CURRICULUM FRAMEWORK AND SYLLABUS

FOR

FIVE YEAR INTEGRATED M.Sc (DATA SCIENCE) DEGREE PROGRAMME

IN CHOICE BASED CREDIT SYSTEM

FOR THE STUDENTS ADMITTED FROM THE

ACADEMIC YEAR 2021-2022 ONWARDS

THIAGARAJAR COLLEGE OF ENGINEERING
(A Government Aided Autonomous Institution affiliated to Anna University)

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BOS Meeting Approved: 28-09-2022

Approved in 64th Academic Council on 11-01-2023

THIAGARAJAR COLLEGE OF ENGINEERING, MADURAI 625 015

DEPARTMENT OF APPLIED MATHEMATICS AND COMPUTATIONAL SCIENCE

VISION

"Academic and research excellence in Computational Science"

MISSION

As a Department, We are committed to

- Achieve academic excellence in Computational Science through innovative teaching and learning processes.
- Enable the students to be technically competent to solve the problems faced by the industry.
- Create a platform for pursuing inter-disciplinary research among the faculty and the students to create state of art research facilities.
- Promote quality and professional ethics among the students.
- Help the students to learn entrepreneurial skills.

Programme Educational Objectives (PEO)

Post graduates of M.Sc.(Data Science) program will be

PEO1: Utilizing strong quantitative aptitude and domain knowledge to apply quantitative modeling and data analysis techniques to provide solutions to the real world business problems.

PEO2: Applying research and entrepreneurial skills augmented with a rich set of communication, teamwork and leadership skills to excel in their profession.

PEO3: Showing continuous improvement in their professional career through life-long learning, appreciating human values and ethics.

Programme Outcomes (PO) for M.Sc. (Data Science) (2019-2020)

On completion of the programme, the students are expected to

PO1: Apply knowledge of quantitative aptitude, programming fundamentals,computing techniques, and domain knowledge to analyze real-world problems and requirements.

PO2: Provide solutions to the complex computing problems reaching substantiated conclusions using fundamental principles of mathematics, computational science, and relevant domain disciplines.

PO3: Create, select, adapt and apply suitable mathematical techniques, and modern computing tools to complex computing activities, with an understanding of the limitations.

Five Year Integrated M.Sc (Data Science) Degree Programme Curriculum

2021-2022 Onwards
CHOICE BASED CREDIT SYSTEM

Credit Distribution:

S.No.	Category of courses	Credits	Percentage of Credits to Total Credits
1	Foundation Courses	50	23.70
2	Professional Core- Theory	85	40.28
3	Professional Core - Practical	31	14.69
4	Professional Electives	18	8.53
5	Employability Enhancement Courses	27	12.80
	Total Credits	**211**	100%

Foundation courses (FC):

Course Code	Name Of The Course	Category	No. Of Hours / Week			Credits
			L	T	P	
THEORY						
21DS110	CALCULUS	FC	4	0	0	4
21DS120	APPLIED PHYSICS	FC	4	0	0	4
21DS130	DIGITAL ELECTRONICS	FC	4	0	0	4
21DS140	PROBLEM SOLVING USING C PROGRAMMING	FC	4	0	0	4
21DS150	DISCRETE STRUCTURES	FC	4	0	0	4
21DS170	C PROGRAMMING LAB	FC	0	0	4	2
21DS210	THEORY OF PROBABILITY	FC	4	0	0	4
21DS220	TRANSFORMS AND THEIR APPLICATIONS	FC	4	0	0	4
21DS250	GRAPH THEORY	FC	3	1	0	4
21DS320	LINEAR ALGEBRA	FC	3	1	0	4
21DS410	ABSTRACT ALGEBRA	FC	4	0	0	4
21DS510	NUMERICAL METHODS	FC	4	0	0	4
21DS640	OPTIMIZATION TECHNIQUES	FC	3	1	0	4

Professional Core (PC):

Course code	Name of the Course	Category	No. of Hours / Week			credits
			L	T	P	
21DS230	DATA STRUCTURES	PC	3	1	0	4
21DS240	OBJECT ORIENTED PROGRAMMING	PC	4	0	0	4
21DS270	OBJECT ORIENTED PROGRAMMING LAB	PC	0	0	4	2
21DS280	DATA STRUCTURES LAB	PC	0	0	4	2
21DS310	APPLIED STATISTICS	PC	3	1	0	4
21DS330	ORGANIZATIONAL THEORY AND BEHAVIOUR	PC	4	0	0	4
21DS340	ADVANCED DATA STRUCTURES	PC	3	1	0	4
21DS350	COMPUTER ORGANIZATION	PC	3	1	0	4
21DS370	APPLIED STATISTICS AND PYTHON PROGRAMMING LAB	PC	0	0	4	2
21DS380	ADVANCED DATA STRUCTURES LAB	PC	0	0	4	2
21DS420	DATABASE MANAGEMENT	PC	4	0	0	4
21DS430	DESIGN AND ANALYSIS OF ALGORITHMS	PC	3	1	0	4
21DS440	OPERATING SYSTEMS	PC	4	0	0	4
21DS450	PREDICTIVE ANALYTICS	PC	4	0	0	4
21DS470	RELATIONAL DATABASE LAB	PC	0	0	4	2
21DS480	DESIGN AND ANALYSIS OF ALGORITHMS LAB	PC	0	0	4	2
21DS520	WEB TECHNOLOGY	PC	4	0	0	4
21DS530	COMPUTER NETWORKS	PC	4	0	0	4
21DS540	MACHINE LEARNING	PC	3	1	0	4
21DS570	JAVA PROGRAMMING LAB	PC	0	0	4	2
21DS580	WEB TECHNOLOGY LAB	PC	0	0	4	2
21DS610	DEEP LEARNING	PC	4	0	0	4

21DS620	DATA MINING	PC	4	0	0	4
21DS630	BIG DATA SYSTEMS	PC	3	1	0	4
21DS670	BIG DATABASE SYSTEMS LAB	PC	0	0	4	2
21DS680	DEEP LEARNING LAB	PC	0	0	4	2
21DS810	REINFORCEMENT LEARNING	PC	4	0	0	4
21DS820	INFORMATION SECURITY	PC	3	1	0	4
21DS830	BUSINESS ANALYTICS	PC	3	1	0	4
21DS870	MATHEMATICAL COMPUTING LAB	PC	0	0	4	2
21DS880	INFORMATION SECURITY LAB	PC	0	0	4	2
21DS910	WEB ANALYTICS	PC	3	1	0	4
21DS920	NATURAL LANGUAGE PROCESSING	PC	4	0	0	4
21DS930	COMPUTER VISION	PC	3	1	0	4
21DS970	NATURAL LANGUAGE PROCESSING LAB	PC	0	0	4	2
21DS980	WEB ANALYTICS LAB	PC	0	0	4	2

Professional Electives (PE):

Course code	Name of the Course	Category	No. of Hours / Week			Credits
			L	T	P	
21DSPA0	HIGH PERFORMANCE COMPUTING	PE	3	0	0	3
21DSPB0	MOBILE APPLICATION DEVELOPMENT	PE	3	0	0	3
21DSPC0	PARALLEL AND DISTRIBUTED COMPUTING	PE	3	0	0	3
21DSPD0	EMBEDDED SYSTEM	PE	3	0	0	3
21DSPE0	MARKETING ANALYTICS	PE	3	0	0	3
21DSPF0	GRAPHICAL MODELS	PE	3	0	0	3
21DSPG0	SOFT COMPUTING	PE	3	0	0	3

21DSPH0	MATHEMATICAL MODELING	PE	3	0	0	3
21DSPJ0	SOFTWARE ENGINEERING	PE	3	0	0	3
21DSPK0	GRAPH ALGORITHMS	PE	3	0	0	3
21DSPL0	ARTIFICIAL INTELLIGENCE	PE	3	0	0	3
21DSPM0	GAME THEORY	PE	3	0	0	3
21DSPN0	SOCIAL MEDIA ANALYTICS	PE	3	0	0	3
21DSPP0	CLOUD COMPUTING	PE	3	0	0	3
21DSPQ0	DATA VISUALIZATION	PE	3	0	0	3
21DSPR0	COMPUTATIONAL FINANCE	PE	3	0	0	3
21DSPS0	ENTERPRISE INFORMATION SYSTEM	PE	3	0	0	3
21DSPT0	RANDOMZIED ALGORITHMS	PE	3	0	0	3
21DSPU0	PRINCIPLES OF MANAGEMENT	PE	3	0	0	3
21DSPV0	ACCOUNTING AND FINANCIAL MANAGEMENT	PE	3	0	0	3
21DSPW0	WIRELESS NETWORKS	PE	3	0	0	3
21DSPX0	NETWORK SCIENCE	PE	3	0	0	3
21DSPY0	INFORMATION RETRIEVAL	PE	3	0	0	3

Employability Enhancement Courses (EEC):

Course code	Name of the Course	Category	No. of Hours / Week			Credits
			L	T	P	
21DS180	PROFESSIONAL COMMUNICATION	EEC	0	2	2	3
21DSP10	PROJECT WORK I	EEC	0	0	24	12
21DSP20	PROJECT WORK II	EEC	0	0	24	12

Thiagarajar College of Engineering, Madurai – 625 015
Department of Computer Applications
Five Year Integrated M.Sc (Data Science) Degree Programme [2021-2022 onwards]
Scheduling of Courses

Sem-ester	Theory					Practical		Credits
1	21DS110 CALCULUS 4:0	21DS120 APPLIED PHYSICS 4:0	21DS130 DIGITAL ELECTRONICS 4:0	21DS140 PROBLEM SOLVING USING C PROGRAMMING 4:0	21DS150 DISCRETE STRUCTURES 4:0	21DS170 C PROGRAMMING LAB 0:2	21DS180 PROFESSIONAL COMMUNICATION 0:3	25
2	21DS210 THEORY OF PROBABILITY 4:0	21DS220 TRANSFORMS AND THEIR APPLICATIONS 4:0	21DS230 DATA STRUCTURES 3:1	21DS240 OBJECT ORIENTED PROGRAMMING 4:0	21DS250 GRAPH THEORY 3:1	21DS270 OBJECT ORIENTED PROGRAMMING LAB 0:2	21DS280 DATA STRUCTURES LAB 0:2	24
3	21DS310 APPLIED STATISTICS 3:1	21DS320 LINEAR ALGEBRA 4:0	21DS330 ORGANAZATIONAL THEORY AND BEHAVIOUR 4:0	21DS340 ADVANCED DATA STRUCTURES 3:1	21DS350 COMPUTER ORGANIZATION 3:1	21DS370 APPLIED STATISTICS AND PYTHON PROGRAMMING LAB 0:2	21DS380 ADVANCED DATA STRUCTURES LAB 0:2	24
4	21DS410 ABSTRACT ALGEBRA 3:1	21DS420 DATABASE MANAGEMENT 4:0	21DS430 DESIGN AND ANALYSIS OF ALGORITHMS 3:1	21DS440 OPERATING SYSTEMS 4:0	21DS450 PREDICTIVE ANALYTICS 4:0	21DS470 RELATIONAL DATABASE LAB 0:2	21DS480 DESIGN AND ANALYSIS OF ALGORITHMS LAB 0:2	24
5	21DS510 NUMERICAL METHODS 4:0	21DS520 WEB TECHNOLOGY 4:0	21DS530 COMPUTER NETWORKS 4:0	21DS540 MACHINE LEARNING 3:1	21DSPX0 PROFESSIONAL ELECTIVE-I 3:0	21DS570 JAVA PROGRAMMING LAB 0:2	21DS580 WEB TECHNOLOGY LAB 0:2	23
6	21DS610 DEEP LEARNING 4:0	21DS620 DATA MINING 4:0	21DS630 BIG DATA SYSTEMS 3:1	21DS640 OPTIMIZATION TECHNIQUES 3:1	21DSPX0 PROFESSIONAL ELECTIVE II 3:0	21DS670 BIG DATABASE SYSTEMS LAB 0:2	21DS680 DEEP LEARNING LAB 0:2	23
7	21DSP10 PROJECT WORK I 0:12							12
8	21DS810 REINFORCEMENT LEARNING 4:0	21DS820 INFORMATION SECURITY 3:1	21DS830 BUSINESS ANALYTICS 3:1	21DSPX0 PROFESSIONAL ELECTIVE-III 3:0	21DSPX0 PROFESSIONAL ELECTIVE-IV 3:0	21DS870 MATHEMATICAL COMPUTING LAB 0:2	21DS880 INFORMATION SECURITY LAB 0:2	22
9	21DS910 WEB ANALYTICS 3:1	21DS920 NATURAL LANGUAGE PROCESSING 4:0	21DS930 COMPUTER VISION 3:1	21DSPX0 PROFESSIONAL ELECTIVE - V 3:0	21DSPX0 PROFESSIONAL ELECTIVE - VI 3:0	21DS970 NATURAL LANGUAGE PROCESSING LAB 0:2	21DS980 WEB ANALYTICS LAB 0:2	22
10	21DSP20 PROJECT WORK II 0:12							12
							Total Credits	211

Thiagarajar College of Engineering, Madurai
Five year Integrated M.Sc (Data Science) Degree Programme [2019-2020] onwards
Choice Based Credit System
Courses of Study

FIRST SEMESTER

Course code	Course Title	Category	No. of Hours / Week			credits
			L	T	P	
THEORY						
21DS110	CALCULUS	FC	4	-	-	4
21DS120	APPLIED PHYSICS	FC	4	-	-	4
21DS130	DIGITAL ELECTRONICS	FC	4	-	-	4
21DS140	PROBLEM SOLVING USING C PROGRAMMING	FC	4	-	-	4
21DS150	DISCRETE STRUCTURES	FC	4	-	-	4
PRACTICAL						
21DS170	C PROGRAMMING LAB	FC	-	-	4	2
21DS180	PROFESSIONAL COMMUNICATION	EEC	-	2	2	3
		TOTAL	20	-	8	25

SECOND SEMESTER

Course code	Course Title	Category	No. of Hours / Week			credits
			L	T	P	
THEORY						
21DS210	THEORY OF PROBABILITY	FC	4	-	-	4
21DS220	TRANSFORMS AND ITS APPLICATIONS	FC	4	-	-	4
21DS230	DATA STRUCTURES	PC	3	1	-	4
21DS240	OBJECT ORIENTED PROGRAMMING	PC	4	-	-	4
21DS250	GRAPH THEORY	FC	3	1	-	4
PRACTICAL						
21DS270	OBJECT ORIENTED PROGRAMMING LAB	PC	-	-	4	2
21DS280	DATA STRUCTURES LAB	PC	-	-	4	2
		TOTAL	18	4	10	24

THIRD SEMESTER

Course code	Course Title	Category	No. of Hours / Week			credits
			L	T	P	
THEORY						
21DS310	APPLIED STATISTICS	PC	3	1	-	4
21DS320	LINEAR ALGEBRA	FC	4	-	-	4
21DS330	ORGANIZATIONAL THEORY AND BEHAVIOUR	PC	4	-	-	4
21DS340	ADVANCED DATA STRUCTURES	PC	3	1	-	4
21DS350	COMPUTER ORGANIZATION	PC	3	1	-	4
PRACTICAL						
21DS370	APPLIED STATISTICS AND PYTHON PROGRAMMING LAB	PC	-	-	4	2
21DS380	ADVANCED DATA STRUCTURES LAB	PC	-	-	4	2
		TOTAL	17	3	8	24

FOURTH SEMESTER

Course code	Course Title	Category	No. of Hours / Week			credits
			L	T	P	
THEORY						
21DS410	ABSTRACT ALGEBRA	FC	3	1	-	4
21DS420	DATABASE MANAGEMENT	PC	4	0	-	4
21DS430	DESIGN AND ANALYSIS OF ALGORITHMS	PC	3	1	-	4
21DS440	OPERATING SYSTEMS	PC	4	0	-	4
21DS450	PREDICTIVE ANALYTICS	PC	4	0	-	4
PRACTICAL						
21DS470	RELATIONAL DATABASE LAB	PC	-	-	4	2
21DS480	DESIGN AND ANALYSIS OF ALGORITHMS LAB	PC	-	-	4	2
		TOTAL	18	2	8	24

FIFTH SEMESTER

Course code	Course Title	Category	No. of Hours / Week			credits
			L	T	P	
THEORY						
21DS510	NUMERICAL METHODS	FC	4	0	0	4
21DS520	WEB TECHNOLOGY	PC	4	0	0	4
21DS530	COMPUTER NETWORKS	PC	4	0	0	4
21DS540	MACHINE LEARNING	PC	3	1	0	4
21DSPX0	PROFESSIONAL ELECTIVE-I	PE	3	0	0	3
PRACTICAL						
21DS570	JAVA PROGRAMMING LAB	PC	-	-	4	2
21DS580	WEB TECHNOLOGY LAB	PC	-	-	4	2
		TOTAL	18	1	8	23

SIXTH SEMESTER

Course code	Course Title	Category	No. of Hours / Week			credits
			L	T	P	
THEORY						
21DS610	DEEP LEARNING	PC	4	0	0	4
21DS620	DATA MINING	PC	4	0	0	4
21DS630	BIG DATA SYSTEMS	PC	3	1	0	4
21DS640	OPTIMIZATION TECHNIQUES	FC	3	1	0	4
21DSPX0	PROFESSIONAL ELECTIVE II	PE	3	0	0	3
PRACTICAL						
21DS670	BIG DATABASE SYSTEMS LAB	PC	-	-	4	2
21DS680	DEEP LEARNING LAB	PC	-	-	4	2
		TOTAL	17	2	8	23

SEVENTH SEMESTER

Course code	Course Title	Category	No. of Hours / Week			credits
			L	T	P	
PRACTICAL						
21DSP10	PROJECT WORK - I	EEC	-	-	24	12
		TOTAL	0	0	24	12

EIGHTH SEMESTER

Course code	Course Title	Category	No. of Hours / Week			Credits
			L	T	P	
THEORY						
21DS810	REINFORCEMENT LEARNING	PC	4		-	4
21DS820	INFORMATION SECURITY	PC	3	1	-	4
21DS830	BUSINESS ANALYTICS	PC	3	1	-	4
21DSPX0	PROFESSIONAL ELECTIVE-III	PE	3	0	-	3
21DSPX0	PROFESSIONAL ELECTIVE-IV	PE	3	0	-	3
PRACTICAL						
21DS870	MATHEMATICAL COMPUTING LAB	PC	-	-	4	2
21DS880	INFORMATION SECURITY LAB	PC	-	-	4	2
		TOTAL	16	2	8	22

