perception and ecological psychology influence affordance learning in robotics, and what parallels can be drawn between child development and robotic learning?
2. Investigate the role of attention and related concepts in the learning process of robots. How does human visual attention influence robotic development, and what existing and potential applications arise from the incorporation of attention mechanisms in robotics?
3. Analyze the applications of affordance learning in robotics. How does the study of human visual attention inform the development of robotic systems, and what insights can be gained from ecological psychology in enhancing the learning capabilities of robots?

Concept Map



Syllabus

Introduction to Cognitive Science

Introduction to the study of cognitive sciences - A brief history of cognitive science - Artificial intelligence and psychology - methodological concerns in philosophy.
Machine learning - Artificial Intelligence - Neural Network Models - language - definition
Concept learning - Linguistic knowledge - Syntax, semantics, pragmatics - Direct perception - Logic.

The Human Brain

Looking at brain signals - Brain Imaging - fMRI, MEG, PET, EEG
Structure and constituents of the brain - Brief history of neuroscience - Multisensory integration in cortex - Processing of sensory information in the brain - Brain and Language. Language Disorders - lateralization.

Concept Hierarchies

Processing of sensory information in the brain - Discretization and generating concept hierarchies - Generative linguistic - Sensory memory - Explicit vs. implicit memory - Short term memory vs. Long term memory - Short term memory - Mathematical models - Constructing memories.
Rationality - Bounded rationality - Prospect theory - Heuristics and biases - looking at brain signals - cybernetics - cognitivist and emergent standpoints - Reasoning in computers - Key points in social cognition.

Information Processing

From sensation to cognition - Processing of sensory information in the brain - Information fusion. From physics to meaning - Analog vs. Digital - Code duality.
Applications of computational models of attention - Context and social judgment.

Schemas - Social signals - Mathematical models - three boxes model of memory - the great past tense debate

Learning in Robotics

Affordances - Direct perception - Ecological Psychology - Affordance learning in robotics – Child and robotic development - Attention and related concepts - Human visual attention - Applications, existing and potential.

Learning Resources

Reference Books:

1. Pradeep KumarMallick, Samarjeet Borah," Emerging Trends and Applications in Cognitive Computing", 2019, IGI Global Publishers.
2. Jose Luis Bermudez, "Cognitive Science: An Introduction to the Science of the Mind", 2020 Cambridge University Press, New York.
4. Vijay V Raghavan,Venkat N.Gudivada, VenuGovindaraju, C.R. Rao, Cognitive Computing: Theory and Applications: (Handbook of Statistics 35), Elsevier publications, 2016
5. Judith Hurwitz, Marcia Kaufman, Adrian Bowles, Cognitive Computing and Big Data Analytics, Wiley Publications, 2015

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Introduction to Cognitive Science**		
1.1	Introduction to the study of cognitive sciences - A brief history of cognitive science - Artificial intelligence and psychology - methodological concerns in philosophy.	2	CO1
1.2	Machine learning - Artificial Intelligence - Neural Network Models - language - definition	2	CO1
1.3	Concept learning - Linguistic knowledge - Syntax, semantics, pragmatics - Direct perception - Logic.	2	CO1
2.	**The Human Brain**		
2.1	Looking at brain signals - Brain Imaging - fMRI, MEG, PET, EEG	2	CO2
2.2	Structure and constituents of the brain - Brief history of neuroscience	1	CO2
2.3	Multisensory integration in cortex - Processing of sensory information in the brain	1	CO2
2.4	Brain and Language. Language Disorders - lateralization	2	CO2
3.	**Concept Hierarchies**		
3.1	Processing of sensory information in the brain - Discretization and generating concept hierarchies - Generative linguistic - Sensory memory	2	CO3
3.2	Explicit vs. implicit memory - Short term memory vs. Long term memory	1	CO3
3.3	Short term memory- Mathematical models - Constructing memories.	2	CO3
4.1	Rationality - Bounded rationality - Prospect theory - Heuristics and biases	2	CO4
4.2	Cybernetics - cognitivist and emergent standpoints -	2	CO4
4.3	Reasoning in computers - Key points in social cognition.	2	CO4
5.	**Information Processing**		
5.1	From sensation to cognition - Processing of sensory information in the brain	1	CO5

5.2	Information fusion. From physics to meaning - Analog vs. Digital - Code duality.	2	CO5
5.3	Applications of computational models of attention - Context and social judgment.	1	CO5
5.3	Schemas - Social signals	1	CO5
5.4	Mathematical models - Information fusion - three boxes model of memory - the great past tense debate	2	CO5
6.	**Learning in Robotics**		
6.1	Affordances - Direct perception	2	CO6
6.2	Ecological Psychology - Affordance learning in robotics – Child and robotic development	2	CO6
6.3	Attention and related concepts - Human visual attention - Applications, existing and potential.	2	CO6

Course Designers:

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2. Mrs. Priya Thiagarajan ptca@tce.edu

21CBRH1	Predictive Analytics

Category	L	T	P	Credit	Terminal Exam Type
PEES	3	0	0	3	Theory

Preamble

This course helps to analyze the data that helps to make predictions and decision making in businesses. It also imparts the knowledge in applying the statistical and analytical tools to automate data retrieval. It gives a technical understanding of data analysis and predictive modelling techniques.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Pre-process the data based on the applications such as Manufacturing, Health, Telecommunication, Supply Chain, etc., to apply simple linear regression models	20%
CO2	Evaluate the multiple linear regression model and parameters for Univariate, Bivariate and Multivariate data	20%
CO3	Perform statistical models, maximum likelihood parameter estimation, and residual analysis for logistic regression models	15%
CO4	Construct decision trees to improve predictive capabilities using pruning and ensemble methods	15%
CO5	Analyze the challenges in unstructured data and apply classification models	15%
CO6	Perform forecasting and time series analysis using addictive, multiplicative, smoothing, Auto-regressive and Moving average models	15%

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Apply	Value		1.1, 1.2, 4.3.2
CO2	TPS3	Apply	Value		1.2, 2.1, 4.3.1, 4.3.3,
CO3	TPS3	Apply	Value		1.2, 2.1, 4.3.1
CO4	TPS3	Apply	Value		1.2, 1.3, 2.1, 4.3.1, 4.3.3,
CO5	TPS3	Apply	Value		1.3, 2.1, 4.3.1
CO6	TPS3	Apply	Value		1.3, 2.1, 4.3.1, 4.3.3

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	S	M	L		M	L					M	L		
CO2	S	M	L		S						M	L		
CO3	S	M	L		S						S	L		
CO4	S	M	L		S						S	L		
CO5	S	M	L		S						S	L		
CO6	S	M	L	L	S						S	L		

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	**2**	1	2	
Remember	20	20			15
Understand	30	30			25
Apply	50	50	100	100	60
Analyse					
Evaluate					
Create					

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject /Assignment/Practical Component
Perception	
Set	
Guided Response	
Mechanism	
Complex Overt Responses	
Adaptation	
Origination	

Sample Questions for Course Outcome Assessment**

** (2 to 3 at the cognitive level of course outcome)

Course Outcome 1(CO1):

1. Derive a simple linear regression model for the given data with monthly sales as outcome variable and calculate R square value.
   Given data:
   monthly sales of 5 outlets and the respective advertising amount spent.
   Find if there exists a linear relationship exists between advertising and sales.

Online Store	Monthly E-commerce Sales (in 1000 s)	Online Advertising Dollars (1000 s)
1	368	1.7
2	340	1.5
3	665	2.8
4	954	5
5	331	1.3

2. Use the given data collected by a sales manager on annual sales Year,GDP,4wheeler_passengar_vehicle_sale(in lakhs)
   2011,6.2,26.3
   2012,6.5,26.65
   2013,5.48,25.03
   2014,6.54,26.01
   2015,7.18,27.9
   2016,7.93,30.47
   Derive a linear regression equation to represent the impact of GDP on the vehicle sale.
3. Test the significance of the advertising cost in determining monthly sales (t critic value= 1.27)

Course Outcome 2(CO2):

1. Given a multiple regression equation for a collected data in a project to predict the annual growth per acre of upland boreal forests in southern Canada. They

hypothesized that cubic foot volume growth (y) is a function of stand basal area per acre (x1), and the stand's site index for black spruce (x2). Find the leverage of observation for the data and interpret the results y = -19.3858 + 0.591004 x1 + 0.489441 x2. (Substitute values for x1 and x2 of your own)

2. Formulate the ANOVA table for the multiple linear regression problem and give the overall significance of the independent variables comparing with f critical value of 5.79
3. Calculate the standardized residual for the observations and interpret the results Year,GDP,4wheeler_passengar_vehicle_sale(in lakhs) 2011,6.2,26.3 2012,6.5,26.65 2013,5.48,25.03 2014,6.54,26.01 2015,7.18,27.9 2016,7.93,30.47

Course Outcome 3(CO3):

1. Given a table, find the odds ratio of eating ice cream during ill state than well state Ate ice-cream 13(Ill) 32(Well) Did not eat ice-cream 17(Ill) 23(Well)
2. Derive the Maximum Likelihood estimation of parameters from a normal distribution
3. Assume that a data analysis experiment used 500 samples to determine if a population carries a certain genetic variant or NOT with logistic regression. The prediction indicates that 150 samples do not carry the variant while others do. Among the predicted variant samples, 150 samples are without the variation. There is 30% wrong prediction in the samples that are predicted NOT having the variant. Fill in a confusion matrix and calculate sensitivity, precision, accuracy, and f-measure.

Course Outcome 4 (CO4):

1. Deciding whether to play or not to play Tennis on a Saturday A binary classification problem (play vs no-play) Each input (a Saturday) has 4 features: Outlook, Temp., Humidity, Wind

day	outlook	temperature	humidity	wind	play
1	sunny	hot	high	weak	no
2	sunny	hot	high	strong	no
3	overcast	hot	high	weak	yes
4	rain	mild	high	weak	yes
5	rain	cool	normal	weak	yes
6	rain	cool	normal	strong	no
7	overcast	cool	normal	strong	yes
8	sunny	mild	high	weak	no
9	sunny	cool	normal	weak	yes
10	rain	mild	normal	weak	yes
11	sunny	mild	normal	strong	yes
12	overcast	mild	high	strong	yes
13	overcast	hot	normal	weak	yes
14	rain	mild	high	strong	no

2. Construct a (full) decision tree for the above data set using the following order of testing features.
   First, test Outlook.
   For Outlook = Sunny, test Temp.
   For Outlook = Rain, test Wind.
   For other branches, test Humidity before testing Wind
3. Consider a distribution (p, 1 − p) where 0 ≤ p ≤ 1. 1. What is the maximum entropy of this distribution? 2. What is the minimum entropy of this distribution? 3. Plot the entropy of the distribution (p, 1 − p) with respect to p.
4. Consider the following set of training examples:
   Instance Classification a1 a2
   1 + T T
   2 + T T
   3 - T F
   4 + F F
   5 - F T

6 - F T

(a) What is the entropy of this collection of training examples with respect to the target function classification?

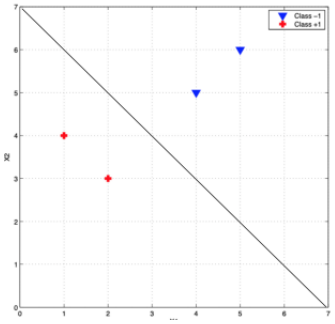
(b) What is the information gain of a2 relative to these training examples?

Course Outcome 5 (CO5):

1. Consider a situation where you have 1000 fruits which are either 'banana' or 'apple' or 'other'. These will be the possible classes of the variable Y. The sum up the training dataset

Type	Long	Not Long	Sweet	Not sweet	Yellow	Not Yellow	Total
Banana	400	100	350	150	450	50	500
Apple	0	300	150	150	300	0	300
Other	100	100	150	50	50	150	200
Total	500	500	650	350	800	200	1000

   The main work of the classifier is to predict if a given fruit is a 'Banana' or an 'Apple' or 'Other' when the three attributes (long, sweet and yellow) are known.
2. Compare and contrast with KNN and SVM
3. Support vector machines learn a decision boundary leading to the largest margin from both classes. You are training SVM on a tiny dataset with 4 points shown below. This dataset consists of two examples with class label -1 (denoted with plus), and two examples with class label +1 (denoted with triangles). Write down the SVM loss function for this data and state how to find the weight vector w and bias b.



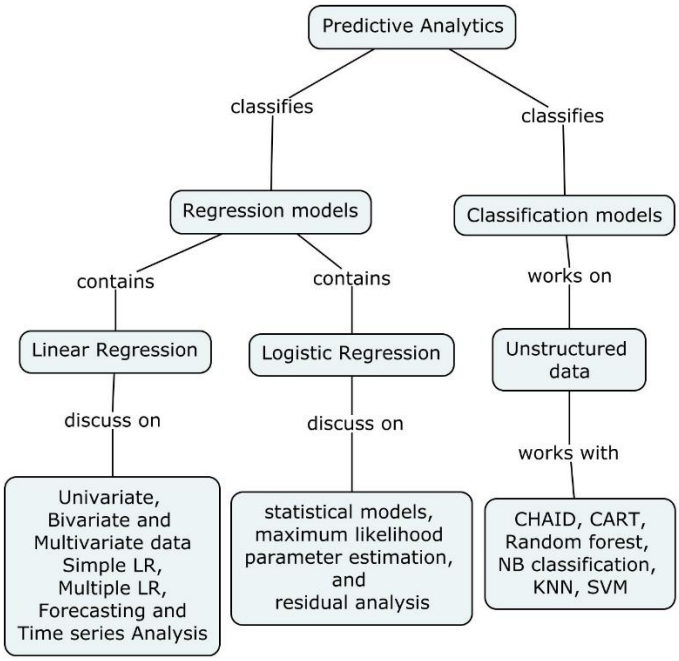
Course Outcome 6(CO6):

1. Demonstrate the moving average model with suitable example
2. With the given time series data on population in millions, demonstrate Holt winters Double exponential smoothing to get the forecast of year 2015 with alpha constant = 0.06 and gamma constant = 0.4

Year	2010	2011	2012	2013	2014	2015	2016
Population	25.5	26.4	27.3	28.2	29.1	30	31

3. Given a time series data for electricity load for several devices at home every minute with two columns (Time stamp, reading) for a years, demonstrate the process of applying ARIMA model for the same.

Concept Map



Syllabus

Introduction to Analytics

Overview, Definition, Need - Analytics in Decision Making - Game changers & Innovators - Predictive Analytics: Types and techniques, Application in *Manufacturing, Health, Supply Chain, Information Technology, Digital Analytics etc.* **Simple Linear Regression (LR)** SLR Introduction, Overview, Importance, Types, SLR: Model Building, OLS Estimation, Model interpretation, validation.

Multiple Linear Regression (MLR) Estimation of Regression Parameters - Model Diagnostics - Dummy, Derived & Interaction Variables - Multi-collinearity - Model Deployment

Logistic Regression

Statistical models for binary data - Discrete choice models - Interpretation of odds and odds ratios - MLE Estimation of Parameters - Logistic Model Interpretation, Diagnostics and Model Deployment - Residual analysis for logistic regression

Decision Trees

Overview, Application, Terminologies, And Model validation- CHI-Square Automatic Interaction Detectors (CHAID) - Classification and Regression Tree (CART) – random forests

Unstructured data analysis

Introduction and Analysis of Unstructured data - Naive Bayes Classification - other classifiers: Sentiment Analysis, KNN, SVM.

Forecasting and Time series Analysis

Forecasting - Time Series Analysis - Additive & Multiplicative models - Exponential smoothing techniques - Forecasting Accuracy - Auto-regressive and Moving average models

Learning Resources

Text Books:

1. Kumar, Vijay, and Mangey Ram, eds. Predictive analytics: modeling and optimization. CRC press, 2021.

2. Kelleher, John D., Brian Mac Namee, and Aoife D'arcy. Fundamentals of machine learning for predictive data analytics: algorithms, worked examples, and case studies. MIT press, 2020.
3. Shmueli, Galit, Peter C. Bruce, Inbal Yahav, Nitin R. Patel, and Kenneth C. Lichtendahl Jr. Data mining for business analytics: concepts, techniques, and applications in R. John Wiley & Sons, 2017.
4. Hastie, Trevor, Robert Tibshirani, and Jerome H. Friedman, The elements of statistical learning: data mining, inference, and prediction. Vol. 2. New York: springer, 2009.

Reference Books:

1. Casella, George, and Roger L. Berger. *Statistical inference*. Cengage Learning, 2021.
2. Larose, Daniel T. Data mining and predictive analytics. John Wiley & Sons, 2015.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Introduction to Analytics**		
1.1	Overview, Definition, Need Analytics in Decision Making	1	CO1
1.2	Game changers & Innovators	1	CO1
1.3	Predictive Analytics: Types and techniques	1	CO1
1.4	Application in Manufacturing, Health, Telecommunication, Supply Chain, Information Technology etc. Digital Analytics	1	CO1
1.5	**Simple Linear Regression (SLR)** Introduction, Overview, Importance Types, SLR: Model Building	1	CO2
1.6	OLS Estimation	1	CO2
1.7	Model interpretation, validation.	1	CO2
2	**Multiple Linear Regression (MLR)**		
2.1	Estimation of Regression Parameters	1	CO2
2.2	Model Diagnostics - Dummy, Derived & Interaction Variables	2	CO2
2.3	Multi-collinearity	2	
2.4	Model Deployment	2	CO2
3.	**Logistic Regression**		
3.1	Statistical models for binary data - Discrete choice models - Interpretation of odds and odds ratios	2	CO3
3.2	MLE Estimation of Parameters	1	CO3
3.3	Logistic Model Interpretation, Diagnostics and Model Deployment	2	CO3
3.4	Residual analysis for logistic regression	1	CO3
4.	**Decision Trees**		
4.1	Overview, Application, Terminologies, And Model validation	1	CO4
4.2	CHI-Square Automatic Interaction Detectors (CHAID)	2	CO4
4.3	Classification and Regression Tree (CART), Random Forest	2	CO4
5	**Unstructured data analysis**		
5.1	Introduction and Analysis of Unstructured data	2	CO5
5.2	Naive Bayes Classification	2	CO5
5.5	other classifiers: Sentiment Analysis, Naïve Bayes algorithm.	2	CO5

6.	**Forecasting and Time series Analysis**		
6.1	Additive & Multiplicative models	1	CO6
6.2	Exponential smoothing techniques	1	CO6
6.3	Forecasting Accuracy	1	CO6
6.4	Auto-regressive and Moving average models	2	CO6
	TOTAL	**36**	

Course Designers:

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2. Dr. J. Felicia Lilian jflcse@tce.edu

21CBRJ1	DEEP LEARNING

Category	L	T	P	Credit	Terminal Exam Type
PEES	2	1	0	3	Theory

Preamble

The course aims to impart a comprehensive understanding of diverse deep architectures, including Convolutional Networks and Recurrent Networks. Its primary goal is to cover the foundational principles of neural networks and to explore advanced topics, including recurrent neural networks, long short-term memory cells, and generative neural networks.

Prerequisite

Basic knowledge of machine learning concepts

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Identify the most suitable machine learning algorithm for a given problem and optimize its hyperparameters for improved performance.	20
CO2	Implement various deep learning algorithms to solve complex problems by considering factors like architecture design and regularization techniques.	20
CO3	Improve deep neural networks to address specific challenges related to training and optimization, utilizing methods such as weight initialization and batch normalization.	15
CO4	Implement convolutional neural networks algorithms to solve real world problems like image processing, making informed decisions etc.	15
CO5	Apply recurrent neural networks (RNNs) to sequence modeling problems, including natural language processing tasks, and optimize their performance using techniques like LSTM and bidirectional architectures.	15
CO6	Generate synthetic data and enhance the understanding of complex data structures using deep generative models, such as Restrictive Boltzmann Machines etc.	15

*** Weightage depends on Bloom's Level, number of contact hours

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS3	Apply	Value		1.2, 1.3, 2.1, 2.2.1
CO2	TPS3	Apply	Value		1.2,1.3, 2.1, 2.2.1
CO3	TPS3	Apply	Value		1.2,1.3, 2.1, 2.2.1
CO4	TPS3	Apply	Value		1.2,1.3, 2.1, 2.2.1
CO5	TPS3	Apply	Value		1.2,1.3, 2.1, 2.2.1
CO6	TPS3	Apply	Value		1.2,1.3, 2.1, 2.2.1

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	S	M	L		S	L					S	M	L	M
CO2	S	M	L		S	L					S	M	L	M
CO3	S	M	L		S	L					S	M	L	M
CO4	S	M	L		S	L					S	M	L	M
CO5	S	M	L		S	L					S	M	L	M
CO6	S	M	L		S	L					S	M	L	M

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	2	1	2	
Remember	20	20			20
Understand	20	20	30	30	20
Apply	60	60	70	70	60
Analyse					
Evaluate					
Create					

Sample Questions for Course Outcome Assessment**

** (2 to 3 at the cognitive level of course outcome)

Course Outcome 1(CO1):

1. Given a dataset with a mix of categorical and numerical features, discuss which learning algorithm (e.g., decision trees, support vector machines) would be most suitable for classification. Justify your choice based on the nature of the data.
2. Propose a strategy to optimize hyperparameters and utilize a validation set effectively to enhance generalization and avoid overfitting
3. Differentiate the various deep learning networks models highlighting their advantages and disadvantages.

Course Outcome 2 (CO2):

1. When designing the architecture of a deep feedforward network for image recognition, discuss the considerations regarding the number of hidden layers and units. How does the architecture impact the model's ability to learn complex features?
2. Autoencoders are known for their role in data compression. Apply the concept of autoencoders to a specific dataset (e.g., images or text) and discuss how the model can be utilized for dimensionality reduction.

Course Outcome 3(CO3):

1. When training a deep neural network for a computer vision task, compare and contrast the optimization methods AdaGrad, RMSProp, and Adam. In what scenarios would you choose one over the others?
2. When building a DNN for natural language processing, explain how second-order methods for training can balance the complexity of the model. What advantages do these methods offer, and are there any limitations?

Course Outcome 4(CO4):

1. Given an image recognition task, justify the choice of a specific deep CNN architecture (e.g., VGG) and discuss how convolution, pooling, and weight initialization contribute to the network's ability to capture features.
2. Apply the concept of sequence modeling using RNNs to a predicting stock prices. Discuss the challenges and advantages of using RNNs for sequential data.

Course Outcome 5(CO5):

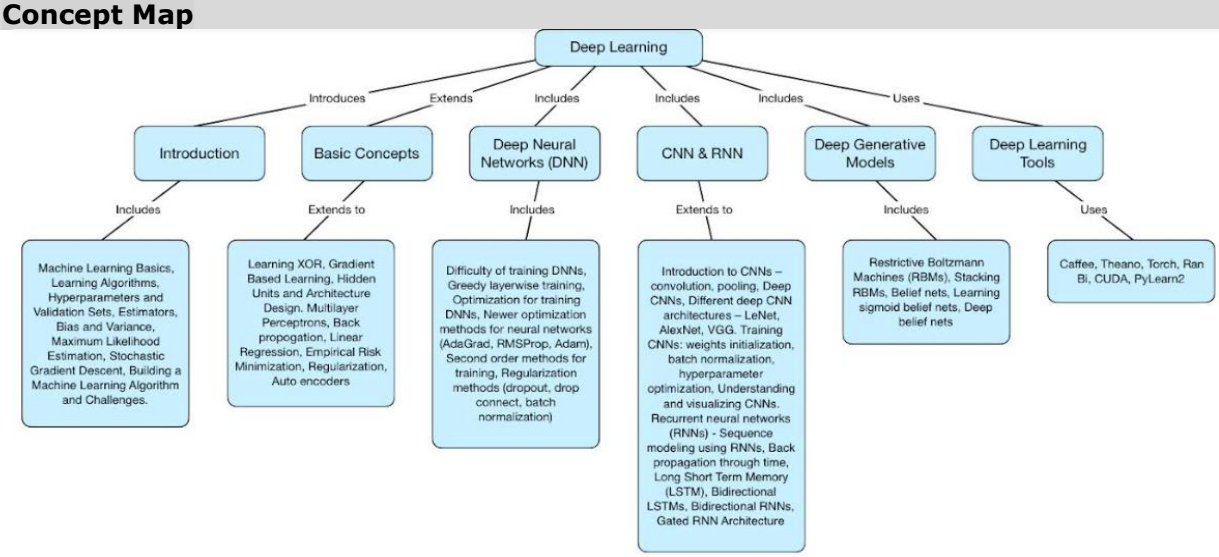
1. Propose a practical application where Restrictive Boltzmann Machines (RBMs) could be effectively used for feature learning or dimensionality reduction. Discuss the advantages RBMs bring to this specific application.
2. In the task to learn complex dependencies in financial data, explain how stacking RBMs can be advantageous. Discuss the challenges that stacking RBMs may help address in this context.
3. Apply the concept of learning sigmoid belief nets to a classification problem involving medical diagnoses using x-rays to detect Covid 19 infection. Discuss how this type of deep generative model can capture intricate patterns in the data

Course Outcome 6(CO6):

1. Compare and contrast the features of Caffe, Theano, and Torch. Based on the specific requirements of a project, justify the selection of one tool over the others, considering factors such as ease of use and community support.

2. In the context of deep learning, explain the significance of GPU acceleration and CUDA. Discuss how these technologies contribute to faster training times and improved model performance with a suitable use case

Concept Map



Syllabus

Introduction
Machine Learning Basics, Learning Algorithms, Hyperparameters and Validation Sets, Estimators, Bias and Variance, Maximum Likelihood Estimation, Stochastic Gradient Descent, Building a Machine Learning Algorithm and Challenges.

Basic concepts of deep learning, Deep Feed forward Networks - Learning XOR, Gradient Based Learning, Hidden Units and Architecture Design. Multilayer Perceptrons, Back propogation, Linear Regression, Empirical Risk Minimization, Regularization, Auto encoders

Deep neural networks (DNNs)
Difficulty of training DNNs, Greedy layerwise training, Optimization for training DNNs, Newer optimization methods for neural networks (AdaGrad, RMSProp, Adam), Second order methods for training, Regularization methods (dropout, drop connect, batch normalization)

CNN and RNN
Introduction to CNNs – convolution, pooling, Deep CNNs, Different deep CNN architectures – LeNet, AlexNet, VGG. Training CNNs: weights initialization, batch normalization, hyperparameter optimization, Understanding and visualizing CNNs.
Recurrent neural networks (RNNs) - Sequence modeling using RNNs, Back propagation through time, Long Short Term Memory (LSTM), Bidirectional LSTMs, Bidirectional RNNs, Gated RNN Architecture

Deep Generative models
Restrictive Boltzmann Machines (RBMs), Stacking RBMs, Belief nets, Learning sigmoid belief nets, Deep belief nets

Deep Learning Tools
Caffee, Theano, Torch, Ran Bi, CUDA, PyLearn2.

Learning Resources

1. Foster, D. (2022). Generative deep learning. " O'Reilly Media, Inc.".

2. Buduma, N., Buduma, N., & Papa, J. (2022). Fundamentals of deep learning. " O'Reilly Media, Inc.".
3. Bengio, Y., Goodfellow, I., & Courville, A. (2017). Deep learning (Vol. 1). Cambridge, MA, USA: MIT press..
4. Chollet, F. (2021). Deep learning with Python. Simon and Schuster.
5. Kapoor, A., Gulli, A., Pal, S., & Chollet, F. (2022). Deep Learning with TensorFlow and Keras: Build and deploy supervised, unsupervised, deep, and reinforcement learning models. Packt Publishing Ltd.
6. Mitchell, T. M, (2017) Machine Learning, McGraw Hill Publishers
7. Huang, K., Hussain, A., Wang, Q. F., & Zhang, R. (Eds.). (2019). Deep learning: fundamentals, theory and applications (Vol. 2). springer.
8. Hassaballah, M., & Awad, A. I. (Eds.). (2020). Deep learning in computer vision: principles and applications. CRC Press.
9. Bishop, C. M., & Nasrabadi, N. M. (2006). Pattern recognition and machine learning (Vol. 4, No. 4, p. 738). New York: springer.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Introduction**		
1.1	Machine Learning Basics, Learning Algorithms, Hyperparameters and Validation Sets, ,	2	CO1
1.2	Estimators, Bias and Variance, Maximum Likelihood Estimation	2	CO1
1.3	Stochastic Gradient Descent, Building a Machine Learning Algorithm and Challenges.	2	CO1
2.	**Basic concepts**		
2.1	Basic concepts of deep learning,	1	CO2
2.2	Deep Feed forward Networks - Learning XOR, Gradient Based Learning, Hidden Units and Architecture	2	CO2
2.3	Design. Multilayer Perceptrons, Back propogation,	2	CO2
2.4	Linear Regression, Empirical Risk Minimization,	2	CO2
2.5	Regularization, Auto encoders	2	CO2
3.	**Deep neural networks (DNNs)**		
3.1	Difficulty of training DNNs, Greedy layerwise training, Optimization for training DNNs, Newer optimization methods for neural networks (AdaGrad, RMSProp, Adam)	2	CO3
3.2	Second order methods for training, Regularization methods (dropout, drop connect, batch normalization	1	CO3
4.	**CNN and RNN**		
4.1	Introduction to CNNs – convolution, pooling, Deep CNNs,	1	CO4
4.2	Different deep CNN architectures – LeNet, AlexNet, VGG.	1	CO4
4.3	Training CNNs: weights initialization, batch normalization, hyperparameter optimization, Understanding and visualizing CNNs.	2	CO4
4.4	Recurrent neural networks (RNNs) - Sequence modeling using RNNs, Back propagation through time,	2	CO4
4.5	Long Short Term Memory (LSTM), Bidirectional LSTMs, Bidirectional RNNs, Gated RNN Architecture	2	CO4
5.	**Deep Generative models**		

5.1	Restrictive Boltzmann Machines (RBMs), Stacking RBMs,	2	CO5
5.2	Belief nets, Learning sigmoid belief nets, Deep belief nets	2	CO5
6.	**Deep Learning Tools**		
6.1	Caffee, Theano,	2	CO6
6.2	Torch, Ran Bi,	2	CO6
6.3	CUDA, PyLearn2	2	CO6
	Total	**36**	

Course Designers:

1. Dr. A. Malini amcse@tce.edu
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21CBRK1	CLOUD STORAGE INFRASTRUCTURES

Category	L	T	P	Credit	Terminal Exam Type
PEES	3	0	0	3	Theory

Preamble

This course will embark the learning from fundamentals of cloud computing to mastering the virtualization, storage solutions, security measures. At the end of this course, students will have the knowledge and skills to design and manage a robust cloud infrastructure.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Appraise the importance and opportunities of cloud storage in business environments	20
CO2	Evaluate various storage infrastructures and its management	15
CO3	Dramatize the virtualization techniques used for building virtual servers	15
CO4	Design secured solutions in cloud environment	15
CO5	Implement effective cloud storage solutions	20
CO6	Investigate replication and availability in various storage environments	15

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Response		1.2, 2.1.1 , 2.2.1 , 2.5.1
CO2	TPS3	Apply	Value		1.2, 2.1.1 , 2.1.2, 4.1.2
CO3	TPS3	Apply	Value		1.2, 2.1.1, 2.1.2, 4.1.2
CO4	TPS3	Apply	Value		1.3, 2.1.1, 2.1.2, 2.1.5, 2.4.7, 4.1.1
CO5	TPS3	Apply	Value		1.2, 2.1.1, 2.1.2, 4.1.1,
CO6	TPS3	Apply	Value		1.2, 2.1.1, 4.1.2

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L		M	L			L	L			L	L	
CO2	S	M	L	M	M			L	L		L	M	L	L
CO3	S	M	L	M	M			L	L		L	M	L	L
CO4	S	M	L	M	M			L	L		L	M	L	L
CO5	S	M	L	M	M			L	L		L	M	L	L
CO6	S	M	L	M	M			L	L		L	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	2	1	2	
Remember	10	10	-	-	20
Understand	30	30	30	30	20
Apply	60	60	70	70	60
Analyse	-	-	-	-	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject /Assignment/Practical Component
Perception	-
Set	-
Guided Response	30
Mechanism	70
Complex Overt Responses	-
Adaptation	-
Origination	-

Sample Questions for Course Outcome Assessment**

** (2 to 3 at the cognitive level of course outcome)

Course Outcome (CO1) :

1.What are the key advantages of using cloud storage over traditional on-premises storage solutions?
2.Define the public internet and its role in connecting devices globally
3.Create a plan for migrating an organization's existing data to a cloud storage service
4.Evaluate the security implications of establishing a site-to-site VPN, especially when connecting geographically dispersed offices

Course Outcome (CO2):

1.Explain the difference between a public cloud, private cloud, and hybrid cloud
2.Develop a use case scenario for a software-as-a-service (SaaS) application in a business context
3.Analyze the implications of selecting a specific cloud service model for a particular project in terms of costs, control, and flexibility
4.Propose strategies for optimizing data storage and access within a specific cloud storage provider

Course Outcome (CO3):

1.List a few common use cases for implementing VDI in organizations
2.How does VDI improve remote access to desktop environments?
3.Analyze the cost-effectiveness of VDI compared to traditional desktop infrastructure, considering factors like hardware, maintenance, and scalability.
4.Assess the potential security risks and compliance challenges associated with VDI

Course Outcome (CO4):

1.What are the primary security concerns when using cloud storage services?
2.Analyze the potential risks and consequences of a data breach in terms of data integrity, confidentiality, and availability.
3.Evaluate the security measures and data encryption options available in various cloud storage providers
4.Critique the success factors and potential drawbacks of implementing hybrid storage networking technologies

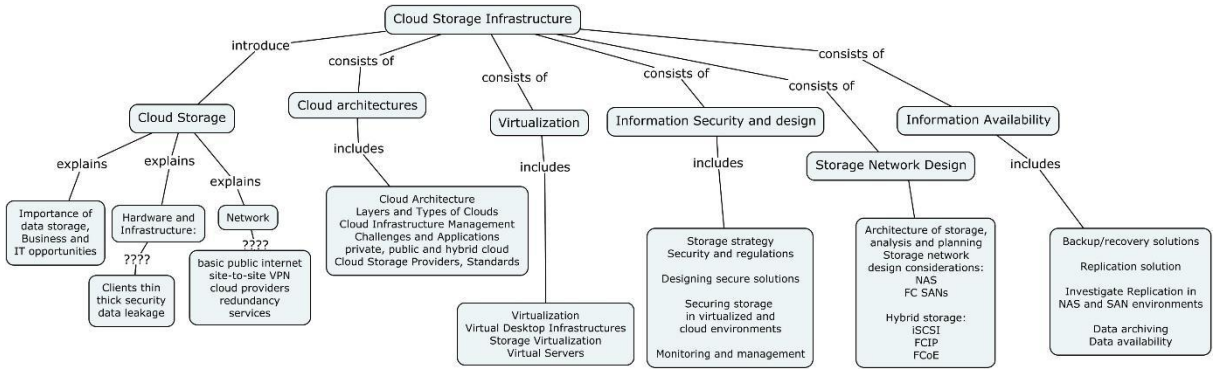
Course Outcome (CO5):

1.Explain how NAS differs from Direct-Attached Storage (DAS) and Storage Area Networks (SANs)
2.How does NAS contribute to simplified data access and sharing in network environments?
3.Develop a NAS implementation plan for a small business, considering storage capacity and data protection requirements
4.Assess the performance benefits and potential challenges of using FCoE in data center environments

Course Outcome (CO6):

1.Explain the difference between data backup and data archiving
2.Explain the concept of data redundancy and data availability in cloud storage
3.Propose methods for data backup and disaster recovery using cloud storage resources
4.Develop a data archiving strategy for an organization, considering data classification and archiving methods

Concept Map



Syllabus

Cloud Introduction :
Introduction to Cloud Computing - Importance of data storage - Business and IT opportunities - Hardware and Infrastructure: Clients thin, thick security, data leakage, Network: basic public internet, site-to-site VPN, cloud providers, redundancy, services.

Cloud Architecture:
Cloud Architecture - Layers and Types of Clouds, Cloud Infrastructure Management, Challenges and Applications. - private, public and hybrid cloud - Cloud Storage Providers, Standards.

Virtualization:
Virtualization technology - Virtual Desktop Infrastructures- Storage Virtualization and Virtual Storage - Virtual Servers.

Information Security and design
Storage strategy and governance - Security and regulations - Designing secure solutions - Securing storage in virtualized environments - Securing Storage in cloud environments - Monitoring and management.

Storage Network Design
Architecture of storage, analysis and planning - Storage network design considerations – NAS FC SANs - Hybrid storage networking technologies - iSCSI, FCIP, FCoE .

Information Availability
Designing backup/recovery solutions to guarantee data availability in a virtualized environment
Design a replication solution - Replication for local remote and advanced - Investigate Replication in NAS and SAN environments - Data archiving solutions - Data availability in a virtualized environment

Tutorials for cloud platforms:
Accessing the Cloud: Platforms, Web Applications, Web APIs, Web Browsers
Middleware: OpenStack, OpenNebula, Windows Azure, CloudSim, EyeOs, Aneka, Google App Engine, Amazon EC2, Eucalyptus.

Learning Resources

1. Zaigham Mahmood, Ricardo Puttini, Thomas Erl , Cloud computing concepts : Technology and architecture, Pearson 2013.
2. Dan C Marinescu , Cloud computing : Theory and practice , 3rd edition , MK , 2022
3. EMC, "Information Storage and Management" Wiley; 2 edition [ISBN: 978-0470294215], 2012
4. Ray rafaels, Cloud computing : From beginning to end ,Create space, 2015

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Cloud Introduction**	**7**	**CO1**
1.1	Introduction to Cloud Computing - Importance of data storage	1	CO1
1.2	Business and IT opportunities	2	CO1
1.3	Hardware and Infrastructure: Clients thin, thick security, data leakage	2	CO1
1.4	Network: basic public internet, site-to-site VPN, cloud providers, redundancy, services	2	CO1
2.	**Cloud Architecture**	**6**	**CO2**
2.1	Cloud Architecture - Layers and Types of Clouds	2	CO2
2.2	Cloud Infrastructure Management	1	CO2
2.3	Challenges and Applications. - private, public and hybrid cloud	2	CO2
2.4	Cloud Storage Providers, Standards	1	CO2
3.	**Virtualization**	**5**	**CO3**
3.1	Virtualization technology	1	CO3
3.2	Virtual Desktop Infrastructures	2	CO3
3.3	Storage Virtualization and Virtual Storage	1	CO3
3.4	Virtual Servers	1	CO3
4.	**Information Security and design**	**6**	**CO4**
4.1	Storage strategy and governance, Security and regulations	1	CO4
4.2	Designing secure solutions	2	CO4
4.3	Securing storage in virtualized environments, Securing Storage in cloud environments	2	CO4
4.4	Monitoring and management	1	CO4
5.	**Storage Network Design**	**7**	**CO5**
5.1	Architecture of storage, analysis and planning	2	CO5
5.2	Storage network design considerations : NAS, FC SANs	2	CO5
5.3	Hybrid storage networking technologies:iSCSI, FCIP, FCoE	3	CO5
6.	**Information Availability**	**5**	**CO6**
6.1	Designing backup/recovery solutions to guarantee data availability in a virtualized environment	1	CO6
6.2	Design a replication solution, Replication for local remote and advanced	2	CO6
6.3	Investigate Replication in NAS and SAN environments	1	CO6
6.4	Data archiving solutions, Data availability in a virtualized environment	1	CO6
	TOTAL	**36**	

Course Designers:

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2. Mr. M.Gowtham Sethupathi mgsca@tce.edu

21CBSD1	CLOUD SECURITY

Category	L	T	P	Credit	Terminal Exam Type
PSE	3	0	0	3	Theory

Preamble

This course provides the fundamental knowledge of cloud computing, the services offered by the cloud, the effective design of a data centre, Virtualization, Cloud Storage. The students will learn the Threats and Vulnerabilities to Infrastructure, Standards for Security and various Cloud Security tools.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Explain the concept of cloud services, architecture and various cloud models.	15
CO2	Implement the cloud security policies in Infrastructure, data and storage for real time scenario.	15
CO3	Examine the different types of risks, threats and Vulnerabilities using risk management strategies in cloud environment.	20
CO4	Apply the Federated Identity management and SAML access management tools to provide the secure authentication service in cloud.	15
CO5	Apply various cloud security standards to provide security in the cloud environment such as OpenID, SSL/TLS, etc..	15
CO6	Use various cloud security tools such as Amazon Inspector, Security hub, Guard duty, etc., to create a secure cloud environment.	20

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO#	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond		1.1, 1.2, 2.2
CO2	TPS3	Apply	Value		1.1, 1.2, 2.2
CO3	TPS3	Apply	Value		1.1, 1.2, 2.1.1, 2.3.1
CO4	TPS3	Apply	Value		1.1, 1.2, 2.1.1, 2.1.5
CO5	TPS3	Apply	Value		1.1, 1.2, 2.1.1, 2.1.5
CO6	TPS3	Apply	Value		1.1, 1.2, 2.1.1, 2.3.1

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L										L		
CO2	S	M	L									L		
CO3	S	M	L		L			M			M	M	L	L
CO4	S	M	L		M	L	L	M			M	M	L	L
CO5	S	M	L		S	L	M	M			M	M	L	L
CO6	S	M	L		S	L	M	M			M	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	2	1	2	
Remember	20	20	-	-	20
Understand	30	30	40	40	30
Apply	50	50	60	60	50
Analyse	-	-	-	-	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject /Assignment/Practical Component
Perception	-
Set	-
Guided Response	-
Mechanism	-
Complex Overt Responses	-
Adaptation	-
Origination	-

Sample Questions for Course Outcome Assessment**

** (2 to 3 at the cognitive level of course outcome)

Course Outcome 1(CO1):

1. What are the characteristics of cloud architecture that separates it from traditional one?
2. "Although Virtualization is widely Accepted today, it does have its limits". Comment on the statement
3. Briefly explain each of the cloud computing services. Identify two cloud providers by company name in each service category.
4. Compare and Contrast: Public, Private and Hybrid clouds

Course Outcome 2(CO2):

1. List the different Security Standards
2. What are the security challenges in cloud computing?
3. What is Cloud Security Defense Strategies and Illustrate with neat diagram.
4. Identify different Cloud Security Requirements for Identity Management and Cloud-wide Time Service.

Course Outcome 3(CO3):

1. Discuss about the various risks available in cloud Service Provider.
2. Apply the principles of risk management to develop a risk mitigation plan for a cloud migration project.
3. Consider a scenario where a company is planning to deploy a critical business application on a cloud platform, outline the steps you would take to conduct a comprehensive risk assessment for this cloud-based application. consider factors such as data sensitivity, regulatory compliance requirements, potential security threats, and the chosen cloud service model.
4. Using the principles of risk management, devise a detailed risk mitigation plan for a cloud migration project. Consider potential risks associated with data transfer, system downtime, data integrity, and compliance during the migration process. Outline specific actions, controls, and contingency measures to address each identified risk effectively.

Course Outcome 4 (CO4):

1. Explain in detail about the Federated Identity Management in cloud environment.
2. Imagine a scenario where a multinational corporation is planning to implement Federated Identity Management (FIM) across its various subsidiaries and partner organizations. Using the principles of FIM, devise a comprehensive plan outlining how you would establish trust relationships, define identity attributes, and ensure

secure authentication and authorization processes across disparate systems and domains. Consider factors such as interoperability, single sign-on (SSO), identity federation protocols, and risk mitigation strategies to address potential security vulnerabilities.

3. A large organization is planning to implement Single Sign-On (SSO) using SAML across its various internal systems and cloud-based applications. Outline the steps involved in configuring a SAML-based authentication flow between the organization's Identity Provider (IdP) and a cloud-based Service Provider (SP). Describe how user authentication and authorization information are exchanged using SAML assertions, and specify the necessary configurations and security measures to ensure the integrity and confidentiality of the SAML messages exchanged between the IdP and SP.