NINTH SEMESTER

Course code	Course Title	Category	No. of Hours / Week			Credits
			L	T	P	
THEORY						
21DS910	WEB ANALYTICS	PC	3	1	-	4
21DS920	NATURAL LANGUAGE PROCESSING	PC	4	-	-	4
21DS930	COMPUTER VISION	PC	3	1	-	4
21DSPX0	PROFESSIONAL ELECTIVE - V	PC	3	0	-	3
21DSPX0	PROFESSIONAL ELECTIVE - VI	PC	3	0	-	3
PRACTICAL						
21DS970	NATURAL LANGUAGE PROCESSING LAB	PC	-	-	4	2
21DS980	WEB ANALYTICS LAB	PC	-	-	4	2
		TOTAL	16	2	8	22

TENTH SEMESTER

Course code	Course Title	Category	No. of Hours / Week			credits
			L	T	P	
PRACTICAL						
21DSP20	PROJECT WORK - II	EEC	-	-	24	12
		TOTAL	0	0	24	12

FC : Foundation Course
PC : Professional Core
PE : Professional Elective
EEC : Employability Enhancement Course

L : Lecture
T : Tutorial
P : Practical

Note:

1 Hour Lecture/week is equivalent to 1 credit 1 Hour Tutorial/week is equivalent to 1 credit 2 Hour

Practical/week is equivalent to 1 credit

Total credits to be earned for the award of degree: 211

Thiagarajar College of Engineering, Madurai
Five year Integrated M.Sc (Data Science) Degree Programme
SCHEME OF EXAMINATIONS
(For Students admitted in the Academic Year 2021-2022 onwards)

FIRST SEMESTER

Course code	Course Title	Duration of Terminal Exam. in Hrs.	MARKS			Minimum Marks for Pass	
			Continuous Assessment *	Terminal Exam **	Max. Marks	Terminal Exam	Total
THEORY							
21DS110	CALCULUS	3	50	50	100	25	50
21DS120	APPLIED PHYSICS	3	50	50	100	25	50
21DS130	DIGITAL ELECTRONICS	3	50	50	100	25	50
21DS140	PROBLEM SOLVING USING C PROGRAMMING	3	50	50	100	25	50
21DS150	DISCRETE STRUCTURES	3	50	50	100	25	50
PRACTICAL							
21DS170	C PROGRAMMING LAB	3	50	50	100	25	50
21DS180	PROFESSIONAL COMMUNICATION	3	50	50	100	25	50

SECOND SEMESTER

Course code	Course Title	Duration of Terminal Exam. in Hrs.	MARKS			Minimum Marks for Pass	
			Continuous Assessment *	Terminal Exam **	Max. Marks	Terminal Exam	Total
THEORY							
21DS210	THEORY OF PROBABILITY	3	50	50	100	25	50
21DS220	TRANSFORMS AND THEIR APPLICATIONS	3	50	50	100	25	50
21DS230	DATA STRUCTURES	3	50	50	100	25	50
21DS240	OBJECT ORIENTED PROGRAMMING	3	50	50	100	25	50
21DS250	GRAPH THEORY	3	50	50	100	25	50
PRACTICAL							
21DS270	OBJECT ORIENTED PROGRAMMING LAB	3	50	50	100	25	50
21DS280	DATA STRUCTURES LAB	3	50	50	100	25	50

THIRD SEMESTER

Course code	Course Title	Duration of Terminal Exam. in Hrs.	MARKS			Minimum Marks for Pass	
			Continuous Assessment *	Terminal Exam **	Max. Marks	Terminal Exam	Total
THEORY							
21DS310	APPLIED STATISTICS	3	50	50	100	25	50
21DS320	LINEAR ALGEBRA	3	50	50	100	25	50
21DS330	ORGANIZATIONAL THEORY AND BEHAVIOUR	3	50	50	100	25	50
21DS340	ADVANCED DATA STRUCTURES	3	50	50	100	25	50
21DS350	COMPUTER ORGANIZATION	3	50	50	100	25	50
PRACTICAL							
21DS370	APPLIED STATISTICS AND PYTHON PROGRAMMING LAB	3	50	50	100	25	50
21DS380	ADVANCED DATA STRUCTURES LAB	3	50	50	100	25	50

FOURTH SEMESTER

Course code	Course Title	Duration of Terminal Exam. in Hrs.	MARKS			Minimum Marks for Pass	
			Continuous Assessment *	Terminal Exam **	Max. Marks	Terminal Exam	Total
THEORY							
21DS410	ABSTRACT ALGEBRA	3	50	50	100	25	50
21DS420	DATABASE MANAGEMENT	3	50	50	100	25	50
21DS430	DESIGN AND ANALYSIS OF ALGORITHMS	3	50	50	100	25	50
21DS440	OPERATING SYSTEMS	3	50	50	100	25	50
21DS450	PREDICTIVE ANALYTICS	3	50	50	100	25	50
PRACTICAL							
21DS470	RELATIONAL DATABASE LAB	3	50	50	100	25	50
21DS480	DESIGN AND ANALYSIS OF ALGORITHMS LAB	3	50	50	100	25	50

FIFTH SEMESTER

Course code	Course Title	Duration of Terminal Exam. in Hrs.	MARKS			Minimum Marks for Pass	
			Continuous Assessment *	Terminal Exam **	Max. Marks	Terminal Exam	Total
THEORY							
21DS510	NUMERICAL METHODS	3	50	50	100	25	50
21DS520	WEB TECHNOLOGY	3	50	50	100	25	50
21DS530	COMPUTER NETWORKS	3	50	50	100	25	50
21DS540	MACHINE LEARNING	3	50	50	100	25	50
21DSPX0	PROFESSIONAL ELECTIVE-I	3	50	50	100	25	50
PRACTICAL							
21DS570	JAVA PROGRAMMING LAB	3	50	50	100	25	50
21DS580	WEB TECHNOLOGY LAB	3	50	50	100	25	50

SIXTH SEMESTER

Course code	Course Title	Duration of Terminal Exam. in Hrs.	MARKS			Minimum Marks for Pass	
			Continuous Assessment *	Terminal Exam **	Max. Marks	Terminal Exam	Total
THEORY							
21DS610	DEEP LEARNING	3	50	50	100	25	50
21DS620	DATA MINING	3	50	50	100	25	50
21DS630	BIG DATA SYSTEMS	3	50	50	100	25	50
21DS640	OPTIMIZATION TECHNIQUES	3	50	50	100	25	50
21DSPX0	PROFESSIONAL ELECTIVE II	3	50	50	100	25	50
PRACTICAL							
21DS670	BIG DATABASE SYSTEMS LAB	3	50	50	100	25	50
21DS680	DEEP LEARNING LAB	3	50	50	100	25	50

SEVENTH SEMESTER

Course code	Course Title	Duration of Terminal Exam. in Hrs.	MARKS			Minimum Marks for Pass	
			Continuous Assessment *	Terminal Exam **	Max. Marks	Terminal Exam	Total
PROJECT WORK I							
21DSP10	PROJECT WORK - I	3	150	150	300	75	150

EIGHTH SEMESTER

Course code	Course Title	Duration of Terminal Exam. in Hrs.	MARKS			Minimum Marks for Pass	
			Continuous Assessment *	Terminal Exam **	Max. Marks	Terminal Exam	Total
THEORY							
21DS810	REINFORCEMENT LEARNING	3	50	50	100	25	50
21DS820	INFORMATION SECURITY	3	50	50	100	25	50
21DS830	BUSINESS ANALYTICS	3	50	50	100	25	50
21DSPX0	PROFESSIONAL ELECTIVE-III	3	50	50	100	25	50
21DSPX0	PROFESSIONAL ELECTIVE-IV	3	50	50	100	25	50
PRACTICAL							
21DS870	MATHEMATICAL COMPUTING LAB	3	50	50	100	25	50
21DS880	INFORMATION SECURITY LAB	3	50	50	100	25	50

NINTH SEMESTER

Course code	Course Title	Duration of Terminal Exam. in Hrs.	MARKS			Minimum Marks for Pass	
			Continuous Assessment *	Terminal Exam **	Max. Marks	Terminal Exam	Total
THEORY							
21DS910	WEB ANALYTICS	3	50	50	100	25	50
21DS920	NATURAL LANGUAGE PROCESSING	3	50	50	100	25	50
21DS930	COMPUTER VISION	3	50	50	100	25	50
21DSPX0	PROFESSIONAL ELECTIVE - V	3	50	50	100	25	50
21DSPX0	PROFESSIONAL ELECTIVE - VI	3	50	50	100	25	50
PRACTICAL							
21DS970	NATURAL LANGUAGE PROCESSING LAB	3	50	50	100	25	50
21DS980	WEB ANALYTICS LAB	3	50	50	100	25	50

TENTH SEMESTER

Course code	Course Title	Duration of Terminal Exam. in Hrs.	MARKS			Minimum Marks for Pass	
			Continuous Assessment *	Terminal Exam **	Max. Marks	Terminal Exam	Total
PROJECT WORK II							
21DSP20	PROJECTWORK II	3	150	150	300	75	150

* Continuous Assessment (CA) evaluation pattern will differ from subject to subject and for different tests. This will have to be declared in advance to students. The department will put a process in place to ensure that the actual test paper follow the declared pattern.

** Terminal Examination will be conducted for maximum marks of 100/300 and subsequently be reduced to 50/150 marks for the award of terminal examination marks

		Category	L	T	P	Credit
21DS110	**CALCULUS**	FC	4	0	0	4

Preamble

The students will be able to:

1. Implement the calculus through numerically and algebraically.
2. Apply the main tools for analyzing and describing the behaviour of functions of single and multi variables: limits, derivatives, to solve complex engineering problems.
3. Model the differential equations to get a analytical solution; find area and volume using double and triple Integrals.

Prerequisite

Nil

Course Outcomes

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

CO1:	Compare and contrast the ideas of continuity and differentiability.	Understand
CO2:	Apply sequences and Series in the problems involving Science and Engineering with the knowledge of convergence and divergence of series using different test.	Apply
CO3:	Classify the maxima and minima for a given function with several variables, through by finding stationary points.	Understand
CO4:	Apply Lagrangian multiplier method for finding maxima and minima of an constrained problem.	Apply
CO5:	Apply integration concept and double integral over general areas and triple integral over general volumes to find mass and moments.	Apply
CO6:	Predict the suitable method to solve second and higher order differential equations.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	L	M	M
CO2	L	S	S
CO3	L	M	M
CO4	L	S	S
CO5	L	S	S
CO6	L	S	S

S- Strong; M-Medium; L-Low

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	10	10	10
Understand	30	20	20
Apply	60	70	70
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

Syllabus

Limits and Continuity: Function of single variable – Definition, limit, continuity, piecewise continuity, periodic, differentiable, absolutely integrable, fundamental theorem of Calculus**.** **Sequences And Series:** Infinite Sequences - convergence, divergence, limit, Sandwich theorem, continuous function theorem, increasing, decreasing, bounded, function limit properties – Infinite Series – convergence and divergence – Integral test, comparison test, ratio test, root test. Alternating series - alternating series test, absolute and conditional convergence – power series, Taylor series and Maclaurin series. **Functions Of Two Variables:** Models, partial derivative and its geometrical interpretation. Stationary points – maxima, minima and saddles. Taylor series about a point. Constrained maxima and minima – Lagrange multipliers method.**Multiple Integrals:** Double integrals in Cartesian form - Change of order of integration – double integrals in polar form, triple integrals in rectangular, cylindrical and spherical coordinates. Applications of multiple integrals to find areas, volume, moments, masses. **Ordinary Differential Equations:** Linear Differential Equations of first order - Exact differential equations, Integrating factors, Bernoulli equations - Linear Differential Equations of higher order with constant coefficients - Euler's equation with variable coefficients - Simultaneous equations - Method of variation of parameters. Modelingsimple systems.

Reference Books

1. Hass M. D. J., Giordano Weir F.R., ¯Thomas Calculus‖, Pearson Education, 2013.
2. Erwin Kreyszig, ¯Advanced Engineering Mathematics‖, John Wiley & Sons, 2011.
3. Lian, Hungerford, and Holcomb ¯Mathematics with Applications‖, Addison Wesley, 2010.
4. Riley K. F., Hobson M. P. and Bence S. J., "Mathematical Methods for Physics and Engineering", Cambridge University Press, 2006.
5. Michael D. Greenberg, ¯Advanced Engineering Mathematics‖, Pearson Education, 2014.

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		Category	L	T	P	Credit
21DS120	**APPLIED PHYSICS**	FC	4	0	0	4

Preamble

The course work aims in imparting fundamental knowledge of physics for integrated postgraduate learners of data science .The course work deals with Laser, Fiber optics, Conductors, Semiconductors, Magnetic materials and Advanced materials. Applications of the course include Sensors, Strain gauge, Memory devices, MEMS etc.

Prerequisite

Nil

Course Outcomes

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

CO1:	Explain the working principle & applications of Laser and Fiber Optics.	Understand
CO2:	Understand basic physical concepts of conductors and semiconductors.	Understand
CO3:	Describe the Semiconductor memory devices such as RAM,ROM,DRAM,CCD, etc	Understand
CO4:	Classify magnetic and super conducting behaviour of solids	Apply
CO5:	Make use of an understanding of nano materials	Apply
CO6:	Utilize the super conduction of advanced materials	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	S	S	S
CO2	M	M	M
CO3	S	L	S
CO4	M	L	M
CO5	S	L	S
CO6	S	L	M

S- Strong; M-Medium; L-Low

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	30	20	30
Understand	40	30	30
Apply	30	50	40
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

Syllabus

Lasers And Fiber Optics: Principle of Laser: spontaneous and stimulated emission, types of laser: He-Ne, CO2 and Nd:YAG laser. Applications: Laser diodes, holography, ,Industrial applications. Fiber optics: Principle of light propagation,. Modes of propagation. Classification based on materials, refractive index profile and modes. Splicing. Losses in optical fiber. Fiber optical communication system, Light sources and Detectors. Fiber optic sensors – temperature, displacement and strain sensors. **Conductors And Applications:** Drude Lorentz theory of electrical conduction. Factors affecting resistivity of metals – temperature, alloying, magnetic field and strain. Applications of conductors – Strain gauge and resistance thermometer. **Semiconductors and Devices:** Elemental and compound semiconductors. Intrinsic and extrinsic semiconductors - Properties. Hall effect - Hall coefficient in extrinsic semiconductors, experimental determination of Hall coefficient. Application of Semiconductors –Solar Cells, LED and LCD. Introduction to semiconductor memory devices: Random Access Memory (RAM), Read only Memory (ROM), DRAM ,CCD. **Magnetic Materials And Memory Devices:** Origin of magnetism, Classification, Ferro magnetic materials – Properties. Domain theory of ferromagnetism. Hysteresis, .Hard and soft magnetic materials. Ferrites – structure and properties. Applications – optical, magnetic and magneto optical memory devices. **Advanced Materials And Applications: Nano Materials** -Synthesis - PVD and ball milling techniques.properties, applications. Shape Memory alloys (SMA) – Characteristics, properties of NiTi alloy, application in MEMS. **Superconductivity**- types of superconductors - High Temperature superconductors, Application of superconductors -SQUID, Levitation and cryotron.

Reference Books

1. William D. Callister Jr., David G. Rethwisch, "Material Science and Engineering", John Wiley &Sons, 2010.
2. Rajendran and Marikani, ¯Materials Science", Tata McGraw Hill, 2011.
3. Leonid V. Azaroff and James J. Brophy, "Electronic Processes in Materials‖, McGraw Hill, 1991.
4. Raghavan V, "Materials Science and Engineering- A First Course‖, Prentice Hall, 2011.
5. Sze SM, ¯Modern Semiconductor Device Physics‖, John Wiley & Sons, 1998.

		Category	L	T	P	Credit
21DS130	**DIGITAL ELECTRONICS**	FC	4	0	0	4

Preamble

This course is designed to enable the students to understand and apply the basic principles of number systems and codes, binary arithmetic, Boolean algebra, digital logic gates, design and implementation of combinational logic circuits and sequential logic circuits. As a foundation for digital circuits, the basic concepts of semiconductor devices and analogcircuits and logic families are also discussed. The fundamental principles of operational amplifiers and their applications and conversion between digital and analog data are also presented so as to provide a comprehensive coverage of all related topics. The concepts learnt in this course form the prerequisite for the course on Computer Organisation.

Prerequisite

Nil

Course Outcomes

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

CO1:	Explain the basic concepts of semiconductor devices and analog circuits and logic families	Understand
CO2:	Understand and apply the basic principles of number systems and codes, binary arithmetic, Boolean algebra, digital logic gates	Apply
CO3:	Construct the combinational logic circuits	Apply
CO4:	Design and implementation of sequential logic circuits.	Apply
CO5:	Discuss fundamental principles of operational amplifiers and their applications	Understand
CO6:	Perform conversion between digital and analog data	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	M	M	M
CO2	S	S	M
CO3	S	M	L
CO4	S	M	L
CO5	S	S	M
CO6	S	S	M

S- Strong; M-Medium; L-Low

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	20	10	20
Understand	30	40	30
Apply	50	50	50
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

Syllabus

Semiconductor Devices And Circuits: (Qualitative treatment only) Fundamental aspects of semiconductors - PN junction diode -Zener diode - Rectifiers - Zener voltage regulators - Filters - Bipolar Junction Transistors - Transistor Amplifiers - Field Effect Transistor.**Number System And Codes:** Binary - Octal - Hexadecimal - BCD - Excess three - Gray codes - Error correcting and detecting codes.**Digital Circuits And Gates:** AND, OR, NOT, NAND and NOR gates - exclusive OR gates. Positive and negative logic systems - Digital integrated circuits-Characteristics -TTL and MOS logic circuits - Comparison.**Boolean Algebra And Karnaugh Maps:** Boolean relations - Laws and theorems - Simplifications - Karnaugh maps and simplifications - Don"t care conditions - NAND-NAND realizations.**Combinational Logic:** Design and Implementation of Half and Full adders - Subtractors – Parallel adders - Carry look ahead addition - Encoders and decoders - Multiplexers and De-multiplexers.**Sequential Logic:** R-S, J-K, D and T type Flip-Flops – Binary counters: Ripple and synchronous types - UP/DOWN counters - Decade counters - Shift registers - Ring counters.**Operational Amplifiers:** Definition of terms - Inverting and non-inverting amplifiers, inverting summing amplifier, integrators and differentiators.**A/D And D/A Convertors:** DACs: weighted and binary ladder types - ADCs: counter, dual slope, successive approximation types.