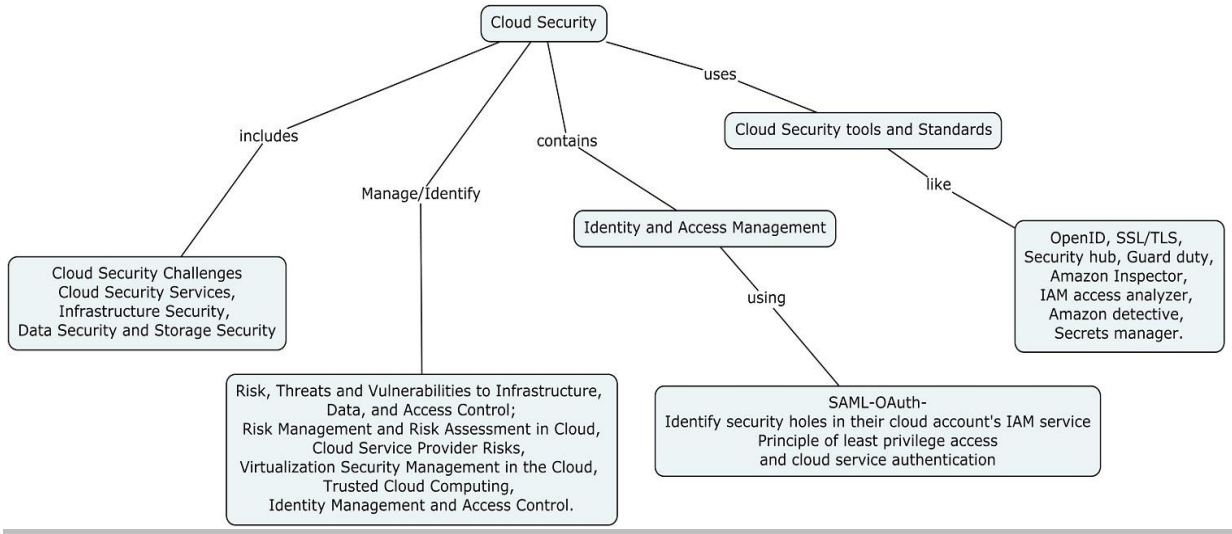
Course Outcome 5 (CO5):

1. In an organization we need to provide the secure cloud environment for the employees to effectively share the resources available. Create a cloud computing strategy to develop this.
2. Suppose you are developing a web application that allows users to sign in using their existing accounts from various OpenID providers, such as Google, Facebook, and GitHub. Outline the implementation steps you would take to integrate OpenID authentication into your application. Describe how you would handle the authentication flow, including redirecting users to their chosen OpenID provider for login, validating the returned identity tokens, and securely managing user sessions. Additionally, discuss any considerations you would take into account to provide a seamless and secure authentication experience for users across different OpenID providers while ensuring compliance with relevant security standards
3. Consider a scenario where you are tasked with securing the communication between a mail server and its clients using SSL/TLS. Outline the steps you would take to implement SSL/TLS for encrypting email traffic. Describe how you would generate or obtain an SSL/TLS certificate for the mail server, configure the server software to support SSL/TLS connections, and ensure compatibility with various email clients. Additionally, discuss any potential challenges you might encounter during the implementation process and how you would address them to ensure a secure and seamless transition to SSL/TLS encryption for email communication.

Course Outcome 6 (CO6):

1. Discuss about the working of amazon inspector tool in providing security to the cloud.
2. Imagine you're a security architect tasked with improving the cybersecurity posture of an organization's AWS environment. Outline the steps you would take to utilize AWS Security Hub effectively. Describe how you would integrate various AWS services, such as Amazon GuardDuty, AWS Config, and AWS IAM, into Security Hub to centralize security findings and automate remediation processes. Additionally, discuss how you would customize Security Hub's insights and findings to prioritize security alerts based on the organization's specific risk factors and compliance requirements. Finally, explain how you would leverage Security Hub's APIs and integrations with third-party security tools to enhance threat detection and incident response capabilities in the AWS environment.
3. Imagine you are a security analyst tasked with strengthening the security posture of an organization's AWS infrastructure. Outline the steps you would take to utilize Amazon Inspector effectively. Describe how you would set up and configure Inspector to conduct automated security assessments of EC2 instances and identify potential vulnerabilities and security misconfigurations. Additionally, discuss how you would interpret and prioritize the findings generated by Inspector, considering factors such as severity, impact, and relevance to the organization's risk profile. Furthermore, explain how you would collaborate with other teams, such as DevOps and system administrators, to remediate identified vulnerabilities and integrate Inspector's findings into the organization's overall security monitoring and incident response processes. Finally, discuss how you would leverage Inspector's continuous assessment capabilities to ensure ongoing compliance with security best practices and regulatory requirements in the AWS environment.

Concept Map



Syllabus

Cloud Computing Fundamentals: Definition, Evolution, Essential characteristics, Cloud Deployment Models, Cloud Service Models, Benefits, Cloud Architecture, Virtualization in Cloud, Cloud Data Centre, SLA, Cloud Applications

Cloud Security: Cloud Security Challenges, Cloud Information Security Objectives, Cloud Security Services, Secure Cloud Software Requirements, Cloud Security Policy Implementation, Infrastructure Security, Data Security and Storage, Privacy in Cloud.

Risk Management in cloud: Threats and Vulnerabilities to Infrastructure, Data, and Access Control; Risk Management and Risk Assessment in Cloud, Cloud Service Provider Risks, Virtualization Security Management in the Cloud, Trusted Cloud Computing, Identity Management and Access Control.

Identity and Access Management: Introduction to Identity and Access Management-Introduction to Federated Identity Management-SAML-OAuth-Identify security holes in their cloud account's IAM service-Principle of least privilege access-Discover and protect various secrets related to cloud service authentication.

Standards for Security: OpenID, SSL/TLS, Encrypting Data and Key Management, Creating a Cloud Security Strategy, The Future of Security in Cloud Computing.

Cloud Security tools: Security hub, Guard duty, Amazon Inspector, IAM access analyzer, Amazon detective, Secrets manager.

Learning Resources

Text Book

1. Rittinghouse, John W., and James F. Ransome, —Cloud Computing: Implementation, Management and Security, CRC Press, 2017
2. John R. Vacca, "Cloud Computing Security: Foundations and Challenges", CRC Press, 1st edition, 2017.
3. Ronald L. Krutz, Russell Dean Vines,"Cloud Security: A Comprehensive Guide to Secure Cloud Computing", Wiley Publishing, 2010.

Reference Book

1. Ryan Ko, Kim-Kwang Raymond Choo, The Cloud Security Ecosystem, Orelly, 2013.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Cloud Computing Fundamentals:**		CO1
1.1	Definition, Evolution, Essential characteristics, Cloud Deployment Models	1	CO1
1.2	Cloud Service Models, Benefits, Architecture	2	CO1
1.3	Cloud Virtualization in Cloud, Cloud Data Centre	2	CO1
1.4	SLA, Cloud Applications	1	CO1
2	**Cloud Security:**		CO2
2.1	Cloud Security Challenges, Cloud Information Security Objectives	1	CO2
2.2	Cloud Security Services, Secure Cloud Software Requirements	1	CO2
2.3	Cloud Security Policy Implementation, Infrastructure Security	2	CO2
2.4	Data Security and Storage, Privacy in Cloud	2	CO2
3	**Risk Management in cloud:.**		CO3
3.1	Threats and Vulnerabilities to Infrastructure, Data, and Access Control	2	CO3
3.2	Risk Management and Risk Assessment in Cloud, Cloud Service Provider Risks	2	CO3
3.3	Virtualization Security Management in the Cloud	1	CO3
3.4	Trusted Cloud Computing, Identity Management and Access Control	2	CO3
4	**Identity and Access Management:**		CO4
4.1	Introduction to Identity and Access Management and Federated Identity Management	1	CO4
4.2	SAML-OAuth-Identify security holes in their cloud account's IAM service	2	CO4
4.3	Principle of least privilege access	1	CO4
4.4	Discover and protect various secrets related to cloud service authentication	2	CO4
5	**Standards for Security:**		CO5
5.1	OpenID, SSL/TLS	2	CO5
5.2	Encrypting Data and Key Management	1	CO5
5.3	Creating a Cloud Security Strategy	1	CO5
5.4	The Future of Security in Cloud Computing.	1	CO5
6.	**Cloud Security tools:**		CO6
6.1	Security hub, Guard duty	2	CO6
6.2	Amazon Inspector, IAM access analyzer	2	CO6
6.3	Amazon detective, Secrets manager.	2	CO6
	TOTAL	**36**	

Course Designers:

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21CBSE1	FOG AND EDGE COMPUTING

Category	L	T	P	Credit	Terminal Exam Type
Pse	3	0	0	3	Theory

Preamble

The course will enable the students to develop a fog or edge network for IoT devices. This will also enable them to apply machine learning / deep learning techniques for fog and edge environments.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Understand the fundamentals of fog and edge computing and its role in IoT systems.	15
CO2	Use IoT and edge architecture, with real-world examples and case studies like 5G slicing and self driving cars, to effectively design and deploy edge solutions.	15
CO3	Apply edge infrastructure principles, storage design, MQTT basics, and edge analytics topologies to design edge networks and storage systems	15
CO4	Apply FOG architecture concepts like hierarchical, layered, dimensional or referred architecture to design smart applications like smart city networks	20
CO5	Compute solutions using deterministic and stochastic optimization techniques like linear programming, heuristic search etc for design challenges to optimize for resource allocation and cost efficiency in Fog/ Edge practical applications	15
CO6	Apply machine learning techniques like classification, regression and clustering in fog and edge computing environments for real life applications like anomaly detection, predictive maintenance etc	20

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psycho motor	
CO1	TPS2	Understand	Respond		1.1,1.2,1.3,1.4,2.1,2.2,2.3
CO2	TPS3	Apply	Value		1.1,1.2,1.3,1.4,2.1,2.2,2.3,2.4,2.5, 4.1,4.2,4.3
CO3	TPS3	Apply	Value		1.1,1.2,1.3,1.4,2.1,2.2,2.3,2.4,2.5, 3.1,3.2,3.3,4.1,4.2,4.3
CO4	TPS3	Apply	Value		1.1,1.2,1.3,1.4,2.1,2.2,2.3,2.4,2.5, 3.1,3.2,4.1,4.2,4.3,4.4,4.5,4.6
CO5	TPS3	Apply	Value		1.1,1.2,1.3,1.4,2.1,2.2,2.3,2.4,2.5, 3.1,3.2,4.1,4.2,4.3,4.4,4.5,4.6
CO6	TPS3	Apply	Value		1.1,1.2,1.3,1.4,2.1,2.2,2.3,2.4,2.5, 3.1,3.2,4.1,4.2,4.3,4.4,4.5,4.6

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L			L	L				L		M	L	L
CO2	S	M	L		L	L				L		M	L	L
CO3	S	M	L		M	L				L		M	L	L
CO4	S	M	L		M	L				L		M	L	L
CO5	S	M	L		M	L				L		M	L	L

CO6	S	M	L		M	L				L		M	L	L
CO7	S	M	L		L	L				L		M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	2	1	2	
Remember	30	20			20
Understand	30	40			40
Apply	40	40	100	100	40
Analyse					
Evaluate					
Create					

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject /Assignment/Practical Component
Perception	
Set	
Guided Response	
Mechanism	
Complex Overt Responses	
Adaptation	
Origination	

Sample Questions for Course Outcome Assessment**

** (2 to 3 at the cognitive level of course outcome)

Course Outcome 1(CO1):

1. Compare round-trip time (RTT) considerations in cloud-based IoT systems with those in edge and fog computing environments. How do these paradigms mitigate latency challenges differently?
2. Discuss the significance of real-time data processing in IoT systems and how edge and fog computing architectures facilitate timely decision-making. Provide examples.
3. Explain how hierarchical data processing in Edge/ Fog networks can optimize data flow and enhance scalability while minimizing latency.

Course Outcome 2(CO2):

1. Illustrate how edge computing enhances the capabilities of self-driving cars by enabling real-time perception, decision-making, and navigation.
2. Design an edge architecture that integrates wearable health monitors, edge servers in hospitals, and cloud-based analytics platforms
3. Discuss how Edge architecture addresses latency, scalability, and data privacy concerns inherent in practical applications.

Course Outcome 3(CO3):

1. Use Docker containers and Kubernetes to streamline the deployment, management, and scaling of containerized workloads in edge computing environments
2. Apply the concept of lightweight edge data centers to support remote office locations of a multinational organization.
3. List the key considerations for selecting hardware, software, and networking components for lightweight edge data centers, and discuss how these deployments integrate with existing cloud services

Course Outcome 4 (CO4):

1. Design a fog computing architecture for a smart manufacturing facility. Show the working procedure of fog architecture, including data processing, resource allocation, and communication between fog nodes and edge devices
2. Describe the methodologies and metrics used to evaluate the performance of fog computing systems, including latency, throughput, resource utilization, and energy efficiency
3. Design a data management strategy for a fog computing platform used to collect and analyze traffic and environmental data. Outline the data lifecycle management process

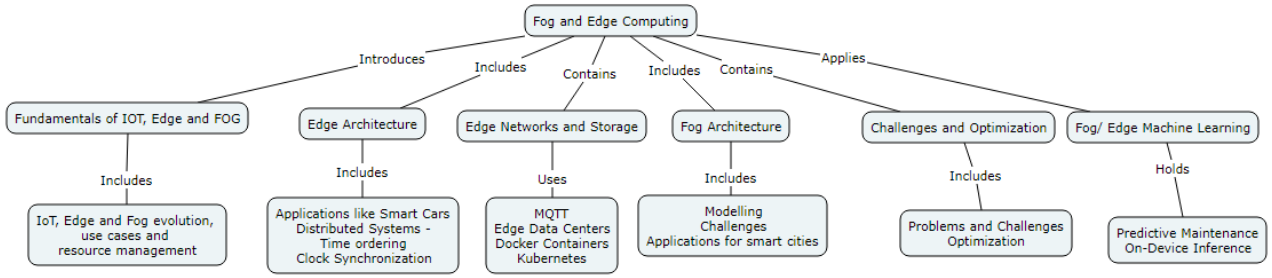
Course Outcome 5 (CO5):

1. Design and optimise resource utilization in a fog computing environment for a smart grid deployment
2. Design middleware solutions for managing mobility in a distributed edge computing environment for autonomous vehicle networks.
3. List the challenges of mobility management in edge computing, such as handover latency, network connectivity, and location awareness

Course Outcome 6(CO6):

1. Implement a machine learning model for predictive maintenance in a manufacturing plant by real-time analysis of sensor data and proactive identification of equipment failures. List and address the challenges
2. Develop an image classifier for a smart surveillance system deployed at the edge. Describe how machine learning algorithms can be applied to process image data from edge devices, such as cameras or drones, to classify objects and detect anomalies
3. Design systems incorporating machine learning to enable autonomous vehicles to perceive their environment, make decisions, and navigate safely in real-time

Concept Map



Syllabus

Fundamentals of Iot, Edge and FOG

Evolution, resource management, RTT and latency considerations in cloud IOT systems. Overview of fog and edge computing and its significance in IoT. Use cases, advantages, disadvantages.

Edge Architecture

Edge Computing architectures. User Applications (5G-slicing, self-driving cars). Concepts of distributed systems in edge computing - time ordering and clock synchronization, distributed snapshot, etc.

Edge Networks and Storage

Edge Data Center, Lightweight Edge, Clouds and services. Introduction to docker container and Kubernetes in edge computing. Design of edge storage systems like key-value stores. Edge frameworks like KubeEdge. Introduction to MQTT. Edge analytics topologies for M2M and WSN network (MQTT)

FOG Architecture

Fog architecture - hierarchical, layered, dimensional and referred. Characteristics, working procedure, differentiating Fog and Edge. Challenges. Performance Evaluation, Modelling and Simulation. Data management - lifecycle, security and privacy. Case studies - smart city applications and health monitoring

Optimization

Problems in Fog and Edge computing, design issues. Optimization techniques - deterministic (linear and nonlinear) and stochastic (heuristic - / metaheuristic - local search, swarm intelligence etc).

Middleware for Fog and Edge computing, mobility management.

Fog/ Edge Machine Learning

Use cases of machine learning algorithms - classification, regression and clustering for applications like predictive maintenance, image classification and self-driving cars. Deep Learning On-Device inference at the edge to support latency-based application

Learning Resources

1. Buyya, Rajkumar, and Satish Narayana Srirama, Fog and Edge computing: Principles and Paradigms, 2019, 1st edition, John Wiley & Sons, USA.

2. Wei Chang, Jie Wu, Fog/Edge Computing For Security, Privacy, and Applications, 2021, Springer
3. Assad Abbas, Samee U. Khan, Albert Y. Zomaya, Fog Computing, 2020, Wiley
4. K. Anitha Kumari, G. Sudha Sadasivam, D. Dharani, M. Niranjanamurthy, Edge Computing, 2021, Taylor and Francis Group
5. NPTEL - Edge Computing
6. https://link.springer.com/article/10.1007/s42979-023-02235-9
7. https://www.sciencedirect.com/science/article/pii/S2210650221000985
8. https://www.sciencedirect.com/science/article/pii/S1574013723000357

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Fundamentals of Iot, Edge and FOG**		
1.1	Evolution, resource management, RTT and latency considerations in cloud IOT systems.	1	CO1
1.2	Overview of fog and edge computing and its significance in IoT	2	CO1
1.3	Use cases, advantages, disadvantages.	2	CO1
2.	**Edge Architecture**		
2.1	Edge Computing architectures.	2	CO2
2.2	User applications (5G-Slicing, self-driving cars).	2	CO2
2.3	Concepts of distributed systems in edge computing - time ordering and clock synchronization, distributed snapshot, etc.	2	CO2
3.	**Edge Networks and Storage**		
3.1	Edge Data Center, Lightweight Edge, Clouds and services.	1	CO3
3.2	Introduction to docker container and Kubernetes in edge computing. KubeEdge	1	CO3
3.3	Design of edge storage systems like key-value stores.	1	CO3
3.4	Introduction to MQTT. Edge analytics topologies for M2M and WSN network (MQTT)	2	CO3
4.	**FOG Architecture**		
4.1	Fog architecture - hierarchical, layered, dimensional and referred, characteristics, working procedure, differentiating Fog and Edge. Challenges.	2	CO4
4.2	Performance evaluation, modelling and simulation.	2	CO4
4.3	Data management - lifecycle, security and privacy.	2	CO4
4.4	Case studies - smart city applications and health monitoring	2	CO4
5.	**Optimization**		
5.1	Problems in Fog and Edge Computing, design issues. optimization techniques - deterministic and stochastic techniques	3	CO5
5.2	Middleware for Fog and Edge Computing, mobility management.	2	CO5
6.	**Fog/ Edge Machine Learning**		
6.1	Machine learning - classification, regression and clustering -	2	CO6
6.2	Use cases for sensor data like predictive maintenance, image classifiers and self-driving cars.	3	CO6
6.3	Deep learning On-Device inference at the edge to support latency-based application	2	CO6

Course Designers:

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2. Mrs. Priya Thiagarajan ptca@tce.edu

21CBSF1	Supply Chain Information Systems

Category	L	T	P	Credit	Terminal Exam Type
PSE	3	0	0	3	Theory

Preamble

Supply chains are increasingly becoming digital with the easy availability of data related to operations & purchases, payments getting digitized, and the advent of the platform economy. This course helps students to develop excellent knowledge and skills in Core concepts in supply chain and the role of information systems to align with business strategy

Prerequisite

Nil

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage In %
CO1	Understand the basic concepts of SCM like supply chain operation strategies, methodologies, trends, best practices, and research issues.	20
CO2	Demonstrate the role of digitization in the supply chain to reduce the cost, provide better insights and cut down manual errors.	10
CO3	Create an e-SCM framework to improve the operations of supply chain activities.	20
CO4	Create an Enterprise Information Systems (EIS) to automate all stages of the organization's supply maintenance and control the entire product distribution in the organization.	20
CO5	Develop supply chain software with the help of industry 4.0 technologies to drive improvements across their supply chain processes.	15
CO6	Apply the concept of decision support system along with traditional support systems in e-SCM for next generation e-business.	15

*** Weightage depends on Bloom's Level, number of contact hours

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond	Guided response	1.1, 2.3.4, 2.4.6, 2.4.7, 2.5.1
CO2	TPS2	Understand	Respond	Guided response	1.1, 1.2, 2.1.3, 2.1.4, 2.1.5, 2.3, 2.4.3, 2.4.6, 2.4.7
CO3	TPS3	Apply	Value	Mechanism	1.1, 1.2, 2.1.3, 2.1.4, 2.1.5, 2.3, 2.4.3, 2.4.6, 2.4.7
CO4	TPS3	Apply	Value	Mechanism	1.1, 1.2, 2.1.3, 2.1.4, 2.1.5, 2.3, 2.4.3, 2.4.6, 2.4.7
CO5	TPS3	Apply	Value	Mechanism	1.1, 1.2, 2.1.3, 2.1.4, 2.1.5, 2.3, 2.4.3, 2.4.6, 2.4.7
CO6	TPS3	Apply	Value	Mechanism	1.2, 2.1.2, 3.2.3, 4.5.3

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L										L		
CO2	M	L				L	L		L		L	M	L	L
CO3	S	M	L			L	L		L		L	M	L	L
CO4	S	M	L			L	L		L		L	M	L	L
CO5	S	M	L			L	L		L		L	M	L	L
CO6	S	M	L			L	L		L		L	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	**2**	1	2	
Remember	20	10			20
Understand	40	30	70		30
Apply	20	60	30	100	50
Analyse					
Evaluate					
Create					

Assessment Pattern: Psychomotor

Psychomotor Skill	Mini project /Assignment/Practical Component
Perception	
Set	
Guided Response	30
Mechanism	70
Complex Overt Responses	
Adaptation	
Origination	

Sample Questions for Course Outcome Assessment**

** (2 to 3 at the cognitive level of course outcome)

Course Outcome 1(CO1):

1. Explain the concept of segmentation in supply chain management with its types and benefits.
2. How do operation strategies fit into daily project needs in supply chain management?
3. Demonstrate various methodologies and theories practiced in supply chain management.

Course Outcome 2(CO2):

1. Compare and contrast the centralized supply chain with decentralized supply chain using examples.
2. What is the role of distributer channel in supply chain management and how it reduces the number of transactions?
3. Demonstrate the concept of Omni channel in supply chain management for distributing consumer goods in variety of platforms.

Course Outcome 3(CO3):

1. Illustrate the e-SCM framework for defining the demand management to customer delivery in logistics and supply chain systems.
2. Identify the transition factors needed for a logistic company to move from traditional SCM to e-SCM.
3. Apply the various methods of communication systems helps in supporting logistics management in supply chain system.

Course Outcome 4 (CO4):

1. Illustrate the potential risk associated with security concerns in supply chain networks and identify various measures taken to resolve it.

2. Select suitable architecture of Enterprise Information Systems that enable organization to integrate and coordinate business process in supply chain networks.
3. Identify suitable frameworks used by Enterprise Information Systems that supports supply chain networks.

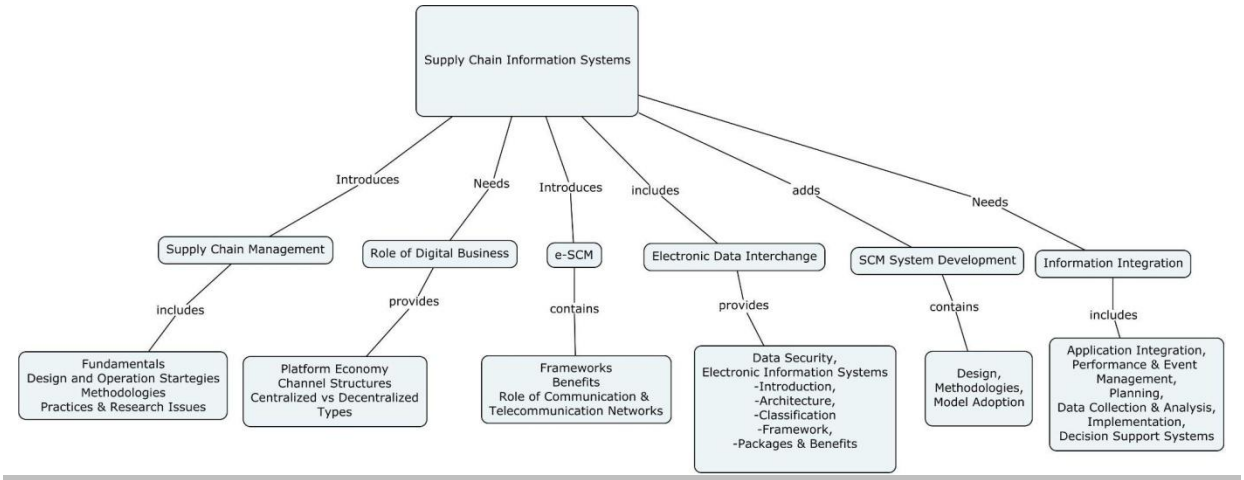
Course Outcome 5 (CO5):

1. Identify potential role and impact of stakeholders in SCM system for production organization.
2. Utilize various methodologies adopted or followed in the system development of Supply Chain Management for e-commerce applications.
3. Identify a case study and select the suitable enterprise architecture for supply chain system development

Course Outcome 6(CO6):

1. Organize the performance metrics in effective supply chain management in accordance with the organization policies.
2. Identify the event management methods used in supply chain systems for e-business applications to compare reported events against the milestones.
3. Apply the concept of decision support system used in along with traditional support systems in e-SCM for support next generation of e-business

Concept Map



Syllabus

Introduction: Supply chain Management-Fundamentals, Segmentation, Design and Operation strategies, methodologies, trends, best practices, and research issues

Role of Digital Business in Supply Chains: Introduction to Platform Economy, Channel Structures in the Supply Chain (Decentralized vs Centralized), Channel Structures in the Supply Chain (Dual Channels, Brick & Mortar, Multi-Channels, Omni Channels)

Supply Chain Communication Networks: Introduction to e-SCM – e-SCM framework - Key success factors for e-SCM - Benefits of e-SCM, Role of communication networks in supply chains - Overview of telecommunication networks

Electronic Data Interchange: Data security in supply chain networks**, Enterprise Information Systems:** Introduction, Architecture, Classification, and Framework for managing supply chain information, Packages, Benefits.

SCM System Development–Role of stakeholders in SCM, Enterprise architectural design, System development methodologies, Model Adoption

Information Integration: Enterprise application integration, Supply Chain visibility-Performance and event management, Planning, Data collection, Analysis, Recommendations and Implementation, Decision Support Systems.

Learning Resources

Text Books

1. Benjamin Blanchard, "Logistics Engineering & Management", Pearson Education, Seventh Edition 2021.

Reference Books

1. Donald J. Bowersox and David J. Closs, "Logistical Management - The Integrated Supply chain", Indian Edition, 2017.

2. Judy Strauss, and Raymond Frost, "E-Marketing, 4/e", Pearson Education Fifth Edition,2008.
3. Simchi-Levi, D., Kaminsky, P., &Simchi-Levi, "Designing and managing the supply chain: Concepts, strategies, and cases", New York: McGraw-hill.,4th Edition 2015.

Online Courses:

1. https://onlinecourses.nptel.ac.in/noc24_mg59

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Introduction**		CO1
1.1	Supply chain Management-Fundamentals	2	CO1
1.2	Segmentation	1	CO1
1.3	Design and Operation strategies	1	CO1
1.4	Methodologies, Trends	1	CO1
1.5	Best practices, and Research issues	1	CO1
2	**Role of Digital Business in Supply Chains**		
2.1	Introduction to Platform Economy	1	CO2
2.2	Channel Structures in the Supply Chain (Decentralized vs Centralized)	2	CO2
2.3	Channel Structures in the Supply Chain (Dual Channels, Brick & Mortar, Multi-Channels, Omni Channels)	2	CO2
3	**Supply Chain Communication Networks**		
3.1	Introduction to e-SCM	1	CO3
3.2	e-SCM framework	2	CO3
3.3	Key success factors for e-SCM	1	CO3
3.4	Benefits of e-SCM	1	CO3
3.5	Role of communication networks in supply chains	1	CO3
3.6	Overview of telecommunication networks	1	CO3
4	**Electronic Data Interchange & Enterprise Information Systems**		
4.1	Data security in supply chain networks	2	CO4
4.2	Introduction, Architecture	1	CO4
4.3	Classification, and Framework for managing supply chain information	2	CO4
4.4	Benefits of EDI & EIS	1	CO4
5	**SCM System Development**		
5.1	Role of stakeholders in SCM	1	CO5
5.2	Enterprise architectural design, ,	2	CO5
5.3	System development methodologies	1	CO5
5.4	Model Adoption	1	CO5
6	**Information Integration**		
6.1	Enterprise application integration	2	CO6
6.2	Supply Chain visibility	1	CO6
6.3	Performance and event management	1	CO6
6.4	Planning, Data collection, Analysis	1	CO6
6.5	Recommendations and Implementation	1	CO6
6.6	Decision Support Systems.	1	CO6
	Total	**36**	

Course Designers:

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2. Mr.M.Venkatesh mvhca@tce.edu

21CBSG1	Digitalization in Logistics and Supply Chain

Category	L	T	P	Credit	Terminal Exam Type
PSE	3	0	0	3	Theory

Preamble

Logistics has an important and a key role to play in customer service strategy of an organization. This course is specifically designed for students to enable digitalization of supply chain and logistics processes from a managerial perspective and equip them with ability to take decisions when faced with different situations in the corporate world.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage In %
CO1	Describe the infrastructures of modernized logistics and supply chain management	20
CO2	Explain the role of digital transformation in the supply chain and logistics process.	10
CO3	Design a Logistic network to optimizes the trade-offs between inventory, transportation, and warehousing costs	20
CO4	Create an application for demand forecasting to predict the future demand accurately	20
CO5	Implement the Service Quality 4.0 framework for suppliers or Logistics Service Providers (LSPs) to enhance the operational efficiency and improved customer satisfaction	15
CO6	Develop a Supply chain and logistic 4.0 framework to create a more efficient and sustainable supply chain	15

*** Weightage depends on Bloom's Level, number of contact hours

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond	Guided response	1.1, 2.3.4, 2.4.6, 2.4.7, 2.5.1
CO2	TPS2	Understand	Respond	Guided response	1.1, 1.2, 2.1.3, 2.1.4, 2.1.5, 2.3, 2.4.3, 2.4.6, 2.4.7
CO3	TPS3	Apply	Value	Mechanism	1.1, 1.2, 2.1.3, 2.1.4, 2.1.5, 2.3, 2.4.3, 2.4.6, 2.4.7
CO4	TPS3	Apply	Value	Mechanism	1.1, 1.2, 2.1.3, 2.1.4, 2.1.5, 2.3, 2.4.3, 2.4.6, 2.4.7
CO5	TPS3	Apply	Value	Mechanism	1.1, 1.2, 2.1.3, 2.1.4, 2.1.5, 2.3, 2.4.3, 2.4.6, 2.4.7
CO6	TPS3	Apply	Value	Mechanism	1.2, 2.1.2, 3.2.3, 4.5.3

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L										L		
CO2	S	M	L									M		
CO3	S	M	L			L	L		L		L	M	L	L
CO4	S	M	L			L	L		L		L	M	L	L
CO5	S	M	L			L	L		L		L	M	L	L
CO6	S	M	L	L		L	L		L		L	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	2	1	2	
Remember	30	10			20
Understand	40	30	70		30
Apply	30	60	30	100	50
Analyse					
Evaluate					
Create					

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject /Assignment / Practical Component
Perception	
Set	
Guided Response	30
Mechanism	70
Complex Overt Responses	
Adaptation	
Origination	

Sample Questions for Course Outcome Assessment**

** (2 to 3 at the cognitive level of course outcome)

Course Outcome 1:

1. Discuss about the sustainable Logistics strategies in detail.
2. What are the Prerequisites and infrastructures of modernized logistics and supply chain management
3. Compare Global vs Domestic supply chain and logistics system.

Course Outcome 2:

1. Explain about the various types of information systems in digital transformation of supply chain and logistics.
2. Discuss about Product Tracking & Traceability.
3. Explain about the various Block chains and Digital Payments methods.

Course Outcome 3:

1. Discuss about Warehouse design and management with analytics.
2. Design an intelligent decision tool for optimizing logistics and supply chain operations for a global e-commerce company. Describe the key features and functionalities of the tool, including how it utilizes data analytics, artificial intelligence (AI), and optimization algorithms to improve decision-making processes in various aspects of the supply chain. Additionally, discuss the potential benefits that the company can expect to achieve by implementing this intelligent decision tool, along with any challenges and considerations in its development and deployment.
3. Imagine you are a logistics manager for a transportation company responsible for scheduling vehicle routes efficiently. Describe a real-world scenario where the vehicle scheduling problem plays a crucial role in optimizing operations. Develop an algorithm

or strategy to address this scenario, considering factors such as vehicle capacity, time constraints, and cost optimization. Discuss potential challenges and limitations of your approach and propose possible solutions to overcome them.

Course Outcome 4:

1. Explain about the Product lifecycle and forecasting.
2. You are a consultant tasked with helping a retail company decide on the optimal location for opening a new store in a metropolitan area. The company wants to maximize profitability by selecting a location with high demand, low competition, and favourable demographics. Develop a location selection strategy to identify the most suitable area for opening the new store. Your strategy should consider factors such as market demand, competitive landscape, accessibility, and demographic characteristics of the target market.
3. You are a data scientist working for a retail chain that operates multiple stores across different regions. Your task is to develop a predictive analytics model to forecast demand for various products sold in these stores. The company wants to optimize inventory management, minimize stockouts, and improve customer satisfaction by ensuring that the right products are available in the right quantities at the right time.

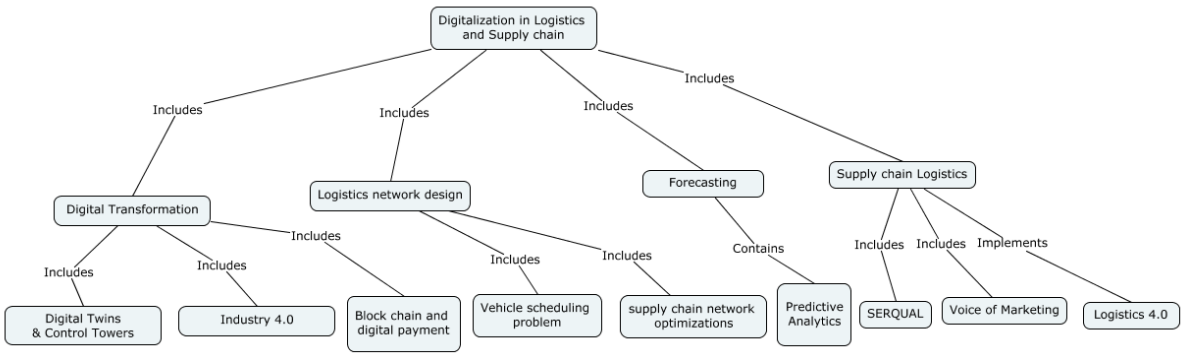
Course Outcome 5 (CO5):

1. Discuss about SERVQAL framework for digital supply chain.
2. You are a customer experience manager for a leading telecommunications company. The company is committed to providing excellent customer service and wants to assess and improve the quality of service at its call centers. Your task is to design a SERVQUAL (Service Quality) survey to measure customer perceptions and expectations regarding the service provided by the call centers.
3. You are the Head of Customer Experience for a leading online marketplace that connects buyers and sellers of various products. Your company is committed to continuously improving service quality and wants to incorporate the "Voice of the Market" (VoM) into its service design process. Your task is to develop a strategy for gathering and analyzing the VoM to inform service quality design decisions.

Course Outcome 6(CO6):

1. Discuss about Data-driven supply chain and logistics.
2. You are part of a team tasked with designing a hyperloop-based logistics system for transporting goods between major cities. The goal is to leverage the speed and efficiency of hyperloop technology to revolutionize the logistics industry and streamline supply chain operations. Your task is to develop a comprehensive plan for implementing hyperloop logistics, considering various aspects such as infrastructure design, route optimization, and operational logistics.
3. Develop a comprehensive strategic procurement plan that outlines the company's approach to sourcing raw materials and components from suppliers. Your plan should address key aspects such as supplier selection, contract negotiation, supplier relationship management, risk assessment, and performance measurement.

Concept Map



Syllabus

Introduction to Logistics and Supply chain

Fundamentals of Supply Chain Management - Supply Chain Segmentation - Supply Chain Design & Operations Strategies (Supply Portfolios, Postponement, etc.) - Logistical Strategy and Planning, Sustainable Logistics strategies - Prerequisites and infrastructures

of modernized logistics and supply chain management - Creation of responsive supply chain and logistics system - Global vs Domestic supply chain and logistics system

Digital Transformation of Supply chain and Logistics
Product Tracking & Traceability – Information Systems (ERP, WMS, TMS, etc.), Digital Twins & Control Towers – Industry 4.0 – Block chains and Digital Payments

Supply chain & logistics network design
Introduction to logistics network design - Transport mode selection and type and transport cost modelling - Warehouse design and management with analytics - Vehicle scheduling problem– Intelligent Decision Tool development in logistics and Supply chain – supply chain network optimizations.

Forecasting, facility location, and coordination
Product lifecycle and forecasting - Improving the visibility of demand - supply chain fulcrum, aggregate planning - Predictive analytics for demand, location selection – Application of AI / ML in forecasting & Demand analytics

Supply chain and logistics service quality
Designing and assuring service quality in digital supply chain - SERVQAL framework for digital supply chain - Service quality analytics for LSPs/supply chain actors - "Voice of market" and service quality design - Service quality 4.0 framework for supplier/LSP

Supply chain and logistics 4.0
Sustainable supply chain practices - Data-driven supply chain and logistics - Physical internet, Hyperloop logistics, logistics 4.0 - Framework for Carbon-neutral supply chain and logistics system

Learning Resources

Reference Books

1. Ivanov D. Supply Chain Simulation and Optimization with any Logistix, 5 th, updated edition, Berlin School of Economics and Law 2021
2. Jahn, C., Kersten, W., & Ringle, C. M. logistics 4.0 and sustainable supply chain management: innovative solutions for logistics and sustainable supply chain management in the context of industry 4.0. epubli GmbH, Berlin, www.epubli.de 2018

Online Courses

1. https://onlinecourses.nptel.ac.in/noc24_mg59/preview

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Introduction to Logistics and Supply chain**		
1.1	Fundamentals of Supply Chain Management - Supply Chain Segmentation - Supply Chain Design & Operations Strategies (Supply Portfolios, Postponement, etc.)	2	CO1
1.2	Logistical Strategy and Planning, Sustainable Logistics strategies	1	CO1
1.3	Prerequisites and infrastructures of modernized logistics and supply chain management	1	CO1
1.4	Creation of responsive supply chain and logistics system	1	CO1
1.5	Global vs Domestic supply chain and logistics system	1	CO1
2	**Digital Transformation of Supply chain and Logistics**		
2.1	Product Tracking & Traceability	1	CO2
2.2	Information Systems (ERP, WMS, TMS, etc.), Digital Twins & Control Towers	2	CO2

2.3	Industry 4.0 – Block chains and Digital Payments	1	CO2
3	**Supply chain & logistics network design**		
3.1	Introduction to logistics network design - Transport mode selection and type and transport cost modelling	2	CO3
3.2	Warehouse design and management with analytics	1	CO3
3.3	Vehicle scheduling problem	2	CO3
3.4	Intelligent Decision Tool development in logistics and Supply chain	2	CO3
3.5	supply chain network optimizations	2	CO3
4	**Forecasting, facility location, and coordination**		
4.1	Product lifecycle and forecasting - Improving the visibility of demand	1	CO4
4.2	supply chain fulcrum, aggregate planning	1	CO4
4.3	Predictive analytics for demand, location selection	2	CO4
4.4	Application of AI / ML in forecasting & Demand analytics	2	CO4
5	**Supply chain and logistics service quality**		
5.1	Designing and assuring service quality in digital supply chain	1	CO5
5.2	SERVQAL framework for digital supply chain	1	CO5
5.3	Service quality analytics for LSPs/supply chain actors	2	CO5
5.4	"Voice of market" and service quality design - Service quality 4.0 framework for supplier/LSP	2	CO5
6	**Supply chain and logistics 4.0**		
6.1	Sustainable supply chain practices	1	CO6
6.2	Data-driven supply chain and logistics	1	CO6
6.3	Physical internet, Hyperloop logistics, logistics 4.0	1	CO6
6.4	Framework for Carbon-neutral supply chain and logistics system	2	CO6
	Total	**36**	

Course Designers:

1. Mr.V.Janakiraman vjncse@tce.edu
2. Mr.T.Siva tsca@tce.edu

21CBSH1	Intelligent Supply Chain Strategies

Category	L	T	P	Credit	Terminal Exam Type
PSE	3	0	0	3	Theory

Preamble

This course helps to gain the knowledge about collect, clean, and analyze supply chain data using machine learning and business intelligence technique to improve the performance of the organizations. It provides technical understanding of analytics applied to different strategic supply chain models, focusing on optimizing efficiency, resilience, and sustainability across the entire network and how to apply AI technique to solve real-world problems.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage *** in %
CO1	Understand the fundamentals of supply chain strategies including make vs buy decisions, quality control principles, product design, and service design.	10
CO2	Comprehend the emerging trends in ML and Business Intelligence for supply chain strategies.	20
CO3	Apply Generative AI techniques to Simulate Supply Chain Planning optimization.	20
CO4	Perform route optimization by identifying the main inputs that affect the inventory level.	20
CO5	Apply machine learning algorithms to develop predictive models for supply chain resiliency and sustainability.	20
CO6	Explain ethical considerations and challenges associated with using AI and ML in supply chain management.	10

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond		1.2,2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3
CO2	TPS3	Apply	Value		1.2,2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3
CO3	TPS3	Apply	Value		1.2,2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3
CO4	TPS3	Apply	Value		1.2,2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3
CO5	TPS3	Apply	Value		1.2,2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3
CO6	TPS2	Understand	Respond		1.2,2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L			M	L			M		M	L		
CO2	S	M	L		S				S		M	L		
CO3	S	M	L		S		L		M		S	L		
CO4	S	M	L		S	M	M		L		S	L		
CO5	S	M	L		S	M	M		L		S	L		
CO6	M	L			S	L	M				S	L		

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	2	1	2	
Remember	20	20	-	-	20
Understand	30	30	40	40	30
Apply	50	50	60	60	50
Analyse	-	-	-	-	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Assessment Pattern: Psychomotor

Psychomotor Skill	Mini project /Assignment/Practical Component
Perception	-
Set	-
Guided Response	-
Mechanism	-
Complex Overt Responses	-
Adaptation	-
Origination	-

Sample Questions for Course Outcome Assessment**

** (2 to 3 at the cognitive level of course outcome)

Course Outcome 1(CO1):

1. Describe the key elements of a Six Sigma quality control program.
2. What are the four main costs associated with quality control, and how can they be balanced for optimal efficiency?
3. Describe two key elements to consider when designing a service for responsiveness and customer satisfaction.

Course Outcome 2(CO2):

1. Describe the key skills and strategies that supply chain professionals should possess to effectively manage and implement change.
2. A grocery store chain wants to optimize its pricing strategies to maximize profit margins while maintaining customer satisfaction. How can they combine ML algorithms with real-time sales data from BI dashboards to implement dynamic pricing that adjusts based on demand, product availability, and competitor pricing?
3. Explain how business intelligence dashboards can be used to visualize key supply chain metrics for improved decision-making.

Course Outcome 3(CO3):

1. What are the advantages of using Generative Adversarial Networks (GANs) over traditional simulation modelling techniques in supply chain planning?

2. Explain how anomaly detection algorithms can be used to identify potential equipment failures and prevent disruptions in the production process.
3. ACME integrated real-time sales data and market trends into the ML models, enabling them to adapt to sudden changes in demand or unexpected market events. Explain the steps to create automated alerts were set up to notify planners of potential stockouts or excess inventory situations, allowing them to make proactive adjustments like expedited shipments or product promotions.

Course Outcome 4 (CO4):

1. Discuss the factors would significantly impact inventory levels and route optimization?
2. escribe the concept of Smart Sales & Operations Planning (S&OP) and explain how AI can facilitate seamless collaboration between these functions to optimize transportation planning.
3. While traditional route planning focuses on static factors like distance, explain how AI algorithms can incorporate dynamic elements like real-time traffic congestion and weather conditions to optimize delivery routes.

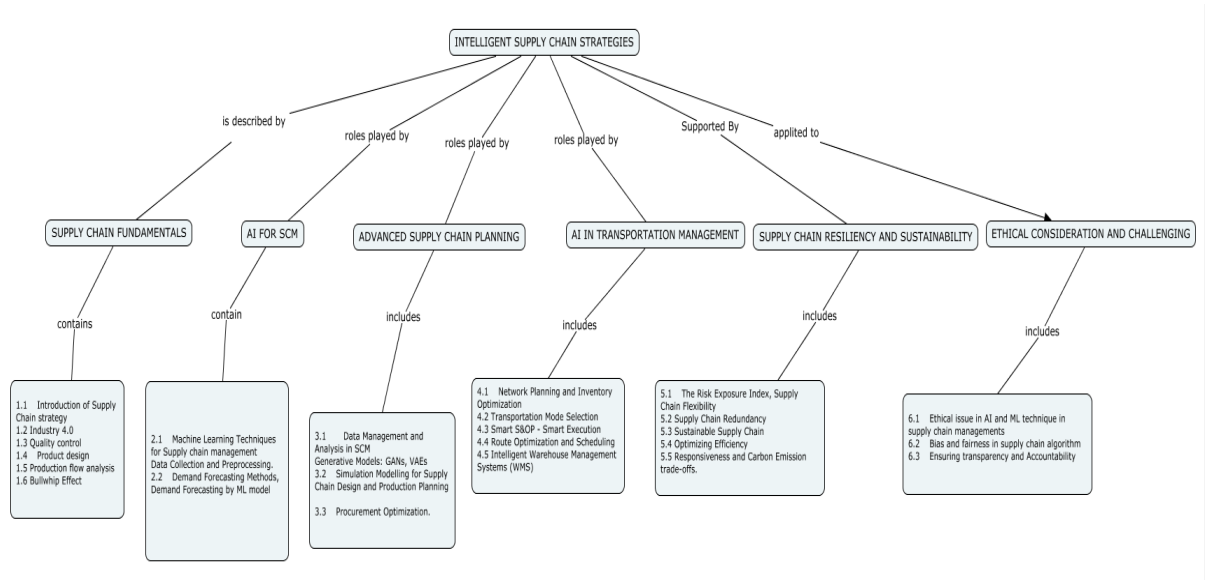
Course Outcome 5 (CO5):

1. How can supply chain redundancy, achieved through backup suppliers or production facilities, contribute to building resilience against disruptions?
2. Explain the trade-offs between responsiveness (meeting customer demands quickly) and carbon emissions in a supply chain. What strategies can be used to minimize this trade-off?
3. A clothing company is facing increasing pressure to reduce its environmental impact. Analyse how they can integrate sustainability practices into their supply chain, considering factors like sourcing materials, production processes, and transportation logistics.

Course Outcome 6(CO6):

1. While AI automates tasks and increases efficiency, how can companies ensure that human expertise and judgment are still valued and integrated within AI-driven supply chain management?
2. Discuss potential job displacement concerns associated with AI implementation in supply chains and propose strategies for workforce reskilling and transition.
3. A company utilizes an AI-powered algorithm for supplier selection based on cost and efficiency metrics. However, concerns arise about potential bias against smaller, historically disadvantaged suppliers. Analyse the ethical implications of this situation and propose strategies to ensure fair and equitable supplier selection practices.

Concept Map



Syllabus

SUPPLY CHAIN FUNDAMENTALS

Introduction - Make vs buy, linkages in supply chains - Industry 4.0 - Quality control: Cost of quality, quality reporting, six sigma, control charts - Product design - queuing system - Break even analysis - Production flow analysis - Bullwhip Effect.

AI FOR SCM

Introduction to Machine learning- Machine Learning Techniques for Supply chain management - Data Collection and Preprocessing: Strategies for collecting Supply Chain Data - Data Preprocessing Technique - Demand Forecasting by ML model.

ADVANCED SUPPLY CHAIN PLANNING

Data Management and Analysis in SCM - Generative Models: GANs, VAEs - Simulation Modelling for Supply Chain Design and Production Planning - AI powered Procurement Optimization.

AI IN TRANSPORTATION MANAGEMENT

Network Planning and Inventory Optimization -Transportation Mode Selection - Smart S&OP - Smart Execution - Route Optimization and Scheduling - Intelligent Warehouse Management Systems (WMS) - Autonomous Vehicles and Drones in Logistics.

SUPPLY CHAIN RESILIENCY AND SUSTAINABILITY

The Risk Exposure Index - Supply Chain Flexibility - Supply Chain Redundancy.
Sustainable Supply Chain - Optimizing Efficiency - Responsiveness and Carbon Emission trade-offs.

ETHICAL CONSIDERATION AND CHALLENGING

Ethical issue in AI and ML technique in supply chain managements - Bias and fairness in supply chain algorithm - Ensuring transparency and Accountability.

Learning Resources

Text Books:

1. Supply Chain Management: Strategy, Planning, And Operation 6Th Edition by Pearson 2019
2. Supply Chain Analytics September 2021 by T. A. S. Vijayaraghavan (Author) by Wiley, 2021.
3. AI-Based Transportation Planning and Operation 2021 by Keemin Sohn by Pearson 2016
4. AI and Machine Learning Impacts in Intelligent Supply Chain 2023 by Binay Kumar Pandey, Uday Kumar Kanike by IGI Global publication.

Reference Books:

1. Casella, George, and Roger L. Berger. *Statistical inference*. Cengage Learning, 2021.
2. Larose, Daniel T. Data mining and predictive analytics. John Wiley & Sons, 2015

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**SUPPLY CHAIN FUNDAMENTALS**		
1.1	Introduction of Supply Chain strategy Industry 4.0, Quality control	3	CO1
1.2	Product design, Production flow analysis Bullwhip Effect	3	CO1
2.	**AI FOR SCM**		
2.1	Machine Learning Techniques for Supply chain management, Data Collection and Preprocessing.	3	CO3
2.2	Demand Forecasting Methods, Demand Forecasting by ML model	3	CO3, CO5
3	**ADVANCED SUPPLY CHAIN PLANNING**		
3.1	Data Management and Analysis in SCM Generative Models: GANs, VAEs	3	CO3, CO4

3.2	Simulation Modelling for Supply Chain Design and Production Planning	2	CO4 CO6
3.3	Procurement Optimization.	2	
4.	**AI IN TRANSPORTATION MANAGEMENT**		
4.1	Network Planning and Inventory Optimization Transportation Mode Selection Smart S&OP - Smart Execution	3	CO4, CO6
4.2	Route Optimization and Scheduling Intelligent	2	CO4, CO6
4.3	Warehouse Management Systems (WMS)	2	
5.	**SUPPLY CHAIN RESILIENCY AND SUSTAINABILITY**		
5.1	The Risk Exposure Index, Supply Chain Flexibility, Supply Chain Redundancy Sustainable Supply Chain	3	CO6
5.2	Optimizing Efficiency, Responsiveness and Carbon Emission trade-offs.	3	CO6
6.	**ETHICAL CONSIDERATION AND CHALLENGING**		
6.1	Ethical issue in AI and ML technique in supply chain managements	2	CO5
6.2	Bias and fairness in supply chain algorithm	1	CO5
6.3	Ensuring transparency and Accountability	1	CO5
	Total Hours	**36**	

Course Designers:

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21CBRL1	BLOCKCHAIN TECHNOLOGY

Category	L	T	P	Credit	Terminal Exam Type
PEES	3	0	0	3	Theory

Preamble

This course gives knowledge about block chain technology by introducing the concept of decentralization that leads to evolution of block chain and its components. It also imparts the study of cryptographic techniques applied in blockchain networks and gives the insight of setting up new business applications in permissioned and permission less models.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Understand the concept of decentralization in evolution of Blockchain technology and its components.	15
CO2	Explain the techniques of cryptographic primitives in creation of chains of blocks.	20
CO3	Apply the suitable consensus protocols in permissioned and permission less models for adding new blocks in the chain.	20
CO4	Develop applications using Ethereum networks in permission less blockchain platforms.	15
CO5	Build applications using hyperledger fabric in permissioned blockchain platforms.	15
CO6	Construct applications on a secured basis by incorporating various anonymity preservation methods.	15

*** Weightage depends on Bloom's Level, number of contact hours

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond	-	1.1,1.2,1.3,1.4,2.1,2.2,2.3
CO2	TPS2	Understand	Respond	-	1.1,1.2,1.3,1.4,2.1,2.2,2.3, 2.4,2.5,4.1,4.2,4.3
CO3	TPS3	Apply	Value	-	1.1,1.2,1.3,1.4,2.1,2.2,2.3, 2.4,2.5,3.1,3.2,3.3,4.1,4.2, 4.3
CO4	TPS3	Apply	Value	-	1.1,1.2,1.3,1.4,2.1,2.2,2.3, 2.4,2.5,3.1,3.2,4.1,4.2,4.3, 4.4,4.5,4.6
CO5	TPS3	Apply	Value	-	1.1,1.2,1.3,1.4,2.1,2.2,2.3, 2.4,2.5,3.1,3.2,4.1,4.2,4.3, 4.4,4.5,4.6
CO6	TPS3	Apply	Value	-	1.1,1.2,1.3,1.4,2.1,2.2,2.3, 2.4,2.5,3.1,3.2,4.1,4.2,4.3, 4.4,4.5,4.6

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L			L	S	L	M		L	M	S	L	L
CO2	S	M	L		L	S	L	M		L	M	L	L	L
CO3	S	M	L		M	M	L	M	S	M	M	S	L	L
CO4	S	M	L		M	M	L	M	S	M	M	M	M	L
CO5	S	M	L		M	M	L	M	S		M	M	M	L
CO6	S	M	L		S	M	L	M			M	S	M	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	**2**	1	2	
Remember	20	20			20
Understand	20	30			30
Apply	60	50	100	100	50
Analyse					
Evaluate					
Create					

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject /Assignment/Practical Component
Perception	-
Set	-
Guided Response	-
Mechanism	-
Complex Overt Responses	-
Adaptation	-
Origination	-

Sample Questions for Course Outcome Assessment**

** (2 to 3 at the cognitive level of course outcome)

Course Outcome 1(CO1):

1. Define blockchain ? Give any two application.
2. Explain the concept of decentralization using real time case study.
3. Interpret the various attacks in blockchain networks.

Course Outcome 2(CO2):

1. Explain the SHA256 algorithm for securing the integrity and immutability of data stored in blocks.
2. What is the role of a hashpointer ?
3. Explain the working principle in construction of Merkle Tree using hashing techniques.

Course Outcome 3(CO3):

1. Apply the proof of work algorithm used to add new transactions to the blockchain networks.
2. Identify various methods in the proof of work algorithm for adding new blocks and its alternatives to proof of work.
3. Compare and contrast permissioned and permissionless models of blockchain.

Course Outcome 4 (CO4):

1. Identify the role of solidity language and EVM helps in developing and deploying smart contractsusingethereumfor digital money transfer applications.
2. Develop a simple smart contract using a solidity program.
3. Identify the key principles and technologies that differ frombitcoin with suitable examples.

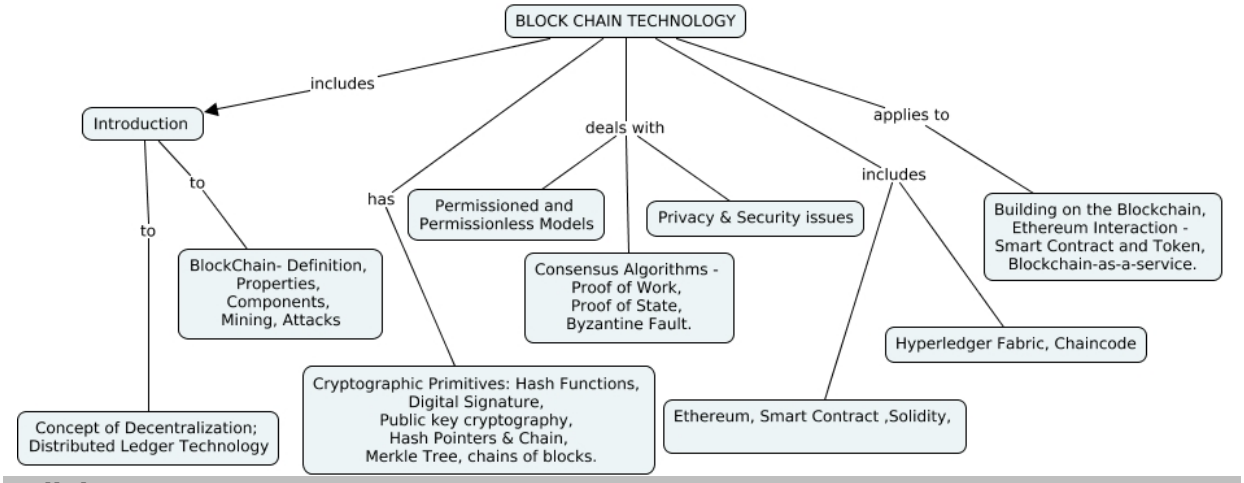
Course Outcome 5 (CO5):

1. Illustrate the industrialuse casessupported byhyperledger fabric.
2. Identify the methods of invoking chain code in hyperledger fabric in digital identity.
3. Explain the role of peers or nodes in hyperledger fabric for invoking transactions.

Course Outcome 6(CO6):

1. Differentiate between Pseudo-anonymity and. anonymity in cryptography.
2. Explain the concept of blockchain as a service with suitable examples.
3. Model an application using Zcash for building secure applications for financial transactions.

Concept Map



Syllabus

Introduction : Concept of Decentralization; Distributed Ledger Technology,BlockChain-Definition and Properties, Components, Mining, Attacks- Double Spending, 51% Attacks
Cryptographic Primitives: Hash Functions- Properties, SHA-256; Digital Signature, Public key cryptography, Hash Pointers, Hash Chain, Merkle Tree, chains of blocks.
Permissioned blockchains: Permissioned and Permissionless Models- Definitions, Comparisons.
Consensus Algorithms - Proof of Work, Proof of State, Byzantine Fault.
Ethereum: Introduction, Networks, DApps, EVM, Smart Contract ,Solidity, deploy and execute contracts.
Hyperledger Fabric: Hyperledger Architecture, Network, Transaction, Chaincode, configuring channel and chain code, Query and Invoke chaincodes. Hyperledger Caliper-Peformance Tool-Components and Features, examples.
Issues & Limitation, Use cases: Privacy, Security issues in Blockchain-Pseudo-anonymity vs. anonymity, anonymity preservation. **Usecases:** Decentralized lotteries-Blockchain-as-a-service, Project Ubin, Processing Tax Payment, Blockchain for Decentralized Marketplace

Learning Resources

Text Books

1. Imran Bashir, "Mastering Blockchain: A deep dive into distributed ledgers, consensus protocols, smart contracts, DApps, cryptocurrencies, Ethereum, and more", 3rd Edition, Packt Publishing, 2020.
2. Andreas M Antonopoulos, "Mastering Bitcoin: Unlocking Digital Cryptocurrencies", First Edition, O'Reilly, 2018.
3. A. Bahga, V. Madisetti, "Blockchain Applications: A Hands-On Approach", VPT, 2017.

Reference Books

1. Henning Diedrich, "Ethereum: Blockchains, Digital Assets, Smart Contracts, Decentralized Autonomous Organizations" WildFire Publication-2016.
2. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, "Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction", Princeton University Press, 2016

Online Courses

3. NPTEL Course on Block Chain and Applications: https://onlinecourses.nptel.ac.in/noc24_cs15

Websites

1. https://github.com/ethereum/wiki/wiki/White-Paper,
2. http://gavwood.com/paper.pdf,
3. https://docs.soliditylang.org/en/latest
4. https://www.hyperledger.org/

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Introduction**		CO1
1.1	Concept of Decentralization; Distributed Ledger Technology	1	CO1
1.2	BlockChain Definition and Properties	1	CO1
1.3	Components, Mining, Attacks	1	CO1
1.4	Double Spending, 51% Attacks	2	CO1
2.	**Cryptographic Primitives**		CO2
2.1	Hash Functions- Properties, SHA-256	2	CO2
2.2	Digital Signature, Public key cryptography	2	CO2
2.3	Hash Pointers, Hash Chain	2	CO2
2.4	Merkle Tree, chains of blocks.	1	CO2
3.	**Permissioned blockchains**		
3.1	Permissioned and Permissionless Models Definitions, Comparisons.	2	CO3
3.2	**Consensus Algorithms** - Proof of Work	2	CO3
3.3	Proof of State	2	CO3
3.4	Byzantine Fault	1	CO3
4.	**Ethereum:**		
4.1	Introduction, Networks	2	CO4
4.2	DApps, EVM, Smart Contract	2	CO4
4.3	Solidity, deploy and execute contracts.	2	CO4
5.	**Hyperledger Fabric**		
5.1	Hyperledger Architecture, Network, Transaction, Chaincode	2	CO5
5.2	configuring channel and chain code, Query and Invoke chaincodes	2	CO5
5.3	Hyperledger Caliper- Peformance Tool-Components and Features, examples.	2	CO5
6.	**Issues & Limitation, Use cases**		
6.1	Privacy, Security issues in Blockchain	1	CO6
6.2	Pseudo-anonymity vs. anonymity, anonymity preservation	1	CO6
6.3	**Usecases**: Decentralized lotteries- Blockchain-as-a-service	1	CO6
6.4	Project Ubin, Processing Tax Payment	1	CO6
6.5	Blockchain for Decentralized Marketplace	1	CO6
	TOTAL	**36**	

Course Designers:

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2. Mr.M.Venkatesh mvhca@tce.edu

21CBRM1	MOBILE CYBER PHYSICAL SYSTEM

Category	L	T	P	Credit	Terminal Exam Type
PEES	3	0	0	3	Theory

Preamble

This course describes about the basic concepts, requirements, principles and techniques in mobile cyber physical system. Examine the challenges in implementing a cyber-physical system from a computational perspective.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage *** in %
CO1	Explain the Components of CPS and need of mobile cyber physical systems over traditional CPS	10
CO2	Illustrate the CPS design recommendations and wireless technologies for mobility management	20
CO3	Compare the Behaviours of various system models such as Continuous Dynamics, Discrete dynamics and Hybrid Systems	20
CO4	Design deployment strategies for Mobile CPS application based on application requirements	20
CO5	Develop strategies for optimization and recovery to maintain reliability in CPS systems	20
CO6	Examine the use of mobile CPS in a variety of industries, such as healthcare and transportation.	10

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond	Guided Response	1.3,1.2,2.1.1,2.1.2,2.2.1, 2.5.1
CO2	TPS2	Understand	Respond	Guided Response	1.3,2.1.1,4.4.1,2.3.1,2.5.1,
CO3	TPS3	Apply	Value	Mechanism	1.3,2.1.1,2.1.2,2.5.1,4.1.2, 4.4.1,4.4.2, 4.4.3,4.5
CO4	TPS3	Apply	Value	Mechanism	1.3,2.1.1,2.1.2,2.5.1,4.1.2, 4.4.1,4.4.2, 4.4.3,4.5
CO5	TPS3	Apply	Value	Mechanism	1.3,2.1.1,2.1.2,2.5.1,4.1.2, 4.4.1,4.4.2, 4.4.3,4.5
CO6	TPS3	Apply	Value	Mechanism	1.3,2.1.1,2.1.2,2.5.1,4.1.2, 4.4.1,4.4.2, 4.4.3,4.5

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L									L	L		L
CO2	M	L									L	L		L
CO3	S	M	L								L	L		L
CO4	S	M	L		M			M	M		M	M	M	L
CO5	S	M	L		M			M	M		M	M	M	L
CO6	S	M	L		M			M	M		M	M	M	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	2	1	2	
Remember	20	20	-	-	20
Understand	40	40	30	30	20
Apply	40	40	70	70	60
Analyse	-	-	-	-	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject /Assignment/Practical Component
Perception	-
Set	-
Guided Response	20
Mechanism	80
Complex Overt Responses	-
Adaptation	-
Origination	-

Sample Questions for Course Outcome Assessment**

** (2 to 3 at the cognitive level of course outcome)

Course Outcome 1(CO1):

1.What are the main characteristics of Mobile CPS that differentiate it from traditional CPS?

2.How do CPS applications such as smart homes or smart cities integrate physical processes with computational elements?

3.What distinguishes the Industrial Internet of Things (IIoT) from traditional industrial systems?

Course Outcome 2(CO2):

1.What factors influence the selection of system requirements for a Cyber-Physical System (CPS)?

2.How does the architecture of a CPS support the seamless integration of physical processes and computational elements?

3.What are some examples of mobile sensors and actuators used in CPS applications, and how do they enhance system functionality?

4.What are the advantages of using wireless technologies in Mobile Cyber-Physical Systems (CPS)?

Course Outcome 3(CO3):

1.What are the key differences between continuous dynamics and discrete dynamics in the context of modeling systems?
2.How do timed models enable the analysis and verification of system properties related to timing, such as deadlines and response times?
3.Propose a control strategy to maintain the temperature within a specified range.
4.Design a hybrid system model that captures the interaction between the continuous dynamics of the robot's movement and the discrete events of picking and placing items.
5.Evaluate the performance of the dataflow model on different hardware platforms.

Course Outcome 4 (CO4):

1.What factors should be considered when selecting a deployment strategy for a CPS ?
2.How does middleware contribute to the scalability, flexibility, and interoperability of CPS solutions?
3.How does the integration of CPS with cloud and edge technologies impact system latency, reliability, and data processing capabilities?
4.Develop a deployment strategy outlining how you would ensure scalability and reliability while minimizing latency.
5.Develop an integration strategy for securely transferring real-time sensor data from edge devices to cloud-based analytics platforms.

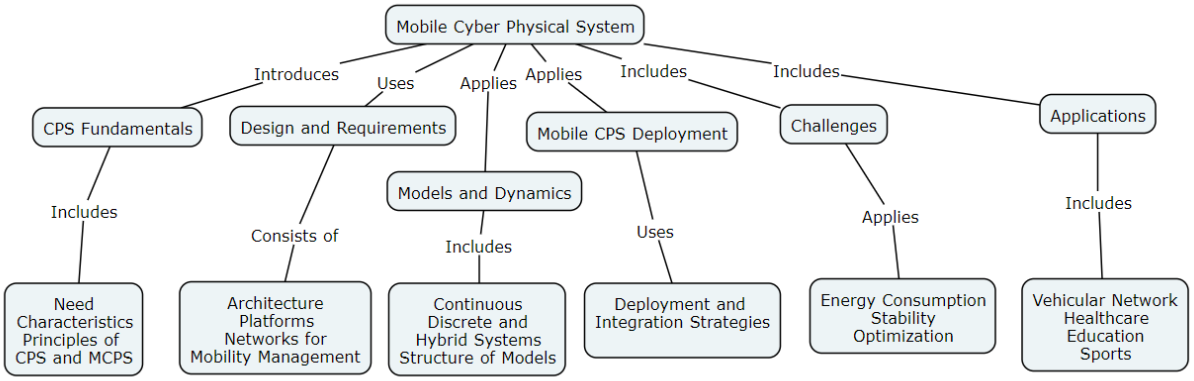
Course Outcome 5 (CO5):

1.Design a fault detection and recovery system that automatically detects and mitigates stability issues in a Mobile CPS application, minimizing the impact of faults on system performance and user experience.
2.Implement a privacy-preserving data aggregation algorithm that anonymizes and aggregates sensitive user data in a Mobile CPS system, balancing the need for data analysis with user privacy concerns.
3.Develop a scalable architecture for a Mobile CPS application that accommodates increasing numbers of devices and users while maintaining performance and reliability.

Course Outcome 6 (CO6):

1.Design a traffic management system for a smart city using vehicular network systems, considering factors such as real-time traffic data, vehicle-to-infrastructure communication, and congestion mitigation strategies.
2.Design a remote patient monitoring system using wearable devices and mobile applications, enabling healthcare professionals to monitor patients' vital signs and provide timely interventions when necessary.
3.Design a collaborative learning application that enables students to participate in virtual classrooms, engage in group discussions, and collaborate on projects using mobile devices, fostering interactive and engaging learning experiences.

Concept Map



Syllabus

Introduction to Cyber Physical Systems: Cyber Physical Systems in Real world, Basic Principles of Cyber Physical Systems, IIoT , Traditional CPS vs Mobile CPS, Need for Mobile CPS, Characteristics of Mobile CPS

Design , Requirements and Components : CPS Design Recommendations, CPS system requirements, CPS Architecture , Hardware platforms, Mobile Sensors/Actuators, Wireless Technologies for Mobile CPS, Network architecture for mobility management.

Models and Dynamics: Continuous Dynamics, Discrete dynamics, Hybrid Systems, Structure of Models: Synchronous Reactive models, Dataflow models of computation, Timed models of computation

Mobile CPS Deployment : Deployment strategies, Middleware , Integration with cloud and edge , RTOS , Realtime data processing and decision making.

Challenges in Mobile CPS : Energy Consumption , Mobile dynamic environment , System stability , Energy Harvesting and Optimization, Security and Privacy Issues, Scalability and interoperability

Mobile CPS Applications: Vehicular Network systems , Healthcare Systems, Mobile Education , Sports , Broadcasting

Learning Resources

Text Books:

1. Walid M. Taha, Abd-Elhamid M. Taha, Johan Thunberg, "Cyber-Physical Systems: A Model-Based Approach" , Springer Cham , 2020 ,
2. Y. Guo, X. Hu, B. Hu, J. Cheng, M. Zhou and R. Y. K. Kwok, "Mobile Cyber Physical Systems: Current Challenges and Future Networking Applications," IEEE Access, vol. 6, pp. 12360-12368, 2018.
3. Rajeev Alur, Principles of Cyber Physical Systems, MIT Press, 2015

References:

1. E. A. Lee, Sanjit Seshia , "Introduction to Embedded Systems – A Cyber–Physical Systems Approach", ISBN: 978-0-262-53381-2, Second Edition, MIT Press, 2017.
2. A.Platzer, Logical Foundations of Cyber Physical Systems, Springer , 2017.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Introduction to Cyber Physical Systems**	**3**	**CO1**
1.1	Cyber Physical Systems in Real world, Basic Principles of Cyber Physical Systems	1	CO1
1.2	IIoT , Traditional CPS vs Mobile CPS	1	CO1
1.3	Need for Mobile CPS, Characteristics of Mobile CPS	1	CO1
2.	**Design , Requirements and Components**	**7**	**CO2**
2.1	CPS Design Recommendations, CPS system requirements	1	CO2
2.2	CPS Architecture	1	CO2
2.3	Hardware platforms	1	CO2
2.4	Mobile Sensors/Actuators	1	CO2
2.5	Wireless Technologies for Mobile CPS	2	CO2
2.6	Network architecture for mobility management	1	CO2
3.	**Models and Dynamics Behaviours**	**8**	**CO3**
3.1	Continuous Dynamics	2	CO3
3.2	Discrete dynamics	2	CO3
3.3	Hybrid Systems	2	CO3
3.4	Structure of Models: Synchronous Reactive models	1	CO3
3.5	Dataflow models of computation , Timed models of computation	1	CO3
4.	**Mobile CPS Deployment**	**7**	**CO4**
4.1	Deployment strategies	2	CO4
4.2	Middleware	1	CO4

4.3	Integration with cloud and edge	2	CO4
4.4	RTOS	1	CO4
4.5	Realtime data processing and decision making	1	CO4
5	**Challenges in Mobile CPS**	**8**	**CO5**
5.1	Energy Consumption	1	CO5
5.2	Mobile dynamic environment	1	CO5
5.3	System stability	1	CO5
5.4	Energy Harvesting and Optimization	2	CO5
5.5	Security and Privacy Issues	2	CO5
5.6	Scalability and interoperability	1	CO5
6	**Mobile CPS Applications**	**3**	**CO6**
6.1	Vehicular Network systems	1	CO6
6.2	Healthcare Systems, Mobile Education	1	CO6
6.3	Sports , Broadcasting	1	CO6
	TOTAL	**36**	

Course Designers:

1. Mr. M.Gowtham Sethupathi mgsca@tce.edu
2. Mrs. Priya Thiagarajan ptca@tce.edu

21CBRN1	DIGITAL TWINS IN LOGISTICS

Category	L	T	P	Credit	Terminal Exam Type
PEES	3	0	0	3	Theory

Preamble

This course describes about basic building blocks for digital twins, types of twins and identifying optimal implementation strategies for logistics with simulation and also focusses on monitoring, decision-making, security and maintenance in that field.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage *** in %
CO1	Understanding of basics and significance of Digital Twins in Industrial informatics	10
CO2	Illustrate different building blocks in Digital Twins for decision making and monitoring in logistics	20
CO3	Develop solutions to the problems in various application by Identifying the appropriate Twin implementation tool and maintenance strategies	20
CO4	Compare the trends of digital twins for Inventory management, Transportation in logistics field	20
CO5	Evaluate the Risks and safety of digital twins for privacy preservation	15
CO6	Implement advanced logistics solutions by integrating twins with trending technologies such as AI and Blockchain	15

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond		1.1, 1.2, 2.2
CO2	TPS2	Understand	Respond		1.1, 1.2, 2.2
CO3	TPS3	Apply	Value		1.1, 1.2, 2.1.1, 2.3.1
CO4	TPS3	Apply	Value		1.1, 1.2, 2.1.1, 2.1.5
CO5	TPS3	Apply	Value		1.1, 1.2, 2.1.1, 2.3.1
CO6	TPS3	Apply	Value		1.1, 1.2, 2.1.1, 2.1.5

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L									L	S	M	
CO2	M	L									L	S	M	
CO3	S	M	L		S			M	M	L	L	S	M	L
CO4	S	M	L		S	M		M	M	L	L	S	M	L
CO5	S	M	L		M	M		M	M	L	L	S	L	L
CO6	S	M	L		M	M		M	M	L	L	S	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	2	1	2	
Remember	20	20	-	-	20
Understand	40	40	30	30	20
Apply	40	40	70	70	60
Analyse	-	-	-	-	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject /Assignment/Practical Component
Perception	-
Set	-
Guided Response	20
Mechanism	80
Complex Overt Responses	-
Adaptation	-
Origination	-

Sample Questions for Course Outcome Assessment**

Course Outcome 1(CO1):

1. What is a digital twin, and how does it differ from traditional modeling and simulation techniques?
2. How can digital twins improve operational efficiency, predictive maintenance, and product lifecycle management?
3. What are the potential cost savings and productivity gains associated with implementing digital twin technology?
4. How can industrial informatics help organizations make data-driven decisions and optimize their operations?

Course Outcome 2(CO2):

1. What is the role of physical sensors in data collection for logistics and supply chain management?
2. How does IoT technology enable the integration of physical sensors into a network for real-time data monitoring and collection?
3. What are the different types of digital twins used in logistics and supply chain management?
4. How does the digital thread enable the seamless flow of data and information across the entire supply chain
5. Why is data integration from various sources important for effective decision-making in logistics?

Course Outcome 3(CO3):

1. How do communication frameworks facilitate data exchange between physical assets and their digital twins?
2. Can you explain how modeling and simulation help in identifying bottlenecks and improving efficiency in logistics operations?
3. Identify key challenges in implementing digital twins for logistics operations, such as data integration issues, model accuracy, and scalability limitations

4.Design a scalable communication architecture for synchronizing multiple digital twins across different locations

Course Outcome 4 (CO4):

1.How do digital twins facilitate the virtual representation of physical assets and processes in manufacturing?
2.How does effective inventory management contribute to minimizing costs and maximizing customer satisfaction?
3.Implement a real-time monitoring system using digital twins for tracking the movement of goods in transit, enabling proactive interventions to address delays, reroute shipments.
4.Design a dynamic control strategy for warehouse operations using digital twins, adjusting inventory allocation.

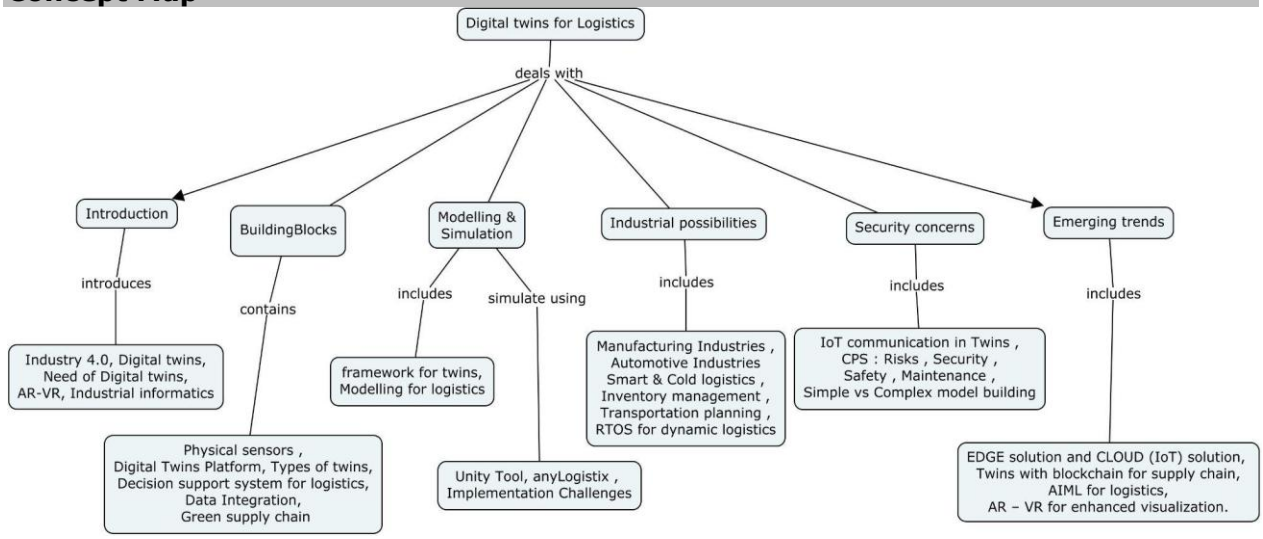
Course Outcome 5 (CO5):

1.What communication protocols are commonly used in IoT systems integrated with digital twins?
2.What are the different types of IoT systems commonly used in various industries?
3.Identify potential cybersecurity risks in a smart grid cyber-physical system and propose mitigation strategies to safeguard critical infrastructure components
4.Compare and contrast the benefits and limitations of building simple versus complex digital twin models for predictive maintenance in industrial equipment

Course Outcome 6 (CO6):

1.What are the advantages and limitations of deploying IoT applications on the Edge versus the Cloud?
2.Develop a smart contract mechanism using blockchain for automating transactions and agreements between stakeholders in a supply chain
3.Develop an edge computing solution for real-time monitoring of environmental sensors in a smart city infrastructure
4.How does Blockchain technology enhance transparency and traceability in supply chain operations when integrated with Digital Twins?

Concept Map



Syllabus

Introduction to Digital Twins:

Introduction to Innovation, Technology Adoption, Industry 4.0, Digital twins: Uses and advantages , Need of Digital twins , AR-VR, Industrial informatics.

Building Blocks:
Physical sensors and IoT for Data Collection , Digital Twins Platform, Ecosystem and Business Context, Types of twins , Digital thread , Decision support system for logistics, Data Integration from various sources , Green supply chain

Modelling and simulation:
Communication framework for twins, Modelling and Simulation for logistics , Building twins: Unity Tool , anyLogistix , Digital twins Implementation Challenges

Industrial possibilities:
Digital Twins in Manufacturing Industries , Automotive Industries – Smart & Cold logistics , Inventory management , Transportation planning , Realtime monitoring and control strategies for dynamic logistics,

Security concerns: Various IoT systems , IoT communication in Twins , Cyber physical systems : Risks , Security , Safety , Maintenance , Simple vs Complex model building.

Emerging trends:
Why and when implement an EDGE solution and CLOUD (IoT) solution, Digital Twins with blockchain for supply chain, AIML for predictive analysis of logistics, AR – VR for enhanced visualization.

Learning Resources

Text Books:

1. Manisha Vohra , "Digital Twin Technology: Fundamentals and Applications", ISBN:9781119842200, Wiley Scrivener Publishing LLC , 2022
2. Kavita saini, Pethuru raj, "Digital Twins: The Industry 4.0 Use Cases: The Technologies, Tools, Platforms and Applications" , Nova publication , 2023
3. Vijay raghunathan, santhanu deb barma, "Digital Twin: A Complete Guide For The Complete Beginner" , Amazon kindle edition , 2021

References:

1. https://www.coursera.org/learn/digital-twins#modules
2. https://www.udemy.com/course/digital-twin-a-comprehensive-overview
3. Ivanov, Dmitry., Supply chain simulation and optimization with anyLogistix , anyLogistix.com, 2021

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Introduction to Digital Twins**	**3**	**CO1**
1.1	Introduction to Innovation, Technology Adoption, Industry 4.0	1	CO1
1.2	Digital twins: Uses and advantages, Need of Digital twins	1	CO1
1.3	AR - VR , Industrial informatics	1	CO1
2.	**Building Blocks**	**7**	**CO2**
2.1	Physical sensors and IoT for Data Collection	1	CO2
2.2	Digital Twins Platform	1	CO2
2.3	Ecosystem and Business Context	1	CO2
2.4	Types of twins , Digital thread	1	CO2
2.5	Decision support system for logistics	1	CO2
2.6	Data Integration from various sources	1	CO2
2.7	Green Supply chain	1	CO2
3.	**Modelling and simulation**	**8**	**CO3**
3.1	Communication framework for twins	1	CO3

3.2	Modelling and Simulation for logistics	2	CO3
3.3	Building twins: Unity Tool	2	CO3
3.4	Building twins: anyLogistix	2	CO3
3.5	Digital twins Implementation Challenges	1	CO3
4.	**Industrial possibilities**	**7**	**CO4**
4.1	Twins in Manufacturing Industries	2	CO4
4.2	Twins in Automotive Industries	1	CO4
4.3	Twins in Inventory management	2	CO4
4.4	Twins in Transportation planning	1	CO4
4.5	Realtime monitoring and control strategies for dynamic logistics	1	CO4
5	**Security concerns**	**7**	**CO5**
5.1	Various IoT systems	1	CO5
5.2	IoT communication in Twins	1	CO5
5.3	CPS : Risks , Security	2	CO5
5.4	CPS: Safety , Maintenance	2	CO5
5.5	Simple vs Complex model building	1	CO5
6	**Emerging trends**	**4**	**CO6**
6.1	Why and when implement an EDGE solution and CLOUD (IoT) solution	1	CO6
6.2	Digital Twins with blockchain for supply chain	1	CO6
6.3	AIML for predictive analysis of logistics	1	CO6
6.4	AR – VR for enhanced visualization	1	CO6
	TOTAL	**36**	

Course Designers:

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21CBRP1	Graph Algorithms and Complexity Theory

CATEGORY	L	T	P	CREDIT	TERMINAL EXAM TYPE
PEES	3	0	0	3	Theory

Preamble

This course enables the students to understand and use the algorithms for real world problems that can be modelled by graph data structures. The complexities of the algorithms are analyzed and construct the reductions to prove the NP-hardness.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage *** in %
CO1	Understand the mathematical foundations of graph theory and their applications in analyzing graph structures	10
CO2	Apply network flow algorithms to model and optimize flow in various real world network scenarios	20
CO3	Examine matching theorem to solve matching problems of graph theory	15
CO4	Explain the fundamentals of complexity class theory, P Vs NP class, NP completeness and their implications in computational complexity	10
CO5	Compute the time and space complexity for different computational algorithms	25
CO6	Solve computational problems using complexity reduction techniques	20

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond		1.1,1.2,1.3,2.1.1
CO2	TPS3	Apply	Value		1.1,1.2,1.3,2.1,2.2,4.1,4.2.1,4.3.1,4.3.2, 4.3.3,4.4
CO3	TPS3	Apply	Value		1.1,1.2,1.3,2.1,2.2,4.1,4.2.1,4.3.1,4.3.2, 4.3.3,4.4
CO4	TPS2	Understand	Respond		1.1,1.2,1.3,2.1.1
CO5	TPS3	Apply	Value		1.1,1.2,1.3,2.1,2.2.1,4.1,4.3.1
CO6	TPS3	Apply	Value		1.1,1.2,1.3,2.1,2.2,4.1,4.2.1,4.3.1,4.3.2, 4.3.3,4.4

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L			L							L	L	
CO2	S	M	L		L	L						M	L	L
CO3	S	M	L		L							M	L	
CO4	M	L			L	L						L	L	L
CO5	S	M	L		L	L						M	L	L
CO6	S	M	L		L	L						M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	**Continuous Assessment Tests**		**Assignment**		**Terminal Examination**
	1	**2**	**1**	**2**	
Remember	30	30			20
Understand	30	30			40
Apply	40	40	100	100	40
Analyse					
Evaluate					
Create					

Assessment Pattern: Psychomotor

Psychomotor Skill	**Miniproject /Assignment/Practical Component**
Perception	
Set	
Guided Response	
Mechanism	
Complex Overt Responses	
Adaptation	
Origination	

Sample Questions for Course Outcome Assessment**

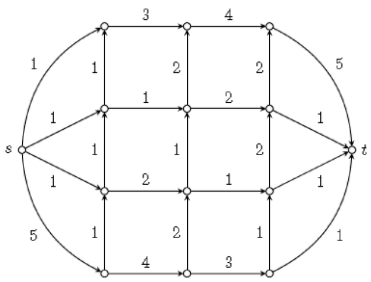
** (2 to 3 at the cognitive level of course outcome)

Course Outcome 1(CO1):

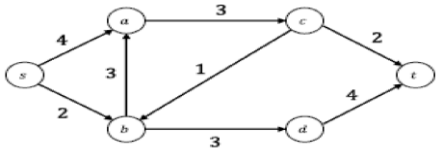
1. State the Adjacency matrix for a graph and mention the properties of the Laplacian Matrix
2. What is meant by Fiedler vector in Algebraic Connectivity and describe its Monotonicity properties?
3. Explain the Friendship theorem in a regular graph.

Course Outcome 2(CO2):

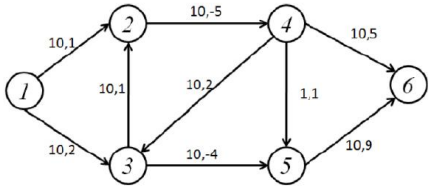
1. In the network below capacities are indicated by numbers next to the edges. Compute a maximum flow in this network, state its value, and find a minimum cut, the edges across this cut, and state the cut's capacity.



2. Determine the maximum network flow problem from the source vertex (s) to the sink vertex (t) using Ford Fulkerson algorithm



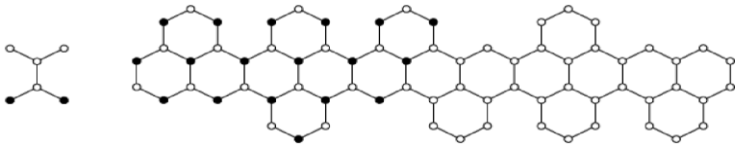
3. Apply the minimum cost flow algorithm for the given graph with minimum flow cost as a function of flow value v=15



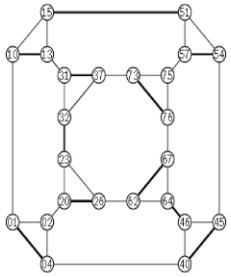
Course Outcome 3(CO3):

1. For both of the connected bipartite graphs below, find either a perfect matching or a set S

of vertices such that |S| > |N(S)| as in Hall's theorem. Both graphs are bipartite. Let S be the set of vertices marked in black. Then in the left graph we have |S| = 2 and |N(S)| = 1, and in the right graph |S| = 18 and |N(S)| = 17. So by Hall's theorem neither graph has a perfect matching.