Reference Books

1. Leach D.P., ¯Digital Principles & Applications‖, Tata McGraw Hill, 2010.
2. Mottershed A., ¯Electronic devices and circuits‖, Prentice Hall, 2009.
3. Gothamann H., ¯Digital Electronics: An Introduction to Theory and Practice‖, Prentice Hall, 2000.
4. Paul Horowitz and Winfield Hill, ¯The Art of Electronics‖, Cambridge University Press, 2010.
5. Hamachar V. C., Vranesic Z. G. and Zaky S. G., ¯Computer Organization‖, McGraw Hill, 2011.

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21DS140	PROBLEM SOLVING USING C PROGRAMMING	Category	L	T	P	Credit
		FC	4	0	0	4

Preamble

The course aims to provide exposure to problem-solving through C programming. It aims to train the student to the basic concepts of the C-programming language.

Prerequisite

- Fundamental of Programming languages

Course Outcomes

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

CO1:	Assess the applicability of algorithms and flowcharts in problem solving.	Understand
CO2:	Explain the concept of dynamic memory allocation and pointers for developing simple applications.	Understand
CO3:	Choose the applicable programming construct for solving the problem by comparing the various programming constructs	Apply
CO4:	Apply the concept of structures and unions in development of simple applications.	Apply
CO5:	Justify the selection of suitable programming constructs for best solving the problem.	Evaluate
CO6:	Demonstrate the ability to create simple programs involving input and output statements, expressions, arrays, control and iterative statements by appropriate choice of data types, expressions and control structures.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	S	S	M
CO2	S	S	M
CO3	S	S	M
CO4	S	S	M
CO5	S	S	M
CO6	S	S	M

S- Strong; M-Medium; L-Low

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	30	10	10
Understand	30	20	20
Apply	30	40	40
Analyze	10	20	20
Evaluate	0	10	10
Create	0	0	0

Syllabus

Introduction to Programming Language : Algorithms, Flowcharts, The Role of Programming Languages, Language Description, Structured Programming, Data Representation, Procedure Activations **Structured Programming Language:** Symbols and data types, Looping control structures, Decision control structures, Case control structures, Arrays and Strings **Functions and Pointers:** Functions, Structures, Union, Pointers, Type of Pointer **File Management:** File Management in C, Command Line Argument, Dynamic Memory allocation, Linked List and Preprocessors **Hardware Interface** : Types of I/O, Interaction with H/W in C, CPU Registers, Interrupts, DOS Function Requests, Interaction with HW using Port I/O, Operation on bits, Mouse Programming.

Reference Books

1. Brian W Kernighan & Dennis Ritchie, ―The C programming language‖, 2nd Edition, Prentice Hall ,2015
2. Yashavant Kanetkar,‖ Let us C‖, BPB Publications 8th Edition, 2014
3. Darnell and Margolis, ―ANSI C- A Systematic programming Approach‖, Narosa publications, 2010.

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		Category	L	T	P	Credit
21DS150	**DISCRETE STRUCTURES**	FC	4	0	0	4

Preamble

The students will be able to:

1. Outline an equivalent logical proposition for a real world statement by applying predicates and quantifiers and Interpret.
2. Apply logic rules of inference to check the validity of the predicate calculus statements and to prove theorems.
3. Apply the concepts of sets, functions and relations to solve the given problem.
4. Construct the Automata to reduce the complexity of a model.

Prerequisite

Nil

Course Outcomes

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

CO1:	Prove implication problems using truth table method, replacement process, analyzation method, truth table technique, rules of inference. Obtain PCNF and PDNF of given logical expression.	Apply
CO2:	Construct verbal arguments with predicates in symbolic form after validate them using inference	Apply
CO3:	Represent the different types of relation in matrix, digraph and vice versa.	Understand
CO4:	Find inverse and composition of functions	Apply
CO5:	Prove the properties of lattices and Boolean algebra.	Apply
CO6:	Construct DFA and NDFA which accepts a given language	Apply
CO7:	Modify the given grammar into language and vice-versa	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	L	S	S
CO2	L	S	S
CO3	L	M	M
CO4	L	S	S
CO5	L	S	S
CO6	L	S	S
CO7	L	S	S

S-Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	10	10	10
Understand	20	20	20
Apply	70	70	70
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

Syllabus

Mathematical logic:

Propositional Logic: Introduction – statements and notation, connectives- Conjunction, Disjunction, Negation, Conditional and biconditional,-Implications and Equivalence, Tautology and Contradictions, Normal forms: Conjunctive Normal Form,Disjunctive Normal Form - Principal Conjunctive Normal Forms - Principal Disjunctive Normal Form, Rules of Inference: P,T,CP,AP rules -Consistency of premises.Validity by truth table technique.**Predicate Logic:** Predicates- Statement Function, Variables and Quantifiers, Predicate formulas – Free and Bound Variables,-Theory of inferences on one place predicate using P,T,CP rules.

Set Theory : Basic Concepts of set theory and Cartesian products , Relations, Binary relations, Equivalence relations and Partitions, Composition of relations. **Functions**: Types of functions, Inverse of a function, Composition of functions, Recursive functions.

Lattices & Boolean Algebra:

Partially ordered set : Definition of Partially ordered set(PO Set), Hasse Diagram, LUB, GLB, Meet and Join of elements of PO set.**Lattices as partially ordered sets** :Definition and basic properties of lattices, Sub lattices, Special lattices.

Boolean Algebra: – Definition and examples – Boolean functions — Minimization of Boolean functions. **Automata Theory and Grammar :**Deterministic and Non-Deterministic finite Automaton, NDFA to DFA,NDFA with ε-moves, Regular language and Regular Expression, NFA and Regular Expressions, Pushdown Automaton, Introduction to Turing Machine.Pumping Lemma (without proof) and its applications, , Grammar, Types of Grammars – Language to Grammar -Grammar to Language.

Reference Books

1. Trembly and Manohar, ¯Discrete mathematical structures with applications to Computer Science‖, Tata McGrawHill, 2002.
2. Kenneth H. Rosen, ¯Discrete mathematics and its applications‖, McGrawHill International Editions 1999.
3. Dr. M.K.Venkataraman.,Dr.N.Sridharan and N.Chandrasekaran, Discrete Mathematics,National Publishing Company,Chennai.of India(2004)
4. John E.Hopcraft,Rajeev Motwani,Jeffery D.Ullman, `` Introduction to Automata Theory, Languages and Computation ¯, Pearson Education, Asia, 2001.
5. John C.Martin, `` Introduction to Languages and the theory of Computation‖, Tata McGraw-Hill Publishing Company Limited,New Delhi.
6. http://www.research.ibm.com/haifa/dept/svt/papers/Mathematical_Logic.pdf
7. Mathematical Logic and its Application to Computer Science - Lecture Notes EitanFarchi, Ben-Chaim, March 3, 2010

		Category	L	T	P	Credit
21DS170	**C PROGRAMMING LAB**	FC	0	0	4	2

Preamble

The course aims to provide exposure to problem-solving through C programming. This course involves a lab component which is designed to give the student hands-on experience with the concepts.

Prerequisite

- Fundamental of Programming languages

Course Outcomes

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

CO1:	Write C programs by choosing suitable data types and looping constructs for given requirements.	Apply
CO2:	Write C programs to use one dimensional and multidimensional arrays.	Apply
CO3:	Write C programs to implements recursive and nonrecursive functions.	Apply
CO4:	Implement structures and unions in C programs based on programming needs.	Apply
CO5:	Write C programs for demonstrating pointer concepts.	Apply
CO6:	Write C programs to create and process data files.	Apply
CO7:	Write technical report on the observations from the experiments.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	S	S	S
CO2	S	S	S
CO3	S	S	S
CO4	S	S	S
CO5	S	S	S
CO6	S	S	S
CO7	S	M	M

S- Strong; M-Medium; L-Low

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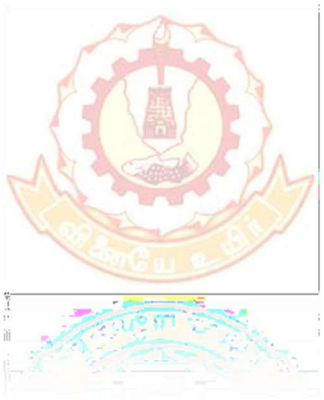
List of Experiments

1. Simple programs to understand the concepts of data types.
2. Familiarizing conditional, control and repetition statements.
3. Usage of single and double dimensional arrays including storage operations.
4. Implementation of functions, recursive functions.
5. Defining and handling structures, array of structures and union.
6. Implementation of pointers, operation on pointers and dynamic storage allocation.
7. Creating and processing data files.



		Category	L	T	P	Credit
21DS180	**PROFESSIONAL COMMUNICATION**	EEC	0	2	2	3

Preamble

The students will be able to:

1. Improve their skills as technical writers, by demonstrating skills in analysis, argumentation, assertion with evidence, and synthesis.
2. Develop productive planning and revising process.
3. Focus on diction and spelling, punctuation and mechanics.

Prerequisite

Nil

Course Outcomes

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

CO1:	Present technical articles by carefully planning and organizing in the frame of the scientific method	Apply
CO2:	Show appropriate responses through communication skills needed for a corporate environment	Apply
CO3:	Solve verbal aptitude questions related to placement and higher studies	Apply
CO4:	Apply their interpersonal skills in technical, professional and social contexts	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	M	M	L
CO2	L	L	-
CO3	M	L	-
CO4	L	L	-

S- Strong; M-Medium; L-Low

Assessment Pattern

Internal

No Common Continuous Assessment Test (CAT) will be conducted.

Students' performance will be continuously assessed in various classroom activities on Listening, Speaking, Reading and Writing for 50 marks as detailed below

Listening Test	-	10
Speaking Test- Presentation (Technical / Review: Movie/Book) and Group Discussion	-	20
Written Test – Verbal Aptitude for Placement and Higher studies (The test will be conducted for 50 marks and reduced to 20)	-	20

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External (Practical)

Test – Listening (20),Reading (10) and E-Mail Writing(10)	-	40
Group Discussion	-	25
Personal Interview / Situational Conversation	-	25
Resume Submission	-	10

Coverage of Topics:

Sl. No.	Topic
1	Characteristics of Technical Writing
2	Development of Employability Skills
3	Vocabulary Development
4	Sentence Completion
5	Error Spotting
6	Interpretation of Verbal Analogy
7	Interpretation of Reading (Comprehension - Conception)
8	Interpretation of Reading (Comprehension - Reasoning)
9	Practice for writing E-mails/Technical Blogs/Forums
10	PPT Preparation / Demonstration of Technical Presentation
11	Preparation of Resume
12	Preparation for Job Interviews
13	Demonstration of Group Discussion Skills
14	Developing Listening Skill (Comprehension)
15	Practice for Short Speeches / Situational Conversation
16	Review : English Movies / Novels

Reference Books:

1. Courseware on ¯Technical Communication for Scientists and Engineers‖, IIT Bombay, 2015.
2. Cappel, Annette and Sharp, Wendy, Cambridge English: Objective First, 4th Ed., CUP, New Delhi, 2013.
3. Sue Prince, Emma, The Advantage: The 7 Soft Skills You Need to Stay One Step Ahead, Pearson; 1 Edition, 2013.
4. Hart, Guy Brook, Cambridge English Business Benchmark: 2 Ed., CUP 2014
5. Lewis, Norman. How to Read better & Faster. New Delhi: Binny Publishing House. 1978
6. McCarthy, Michael and Felicity O'Dell.. English vocabulary in use: 100 Units of Vocabulary reference and practice. Cambridge: CUP. 1996

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		Category	L	T	P	Credit
21DS210	**THEORY OF PROBABILITY**	FC	4	0	0	4

Preamble

The students will :

1. Apply conditional probability, Bayes' theorem to solve real world problems.
2. Learn the concepts of moment generating functions to discrete and continuous distributions and find the probability values for the defined distributions.
3. Learn the concepts of Limit theorems and applications of central limit theorem
4. Trained to apply the reliability models for the system life time.

Prerequisite

Nil

Course Outcomes

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

CO1:	Understand the concepts of basics of probability, conditional probability and Baye's Theorem.	Understand
CO2:	Infer discrete and continuous random variables, probability mass function and density function, expectation and variance	Apply
CO3:	Apply the concepts of discrete and continuous distributions as binomial, Poisson, geometric, uniform, normal, exponential, Weibull, erlang and gamma distributions to the biological decision making situations	Apply
CO4:	Apply joint probability distributions and find marginal and conditional distributions and also for the transformation of two random variables	Apply
CO5:	Apply the concept of moment and moment generating functions to discrete and continuous distributions and also for the central limit theorem.	Apply
CO6:	Apply the concept of reliability for system of independent components and expected system lifetime.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	L	M	M
CO2	L	S	S
CO3	L	S	S
CO4	L	S	S
CO5	L	S	S
CO6	L	S	S

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	10	10	10
Understand	30	20	20
Apply	60	70	70
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

Syllabus

Probability Basic Concepts: Introduction - Sample space and events - Axiomatic approach to probability – Basic theorems. Conditional Probability - Law of multiplication - Law of total probability and Bayes‟ Theorem - Independence.**Random Variables:** Discrete and continuous random variables - probability mass function and density function - distribution function - Expectation and variance.**Theoretical Distributions:** Discrete: Binomial, Poisson and Geometric - Continuous: Uniform, Normal, Exponential, Weibull, Erlang and Gamma.**Bivariate Distributions:**Joint probability distributions - Marginal and conditional distributions - Statistical independence - Conditional expectation – Transformation of two random variables. **Limit Theorems:** Moments and moment generating functions- Sums of independent random variables - Limit theorems: Markov and Chebyshev inequalities, Law of Large numbers, Central Limit Theorem. **Reliability:** Introduction - Structure Functions - Reliability of Systems of Independent Components - System Life as a Function of Component Lives - Expected System Lifetime.

Reference Books

1. Saeed Ghahramani, ¯Fundamentals of Probability with Stochastic Processes‖, Pearson Education, 2014.
2. Sheldon M.Ross, ¯Introduction to Probability Models‖, Academic Press, 2014.
3. K. S. Trivedi, ¯Probability and Statistics with Queuing, Reliability and Computer Science Applications‖, Prentice-Hall, 2011.
4. Anthony J. Hayter, ¯Probability and Statistics for Engineers and Scientists¯, Cengage Learning, 2013.
5. Jay L Devore, ¯Probability and Statistics for Engineering and Sciences‖, Cengage Learning, 2015.
6. Richard A. Johnson, Irwin Miller and John Freund, ¯Probability and Statistics for Engineers‖, Pearson Education, 2014.
7. Ronald E. Walpole, Raymond H. Meyers and Sharon L. Meyers, ¯Probability and Statistics for Engineers and Scientists‖, Pearson Education, 2014.

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21DS220	TRANSFORMS AND THEIR APPLICATIONS	Category	L	T	P	Credit
		FC	4	0	0	4

Preamble

The students will be able to:

1. Use some of the well-known transform like Laplace Transform and apply the Laplace transform to solve the differential equations.
2. Demonstrate periodic functions arising in the study of engineering problems as Fourier series of Sines and Cosines.
3. Learn Fourier Transform , periodic, convolution functions and inverse discrete Fourier Transform.
4. Model and Solve the difference equation using Z Transform.

Prerequisite

Nil

Course Outcomes

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

CO1:	Understands the Concept of Transformation with examples	Understand
CO2:	Apply Laplace transform technique to find the inverse laplace, solve the given ordinary differential equation and integral equations	Apply
CO3:	Express the periodic functions arising in the study of engineering problems as Fourier series of Sines and Cosines	Apply
CO4:	Solve some of the well-known integral transforms (like Fourier, Fourier Sine and Cosine) and properties	Apply
CO5:	Apply the fourier concepts in solving Discrete and Fast fourier transforms and also in its computation of inverse DFT	Apply
CO6:	Apply Z transform technique to find the inverse Z transforms, solve the given ordinary differential equation and modeling	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	L	M	M
CO2	L	S	S
CO3	L	S	S
CO4	L	S	S
CO5	L	S	S
CO6	L	S	S

S- Strong; M-Medium; L-Low

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	10	10	10
Understand	20	20	20
Apply	70	70	70
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

Syllabus

Transform Methods: Concept of Transformation - Examples for Transformations. **Laplace Transform**: Definition - Transforms of Standard Functions - Transform of unit step function - Dirac delta function. – Transforms of derivatives and integrals -Transforms of Periodic functions - Inverse Laplace transform- Convolution Theorem. Method of solving ordinary linear differential equations with constant coefficient and solving integral equations by Laplace transform technique. **Fourier Series:** Even and odd functions, Dirichlet‟s conditions, statement of Fourier theorem, Fourier coefficients, change of scale, Half-range sine and cosine series, RMS value, Parseval‟s theorem. **Fourier Transform :** Fourier integrals - Fourier transform- Fourier sine and cosine transform - Transforms of standard functions - Properties, Convolution theorem (Statement only) – Discrete Fourier and Fast Fourier Transforms – Discrete Convolution – Periodic sequence and circular convolution – Discrete Fourier Transform – decimation-in-time algorithm – Decimation-in-frequency algorithm – Computation of inverse DFT.**Z-Transform:** Z - transform of standard functions, inverse Z-transform – properties of Z – transform – Difference equations – Modeling, Solution of difference equations.