2. Bold lines in the figure below mark a matching in this graph. Execute Edmonds' Algorithm starting from that matching.



3. Prove the Konig-Egervary theorem: in any bipartite graph, the size of the maximum matching equals the size of the minimum vertex cover.

Course Outcome 4 (CO4):

1. Differentiate the complexity classes N and NP.

2. SAT is known to be NP-complete. The instances of SAT are propositional formulas in conjunctive normal form (CNF). Consider the variant DNF-SAT where the instances are propositional formulas in disjunctive normal form (DNF). Is DNF-SAT also NP complete, or solvable in (deterministic) polynomial time?

3. Explain the Polynomial-time many-one reductions with the proof to reflexivity, transitivity and complement

4. Give an instance of 3SAT that is not satisfiable.

Course Outcome 5 (CO5):

1. Consider the following two decision problems:

- Reach – the problem of deciding, given a directed graph G and two vertices a and b in G, whether there is a path in G from a to b.
- UReach – the problem of deciding, given an undirected graph G and two vertices a and b in G, whether there is a path in G from a to b.

It is known that Reach is NL-complete (under logarithmic-space reductions) and that UReach is in the complexity class L.

(a) Based on the above information, for each of the following statements, state whether it is true, false, or unknown. In each case, give justification for your answer and in the case where the truth of the statement is unknown, state any implications that might follow from it being true or false.

(i) Reach ≤L UReach, i.e. Reach is reducible in logarithmic-space toUReach

(ii) UReach ≤L Reach.

(iii) UReach is in P.

(iv) If Reach is in L, then P=NP.

(b) Let us say that a nondeterministic Turing machine M is symmetric if for any two configurations c1 and c2 of M, if c1 →M c2, then c2 →M c1. We write SL for the class of all languages that are accepted by a symmetric Turing machine using O(log n) work space on inputs of length n.

By considering the configuration graph of a machine and using the fact that UReach is in L, explain why it follows that SL⊆L.

2. Let f : N → N be a constructible function.

(a) Explain why NTime(f) ⊆ Space(f)

(b) Explain why any language L ∈NSpace(f) is also in Time(c (f(n)+log n))) for some constant c.

(c) A deterministic machine is a special case of a non-deterministic machine. Expain what this and the results above tell us about the inclusions among the following complexity classes: L, NL, P, NP, PSpace, NPspace.

(d) Savitch proved that there is an algorithm for the graph reachability problem that uses O((log n) 2) space.

What further inclusions can you derive among the above complexity classes using this fact?

3. Let Σ = {0, 1}. Prove that ∅ and {0, 1} ∗ are the only languages in P which are not complete for P with respect to polynomial-time reductions.

Course Outcome 6(CO6):

1. The HAMP AT H problem determines whether in a directed graph G, there is a directed path from node s to node t that goes through each node exactly once. HAMP AT H = {(G, s, t) | G is a directed graph with a Hamiltonian path from s to t}.

HAMP AT H ∈ NP. We can write a NTM M that decides HAMP AT H as follows: M = "On input (G, s, t) where G is a directed graph with nodes s and t:

1. Nondeterministically guess a list of n nodes, a1, ..., an where n is the number of nodes in G Graph.

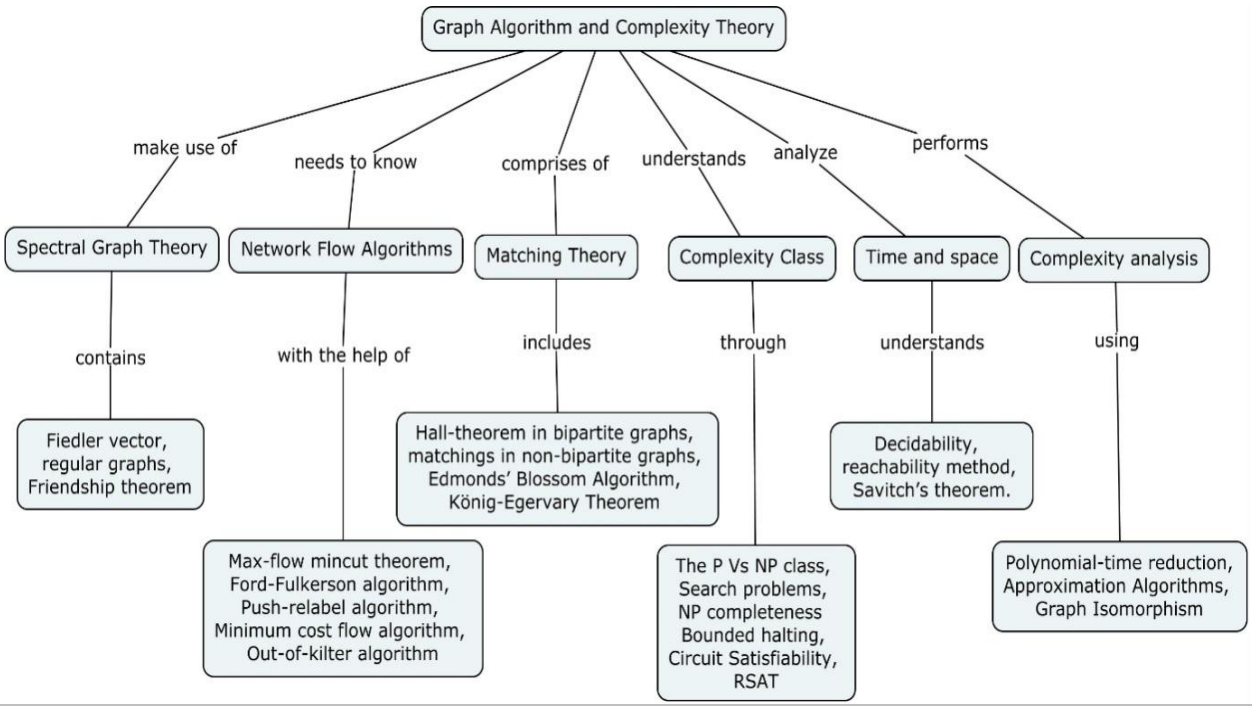
2. Check for repetitions in the list. If any repetitions are found, reject.
3. Check whether s = a1 and t = an. If either fail, reject.
4. For each i between 1 and n − 1, check whether (ai , ai+1) is an edge of G. If any are not, reject. Otherwise, accept.

We can see that when there is a Hamiltonian path from s to t, then M is guaranteed to accept because no nodes are gone through more than once. If there is not a Hamiltonian path from s to t, then M is guaranteed to reject because there will be overlapping nodes and check whether the algorithm runs in nondeterministic polynomial time.

2. The Graph Isomorphism problem is the problem of deciding, given two graphs G1 = (V1, E1) and G2 = (V2, E2), whether there is a bijection β : V1 → V2 such that (u, v) (E1 if, and only if, (β(u), β(v))) E2, for all u, v belongs V1. The Graph Isomorphism problem is not known to be in P nor known to be NP-complete. We define GI to be the set of all languages L which are polynomial-time reducible to Graph Isomorphism. What can you conclude from the above definitions and information about the truth of the following statements? If the statement is true or false, justify your answer and if you cannot conclude anything about its truth, explain why that is so.

(a) Graph Isomorphism is in NP.
(b) Graph Isomorphism is in co-NP.
(c) GI ⊆ NP.
(d) NP ⊆ GI.
(e) P ⊆GI.
(f) GI ⊆ P.

Concept Map



Syllabus

Spectral Graph Theory: Adjacency matrix, Laplacian Matrix, Algebraic Connectivity, Fiedler vector, Algebra of regular graphs, Strongly regular graphs and Friendship theorem.

Network Flow Algorithms: Basic concepts on network flow, Max-flow mincut theorem, Ford-Fulkerson algorithm, Push-relabel algorithm, Minimum cost flow algorithm, Out-of-kilter algorithm

Matching Theory: Hall-theorem for matchings in bipartite graphs, matchings in non-bipartite graphs, stable matchings, Edmonds' Blossom Algorithm, König-Egervary Theorem

Complexity Class: The P Vs NP class, Search problems, NP completeness and self reducibility – Bounded halting, Circuit Satisfiability and RSAT

Time and space: Models of computation and measures of complexity, Decidability, Time complexity classes, Deterministic and non-deterministic space complexity classes, reachability method, Savitch's theorem.

Complexity analysis: Complexity notations, Polynomial-time reduction, Approximation Algorithms, Graph Isomorphism, Counting number of spanning trees v/s counting number of perfect matchings.

Learning Resources

Text Books:

1. Hubie Chen, Computability and Complexity, The MIT Press, 2023
2. Karin R. Saoub,"Graph Theory An Introduction to Proofs, Algorithms, and Applications", First edition published,CRC Press, 2021
3. D. B. West:," Introduction to Graph Theory", Pearson Education: India : 2015.

References Books:

1. R.B. Bapat," Graphs and matrices",Springer London, 2010
2. Goldreich, O., "P, NP, and NP-Completeness: the basics of computational complexity", Cambridge University Press, 2010.
3. Alan Gibbons," Algorithmic Graph Theory", Cambridge University Press, 1985

Online Course:

1. https://onlinecourses.swayam2.ac.in/cec23_ma01/preview
2. https://onlinecourses.nptel.ac.in/noc24_cs05/preview
3. https://www.cl.cam.ac.uk/teaching/2021/Complexity/materials.html

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Spectral Graph Theory:**		
1.1	Adjacency matrix, Laplacian Matrix,	1	CO1
1.2	Algebraic Connectivity, Fiedler vector,	1	CO1
1.3	Algebra of regular graphs, Strongly regular graphs	1	CO1
1.4	Friendship theorem	1	CO1
2.	**Network Flow Algorithms:**		
2.1	Basic concepts on network flow	1	CO2
2.2	Max-flow mincut theorem	1	CO2
2.3	Ford-Fulkerson algorithm,	1	CO2
2.4	Push-relabel algorithm,	1	CO2
2.5	Minimum cost flow algorithm,	1	CO2
2.6	Out-of-kilter algorithm	1	CO2
3.	**Matching Theory:**		
3.1	Hall-theorem for matchings in bipartite graphs,	1	CO3
3.2	matchings in non-bipartite graphs,	1	CO3
3.3	stable matchings	1	CO3
3.4	Edmonds' Blossom Algorithm	1	CO3

3.5	König-Egervary Theorem	1	CO3
4	**Complexity Class:**		
4.1	The P Vs NP class	1	CO4
4.2	Search problems	1	CO4
4.3	NP completeness	1	CO4
4.4	self reducibility – Bounded halting	1	CO4
4.5	Circuit Satisfiability and RSAT	1	CO4
5	**Time and space:**		
5.1	Models of computation and measures of complexity.	2	CO5
5.2	Decidability	1	CO5
5.3	Time complexity classes.	2	CO5
5.4	Deterministic and non-deterministic space complexity classes.	2	CO5
5.5	Reachability method	1	CO5
5.6	Savitch's theorem	1	CO5
6	**Complexity analysis:**		
6.1	Complexity notations	2	CO6
6.2	Polynomial-time reduction	1	CO6
6.3	Approximation Algorithms	2	CO6
6.4	Graph Isomorphism	1	CO6
6.5	Counting number of spanning trees v/s counting number of perfect matchings	1	CO6
	Total Hours	**36**	

Course Designers:

1. Dr. J. Felicia Lilian jflcse@tce.edu
2. Mrs. Yuvasini. D dyica@tce.edu

21CBRQ1	REINFORCEMENT LEARNING

CATEGORY	L	T	P	CREDIT	TERMINAL EXAM TYPE
PEES	3	0	0	3	Theory

Preamble

The course will enable the students to develop a computer agent that learns and performs a specific task through repeated trial and error method in a dynamic environment. This also enables them to make decisions that are sequential or discrete by analysing the behavioural patterns for any real world applications.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Construct a RL framework by using MDPs to solve real world problems	15
CO2	Utilize the concepts of dynamic programming to model an agent that can take discrete actions	15
CO3	Apply the model free prediction and control algorithms to estimate the value function of an unknown MDP	20
CO4	Compute the intermediate rewards by analysing the behaviour patterns using temporal difference learning algorithms	15
CO5	Identify the value function to be stable and reliable using function approximation algorithms for problems with large state - action space	20
CO6	Construct solutions for large dimensional data using deep RL and hierarchical RL	1

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psycho motor	
CO1	TPS3	Apply	Value		1.1,1.2,1.3,2.1,2.2.1,4.1,4.3.1
CO2	TPS3	Apply	Value		1.1,1.2,1.3,2.1,2.2.1,4.1,4.3.1
CO3	TPS3	Apply	Value		1.1,1.2,1.3,2.1,2.2,4.1,4.2.1,4.3.1,4.3.2, 4.3.3,4.4
CO4	TPS3	Apply	Value		1.1,1.2,1.3,2.1,2.2,4.1,4.2.1,4.3.1,4.3.2, 4.3.3,4.4
CO5	TPS3	Apply	Value		1.1,1.2,1.3,2.1,2.2.1,4.1,4.3.1
CO6	TPS3	Apply	Value		1.1,1.2,1.3,2.1,2.2,4.1,4.2.1,4.3.1,4.3.2, 4.3.3,4.4

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	S	M	L		L	L				L		M	L	L
CO2	S	M	L		L	L				L		M	L	L
CO3	S	M	L		M	L				L		M	L	L
CO4	S	M	L		M	L				L		M	L	L
CO5	S	M	L		M	L				L		M	L	L
CO6	S	M	L		M	L				L		M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	2	1	2	
Remember	20	20			20
Understand	30	30			30
Apply	50	50	100	100	50
Analyse					
Evaluate					
Create					

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject /Assignment/Practical Component
Perception	
Set	
Guided Response	
Mechanism	
Complex Overt Responses	
Adaptation	
Origination	

Sample Questions for Course Outcome Assessment**

** (2 to 3 at the cognitive level of course outcome)

Course Outcome 1(CO1):

1. Consider a 4×4 Grid-world problem where the goal is to reach either the top-left corner or the bottom-right corner (refer to Table 1). The agent can choose from four actions hup, down, left, righti which deterministically cause the corresponding state transitions, except that actions that would take the agent off the grid leave the state unchanged. We model this as an undiscounted, episodic task, where the reward is −1 for all transitions. Suppose that the agent follows the equiprobable random policy, π. (Hint: The Bellman equation must hold for every state.)

Table 1: 4 × 4 Grid-world

0		-20	-22
-14	-18	-20	
	-20	-18	-14
-22	-20		0

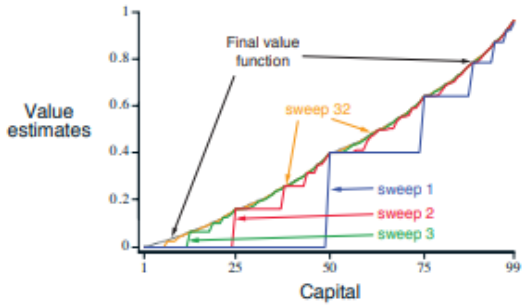
What are the respective values of qπ(s1, down) and qπ(s2, down) given that s1 is the last

cell in the third row (value is −14) and s2 is the last cell in the second row?

2. Consider a finite, episodic and undiscounted Markov Decision Process (MDP) with states P and Q apart from the terminal state. Let the following two samples are observed when a Monte-Carlo (MC) evaluation is being carried out. • (P, +3) → (P, +2) → (Q, −4) → (P, +4) → (Q, −3) • (Q, −2) → (P, +3) → (Q, −3) For example, a sample such as, (Q, −2) → (P, +3) → (Q, −3), means that the episode starts at Q then goes to P again, , then goes to Q and then terminates. On the way, the agent gets rewards of −2, +3 and −3, respectively. Construct a Markov model that best explains the observations given in the question
3. What would be the value function estimate of P and Q (call it as v(P) and v(Q), respectively) if batch TD(0) (Temporal Difference learning) were applied to the above transaction data?

Course Outcome 2(CO2):

1. A gambler has the opportunity to make bets on the outcomes of a sequence of coin flips. If the coin comes up heads, he wins as many dollars as he has staked on that flip; if it is tails, he loses his stake. The game ends when the gambler wins by reaching his goal of $100, or loses by running out of money. On each flip, the gambler must decide what portion of his capital to stake, in integer numbers of dollars.



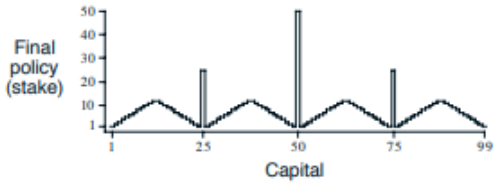
Why does the optimal policy for the gambler's problem have such a curious form? In particular, for capital of 50 it bets it all on one flip, but for capital of 51 it does not. Why is this a good policy?

2. What is the analog of the value iteration update

$$v_{k+1}(s) \doteq \max_a \mathbb{E}[R_{t+1} + \gamma v_k(S_{t+1}) \mid S_t = s, A_t = a]$$
$$= \max_a \sum_{s',r} p(s', r \mid s, a)\left[r + \gamma v_k(s')\right],$$

for action values, qk+1(s, a)?

3. Implement value iteration for the gambler's problem and solve it for ph = 0.25 and ph = 0.55. In programming, you may find it convenient to introduce two dummy states corresponding to termination with capital of 0 and 100, giving them values of 0 and 1 respectively. Show your results graphically, as in Figure below. Are your results stable as ✓ ! 0?



Course Outcome 3(CO3):

1. The agent starts with the policy that always chooses to go right, and executes the following three trials: 1) (1,1)–(1,2)–(1,3), 2) (1,1)–(1,2)–(2,2)–(2,3), and 3) (1,1)–(2,1)–(2,2)–(2,3). What are the monte carlo (direct utility) estimates for states (1,1) and (2,2), given these traces?
2. Using a learning rate of .1 and assuming initial values of 0, what updates does the TD-learning agent make after trials 1 and 2, above?
3. Question 3

Course Outcome 4 (CO4):

1. Describe the Temporal Difference method that combines the Monte Carlo and TD traces.
2. Which TD learning approach (Q-Learning or SARSA) will you prefer if your objective is to train an optimal agent in simulation or in a low-cost and quick-iterating environment?
3. For Q-learning to converge we need to correctly manage the exploration vs. exploitation tradeoff. What property needs to be hold for the exploration strategy?

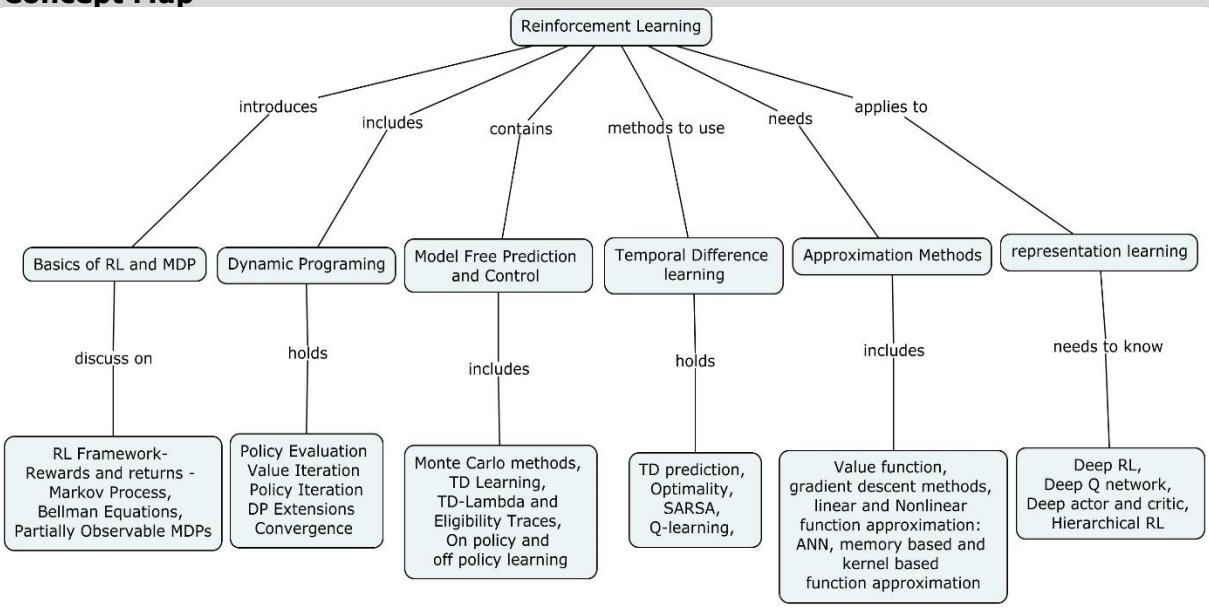
Course Outcome 5 (CO5):

1. "Role of Gradient descent methods in function approximation" – Justify this statement using suitable real time examples.
2. Explain the value prediction and value control methods in function approximation
3. What properties assure convergence of the linear TD(0) algorithm?

Course Outcome 6(CO6):

1. Deep Q-Network (DQN) is a seminal algorithm in Deep Reinforcement Learning (DRL) that combines Q-learning with deep neural networks to approximate the Q-value function. Construct the training process with the agent and environment for MSE loss convergence.
2. Model all available actions and the sub tasks for a chess game using options and decomposition methods in Hierarchical RL.?

Concept Map



Syllabus

Basics of RL and MDP - RL Framework- Rewards and returns - Markov Process, Markov Reward Process, Markov Decision Process and Bellman Equations, Partially Observable MDPs
Dynamic Programing - Policy Evaluation, Value Iteration, Policy Iteration, DP Extensions and Convergence using Contraction Mapping
Model Free Prediction and Control - Overview of Monte Carlo methods for model free RL, Monte Carlo control, Temporal-Difference (TD) Learning, TD-Lambda and Eligibility Traces, On policy and off policy learning
Temporal Difference learning: TD prediction, Optimality of TD, SARSA, Q-learning, Case studies on Q-learning for healthcare.
Approximation Methods - Value function, gradient descent methods, linear methods approximation, Nonlinear function approximation: ANN based function approximation, memory based and kernel based function approximation
Representation Learning - Deep RL, Deep Q network, Deep actor and critic, Hierarchical RL case study on games.

Learning Resources

1. Richard S. Sutton and Andrew G. Barto; Reinforcement Learning: An Introduction; 2nd Edition, MIT Press, 2020
2. Dimitri P. Bertsekas; Reinforcement Learning and Optimal Control; 1st Edition, Athena Scientific, 2019.
3. Tom M Mitchell, "Machine Learning", McGraw-Hill, Indian Edition, 2017.
4. Csaba Szepesvári; Algorithms of Reinforcement Learning; Synthesis Lectures on Artificial Intelligence and Machine Learning, vol. 4, no. 1, 2010.
5. https://onlinecourses.nptel.ac.in/noc20_cs74/preview - Reinforcement learning by Prof. Balaraman Ravindran, IIT Madras
6. Andrew G. Barto and Sridhar Mahadevan; Recent Advances in Hierarchical Reinforcement Learning; Discrete Event Dynamic Systems, vol. 13, pp. 341–379, 2003.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Basics of RL and MDP**		
1.1	RL Framework- Rewards and returns	1	CO1
1.2	Markov Process, Markov Reward Process, Markov Decision Process	2	CO1
1.3	Bellman Equations	2	CO1
1.4	Partially Observable MDPs	1	CO1
2	**Dynamic Programing**		
2.1	Policy Evaluation,	1	CO2
2.2	Value Iteration, Policy Iteration,	2	CO2
2.3	DP Extensions	2	CO2
2.4	Convergence using Contraction Mapping	2	CO2
3	**Model Free Prediction and Control**		
3.1	Overview of Monte Carlo methods for model free RL,	1	CO3
3.2	Monte Carlo control,	1	CO3
3.3	Temporal-Difference (TD) Learning,	1	CO3
3.4	TD-Lambda and Eligibility Traces	1	CO3
3.5	On policy and off policy learning	2	CO3

4	**Temporal Difference learning**		
4.1	TD prediction	1	CO4
4.2	Optimality of TD, SARSA,	2	CO4
4.3	Q-learning,	1	CO4
4.4	Case studies on Q-learning for healthcare	2	CO4
5	**Approximation Methods**		
5.1	Value function, gradient descent methods	1	CO5
5.2	Linear methods approximation	1	CO5
5.3	Nonlinear function approximation: ANN based function approximation	2	CO5
5.4	Memory based & kernel based function approximation	2	CO5
6	**Representation Learning**		
6.1	Deep RL, Deep Q network	2	CO6
6.2	Deep actor and critic	1	CO6
6.3	Hierarchical RL case study on games	2	CO6
	TOTAL	36	

Course Designers:

1. Dr. A. Malini amcse@tce.edu
2. Dr. J. Felicia Lilian jflcse@tce.edu

21CBQD1	Human Resource Analytics

Category	L	T	P	Credit	Terminal Exam Type
PSE	3	0	0	3	Theory

Preamble

This course aims to provide knowledge on various human resource analytics frameworks and its applications. It will equip students with knowledge on the significance of the alignment between human resource processes and organizational processes. The students acquire familiarity with various human resource metrics and the preparation of human resource scorecard. Students will apply the analytical approaches for identifying the business contributions of the HR function in organizations.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Explain the various human resource analytics frameworks such as LAMP and HCM21.	15
CO2	Apply the human resource process and organization process for real world business scenarios.	15
CO3	Examine the various human resource metrics to improve employer-employee relationship, employee retention and design/implement human resource scorecard.	20
CO4	Apply the descriptive approaches to improve organizational performance by providing better insights on human resources data such as HR Dashboards and KPI Catalogue Creation, etc.	15
CO5	Apply the analytical approaches to predict the future performance and impact of people data on organization/business performance.	15
CO6	Identify the effectiveness of human resource practices by applying qualitative and quantitative (statistical) evaluative techniques.	20

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO#	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond		1.1,4.1
CO2	TPS3	Apply	Value		1.1,2.5,3.1,4.2
CO3	TPS3	Apply	Value		2.5,3.1,4.1,4.2
CO4	TPS3	Apply	Value		1.1,4.2
CO5	TPS3	Apply	Value		2.5,3.1,4.1,4.2
CO6	TPS3	Apply	Value		2.5,3.1,4.1,4.2

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L			M						L	S	L	L
CO2	S	M	L								L	L	L	L
CO3	S	M	L		M						M	S	L	L
CO4	S	M	L		M			M	M		M	M	M	L
CO5	S	M	L		M			M	M		M	M	M	L
CO6	S	M	L		M		L	M	M		M	S	M	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	2	1	2	
Remember	20	20	-	-	20
Understand	30	30	40	40	30
Apply	50	50	60	60	50
Analyse	-	-	-	-	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject /Assignment/Practical Component
Perception	-
Set	-
Guided Response	-
Mechanism	-
Complex Overt Responses	-
Adaptation	-
Origination	-

Sample Questions for Course Outcome Assessment**

** (2 to 3 at the cognitive level of course outcome)

Course Outcome 1(CO1):

1. Describe the need of HR Analytics.
2. Explain the concepts of HCM 21 framework with suitable example.
3. Explain the five overreaching components of an effective HR analytics framework using LAMP.

Course Outcome 2(CO2):

1. How will you link the HR process and the organizational process?
2. Do you think that if one employee leaves a small startup? It has an impact on the whole organization.
3. Suppose you are working as an HR manager in a company where the attrition level of employees is quite high. By using the HR analytics process how you can curb this issue?

Course Outcome 3(CO3):

1. Write a note on Recruiters performance metrics.
2. Compare HR scorecard with workforce scorecard and their relationship with HR analytics.

3. Businesses use human resources scorecards to measure effectiveness. Critically analyse this statement with your own scenario.

Course Outcome 4 (CO4):

1. Write the steps for HR data collection. explain the ethics involved in the data collection process.
2. Modern reporting methods not only allow professionals to access data more quickly as business concerns emerge, but they also allow them to plan more effectively and strategically. Justify this statement.
3. Assume that the lead time is measured as the 'time to hire in days', which is currently 38, but has to be decreased to 25, a 34% improvement! Create a KPI for the above scenario.

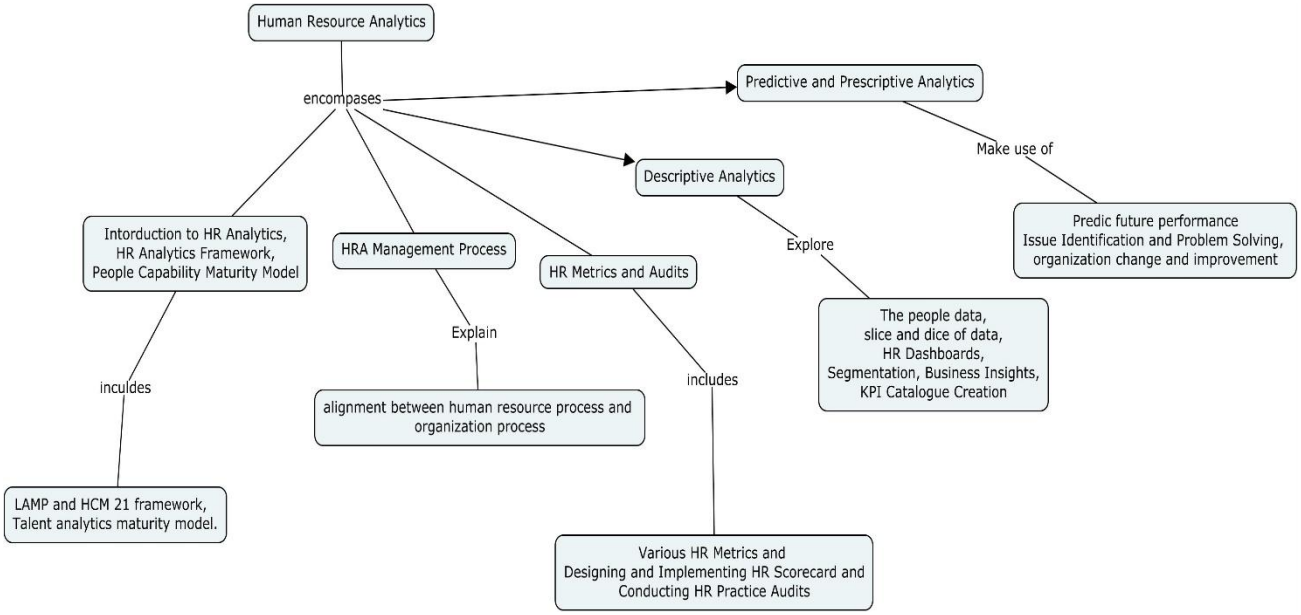
Course Outcome 5 (CO5):

1. Describe the steps involved in predictive analytics and determine the key performance indicators.
2. Examine the use of statistics and statistical modelling for an HR decision making process. Give the suitable example.
3. You're Uber and you want to design a heatmap to recommend to drivers where to wait for a passenger. How would you approach this?

Course Outcome 6 (CO6):

1. Travis Credit Union (TCU) is a not-for-profit cooperative financial institution. TCU is one of the largest credit unions in California with more than 158,000 members and more than $1.6 billion in assets. The Employee Incentive Analytics initiative includes a data warehouse, data integration and dashboards to streamline the incentive calculation process. The application eliminates the need for manual intervention that could otherwise drastically reduce the number of resources their Audit Department needs to spend on the monthly process. Issues that existed due to legacy system limitations are now eliminated. The new Employee Incentive Analytics application provides higher accuracy. Challenges with the legacy process included human errors caused by manual spreadsheet maintenance on payroll data. How will you solve the problem?
2. Absenteeism in this German energy company had risen the benchmark, so, the company used predictive analytics to formulate 55 hypotheses to uncover the reason behind absenteeism, out of which they tested 21 and validated 11. How the company discovered that a lack of a long holiday in the year increased absenteeism and shared this insight with managers to improve PTO policies.
3. Novartis provides healthcare solutions that address the evolving needs of patients and societies worldwide. Their broad portfolio includes innovative medicines, preventive vaccines and diagnostic tools, generic pharmaceuticals and consumer health products. Novartis is the only company to have leadership positions in each of these areas. Novartis' HR department was having a difficult time understanding the factors influencing the retention of key employees. Their employee performance was difficult to analyze and improve. Provide the best solution to solve this problem.

Concept Map



Syllabus

Introduction to HR Analytics: Overview of HR Process - HR Analytics – An overview - Role of analytics in HR - HRM in changing context - Transition from transaction orientation to analytics orientation - HR Analytics Framework – People Capability Maturity Model – LAMP framework – HCM 21 framework – Talent analytics maturity model.

HRA Management Process: Alignment Analytics – link HR process and organization process - identify alignment opportunities; Human Capital Strategy - HR Alignment Inventory - workforce planning - Measurement Map – Lead and Lag indicators.

HR Metrics and Audits: Formulation of key performance indicators and key result areas; HR Metrics – Recruitment metrics – Training and development metrics - Talent retention metrics –HR cost benefit metrics – Career Progression Metrics - Performance metrics – Diversity and Inclusion Metrics - Human capital ROI - Designing and Implementing HR Scorecard - Conducting HR Practice Audits

Descriptive Analytics: Exploring the people data – slice and dice of data - HR Dashboards - Segmentation - Business Insights - KPI Catalogue Creation.

Predictive and Prescriptive Analytics: Predicting future performance - techniques to capture the fallouts of HR Practices - Data driven decision making Issue Identification and Problem Solving, organization change and improvement.

Case study: Studying Human Resource Analytics of two Indian corporate in the limelight- Mini Project on Human Resource information system in the firms in the Locale.

Learning Resources

Text Book

3. Rama Shankar Yadav & Sunil Maheshwari, "HR Analytics : Connecting Data and Theory", 1st edition, Wiley, 2021.
4. Nishant Uppal, "Human Resource Analytics: Strategic Decision Making", 1st edition, Pearson, 2021.
5. Bharti Motwani, "HR Analytics: Practical Approach Using Python", 1st edition, Wiley, 2021.

Reference Book

1. Pratyush Banerjee, Manish Gupta and Jatin Pandey, "Practical Applications of HR Analytics", 1st edition, Sage Publications, 2019.
2. Dr Martin Edwards and Kirsten Edwards, "Predictive HR Analytics: Mastering the HR Metric", 1st edition, Kogan Page, 2019.

Online courses

6. https://www.coursera.org/learn/human-resources-analytics
7. https://www.classcentral.com/course/human-resources-analytics-32615
8. https://courseconnected.com/free-online-hr-analytics-course/
9. https://ecornell.cornell.edu/certificates/human-resources/hr-analytics/

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Introduction to HR Analytics**		CO1
1.1	Overview of HR Process - HR Analytics – An overview - Role of analytics in HR - HRM in changing context	1	CO1
1.2	Transition from transaction orientation to analytics orientation	1	CO1
1.3	HR Analytics Framework – LAMP framework – HCM 21 framework	2	CO1
1.4	People Capability Maturity Model – Talent analytics maturity model.	1	CO1
2	**HRA Management Process**		CO2
2.1	Alignment Analytics	1	CO2
2.2	link HR process and organization process	1	CO2
2.3	identify alignment opportunities; Human Capital Strategy	1	CO2
2.4	HR Alignment Inventory	1	CO2
2.5	workforce planning	1	CO2
2.6	Measurement Map – Lead and Lag indicators.	1	CO2
3	**HR Metrics and Audits**		CO3
3.1	Formulation of key performance indicators and key result areas	1	CO3
3.2	HR Metrics – Recruitment metrics	1	CO3
3.3	Training and development metrics - Talent retention metrics	1	CO3
3.4	HR cost benefit metrics – Career Progression Metrics	1	CO3
3.5	Performance metrics – Diversity and Inclusion Metrics	1	CO3
3.6	Human capital ROI - Designing and Implementing HR Scorecard	1	CO3
3.7	Conducting HR Practice Audits	1	CO3
4	**Descriptive Analytics**		CO4
4.1	Exploring the people data – slice and dice of data	1	CO4
4.2	HR Dashboards	2	CO4
4.3	Segmentation	1	CO4

4.4	Business Insights - KPI Catalogue Creation	2	CO4
5	**Predictive and Prescriptive Analytics**		CO5
5.1	Predicting future performance	1	CO5
5.2	techniques to capture the fallouts of HR Practices	2	CO5
5.3	Data driven decision making - Issue Identification and Problem Solving	2	CO5
5.4	organization change and improvement.	1	CO5
6.	**Case study**		CO6
6.1	Studying Human Resource Analytics of two Indian corporate in the limelight	2	CO6
6.2	Mini Project on Human Resource information system in the firms in the Locale	4	CO6
	TOTAL	**36**	

Course Designers:

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21CBQE1	MARKETING AND SOCIAL MEDIA WEB ANALYTICS

Category	L	T	P	Credit	Terminal Exam Type
PSE	3	0	0	3	Theory

Preamble

To develop students understanding of Digital Media and enable them to learn it's potential limitations. It also helps them to find out the ways of extracting information and analyse the data over real time social media networks. It showcases the opportunities that exist today to leverage the power of the marketing, web and social media.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Understand the basic concepts of marketing analytics, budget making and marketing metrics in various applications.	10
CO2	Identity the principles and practices for social media management in a rapidly changing media environment.	15
CO3	Apply web analytics tools such as Clickstream analysis, A/B testing, online surveys and perform search engine optimization.	20
CO4	Illustrate the graph and matrices methods for social media networks and show Information visualization.	15
CO5	Illustrate the different social contexts in media sites such as Twitter, Facebook and YouTube using techniques of social network analysis.	20
CO6	Demonstrate the importance of personal and business branding and their role in social media marketing.	20

*** Weightage depends on Bloom's Level, number of contact hours

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond	-	1.1,1.2,1.3,2.1.1,2.3.1,2.4.1,2.5
CO2	TPS2	Understand	Respond	-	1.1,1.2,1.3,2.1.1,2.2,2.3.1, 2.4.1,2.5.1,2.5.2, 2.5.3,2.5.4
CO3	TPS3	Apply	Value	-	1.1,1.2,1.3,2.1.1,2.2,2.3.1, 2.4.1,2.5.1,2.5.2, 2.5.3,2.5.4, 3.1, 4.1,4.2,4.3
CO4	TPS3	Apply	Value	-	1.1,1.2,1.3,2.1.1,2.2,2.3.1, 2.4.1,2.5.1,2.5.2, 2.5.3,2.5.4, 3.1, 4.1,4.2,4.3,4.4

CO5	TPS3	Apply	Value	-	1.1,1.2,1.3,2.1.1,2.2,2.3.1, 2.4.1,2.5.1,2.5.2, 2.5.3,2.5.4, 3.1,3.2, 4.1,4.2,4.3,4.4,4.5,4.6
CO6	TPS3	Apply	Value	-	1.1,1.2,1.3,2.1.1,2.2,2.3.1, 2.4.1,2.5.1,2.5.2, 2.5.3,2.5.4, 3.1,3.2, 4.1,4.2,4.3,4.4,4.5,4.6

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L			M	L			S		L	S	L	L
CO2	M	L			M	L	S		S	S	L	L	L	L
CO3	S	M	L		M	M					L	S	L	L
CO4	S	M	L		M	L					L	M	M	L
CO5	S	M	L			M	S	M		M	L	M	M	L
CO6	S	M	L			S	S	S		S	L	S	M	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	**2**	1	2	
Remember	30	30			20
Understand	30	30			40
Apply	40	40	100	100	40
Analyse					
Evaluate					
Create					

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject /Assignment/Practical Component
Perception	-
Set	-
Guided Response	-
Mechanism	-
Complex Overt Responses	-
Adaptation	-
Origination	-

Sample Questions for Course Outcome Assessment**

** (2 to 3 at the cognitive level of course outcome)

Course Outcome 1(CO1):

1. Discuss the need for linking Marketing to financial performance of a firm
2. What are the financial implications of marketing strategic decisions? Explain.
3. Explain about the Market Basket Analysis and elaborate about its types

Course Outcome 2(CO2):

1. Explain how Social media helps in formation of communities, activist's movements and consumer groups.
2. Nike Golf: the golf-specific retail branch of Nike. Although there is the benefit of the Nike brand, there is also the lack of a focused keyword strategy on the Nike Golf website. It is very difficult for search engines to crawl for content. Research helps make decisions like whether target keywords should be "golf apparel," "golf clothing," "golf clothes," or "golf sportswear." As a result of the research, Nike Golf sees a 169% in total increase in organic search traffic. Analyze the effectiveness of Google and search engine
3. Explain the concept of Social media analytics and the insights gained from Social media?
4. Pick a Place to Start: They decided to focus first Lead Generation. Social media can be used for many different purposes, but the new team knew they couldn't tackle everything at once. Lead Generation made sense, as digital marketing was already focusing on it. Analyze the business process of lead generation in social media

Course Outcome 3(CO3):

1. Discuss the application of web analytics tools in the travel industry to analyze website traffic and user interactions, leading to personalized marketing strategies.
2. How can web analytics tools assist educational institutions in tracking and improving the online learning experience for students?
3. Explain the significance of web search and retrieval in the real estate industry for users searching for properties based on specific criteria.

Course Outcome 4 (CO4):

1. Explain how basic measures for individuals and networks can be utilized in the analysis of online gaming communities to identify influential players and encourage community engagement.
2. How can social network and web data analysis contribute to identifying and combating misinformation and fake news on social media platforms?

Course Outcome 5 (CO5):

1. In cybersecurity, discuss how link analysis can be employed to trace and investigate the sources of cyber threats and attacks.
2. In e-commerce, how can the analysis of network evolution be employed to identify changes in customer preferences and adapt marketing strategies accordingly.
3. In social media platforms, how can the analysis of random graphs and network evolution contribute to predicting the spread of viral content?

Course Outcome 6(CO6):

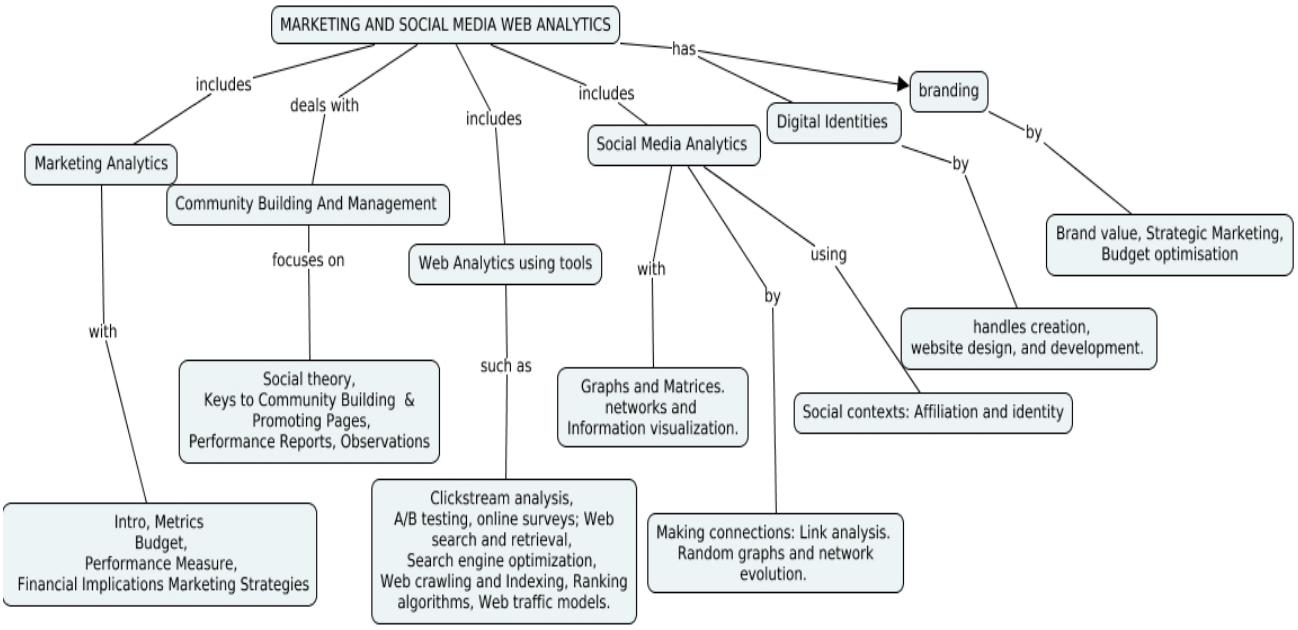
1. Flipkart is an Indian e-commerce company headquartered in Bangalore, Karnataka. It was founded by Sachin Bansal and BinnyBansal in 2007, both alumni of IIT, Delhi. Both worked for Amazon.com before quitting and founding their own company. Initially it was funded by both Bansals' themselves with %4 lakhs. In its initial years, it focused on online sale of books only, but later it expanded to electronic goods and a variety of other products in its portfolio. Moreover, it offers multiple payment methods like credit card, debit card, net banking, e-gift voucher, COD and Cash Swipe on delivery. Today ,Flipkart is among the top 20 Indian e-tailers. The company came up with the innovative idea of delivering its products in 2 days time and with interest to be paid in case of any delay therein. A 30 days return policy was also introduced to ensure that the delivered product is not faulty. The company made browsing easy and user-friendly by comparing different product models on the same

webpage. The company offers various rebates, discounts, refunds, quantity deals, full finance @ 0%. Visualising an increasing potential in the Indian market, the company aspires to become a leader in the online market.

a. Do you think Flipkart should change its promotional strategy in order to become world class leader in the online market? Justify your answer.
b. Devise an effective promotion mix for the company.
c. In which other Ps of marketing mix may Flipkart need improvement?
d. Name any other three e-tailers who compete with Flipkart in theIndian market.