Reference Books

1. EwinKreyszig, ¯Advanced Engineering Mathematics‖, John Wiley & Sons, 2011.
2. Ray Wylie C, Louis C Barret, ¯Advanced Engineering Mathematics‖, McGraw Hill, 2013.
3. Michael D. Greenberg, ¯Advanced Engineering Mathematics‖, Pearson Education, 2009.
4. Roland E. Thomas and Albert J. Rosa, ¯The Design and Analysis of Linear Circuits‖, John Wiley & Sons, 2011.
5. Thomas L. Harman, James Dabney and Norman Richert, ¯Advanced Engineering with MATLAB‖, Brooks/Cole, 2000.

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		Category	L	T	P	Credit
21DS230	**DATA STRUCTURES**	PC	3	1	0	4

Preamble

This course aims at facilitating the student to understand the various data structures, their operations and apply them in real world problems.

Prerequisite

Nil

Course Outcomes

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

CO1:	Explain the organization and operations of data structures such as Array, String, Structure and Union, Stack, Queues and Lists.	Understand
CO2:	Compare and contrast the functionalities and applications of different data structures.	Understand
CO3:	Implement non-linear data structures such as trees and Hash tables with their related operations	Apply
CO4:	Compute space and time complexity for a given algorithm.	Apply
CO5:	Identify suitable data structure and design technique for developing algorithm to solve a given problem.	Apply
CO6:	Modify the existing operations of data structures for changing needs of the software requirements	Analyze

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	M	S	M
CO2	M	S	L
CO3	S	M	M
CO4	S	M	L
CO5	S	S	M
CO6	S	M	M

S- Strong; M-Medium; L-Low

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	20	20	20
Understand	30	30	30
Apply	50	40	40
Analyze	0	10	10
Evaluate	0	0	0
Create	0	0	0

Syllabus

Introduction: Software Development process – Abstraction - Data structures - Abstract Data Types - Primitive data structures - Analysis of algorithms - Best, worst and average case time complexities - notations. **Arrays**: Operations - Implementation of one, two, three and multi dimensioned arrays – Sparse and dense matrices - Applications. **Strings:** Implementation - operations - String applications. SETS: Operations on sets - implementation of sets. **Structures And Unions:** Implementation – operations – Applications. **Stacks:** Primitive operations - Sequential implementation - Applications: Subroutine handling - Recursion - Expression Processing. **Queues:** Primitive operations - sequential implementation - Priority Queues - Dequeues - Applications: Image component labeling; Machine shop simulation. **Lists:** Primitive Operations - Singly linked lists, Doubly linked lists, Circular lists, Multiply linked lists - Applications: Addition of Polynomials; Sparse Matrix representation and Operations. - Linked Stacks - Linked queues - Linked Priority queues - Dynamic Storage Management. **Trees:** Terminologies - Implementation - BINARY TREE: Properties - Sequential and linked representation - Common binary tree operations - Traversals - Expression trees - Infix, Postfix and Prefix expressions - Threaded trees - Tournament trees - Heaps, Max heap, Min heap. **Hashing:** Hash function – Separate chaining – Open addressing – Linear probing – Quadratic probing – Double hashing - rehashing.

Reference Books

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, ―Introduction to Algorithms‖, MIT Press, Third Edition 2011.
2. Sahni Sartaj, "Data Structures, Algorithms and Applications in C++", Silicon Press, 2011.
3. Aaron M. Tanenbaum, Moshe J. Augenstein and YedidyahLangsam, "Data structures using C and C++", Prentice Hall, 2012.
4. Michael T. Goodrich, Roberto Tamassia and David Mount, ― Data Structures and Algorithms in C++‖, John Wiley, 2011.

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21DS240	OBJECT ORIENTED PROGRAMMING	Category	L	T	P	Credit
		PC	4	0	0	4

Preamble

To provide sound knowledge on basic and advanced concepts of Object Oriented programming and apply them in developing industrial strength software applications.

Prerequisite

- 21DS140 Problem Solving Using C

Course Outcomes

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

CO1:	Explain the differences between structural and object oriented Programming	Understand
CO2:	Identify classes and objects from the given problem description and able to create classes and objects.	Apply
CO3:	Improve secured data processing by applying Abstraction, Encapsulation and Information hiding	Understand
CO4:	Achieve code reusability and extensibility by means of Inheritance and Polymorphism.	Apply
CO5:	Illustrate the use of templates, streams, exceptions and I/O classes for the given scenario.	Apply
CO6:	Identify suitable object oriented programming constructs for real time applications.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	M	M	L
CO2	S	S	L
CO3	M	M	L
CO4	S	S	M
CO5	S	S	M
CO6	S	M	M

S- Strong; M-Medium; L-Low

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	20	20	20
Understand	60	40	40
Apply	20	40	40
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

Syllabus

Principles Of Object Oriented Programming: Software crisis Software Evolution - Procedure Oriented Programming - Object Oriented Programming Paradigm - Basic Concepts and Benefits of OOP - Object Oriented Programming Language - Application of OOP - Structure of C++ - Tokens, Expressions and Control Structures - Operators in C++ - Manipulators.**Functions In C++**: Function Prototyping - Call by Reference - Return by reference - Inline functions - Default, Const Arguments - Function - Overloading - Friend and Virtual Functions - Classes and Objects - Member functions - Nesting of Member functions - Private member functions - Memory allocation for Objects - Static data members - Static MemberFunctions - Arrays of Objects - Objects as Function Arguments - Friend Functions - Returning Objects - Const Member functions - Pointers to Members.**Constructors:** Parameterized Constructors - Multiple Constructors in a Class - Constructors with Default Arguments - Dynamic Initialization of Objects - Copy and Dynamic Constructors – Destructors overloading.**Operator Overloading:** Overloading Unary and Binary Operators - Overloading Binary Operators using Friend functions – Operator Type conversion.**Inheritance:** Defining Derived Classes - Single Inheritance - Making a Private Member Inheritable - Multiple Inheritance - Hierarchical Inheritance - Hybrid Inheritance - Virtual Base Classes - Abstract Classes - Constructors in Derived Classes - Member Classes - Nesting of Classes – Composition – Aggregation.**Polymorphism:** Basics of polymorphism – Types of polymorphism - Compile and Run Time Polymorphism - Virtual function – Object Slicing – Virtual Destructor – Dynamic binding.**Templates & Exception Handling:** Introduction to Templates, Generic Functions and Generic Classes – Exception Handling – Examples.**Streams:** String I/O - Character I/O - Object I/O - I/O with multiple Objects - File pointers - Disk I/O with member functions.

Reference Books

1. Bjarne Stroustrup, ¯The C++ Programming Language‖, Pearson Education, 2014.
2. Yashavant P. Kanetkar, ¯Let Us C++‖, BPB Publications, 2007.
3. Stanley B. Lippman, JoseeLajoie andBarbara E. Moo, ¯The C++ Primer‖, Addison Wesley, 2013.¯
4. Scott Meyers, ¯Effective C++‖, Addison Wesley, 2005.

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		Category	L	T	P	Credit
21DS250	**GRAPH THEORY**	FC	3	1	0	4

Preamble

The students will :

1. Learn some basic types of graphs, connectivity and the complexity of the model can be viewed through graph.
2. Be able to model a real time problem to represent through graphs.
3. Learn the random graphs and Ramsey number to apply in the social networks.

Prerequisite

Nil

Course Outcomes

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

CO1:	Understand the basic concepts of Graphs, walk, path, tree and also decomposition of graphs	Understand
CO2:	Apply the concepts of Connectivity in Harary's construction of k-connected graphs	Apply
CO3:	Apply the concepts of Eulerian and Hamiltonian graphs in computer networks and other network related problems	Apply
CO4:	Apply the concepts of Matching, domination number in concepts of networks	Apply
CO5:	Apply the concept of Random graphs to find the Ramsey numbers.	Apply
CO6:	Apply the concept of first and second moment method in web graph models and social networks	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	L	M	M
CO2	L	S	S
CO3	L	S	S
CO4	L	S	S
CO5	L	S	S
CO6	L	S	S

S- Strong; M-Medium; L-Low

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	10	10	10
Understand	30	20	20
Apply	60	70	70
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

Syllabus

BASIC CONCEPTS: Graphs - directed and undirected, subgraphs, graph models, degree of a vertex, degree sequence, Havel- Hakimi theorem, Hand-shaking lemma. Connectivity, walk, path, distance, diameter. Isomorphic graphs. Common classes of graphs – regular, complete, Petersen, cycle, path, tree, k-partite, planar, hypercube. Spanning trees – Matrix tree theorem, graph decomposition.**CONNECTIVITY:** Vertex and edge connectivity, Vertex and edge cuts, relationship between vertex and edge connectivity, bounds for connectivity. Harary‟s construction of k-connected graphs.**EULERIAN AND HAMILTONIAN GRAPHS:** Eulerian graphs, Route inspection problem, Hamiltonian graphs, Dirac‟s and Ore‟s theorems, Gray codes, Walecki‟s construction. **MATCHING, VERTEX-COLORING AND DOMINATION:** Matching, Perfect matching, Bipartite matching, Hall‟s theorem. Vertex- coloring – upper chromatic number, bounds using clique number, $\Delta(G)$, Welsh – Powell theorem. Dominating set, domination number, bounds. Applications of the above concepts to networks.**RANDOM GRAPHS:** Random graph – Definitions of G(n, p) and G(n, M) models. Ramsey number – definition, Erdos theorem. n- existentially closed graphs, asymptotically almost surely graphs and their existence theorem. Expectation and the first moment method, variance and second moment method, threshold function. Web graph models, applications to social networks.

Reference Books

1. Bondy J.A. and Murty U.S.R., ―Graph Theory‖, Springer, 2013.
2. Anthony Bonato, ―A Course on Web Graphs‖, American Mathematical Society, 2008.
3. BelaBollobas, ―Random Graphs‖, Cambridge University Press, 2008.
4. Douglas B. West, ―Graph Theory‖, Prentice Hall, 2014.
5. Jonathan Gross and Jay Yellen, ―Graph Theory and its Applications‖, CRC Press, 2006.

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21DS270	OBJECT ORIENTED PROGRAMMING LAB	Category	L	T	P	Credit
		PC	0	0	4	2

Preamble

This course enables the students to use object oriented techniques to solve problem.

Prerequisite

- 21DS170 C Programming Lab

Course Outcomes

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

CO1:	Explain the concepts of oops for building object based applications.	Understand
CO2:	Write a program in different logic with suitable validations for a given problem.	Apply
CO3:	Implement the techniques and features of the Object Oriented Programming constructs to construct an application.	Apply
CO4:	Implement method overloading and method overriding for different user specifications.	Apply
CO5:	Write programs implementing inheritance for an application domain.	Apply
CO6:	Write technical report on the observations from the experiments.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	M	M	L
CO2	S	S	S
CO3	S	M	M
CO4	S	S	L
CO5	S	L	S
CO6	S	S	L

S- Strong; M-Medium; L-Low

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List of Experiments

Develop C++ programs for

1. Constructor and copy constructor.
2. Storage classes like auto, extern, register and static.
3. Static member data, static member function and bitwise operators.
4. Overloading and method overriding.
5. Inheritance
6. Pointer Arithmetic.
7. Inline Functions.
8. Functions & Recursion. a.Recursion b.Function with ¯this‖ pointer
9. Friend Function & Friend Class.
10. Exception handling methods.
11. Overload Unary & Binary Operators as Member Function & Non Member Function. a. Unary operator as member function b. Binary operator as non member function
12. Class Templates

- **Mini Project**: The course instructor shall provide real time problems/specifications to the students for mini project. The project shall be completed before the commencement of 3rd semester and a report shall be submitted.

Note: For all exercises, students shall develop C++ programs in any one application domain (e.g. Banking, Online shopping, Employee management etc.)

		Category	L	T	P	Credit
21DS280	**DATA STRUCTURES LAB**	PC	0	0	4	2

Preamble

The objective of this lab is to teach students various data structures and to explain them algorithms for performing various operations on these data structures. This lab complements the data structures course. Students will gain practical knowledge by writing and executing programs in C++ using various data structures such as arrays, linked lists, stacks, queues, trees, graphs, hash tables and search trees

Prerequisite

- 21DS230 Data Structures
- 21DS240 Object Oriented Programming

Course Outcomes

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

CO1:	Design algorithms for the given problem specifications.	Understand
CO2:	Write C programs for the designed algorithm specification.	Apply
CO3:	Write C programs to implement linear data structures : Stack and Queue using arrays and linked list in an application context.	Understand
CO4:	Implement Non linear data structures: Graph, Trees, Hashtable in an application context	Apply
CO5:	Implement algorithms which use sorting, searching and/or selection as sub-procedures.	Apply
CO6:	Assess the suitability of a data structure to solve a problem, based on the time and space complexities of different operations on the data structure.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	M	M	L
CO2	S	M	M
CO3	M	S	M
CO4	S	S	M
CO5	S	S	M
CO6	S	S	L

S- Strong; M-Medium; L-Low

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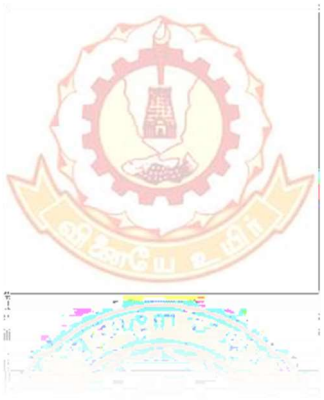
List of Experiments

1. Sparse and dense Matrix operations using arrays.
2. Library of string operations - representing strings using arrays.
3. Set operations.
4. Stack and Queue using array.
5. Linked Lists: Singly linked, Doubly linked and Circular lists.
6. Linked Stacks and Queues.
7. Conversion and Manipulation of Expressions.
8. Binary trees and Threaded trees (with graphical representation).
9. Hash Table linear probing and chaining.



21DS310	APPLIED STATISTICS	Category	L	T	P	Credit
		PC	3	1	0	4

Preamble

The students will be able to:

1. Learn the data analysis with the basics of graphs and tables.
2. Test the hypothesis on mean, variance, proportion of small and large samples, for goodness of fit and independence of attributes.
3. Apply the concept of correlation, linear and non linear regressions to engineering problems.
4. Design and conduct of engineering experiments involving a single factor, two factors and three factors.

Prerequisite

Nil

Course Outcomes

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

CO1:	Learn the basic concepts of distributions, charts and various types of measures.	Understand
CO2:	Apply the concepts of estimation and its type in mean, proportion and variance.	Apply
CO3:	Demonstrate the concept of testing of hypothesis for small and large samples by using various tests like t-test, F-test, z-test and chi-square test	Apply
CO4:	Apply the concept of Correlation and regressions to engineering problems Apply least square method in fitting linear and non linear regression curves.	Apply
CO5:	Apply Multiple regression and correlation analysis, Inferences about population parameters and Modeling techniques.	Apply
CO6:	Apply the concepts of Analysis of variance in real life problems	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	L	M	M
CO2	L	S	S
CO3	L	S	S
CO4	L	S	S
CO5	L	S	S
CO6	L	S	S

S- Strong; M-Medium; L-Low

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	10	10	10
Understand	30	20	20
Apply	60	70	70
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

Syllabus

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) - Maximum likelihood estimator. Hypothesis Testing: General concepts - Errors in Hypothesis testing - One- and two-tailed tests - 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 - Completely Randomized Design and Randomized Block Design.

Reference Books

1. Richard I. Levin. David S. Rubin, ―Statistics for Management‖, Pearson Education, 2014.
2. Ronald E. Walpole, Raymond H. Meyers and Sharon L. Meyers, ―Probability and Statistics for Engineers and Scientists‖, Pearson Education, 2014.
3. Jay L. Devore, ―Probability and Statistics for Engineering and Sciences‖, Cengage Learning, 2015.
4. Anderson, Sweeney and Williams ―Statistics for business and economics‖, Cengage Learning, 2014.
5. Saeed Ghahramani, ―Fundamentals of Probability with Stochastic Processes‖, Pearson Education, 2014.
6. Sheldon M.Ross, ―Introduction to Probability Models‖, Academic Press, 2014.
7. Douglas C Montgomery and George C Runges, ―Applied Statistics and Probability for Engineers‖, John Wiley &Sons, 2014.
8. Roy D.Yates and David J. Goodman, ―Probability and Stochastic Processes – A friendly Introduction for Electrical and Computer Engineers‖, John Wiley & Sons, 2015.
9. Trivedi K.S., ―Probability and Statistics with Reliability, Queueing and Computer Science Applications‖, Prentice Hall, 2011.

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		Category	L	T	P	Credit
21DS320	**LINEAR ALGEBRA**	FC	3	1	0	4

Preamble

The students will be able to:

1. Solve the given system of linear equations through matrices.
2. Verify whether the given set is a vector space or not. If So, determine its dimension.
3. Determine the matrix for the given linear transformation.
4. Predict ortho normal basis
5. Compute Eigen values , Eigen vectors and model to a quadratic form; and Construct a singular value decomposition for the given matrix
6. Perform diagonalization of a given matrix

Prerequisite

Nil

Course Outcomes

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

CO1:	Apply the concept of Gauss elimination in solving linear equations and to find the inverse of a matrices	Apply
CO2:	Apply the concept of vector spaces, linear independence, basis and dimensions to find Rank and also in electrical network applications	Apply
CO3:	Apply the concepts of Inner product spaces and orthogonal projections to find QR decomposition and least squares	Apply
CO4:	Apply the concept of linear transformation in matrices and geometry linear operators	Apply
CO5:	Apply the concept of Eigen values and vectors to orthogonal diagonalizing a given matrix	Apply
CO6:	Apply the concept of Eigen values and vectors to diagonalize a given matrix from quadratic form and applications of differential equations	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	L	S	S
CO2	L	S	S
CO3	L	S	S
CO4	L	S	S
CO5	L	S	S
CO6	L	S	S

S- Strong; M-Medium; L-Low

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	10	10	10
Understand	20	20	20
Apply	70	70	70
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

Syllabus

SYSTEM OF LINEAR EQUATIONS AND MATRICES: System of linear equations ,Gauss – elimination, Elementary matrices and a method for finding inverse of a matrix. **VECTOR SPACES:** Vector spaces and subspaces – Linear combination, Span, Linear independence and dependence - Null space, Column space, and Row space – Basis and dimension of a vector space – Rank and nullity-Applications to Electrical network.**INNER PRODUCT SPACES:** Inner product, Length, angle and orthogonality – Orthogonal sets – Orthogonal projections – Inner product spaces – Orthonormal basis: Gram-Schmidt process – QR Decomposition- Best Approximation, Least-squares. **LINEAR TRANSFORMATION:** Introduction to linear transformations – General Linear Transformations - Kernel and range - Matrices of general linear transformation- Geometry linear operators-Change of basis. **EIGEN VALUES AND EIGEN VECTORS:** Introduction to Eigen values- Diagonalizing a matrix- Orthogonal diagonalization-, Applications to differential equations- Positive definite matrices- Similar matrices -Quadratic forms- Quadratic surfaces Singular value decomposition.