2. Outline the steps involved in designing a website. Analyse According, which of the two is more effective for marketing: Facebook or Whatsapp? State Why?
3. Write a brief note on Domain name branding. State certain things toconsider when choosing a Domain name.Or, State the importance of Domain name.
4. Case Study: cupcakes-online marketing
   Tanu and Manu have just completed their management degree from a reputed institution. Both of them wish to start a new business of fresh bakery items including cupcakes in Indian markets. After doing research in this particular product line, they decide to venture into the business of healthy cakes and cookies. Oats, walnuts, and almonds in cakes are known to be excellent alternative ingredients for the health conscious people. Both Tanu and Manu aim to sell these healthy cupcakes worldwide.
   Questions:
   (1) What bases of segmentation would you advise them?
   (2) Suggest them the most suitable positioning strategies for launching these cupcakes.
   (3) Advice Tanu and Manu on how to plan their e-marketing mix.

Concept Map



Syllabus

Marketing Analytics- Introduction to Marketing Analytics- Marketing Budget and Marketing Performance Measure, Marketing Metrics and its application- Financial

Implications of various Marketing Strategies- Geographical Mapping, Data Exploration, Market Basket Analysis

Community Building And Management Social theory and social media - technological determinism-Keys to Community Building - Promoting Social Media Pages- Linking Social Media Accounts-Digital PR-Encourage Positive Chatter in Social Media - Identity in social media: formation of identities, communities, activist movements, and consumer markets - Social Media as business. Customized Campaign Performance Reports - Observations of social media use.

Web Analytics: Web analytics tools, Clickstream analysis, A/B testing, online surveys; Websearch and retrieval, Search engine optimization, Web crawling and Indexing, Ranking algorithms, Web traffic models.

Social Media & Web Methods: Social network and web data, methods: Graphs andMatrices.Basic measures for individuals and networks.Information visualization.

Social Media Analytics Making connections: Link analysis. Random graphs and networkevolution. Social contexts: Affiliation and identity; Social network analysis, Viral marketing/ organic traffic

Digital Identities and Branding: Digital identities implementation including Social media handles (Facebook, Instagram& LinkedIn) creation, Google Ads, website design, and development. Brand management- Brand value, architecture, identity & equity, Strategic Marketing - Budget optimisation.

Learning Resources

1. Bu Zhong, "Social Media Communications Trends and Theories" Wiley,2021
2. Takeshi Moriguchi, "Web Analytics Consultant Official Textbook", 7th Edition, 2016
3. Damian Ryan, "Understanding Digital Marketing: Marketing Strategies for Engaging the Digital Generation", Import, Kogan 2014
4. Christian Fuchs, "Social Media a critical introduction", SAGE Publications Ltd, 2014

Reference Materials:

1. AvinashKaushik, "Web Analytics 2.0: The Art of Online Accountability", 2009
2. Hansen, Derek, Ben Sheiderman, Marc Smith, "Analyzing Social Media Networks with NodeXL: Insights from a Connected World", Morgan Kaufmann, 2011

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Marketing Analytics**		
1.1	Introduction- Marketing Budget and Marketing Performance Measure	1	CO1
1.2	Marketing Metrics and its application	1	CO1
1.3	Financial Implications of various Marketing Strategies	1	CO1
1.4	Geographical Mapping, Data Exploration, Market Basket Analysis	1	CO1
2	**Community Building And Management**		

2.1	Social theory and social media - technological determinism	1	CO2
2.2	Keys to Community Building - Promoting Social Media Pages	1	CO2
2.3	Linking Social Media Accounts-Digital PR-Encourage Positive Chatter in Social Media	1	CO2
2.4	Identity in social media: formation of identities, communities, activist movements, and consumer markets - Social Media as business.	2	CO2
2.5	Customized Campaign Performance Reports - Observations of social media use	1	CO2
3	**Web Analytics**		
3.1	Web analytics tools, Click stream analysis, A/B testing, online surveys	2	CO3
3.2	Web search and retrieval, Search engine optimization	2	CO3
3.3	Web crawling and Indexing	1	CO3
3.4	Ranking algorithms, Web traffic models	2	CO3
4	**Social Media & Web Methods**:		
4.1	Social network and web data	1	CO4
4.2	Methods: Graphs and Matrices.	2	CO4
4.3	Basic measures for individuals and networks.	1	CO4
4.4	Information visualization	1	CO4
5	**Social Media Analytics Making connections**		
5.1	Link analysis, Random graphs	2	CO5
5.2	Network evolution	1	CO5
5.3	Social contexts: Affiliation and identity	2	CO5
5.4	Social network analysis	1	CO5
5.5	Viral marketing/ organic traffic	1	CO5
6	**Digital Identities and Branding:**		
6.1	Digital identities implementation including Social media handles (Facebook, Instagram& LinkedIn) creation	2	CO6
6.2	Google Ads, website design and development.	1	CO6
6.3	Brand management- Brand value, Architecture, identity & equity	2	CO6
6.4	Strategic Marketing	1	CO6
6.5	Budget optimisation	1	CO6
	Total Hours	**36**	

Course Designers:

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21CBQF1	FINANCIAL ANALYTICS

CATEGORY	L	T	P	CREDIT	TERMINAL EXAM TYPE
PSE	3	0	0	3	THEORY

Preamble

This course deals with understanding finance analysis from crafting financial reports to employing machine learning for predictive analytics and decision making. It also emphasizes practical skills in financial modelling, investment evaluation, and portfolio optimization for risk mitigation and maximizing returns.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Understand the concepts of Finance, Probability & statistics	15
CO2	Understand usage, resources and functions for basic financial time series analysis	15
CO3	Build univariate and volatility models for forecasting financial time series	20
CO4	Construct financial models using Stochastic Calculus to analyze financial status	20
CO5	Evaluate the various investment opportunities to minimize the risk	15
CO6	Assess the portfolio optimization models for maximum returns	15

*** Weightage depends on Bloom's Level, number of contact hours

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond	Guided response	1.1, 2.3.4, 2.4.6, 2.4.7, 2.5.1
CO2	TPS2	Understand	Respond	Guided response	1.1, 1.2, 2.1.3, 2.1.4, 2.1.5, 2.3, 2.4.3, 2.4.6, 2.4.7
CO3	TPS3	Apply	Value	Mechanism	1.1, 1.2, 2.1.3, 2.1.4, 2.1.5, 2.3, 2.4.3, 2.4.6, 2.4.7
CO4	TPS3	Apply	Value	Mechanism	1.1, 1.2, 2.1.3, 2.1.4, 2.1.5, 2.3, 2.4.3, 2.4.6, 2.4.7
CO5	TPS3	Apply	Value	Mechanism	1.1, 1.2, 2.1.3, 2.1.4, 2.1.5, 2.3, 2.4.3, 2.4.6, 2.4.7
CO6	TPS3	Apply	Value	Mechanism	1.2, 2.1.2, 3.2.3, 4.5.3

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L										L		
CO2	M	L				L	L		L		L	M	L	L
CO3	S	M	L	L		L	L		L		L	M	L	L
CO4	S	M	L	L		L	L		L		L	M	L	L
CO5	S	M	L	L		L	L		L		L	M	L	L
CO6	S	M	L	L		L	L		L		L	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	2	1	2	
Remember	40	10			10
Understand	40	30	70		30
Apply	20	60	30	100	60
Analyse					
Evaluate					
Create					

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject /Assignment/Practical Component
Perception	
Set	
Guided Response	30
Mechanism	70
Complex Overt Responses	
Adaptation	
Origination	

Sample Questions for Course Outcome Assessment**

Course Outcome 1(CO1):

1. Define finance and explain its importance in business decision-making.
2. Describe the functions of the financial system in an economy.
3. What are the basic principles of probability theory?
4. How does the understanding of basic probability concepts help in making informed financial decisions?
5. Provide an example of how descriptive statistics can be used to assess the performance of a financial portfolio.

Course Outcome 2(CO2):

1. Explain the three main uses of forecasts in financial time series analysis.
2. Describe the steps involved in the typical forecasting process for financial data.
3. Compare and contrast the advantages and disadvantages of using historical data versus external data sources for forecasting financial time series.

4. Explain the concept of autocovariance and its role in analyzing the dependence between observations in a financial time series.
5. Differentiate between the Autocorrelation Function (ACF) and the Partial Autocorrelation Function (PACF), and explain how they are used to identify the underlying structure of a financial time series.

Course Outcome 3(CO3):

1. Compare and contrast the AR (Autoregressive) and MA (Moving Average) models. Explain how they capture different aspects of the data's behaviour.
2. Describe the ARMA (Autoregressive Integrated Moving Average) model and its role in forecasting stationary time series data. How does it address the limitations of AR and MA models?
3. Explain the concept of differencing in ARIMA models and how it is used to achieve stationarity in non-stationary data.
4. Outline the Box-Jenkins methodology for building and evaluating ARIMA models. What are the key steps involved in this approach?
5. Discuss the advantages and disadvantages of using ARIMA models for forecasting financial time series data.

Course Outcome 4 (CO4):

1. Explain the concept of a stochastic process and how it is used to model random phenomena in finance. Provide an example of a commonly used stochastic process in financial modeling.
2. Define a Markov process and its key properties. How does the Markov property simplify the analysis of certain financial models?
3. Explain the concept of a martingale and its role in fair pricing of financial instruments. How does the martingale property relate to the efficient market hypothesis?
4. Describe the concept of a random walk and its application in modeling asset price movements. Differentiate between a simple random walk and a geometric Brownian motion.
5. Explain the concept of Brownian motion with drift and its significance in financial modeling. How does Ito's Lemma provide a framework for analyzing stochastic differential equations involving Brownian motion?

Course Outcome 5 (CO5):

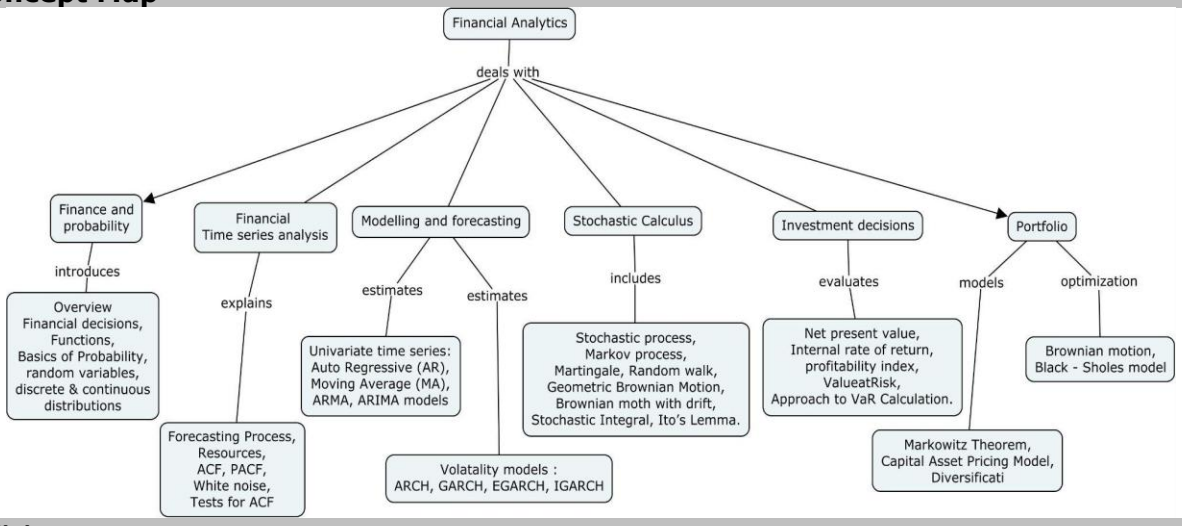
1. Explain the concept of Net Present Value (NPV) and its role in capital budgeting decisions. How does NPV account for the time value of money?
2. Describe how NPV analysis is used to compare and rank different investment opportunities. What are the key decision rules based on NPV calculations?
3. Explain the concept of Internal Rate of Return (IRR) and its interpretation in investment decision-making. How does IRR compare to NPV, and what are the limitations of using IRR?
4. Define the Profitability Index (PI) and its significance in evaluating investment projects. How does PI relate to NPV and IRR?
5. Discuss the concept of Value at Risk (VaR) and its importance in risk management. Explain the different approaches to calculating VaR, such as the historical simulation method and the variance-covariance method.

Course Outcome 6(CO6):

1. Explain the basic principles of portfolio construction. How does diversification help manage portfolio risk?
2. Describe the Markowitz Theorem and its role in portfolio optimization. What is the efficient frontier and how does it represent optimal portfolios?
3. Explain the Capital Asset Pricing Model (CAPM) and its assumptions. How does CAPM relate the expected return of an asset to its systematic risk?

4. Explain the basic principles of portfolio construction. How does diversification help manage portfolio risk?
5. Describe the Markowitz Theorem and its role in portfolio optimization. What is the efficient frontier and how does it represent optimal portfolios?

Concept Map



Syllabus

Introduction to Finance and Probability: Overview of finance, financial decision in firms, Functions of Financial System, Basics of Probability, random variables, discrete & continuous distributions, descriptive statistics

Financial Time Series Analysis: The Nature and Uses of Forecasts, The Forecasting Process , Resources for Forecasting, Numerical Description of Time Series Data : Autocovariance and Auto Correlation Function (ACF), Partial Auto Correlation Function (PACF), White noise, Tests for ACF.

Modelling and Forecasting with time series: Univariate time series Model : Auto Regressive (AR), Moving Average (MA), ARMA, ARIMA models – estimation and forecasting. Volatility Models: ARCH, GARCH, EGARCH, IGARCH. Volatility forecasting.

Stochastic Calculus for Finance: Stochastic process, Markov process, Martingale, Random walk, Geometric Brownian Motion, Brownian moth with drift, Stochastic Integral, Ito's Lemma.

Investment Decisions: Techniques for evaluating investment opportunities - Net Present Value (NPV) analysis and decision-making - Internal Rate of Return (IRR) and profitability index applications - ValueatRisk , Approach to VaR Calculation.

Portfolio optimization: Asset Portfolio Models: Basics of portfolio construction, Markowitz Theorem, Capital Asset Pricing Model, Diversification and Portfolio Optimization - Derivative Pricing: Issues regarding derivative markets. Brownian motion, Black - Sholes model. Modeling derivative prices.

Learning Resources

1. Montgomery, D. C., Jennings, C. L., & Kulahci, M. (2015). Introduction to time series
   analysis and forecasting. John Wiley & Sons.
2. Ruey S. Tsay, Analysis of Financial Time Series (Third Edition), Wiley Publication. ISBN: 978-8126548934.

Learning Resources

1. Robert N Anthony, David Hawkins, Kenneth Marchant, "Accounting: Texts and Cases", McGraw-Hill 2017.

2. S P. Jain and K L Narang ,"Corporate Accounting" 9th edition, Kalyani Publishers, New India, 2019.
3. Machine Learning by Tom M. Mitchell: Chapter 1, 2, 4.
4. Chandra, P., 'Financial Management: Theory and Practice', 9e, TMH, 2017.
5. Financial Modeling (MIT Press), Fifth Edition by Simon Benninga and Tal Mofkadi

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Introduction to Finance and Probability**	**5**	**CO1**
1.1	Overview of finance	1	CO1
1.2	Financial decision in firms, Functions of Financial System	1	CO1
1.3	Basics of Probability, random variables	1	CO1
1.4	Discrete & continuous distributions	1	CO1
1.5	Descriptive statistics	1	CO1
2.	**Financial Time Series Analysis**	**5**	**CO2**
2.1	The Nature and Uses of Forecasts , The Forecasting Process	1	CO2
2.2	Resources for Forecasting	1	CO2
2.3	Autocovariance and Auto Correlation Function (ACF)	1	CO2
2.4	Partial Auto Correlation Function (PACF)	1	CO2
2.5	White noise, Tests for ACF	1	CO2
3.	**Modelling and Forecasting with time series**	**8**	**CO3**
3.1	Auto Regressive (AR)	1	CO3
3.2	Moving Average (MA)	1	CO3
3.3	ARMA, ARIMA models – estimation and forecasting	1	CO3
3.4	ARCH, GARCH	2	CO3
3.5	EGARCH, IGARCH.	2	CO3
3.6	Volatility forecasting	1	CO3
4.	**Stochastic Calculus for Finance**	**7**	**CO4**
4.1	Stochastic process	1	CO4
4.2	Markov process	1	CO4
4.3	Martingale, Random walk	1	CO4
4.4	Geometric Brownian Motion	1	CO4
4.5	Brownian moth with drift	1	CO4
4.6	Stochastic Integral	1	CO4
4.7	Ito's Lemma	1	CO4
5.	**Capital Budgeting and Investment Decisions**	**5**	**CO5**
5.1	Techniques for evaluating investment opportunities	1	CO5
5.2	Net Present Value (NPV) analysis and decision-making	1	CO5
5.3	Internal Rate of Return (IRR)	1	CO5
5.4	Profitability index applications	1	CO5
5.5	ValueatRisk , Approach to VaR Calculation.	1	CO5
6.	**Portfolio optimization**	**6**	**CO6**
6.1	Basics of portfolio construction	1	CO6
6.2	Markowitz Theorem, Capital Asset Pricing Model	1	CO6
6.3	Diversification and Portfolio Optimization	1	CO6
6.4	Derivative Pricing: Issues regarding derivative markets	1	CO6
6.5	Brownian motion, Black - Sholes model	1	CO6
6.6	Modeling derivative prices	1	CO6
	Total	**36**	

Course Designers:

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21CBQG1	Fundamentals of Business Intelligence & Analytics (Common to all branches)

CATEGORY	L	T	P	CREDIT
PSE	1	0	0	1

Preamble

This course provides students with essential skills to utilize business analytics for strategic decision-making. By examining various analytical techniques and tools, students will learn how to effectively model complex business scenarios and perform thorough analyses of potential solutions.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage *** in %
CO1	Explain the basic concepts of business intelligence & analytics	10
CO2	Use descriptive analytics to summarize and interpret the data	20
CO3	Applying clustering methods to manage outliers in the data set.	40
CO4	Demonstrate the effectiveness of different predictive analytics techniques.	30

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond	-	1.2,2.1.1,2.1.3
CO2	TPS3	Apply	Value	-	1.2,2.1,1.1
CO3	TPS3	Apply	Value	-	1.2,2.1.1
CO4	TPS3	Apply	Value	-	1.2,2.1.1

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	S	M	L							M	M	M	L	
CO2	M	L	L							L	L	L		
CO3	S	M	L							M	M	M	L	
CO4	S	M	L							S	M	M	L	

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive levels	Continuous Assessment	Assignment	Terminal examination
	1	1	
Remember	10		
Understand	30		40
Apply	60	100	60
Analyze			
Evaluate			
Create			

Assessment Pattern: Psychomotor

Psychomotor Skill	Mini project/ Assignment/Practical Component
Perception	
Set	
Guided Response	30
Mechanism	70
Complex Overt Responses	
Adaptation	

Syllabus

Introduction to Business Intelligence & Analytics (BIA): drivers of BIA, types of analytics: descriptive to prescriptive, vocabulary of business analytics

Descriptive Analytics: Introduction, Statistics in business, Sampling and Data collection, Types of variable measurement scales, Populations and samples, Measures of central tendency, and Measures of variation

Cluster analysis: Preparing Data and Measuring Dissimilarities, Hierarchical and k-Means Clustering

Predictive Analytics: Simple Linear regression, Logistic Regression, Multiple Linear regression

Learning Resources

1. U.Dinesh Kumar , "Business Analytics: The Science of Data - Driven Decision Making", Wiley, Second Edition, 2021.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Out come
1	**Introduction to Business Intelligence & Analytics (BIA)**		
1.1	drivers of BIA, types of analytics: descriptive to prescriptive, vocabulary of business analytics	2	CO1
2	**Descriptive Analytics**		
2.1	Introduction, Statistics in business, Sampling and Data collection	1	CO2
2.2	Types of variable measurement scales, Populations and samples	1	CO2
2.3	Measures of central tendency, Measures of variation	1	CO2
3	**Classification and Clustering**		
3.1	Preparing Data and Measuring Dissimilarities	2	CO3
3.2	Hierarchical and k-Means Clustering	2	CO3
4	**Predictive Analytics**		
4.1	Simple Linear regression	2	CO4
4.2	Logistic Regression	1	
4.2	Multiple Linear regression	2	CO4
	TOTAL	**14**	

Course Designers

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3. Mrs.Priya Thiagarajan ptca@tce.edu

21CBQH1	TOOLS FOR DATA ANALYTICS (COMMON TO ALL BRANCHES)

Category	L	T	P	Credit
PSE	1	0	0	1

Preamble

This course introduces students to the essential concepts and practices of data analytics, focusing on the use of various tools to analyze and interpret data. students will be equipped to perform data analysis, generate visualizations, and make data-driven decisions to enhance business operations, research, and decision-making processes.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Explain the foundational understanding of data analytics concepts and data driven decision making	20
CO2	Identify the type of data and perform cleaning and transformation of data	20
CO3	Apply data analysis and visualization using MATLAB and python	30
CO4	Create an interactive dashboard using Power BI for various applications.	30

*** Weightage depends on Bloom's Level, number of contact hours

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psycho motor	
CO1	TPS 2	Understand	Respond		1.2,1.3,2.1.1,2.1.2,2.1.5,2.2
CO2	TPS 3	Apply	Value		1.2,1.3,2.1.1,2.1.2,2.1.5,2.2,3.1
CO3	TPS 3	Apply	Value		1.2,1.3,2.1.1,2.1.2,2.1.5,2.2,3.1, 4.1, 4.2, 4.3
CO4	TPS 3	Apply	Value		1.2,1.3,2.1.1,2.1.2,2.1.5,2.2,3.1, 4.4, 4.5

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	S	L	M	L	S					L	L	M	L	L
CO2	S	M	M	L	S					L	L	M	L	L
CO3	S	M	M	M	S					L	L	S	L	L
CO4	S	M	M	M	S					L	L	S	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive levels	Continuous Assessment	Assignment	Terminal examination
	1	1	
Remember	20		
Understand	20		40
Apply	60	100	60

Analyze			
Evaluate			
Create			

Assessment Pattern: Psychomotor

Psychomotor Skill	Mini project/ Assignment/Practical Component
Perception	
Set	
Guided Response	30
Mechanism	70
Complex Overt Responses	
Adaptation	

Syllabus

Introduction to Data Analytics and Tools: Role of Data Analytics-Types of Data Analytics-Overview of Analytical tools: Excel, Python, Power BI, MATLAB- Selecting the right tool for data analysis.

Data Collection, Cleaning and Transformation: Data Collection- Types of Data- Data Cleaning Techniques: Missing values, Duplicate values and Outliers-Data Transformation: Aggregating Filtering and Standardizing Data for Analysis.

Exploratory Data Analysis and Visualization in Python and MATLAB: Descriptive Statistics and Pivot Tables – Visualizing Data in Python and MATLAB: Bar, Line and Scatter Plots. Python Libraries for Data Analysis: Pandas, Matplotlib, Seaborn.

Dashboard Creation and Insight Presentation using Power BI: Introduction to Power BI for Dashboarding- Designing Interactive Dashboards to communicative Findings-Case Study: Create sample dashboard in Power BI using business or healthcare scenario.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Introduction to Data analytics and tools**		
1.1	Role of Data Analytics-Types of Data Analytics	1	CO1
1.2	Overview of Analytical tools: Excel, Python, Power BI, MATLAB- Selecting the right tool for data analysis.	1	CO1
2	**Data Collection, Cleaning and Transformation**		
2.1	Data Collection and Types of Data	1	CO2
2.2	Data Cleaning Techniques: Missing values, Duplicate values and Outliers-	1	CO2
2.3	Data Transformation: Aggregating Filtering and Standardizing Data for Analysis.	1	CO2
3	**Exploratory Data Analysis and Visualization in Python, MATLAB**		
3.1	Descriptive Statistics and Pivot Tables	1	CO3
3.2	Visualizing Data in Python and MATLAB: Bar, Line and Scatter Plots	1	CO3
3.3	Python Libraries for Data Analysis: Pandas, Matplotlib and Seaborn	1	CO3
3.4	Python Libraries for Data Analysis: Matplotlib, Seaborn	1	CO3
4	**Dashboard Creation and Insight Presentation using Power BI**		

4.1	Introduction to Power BI for Dashboarding-	1	CO4
4.2	Designing Interactive Dashboards to communicative Findings	1	CO4
4.3	Case Study: Create sample dashboard in Power BI using business scenario	2	CO4
4.4	Case Study: Create sample dashboard in Power BI using healthcare scenario	1	CO4
	Total Hours	**14**	

Course Designers:

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3. Mrs. D. Yuvasini dyica@tce.edu

21CBQJ1	DIGITAL BUSINESS TRANSFORMATION

Category	L	T	P	Credit	Terminal Exam Type
PSE	3	0	0	3	Theory

Preamble

This course explores how emerging digital technologies are transforming modern enterprises across sectors. It provides a comprehensive understanding of cloud computing, IoT, AI/ML, RPA, and blockchain as enablers of strategic innovation and operational excellence. Through case studies and practical frameworks, learners will assess, design, and measure successful digital transformation initiatives.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Use the concepts of cloud computing service and deployment models to transform enterprise infrastructure and operations.	15
CO2	Apply IoT architecture and tools to improve operational efficiency and innovation in enterprises.	15
CO3	Apply AI/ML technologies to automate business processes and enhance decision-making.	20
CO4	Apply the concept of platform economy to develop and analyze digital business models.	15
CO5	Apply digital transformation frameworks to assess technology adoption in the banking sector.	15
CO6	Apply digital maturity models and ROI frameworks to evaluate and sustain enterprise transformation.	20

*** Weightage depends on Bloom's Level, number of contact hours

CO Mapping with CDIO Curriculum Framework

CO#	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS3	Apply	Value	-	1.1,1.2,1.3,,2.4.1,4.2.1,4.2.2
CO2	TPS3	Apply	Value	-	1.1,1.2,1.3,2.1.2, 2.4.1,2.4.3, 4.5.3,
CO3	TPS3	Apply	Value	-	1.1,1.2,1.3,2.1.3,2.4.3, 4.5.3,
CO4	TPS3	Apply	Value	-	1.1,1.2,1.3, 2.1.3, 2.4.3, 4.5.3,
CO5	TPS3	Apply	Value	-	1.1,1.2,1.3,2.1.3, 2.4.3, 4.5.3,
CO6	TPS3	Apply	Value	-	1.1,1.2,1.3, 2.1.3, 2.4.3, 4.5.3,

Mapping with Programme Outcomes and Programme Specific Outcomes

CO#	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	S	M	L					M	M			L	L	
CO2	S	M	L					M	M			L	L	
CO3	S	M	L					M	M			L	L	
CO4	S	M	L					M	M			L	L	
CO5	S	M	L					M	M			L	L	
CO6	S	M	L					M	M			L	L	

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	2	1	2	
Remember	20	20	-	-	20
Understand	20	20	40	40	20
Apply	60	60	60	60	60
Analyse	-	-	-	-	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject /Assignment/Practical Component
Perception	-
Set	-
Guided Response	-
Mechanism	-
Complex Overt Responses	-
Adaptation	-
Origination	-

Sample Questions for Course Outcome Assessment**

** (2 to 3 at the cognitive level of course outcome)

Course Outcome 1 (CO1):

1. Apply the concepts of cloud service models (IaaS, PaaS, SaaS) to recommend a suitable model for a startup planning to launch an online retail application. Justify your choice.
2. Demonstrate how an enterprise can use cloud migration and modernization strategies to improve its operational efficiency and scalability.
3. Illustrate with an example how cost, compliance, and culture can act as either enablers or barriers during cloud adoption in an Indian enterprise such as TCS or a Digital India initiative.

Course Outcome 2 (CO2):

1. Apply the concepts of IoT components—sensors, connectivity, and analytics—to design a basic IoT system that could improve energy efficiency in a manufacturing unit.
2. Demonstrate how IoT integration with business systems and data platforms can enhance decision-making and predictive maintenance in logistics operations.
3. Illustrate with a real or hypothetical example how organizations like Siemens or Indian Railways can apply IoT technologies to improve operational efficiency and drive innovation.

Course Outcome 3 (CO3):

1. Apply AI/ML concepts to design a process automation model that can reduce manual intervention and improve efficiency in a business workflow.
2. Demonstrate how AI-based analytics can be used to enhance customer experience and personalize services in an e-commerce platform.
3. Illustrate with a suitable example how enterprises like Amazon or TCS Ignio have applied AI-driven solutions for innovation and intelligent decision support, considering ethical implications.

Course Outcome 4 (CO4):

1. Apply the concept of the platform economy to design a digital ecosystem model that connects producers and consumers in a new service domain.
2. Demonstrate how network effects can be leveraged to enhance value creation and competitiveness in a platform-based business such as Zomato or Flipkart.
3. Illustrate with an example how technology enablers support the development and scaling of platform models in the Indian digital ecosystem.

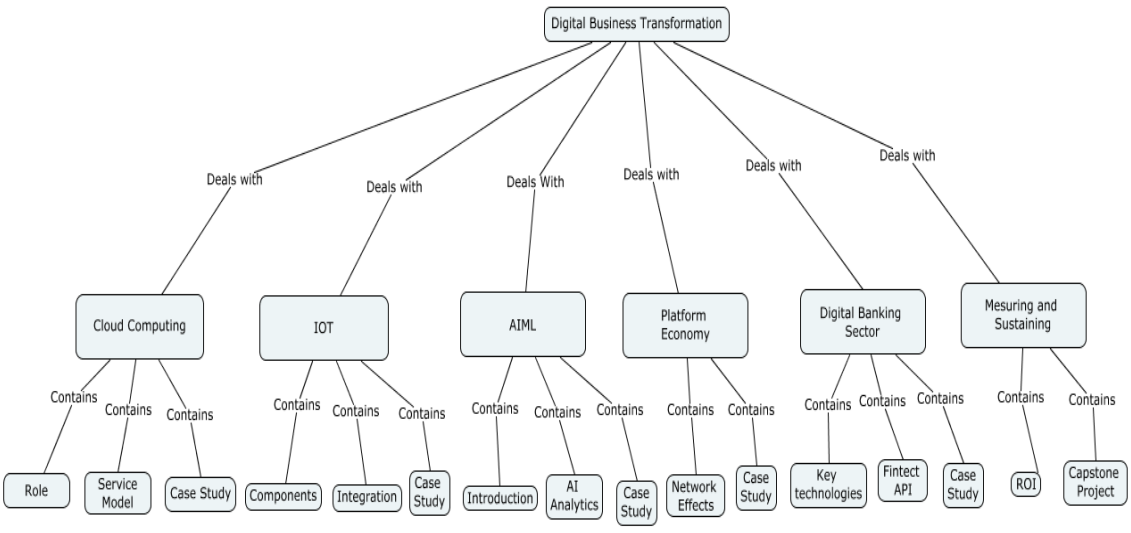
Course Outcome 5 (CO5):

1. Apply digital transformation concepts to design a technology-enabled banking model that improves customer accessibility and operational efficiency.
2. Demonstrate how cloud banking, mobile applications, and fintech APIs can be integrated to enhance customer experience and streamline banking operations.
3. Illustrate with a case study (e.g., SBI YONO, HDFC Digital, or Paytm Bank) how banks in India have implemented digital adoption strategies, highlighting both drivers and challenges.

Course Outcome 6 (CO6):

1. Apply a suitable digital maturity assessment framework to evaluate the transformation level of an organization in a chosen industry.
2. Demonstrate how ROI and value measurement techniques can be used to analyze the effectiveness of digital initiatives in improving business performance.
3. Illustrate through a capstone-style example how continuous improvement practices can sustain digital transformation outcomes in a specific sector (e.g., healthcare, manufacturing, or education).

Concept Map



Syllabus

Cloud Computing and Enterprise Transformation: Role of cloud computing in digital transformation - Overview of service models: IaaS, PaaS, SaaS - Cloud migration and

modernization – concepts and benefits - Key enablers and barriers: cost, compliance, and culture - **Case Study:** Cloud adoption in Indian enterprises (e.g., TCS, Digital India)

Internet of Things (IoT) and Smart Enterprises: IoT basics and core components (sensors, connectivity, analytics) - IoT for operational efficiency and innovation - Integration with business systems and data platforms - Case Study:IoT in manufacturing or logistics (e.g., Siemens, Indian Railways)

Artificial Intelligence and Machine Learning in Strategy: AI/ML in process automation and decision support - Enhancing customer experience through AI analytics - Intelligent business models and ethical considerations - **Case Study:** AI-driven innovation (e.g., Amazon, TCS Ignio)

Platform Economy & Business Model Transformation: Understanding the platform economy and digital ecosystems - Technology's role in creating platform-based models - Network effects and value creation - Case Study: Platform models in India (e.g., Zomato, Flipkart)

Digital Transformation in Banking Sector: Overview of digital transformation in banking - Key technologies: cloud banking, mobile apps, fintech APIs - Drivers and challenges of digital adoption - **Case Study:** SBI YONO / HDFC Digital / Paytm Bank

Measuring & Sustaining Digital Transformation: Assessing digital maturity and performance - ROI and value measurement of digital initiatives Sustaining transformation through continuous improvement - **Capstone Project:** Evaluate transformation outcomes in a selected sector

Learning Resources

Text Books

1. Rogers, D. – The Digital Transformation Playbook, Columbia University Press, 2023.
2. Westerman, G., Bonnet, D., & McAfee, A. – Leading Digital: Turning Technology into Business Transformation, Harvard Business Review Press, 2014.

Reference Books

1. NPTEL Course Materials – Strategy and Technology: A Practical Primer (IIT Madras), 2023.
2. Selected Harvard/IIM/IIT case studies on Digital Strategy and Transformation, 2018.
3. Venkatraman, V. – Digital Matrix: New Rules for Business Transformation through Technology,2017.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Cloud Computing and Enterprise Transformation:**	**6**	CO1
1.1	Role of cloud computing in digital transformation - Overview of service models: IaaS, PaaS, SaaS	1	CO1
1.2	Cloud migration and modernization - concepts and benefits	2	CO1
1.3	Key enablers and barriers: cost, compliance, and culture	1	

1.4	**Case Study:** Cloud adoption in Indian enterprises (e.g., TCS, Digital India)	2	CO1
2	**Internet of Things (IoT) and Smart Enterprises:**	**6**	CO2
2.1	IoT basics and core components (sensors, connectivity, analytics)	1	CO2
2.2	IoT for operational efficiency and innovation	1	CO2
2.3	Integration with digital infrastructure and data management	1	CO2
2.4	Integration with business systems and data platforms	1	CO2
2.5	**Case Study**: IoT in manufacturing or logistics (e.g., Siemens, Indian Railways)	2	CO2
3	**Artificial Intelligence and Machine Learning in Strategy**	**6**	CO3
3.1	AI/ML in process automation and decision support	1	CO3
3.2	Enhancing customer experience through AI analytics	1	CO3
3.3	Intelligent business models and ethical considerations	2	CO3
3.4	**Case Study:** AI-driven innovation (e.g., Amazon, TCS Ignio)	2	CO3
4	**Platform Economy & Business Model Transformation**	**6**	CO4
4.1	Understanding the platform economy and digital ecosystems	1	CO4
4.2	Technology's role in creating platform-based models	2	CO4
4.3	Network effects and value creation	1	CO4
4.4	**Case Study**: Platform models in India (e.g., Zomato, Flipkart)	2	CO4
5	**Digital Transformation in Banking Sector**	**6**	CO5
5.1	Overview of digital transformation in banking	2	CO5
5.2	Key technologies: cloud banking, mobile apps, fintech APIs	2	CO5
5.3	Drivers and challenges of digital adoption	1	CO5
5.4	**Case Study:** SBI YONO / HDFC Digital / Paytm Bank	1	CO5
6.	**Measuring & Sustaining Digital Transformation**	**6**	CO6
6.1	Assessing digital maturity and performance	2	CO6
6.2	ROI and value measurement of digital initiatives Sustaining transformation through continuous improvement	2	CO6
6.3	**Capstone Project:** Evaluate transformation outcomes in a selected sector	2	CO6
	TOTAL	**36 Hours**	

Course Designers:

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21CBQK1	APPLIED BUSINESS FORECASTING

Category	L	T	P	Credit	Terminal Exam Type
PSE	3	0	0	3	Theory

Preamble

This course introduces the foundational concepts of forecasting and predictive analytics with various methods across business domains. Students will learn to apply methods such as time series, smoothing techniques, seasonality, decomposition, regression and ARIMA in various business applications with tools and technologies for better analytics and forecasting.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Explain the fundamentals of business forecasting and predictive analytics with their applications in business decision-making.	15
CO2	Use various methods of time series in business applications for preparing and validating models to support forecasting.	15
CO3	Apply moving average and exponential smoothing techniques to business applications for identifying short- and long-term trends and patterns.	20
CO4	Demonstrate decomposition methods to identify and model seasonal patterns in business time series data for accurate forecasting	20
CO5	Use regression-based forecasting models to identify and quantify the relationship between data for predicting business outcomes.	15
CO6	Apply ARIMA modelling techniques and predictive analytics tools to business data for forecasting and interpreting results with ethical considerations.	15

*** Weightage depends on Bloom's Level, number of contact hours

CO Mapping with CDIO Curriculum Framework

CO#	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond	-	1.1,1.2,1.3,,2.4.1,4.2.1,4.2.2
CO2	TPS3	Apply	Value	-	1.1,1.2,1.3,2.1.2, 2.4.1, 2.4.3, 4.5.3
CO3	TPS3	Apply	Value	-	1.1,1.2,1.3,2.1.3,2.4.3, 4.5.3
CO4	TPS3	Apply	Value	-	1.1,1.2,1.3, 2.1.3, 2.4.3,4.5.3
CO5	TPS3	Apply	Value	-	1.1,1.2,1.3,2.1.3, 2.4.3, 4.5.3
CO6	TPS3	Apply	Value	-	1.1,1.2,1.3, 2.1.3, 2.4.3,4.5.3

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	O6	PO7	PO8	PO9	O10	PO11	PSO1	PSO2	PSO3
CO1	M	L		L	L				L		L	L	L	
CO2	S	M	L	M	L	L	L		L	L	M	M	L	L
CO3	S	M	L	M	L	L	L		L	L	M	M	L	L
CO4	S	M	L	M	L	L	L		L	L	M	M	L	L
CO5	S	M	L	M	L	L	L		L	L	M	M	L	L
CO6	S	M	L	M	L	L	L		L	L	M	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	2	1	2	
Remember	20	20	-	-	20
Understand	30	30	40	40	30
Apply	50	50	60	60	50
Analyse	-	-	-	-	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject /Assignment/Practical Component
Perception	-
Set	-
Guided Response	-
Mechanism	-
Complex Overt Responses	-
Adaptation	-
Origination	-

Sample Questions for Course Outcome Assessment**

** (2 to 3 at the cognitive level of course outcome)

Course Outcome 1(CO1):

1. Explain how business forecasting contributes to strategic, tactical, and operational decision making.
2. Summarize the purpose of each stage in the forecasting cycle — problem definition, data collection, model selection, and validation.
3. Explain situations where qualitative forecasting methods are more suitable than quantitative methods. Support your answer with relevant business examples.

Course Outcome 2(CO2):

1. Summarize the key considerations for selecting an appropriate time series model.
2. Apply time series forecasting to the given dataset of monthly product sales and predict the sales for December. Calculate suitable performance metrics

Sales Dataset (Monthly Sales in Units):

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Sales	120	135	150	165	155	170	160	180

3. Using historical stock price data, perform a simple forecasting exercise and evaluate model accuracy using MSE and RMSE.

Stock Price Dataset (Daily Closing Prices in ₹):

Day	1	2	3	4	5	6	7	8
Actual Price	210	215	212	218	220	225	223	228
Forecasted Price	212	214	214	217	221	224	222	226

Course Outcome 3(CO3):

1. Calculate the weighted moving average for a 3-period window using weights of 0.5, 0.3, and 0.2 (most recent has highest weight).

Data (Demand in units):

Period	1	2	3	4	5	6
Demand	50	54	52	56	58	60

2. Using an initial forecast of 100 units and a smoothing constant ($\alpha = 0.3$), compute exponentially smoothed forecasts for the following demand data:

Period	1	2	3	4	5	6	7	8
Actual Demand	100	110	108	115	120	118	125	130

3. Using moving average and exponential smoothing, forecast quarterly electricity consumption and identify which method better handles seasonal variation.

Course Outcome 4 (CO4):

1. Describe the purpose of decomposing a time series into trend, seasonal, and irregular components.
2. Given a dataset with seasonal indices Q1 = 0.85, Q2 = 0.95, Q3 = 1.10, Q4 = 1.20, and actual quarterly sales = [170, 180, 220, 240], compute the deseasonalized values and interpret the trend.
3. Apply the Holt–Winters exponential smoothing method ($\alpha = 0.3$, $\beta = 0.2$, $\gamma = 0.4$) to a quarterly demand series and forecast for the next period. Use:

Quarter	1	2	3	4	5	6	7	8
Demand (units)	200	240	180	300	220	260	190	310

Course Outcome 5 (CO5):

1. Discuss why residual analysis is important in validating a regression forecasting model

2. A company's monthly sales (Y) depend on *advertising expenditure (X_1)* and *price discount (%) (X_2)*. Use the following dataset to develop a multiple regression model:

Month	X_1 (Ad Spend ₹'000)	X_2 (Discount %)	Y (Sales ₹'000)
1	10	5	40
2	12	6	44
3	14	7	49
4	16	7	52
5	18	8	56
6	20	9	59

3. Given two competing regression equations, calculate and compare their forecast errors (MAD, MSE, RMSE) on test data to choose the best model.