Reference Books

1. Howard Anton and Chris Rorres, ¯Elementary Linear Algebra‖, Wiley, 2011.
2. David C. Lay, ¯Linear Algebra and its Applications", Pearson Education, 2011.
3. Gilbert Strang, ¯Linear Algebra and its Applications‖, Thomson Learning, 2009.
4. Steven J. Leon, ¯Linear Algebra with Applications‖, Prentice Hall, 2006.

21DS330	ORGANIZATIONAL THEORY AND BEHAVIOUR	Category	L	T	P	Credit
		PC	4	0	0	4

Preamble

To learn challenges and opportunities in organizations from a behavioral perspective.

Prerequisite

Nil.

Course Outcomes

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

CO1:	Develop an Organisational Behaviour model for any type of Organization.	Apply
CO2:	Develop Managerial skills for Individual Behaviours.	Understand
CO3:	Develop the quality of Leadership.	Apply
CO4:	Analyze the Common biases and eradication in Decision Making Process.	Analyze
CO5:	Adapt to the organizational culture.	Apply
CO6:	Analyze how to manage the Stress during a job.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	S	L	M
CO2	M	L	L
CO3	L	M	-
CO4	L	L	-
CO5	S	M	L
CO6	M	M	L

S- Strong; M-Medium; L-Low

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	20	10	10
Understand	30	30	30
Apply	40	40	40
Analyze	10	20	20
Evaluate	0	0	0
Create	0	0	0

Syllabus

Organizational Behavior: Introduction to Organizational Behavior(OB), Contributing disciplines to OB Field, challenges and opportunities for OB, Developing an OB Model, Foundation of Individual Behavior, Ability - Learning. Values, Attitudes and Types of Attitudes. Job satisfaction- Measuring Job satisfaction, Effect of Job satisfaction on employee performance. **Personality and Values:** Personality determinants, Achieving personality fit, Factors Influencing perception, Attribution Theory, Perception / Individual Decision Making: Ethics in Decision Making. Motivation, Management by Objectives, Employee Recognition programs, Employee Involvement programs, Variable Pay Programs. **Understanding work teams**: Teams Vs Groups – Types of Teams, Creating Effective Teams – Turning Individuals into Team Players. **Communication:** Functions of Communication, Communication Process - Direction of communication, Interpersonal and Organizational communication, Barriers of effective communication, Current issues in Communication. **Leadership**: Leadership - Meaning, Trait Theories – Behavioral Theories, Contingency Theories, Contemporary issues in Leadership. **Organizational culture and Stress Management:** Meaning – Creating and sustaining culture, How employees learn culture, creating an ethical organizational culture, creating a customer responsive culture, spirituality and organizational culture, Work stress and its Management.

Reference Books

1. Stephen P. Robbins, ¯Organisational Behaviour‖, 11/e, Pearson, 17 edition 2016
2. Uma Sekaran,‖ Organisational Behaviour‖, 2/e, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2010.
3. Sharma, R.A,‖ Organisational Theory and Behaviour‖, 2/e, Tata McGraw-Hill Ltd., New Delhi, 2007.

BOS Meeting Approved: 28-09-2022

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21DS340	ADVANCED DATA STRUCTURES	Category	L	T	P	Credit
		PC	3	1	0	4

Preamble

This course aims at facilitating the student to understand the various advanced data structures, their operations and apply them in real world problems.

Prerequisite

- 21DS230 Data Structures

Course Outcomes

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

CO1:	Discuss algorithms for the given problem specifications and analysis algorithm based on time and space complexity.	Understand
CO2:	Implement Binary Search Tree and AVL Tree	Apply
CO3:	Develop and analyze algorithms for Multiway Search Trees.	Apply
CO4:	Apply the concept of Multi dimensional Search Tree.	Apply
CO5:	Implement Priority Queues like Heap.	Apply
CO6:	Identity suitable data structures and develop algorithms for disjoint set.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	M	M	L
CO2	S	S	M
CO3	S	M	M
CO4	S	M	M
CO5	S	S	M
CO6	S	M	M

S- Strong; M-Medium; L-Low

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	20	10	10
Understand	40	30	30
Apply	40	60	60
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

Syllabus

INTRODUCTION: Algorithms – analysis of algorithms – best case and worst case complexities-analysis of some algorithms using simple data structures, Amortized Time Complexity. **BINARY SEARCH TREES**: Searching - Insertion and deletion of elements - randomly built binary search trees- analysis: height balancing techniques- AVL trees - Height – searching – insertion and deletion of elements- AVL rotations – analysis-Splay trees- notations-analysis. **MULTIWAY SEARCH TREES**: Indexed Sequential Access - m-way search trees – B-Tree – Searching, insertion and deletion - B+ trees, B*-trees, Tries and digital search trees, dictionary applications. **MULTIDIMENSIONALSEARCH TREES:** Range search-k-d trees**-** Quad trees. **PRIORITY QUEUES (HEAPS):** d-Heaps- Leftist Heaps - Property and operations- Binomial heap- Fibonacci heaps. **DATA STRUCTURES FOR DISJOINT SETS:** Disjoint set operations-linked list representation of disjoint sets, disjoint set forests, tree representation, union by rank, find by path compression - analysis.

Reference Books

1. Thomas H. Cormen, Charles E. Leiserson and Ronald L. Rivest, ¯Introduction to Algorithms‖ , MIT Press, 2011.
2. Mark Allen Weiss, ¯Data Structures and Algorithm Analysis in C++‖, Addison-Wesley, 2014.
3. Robert L. Kruse and Clovis L.Tondo, ¯Data Structures and Program design in C‖, Pearson Education, 2009.

BOS Meeting Approved: 28-09-2022

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21DS350	COMPUTER ORGANIZATION	Category	L	T	P	Credit
		PC	3	1	0	4

Preamble

This course dedicated to number system, logic design, and memory and processing. This is the only course that is concerned with the hardware of a computer, its logic design and organization. It aims at making the student familiar with digital logic and functional design of arithmetic and logic unit that is capable of performing floating point arithmetic operations.

Prerequisite

- 21DS130 Digital Electronics

Course Outcomes

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

CO1:	Explain about computer architecture	Understand
CO2:	Compute simple arithmetic operations for fixed-point and floating-point addition, subtraction, multiplication & division and Design combinational and sequential digital functions	Apply
CO3:	Construct an instruction set capable of performing a specified set of operations.	Analyze
CO4:	Demonstrate a memory system for a given set of specifications.	Analyze
CO5:	Explain pipelining concepts.	Understand
CO6:	Compare the different ways of communicating with I/O devices and standard I/O interfaces.	Analyze

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	S	S	L
CO2	S	S	L
CO3	S	M	-
CO4	S	M	-
CO5	M	S	-
CO6	S	M	L

S- Strong; M-Medium; L-Low

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	10	10	10
Understand	20	20	20
Apply	40	40	40
Analyze	30	30	30
Evaluate	0	0	0
Create	0	0	0

Syllabus

Functional Units: Basic operational concepts, Bus structures, Machine instructions, memory locations, addressing modes, assembly language **Arithmetic:** Number representations, addition and subtraction of signed numbers, Design of fast adders, Multiplication of signed numbers, Fast multiplication and Integer division **Processing Unit:** Concepts, Execution of complete instruction, Multi bus organization, ALU; Control Unit: Hardwired Control, Micro programmed Control; Micro Instructions, Micro program sequencing, Micro instructions with next address field and pre-fetching **Memory:** RAM, ROM, Cache Memories, and Virtual memory **Input and output organization:** Accessing I/O devices, Interrupts, DMA, and Interface circuits **Advanced Processor Architecture:** RISC, Pipelining, Super Scalar Processors, VLIW, Parallel and Vector Processors.

Reference Books

1. Carl Hamacher, Zvonko Vranesic, safwat Zaky, ¯Computer Organization and Embedded Systems‖, Sixth Edition, Tata McGraw Hill, 2011.
2. William Stallings, ¯Computer Organization and Architecture‖, Tenth Edition, Pearson Education, 2015.
3. David A. Patterson, John L.Hennessy, ¯Computer Organization and Design‖, Fourth Edition, Morgan Kauffmann Publishers, 2011.

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21DS370	APPLIED STATISTICS AND PYTHON PROGRAMMING LAB	Category	L	T	P	Credit
		PC	0	0	4	2

Preamble

With the power of Python-based tools, the students will rapidly get up to speed and begin thinking statistically at the end of this course.

Prerequisite

- Fundamental of Programming languages

Course Outcomes

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

CO1:	Apply the concept of Classification and tabulation of data and Graphical and diagrammatic presentation of data.	Apply
CO2:	Perform calculations that measure the central tendency and dispersion of data and Implementation of measures of Skewness, moments and kurtosis.	Apply
CO3:	Determination of point and interval estimates.	Apply
CO4:	Apply the concepts of Regression in Solving linear regression, polynomial regression and non-linear regression based problems	Apply
CO5:	Apply the concepts of Regression and correlation in solving multiple regression and correlation analysis based problems.	Apply
CO6:	Solving the problems based on Time series analysis and forecasting and implementing statistical quality control charts.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	L	S	S
CO2	L	S	S
CO3	L	S	S
CO4	L	S	S
CO5	L	S	S
CO6	L	S	S

S- Strong; M-Medium; L-Low

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List of Experiments

Implementation of the following problems using Statistical Packages:

1. Classification and tabulation of data and Graphical and diagrammatic presentation of data.
2. Perform calculations that measure the central tendency and dispersion of data and Implementation of measures of Skewness, moments and kurtosis.
3. Determination of point and interval estimates.
4. Solving linear regression, polynomial regression and non-linear regression based problems and solving multiple regression and correlation analysis based problems.
5. Solving the problems based on Time series analysis and forecasting and implementing statistical quality control charts.

21DS380	ADVANCED DATA STRUCTURES LAB	Category	L	T	P	Credit
		PC	0	0	4	2

Preamble

The course aims to teach students various advanced data structures and to explain them algorithms for performing various operations on these data structures. This lab complements the data structures course. Students will gain practical knowledge by writing and executing programs in C++ using various data structures.

Prerequisite

- 21DS230 Data Structures
- 21DS240 Object Oriented Programming

Course Outcomes

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

CO1:	Develop and analyze algorithms for Sorting.	Apply
CO2:	Implement Binary Search Tree and AVL Tree & Develop problems using linear search and binary search.	Apply
CO3:	Apply the concept of B tree and heap data structure.	Apply
CO4:	Identity suitable data structures and develop algorithms for disjoint set.	Apply
CO5:	Problems related to graphs and graph traversals.	Apply
CO6:	Implement shortest path algorithm.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	S	M	M
CO2	S	M	M
CO3	S	S	M
CO4	S	S	M
CO5	S	S	M
CO6	S	S	M

S- Strong; M-Medium; L-Low

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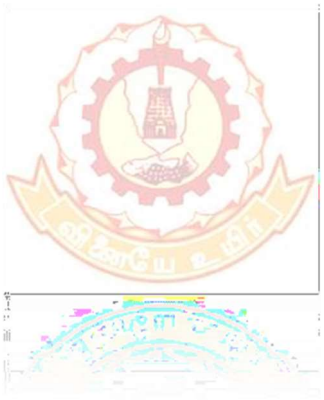
List of Experiments

1. Problems related to sorting algorithms.
2. Problems using linear search and binary search.
3. Applications of binary search tree and its operations.
4. AVL tree including all rotations.
5. B-tree and its operations.
6. Disjoint set operations and some applications.
7. Problem using heap data structure.
8. Implementation of binomial heap and one application.
9. Problems related to graphs and graph traversals.
10. Implementation of shortest path algorithm.



21DS410	ABSTRACT ALGEBRA	Category	L	T	P	Credit
		FC	4	0	0	4

Preamble

1. Learn the basic concepts of algebraic structures and groups.
2. Apply the concepts of normal subgroups and Cayley' theorem,
3. Model the concepts of Coding of Binary information and Error detection.
4. Learn the concepts of rings,fields and unique factorization theorem

Prerequisite

Nil

Course Outcomes

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

CO1:	Understand the concepts of Groups and its properties with permutation	Understand
CO2:	Apply the concept of groups to learn about subgroups, normal subgroups and fundamental theorem of group homomorphism	Apply
CO3:	Apply the concept of groups to learn about coding of binary information, decoding and error correction	Apply
CO4:	Learn the basics of Ring and its properties and apply unique factorization theorem	Apply
CO5:	Apply the concept of rings to find factorization of polynomials and primitive polynomials	Apply
CO6:	Apply the concept of fields to find the structure of finite field and GF(2^n)	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	L	M	M
CO2	L	S	S
CO3	L	S	S
CO4	L	S	S
CO5	L	S	S
CO6	L	S	S

S- Strong; M-Medium; L-Low

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	10	10	10
Understand	30	20	20
Apply	60	70	70
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

Syllabus

ALGEBRAIC STRUCTURES: Groups - Definition and Example, Properties of Groups, Permutation Groups, Symmetric Groups, Cyclic Groups.**SUBGROUPS AND NORMAL SUBGROUPS**: Subgroups - Definition, Cosets and Lagrange‟s theorem, Homomorphism, Isomorphism, Automorphism - Cayley‟s theorem - Normal subgroups - Factor group - Fundamental theorem of group homomorphism.**GROUPS AND CODING**: Coding of Binary information and Error detection - Group codes - Decoding and Error correction. **RINGS**: Definition and Properties - Subrings, Ring of Quaternions, Integral domain - Homomorphism - Ideals and Quotient Rings - Euclidean ring - Unique factorization theorem, Domain of Gaussian Integers. Polynomials Rings - Properties, Division Algorithm, Factorization of Polynomials - Primitive polynomials. **FIELDS:** Definition - subfields - Finite fields - structure of Finite field, GF (2^n).

Reference Books

1. Herstein I. N., ¯Topics in Algebra‖, John Wiley & Sons, 2012.
2. Joseph A. Gallian, ¯Contemporary Abstract Algebra‖, Brooks/Cole, 2013.
3. Tremblay J. P. and Manohar R., ¯Discrete Mathematical Structures with Applications to Computer Science‖, Tata McGrawHill, 2011.
4. Ron M. Roth, ¯Introduction to Coding Theory‖, Cambridge University Press, 2007.
5. Ralph P. Grimaldi and Ramana B. V., ¯Discrete and Combinatorial Mathematics: An Applied Introduction‖, Pearson Education, 2014.

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		Category	L	T	P	Credit
21DS420	**DATABASE MANAGEMENT**	PC	4	0	0	4

Preamble

This course aims at facilitating the student to understand the various functionalities of DBMS software and perform many operations related to creating, manipulating and maintaining databases for Real-world applications and student to understand the various designing concepts, storage methods, querying and managing databases.

Prerequisite

Nil.

Course Outcomes

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

CO1:	Explain Entity Relationship(ER) and Relational Models for a given application.	Understand
CO2:	Build and manipulate relational database using Structured Query Language and relational languages.	Apply
CO3:	Develop & Analyze a normalized database for a given application by incorporating various constraints like integrity and value constraints.	Analyze
CO4:	Construct data structures like indexes and hash tables for the fast retrieval of data	Apply
CO5:	Illustrate different transaction and concurrency control mechanisms to preserve data consistency in a multi-user environment.	Analyze
CO6:	Apply data storage techniques for a given scenario	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	S	L	M
CO2	S	S	M
CO3	S	S	S
CO4	S	M	M
CO5	S	S	M
CO6	S	M	L

S- Strong; M-Medium; L-Low

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	30	20	20
Understand	30	20	20
Apply	30	30	30
Analyze	10	30	30
Evaluate	0	0	0
Create	0	0	0

Syllabus

BASIC CONCEPTS: Introduction to databases – Conventional file Processing – Data Modeling for a database – Three level architecture – Data Independency – Components of a Database Management System (DBMS) – Advantages and disadvantages of a DBMS – System Environment – Users of DBMS – Transaction Management. **DATA MODELS:** Introduction – Conceptual data modeling – Motivation - Entities, entity types, various types of attributes, relationships, relationship types - E/R Diagram(ERD) notation - Generalization – Aggregation – Conversion of ERD into relational schema – Introduction to Network data model and Hierarchical data model. **RELATIONAL DATA MODEL:** Introduction – Keys, relational algebra operators: selection, projection, cross product, various types of joins, division, examples, tuple relation calculus, domain relational calculus. **RELATIONAL DATABASE MANIPULATION: Structured** Query Language (SQL) - Basic data retrieval – nested queries - correlated and uncorrelated - SQL Join – Views. **DATABASE DESIGN THEORY:** Functional dependencies – Normal forms - Dependency theory - Functional Dependencies(FD) – Armstrong's axioms for FDs - Closure of a set of FDs, Minimal covers – 1NF, 2NF, 3NF and BCNF - Join dependencies and definition of 5NF – Examples. **DATA STORAGE AND INDEXING:** Storage device Characteristics – Operations on file - Sequential files - Index Sequential files – Direct files – Indexing using Tree structures. **DATABASE SECURITY, INTEGRITY AND CONTROL:** Security and Integrity threats – Defense mechanisms - Transaction processing – concepts - ACID properties - concurrency control - recovery methods.

Reference Books

1. Silberschatz A., Korth H. and Sudarshan S., ¯Database System Concepts‖, McGraw Hill, 2011.
2. Elmasri R. and Navathe S.B., ¯Fundamentals of Database Systems‖, Pearson Education, 2011.
3. Raghu Ramakrishnan and Johannes Gehrke, ¯Database Management System‖, McGraw Hill, 2010.
4. Bipin C.Desai, ¯An Introduction to Database System „", Galgotia Publishers, 2012.