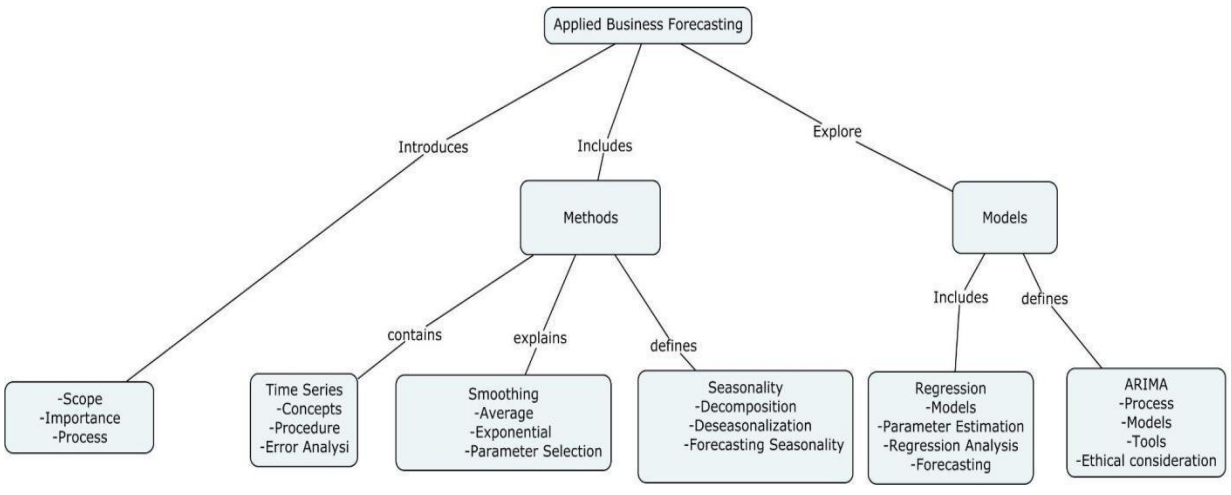
Course Outcome 6 (CO6):

1. Differentiate between Autoregressive (AR), Moving Average (MA), and ARIMA models in terms of their components and assumptions.
2. Using the following dataset, fit an ARIMA(1,1,0) model and forecast the next two values. Compare your results with a simple moving average forecast.

   Data: 52, 57, 60, 65, 70, 74, 80, 85

3. Discuss a case study where ARIMA forecasting can improve decision-making in a business area such as retail inventory control, financial planning, or demand forecasting.

Concept Map



Syllabus

Fundamentals of Business Forecasting and Predictive Analytics: Need and scope - importance in business decision-making- Steps in the forecasting process, data types and sources, qualitative vs. quantitative methods- Introduction to predictive analytics- Business applications in marketing, finance and operations

Time Series Concepts: Time series – trend, seasonality, cyclical and irregular variations, graphical representation and visualization- time series decomposition, data preparation and

transformation, model selection and validation, accuracy measures – MAD, MSE, RMSE, MAPE, error analysis and performance comparison.

Moving Average and Exponential Smoothing Methods: Simple moving average, weighted moving average, exponential smoothing, trend projection using least squares, comparison of smoothing methods,- model updation and parameter selection.

Seasonality and Decomposition Methods: Identification and measurement of seasonal effects, calculation of seasonal indices, decomposition methods, deseasonalizing data, and forecasting with seasonality in retail and service sectors.

Regression-Based Forecasting Model: Concept of causal forecasting, simple and multiple regression models, parameter estimation, model validation, R^2 and adjusted R^2, residual analysis, dummy variables, and business applications of regression forecasting.

ARIMA Process and Predictive Analytics Tools: Autocorrelation, Auto Regression (AR), Moving Average (MA) and ARIMA models, use of tools for analysis, ethical aspects in forecasting.

Case studies: Forecasting product demand using time series models (Ex: Walmart inventory optimization); Predicting customer demand and delivery volume using ARIMA models (Ex: Domino's Pizza order forecasting); Surge pricing and spatio-temporal forecasting through predictive analytics (Ex: Uber demand prediction); Sales forecasting using regression and seasonal trend analysis (Ex: Amazon product demand planning).
Use of tools (Excel, Power BI) for business forecasting analysis

Learning Resources

1. Michael Gilliland, Len Tashman, Udo Sglavo, "Business Forecasting: The Emerging Role of Artificial Intelligence and Machine Learning", Wiley and SAS Business Series, 2021.
2. Makridakis et al., "Forecasting Methods and Applications", 3rd Edition, Willey, 2021.
3. John E Hanke and Dean Wichern, "Business Forecasting", 9th Edition, Pearson, 2020
4. https://onlinecourses.nptel.ac.in/noc24_mg66/preview
5. https://www.coursera.org/specializations/excel-skills-for-business-forecasting

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Fundamentals of Business Forecasting and Predictive Analytics**	**6**	CO1
1.1	Need and scope - importance in business decision-making	1	CO1
1.2	Steps in the forecasting process	1	CO1
1.3	data types and sources	1	CO1
1.4	qualitative vs. quantitative methods	1	CO1
1.5	Introduction to predictive analytics	1	CO1
1.6	Business applications in marketing, finance and operations	1	CO1
2	**Time Series Concepts**	**4**	CO2

2.1	Time series – trend, seasonality, cyclical and irregular variations, graphical representation and visualization	1	CO2
2.2	time series decomposition	1	CO2
2.3	data preparation and transformation, model selection and validation	1	CO2
2.4	accuracy measures – MAD, MSE, RMSE, MAPE, Error analysis and performance comparison.	1	CO2
3	**Moving Average and Exponential Smoothing Methods**	**8**	CO3
3.1	Simple moving average, weighted moving average	2	CO3
3.2	Exponential smoothing	1	CO3
3.3	trend projection using least squares	2	CO3
3.4	comparison of smoothing methods	2	CO3
3.5	Model updation and parameter selection	1	CO3
4	**Seasonality and Decomposition Methods**	**6**	CO4
4.1	Identification and measurement of seasonal effects	1	CO4
4.2	calculation of seasonal indices	1	CO4
4.3	decomposition methods	2	CO4
4.4	deseasonalizing data, and forecasting with seasonality in retail and service sectors.	2	CO4
5	**Regression-Based Forecasting Models**	**7**	CO5
5.1	Concept of causal forecasting	1	CO5
5.2	simple and multiple regression models	1	CO5
5.3	parameter estimation, model validation	1	CO5
5.4	R^2 and adjusted R,	2	CO5
5.5	residual analysis, dummy variables, and business applications of regression forecasting	2	CO5
6.	**ARIMA Process and Predictive Analytics Tools**	**5**	CO6
6.1	Autocorrelation	1	CO6
6.2	Auto Regression (AR), Moving Average (MA) ARIMA models	2	CO6
6.3	use of tools for analysis	1	CO6
6.4	Ethical aspects in forecasting	1	CO6
	TOTAL	**36 Hours**	

Course Designers:

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2. Mr. M.Venkatesh mvhca@tce.edu

21CBQL1	CUSTOMER ANALYTICS

Category	L	T	P	Credit	Terminal Exam Type
PSE	3	0	0	3	Theory

Preamble

This course introduces the foundational concepts of the customer lifecycle, behavior models, and key customer metrics. By integrating real-world case studies, Students will learn to apply various customer acquisition and retention metrics and uplift modelling to enhance customer experience and business performance while ensuring fairness, transparency, and privacy.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	Course Outcome Statement	Weightage in %
CO1	Understand the ecosystem of customer analytics and its data sources.	10
CO2	Use traditional and contemporary customer behavior models to interpret consumer decisions.	15
CO3	Apply suitable customer metrics to improve customer acquisition.	25
CO4	Apply retention analytics and personalization techniques to enhance customer value.	25
CO5	Develop privacy-aware uplifting models to improve customer engagement.	15
CO6	Apply analytical techniques and behavioral insights through real-world case studies.	10

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO#	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond	-	1.1, 1.2, 4.4.3
CO2	TPS3	Apply	Value	-	1.1, 1.2, 2.4.6
CO3	TPS3	Apply	Value	-	1.1, 1.2, 2.1.5, 2.4.6
CO4	TPS3	Apply	Value	-	1.1, 1.2, 2.1.5, 2.2.3,2.4.6
CO5	TPS3	Apply	Value	-	1.1, 1.2, 2.4.3 , 3.2, 2.4.6, 2.5.1
CO6	TPS3	Apply	Value	-	1.2, 2.1.5, 2.4.3, 3.2,4.4.3

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L										L		
CO2	S	M	L	M	M	L				L		M	L	L
CO3	S	M	L	M	M	L		L		L	L	M	L	L
CO4	S	M	L	M	M	L		L		L	L	M	L	L
CO5	S	M	L	M		M	M	M	M	M	L	M	L	L
CO6	S	M	L	M		M		M		M	L	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	2	1	2	
Remember	20	20	-	-	20
Understand	20	20	40	40	20
Apply	60	60	60	60	60
Analyse	-	-	-	-	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject /Assignment/Practical Component
Perception	-
Set	-
Guided Response	-
Mechanism	-
Complex Overt Responses	-
Adaptation	-
Origination	-

Sample Questions for Course Outcome Assessment**

** (2 to 3 at the cognitive level of course outcome)

Course Outcome 1(CO1):

1. Describe how customer analytics can enhance customer experience across different touch points.
2. Differentiate between descriptive and predictive uses of customer analytics within business contexts.
3. Explain the stages of the customer lifecycle and how analytics supports each stage.

Course Outcome 2(CO2):

1. A streaming platform introduces a reward system for frequent viewers. Using the Learning Model, explain how this tactic can reinforce user engagement.
2. A fashion brand notices that customers' clothing choices change after moving to urban areas. How can the *Sociological Model* help explain this shift?
3. Identify at which stage of the *EKB model* digital advertising is most effective and justify your reasoning.

Course Outcome 3(CO3):

1. A startup uses dashboards to track campaign performance in real time. Incorporate the benefits of MKIS to explain how this supports marketing agility and data-driven decisions.
2. A company spends ₹1,00,000 on digital ads and acquires 200 new customers. Calculate the cost per customer and interpret what this means for marketing efficiency.

3. Estimate the lifetime value of a customer who spends ₹1,000 per month with a 20% profit margin and an average retention period of 24 months.

Course Outcome 4 (CO4):

1. A company had 2,000 customers at the start of the quarter, acquired 400 new ones, and ended with 2,100 customers. Calculate the retention and churn rate.
2. A telecom firm lost 120 customers out of 1,500 this month. Compute the churn rate and suggest one actionable tactic to reduce it.
3. For the customer data like age, tenure, purchase frequency, support tickets, build a simple logistic regression model to predict churn, and interpret the coefficients.

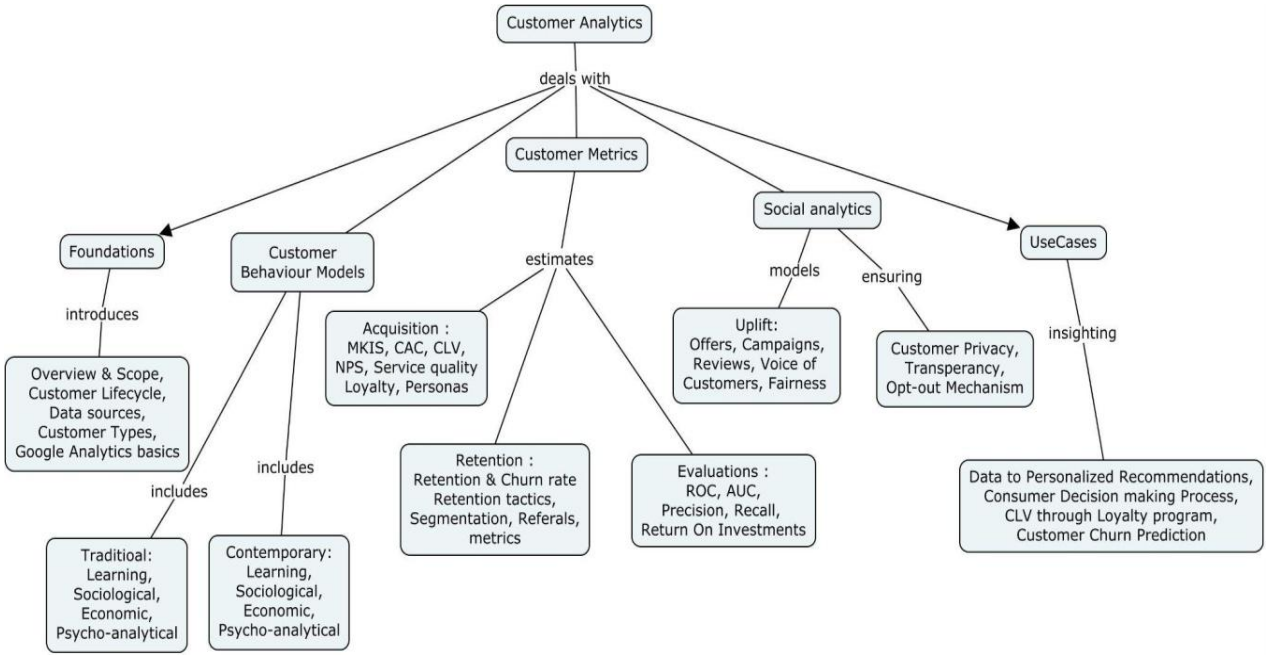
Course Outcome 5 (CO5):

1. A retail company runs two marketing campaigns, one for customers who received an offer and one for those who did not. Use uplift modelling to measure the true incremental impact of the offer on purchase behavior.
2. Design a VoC feedback loop that integrates review data directly into marketing or product development cycles.
3. Use fairness metrics (e.g., demographic parity, equal opportunity) to assess bias in an AI-based offer targeting model.

Course Outcome 6 (CO6):

1. Predict Customer Churn Using Behavioral Data (e.g., Telecom Industry).
2. Design a customer persona and apply both models to explain how internal and external factors drive that persona's brand choice.
3. Using sample transaction data, calculate pre- and post-program retention rates and interpret how loyalty initiatives enhance CLV.

Concept Map



Syllabus

Foundations of Customer Analytics: Overview & Scope; Customer Lifecycle; Data sources: first-party (CRM, web/app logs), second-party, third-party, primary vs. secondary data; Customer Types: Google Analytics basics for customer measurement.

Customer Behavior Models: Traditional Models: Learning, Sociological, Economic, Psychoanalytical; Contemporary models: Engel-Kollat-Blackwell (EKB), Howard-Sheth, Nicosia, Black Box; Determinants: needs, motivation, personality, perception, and attitude.

Customer Metrics Analytics: Marketing Information Systems (MKIS): Components, Types, Benefits; Customer Acquisition analytics: Customer Acquisition Cost (CAC), Customer Lifetime Value (CLV), Contractual vs. Non-Contractual settings, Satisfaction, Net Promoter Score (NPS), Service quality, Brand loyalty; Personas, Journey Map.

Retention & Profitability: Customer Retention analytics: Retention rate, Churn rate, Retention tactics, Churn Prediction, Customer Segmentation for Profitability, Customer Referral Value; Designing research & surveys: Questionnaire, Scaling, Sampling; Evaluation metrics: ROC, AUC, Precision, Recall, Return On Investments.

Social Analytics & Privacy: Uplift Analytics: Offer Campaigns, Win-back Campaigns; Reviews & Voice-of-customer, Fairness in targeting, Opt-out mechanisms, Privacy-preserving personalization: Protecting Identity in Voice, Chat, and Text Analytics, Transparency in decisions and cookie usage.

Case Studies: Leveraging First-Party Data to Personalize Recommendations (Ex: Netflix); Analyzing the Consumer Decision making Process (Ex: iPhone Purchase) by Mapping the stages of EKB and Howard-Sheth models; Enhancing Customer Lifetime Value through Loyalty program (Ex: Starbucks Rewards Program); Predicting Customer Churn using behavioral data (Ex: Telecom).

Learning Resources

Text Books

1. "Consumer Behaviour and Analytics", Andrew Smith, 2nd Edition, Routledge, 2024
2. "Customer Insights," Aila Khan, Second Edition, Western Sydney University, 2023
3. "Customer Analytics for Dummies", Jeff Sauro, Wiley – 2020

Reference Books

1. "Advanced Customer Analytics," Mike Grigsby, Kogan page , 2016
2. https://onlinecourses.swayam2.ac.in/imb24_mg124/preview
3. https://blog.hubspot.com/service/consumer-behavior-model

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Foundations of Customer Analytics**	**4**	CO1
1.1	Overview & Scope; Customer Lifecycle	1	CO1
1.2	Data sources: first-party (CRM, web/app logs), second-party, third-party, primary vs. secondary data	1	CO1
1.3	Customer Types	1	CO1
1.4	Google Analytics basics for customer measurement.	1	CO1
2	**Customer Behavior Models**	**5**	CO2
2.1	Traditional Models: Learning, Sociological, Economic, Psychoanalytical	2	CO2
2.2	Contemporary models: Engel-Kollat-Blackwell (EKB), Howard-Sheth, Nicosia, Black Box	2	CO2
2.3	Determinants: needs, motivation, personality, perception, attitude	1	CO2

3	**Customer Metrics Analytics**	**9**	CO3
3.1	Marketing Information Systems (MKIS): Components, Types, Benefits	2	CO3
3.2	Customer Acquisition analytics: Customer Acquisition Cost (CAC), Customer Lifetime Value (CLV)	2	CO3
3.3	Contractual vs. Non-Contractual settings, Satisfaction,	1	CO3
3.4	Net Promoter Score (NPS), Service quality, Brand loyalty	2	CO3
3.5	Personas, Journey Map	2	CO3
4	**Retention & Profitability**	**9**	CO4
4.1	Customer Retention analytics: Retention rate, Retention tactics , Churn rate	2	CO4
4.2	Churn Prediction	2	CO4
4.3	Customer Segmentation for Profitability, Customer Referral Value	2	
4.4	Designing research & surveys: Questionnaire, Scaling, Sampling	1	CO4
4.5	Evaluation metrics: ROC, AUC, Precision, Recall, Return On Investments	2	CO4
5	**Social Analytics & Privacy**:	**5**	CO5
5.1	Uplift Analytics: Offer Campaigns, Win-back Campaigns	2	CO5
5.2	Reviews , Voice-of-customer, Fairness in targeting, Opt-out mechanisms	1	CO5
5.3	Privacy-preserving personalization: Protecting Identity in Voice, Chat, and Text Analytics, Transparency in decisions & cookie usage,	2	CO5
6.	**Case Studies**	**4**	CO6
6.1	Leveraging First-Party Data to Personalize Recommendations (Ex: Netflix)	1	CO6
6.2	Analyzing the Consumer Decision making Process (Ex: iPhone Purchase) by Mapping the stages of the EKB and Howard-Sheth models	1	CO6
6.3	Enhancing Customer Lifetime Value through Loyalty Programs (Ex: Starbucks Rewards Program)	1	CO6
6.4	Predicting Customer Churn using behavioral data (Ex: Telecom).	1	CO6
	TOTAL	**36 Hours**	

Course Designers:

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CURRICULUM AND DETAILED SYLLABI

FOR

B.TECH DEGREE (Computer Science and Business Systems) PROGRAMME

INDUSTRY SUPPORTED COURSES

FOR THE STUDENTS ADMITTED FROM THE

ACADEMIC YEAR 2025 – 2026 ONWARDS

THIAGARAJAR COLLEGE OF ENGINEERING

(A Government Aided ISO 9001-2008 Certified

Autonomous Institution affiliated to Anna University)

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21CB1A1	DEVOPS

Category	L	T	P	Credit	Terminal Exam Type
PEES	1	0	0	1	Theory

Preamble

The DevOps Foundation course provides a comprehensive overview of understanding the DevOps competencies needed to accelerate time-to-market by improving the flow of value through the continuous delivery pipeline. Students will map the current value stream through their delivery pipeline from idea to cash, and identify practices that will eliminate bottlenecks to flow

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Gain insights into the DevOps environment and execute various Git commands	15
CO2	Managing authorization in Jenkins, Build and deploy codes using Jenkins and perform testing with selenium	15
CO3	Utilize Ansible CLI, execute Ansible Ad-Hoc Commands for one-off tasks and perform various actions using Docker CLI	20
CO4	Learn about Kubernetes Core Concept, Deploy Pods and scale your containerized Applications	20
CO5	Implementation of Devops using AWS cloud	15
CO6	Implement the latest releases such as Canary releases, Dark launches, Chaos Engineering	15

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond	-	1.2, 1.3
CO2	TPS3	Apply	Value	-	1.2, 1.3, 2.1.2, 3.2.3, 4.5.3
CO3	TPS3	Apply	Value	-	1.2, 1.3, 2.1.2, 3.2.3, 4.3.2
CO4	TPS3	Apply	Value	-	1.2, 1.3, 2.1.2, 3.2.3, 4.5.3
CO5	TPS3	Apply	Value	-	1.2, 1.3, 2.1.2, 3.2.3, 4.5.3
CO6	TPS3	Apply	Value	-	1.2, 1.3, 2.1.2, 3.2.3, 4.5.3

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L										L		
CO2	S	M	L		S	L	L				L	M	L	L
CO3	S	M	L		S	L	L				L	M	L	L
CO4	S	M	L		S	L	L				L	M	L	L
CO5	S	M	L		S	L	L				L	M	L	L
CO6	S	M	L		S	L	L				L	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive levels	**CAT/Terminal Examination**
Remember	20
Understand	30
Apply	50
Analyse	0
Evaluate	0
Create	0

Sample Questions for Course Outcome Assessment**

Course Outcome 1(CO1):

1. Explain briefly about Devops life cycle
2. If you want to develop a new project in Devops platform what are the preparatory things you need?.
3. Suppose you want to configure GIT repository so that it runs the code sanity checking tooks before any commits? How do you prevent it from happening again if the sanity testing fails? And explain the basic GIT Commands

Course Outcome 2(CO2):

1. Explain in detail about architecture of Jenkins
2. Suppose you want to integrate the code in to shared repository how it will achieve?
3. How to automate Testing in DevOps lifecycle?
4. Which Testing tool are you comfortable with and what are the benefits of that tool?

Course Outcome 3(CO3):

1. Suppose you want to deploy the code how does Ansible work?
2. How exactly are containers (Docker in our case) different from hypervisor virtualization (vSphere)? What are the benefits?
3. Can I use json instead of yaml for my compose file in Docker?

Course Outcome 4 (CO4):

1. What are the main differences between the Docker Swarm and Kubernetes?
2. Give examples of recommended security measures for Kubernetes.
3. Consider you have 5-6 microservices for a single application performing various tasks, and all these microservices are put inside containers. How to make sure that these containers communicate with each other we need container orchestration?

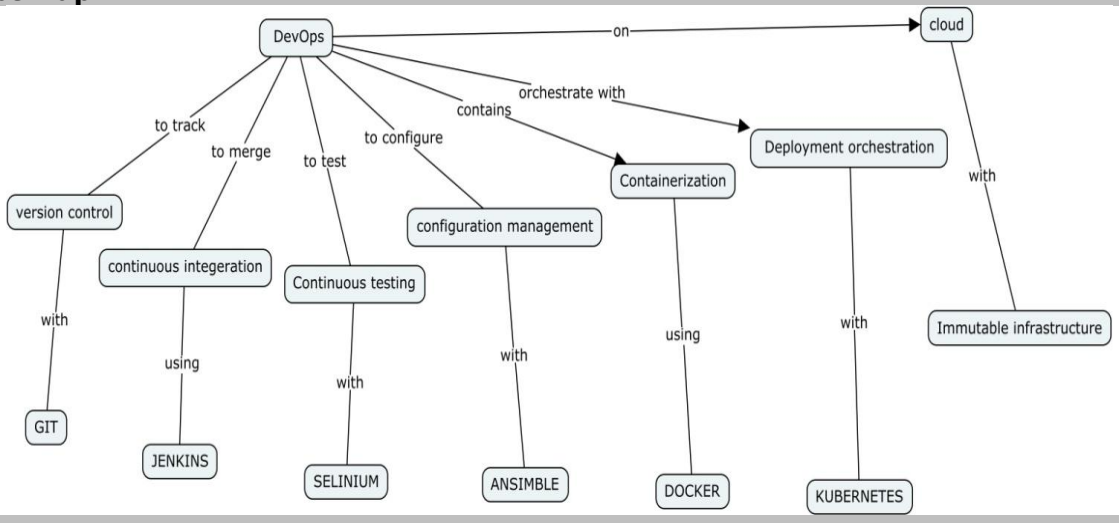
Course Outcome 5 (CO5):

1. Explain with a use case where DevOps can be used in industry / real life.
2. Explain your understanding and expertise on both the software development side and the technical operations side of an organization you have worked with in the past?

Course Outcome 6(CO6):

1. How to achieve chaos engineering like netflix & amazon (with kolton andrus from gremlin)
2. Your software development teams want to release new product features frequently, but without endangering established production systems or confusing users who are familiar with the existing customer experience. What are the latest releases in Devops? Explain
3. What is canary testing?

Concept Map



Syllabus

- Overview & Principles of DevOps
- Version control with GIT
- Continuous integration using Jenkins
- Continuous testing with Selenium
- Continuous deployment; Configuration management with Ansible
- Containerization with Docker
- Deployment orchestration using Kubernetes
- Continuous Monitoring
- Introduction to DevOps on Cloud; Immutable Infrastructure
- Canary releases, Dark launches, Chaos Engineering
- Tools Used: GCP, GIT, Jenkins, Maven, selenium, Ansible, Docker, Kubernetes

Learning Resources

1. Devops basics - https://learning.tcsionhub.in/courses/industry-honour- certification/basic-devops
2. GIT basics - https://git-scm.com/
3. Kubernetes Basics - https://kubernetes.io/docs/tutorials/kubernetes-basics/
4. Jenkins basics - https://www.jenkins.io/doc/tutorials/
5. Docker-https://docs.docker.com/get-started/
6. Selenium testing - https://www.softwaretestingmaterial.com/selenium-tutorial/

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1	Overview & Principles of DevOps	1	CO1
2	Version control with GIT	1	CO1
3	Continuous integration using Jenkins	1	CO2
4	Continuous testing with Selenium	1	CO2
5	Continuous deployment; Configuration management with Ansible	2	CO3
6	Containerization with Docker	1	CO3
7	Deployment orchestration using Kubernetes	2	CO4
8	Continuous Monitoring	1	CO4
9	Introduction to DevOps on Cloud; Immutable Infrastructure	2	CO5
10	Canary releases, Dark launches, Chaos Engineering	2	CO6
Total		14	

Course Designers:

1. Dr. A. Malini amcse@tce.edu
2. Mr. V. Janakiraman vjncse@tce.edu
3. Expert from TCS

21CB2A1	APPLICATION SECURITY

Category	L	T	P	Credit	Terminal Exam Type
PEES	2	0	0	2	Theory

Preamble

The syllabus is designed for the students to learn and understand the basic concepts of application security. It gives a brief overview of all the aspects involved with Application Security. It examines secure coding practices and processes, web application security configuration management techniques, and web application security standards, also learn the convergence between web application security and associated threat vectors/attack methods.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Understand the concepts of OWASP 10 and Fundamentals of application security keywords	15
CO2	Explain the web application security vulnerabilities and different Attacks	35
CO3	Demonstrate the Installation & Setting up a proxy on Android & iOS mobile devices	20
CO4	Apply Hacking concepts in real-time mobile applications.	10
CO5	Apply IDOR attacks using the BurpSuite Autorize plugin	10
CO6	Analyze JavaScript files for secret endpoints Scanning websites using Acunetix	10

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO#	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond	-	1.2,1.3
CO2	TPS2	Understand	Respond	-	1.2, 1.3,2.1.2, 3.2.3,4.5.3
CO3	TPS2	Understand	Respond	-	1.2, 1.3,2.1.2, 3.2.3,4.3.2
CO4	TPS3	Apply	Value	-	1.2, 1.3,2.1.2, 3.2.3,4.5.3
CO5	TPS3	Apply	Value	-	1.2, 1.3,2.1.2, 3.2.3,4.5.3
CO6	TPS2	Apply	Value	-	1.2, 1.3,2.1.2, 3.2.3,4.5.3

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L										L		
CO2	M	M										L		
CO3	M	M	L		M	L				L	L	L	L	L
CO4	S	M	M	L	M	L				L	L	M	L	L
CO5	S	M	M	L	S	L				L	L	M	L	L
CO6	S	M	M	L	S	L				L	L	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	CAT/Assignment	Terminal Examination
Remember	-	20
Understand	50	40
Apply	50	40
Analyse	-	0
Evaluate	-	0
Create	-	0

Sample Questions for Course Outcome Assessment**

** (2 to 3 at the cognitive level of course outcome)

Course Outcome1(CO1):

1. What is Application Security?
2. What are the three phases of application security?
3. Explain about Web Application Penetration Testing

Course Outcome2(CO2):

1. Discuss protection against CSRF?
2. Write a note on database vulnerabilities. Discuss some mechanisms to handle it.
3. Describe how source code disclosure can be effectively used to safeguard against the vulnerabilities in applications

Course Outcome3(CO3):

1. What is server hacking?
2. Define Hunt Vulnerabilities
3. Exfiltrating Sensitive Information by CORS Vulnerability

Course Outcome 4 (CO4):

1. Explain API keys
2. Describe about HTTP Requests in Burp Suite
3. Discover the Automating IDOR attacks using the BurpSuite Autorize plugin

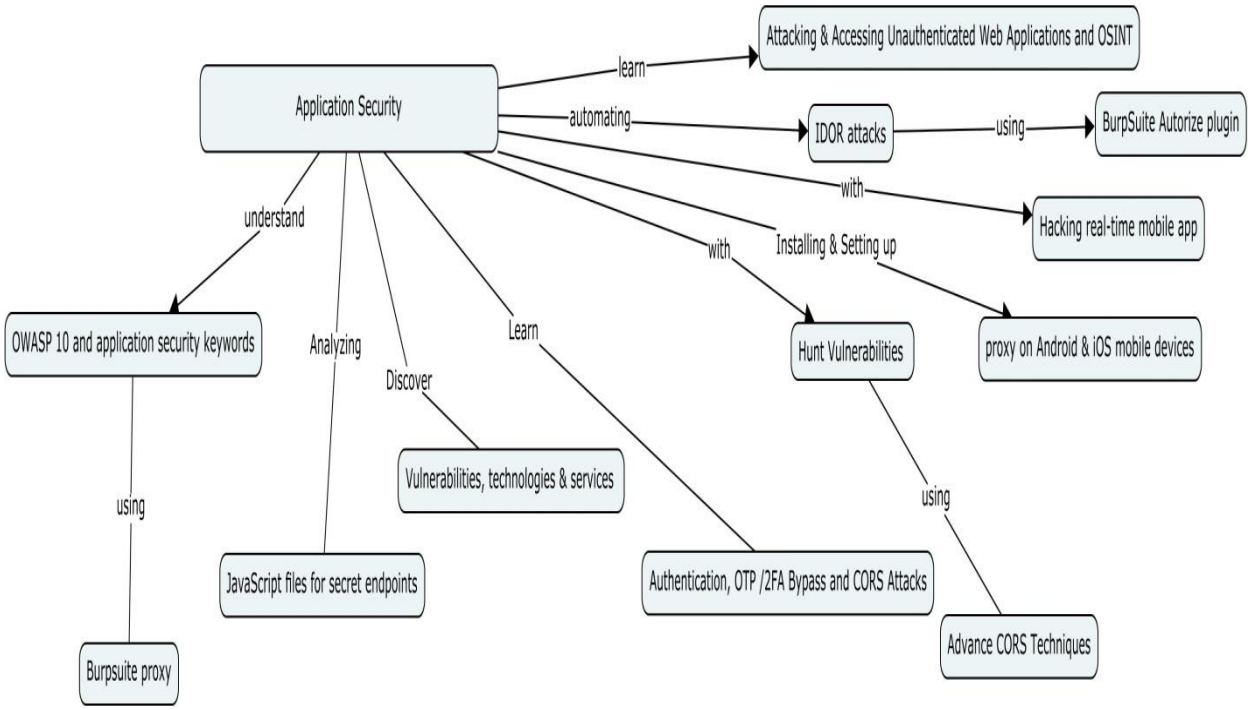
Course Outcome 5 (CO5):

1. What are the measures that one should take to secure his application?
2. Apply the Hacking techniques with Shodan

Course Outcome6(CO6):

1. Explain OSINT
2. Explore the secrets from GitHub commits
3. Illustrate the Scanning of websites using Acunetix.

Concept Map



Syllabus

OWASP10 and Fundamentals: Understanding application security keywords, Intercept requests using a Burpsuite proxy, Web Application Penetration Testing-Live

Discover Vulnerabilities and Attacks: Vulnerabilities technologies & services used on the target website, Gain full control over the target server using Authentication Bypass Attacks, OTP/2FA Bypass Attacks and using CSRF Attacks, Break down of XSS of all Hackerone Reports by Hackers.

CSRF: Hunt Vulnerabilities using Advance CSRF Techniques, Perform Complete Account Take over using CSRF on Live, Fix and Mitigations against CSRF Vulnerabilities

CORS Attacks: Gain full control over the target server using CORS Attacks, Hunt Vulnerabilities using Advance CORS Techniques, Exfiltrating Sensitive Information by CORS Vulnerability, Fix and Mitigations against CORS Vulnerabilities

Installing & Setting up a proxy on Android & iOS mobile devices, Intercepting HTTP Requests in Burp Suite, Hacking real-time mobile app tra c & changing the values, Hunting for secrets & API keys inside application source code

IDOR attacks: Automating IDOR attacks using the BurpSuite Autorize plugin

Application Security: Introduction to Reconnaissance of Application Security, Live Hacking with Shodan, Attacking & Accessing Unauthenticated Web Applications

OSINT: Introduction to OSINT, Exploring secrets from GitHub commits, Analyzing JavaScript files for secret endpoints, Scanning websites using Acunetix

Learning Resources

1. Andrew Hoffman., "Web Application Security: Exploitation and Countermeasures for Modern Web Applications", 1st Edition, O'Reilly Media,2020.
2. Roger A Grimes, "The Web Application Hacker's Handbook: Finding and Exploiting Security Flaws", 2nd edition, Wiley, 2011.
3. DafyddStuttard and Marcus Pinto, "The Web Application Hacker's Handbook: Discovering and Exploiting Security Flaws", Wiley, 2008.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	OWASP10andFundamentals - Understanding application security keywords Intercept requests using a Burpsuite proxy	2	CO1
2.	Web Application Penetration Testing–Live	2	CO1
3.	Discover Vulnerabilities, technologies & services used on the target website	2	CO2
4.	Gain full control over the target server using Authentication Bypass Attacks and OTP/2FA Bypass Attacks	2	CO2
5.	Break down of XSS of all Hackerone Reports by Hackers, Gain full control over target server using CSRF Attacks	2	CO2
6.	Hunt Vulnerabilities using Advance CSRF Techniques, Perform Complete Account Takeover using CSRF on Live	2	CO2
7.	Fix and Mitigations against CSRF Vulnerabilities Gain full control over the target server using CORS Attacks	2	CO2
8.	Hunt Vulnerabilities using Advance CORS Techniques, Exfiltrating Sensitive Information by CORS Vulnerability	2	CO3
9.	Fix and Mitigations against CORS Vulnerabilities Installing & Setting up a proxy on Android & iOS mobile devices	2	CO3

10.	Intercepting HTTP Requests in Burp Suite, Hacking real-time mobile app tra c & changing the values	2	CO4
11.	Hunting for secrets & API keys inside application source code, Automating IDOR attacks using the BurpSuite Autorize plugin	2	CO4
12.	Introduction to Reconnaissance of Application Security, Live Hacking with Shodan	2	CO5
13.	Attacking & Accessing Unauthenticated Web Applications, Introduction to OSINT	2	CO6
14.	Exploring secrets from GitHub commits Analyzing JavaScript files for secret endpoints Scanning websites using Acunetix	2	CO6
	Total	**28**	

Course Designers:

1. Mr.Udhaya Prakash Senior Application Security Engineer, Poshmark
2. Mrs.P.Suganthi psica@tce.edu

21CB1B1	VERSION CONTROL SYSTEM WITH GIT AND GITHUB

Category	L	T	P	Credit	Terminal Exam Type
PEES	1	0	0	1	Theory

Preamble

The Version Control with Git and GitHub course provides with a solid, hands-on foundation for understanding the Git version control system. Students will create a new Git project and configure it. They will also commit and review changes to code by using Git. Students will learn GitHub working and also add existing projects to GitHub.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	To understand basics of Git and GitHub and its difference from any centralized version control systems.	10
CO2	Implement Git operations such as create, change, stage, commit and view.	15
CO3	Create new repositories and clone those repositories on GitHub.	20
CO4	Implement new branches, merge local branches and share to a server.	15
CO5	Develop own git repository to collaborate and share the work with others.	25
CO6	Implement advanced git techniques such as tagging release, Stashing changes, Cherry-picking commits.	15

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond		1.2,2.1.1,2.1.3
CO2	TPS3	Apply	Value		1.2,2.1.1,2.4.6
CO3	TPS3	Apply	Value		1.2,2.1,1.1
CO4	TPS3	Apply	Value		1.2,2.1.1
CO5	TPS3	Apply	Value		1.2,2.1.1
CO6	TPS3	Apply	Value		1.2, 2.1.1, 2.1.4

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	S	M	L						M	M				L
CO2	M	L	L						L	L				
CO3	S	M	L						M	M				L
CO4	S	M	L						S	M				L
CO5	S	M	L						S	M				L
CO6	S	M	L						S	M				L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	CAT/ Terminal Examination
Remember	20
Understand	30
Apply	50
Analyse	0
Evaluate	0
Create	0

Sample Questions for Course Outcome Assessment**

** (2 to 3 at the cognitive level of course outcome)

Course Outcome 1(CO1):

1. What do you understand by the term 'Version Control System'?
2. What is Git and list its features?
3. List the steps for git installation.
4. Create a repository and add a file to it.

Course Outcome 2(CO2):

1. Illustrate Git objects after second commit.
2. How Do We Know a SHA1 Hash Is Unique?
3. Write the usage of git commit statements using commit- all and give log messages.
4. Configure GitHub repository locally and push it to server.

Course Outcome 3(CO3):

1. Illustrate fetching, pulling requests from remote repository.
2. Explain techniques to resolve merge conflict and ways to skip it.

Course Outcome 4 (CO4):

1. How will you know in GIT if a branch has been already merged into master?
2. Elaborate on branching strategies with suitable example.
3. How to give an access to a specific person to repository?

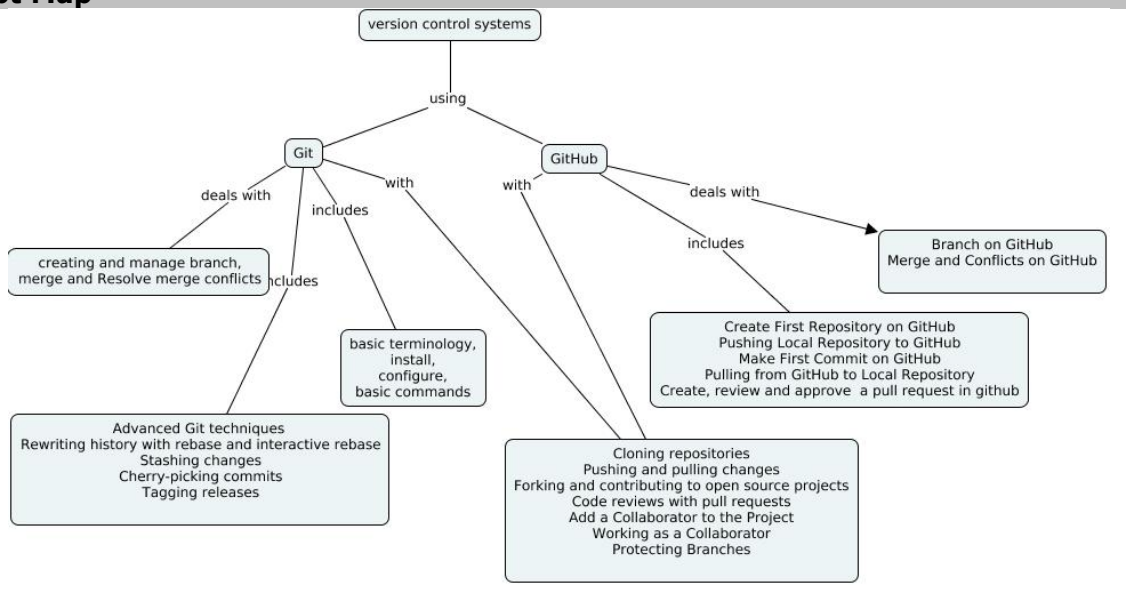
Course Outcome 5 (CO5):

1. Differentiate git merge and git rebase.
2. Elaborate on Git References and distinguish between direct and indirect commit statements.

Course Outcome 6(CO6):

1. Depict setting up git environment variables to determine its behaviour.
2. Explain stashing and cleaning operations with example.
3. Apply Commit through git SVN rebase.

Concept Map



Syllabus

Introduction to version control and Git - Overview of version control and Git- Benefits of using Git- Git terminology and concepts

Setting up Git and basic commands- Installing Git- Configuring Git- Basic Git commands: init, add, commit, status, log, diff, reset

The Basics of GitHub- Definition- Create First Repository on GitHub- Pushing Local Repository to GitHub- Make First Commit on GitHub- Pulling from GitHub to Local Repository- Creating a pull request in github- Review and Approve pull request

Branching and merging- Creating and managing branches- Merging branches- Resolving merge conflicts- Branching strategies- Branching on GitHub- Merge Conflicts on GitHub

Collaborating with Git and GitHub- Cloning repositories- Pushing and pulling changes- Forking and contributing to open source projects- Code reviews with pull requests- Add a Collaborator to the Project- Working as a Collaborator- Protecting Branches

Advanced Git techniques- Rewriting history with rebase and interactive rebase- Stashing changes- Cherry-picking commits- Tagging releases

Learning Resources

1. Prem Kumar Ponuthorai, Jon Loeliger, Version Control with Git, 3rd edition, O'Reilly Media, Inc, October,2022.
2. Scott Chacon, Ben Straub, Pro Git book, 2nd edition, Apress publisher, 2014.
3. Git basics- https://git-scm.com/

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1	**Introduction to version control and Git**		
1.1	Overview of version control and Git- Benefits of using Git- Git terminology and concepts	1	CO1
2	**Setting up Git and basic commands**		
2.1	Installing Git- Configuring Git	1	CO2
2.2	Basic Git commands: init, add, commit, status, log, diff, reset	1	CO2
3	**The Basics of GitHub**		
3.1	Definition- Create First Repository on GitHub- Pushing Local Repository to GitHub	1	CO3
3.2	Make First Commit on GitHub- Pulling from GitHub to Local Repository	1	CO3
3.3	Creating a pull request in github- Review and Approve pull request	1	CO3
4	**Branching and merging**		
4.1	Creating and managing branches- Merging branches- Resolving merge conflicts	1	CO4
4.2	Branching strategies- Branching on GitHub- Merge Conflicts on GitHub	1	CO4
5	**Collaborating with Git and GitHub**		
5.1	Cloning repositories- Pushing and pulling changes	1	CO5
5.2	Forking and contributing to open source projects- Code reviews with pull requests	2	CO5
5.3	Add a Collaborator to the Project- Working as a Collaborator- Protecting Branches	1	CO5
6	**Advanced Git techniques**		
6.1	Rewriting history with rebase and interactive rebase	1	CO6
6.2	Stashing changes- Cherry-picking commits- Tagging releases	1	CO6
	TOTAL	**14**	

Course Designers:

1. Ms. R.Subhashni rsica@tce.edu
2. Mr. Sasikumar, Lead Consultant, ThoughtWorks

21CB2B1	MERN Stack

Category	L	T	P	Credit	Terminal Exam Type
PEES	2	0	0	2	Theory

Preamble

The course explores the knowledge and skill about front-end and back-end servers. The students should able to develop web and hybrid mobile apps, as well as server-side support, to build a multi-platform solution.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Create a framework to build interactive user interfaces and web applications using ReactJS	20
CO2	Apply Hook in-built functions to use state and lifecycle methods inside functional components.	15
CO3	Understand the schemas and relation for unstructured database.	15
CO4	Create open-source document oriented database for holding largeamount of data using MongoDB	20
CO5	Create single-threaded, open-source, cross-platform server side application using NodeJS	15
CO6	Create web application framework to manage servers and routes using ExpressJS	15

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS3	Apply	Value	Mechanism	1.2, 2.1.2, 3.2.3, 4.5.3
CO2	TPS3	Apply	Value	Mechanism	1.2, 2.1.2, 3.2.3, 4.5.3
CO3	TPS2	Understand	Respond	Guided Response	1.2, 4.3.2
CO4	TPS3	Apply	Value	Mechanism	1.2, 2.1.2, 3.2.3, 4.5.3
CO5	TPS3	Apply	Value	Mechanism	1.2, 2.1.2, 3.2.3, 4.5.3
CO6	TPS3	Apply	Value	Mechanism	1.2, 2.1.2, 3.2.3, 4.5.3

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L										L		
CO2	S	M	L		M	L	L		L		L	M	L	L
CO3	S	M	L		M	L	L		L		L	M	L	L
CO4	S	M	L		M	L	L		L		L	M	L	L
CO5	S	M	L		S	L	L		L		L	M	L	L
CO6	S	M	L		M	L	L		L		L	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive levels	Assignment / CAT / Terminal examination
Remember	10
Understand	30
Apply	60
Analyse	
Evaluate	
Create	

Assessment Pattern: Psychomotor

Psychomotor Skill	**Miniproject /Assignment/Practical Component**
Perception	
Set	
Guided Response	30
Mechanism	70
Complex Overt Responses	
Adaptation	
Origination	

Sample Questions for Course Outcome Assessment**

Course Outcome 1 (CO1):

1. How is React different from AngularJS?
2. Illustrate conditional rendering in ReactJS.
3. What do you know about React Router?

Course Outcome 2 (CO2):

1. How does use State hook operate? What arguments does/does this hook accept, and what doesthe hook return?
2. Give an example of a straightforward Custom React Hook. Why are Custom Hooksnecessary?
3. Illustrate with an example for componentWillMount()?

Course Outcome 3(CO3):

1. Explain the term "Indexing" in Mongodb.
2. Illustrate the process of Sharding.
3. Explain the concept of pipeline in the MongoDB aggregation framework

Course Outcome 4(CO4):

1. Illustrate the Replication Architecture in MongoDB
2. What are some utilities for backup and restore in MongoDB?
3. Illustrate the SET modifier in MongoDB

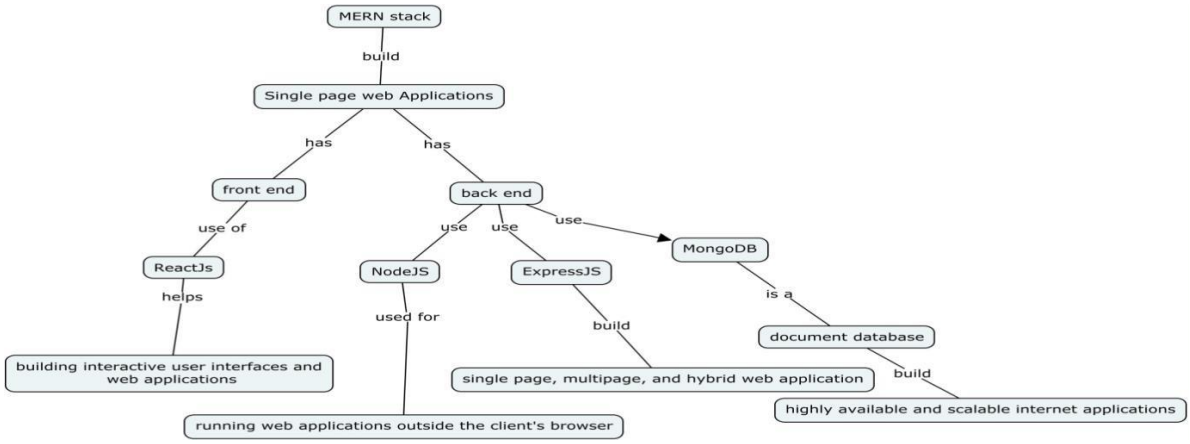
Course Outcome 5(CO5):

1. List down the major benefits of using Node.js?
2. Illustrate Event loop in Node.js and how does it work?
3. Explain REPL in the context of Node.js

Course Outcome 6(CO6):

1. What function are arguments available to Express JS route handlers?
2. How Should I Structure my Express JS Application?
3. Illustrate how to allow CORS in Express JS? Explain with an example.
4. Do Other MVC frameworks also support scaffolding?

Concept Map



Syllabus

REACTJS: HTML CSS Overview - Javascript Overview - ES6 Basics - React Basics (JSX, components, props) - React - State and Lifecycle - Create React App installation and hands on practice - Conditional Rendering, Lists & Keys - States and Props in detail - Problem solving - Application approach - React Router

Hooks Basics - Hooks in Detail (Ref, State, Effect) - Styled Components - State Management Basics - Application data Flow from backend to frontend - Redux - Redux Saga - Overview of our applications

- Features to be built in our application with all the concepts covered

MONGODB – Introduction – No SQL and SQL comparision – why MongoDB? - Understanding the Basics & CRUD Operations - Schemas & Relations: How to Structure Documents - Exploring The Shell & The Server - Using the MongoDB Compass to Explore Data Visually

OPERATIONS ON MONGODB: - Diving into Create Operations - Read Operations - A Closer look - Update Operations - Understanding Delete Operations - Working with Indexes - Working with Geospatial Data - Understanding the Aggregation Framework - Working Numeric Data - MongoDB & Security - Performance, Fault Tolerance & Deployment - Transactions - From Shell to Driver - Introducing Stitch

NODEJS - Understanding the Basics - Working with Express.js - Working with Dynamic Content &Adding Templating Engines - The Model View Controller (MVC) - Dynamic Routes and Advanced Models - Sessions & Cookies - Error Handling - Pagination - Understanding Async Requests - Working with REST APIs - Understanding Async Await in NodeJs - Nodejs and Typescript **EXPRESSJS** - Introduction, Project Setup, Server Setup, Basic Routing Sending Data, Rendering HTML, Routers, Advanced Routing, Middleware, Rendering Static Files, Parsing Form/JSON Data Parse Query Params

Assignment:

Creating a job listing website has never been easier — the easiest to use job board theme available. Create a community of employers and prospective employees.

Learning Resources

1. Vasan Subramanian, "Pro MERN Stack: Full Stack Web App Development with Mongo, Express, React, and Node" 2nd edition, Apress, 2019.
2. Shama Hoque, "Full-Stack React Projects: Learn MERN stack development by building modern web apps using MongoDB, Express, React, and Node.js", 2nd Edition, Packt publishing Ltd, 2021.
3. https://www.udemy.com/course/mern-stack-course-mongodb-express-react-

and-nodejs/

4. https://www.udemy.com/course/react-nodejs-express-mongodb-the-mern-fullstack-guide/

Course Contents and Lecture Schedule

Module no	**Topic**	No of hours	Course outcome
1	**REACTJS**		
1.1	HTML CSS Overview	1	CO1
1.2	Javascript Overview, ES6 Basics		CO1
1.3	React Basics (JSX, components, props)	1	CO1
1.4	React - State and Lifecycle		CO1
1.5	Create React App installation and hands on practice	1	CO1
1.6	Conditional Rendering, Lists & Keys	1	CO1
1.7	States and Props in detail		CO1
1.8	Problem solving - Application approach	1	CO1
1.9	React Router	1	CO1
2	**HOOKS**		
2.1	Hooks Basics	1	CO2
2.2	Hooks in Detail (Ref, State, Effect)		CO2
2.3	Styled Components	1	CO2
2.4	State Management Basics		CO2
2.5	Application data Flow from backend to frontend	1	CO2
2.6	Redux, Redux Saga	1	CO2
3	**MONGODB**		
3.1	Comparison between NoSQL and SQL, Why MongoDB?	1	CO3
3.2	Understanding the Basics & CRUD Operations	1	CO3
3.3	Schemas & Relations: How to Structure Documents	1	CO3
3.4	Exploring The Shell & The Server, Using the MongoDB Compass to Explore Data Visually	1	CO3
4	**OPERATIONS ON MONGODB**		
4.1	Diving into Create Operations, Read Operations - A Closer look	1	CO4
4.2	Update Operations, Understanding Delete Operations	1	CO4
4.3	Working with Indexes, Working with Geospatial Data	1	CO4
4.4	Understanding the Aggregation Framework	1	CO4
4.5	Working Numeric Data , MongoDB & Security	1	CO4
4.6	Performance, Fault Tolerance & Deployment	1	CO4
4.7	Transactions, From Shell to Driver, Introducing Stitch		CO4
5	**NODEJS**		
5.1	Understanding the Basics	1	CO5
5.2	Working with Express.js		CO5
5.3	Working with Dynamic Content & Adding Templating Engines	1	CO5
5.4	The Model View Controller (MVC)		CO5
5.5	Dynamic Routes and Advanced Models		CO5

5.6	Sessions & Cookies	1	CO5
5.7	Error Handling, Pagination, Understanding Async Requests		CO5
5.8	Understanding Async Await in NodeJs,	1	CO5
5.9	Nodejs and Typescript, Working with REST APIs		CO5
6	**EXPRESSJS**		
6.1	Introduction	1	CO6
6.2	Project Setup, Server Setup, Basic Routing		CO6
6.3	Sending Data, Rendering HTML,	1	CO6
6.4	Routers, Advanced Routing		CO6
6.5	Middleware, Rendering Static Files	1	CO6
6.6	Parsing Form/JSON Data	1	CO6
6.7	Parse Query Params		CO6
	Total	**28**	

Course Designers

1. Mr.S.Sowmyanarayanan, Front end developer, Zoho, virvind@gmail.com
2. Mr.V.Janakiraman vjncse@tce.edu

21CB1C1	AUGMENTED REALITY

CATEGORY	L	T	P	CREDIT	TERMINAL EXAM TYPE
PEES	1	0	0	1	Theory

Preamble

This course provides an extensive exploration of Augmented reality (AR) systems. It covers the hardware and software technological details, design ideologies, and real-world applications. The course will enable the students to gather information and build abilities to comprehend and create real world applications using AR.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Explain the historical evolution and the core principles of AR based on the application domain	20
CO2	Demonstrate the various domain environments for developing AR applications	20
CO3	Apply the AR functionalities for constructing AR models for real world applications	15
CO4	Construct the game engine interface and objects to assets various scenes using unity	15
CO5	Build models for marker and markerless based applications	15
CO6	Develop AR application for real world problems to detect the face using AR filters	15

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond		1.1,1.2,1.3,2.1.1
CO2	TPS3	Apply	Value		1.1,1.2,1.3,2.1,2.2.1,4.1,4.3.1
CO3	TPS3	Apply	Value		1.1,1.2,1.3,2.1,2.2,4.1,4.2.1, 4.3.1,4.3.2, 4.3.3,4.4
CO4	TPS3	Apply	Value		1.1,1.2,1.3,2.1,2.2,4.1,4.2.1, 4.3.1,4.3.2, 4.3.3,4.4
CO5	TPS3	Apply	Value		1.1,1.2,1.3,2.1,2.2,4.1,4.2.1, 4.3.1,4.3.2, 4.3.3,4.4
CO6	TPS3	Apply	Value		1.1,1.2,1.3,2.1,2.2,4.1,4.2.1, 4.3.1,4.3.2, 4.3.3,4.4

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L			L	L					L	L	L	L
CO2	S	M	L		S	L	M				L	M	L	L
CO3	S	M	L		S	L	M				M	M	L	M
CO4	S	M	L		S	L	M				M	M	L	M
CO5	S	M	L		M	L	M				M	M	L	M
CO6	S	M	L		M	L	M				M	M	L	M

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	CAT / Terminal Examination
Remember	20
Understand	30
Apply	50
Analyse	
Evaluate	
Create	

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject /Assignment/Practical Component
Perception	
Set	
Guided Response	
Mechanism	
Complex Overt Responses	
Adaptation	
Origination	

Sample Questions for Course Outcome Assessment**

** (2 to 3 at the cognitive level of course outcome)

Course Outcome 1(CO1):

1. Explore the relationship between Augmented Reality and other technologies, such as media
2. Explain 2D and 3D with respect to AR its evolution and background.
3. "Augumented Reality may complement our everyday activities in various ways" – Explain

Course Outcome 2(CO2):

1. Describe in detail the AR Spark its environmental aspects and the core principle in accessing it.
2. Summarize the various AR platforms. Compare its features.
3. What is Stereo technology? And what is software and hardware technology on stereoscopic?

Course Outcome 3(CO3):

1. Explain why deferred lighting optimizes scenes with a lot of lights and elements.
2. Is it possible to properly handle occlusion in Augmented Reality given only an RGB-D input?
3. Describe in detail about the event control functions that are invoked for an application.

Course Outcome 4 (CO4):

1. How to create a QUIZ game interface using Unity and ensure that the answers for the questions are multiple choice questions.
2. Explain about adding a texture to a shape using Loader3D.
3. Explain in brief about different aspects involved in creating a simple 3D sprite application.
4. Describe the functioning of 3D audio chips. Make a drawing and explain.

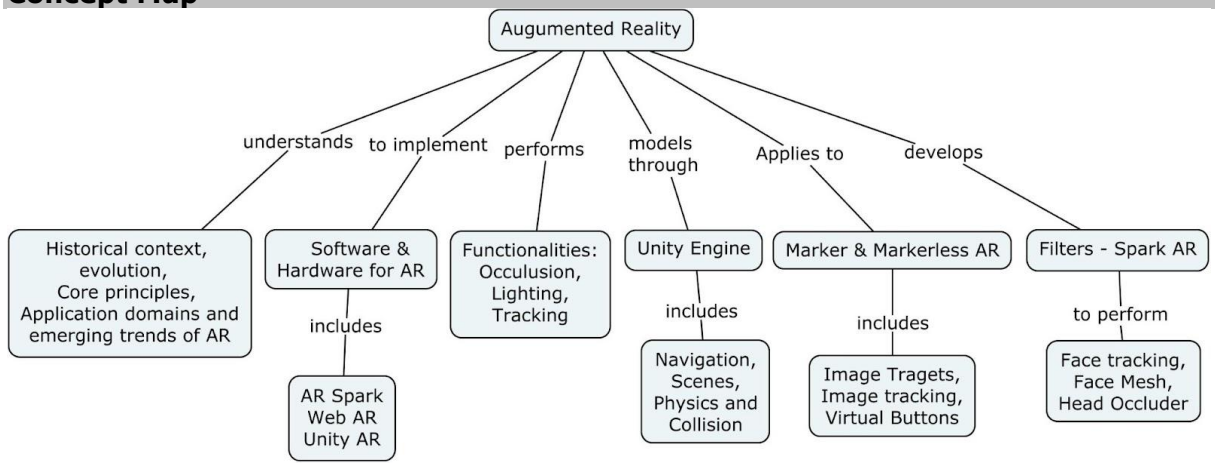
Course Outcome 5 (CO5):

1. Use Virtual Buttons, to change the video to different models with animations and textures.
2. Create Image Targets to select your target images and ensure they adhere to the directions for sizing, defining, and optimizing the images.

Course Outcome 6(CO6):

1. Design a true or false game with multiple random questions using Spark AR Studio.
2. Explain in detail about the constraints that affect the experiences in a mobile based application.
3. "AR displays can be categorized according to the distance from eye to display", explain the various AR display technologies.

Concept Map



Syllabus

Introduction to AR Systems: Historical context and evolution of AR - Core principles - Application domains and emerging trends in AR

Software & Hardware for AR: Fundamentals of ARCore, AR Spark, web AR, Unity AR, Vuforia Engine

AR functionality: Occlusion; Lighting; Tracking; Restrictions of Augmented Reality

UnityEngine: Navigating through Interface, Game Object, Scenes, Physics and Collision

Marker and Markerless based AR: Image Targets and Image Tracking, Virtual Buttons

AR Filters with Spark AR: Face Tracking, Face Mesh, Head Occluder: Case Studies

Learning Resources

1. Ralf Doerner, Wolfgang Broll, Paul Grimm, Bernhard Jung Eds., Virtual and Augmented Reality Foundations and Methods of Extended Realities (XR), Springer, 2022, 978-3-030-79062-2.
2. Allan Fowler- Beginning iOS AR Game Development Developing Augmented Reality Apps with Unity and C#, 1st Edition, Apress Publications, 2018, ISBN 978-1484236178.
3. Steve Aukstakalnis- Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VR, Addison-Wesley Professional, September 2016, ISBN: 9780134094328.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Introduction to AR Systems**:		
1.1	Historical context and evolution of AR	1	CO1
1.2	Core Principles, Application domains and emerging trends	1	CO1
2	**Software & Hardware Development for AR**:		
2.1	Fundamentals of ARCore, AR Spark,	1	CO2
2.2	Web AR, Unity AR, Vuforia Engine	2	CO2
3	**AR functionality:**		
3.1	Occlusion; Lighting;	1	CO3
3.2	Tracking; Restrictions of Augmented Reality	1	CO3
4.	**Unity Engine:**		
4.1	Navigating through Interface, Game Object, Scenes,	1	CO4
4.2	Physics and Collision	1	CO4
5.	**Marker and Markerless based AR**:		
5.1	Image Targets and Image Tracking,	1	CO5
5.2	Virtual Buttons	1	CO5
6	**AR Filters with Spark AR:**		
6.1	Face Tracking, Face Mesh,	1	CO6
6.2	Head Occluder: Case Studies	2	CO6
	TOTAL	14	

Course Designers:

1. Mr. Nirmal, Wizardlenz XR Studio (opc) pvt Ltd nirmaljeyavelraj.work@gmail.com
2. Dr. J. Felicia Lilian jflcse@tce.edu

21CB1D1	FOUNDATION OF NLP

Category	L	T	P	Credit	Terminal Exam Type
PEES	1	0	0	1	Theory

Preamble

This course helps to gain the knowledge about collect, clean, and analyze text data to gain valuable insight from the given text data or real-world tasks. It offers a technical understanding of applying NLP techniques to extract insights from text data, aiding in the solution of real-world problems.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage* ** in %
CO1	Understand the basic concepts of Natural Language Processing (NLP), including its major tasks, challenges, building block and the importance of text data in NLP applications.	20
CO2	Apply data cleaning and preprocessing techniques for text data in real world task.	20
CO3	Implement various text representation and feature engineering methods, such as Bag of Words, Bigram models, TF-IDF, and Word Embeddings.	30
CO4	Apply advanced NLP techniques, including semantic similarity, topic modelling and sequence modelling information extraction from unstructured text to solve real-world problems.	30

*** Weightage depends on Bloom's Level, number of contact hours

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond		1.2,2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3
CO2	TPS3	Apply	Value		1.2,2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3
CO3	TPS3	Apply	Value		1.2,2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3
CO4	TPS3	Apply	Value		1.2,2.1.5,2.2.3,2.5.1,3.2.3, 4.5.3

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L			M	L			M		M	L		
CO2	S	M	L		S				S		M	L		
CO3	S	M	L		S		L		M		S	L		
CO4	S	M	L		S	M	M		L		S	L		

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Terminal Examination
Remember	20
Understand	30
Apply	50
Analyse	-
Evaluate	-
Create	-

Assessment Pattern: Psychomotor

Psychomotor Skill	Mini project /Assignment/Practical Component
Perception	-
Set	-
Guided Response	-
Mechanism	-
Complex Overt Responses	-
Adaptation	-
Origination	-

Sample Questions for Course Outcome Assessment**

** (2 to 3 at the cognitive level of course outcome)

Course Outcome 1(CO1):

1. Explain the major tasks involved in Natural Language Processing (NLP) and how they contribute to the understanding of text data.
2. Why is text data important in NLP applications? Provide examples to illustrate your answer.
3. How can knowledge of NLP tasks enhance decision-making processes in real-world scenarios?
4. Discuss the challenges faced in processing natural language text, especially in the context of machine learning models.
5. How can understanding the building blocks of a language help improve NLP systems' performance?

Course Outcome 2(CO2):

1. Describe the steps involved in cleaning and preprocessing text data for NLP tasks.
2. Provide examples of real-world tasks where data cleaning and preprocessing are crucial for successful NLP applications.
3. How does the quality of text data preprocessing impact the performance of NLP models?

Course Outcome 3 (CO3):

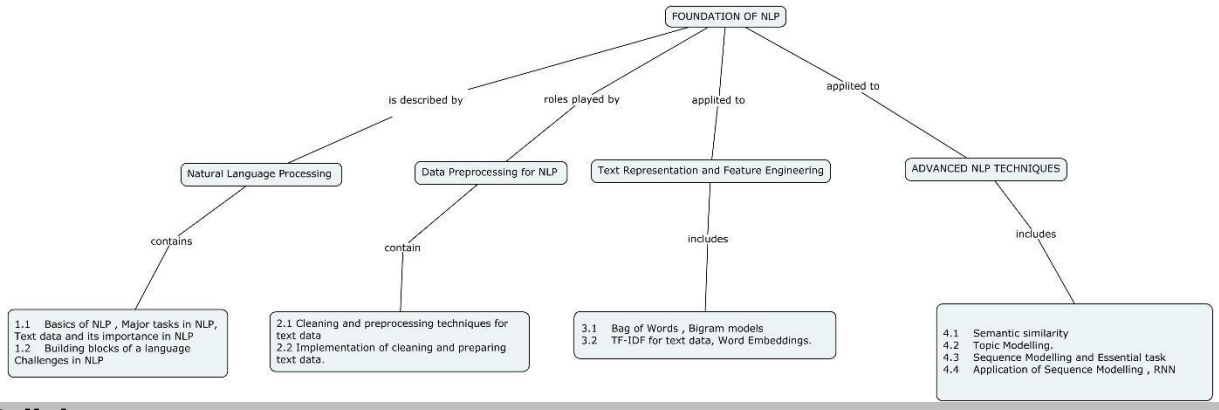
1. Compare and contrast the Bag of Words and TF-IDF approaches for text representation in NLP.
2. How does the use of Bigram models improve the representation of text data in NLP compared to unigram models?
3. Explain how Word Embeddings help capture semantic relationships between words in text data.

Course Outcome 4 (CO4):

1. How can semantic similarity be measured in NLP, and what are its applications in real-world tasks?

2. Discuss the importance of information extraction from unstructured text and its impact on NLP applications.
3. How does topic modelling help in organizing and understanding large volumes of text data in NLP?
4. Provide examples of real-world tasks where sequence modelling is used in NLP applications.
5. Explain how Recurrent Neural Networks (RNNs) are used for sequence modelling in NLP.

Concept Map



Syllabus

Unit 1 - Natural Language Processing (NLP)
Basics of NLP - Major tasks in NLP - Text data and its importance in NLP - Building blocks of a language - Challenges in NLP.

Unit 2 - Data Preprocessing for NLP
Cleaning and preprocessing techniques for text data – implementation of cleaning and preparing text data.

Unit 3 - Text Representation and Feature Engineering
Bag of Words - Bigram models - TF-IDF for text data - Word Embeddings.

Unit 4 - Advanced NLP Techniques
Semantic similarity - Topic Modelling - Sequence Modelling - Essential task – Application of Sequence Modelling - RNN

Learning Resources

Text Books:

1. Speech and Language Processing: Pearson International Edition (2008) by Daniel Jurafsky, James H. Martin.
2. Natural Language Processing with Python ,O'Reilly Klein, Ewan and Loper, Edward Paperback – 1 January 2011
3. Text Analytics with Python: A Practical Real-World Approach to Gaining Actionable Insights from Your Data by Dipanjan Sarkar (2016).

Reference Books:

1. VanderPlas, J. (2017). Python Data Science Handbook. O'Reilly.
2. McKinney, W (2017) Python for Data Analysis: Data Wrangling with Pandas, NumPy, and I Python 2nd Edition. O'Reilly.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**NATURAL LANGUAGE PROCESSING (NLP)**		
1.1	Basics of NLP Major tasks in NLP Text data and its importance in NLP	1	CO1
1.2	Building blocks of a language Challenges in NLP	1	CO1
2.	**DATA PREPROCESSING FOR NLP**		
2.1	Cleaning and preprocessing techniques for text data	1	CO2
2.2	Implementation of cleaning and preparing text data.	2	CO2
3.	**TEXT REPRESENTATION AND FEATURE ENGINEERING**		
3.1	Bag of Words Bigram models	2	CO3
3.2	TF-IDF for text data Word Embeddings.	2	CO3
4.	**ADVANCED NLP TECHNIQUES**		
4.1	Semantic similarity	1	CO4
4.2	Topic Modelling.	2	CO4
4.3	Sequence Modelling and Essential task	1	CO4
4.4	Application of Sequence Modelling RNN	1	CO4
	Total Hours	**14**	

Course Designers:

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3. Priya Thiagarajan ptca@tce.edu

21CB2C1	TEXT ANALYTICS AND LANGUAGE MODELLING

CATEGORY	L	T	P	CREDIT	TERMINAL EXAM TYPE
PEES	2	0	0	2	Theory

Preamble

The course will enable the students to develop transforming NLP with attention mechanism and pre-trained models. This course also includes design and customisation of Large Language Models (LLM) for real life applications

Prerequisite

Nil

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Understand the basic concepts of attention mechanism in neural networks. and the architecture s of a transformer encoder.	15
CO2	Apply neural network transformers for neural machine translation (NMT) tasks	20
CO3	Illustrate the ability to train and deploy BERT models for specific applications like , considering factors like data preprocessing, model selection, and evaluation metrics	20
CO4	Apply knowledge of transfer learning techniques to fine-tune a pre-trained GPT model for task-specific objectives.	20
CO5	Apply knowledge of commercial and open-source implementations of LLMs like LoRA and RAG.	25

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psycho motor	
CO1	TPS2	Understand	Respond		1.1,1.2,1.3,1.4,2.1,2.2,2.3
CO2	TPS3	Apply	Value		1.1,1.2,1.3,1.4,2.1,2.2,2.3,2.4,2.5,4.1,4.2,4.3
CO3	TPS3	Apply	Value		1.1,1.2,1.3,1.4,2.1,2.2,2.3,2.4,2.5,3.1,3.2,3.3,4.1,4.2,4.3
CO4	TPS3	Apply	Value		1.1,1.2,1.3,1.4,2.1,2.2,2.3,2.4,2.5,3.1,3.2,4.1,4.2,4.3,4.4,4.5,4.6
CO5	TPS3	Apply	Value		1.1,1.2,1.3,1.4,2.1,2.2,2.3,2.4,2.5,3.1,3.2,4.1,4.2,4.3,4.4,4.5,4.6

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L				L					L	M	L	L
CO2	S	M	L		L	L					L	M	L	L
CO3	S	M	L		M	L					L	M	L	L
CO4	S	M	L		M	L					L	M	L	L
CO5	S	M	L		M	L					L	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	CAT / Terminal Examination
Remember	20
Understand	30
Apply	50
Analyse	
Evaluate	
Create	

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject /Assignment/Practical Component
Perception	
Set	
Guided Response	
Mechanism	
Complex Overt Responses	
Adaptation	
Origination	

Sample Questions for Course Outcome Assessment**

** (2 to 3 at the cognitive level of course outcome)

Course Outcome 1(CO1):

1. How does the Key, Query, Value mechanism facilitate the extraction of relevant information in attention-based models
2. How does the utilization of multiple attention heads enhance the representation learning capabilities of Multi-Head Attention?
3. How does positional encoding enable Transformer models to account for the sequential nature of input data without using recurrent or convolutional layers?
4. How does layer normalization differ from other normalization techniques like batch normalization, and in what scenarios is it preferred?

Course Outcome 2(CO2):

1. Illustrate the steps involved in developing a neural machine translation system for translating text from English to French.
2. Design a systematic approach to evaluate the translation quality of a neural machine translation model. Include specific metrics to calculate and any potential challenges during the evaluation process.
3. Adapt and fine-tune a pretrained transformer model trained with masked attention, for a specific natural language processing task, such as text classification or named entity recognition?

Course Outcome 3(CO3):

1. Illustrate the steps to pre-train a BERT model from scratch using a corpus of text data.
2. Given a dataset consisting of text samples labeled with sentiment polarity (positive, negative, neutral), fine-tune a pre-trained BERT model to perform sentiment analysis on this dataset?
3. Design a named entity recognition (NER) system where to identify and classify entities such as person names, organization names, and locations in a given text.

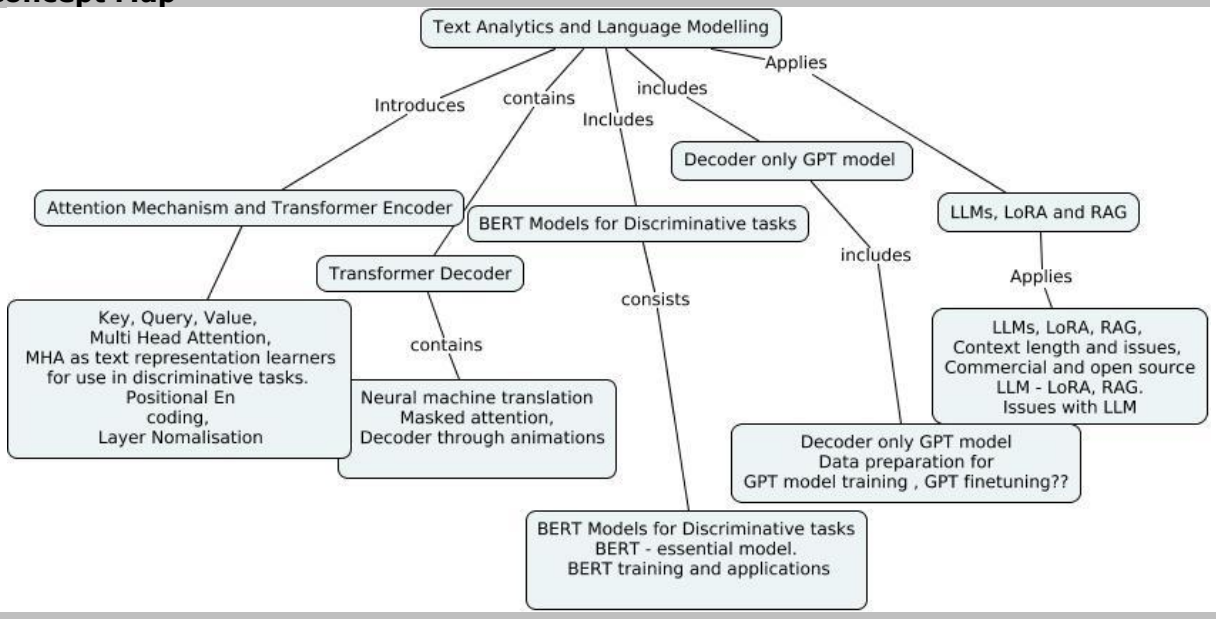
Course Outcome 4 (CO4):

1. Propose a finetuning strategy that leverages transfer learning techniques to adapt a pretrained model's language modeling capabilities to a target language or dialect.
2. Design and fine-tune a pre-trained GPT model on a conversational dataset to improve its ability to generate human-like responses for a chat bot application.
3. Design a data preparation pipeline that collects and preprocesses relevant training data from diverse sources, including literary works, or online forums to build a poetry writing model

Course Outcome 5 (CO5):

1. Illustrate how to select an appropriate pre-trained LLM, fine-tune it on domain-specific data, and evaluate its performance using suitable metrics. Discuss the trade-offs between using a large pre-trained LLM and training a smaller model from scratch.
2. Develop a user interface that integrates the LLM's text generation capabilities with features for prompting user input, guiding story progression, and providing feedback on generated content
3. Design a conversational flow that leverages the RAG framework to retrieve and generate informative responses to student queries in real-time in an educational chat bot.

Concept Map



Syllabus

Attention Mechanism and Transformer Encoder

Key, Query, Value, Multi Head Attention, MHA as text representation learners for use in discriminative tasks. Positional Encoding, Layer Normalisation.

Transformer Decoder

Introduction to neural machine translation. Masked attention, Understanding decoder through animations

BERT Models for Discriminative tasks

BERT - essential model. BERT training and applications

Decoder only GPT model

Data preparation for GPT model training , GPT finetuning

LLMs, LoRA, RAG,

Context length and issues, Commercial and open source LLM - LoRA, RAG.
Issues with LLM

Learning Resources

1. Sowmya Vajjala, Bodhisattwa Majumder, Anuj Gupta, Harshit Surana, Practical Natural Language Processing, O'Reilly Media, Inc, 2020
2. Denis Rothman, Transformers for Natural Language Processing and Computer Vision, Packt Publishing, 2024
3. Lewis Tunstall, Leandro von Werra, Thomas Wolf, Natural Language Processing with Transformers, O'Reilly Media, Inc, 2022

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Attention Mechanism and Transformer Encoder**		
1.1	Key, Query, Value, Multi Head Attention, MHA as text representation learners for use in discriminative tasks.	2	CO1
1.2	Positional Encoding, Layer Normalisation.	2	CO1
2.	**Transformer Decoder**		
2.1	Introduction to neural machine translation.	2	CO2
2.2	Masked attention	2	CO2
2.3	Understanding decoder through animations	2	CO2
3.	**BERT Models for Discriminative tasks**		
3.1	BERT - essential model.	2	CO3
3.2	BERT training and applications	3	CO3
4.	**Decoder only GPT model**		
4.1	Data preparation for GPT model training	3	CO4
4.2	GPT finetuning	3	CO4
5.	**LLMs, LoRA and RAG**		
5.1	Context length and issues	2	CO5
5.2	Commercial and open source LLM - LoRA, RAG.	3	CO5
5.3	Issues with LLM	2	CO5
		TOTAL: 28 hours	

Course Designers:

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21CB2D1	CHANGE DATA CAPTURE FOR BIGDATA

Category	L	T	P	C	Terminal Exam Type
PEES	2	0	0	2	Theory

Preamble

This course enables how to track and capture changes in databases using Change Data Capture (CDC) techniques. Students will learn to build real-time data pipelines using tools like PostgreSQL, Debezium, Kafka and Apache Spark. By the end, they will be able to stream, transform and store live data for analytics and decision-making.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage *** in %
CO1	Explain the fundamentals and importance of Change Data Capture (CDC) in real-time data systems.	15
CO2	Develop a CDC pipeline with open-source and cloud native tools.	20
CO3	Implement the source configuration in PostgreSQL using Debezium and Docker.	15
CO4	Implement the streaming workflows for transforming events using Spark.	15
CO5	Identify the suitable tool to store, manage and evolve datasets using Apache Iceberg.	15
CO6	Demonstrate the applications of CDC concepts in the implementation of real time user analytics systems.	20

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO#	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond	Guided Response	1.1,1.2,1.3,2.1.1
CO2	TPS3	Apply	Value	Mechanism	1.1,1.2,1.3,2.1,2.2,4.1,4.2.1,4.3.1,4.3.2, 4.3.3,4.4
CO3	TPS3	Apply	Value	Mechanism	1.1,1.2,1.3,2.1,2.2,4.1,4.2.1,4.3.1,4.3.2, 4.3.3,4.4
CO4	TPS3	Apply	Value	Mechanism	1.1,1.2,1.3,2.1,2.2,4.1,4.2.1,4.3.1,4.3.2, 4.3.3,4.4
CO5	TPS3	Apply	Value	Mechanism	1.1,1.2,1.3,2.1,2.2.1,4.1,4.3.1
CO6	TPS3	Apply	Value	Mechanism	1.1,1.2,1.3,2.1,2.2,4.1,4.2.1,4.3.1,4.3.2, 4.3.3,4.4

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L										L		
CO2	S	M	L		M	L	L	L		L	L	M	L	L
CO3	S	M	L		M	L	L	L		L	L	M	L	L
CO4	S	M	L		M	L	L	L		L	L	M	L	L
CO5	S	M	L		S	L	L	L		L	L	M	L	L

CO6	S	M	L		M	L	L	L		L	L	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Assignment/CAT/ Terminal Examination
Remember	10
Understand	30
Apply	60
Analyse	-
Evaluate	-
Create	-

Assessment Pattern: Psychomotor

Psychomotor Skill	Mini project /Assignment/Practical Component
Perception	-
Set	-
Guided Response	30
Mechanism	70
Complex Overt Responses	-
Adaptation	-
Origination	-

Sample Questions for Course Outcome Assessment**

Course Outcome 1(CO1):

1. Explain briefly about CDC Architecture.
2. Explain briefly about CDC Tools

Course Outcome 2(CO2):

1. How would you build a real-time dashboard that reflects the latest changes in an e-commerce inventory system?
2. A column was added to a table already being monitored by Debezium. What steps would you take to ensure the new column is included in the CDC stream?
3. MongoDB's schema-less design allows fields to be added dynamically. How does Debezium handle changes to document structures in such a case?

Course Outcome 3(CO3):

1. A retail company streams customer data changes from PostgreSQL to Kafka using Debezium. These changes include inserts, updates, and deletes. The marketing team wants to enrich the streaming data with loyalty tier information stored in a static CSV file and filter only update events for targeted recommendations.
   - Connect Spark to the appropriate Kafka topic.
   - Deserialize and flatten the Debezium after payload.
   - Join with the loyalty data on customer_id.
   - Output to console or Delta table for verification.

2. A network of IoT devices sends temperature readings to a PostgreSQL database. These changes are captured using Debezium and streamed into Kafka. Spark needs to monitor these events and raise alerts when a sensor reports temperatures above 70°C.
   - Set up schema for nested CDC JSON.
   - Parse JSON into structured columns.
   - Apply filter condition on temperature.

- Handle schema evolution (e.g., new sensor type added later).

Course Outcome 4 (CO4):

1. Your finance team needs to audit sales transactions by querying historical snapshots of an Iceberg table that stores CDC data from MongoDB. The team wants to compare today's state with the one from 7 days ago.
    - How would you enable time travel and rollback in Apache Iceberg to support this use case?
2. You have hourly batch jobs that read Kafka CDC logs and write to an Iceberg warehouse. However, some teams want near real-time updates for better decision-making.
    - How do you manage table snapshots and compaction?
    - Would you recommend stream-to-Iceberg or batch loaders via DBT?

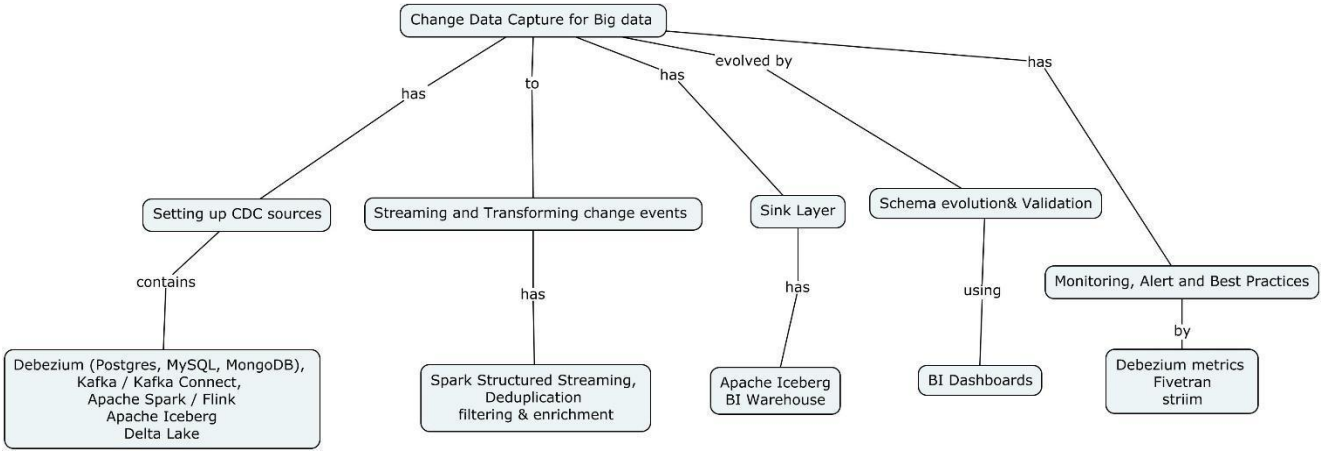
Course Outcome 5 (CO5):

1. A new column marketing_opt_in (boolean) is added to your source PostgreSQL customers table. This CDC change flows into your Apache Iceberg table, which powers multiple BI dashboards via Presto.
    - How would you update your Iceberg pipeline to reflect this schema change without breaking existing dashboards that expect the old schema?
2. The amount field in a PostgreSQL transactions table changes from INTEGER to DECIMAL(10,2) due to new financial precision requirements. This table is CDC-tracked by Debezium and written to Iceberg.
    - What steps must be taken to ensure that Iceberg and downstream query engines like Spark or Trino handle the data type change safely?

Course Outcome 6(CO6):

1. Your CDC pipeline streams PostgreSQL and MongoDB changes into Kafka, processed by Spark, and written to Apache Iceberg. Lately, Spark is lagging behind Kafka topics, and BI dashboards show stale data.
    - How would you detect and alert on Kafka topic lag, and what metrics would you monitor to identify the root cause?
1. A microservice stores business events (e.g., order status) in a relational database, and these must be captured in Kafka for real-time analytics. Direct table change capture is discouraged due to tight coupling.
    - How would you implement the outbox pattern and ensure reliable CDC from microservices into Kafka topics?

Concept Map



Syllabus

Introduction to Change Data Capture
Basic concepts and Role of Change data capture, Use cases: Real-time analytics, replication, audit logs, Overview of relational sources,Hands-on session: Docker and Debezium Environment Setup.

CDC Architecture and Tools
CDC core concepts: WAL, logical decoding, CDC Tools Overview, Optional sinks, Hands-on session: Logical Replication in PostgreSQL.

Setting Up CDC Source – PostgreSQL
Enable logical replication in Postgres, Setup with Docker Compose, Configure Debezium connector, Capture & inspect change events, Hands-on session: Debezium for Postgres CDC, Kafka for Postgres CDC.

Streaming & Transforming Change Events
Consume Kafka events in Spark Structured Streaming, Deduplication, filtering, enrichment, Payload transformation, Hands-on session: Stream Processing with Spark.

Sink Layer: Apache Iceberg
Write change logs into Apache Iceberg tables, Perform upserts and deletions, Time travel, rollback and schema evolution, Sink, Hands-on session: Write to Apache Iceberg.

End-to-End CDC Pipeline
CDC: PostgreSQL → Kafka → Spark → Iceberg, Hands-on session: Real-Time User Analytics System.