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21DS430	DESIGN AND ANALYSIS OF ALGORITHMS	Category	L	T	P	Credit
		PC	3	1	0	4

Preamble

This course will enable students to solve a given problem using an algorithm. Also, it enables to mathematically analyze the algorithms for its efficiency and effectiveness.

Prerequisite

- 21DS230 Data Structures

Course Outcomes

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

CO1:	Summarize the relevance of algorithms for computational problems solving and real time applications.	Understand
CO2:	Differentiate different algorithmic approaches, techniques and methods.	Understand
CO3:	Apply paradigms like divide and conquer, greedy and dynamic programming for a given algorithm.	Apply
CO4:	Apply optimization techniques for improving the efficiency of algorithms and graph-based algorithms to solve engineering problems.	Apply
CO5:	Analyze the worst-case, best-case and average-case running time of algorithms using asymptotics.	Analyze
CO6:	Evaluate polynomial reductions for standard problems with an understanding of the intractable complexity classes like NP-Complete and NP-hard..	Evaluate

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	S	M	-
CO2	S	M	-
CO3	S	S	-
CO4	S	S	M
CO5	S	S	M
CO6	S	S	L

S- Strong; M-Medium; L-Low

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	15	10	10
Understand	40	20	20
Apply	25	20	20
Analyze	20	30	30
Evaluate	0	20	20
Create	0	0	0

Syllabus

INTRODUCTION: Fundamentals of algorithmic problem solving - Methods of specifying an algorithm – proving the correctness – analyzing an algorithm, Asymptotic notations, Recurrences – Master theorem. DIVIDE AND CONQUER: Integer multiplication,Strassen‟s matrix multiplication, closest pair**. GREEDY METHOD:** Minimum cost spanning tree (Kruskal and Prim‟s algorithms), topological sorting, Huffman codes and data compression. **DYNAMIC PROGRAMMING:** Principles of dynamic programming – 0/1 knapsack problem, all pairs shortest problem, travelling salesman problem. **GRAPHS:** Definition – Representations (Adjacency matrix, packed adjacency list and linked adjacency list) – Network representation, shortest path- Dijkstra‟s algorithm, Graph search methods (Breadth first and depth first traversals)- Applications of depth first search-biconnectivity-finding strong components. **STRING MATCHING:** The naïve string-matching algorithm, Rabin-karp algorithm and analysis. **NP AND COMPUTATIONAL INTRACTABILITY:** Basic concepts – Polynomial time reductions, efficient certification and NP, NP hard and NP complete problems. **COPING WITH NP-COMPLETENESS:** Backtracking-n queens problem, Graph coloring problem - branch and bound - 0/1 knap sack problem , Traveling salesman problem, Approximation algorithm – Introduction – traveling salesman problem.

Reference Books

1. Thomas H. Cormen, Charles E. Leiserson, and Ronald LRivest, ―Introduction to Algorithms‖, MIT Press, 2011.
2. Jon Kleinberg and Eve Tardos, ―Algorithm Design‖, Pearson Education, 2012
3. Anany Levitin, ―Introduction to Design and Analysis of Algorithms‖, Pearson Education, 2012.

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21DS440	OPERATING SYSTEMS	Category	L	T	P	Credit
		PC	4	0	0	4

Preamble

The major objective of this course are to introduce basic concepts and principles of Windows and Linux operating systems which include memory management, device management, process management, file management and security & protection mechanisms.

Prerequisite

- 21DS230 Data Structures

Course Outcomes

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

CO1:	Describe the evolution, types, structure and functions of operating systems	Understand
CO2:	Explain techniques involved in process, memory, device and file management.	Understand
CO3:	Describe security and protection measures used in operating systems.	Understand
CO4:	Execute Linux basic commands and shell scripts.	Apply
CO5:	Implement processor scheduling, synchronization, deadlocks and disk allocation algorithms for a given scenario.	Apply
CO6:	Analyze the code for the resource allocation.	Analyze

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	S	M	-
CO2	S	M	-
CO3	S	S	-
CO4	S	S	M
CO5	S	S	M
CO6	S	S	M

S- Strong; M-Medium; L-Low

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	3	
Remember	20	20	20
Understand	50	30	30
Apply	30	40	40
Analyze	0	10	10
Evaluate	0	0	0
Create	0	0	0

Syllabus

Operating System Introduction : Basics, OS Architecture, OS Operations. **Process Management:** Process states – Operations on process-Interrupts-Interprocess communication-Thread concepts -Job and processor Scheduling **Concurrent Execution:** Asynchronous Concurrent Processes- Concurrent Programming-Deadlock and indefinite postponement. **Memory Management:** Swapping, Paging, Segmentation, Virtual Memory – Demand paging, Page Replacement. **File & Storage Management:** File System, File Organization, Allocation methods, free space management, Disk Structure, Disk Scheduling, Swap-Space Management. **Linux Programming** - Command Line and Shell Scripting Basics. **Case Studies:** Linux, Windows, Mobile Operating System

Reference Books

1. William Stallings, ¯Operating systems Internal and Design Principles‖, Eighth Edition, Pearson Education, Global edition. 2015.
2. Andrew Tanenbaum, ¯Modern Operating Systems‖, Fourth Edition, Pearson Education,Global edition, 2014.
3. Abraham Silberschatz, Greg Gagne, Peter B. Galvin, ¯Operating System Concepts‖, 9th edition, Wiley, 2013.
4. H M Deital, P J Deital and D R Choffnes, ¯Operating Systems‖, Third Edition ,Pearson Education, (2004),Reprint 2012.

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		Category	L	T	P	Credit
21DS450	**PREDICTIVE ANALYTICS**	PC	4	0	0	4

Preamble

This course will enable students to apply specific statistical and regression analysis methods applicable to predictive analytics to identify new trends and patterns, uncover relationships, create forecasts and to develop and use various quantitative and classification predictive models based on various regression and models.

Prerequisite

Nil

Course Outcomes

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

CO1:	Apply the concept of linear regression to find residual analysis, confidence and prediction intervals	Apply
CO2:	Apply the concept of multiple linear regression to find interpretation of regression coefficients, heteroscedasticity	Apply
CO3:	Apply the concept of multiple linear regression to find auto regression and transformation of variables and in building Models	Apply
CO4:	Apply the concept of logistic and multinomial regression to find estimation of probability and gini co-efficient	Apply
CO5:	Apply the concept of forecasting in Moving average, Exponential Smoothing, Casual Models	Apply
CO6:	Apply the concept of time series analysis in Moving Average Models, ARIMA models, Multivariate Models	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	L	S	S
CO2	L	S	S
CO3	L	S	S
CO4	L	S	S
CO5	L	S	S
CO6	L	S	S

S- Strong; M-Medium; L-Low

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	10	10	10
Understand	20	20	20
Apply	70	70	70
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

Syllabus

LINEAR REGRESSION: Coefficient of determination, Significance test, Residual analysis, Confidence and Prediction intervals. **MULTIPLE LINEAR REGRESSION:**Coefficient of determination, Interpretation of regression coefficients, Categorical variables, heteroscedasticity, Multi-co linearity outliers, Auto regression and Transformation of variables, Regression, Model Building. **LOGISTIC AND MULTINOMIAL REGRESSION:** Logistic function, Estimation of probability using Logistic regression, Variance, Wald Test, Hosmer Lemshow Test, Classification Table, Gini Co-efficient. **FORECASTING:** Moving average, Exponential Smoothing, Casual Models. **TIME SERIES ANALYSIS:** Moving Average Models, ARIMA models, Multivariate Models. CASE STUDIES

Reference Books

1. Anderson, Sweeney and Williams ―Statistics for business and economics‖, Cengage Learning, 2011.
2. Richard I. Levin. David S. Rubin, ―Statistics for Management‖, Pearson Education, 2012.
3. Richard A. Johnson, Irwin Miller and John Freund, ―Probability and Statistics for Engineers‖, Pearson Education, 2014.
4. Ronald E. Walpole, Raymond H. Meyers, Sharon L. Meyers, ―Probability and Statistics for Engineers and Scientists‖, Pearson Education, 2014

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		Category	L	T	P	Credit
21DS470	**RELATIONAL DATABASE LAB**	PC	0	0	4	2

Preamble

This course aims at giving adequate exposure to students on the Database design and E-R modelling. The course also facilitates students with hands on training on SQL and programming language extension to SQL within the RDBMS environment.

Prerequisite

Nil

Course Outcomes

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

CO1:	Model Entity Relationship with E-R diagrams.	Apply
CO2:	Design database schema considering normalization and relationships within database.	Apply
CO3:	Write SQL queries to user specifications.	Apply
CO4:	Develop triggers, procedures, user defined functions and design accurate and PLSQL programs in Oracle and DB2.	Apply
CO5:	Use the database from a front end application.	Apply
CO6:	Prepare technical report on the observations of the experiments and develop package for database.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	S	M	M
CO2	S	S	S
CO3	S	M	S
CO4	S	S	S
CO5	S	S	S
CO6	S	M	M

S- Strong; M-Medium; L-Low

List of Experiments

1. Working with DDL and DML commands of SQL for creation and manipulation of single, multiple tables, Report Generation.
2. Working with PL/SQL- Triggers and stored procedures.
3. Developing Packages using a database.

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21DS480	DESIGN AND ANALYSIS OF ALGORITHMS LAB	Category	L	T	P	Credit
		PC	0	0	4	2

Preamble

This Laboratory will enable students to identify, formulate and solve real world engineering problems that require powerful algorithms.

Prerequisite

- 21DS140 Problem Solving Using C Programming
- 21DS230 Data Structures

Course Outcomes

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

CO1:	Develop efficient algorithms and implementation schemes like Graphs, BFS and DFS for solving a given problem.	Apply
CO2:	Apply the concepts of Kruskal's and Prim's algorithms in finding the shortest spanning tree in a given graph.	Apply
CO3:	Solve problems related to topological sorting.	Apply
CO4:	Model, implement and evaluate the algorithms designed for all pairs shortest path problem.	Apply
CO5:	Use and Implement the Optimal binary search tree and Optimal Caching.	Apply
CO6:	Construct graph-based algorithms to solve engineering problems and Construct algorithm TSP using branch and bound.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	S	S	M
CO2	S	S	S
CO3	S	S	M
CO4	S	S	M
CO5	S	S	S
CO6	S	S	M

S- Strong; M-Medium; L-Low

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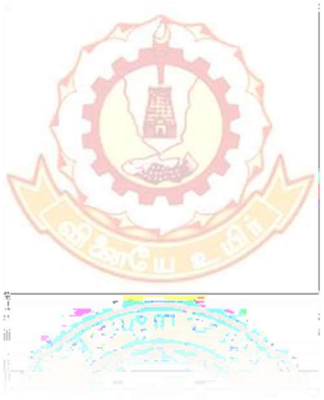
List of Experiments

1. Problems using Graphs, BFS, DFS.
2. Prim‟s minimum cost spanning tree.
3. Kruskal‟s minimum cost spanning tree using min heap data structure, union and find operation.
4. Problem related to topological sorting.
5. Application of all pairs shortest path problem.
6. Optimal binary search tree.
7. Optimal caching.
8. Application of graph coloring using back tracking.
9. TSP using branch and bound.



21DS510	NUMERICAL METHODS	Category	L	T	P	Credit
		FC	4	0	0	4

Preamble

The students will be able to:

1. Apply appropriate numerical methods to solve algebraic, transcendental equations and polynomial equations.
2. Compute an approximate solution for simultaneous linear algebraic equations and the inverse of a non-singular matrix.
3. Calculate the approximate solutions for problems related to interpolation, differentiation and integration
4. Apply various computational methods for finding approximate solutions of Partial Differential Equations of different types

Prerequisite

Nil

Course Outcomes

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

CO1:	Apply the different methods for solving algebraic equations to find the root of the given equation	Apply
CO2:	Apply different methods for solving algebraic simultaneous equations to find the values in matrix form and also to find inverse of a matrix	Apply
CO3:	Apply the concept of Eigen values and vectors to find the dominant and smallest eigen value	Apply
CO4:	Apply the concept of matrix operations in sparse direct solutions and random walk problems	Apply
CO5:	Apply the concept of interpolation in spline surves and B-spline Curves	Apply
CO6:	Apply the concept of differentiation and intergration in numerical problems in real life statistical data and interpolate the value	Apply
CO7:	Apply the concept of partial differential equations in solving laplace and poisson equations and also explicit method for hyperbolic equations	Apply

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Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	L	S	S
CO2	L	S	S
CO3	L	S	S
CO4	L	S	S
CO5	L	S	S
CO6	L	S	S
CO7	L	S	S

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	10	10	10
Understand	20	20	20
Apply	70	70	70
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

Syllabus

TYPES OF ERRORS: Different types of error.**SOLUTION OF ALGEBRAIC EQUATIONS:** Newton Raphson method, Modified Newton Raphson method, Method of false position, Graffe‟s root squaring method, Bairstow‟s method.**SOLUTION OF ALGEBRAICSIMULTANEOUS EQUATIONS:** Gauss – Jordan elimination, Cholesky method, Crout‟s method, Gauss - Jacobi method, Gauss - Seidel method. Matrix Inverse by Gauss - Jordan method.**EIGENVALUES AND EIGENVECTORS:** Power method for finding dominant eigenvalue and inverse power method for finding smallest eigenvalue, Jacobi method for symmetric matrices.**SPARSE MATRICES** : Introduction – Storage Schemes – Basic sparse matrix operations – Sparse direct solutions – random walk problems.**INTERPOLATION AND CURVE FITTING:** Finite difference operators-Interpolating Polynomials, Divided Difference, Spline Curves, Bezier Curves and B-Spline Curves.Solution of linear second order difference equations with constant coefficients.**NUMERICAL DIFFERENTIATION AND INTEGRATION:** Numerical Differentiation using Newton forward and backward formulas. Numerical Integration: Newton -Cotes formula, Trapezoidal rule, Simpson‖s $(1/3)^{rd}$ and $(3/8)^{th}$ rule . Gaussian Quadrature Applications of Cubic Splines.**PARTIAL DIFFERENTIAL EQUATIONS:** Classification of partial differential equations of second order. Liebmann‟s method for Laplace equation and Poisson equation, Explicit method and Crank - Nicolson method for parabolic equations. Explicit method for hyperbolic equations..

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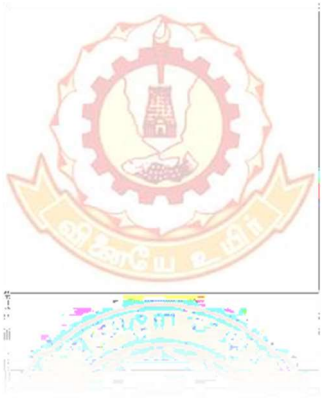
Reference Books

1. Steven C. Chapra and Raymond P. Canale, ¯Numerical Methods for Engineers with Software and Programming Applications‖, McGraw Hill, 2011.
2. Curtis F. Gerald,and Patrick O. Wheatley, ¯Applied Numerical Analysis‖ Pearson, 2011.
3. Yousef Saad. ¯Numerical methods for large eigen value problems‖, University Press, 2011.
4. Richard L. Burden and Dougglas Faires J., ¯Numerical Analysis‖ Thomson Brooks/Cole, 2005.
5. Brian Bradie, ¯A Friendly introduction to Numerical Analysis‖, Pearson, 2006.



21DS520	WEB TECHNOLOGY	Category	L	T	P	Credit
		PC	4	0	0	4

Preamble

This course aims at giving adequate exposure to students to develop the modern Web applications using the client and server side technologies and the web design fundamentals.

Prerequisite

- Fundamentals of Programming and Networking

Course Outcomes

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

CO1:	Use the object oriented concepts of java for the given problem.	Understand
CO2:	Use exceptions, threads, collections, logs of Java for the given problem.	Apply
CO3:	Apply events through swing, RMI, JAR operations for the given application.	Understand
CO4:	Select the proper library classes in Java based on the need of a problem.	Apply
CO5:	Apply different Java technologies to solve Internet applications.	Apply
CO6:	Design an application using DHTML and JSP	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	S	S	S
CO2	S	S	S
CO3	S	S	S
CO4	S	S	M
CO5	S	S	M
CO6	S	S	S

S- Strong; M-Medium; L-Low

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	30	20	20
Understand	30	30	30
Apply	40	50	50
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

Syllabus

Internet Programming: Internet Basics, DHTML: Introduction - CSS - DOM: Collections- Event Model - Filters and Transitions. **Java Programming**: Java Basics:Java features, Array and Strings, Object Oriented Features, Language Interface: JNI, Utilities and Collections, Stacks, Queues and vectors **Multithreading and Exceptions**: Multithreaded Programming, Exception Handling, **Applets**: Applet life cycle, Built in String functions, Streams and serialization: I/O Streams, Object Serialization, Files, AWT Controls: Controls, Layout Managers, Menus, Graphics, Event Handling. **JSP** : Basics and Comments - Scripting Elements - Expressions - Scriplets - Declarations- Directives - Predefined variables. **Database Handling**: JDBC connectivity, Types of Statement, Types of Execute Methods. **Networking**: Networking Basics - Java and the Net - InetAddress - TCP/IP Client Sockets - URL -URL Connection – TCP/IP Server Sockets – A Caching Proxy HTTP Server – Datagrams, RMI Technology.

Reference Books

1. Herbert Schildt, "Java the Complete Reference", 9th Edition, McGraw Hill, 2014.
2. Margaret Levine Young, "The Internet - Complete Reference" , 2nd Edition, Tata McGraw Hill, 2002, (Reprint 2016).
3. Paul Deitel, Harvey Deitel, Abbey Deitel, ¯Internet and WWW How to Program‖, 5th Edition, Tata McGraw Hill, 2011.

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21DS530	COMPUTER NETWORKS	Category	L	T	P	Credit
		PC	4	0	0	4

Preamble

The course aims to provide an understanding of computer networks architecture, various technologies available to build a network and protocols in use at different levels of network layers stack. An overview of global Internet, Internet applications and introduction to Network simulation is also provided.

Prerequisite

Nil

Course Outcomes

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

CO1:	Describe the building blocks of Computer Networks	Understand
CO2:	Explain the functionalities and protocols of various layers in ISO/OSI Network model.	Understand
CO3:	Implement a suitable routing strategies for a given network.	Apply
CO4:	Use suitable transport/application layer protocol based on application requirements.	Apply
CO5:	Suggest appropriate access control, congestion control and congestion avoidance technique for a given traffic scenario.	Analyze
CO6:	Examine performance analysis for a network using tools like NS2, wire shark.	Analyze

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	S	M	-
CO2	S	M	-
CO3	S	S	M
CO4	S	S	M
CO5	S	S	M
CO6	S	S	M

S- Strong; M-Medium; L-Low

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	20	20	20
Understand	40	30	30
Apply	30	30	30
Analyze	10	20	20
Evaluate	0	0	0
Create	0	0	0

Syllabus

Network Architecture and Components – ISO/OSI architecture – Functionalities of OSI Layers - TCP/IP architecture – Types of Networks (LAN, WAN, VPN, VLAN) – Network Components (NIC, Bridges, Switches, Routers, Hubs, Gateways)
Network Technologies to connect hosts – LAN Technologies (Ethernet, Token Ring) WAN Technologies (Circuit switching- ISDN , Packet Switching – Frame Relay - (IEEE802.11) – Multiple Access – CSMA/CD – Flow control techniques – Error control techniques.
Internetworking – IPv4 – Global Addresses – ARP – DHCP – ICMP – Routing – Intra domain Routing algorithms (RIP, OSPF) - Subnetting - Classless Addressing - Inter domain routing – Ipv6 – Multicasting – VoIP.
Protocol stack – End to End protocols [TCP (segment format, connection establishment & Termination, Congestion control, Flow Control), UDP] - Application layer protocols (SMTP, IMAP,POP, HTTP, FTP, DNS, Telnet).
Network Performance and Simulation – Bandwidth - latency - Throughput - Jitter - Delay– Network simulation using NS2, WireShark.
Fundamentals of Software defined networks

Reference Books

1. BehrouzA.Foruzan, ¯Data Communication and Networking‖, Tata McGraw Hill, Fifth Edition, 2013
2. William Stallings, ¯Data and Computer Communications‖,Pearson Education Ninth Edition 2013
3. Larry L.Peterson and Bruce S. Davie, ¯Computer Networks – A systems Approach‖ Fifth Edition, Morgan Kaufmann Publishers,2011

		Category	L	T	P	Credit
21DS540	**MACHINE LEARNING**	PC	3	1	0	4

Preamble

The course aims to provide an understanding of machine learning's role in data-driven modeling, prediction, and decision-making.

Prerequisite

- 21DS310 Applied Statistics

Course Outcomes

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

CO1:	Gain knowledge about basic concepts of Machine Learning develop an appreciation for what is involved in learning from data.	Understand
CO2:	Develop learning algorithms based on logistic regression, Support Vector Machines to predict discrete-valued output given a training data comprising of features and corresponding class labels.	Apply
CO3:	Design and implement machine learning solutions to classification, regression, and clustering problems; and be able to evaluate and interpret the results of the algorithms.	Apply
CO4:	Develop Linear Models for Regression using Bias-Variance Decomposition, Bayesian Linear Regression.	Apply
CO5:	Design Linear Models for Classification using Probabilistic Discriminative Models , The Laplace Approximation, Bayesian Logistic Regression.	Apply
CO6:	Construct algorithms based on neural networks to perform simple learning tasks like speech recognition, digit recognition, optical character recognition and similar cognitive applications.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	S	M	M
CO2	S	S	S
CO3	S	S	S
CO4	S	S	S
CO5	S	S	M
CO6	S	S	M

S- Strong; M-Medium; L-Low

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	30	20	20
Understand	30	30	30
Apply	40	50	50
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

Syllabus

Introduction: to Machine Learning, Probability Theory, **Model Selection**, The Curse of Dimensionality, Decision Theory, Information Theory. **Probability Distributions:** Binary Variables, Multinomial Variables, The Gaussian distribution, The Exponential Family, Nonparametric Methods. **Linear Models for Regression:** Linear Basis Function Models, The Bias-Variance Decomposition, Bayesian Linear Regression, Bayesian Model Comparison, The Evidence Approximation, Limitations of Fixed Basis Functions. **Linear Models for Classification L:** Discriminant Functions, Probabilistic Generative Models, Probabilistic Discriminative Models , The Laplace Approximation, Bayesian Logistic Regression. **Neural Networks and Kernel Methods.**

Reference Books

1. Christopher M. Bishop, ¯Pattern Recognition and Machine Learning‖, Springer, 2013.
2. AlpaydinEthem, ¯Introduction to Machine Learning‖, Prentice Hall, 2009.
3. Richard O. Duda, Peter E. Hart and David G. Stork, ¯Pattern Classification‖, Wiley and Sons, 2012.
4. Tom Mitchell, ¯Machine Learning‖, McGraw Hill, 2010.

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		Category	L	T	P	Credit
21DS570	**JAVA PROGRAMMING LAB**	PC	0	0	4	2

Preamble

To enable the students practice the concepts of java programming language and develop solutions for real world problems.

Prerequisite

- 21DS270 Object Oriented Programming Lab

Course Outcomes

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

CO1:	Understand the enabling technologies for building internet applications.	Understand
CO2:	Write Java programs for techniques and features of the networking and remote method development to Construct a internet application.	Apply
CO3:	Implement packages, access specifiers and interfaces in a program.	Apply
CO4:	Implement Program for Events and interactivity using Layout Manager.	Apply
CO5:	Generate program for network chatting	Analyze
CO6:	Write technical report on the observations from the experiments.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	S	M	M
CO2	S	S	S
CO3	S	S	M
CO4	S	S	S
CO5	S	S	S
CO6	S	S	L

S- Strong; M-Medium; L-Low

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List of Experiments

Develop Java Programs for
1. Use of Objects
2. Using classes and inheritance
3. JNI concepts
4. Multithread applications
5. Exception handling
6. Implementing packages, access specifiers and interfaces
7. Streams
8. JDBC program using different statements
9. Applet program for Animation text, images and sounds
10. Events and interactivity using Layout Manager.
11. Socket program for network chatting
12. Client server application using RMI techniques

Mini Project :

The course instructor shall provide real time problems/specifications to the students for mini project. The project shall be completed before the commencement of next semester and a report shall be submitted.

		Category	L	T	P	Credit
21DS580	**WEB TECHNOLOGY LAB**	PC	0	0	4	2

Preamble

With a dynamic learn-by-doing focus, the laboratory course encourages the students to explore the designing of web application by implementing the relevant and recent techniques. This course challenges the students to exercise their creativity in both programming and designing.

Prerequisite

- 21DS270 Object Oriented Programming Lab
- 21DS470 Relational Database Lab

Course Outcomes

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

CO1:	Select suitable Technology as per the application requirements.	Apply
CO2:	Develop application in different frameworks.	Apply
CO3:	Apply the recent techniques and features to Construct an internet application.	Apply
CO4:	Host Web applications.	Apply
CO5:	Work effectively in a team through proper communication based on the given task.	Apply
CO6:	Develop applications for any IT problems using Web Technologies.	Analyze

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	S	M	S
CO2	S	S	S
CO3	S	S	S
CO4	S	S	S
CO5	S	M	S
CO6	S	S	S

S- Strong; M-Medium; L-Low

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List of Experiments

I-Dynamic HTML- Develop a web application by having pages designed using

1. Cascading Style Sheets
2. Object Model and Collections
3. Event Model
4. Filters and TransitionsII-XML

II XML

1. Creating XML documents
2. XML style sheet
3. XML document object model
4. XML query language

III- Scripting Language- Enhance the web application with suitable client side validations and processing using javascript/ vbscript

IV- ASP

10. Server side ActiveX components
11. File System objects
12. Session tracking

V- JSP

13. Request, response, session, application
14. AJAX/JSON/ Angular JS/JQuery

VI- PHP & MySQL and protect it by performing **SQL injection**

Mini Project – The lab exercises are to be carried out in a single application domain such as shopping cart, internet banking, online bidding, online cab booking and the site has to be hosted in a free host web server. The report for the project has to be submitted during the commencement of next semester.

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		Category	L	T	P	Credit
21DS610	**DEEP LEARNING**	PC	4	0	0	4

Preamble

The course aims to provide an understanding of different types of Deep Architectures,including Convolutional Networks and Recurrent Networks.

Prerequisite

- 21DS540 Machine Learning

Course Outcomes

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

CO1:	Understand the fundamental principles, theory and approaches for learning with deep neural networks	Understand
CO2:	Explain the key concepts, issues and practices when training and modeling with deep architectures	Understand
CO3:	Identify the deep learning algorithms which are more appropriate for various types of learning tasks in various domains.	Understand
CO4:	How to implement basic versions of some of the core deep network algorithms (such as backpropagation) and Implement deep learning algorithms and solve real-world problems.	Apply
CO5:	How deep learning fits within the context of other ML approaches and what learning tasks it is considered to be suited and not well suited to perform.	Apply
CO6:	Identify the suitable framework like Caffe, Torch7, Theano, cuda and etc for real world problems.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	S	M	-
CO2	S	S	-
CO3	S	M	-
CO4	S	S	S
CO5	S	S	S
CO6	S	S	M

S- Strong; M-Medium; L-Low

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	30	20	20
Understand	30	30	30
Apply	40	50	50
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

Syllabus

Applied Math and Machine Learning Basics. Modern Practical Deep Networks-Deep Feedforward Networks-Regularization for Deep Learning-Optimization for Training Deep Models-Convolutional Networks-Sequence Modeling: Recurrent and Recursive Nets-Practical Methodology-Applications-Deep Learning Research-Linear Factor Models-Autoencoders-Representation Learning-Structured Probabilistic Models for Deep Learning-Monte Carlo Methods-Confronting the Partition Function Approximate Inference- Deep Generative Models.

Overview to FRAMEWORKS-Caffe, Torch7, Theano, cuda-convnet, Ccv, NuPIC, DeepLearning4J.

Reference Books

1. Deep Learning (Adaptive Computation and Machine Learning Series) by Ian Goodfellow, Yoshua Bengio and Aaron Courville, MIT Press, 2016

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21DS620	DATA MINING	Category	L	T	P	Credit
		PC	4	0	0	4

Preamble

This course aims at facilitating the student to understand the concepts of data mining. Students to understand the various techniques involved in mining the data from the databases.

Prerequisite

- 21DS420 Database Management

Course Outcomes

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

CO1:	Explain the architecture of data mining process.	Understand
CO2:	Apply suitable data pre-processing methods for the given dataset.	Apply
CO3:	Generate association rules using algorithms like Apriori, Frequent Pattern tree for the given problem.	Apply
CO4:	Analyze the performance of different classification algorithms like Cascading, Random forest, Semi supervised Learning etc.	Analyze
CO5:	Use clustering techniques such as partitioning, hierarchical, density based for grouping data and processing massive data set.	Apply
CO6:	Experiment data mining techniques using Weka, R tool, and Rapid Miner etc.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	S	M	-
CO2	S	S	M
CO3	S	M	M
CO4	S	S	S
CO5	S	S	S
CO6	S	S	S

S- Strong; M-Medium; L-Low

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	30	20	20
Understand	30	20	20
Apply	40	40	40
Analyze	0	20	20
Evaluate	0	0	0
Create	0	0	0

Syllabus

INTRODUCTION: Motivation for Data Mining - Data Mining Issues -Importance - DataMining from a Database Perspective - Statistical Perspective on Data Mining, Similarity Measures, Classification of Data Mining Systems – Major issues in Data Mining. **DATA PREPROCESSING:** Types of data - Data cleaning – Aggregation - Sampling – Feature subset selection-wrapper and filter methods. **MINING FREQUENT PATTERNS, ASSOCIATIONS AND CORRELATIONS:** Basic concepts - Efficient and Scalable Frequent Itemset Mining methods - Apriori, FP-Tree- Handling large larger data sets in main memory. **ENSEMBLE OF CLASSIFIERS:** Classification – Prediction – Voting, Bagging, Boosting, Stacking, Cascading, Random forest, Semi supervised Learning. **CLUSTERING:** Similarity and Distance Measures, Hierarchical Algorithms, Clustering Large Data sets, Clustering with Categorical Attributes-Outlier analysis. **MINING DATA STREAMS:** Challenges-Stream data model – Sampling data in a stream, Frequency moments of data stream- Counting frequency items in a stream- Mining time- Series databases. **MINING MASSIVE DATA SETS:** Challenges- Mining high dimensional association rules - CARPENTER- classifying high- dimensional data- PLANET- clustering high-dimensional Data – BIRCH Distributed Data Mining. **CASE STUDIES:** Web Mining, Spatial Mining, Graph Mining, Temporal Mining.

Reference Books

1. Jiwai Han and Micheline Kamber , ¯Data Mining - Concepts and Techniques‖, Morgan Kaufmann, 2012.
2. Tan, Steinbach, Kumar, ¯Introduction to Data Mining‖, Pearson Education, 2014.
3. AnandRajaraman and Jeffrey Ullman, ¯Mining Massive Data sets‖, Cambridge University Press, 2014.
4. Giovanni Seni, John Elder, ¯Ensemble methods in data mining: Improving accuracy through combining prediction‖, Morgan & ClayPool, 2010.
5. Ian Witten, Frank Eibe and Mark A. Hall, "Data Mining: Practical Machine Learning Tools and Techniques‖, Elsevier, 2011.

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		Category	L	T	P	Credit
21DS630	**BIG DATA SYSTEMS**	PC	3	1	0	4

Preamble

The course enables the students to understand Big Data processing used in different business intelligence applications and provide an in depth coverage of MapReduce analytics using Hadoop Eco system tools. The student will gain programming knowledge in Pig, Hive, Hbase to handle the Big Data applications and they will get exposure in blooming Big Data technologies.

Prerequisite

- 21DS420 Database Management
- 21DS620 Data Mining

Course Outcomes

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

CO1:	Appraise the business areas where big data technologies	Understand
CO2:	Demonstrate the ideas to integrate big data with cloud service.	Analyze
CO3:	Provide solutions for Big data Applications using different Eco system tools.	Understand
CO4:	Use the various NoSQL data models for the appropriate data bases.	Apply
CO5:	Implement the map reduce algorithms in Hadoop framework.	Apply
CO6:	Apply the Database integration and Schema mapping and information preservation.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	S	-	-
CO2	S	S	-
CO3	S	M	L
CO4	S	M	S
CO5	S	S	S
CO6	S	S	M

S- Strong; M-Medium; L-Low

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	20	20	20
Understand	20	20	30
Apply	50	60	40
Analyze	10	0	10
Evaluate	0	0	0
Create	0	0	0

Syllabus

PARALLEL AND DISTRIBUTED DATABASES: Architecture of parallel databases – Parallel query evaluation, Par*a*llel query optimization – Introduction to parallel and distributed databases, DDBMS Architecture, Distributed Database Design, Distributed Query Processing and Optimization.**DATA MODELING FOR BIG DATA:** Big Data and Challenges, Big Data models, NoSQL data models, Basic principles of NoSQL models, SQL databases VsNoSQL databases.**NOSQL DATABASES (PART 1):** Key - Value Stores: Oracle Coherence – FoundationDB – Amazon‟s DynamoDB, Key -Value Stores (in-memory) : Redis , Key-value Stores (B-tree): Berkeley DB, Column Oriented Store: Google BigTable - Apache Cassandra – Hbase.**NOSQL DATABASES (PART 2)**: Document Oriented Stores – Amazon‟s SimpleDB for cloud – MongoDB - Apache CouchDB - XML databases - ClusterPoint, Graph databases: Neo4J- OrientDB, Object Database: Db4o - Perst.**MAP-REDUCE:** Apache Hadoop and HDFS, Pig, Hive, Microsoft Azure -Big data Applications.**DATABASE INTEGRATION**: Data warehousing, Schema directed data integration - Data exchange: Schema mapping and information preservation - automatic schema matching - Information Preserving XML Schema Embedding

Reference Books

1. Ramez Elmasri and Shamkrant Navathe, ¯Fundamentals of Database Systems‖, Addison Wesley, 2013.
2. Corbett J.C., ¯Spanner: Google's Globally-Distributed Database‖, OSDI, 2012.
3. Stonebraker M, SQL Databases v. NoSQL Databases, Communications of the ACM, 2010.
4. Stonebraker M, Intel "Big Data" Science And Technology Center Vision And Execution Plan, SIGMOD Record, 2013.
5. www. Hbase.apache.org.
6. www.MongoDB.org.

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		Category	L	T	P	Credit
21DS640	**OPTIMIZATION TECHNIQUES**	FC	3	1	0	4

Preamble

The students will be able to:

1. Apply linear programming techniques to optimize problems arising in communication engineering.
2. Solve the assignment problem through Hungarian algorithm.
3. Determine the optimum values of integer programming problems using Gomary's cutting plane method.
4. Solve the single and multi channel queuing models.

Prerequisite

Nil

Course Outcomes

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

CO1:	Apply linear programming techniques to optimize problems arising in communication engineering.	Apply
CO2:	Analyze the various methods under transportation model and apply the model for testing the closeness of their results to optimal results	Apply
CO3:	Solve the assignment problem through Hungarian algorithm to domain specific situations.	Apply
CO4:	Determine the optimum values of integer programming problems using Gomary's cutting plane method.	Apply
CO5:	Analyze the various sequencing models and apply them for arriving at optimal decisions	Apply
CO6:	Apply the concepts of PERT and CPM for decision making and optimally managing projects	Apply
CO7:	Analyze and apply appropriate inventory techniques in domain specific situations.	Apply
CO8:	Apply the concept of Queuing model Solve the single and multi channel queuing models.	Apply

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Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	L	S	S
CO2	L	S	S
CO3	L	S	S
CO4	L	S	S
CO5	L	S	S
CO6	L	S	S
CO7	L	S	S
CO8	L	S	S

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	10	10	10
Understand	20	20	20
Apply	70	70	70
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

Syllabus

Linear Programming-Graphical Solution- The Simplex algorithm, Artificial Variable Technique -Duality-Dual Simplex - Variants of the Simplex Method **Transportation Model**- Initial Basic Feasible Solution methods Test for optimality-Variants of the Transportation problem **Assignment Model**- Hungarian algorithm Variants of the Assignment problem, Travelling Salesman Problem **Integer Linear Programming**- Gomary's cutting plane method Branch and Bound method **Sequencing Problem -** N jobs through 2 machines, N Jobs through 3 machines, N jobs through m machines **Scheduling -** Critical path Method, Project Evaluation and Review Techniques **Inventory control** - Purchase and production model with and without shortage , price break **Queuing Model**- Single channel model, Multichannel model.