Learning Resources

1. Andrew Psaltis, "Streaming Data Mesh: Data Management for Real-Time Platforms", O'Reilly Media, 2023
2. Ben Stopford, "Designing Event-Driven Systems: Concepts and Patterns for Streaming Services", O'Reilly Media, 2024
3. Manoj Kukreja, DanilZburivsky, " Data Engineering with Apache Spark, Delta Lake, and Lakehouse", Packt Publishing,2022
4. James Densmore, "Data Pipelines Pocket Reference: Moving and Processing Data for Analytics", O'Reilly Media,2022.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Introduction to Change Data Capture**		
1.1	Basic concepts and Role of Change data capture	1	CO1
1.2	Use cases: Real-time analytics, replication, audit logs	1	CO1
1.3	Overview of relational sources.	1	CO1
1.4	Hands-on session: Docker and Debezium Environment Setup	2	CO1
2.	**CDC Architecture and Tools**		

2.1	CDC core concepts: WAL, logical decoding	1	CO2
2.2	CDC Tools Overview	1	CO2
2.3	Optional sinks	1	CO2
2.4	Hands-on session: Logical Replication in PostgreSQL	2	CO2
3.	**Setting Up CDC Source – PostgreSQL**		
3.1	Enable logical replication in Postgres, Setup with Docker Compose	1	CO3
3.2	Configure Debezium connector, Capture & inspect change events	1	CO3
3.3	Hands-on session: Debezium for Postgres CDC	2	CO3
3.4	Hands-on session: Kafka for Postgres CDC	2	CO3
4.	**Streaming & Transforming Change Events**		
4.1	Consume Kafka events in Spark Structured Streaming, Deduplication, filtering, enrichment	1	CO4
4.2	Payload transformation	1	CO4
4.3	Hands-on session: Stream Processing with Spark	2	CO4
5.	**Sink Layer: Apache Iceberg**		
5.1	Write change logs into Apache Iceberg tables, Perform upserts and deletions	1	CO5
5.2	Time travel, rollback, and schema evolution, Sink	1	CO5
5.3	Hands-on session: Write to Apache Iceberg	2	CO5
6.	**End-to-End CDC Pipeline**		
6.1	CDC: PostgreSQL→ Kafka → Spark → Iceberg	2	CO6
6.2	Hands-on session: Real-Time User Analytics System	2	CO6
	TOTAL HOURS	**28**	

Course Designers:

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21CB1E1	RESPONSIBLE & SAFE AI

Category	L	T	P	Credit	Terminal Exam Type
PEES	1	0	0	1	Theory

Preamble

This course equips learners with the foundational principles of responsible AI, ensuring fairness in AI by eliminating Bias, and accountable AI systems. It addresses key topic like LLM in AI.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Understand the various responsible AI principles.	15
CO2	Apply responsible AI principles to detect and mitigate bias to ensure fairness in AI systems.	15
CO3	Apply privacy and fairness principles to develop a responsible AI systems.	20
CO4	Develop AI-driven solutions for real-world problems across various domains using responsible AI practices.	20
CO5	Apply Responsible AI concepts to eliminate risks like Bisa and Language manipulation.	15
CO6	Apply responsible AI principles in large language models (LLMs) to enhance safety, reliability, and ethical compliance.	15

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

CO#	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond	Guided Response	1.1,1.2,1.3,2.1.1
CO2	TPS3	Apply	Value	Mechanism	1.1,1.2,1.3,2.1,2.2,4.1,4.2.1,4.3.1,4.3.2, 4.3.3,4.4
CO3	TPS3	Apply	Value	Mechanism	1.1,1.2,1.3,2.1,2.2,4.1,4.2.1,4.3.1,4.3.2, 4.3.3,4.4
CO4	TPS3	Apply	Value	Mechanism	1.1,1.2,1.3,2.1,2.2,4.1,4.2.1,4.3.1,4.3.2, 4.3.3,4.4
CO5	TPS3	Apply	Value	Mechanism	1.1,1.2,1.3,2.1,2.2.1,4.1,4.3.1
CO6	TPS3	Apply	Value	Mechanism	1.1,1.2,1.3,2.1,2.2,4.1,4.2.1,4.3.1,4.3.2, 4.3.3,4.4

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L										L		
CO2	S	M	L		M	L	L	L		L	L	M	L	L
CO3	S	M	L		M	L	L	L		L	L	M	L	L
CO4	S	M	L		M	L	L	L		L	L	M	L	L
CO5	S	M	L		S	L	L	L		L	L	M	L	L
CO6	S	M	L		M	L	L	L		L	L	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Assignment/CAT/ Terminal Examination
Remember	20
Understand	40
Apply	40
Analyse	-
Evaluate	-
Create	-

Sample Question for Course Outcomes

Course Outcome 1 (CO1):

1. Explain briefly about long-term risks from AI Models.
2. Explain briefly about responsible AI.

Course Outcome 2 (CO2):

1. Explain about bias/fairness detection.
2. You are working on a loan approval AI system for a bank. After analyzing the model's outputs, you notice that applicants from a particular region consistently receive lower approval scores despite similar financial profiles.
Task: Apply appropriate bias detection tools or metrics to investigate this issue. Explain the steps you would take and describe how your approach ensures fairness in the system.
3. You are developing a healthcare diagnosis model and are required to ensure it is both fair and explainable. You observe that the model performs better for one gender compared to another.
Task: Apply an explanation method (e.g., SHAP, LIME) to understand feature influence and recommend how to mitigate bias found in the model predictions.
Expected Answer Key Points:
- Use SHAP/LIME to explain predictions across groups.
- Compare feature contributions for each gender group.

Course Outcome 3 (CO3):

1. Explain privacy and fairness in AI model.

2. You are designing a recommendation system for a healthcare app that uses personal medical data. How would you apply privacy-preserving techniques such as data anonymization and differential privacy to ensure user confidentiality while maintaining system performance?

3. Given a loan approval AI model that shows bias against certain demographic groups, how would you modify the data pipeline and model training process to improve fairness without significantly impacting accuracy?

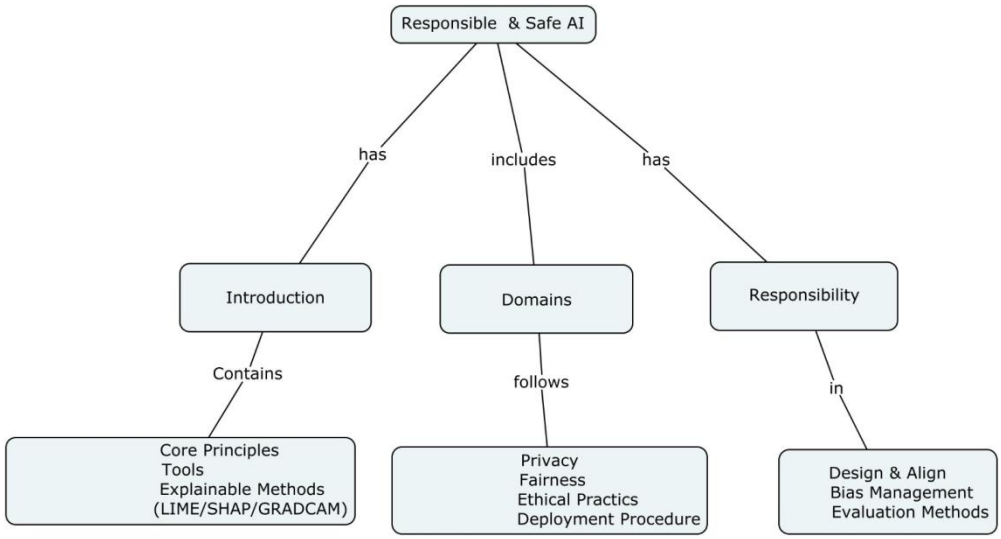
Course Outcome 4 (CO4):

1. Discuss various ethical issues in deploying AI responsibly.
2. Design an AI-based tool to support remote education in under-resourced areas. How would you apply responsible AI principles such as fairness, inclusivity, and data privacy during the development and deployment of your solution?
3. Design an AI-based remote patient monitoring system for elderly individuals with chronic conditions. How would you apply responsible AI principles to ensure ethical data usage, informed consent, and unbiased alert generation?

Course Outcome 5 (CO5):
1. Explain risks such as Bias and Language Manipulation in LLM.
2. You are building a resume screening AI tool for a multinational company. How would you apply responsible AI concepts to identify and mitigate biases related to gender, ethnicity, or educational background during model training and evaluation?
3. You are developing a chatbot for mental health support. How would you apply responsible AI techniques to prevent harmful language manipulation, ensure safe interactions, and maintain user trust?

Course Outcome 6 (CO6):
1. Explain the role of reward function.
2. You are deploying a large language model as a virtual assistant in a healthcare setting. How would you apply responsible AI principles to ensure the model provides safe, accurate, and reliable information while avoiding harmful or misleading responses?
3. While fine-tuning an LLM for use in legal document generation, how would you ensure the model adheres to ethical guidelines, avoids biased language, and respects data privacy regulations such as GDPR?

Concept Map



Assessment Pattern: Psychomotor

Psychomotor Skill	Mini project /Assignment/Practical Component
Perception	-
Set	-
Guided Response	30
Mechanism	70
Complex Overt Responses	-
Adaptation	-
Origination	-

Syllabus

Introduction to Responsible AI: (4 Hours)
Everyday and long-term risks from AI Models, Core principles of Responsible AI, Tools and metrics to ensure safety – bias/fairness detection, adversarial testing basics, explanation methods (LIME / SHAP / Grad-CAM), and audit mechanisms.

Responsible AI in Various Domains: (5 Hours
Understanding Privacy & Fairness in AI, Responsible AI practices in Legal systems, Healthcare, and Education. Key policy and ethical issues in deploying AI responsibly.

Responsibility in Modern AI Systems: (5 Hours)
How today's AI models (like LLMs) are built and evaluated, understanding risks such as Bias and Language Manipulation, Role of Reward functions, and how to design safer and more aligned AI systems.

Learning Resources

1. Responsible & Safe AI Systems, by Prof. Ponnurangam Kumaraguru, Prof. Balaraman Ravindran, Prof. Arun Rajkumar, IIIT Hyderabad, IIT Madras
2. Introduction to Large Language Models (LLMs), by Prof. Tanmoy Chakraborty, Prof. Soumen Chakraborti, IIT Delhi, IIT Bombay

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Introduction to Responsible AI:**		
1.1	Everyday and long-term risks from AI Models,	1	CO1
1.2	Core principles of Responsible AI,	1	CO1
1.3	Tools and metrics to ensure safety – bias/fairness detection, adversarial testing basics,	1	CO2
1.4	Explanation methods (LIME / SHAP / Grad-CAM), and audit mechanisms.	1	CO2
2.	**Responsible AI in Various Domains:**		
2.1	Understanding Privacy & Fairness in AI,	1	CO3
2.2	Responsible AI practices in Legal systems,	1	CO3
2.3	Healthcare, and Education.	1	CO4
2.4	Key policy and ethical issues in deploying AI responsibly.	2	CO4
3.	**Responsibility in Modern AI Systems:**		
3.1	How today's AI models (like LLMs) are built and evaluated	1	CO5
3.2	Understanding risks such as Bias and Language Manipulation	1	CO5
3.3	Role of Reward functions	1	CO6
3.4	How to design safer and more aligned AI systems.	2	CO6
	TOTAL HOURS	**14**	

Course Designers:

1. Mr. Sasikumar, sasi.kumart@thoughtworks.com
   Lead Consultant, ThoughtWorks
2. Mr. Siva T tsca@tce.edu

21CB1F1	OPERATIONS STRATEGY

Category	L	T	P	Credit	Terminal Exam Type
PEES	1	0	0	1	Theory

Preamble

This course introduces engineering students to how firms plan and make decisions that align operations with overall business strategy. It explains how operational capabilities can be leveraged to gain competitive advantage in dynamic markets. Students explore the strategic role of operations in both manufacturing and service sectors and understand how firms use operations for growth. Through case studies, they analyze real-world strategies and critically evaluate implementation challenges and trade-offs.

Prerequisite

- 21CB530-Fundamentals of Management

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Use operations strategy along with operational performance metrics and trade-off analysis to enhance organizational performance at societal, strategic, and operational levels.	30
CO2	Demonstrate the use of TQM, Lean, BPR, and Six Sigma methods to achieve efficiency and quality enhancement.	35
CO3	Implement capacity and location planning techniques to align resources with dynamic demand for achieving strategic objectives.	15
CO4	Examine the impact of integrating process and technology plans on flexibility, innovation, and sustainable performance.	20

*** Weightage depends on Bloom's Level, number of contact hours

CO Mapping with CDIO Curriculum Framework

CO#	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS3	Apply	Value	Mechanism	1.1,1.2,1.3,2.1,2.2,4.1,4.2.1,4.3.1,4.3.2, 4.3.3,4.4
CO2	TPS3	Apply	Value	Mechanism	1.1,1.2,1.3,2.1,2.2,4.1,4.2.1,4.3.1,4.3.2, 4.3.3,4.4
CO3	TPS3	Apply	Value	Mechanism	1.1,1.2,1.3,2.1,2.2,4.1,4.2.1,4.3.1,4.3.2, 4.3.3,4.4
CO4	TPS4	Analyze	Organize	Mechanism	2.5.4, 4.3.4, 4.3.3

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L										L		
CO2	S	M	L		M	L	L	L		L	L	L	L	L
CO3	S	M	L		M	L	L	L		L	L	L	L	L
CO4	S	S	M	L	M	L	L	L		L	L	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Assignment/CAT/Terminal Examination
Remember	10
Understand	30
Apply	50
Analyze	10
Evaluate	-
Create	-

Sample Questions for Course Outcome Assessment**

** (2 to 3 at the cognitive level of course outcome)

Course Outcome 1(CO1):

1. Use the principle of trade-offs to illustrate how an organization can achieve a balance between cost efficiency and product quality in its operations strategy.
2. Demonstrate how societal, strategic, and operational performance levels can be integrated to improve the overall sustainability of an organization.
3. Evaluate the effectiveness of a company's production process in achieving strategic goals.

Course Outcome 2(CO2):

1. A hospital experiences inconsistent patient service quality across departments. Demonstrate how TQM tools such as PDCA and benchmarking can be used to standardize service delivery.
2. A software firm wants to reduce development cycle time without compromising quality. Suggest how Lean principles can be implemented to streamline the software development process.
3. A car service center wants to improve the consistency of its maintenance services. Demonstrate how Six Sigma tools can be used to minimize variation in service quality.

Course Outcome 3(CO3):

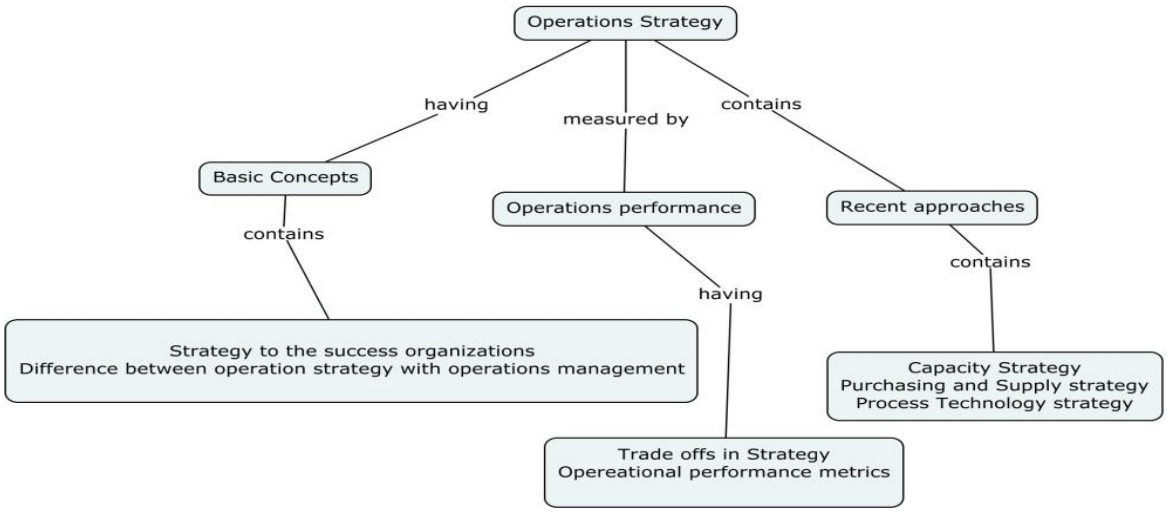
1. Demonstrate how an organization can determine the optimal production capacity to meet seasonal demand variations without incurring excess costs.
2. Illustrate how a manufacturing firm can adjust its capacity plan when introducing a new product line to maintain efficiency and customer satisfaction.
3. Use a real-world example to show how a company can select an appropriate facility location based on factors like logistics cost, labour availability, and market access.

Course Outcome 4(CO4):

1. A consumer electronics company is evaluating whether to manufacture its circuit boards in-house or outsource production to a supplier in another city. The in-house option requires high setup costs but promises better quality control, while outsourcing offers lower unit costs but higher logistics and monitoring expenses. Apply the concept of Total Cost of Ownership (TCO) to decide whether the company should make or buy the circuit boards. Justify your recommendation with cost and non-cost factors.
2. A food processing firm has faced disruptions due to raw material shortages from its single supplier. The company is exploring multiple sourcing options and short-term contracts to improve resilience. Apply the principles of flexible contracting and supply chain risk management to recommend a suitable purchasing strategy that balances cost efficiency with supply reliability.

3. Using Cost-Benefit Analysis (CBA), assess whether the company should proceed with the outsourcing contract or maintain internal production. Include how flexible contracting terms could reduce associated risks.

Concept Map



Syllabus

Basic concepts of Operations Strategy: Importance of Operations Strategy to the success of organizations, Difference between operations strategy and operations management, Operation strategy aligned with corporate strategy.

Operations Performance: Judging operations performance at societal, strategic and operational levels, The concept of trade-offs in strategy, Operational performance metrics

Operations Strategy – Recent Approaches: Total quality management (TQM), Lean Operations (Lean), Business Process Re-engineering (BPR), Six-Sigma (6σ)

Capacity Strategy: Capacity of Operations, Changes in capacity, Location of capacity

Purchasing and Supply Strategy: Make or buy decision: tools, Total Cost of Ownership (TCO), Cost-Benefit Analysis (CBA), contracting relationships, Flexible contracting, Purchasing and supply chain risks

Mini Project:

- Evaluation of Emerging Technologies in Smart Manufacturing (IoT, Robotics)
- Make-or-Buy Analysis for a Local Furniture Manufacturer
- Cost-Benefit Analysis of Outsourcing Logistics Operations

Learning Resources

1. Nigel Slack, Michael Lewis, "Operations Strategy", Pearson Education, 5th Edition, 2023.
2. Jay Heizer, Barry Render, Chuck Munson, Amit Sachan, "Operations Management", Pearson Education, 2023.
3. S. N. Chary, "Production & Operations Management", McGraw Hill Education, 6th Edition, 2022.

4. B. Mahadevan, "Operations Management: Theory and Practice", Pearson Education, 2022.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Basic Concepts of Operations Strategy**:	**2**	
1.1	Importance of Operations Strategy to the success of organizations, Difference between operations strategy and operations management	1	CO1
1.2	Operation strategy aligned with corporate strategy	1	CO1
2.	**Operations Performance**:	**2**	
2.1	Judging operations performance at societal, strategic and operational levels	1	CO1
2.2	The concept of trade-offs in strategy, Operational performance metrics	1	CO1
3.	**Operations Strategy – Recent Approaches**	**5**	
3.1	Total quality management (TQM),Lean Operations (Lean)	2	CO2
3.2	Business Process Re-engineering (BPR)	1	CO2
3.3	Six-Sigma (6σ)	2	CO2
4.	**Capacity Strategy**	**2**	
4.1	Capacity of Operations	1	CO3
4.2	Changes in capacity, Location of capacity	1	CO3
5.	**Purchasing and Supply Strategy**	**3**	
5.1	Make or buy decision: tools, Total Cost of Ownership (TCO), Cost-Benefit Analysis (CBA), Contracting relationships	2	CO4
5.2	Flexible contracting, Purchasing and supply chain risks	1	CO4
	TOTAL	**14 Hours**	

Course Designers:

1. Mr. Ravi Chandran, Aptus Consulting ravimrc@yahoo.com
2. Mrs. Yuvasini. D dyica@tce.edu
3. Mr. Janakiraman. V vjncse@tce.edu

21CB1G0	AI IN INDUSTRY 4.0

Category	L	T	P	C	Terminal Exam Type
PEES	1	0	0	1	Theory

Preamble

This course bridges the gap between technical implementation and business strategy for AI-driven industrial solutions. It helps students understand the complete lifecycle of an Industry 4.0 product, from development to market launch. Emphasizing AI integration in smart manufacturing, the course combines conceptual learning with hands-on practice, enabling students to design scalable, market ready industrial technologies.

Course Outcomes

On the successful completion of the course students will be able to

CO No.	Course Outcome	Weightage*** in %
CO1	Explain Industry 4.0 principles and AI integration.	15
CO2	Implement cyber-physical concepts to develop an AI-enabled smart manufacturing system.	25
CO3	Use edge–cloud architecture and DevOps containerization practices to build and deploy an industrial AI solution.	30
CO4	Analyze the integration of leadership, sustainability, and ROI-driven AI strategy within a go-to-market plan	30

*** Weightage depends on Bloom's Level, number of contact hours

CO Mapping with CDIO Curriculum Framework

CO#	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond	-	1.1, 1.3, 2.1.1, 2.3.1, 3.2.1, 4.1.1, 4.1.5
CO2	TPS3	Apply	Value	-	2.1.2, 2.1.4, 2.2, 2.3.3, 2.4.3, 4.3.1, 4.3.2, 4.4.1
CO3	TPS3	Apply	Value	-	1.3, 2.1.2, 2.2.4, 3.1.4, 4.3.3, 4.4.3, 4.5.1, 4.5.4
CO4	TPS3	Analyze	Organize	-	2.3.3, 2.4.4, 2.5.1, 3.1.4, 3.2.1, 4.1.5, 4.2.4, 4.5.5

Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L			M	L			L		M	L	L	L
CO2	S	M	L	M	S	L		M	M	M	L	M	M	L
CO3	S	M	L	S	S				M	S	M	M	M	L
CO4	S	S	M	L		S	L	M	M	S	M	M	M	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Assignment/CAT/Terminal Examination
Remember	20
Understand	30
Apply	30
Analyse	20
Evaluate	-
Create	-

Sample Questions for Course Outcome Assessment**

** (2 to 3 at the cognitive level of course outcome)

Course Outcome 1(CO1):

3. Explain briefly about CDC Architecture. Define interoperability in the context of Industry 4.0.
4. Differentiate between traditional automation and Industry 4.0-based intelligent automation.
5. List any four core principles of Industry 4.0.

Course Outcome 2(CO2):

4. Explain how CI/CD pipelines can be implemented for continuous deployment of an AI-based predictive maintenance system.
5. Develop a conceptual design for an AI-enabled process control system integrating cyber-physical systems and cloud intelligence. Highlight scalability and efficiency aspects.

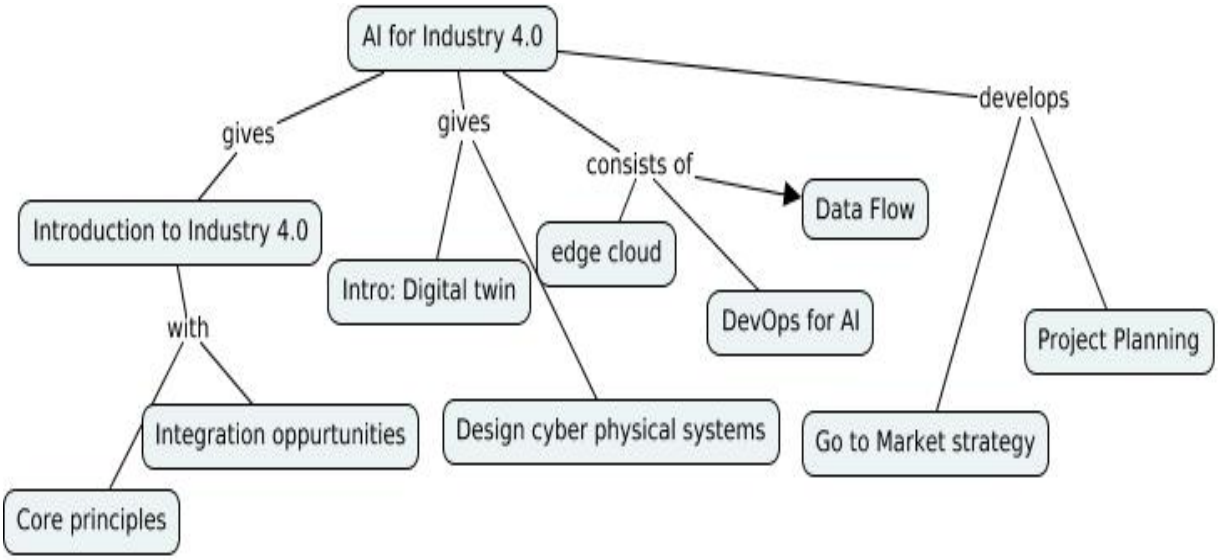
Course Outcome 3(CO3):

1. Demonstrate how DevOps automation tools (e.g., Jenkins or GitHub Actions) can help in retraining and redeploying an AI model efficiently.
2. Apply DevOps principles to streamline data preparation, model training, and deployment stages in an AI workflow.
3. Design and demonstrate the deployment of a lightweight AI model using edge–cloud architecture and containerization to enable scalable industrial operations.

Course Outcome 4 (CO4):

3. Analyze an existing industrial business model and propose modifications for improved financial sustainability through AI integration.
4. Develop a comparative analysis of two Industrial AI business models — one focused on cost leadership and another on innovation.
5. Evaluate the long-term financial and sustainability trade-offs in adopting AI-based automation for a mid-sized manufacturing enterprise.
6. Develop a go-to-market (GTM) proposal for an AI-based predictive maintenance system for manufacturing industries. Explain how technical feasibility, financial viability, and strategic positioning are integrated into your plan.

Concept Map



Syllabus

AI and Industry 4.0 Foundations: Introduction to Industry 4.0: Core Principles and AI Integration Opportunities

Designing Intelligent Systems: Introduction to Digital Twin, From Cyber-Physical Systems to Smart Manufacturing, Hands-on: Simple AI based Automation prototype.

Technical Architecture and Deployment: Industrial AI Architecture: basics of Edge-Cloud and Data Flow, DevOps for AI: Essential Practices for Scalable Deployment, Hands-on: Deploying a Lightweight AI Model using Containerization

AI Project Strategy and Market Integration: Key ideas in AI project planning, ROI and Sustainability, Integration and Go-to-Market: MVP and Market Entry Strategy, Pitch: Integrating Technical and Business Plans

Learning Resources

1. NazmulSiddique, Mohammad ShamsulArefin, M. ShamimKaiser & ASM Kayes (Eds.), Applied Intelligence for Industry 4.0, Chapman & Hall/CRC Press, 2023
2. Aboul Ella Hassanien, Jyotir Moy Chatterjee& Vishal Jain (Eds.), Artificial Intelligence and Industry 4.0, Academic Press/Elsevier, 2022.
3. Artificial Intelligence and Machine Learning for Industry 4.0, Wiley/O'Reilly, 2022.
4. James Densmore, Data Pipelines Pocket Reference: Moving and Processing Data for Analytics, O'Reilly Media, 2021.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**AI and Industry 4.0 Foundations**	**2**	
1.1	Introduction to Industry 4.0: Core Principles and AI Integration Opportunities	2	CO1
2	**Designing Intelligent Systems**	**4**	
2.1	Introduction to Digital Twin, From Cyber-Physical Systems to Smart Manufacturing	2	CO2
2.2	Hands-on: Simple AI based Automation prototype.	2	CO2
3.	**Technical Architecture and Deployment**	**4**	
3.1	Industrial AI Architecture: basics of Edge-Cloud and Data Flow	2	CO3
3.2	DevOps for AI: Essential Practices for Scalable Deployment	1	CO3
3.3	Hands-on: Deploying a Lightweight AI Model using Containerization	1	CO3
4.	**AI Project Strategy and Market Integration:**	**4**	
4.1	Key ideas in AI project planning, ROI and Sustainability	1	CO4
4.2	Integration and Go-to-Market: MVP and Market Entry Strategy	2	CO4
4.3	Pitch: Integrating Technical and Business Plans	1	CO4
	TOTAL	**14 Hours**	

Course Designers:

1. Mr.Bhagath Singh, Karunakaran, i45g bhagath@i45g.com
2. Dr.S.Karthiga skait@tce.edu
3. Ms.R.Subhashni rsica@tce.edu

21CB1H1	GENAI TECHNOLOGIES

Category	L	T	P	Credit	Terminal Exam Type
PEES	1	0	0	1	Theory

Preamble

This course introduces the core concepts of Artificial Intelligence, Machine Learning, Deep Learning, and Natural Language Processing. It emphasizes practical applications through Generative AI, Prompt Engineering, and transformer-based models. Students gain hands-on experience in building intelligent systems with RAG, Agentic AI, and AI governance principles.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Explain the evolution of AI and interpret the ethical principles in evaluating modern AI workflows.	20
CO2	Apply structured data processing and training techniques to build computational models for given problem scenarios.	30
CO3	Apply advanced prompting strategies to solve business or engineering tasks.	30
CO4	Analyze RAG pipelines by examining how vector databases, autonomous workflows, and governance mechanisms interact to ensure reliable and safe GenAI solutions.	20

*** Weightage depends on Bloom's Level, number of contact hours

CO Mapping with CDIO Curriculum Framework

CO#	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond	Guided Response	1.2, 2.4.6, 4.3
CO2	TPS3	Apply	Value	Mechanism	1.3, 2.4.6, 4.3
CO3	TPS3	Apply	Value	Mechanism	1.3, 2.4.6, 4.3
CO4	TPS4	Analyze	Organize	Mechanism	2.5.4, 4.3.4, 4.3.3

Mapping with Programme Outcomes and Programme Specific Outcome

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	L			M	M					M	L	L	L
CO2	S	M	L		M	M					M	L	L	L
CO3	S	M	L		M	M					M	L	L	L
CO4	S	S	M	L	M	M					M	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Assignment/CAT/Terminal Examination
Remember	20
Understand	20
Apply	50
Analyse	10
Evaluate	-
Create	-

Sample Questions for Course Outcome Assessment**

** (2 to 3 at the cognitive level of course outcome)

Course Outcome1 (CO1):

1. Explain the basic workflow of an Artificial Intelligence system. Describe the major stages from data collection to decision-making, and how each stage contributes to building intelligent behaviour.
2. Explain the differences between supervised, unsupervised, and reinforcement learning
3. Describe how the historical evolution of AI has influenced its current applications in fields such as healthcare, finance, and education.

Course Outcome2 (CO2):

1. Given a dataset of handwritten digits, outline the steps to design and train a Convolutional Neural Network (CNN) for classification.
2. Consider a customer sentiment dataset containing text reviews labeled as positive, negative, or neutral. Explain how you would pre-process the data and use a deep learning model (such as an RNN or LSTM) to classify the sentiments. Mention how word embeddings can be used.
3. A house price dataset has numerical features such as size, number of rooms, and location score. Describe how you would build and train a feed forward neural network to predict house prices. Include pre-processing, normalization, and loss function selection.

Course Outcome 3 (CO3):

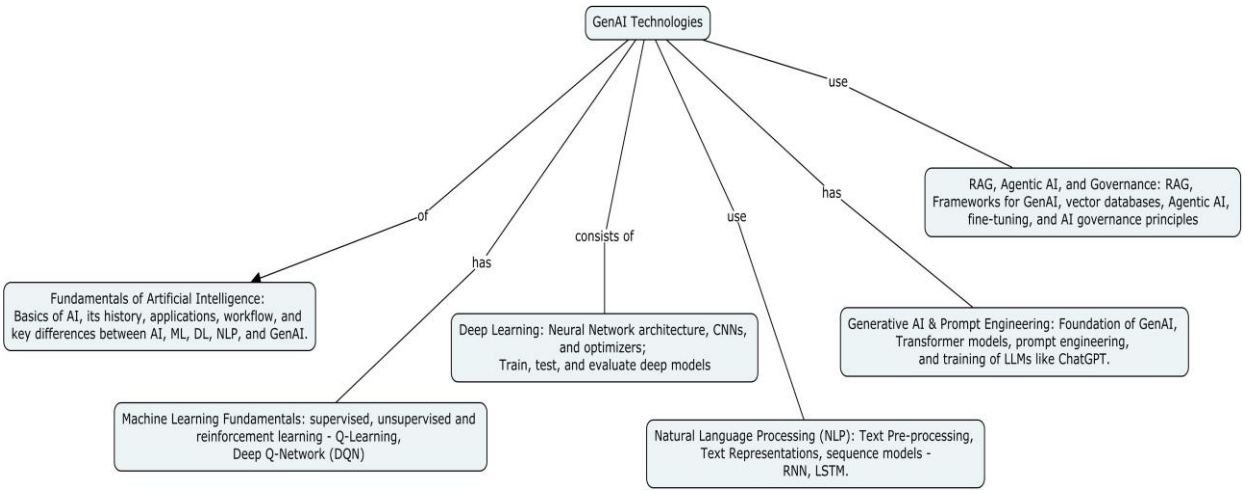
1. Given a story-writing dataset, describe how you would use prompt engineering techniques — such as few-shot, zero-shot, and chain-of-thought prompting — to guide a generative model to produce coherent and stylistically consistent stories.
2. Content Generation or Automatic Summarization Bot: You have access to a dataset of news articles and want to build a summarization bot using a transformer-based model. Describe the approach you would take to preprocess text, fine-tune a pretrained model (like T5 or BART), and evaluate the summaries generated.
3. In a real-time financial monitoring system, the LLM occasionally hallucinates inaccurate summaries. Demonstrate how introducing a retrieval layer and confidence-scoring mechanism could reduce hallucinations and enhance factual reliability.

Course Outcome4 (CO4):

1. Your college wants to deploy an AI-powered enquiry assistant that answers student and parent queries about courses, fees, and admission. Describe how you would build this system using NLP and Retrieval-Augmented Generation (RAG). Include how you'd collect data, preprocess text, and ensure accurate and up-to-date responses.

2. Your institution wants a document-based chatbot to answer queries from academic handbooks and circulars. Apply the RAG framework to explain how you would index documents in a vector database, retrieve relevant context, and generate factual, conversational responses using an LLM.

Concept Map



Syllabus

Introduction to Generative AI: Evolution of AI, AI workflow overview, Ethical & Responsible AI

Deep Learning: Neural network architecture, Forward & Backward propagation

Natural Language Processing (NLP): Text Pre-processing, Text Representations, sequence models -RNN, LSTM.

Prompt Engineering & Vibe Coding: Transformer models, Zero-shot, few-shot, Style steering, Tone control prompts, Persona-based prompting.

RAG, and Governance: RAG Pipeline, vector databases, Autonomous workflow

Case studies and real-world tasks:

1. Smart College Enquiry Assistant
2. Predicting student grades or attendance trends
3. Handwritten digit recognition or image classification (e.g., fruits, signs)
4. Movie review sentiment analyzer or social media comment classifier
5. Content generation or automatic summarization bot
6. College knowledge assistant or document query chatbot

Learning Resources

1. Charu C. Aggarwal, "Artificial Intelligence: Foundations, Models, and Applications", 1st edition, Springer, 2024
2. Aurélien Géron, "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow", 3rd edition, O'Reilly, 2023

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Fundamentals of Artificial Intelligence**	**3**	
1.1	Evolution of AI	1	CO1
1.2	AI workflow overview	1	CO1
1.3	Ethical AI, Responsible AI	1	CO1
2.	**Deep Learning**	**4**	
2.1	Neural network architecture,	1	CO2
2.2	Forward & Backward propagation	1	CO2
2.3	Natural Language Processing (NLP) - Text Pre-processing - Text Representations	1	CO2
2.4	Sequence Models - RNN, LSTM	1	CO2
3	**Prompt Engineering & Vibe Coding**	**4**	
3.1	Transformer models,	1	CO3
3.2	Zero-shot, few-shot,	1	CO3
3.3	Style steering, Tone control prompts,	1	CO3
3.4	Persona-based prompting.	1	CO3
4	**RAG, and Governance:**	**3**	
4.1	RAG Pipeline,	1	CO4
4.2	vector databases,	1	CO4
4.3	Autonomous workflow	1	CO4
	TOTAL	**14**	

Course Designers:

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3. Dr. J. Felicia Lilian jfl@tce.edu

CURRICULUM AND DETAILED SYLLABI

FOR

B.TECH DEGREE (Computer Science and Business Systems) PROGRAMME

VALUE ADDED COURSES

FOR THE STUDENTS ADMITTED FROM THE

ACADEMIC YEAR 2025 – 2026 ONWARDS

THIAGARAJAR COLLEGE OF ENGINEERING

(A Government Aided ISO 9001-2008 Certified

Autonomous Institution affiliated to Anna University)

MADURAI – 625 015, TAMILNADU

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Fax: 04522483427

Web:www.tce.edu

THIAGARAJAR COLLEGE OF ENGINEERING, MADURAI- 625 015
(A Govt. Aided, ISO 9001:2008 certified Autonomous Institution affiliated to Anna University)

B.Tech. Degree (Computer Science and Business Systems) Programme

VALUE ADDED COURSES
(For the candidates admitted from 2025 – 2026 onwards)

S.No	COURSE CODE	COURSE TITLE	CATEGORY	No. of Hours
1	21CBVA1	Linux Administration	VAC	30
2	21CBVB1	Cross Platform Mobile Application Development	VAC	30

21CBVA1	LINUX ADMINISTRATION

Category	L	T	P	C
VAC	-	-	-	-

Preamble

This course introduces foundational to advanced concepts in Linux system administration, designed to build skills in managing Linux environments. The course covers installation, basic command-line operations, file system management, user and group administration, networking, security, and shell scripting. By the end of this course, students will be equipped with practical skills essential for effective Linux system management and troubleshooting.

Prerequisite

Nil

Syllabus

Linux Fundamentals and Installation: Overview of Linux - Linux vs. Unix - Virtualization Basics **-** Installation of Linux**-** Basic System Navigation.

File System and Basic Commands: Linux File System Structure - File and Directory Management -

File Permissions and Ownership - File Types and Links - Text Processing - File Compression and Archive Management.

Essential Linux Administration Skills: Text Editors - User and Group Management - Process Management and Monitoring - Scheduled Tasks - System Utilities.

Networking and Security in Linux: Networking Basics - File Transfer Protocols - Package Management - Remote Access - System Security - System Logs.

Advanced System Administration and Shell Scripting:

Disk and File System Management - File System Maintenance - Shell Scripting Basics - Boot Process and System Run Levels - System Configuration.

Out Comes /deliverables

Upon completing this course, students will be able to:

- Install and configure Linux systems on virtual machines.
- Use Linux commands for efficient file and directory management.
- Manage user accounts, groups, and permissions for secure access.
- Administer networking settings, remote connections, and secure configurations.
- Develop basic shell scripts for system automation and management tasks.

Suggested readings and web resources

- Evi Nemeth, Garth Snyder, Trent R. Hein, UNIX and Linux System Administration Handbook, Prentice Hall, 2017, ISBN-13: 978-0134277554.
- Christopher Negus, Linux Bible, 10th Edition, Wiley, 2020, ISBN-13: 978-1119578888.
- Mark G. Sobell, A Practical Guide to Linux Commands, Editors, and Shell Programming, 4th Edition, Pearson, 2018, ISBN-13: 978-0134774602.
- Richard Blum, Linux Command Line and Shell Scripting Bible, 4th Edition, Wiley, 2021, ISBN-13: 978-1119700937.

Course Contents and Lecture Schedule

No.	Topic	No. of Periods
1	**Linux Fundamentals and Installation**	
1.1	Overview of Linux - Linux vs. Unix - Virtualization Basics	2
1.2	Installation of Linux - Basic System Navigation	2
2	**File System and Basic Commands**	
2.1	Linux File System Structure - File and Directory Management	2
2.2	File Permissions and Ownership - File Types and Links	2
2.3	Text Processing - File Compression and Archive Management	2
3	**Essential Linux Administration Skills**	
3.1	Text Editors	2
3.2	User and Group Management	2
3.3	Process Management and Monitoring - Scheduled Tasks	2
4	**Networking and Security in Linux**	
4.1	Networking Basics - File Transfer Protocols	2
4.2	Package Management - Remote Access	2
4.3	System Security - System Logs	2
5	**Advanced System Administration and Shell Scripting**	
5.1	Disk and File System Management - File System Maintenance	2
5.2	Shell Scripting Basics	2
5.3	Boot Process and System Run Levels - System Configuration	4
	Total	**30**

Course Designers

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21CBVB1	CROSS PLATFORM MOBILE APPLICATION DEVELOPMENT

Category	L	T	P	C
VAC	-	-	-	-

Preamble

This course focuses on introducing the set of technological frameworks for cross platform mobile development thereby enhancing application development skills. This course also helps students develop best practices for creating apps for various platforms.

Pre requisite

Nil

Syllabus

Introduction and Environment Set Up: Different types of Mobile app development platforms: Native, Hybrid, Advantages of cross-platform apps - Introduction to React Native, React Native vs hybrid applications - React Native Architecture - Setting up an environment for developing iOS and Android apps.

React Components: Introduction to JSX, Creating First RN Application, React lifecycle methods, Basic components :View, Layouting, Touch events, Modal, List View, Accessibility, Handling Text Input, StatusBar, Images, and media – Touchable Components - Flex Box for Styling.

State Management and Navigation: State and Props – Life cycle methods, Hooks - Navigation : React Navigation library setup, Stack, Tab and Drawer navigation, Navigating between screens, Passing and retrieving parameters between screens

Storage and Platform APIs: AsyncStorage for persistent data – SQLite- realm. API Integeration : fetch and Axios - Handling asynchronous operations with async/await - Camera and Gallery integration , Location Services- Push Notifications, Displaying data with FlatList and SectionList.

Debugging and Testing React Native: Remote debugging, Logging, Inspecting React Native components. Testing: Introduction to the Jest testing framework, Snapshot testing, working with functions, mocking modules – Deployment: Steps to publish the apps to Google Play Store and Apple App Store.

Out Comes /deliverables

Upon completing this course, students will be able to:

- Differentiate between native, hybrid, and cross-platform mobile development techniques.
- Utilize JSX and core React Native components to build mobile applications
- Build multi-screen applications using React Navigation, including Stack, Tab, and Drawer navigators.
- Leverage platform-specific features like Camera, Gallery, Location Services, and Notifications
- Debug, test and deploy react native mobile applications.

Suggested readings and web resources

1. Vladimir Novick, React Native - Building Mobile Apps with JavaScript, PACKT Publishing Limited, 2017, ISBN-13: 978-1787282537.
2. Mark Erikson, React Native – Building Mobile Apps with JavaScript, Independently Published, 2021, ISBN-13: 979-8514214569.
3. Jonathan Lebensold, React Native Cookbook: Bringing the Web to Native Platforms, O'Reilly Media, 2018, ISBN-13: 978-1491993809.
4. Bonnie Eisenman, Learning React Native: Building Native Mobile Apps with JavaScript, 2nd Edition, O'Reilly Media, 2017, ISBN-13: 978-1491989147.

5. Nader Dabit, React Native in Action, Manning Publications, 2019, ISBN-13: 978-1617294051.
6. Devin Abbott, Houssein Djirdeh, Anthony Accomazzo, et al., Fullstack React Native: Create Beautiful Mobile Apps with JavaScript and React Native, Fullstack.io, 2020, ISBN-13: 978-1732175015.
7. Bonnie Eisenman, Learning React Native, 2nd Edition, Building Native Mobile Apps with JavaScript, O'Reilly Media Inc., 2017, ISBN-13: 978-9352136568
8. Sajal Kumar Das, "Mobile Handset Design, John Wiley & Sons", ISBN-13:9781118684573.
9. https://reactnative.com/

Course Contents and Lecture Schedule

No.	Topic	No. of Periods
1	**Introduction and Environment Set Up**	
1.1	Different types of Mobile app development platforms: Native, Hybrid, Advantages of cross-platform apps	1
1.2	Introduction to React Native, React Native vs hybrid applications	1
1.3	React Native Architecture	1
1.4	Setting up an environment for developing iOS and Android apps.	1
2	**React Components**	
2.1	Introduction to JSX, Creating First RN Application	1
2.2	React lifecycle methods	1
2.3	Basic components :View, Layouting, Touch events	1
2.4	Modal, List View, Accessibility, Handling Text Input	1
2.5	StatusBar, Images, and media	1
2.6	Touchable Components	1
2.7	Flex Box for Styling	2
3	**State Management and Navigation**	
3.1	State and Props – Life cycle methods, Hooks	1
3.2	React Navigation library setup, Stack, Tab and Drawer navigation	2
3.3	Navigating between screens	1
3.4	Passing and retrieving parameters between screens	1
4	**Storage and Platform APIs**	
4.1	AsyncStorage for persistent data	1
4.2	SQLite	2
4.3	Realm	1
4.4	API Integeration : fetch and Axios	1
4.5	Handling asynchronous operations with async/await	1
4.6	Camera and Gallery integration	1
4.7	Location Services	1
4.8	Push Notifications, Displaying data with FlatList and SectionList.	2
5	**Debugging and Testing React Native**	

5.1	Remote debugging, Logging, Inspecting React Native components	1
5.2	Testing: Introduction to the Jest testing framework, Snapshot testing, working with functions, mocking modules	1
5.3	Deployment: Steps to publish the apps to Google Play Store and Apple App Store	1
	Total	**30**

Course Designer profile

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