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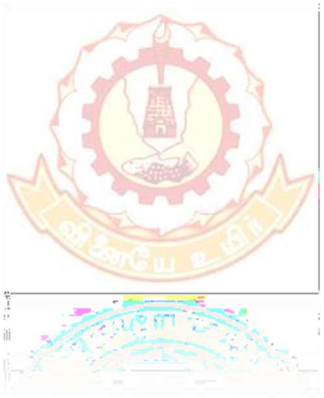
Reference Books

1. Sharma J.K.: ¯Operations Research Theory and applications‖, Macmillan India Ltd., V Edition, 2015.
2. Hamdy A. Taha: Operations Research – An Introduction‖, Prentice Hall of India Pvt Ltd., EIGHT Edition, 2014.
3. Chandrasekara Rao, K. Shanti Lata Misra ¯Operation Research‖, Alpha science international Ltd-2015.
4. Kanti Swarup, P.K.Gupta and Man Mohan ¯Operations Research‖, Sultan Chand,2014



		Category	L	T	P	Credit
21DS670	**BIG DATABASE SYSTEMS LAB**	PC	0	0	4	2

Preamble

The course aims to impart the architectural concepts of Hadoop and introducing map reduce paradigm and Big Data applications for streaming data.

Prerequisite

- 21DS420 Database Management
- 21DS620 Data Mining

Course Outcomes

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

CO1:	Analyze various Tools to process large amount of data.	Analyze
CO2:	Use WEKA and R tool for implement clustering, classification and etc.,	Apply
CO3:	Understand the architectural concepts of Hadoop	Understand
CO4:	Write a program to perform mapreduce paradigm on Hadoop to process stream of data.	Apply
CO5:	Implement the No-SQL databases like DynamoDB, MongoDB, Google‘s BigTable, DBo4, Neo4J and etc.	Apply
CO6	Create Data Integration from heterogeneous Databases.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	S	S	S
CO2	S	S	S
CO3	S	M	L
CO4	S	S	S
CO5	S	S	S
CO6	S	S	S

S- Strong; M-Medium; L-Low

List of Experiments

Part I : Applications of Data mining tool WEKA and Statistical package R - Classification rules using Decision Tree classifier, Implementation of Clustering Algorithms, Analyzing data with log liner models and graphical models using R and Handling massive data using map reduce.

Part II : Distribution of Databases and Paralleling Operations, Implementation of No-SQL databases- DynamoDB, MongoDB, Google‟s BigTable, DBo4, Neo4J, Implementation of Map-Reduce on Big Data (Hadoop) and Data Integration from heterogeneous Databases.

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		Category	L	T	P	Credit
21DS680	**DEEP LEARNING LAB**	PC	0	0	4	2

Preamble

The students can build, train, and deploy real world applications such as object recognition and Computer Vision, image and video processing, text analytics, Natural Language Processing, recommender systems, and other types of classifiers.

Prerequisite

- 21DS540 Machine Learning

Course Outcomes

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

CO1:	Apply style transfer to your own images, and gain experience using development tools such as Anaconda and Jupyter notebooks.	Apply
CO2:	Use the deep learning framework Python & NumPy and PyTorch to build neural networks	Apply
CO3:	Build convolutional networks based on patterns and objects that appear in them.	Apply
CO4:	Construct recurrent networks to perform sentiment analysis	Apply
CO5:	Implement the DCGAN model to simulate realistic images.	Apply
CO6:	Apply reinforcement learning to complex control tasks like video games and robotics.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	S	M	S
CO2	S	M	S
CO3	S	M	M
CO4	S	S	M
CO5	S	S	S
CO6	S	S	S

S- Strong; M-Medium; L-Low

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Topics / Concepts / Experiments:

Introduction:
Get your first taste of deep learning by applying style transfer to your own images, and gain experience using development tools such as Anaconda and Jupyter notebooks.

Neural Networks:
Learn neural networks basics, and build your first network with Python and NumPy. Use the modern deep learning framework PyTorch to build multi-layer neural networks, and analyze real data.

Convolutional Neural Networks:
Learn how to build convolutional networks and use them to classify images (faces, melanomas, etc.) based on patterns and objects that appear in them. Use these networks to learn data compression and image denoising.

Recurrent Neural Networks:
Build your own recurrent networks and long short-term memory networks with PyTorch; perform sentiment analysis and use recurrent networks to generate new text from TV scripts.

Generative Adversarial Networks:
Learn to understand and implement the DCGAN model to simulate realistic images, with Ian Goodfellow, the inventor of GANS (generative adversarial networks).

Deploying a Sentiment Analysis Model:
Use deep neural networks to design agents that can learn to take actions in a simulated environment. Apply reinforcement learning to complex control tasks like video games and robotics.

SAMPLE PROJECT 1
Predicting Bike-Sharing Patterns
Build and train neural networks from scratch to predict the number of bikeshare users on a given day.

SAMPLE PROJECT 2
Dog-Breed Classifier
Design and train a convolutional neural network to analyze images of dogs and correctly identify their breeds. Use transfer learning and well-known architectures to improve this model—this is excellent preparation for more advanced applications.

SAMPLE PROJECT 3
Generate TV scripts
Build a recurrent neural network on TensorFlow to process text. Use it to generate new episodes of your favorite TV show, based on old scripts.

SAMPLE PROJECT 4
Generate Faces
Build a pair of multi-layer neural networks and make them compete against each other in order to generate new, realistic faces. Try training them on a set of celebrity faces, and see what new faces the computer comes out with!

SAMPLE PROJECT 5
Deploying a Sentiment Analysis Model
Train and deploy your own PyTorch sentiment analysis model. You'll build a model and create a gateway for accessing it from a website.

21DS810	REINFORCEMENT LEARNING	Category	L	T	P	Credit
		PC	4	0	0	4

Preamble

This course provides an introduction to some of the foundational ideas on which modern reinforcement learning is built, including Markov decision processes, value functions, Monte Carlo estimation, temporal difference learning, eligibility traces, and function approximation. This course will develop an intuitive understanding of these concepts (taking the agent's perspective), while also focusing on the mathematical theory of reinforcement learning. Programming assignments and projects will require implementing and testing complete decision making systems.

Prerequisite

- 21DS210 Theory of Probability
- 21DS310 Applied Statistics

Course Outcomes

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

CO1:	Build a modern reinforcement learning including Markov decision processes, value functions, Monte Carlo estimation, temporal difference learning.	Apply
CO2:	Explain the concept of Dynamic Programming.	Understand
CO3:	Apply the concept of Temporal difference Learning(TML).	Apply
CO4:	Use the Functional Approximation like Gradient Descent methods and Linear methods.	Apply
CO5:	Make planning and learning for complete decision making systems.	Apply
CO6:	Focus on the mathematical theory of reinforcement learning.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	S	M	M
CO2	S	M	-
CO3	S	S	M
CO4	S	S	L
CO5	S	M	L
CO6	S	S	-

S- Strong; M-Medium; L-Low

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	30	20	20
Understand	30	30	30
Apply	40	50	50
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

Syllabus

REINFORCEMENT PROBLEM: Introduction - Elements of RL, History of RL- Evaluative feedback -Goals and rewards – Returns – Markovian Decision Problem (MDP) – Value functions-Optimality Criterion in MDPs.**DYNAMIC PROGRAMMING(DP)**: Policy Evaluation- Policy Improvement- Value Iteration, asynchronous DP- Efficiency of DP.**MONTE CARLO METHODS**: Policy Evaluation- Policy Improvement- On-policy and off-policy Monte Carlo controls-Incremental implementation.**TEMPORAL DIFFERENCE LEARNING(TD)**: TD-prediction- Optimality of TD - Sarsa- Q-Learning – R- Learning-Actor-Critic Model- Unifying Monte Carlo and TD-Traces- Games.**FUNCTION APPROXIMATION**- Value prediction and control – Gradient Descent methods-Linear methods – Artificial Neural Network based approximation.**PLANNING AND LEARNING**: Model based learning and planning- prioritized sweeping-Heuristic search.CASE STUDIES

Reference Books

1. Sutton R. S. and Barto A. G., "Reinforcement Learning: An Introduction", MIT Press, 2012.
2. CsabaSzepesvári, ¯Algorithms for Reinforcement Learning‖, Morgan & Claypool, 2013.
3. Kevin Murphy , ¯Machine Learning - A Probabilistic Perspective‖ , MIT press, 2012.
4. Christopher Bishop, ¯Pattern Recognition and Machine Learning‖, Springer, 2006.

21DS820	INFORMATION SECURITY	Category	L	T	P	Credit
		PC	3	1	0	4

Preamble

This course provides broad understanding of requirements and activities needed to create, manage and maintain a program to implement an information security strategy. The acquired knowledge will be used to manage both the strategic and operational aspects of information security, and to develop business programs implementing effective safeguards to minimize risks to acceptable levels using information security policies

Prerequisite

- 21DS530 Computer Networks

Course Outcomes

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

CO1:	Explain the information security terminologies like confidentiality, integrity, authentication and access control.	Understand
CO2:	Perform Encryption/Decryption of text using symmetric and asymmetric crypto algorithms to provide confidentiality.	Apply
CO3:	Compute hash and digital signature for the given message to provide integrity and non-repudiation.	Apply
CO4:	Examine the strength of any cryptographic algorithm by crypt analysis using Open SSL.	Analyze
CO5:	Explain the working principle of security protocols like Secure Socket layer, Secure Electronic Transaction, Kerberos, Email Security etc.	Understand
CO6:	Analyze threats and vulnerabilities of information systems with tools like DVWA, Pflogsum, NMAP etc.	Analyze

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	L	-	-
CO2	M	-	-
CO3	L	L	-
CO4	L	M	M
CO5	M	S	S
CO6	S	S	S

S- Strong; M-Medium; L-Low

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	20	20	20
Understand	20	30	20
Apply	40	40	40
Analyze	20	10	20
Evaluate	0	0	0
Create	0	0	0

Syllabus

INTRODUCTION: Security Problems in computing – security goals –threats and attacks. – Services and mechanisms. **CRYPTOSYSTEMS:** Introduction- symmetric key cryptography-substitution cipher – transposition cipher -stream ciphers and block ciphers – Advanced Encryption Standard (AES) – cryptanalysis of symmetric key cryptosystems. Public key cryptography - Introduction – RSA cryptosystem- attacks on RSA – Elliptic curve cryptosystem. **MESSAGE INTEGRITY, AUTHENTICATION AND KEY MANAGEMENT:** Message digest – Message authentication code Cryptographic hash function – Digital signatures- Anonymous protocols- Challenge response system- zero knowledge protocol- secure two party computation-DSS. Symmetric key distribution – kerberos- Diffie – Hellman key agreement- Public key distribution Certificates. **NETWORK SECURITY:** Application Layer Security – PGP and S/MIME, Transport Layer security – SSL - Network layer security – IPSec. **PROGRAM SECURITY :** Secure Coding – Malicious and non-Malicious program errors - OWASP/SANS Top Vulnerabilities - Malwares – types - Buffer Overflows – defense mechanisms- Incomplete mediation - XSS - Redirection - Inference – Application Controls - Evaluation of Security Systems. **DATA BASE SECURITY** : Security Requirements – database administration security – SQL injection and exploitation and defense methods - database roles and permissions –Object level security - Sensitive data – Multilevel Databases – Multi level security. **DATA PRIVACY :** Introduction – Foundations of privacy- Logical methods for specification and enforcement of privacy policies- Privacy preserving data publication- An introduction to Differential privacy: Definitions and early uses – Noiseless differential privacy- Applications of Differential privacy – Synthetic datasets and network trace analysis- Differential privacy for large data- Differentially private social network analysis – Web privacy: online tracking and advertisement – Privacy and machine learning – case study: HIPAA privacy rule

Reference Books

1. Charles P. Pfleeger and Shari Lawrence Pfleeger, "Security in Computing", Pearson Education, 2009.
2. Behrouz A.Forouzan and Debdeep Mukhopadhyay, ¯Cryptography and Network Security‖, Tata McGraw Hill, 2011.
3. Mark Stamp, ¯Information Security: Principles and Practice‖, Wiley Inter Science, 2011.

		Category	L	T	P	Credit
21DS830	**BUSINESS ANALYTICS**	PC	3	1	0	4

Preamble

The course is designed to gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making. The course familiarizes the students with the processes needed to develop, report, and analyze business data.

Prerequisite

Nil

Course Outcomes

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

CO1:	Explain the principles of decision making problems.	Understand
CO2:	Apply aptitude for business improvement, innovation and entrepreneurial action.	Apply
CO3:	Apply basic Excel concepts in solving the business related problems.	Apply
CO4:	Analyze and solve complex unstructured business problems.	Analyze
CO5:	Apply the language, theory and models of the field of business analytics.	Apply
CO6:	Identify, model and solve decision problems in different settings	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	L	-	-
CO2	M	-	-
CO3	M	L	-
CO4	M	M	L
CO5	S	M	S
CO6	S	S	S

S- Strong; M-Medium; L-Low

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	30	10	10
Understand	30	20	20
Apply	40	50	50
Analyze	0	20	20
Evaluate	0	0	0
Create	0	0	0

Syllabus

Foundations of Business Analytics: Evolution of Business analytics, scope, Data for Business Analytics, Models in Business Analytics**,** problem solving with business analytics. **Analytics on Spreadsheets:** Basic Excel, Excel Formulas, Excel Functions, Data Queries. **Descriptive Analytics: Descriptive Statistical measures** - Populations and samples, Statistical notations, Measures of Location, Measures of Dispersion, and Measures of Association. **Statistical Inference:** Hypothesis testing, one-Sample Test, Two-Sample Test, Two tailed Hypothesis for mean, ANOVA. **Predictive Analytics:** Simple Linear regression, Multiple Linear regression, Residual Analysis, Building regression models, Regression with categorical Independent variables – CASE STUDIES. **Prescriptive Analytics:** Building Linear Optimization models, Implementing Linear Optimization models on spreadsheets, Solving Linear Optimization models- CASE STUDIES.

Reference Books

1. James Evan, Business Analytics- Methods, Models, and Decisions (2nd Edition), Pearson, 2013. (Chapters: 1, 2, 4, 7, 8, 13)
2. Gert H. N. Laursen, Business Analytics for Managers: Taking Business Intelligence Beyond Reporting, Wiley (2nd Edition),2010.
3. S. Christian Albright and Wayne L. Winston, Analytics: Data Analysis and Decision Making, Sixth Edition, 2014.
4. U. Dinesh Kumar, Business Analytics: The Science of Data-Driven Decision Making, Wiley, 2017.

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		Category	L	T	P	Credit
21DS870	**MATHEMATICAL COMPUTING LAB**	PC	0	0	4	2

Preamble

This Laboratory will enable students to identify, formulate and solve real world engineering problems that require usage of algorithms and at the same time impart rigorous training in fundamental areas of Computer Sciences and Mathematics

Prerequisite

- 21DS140 Problem Solving Using C Programming

Course Outcomes

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

CO1:	Outline an mathematical logical proposition for a real world statement using equivalence and implications	Apply
CO2:	Apply the concept and implement Recursion and Recurrences.	Apply
CO3:	Apply linear programming techniques to optimize problems and solve inequalities arising in communication engineering.	Apply
CO4:	Apply the various methods under transportation model to find the cost of transportation	Apply
CO5:	Solve the assignment problem through Hungarian algorithm to domain specific situations.	Apply
CO6:	Determine the optimum values of integer programming problems using Gomary‘s cutting plane method.	Apply
CO7:	Apply the concepts of PERT and CPM for decision making and optimally managing projects	Apply
CO8:	Apply the concepts of Regression for Solving linear regression, polynomial regression and non-linear regression based problems and solving multiple regression and correlation analysis based problems.	Apply

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Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	L	S	S
CO2	L	S	S
CO3	L	S	S
CO4	L	S	S
CO5	L	S	S
CO6	L	S	S
CO7	L	S	S
CO8	L	S	S

S- Strong; M-Medium; L-Low

List of Experiments

Given below is the list of mathematical concepts using which the programs have to be written by the students using C / C++ / JAVA to address a given problem. Using the list givenbelow, Course handling faculty shall also generate a separate list of specific experiments for the conduct of practical sessions for the students.

1. Write a program to implement mathematical logic such as Equivalence and Implications - Equivalence of statements and Truth Tables.

2. Write a program to implement Recursion and Recurrences.

3. Write a program to apply suitable optimization technique to solve the following:
(a) Solving inequalities using Simplex, Two-Phase, Dual Simplex Methods, Revised Simplex Methods.
(b) Finding initial basic feasible solution using North-West Corner rule, Matrix minimum, Vogel's approximation method and also perform optimality test using MODI method.
(c) Solving Assignment problem using Hungarian method.
(d) Applying Gomary's Cutting Plane methods for all Integer Programming Problem (IPP) and mixed IPP.
(e) Identifying critical path for the given PERT and CPM Networks.

4. Solving linear regression, polynomial regression and non-linear regression based problems and solving multiple regression and correlation analysis based problems.

21DS880	INFORMATION SECURITY LAB	Category	L	T	P	Credit
		PC	0	0	4	2

Preamble

The laboratory course on Cryptography and Network security will enable the students to gain hands on experience in implementation of cryptographic algorithms and tools used in security analysis and forensics.

Prerequisite

Nil

Course Outcomes

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

CO1:	Implement secure cryptography through RSA cryptosystem.	Understand
CO2:	Apply the client server model for basic cryptosystem.	Apply
CO3:	Identify the usage of authentication, authorization and access rights in real world.	Apply
CO4:	Analyze the process of securing transaction through SQL injection.	Analyze
CO5:	Compare and contrast the concepts of vulnerabilities from web applications.	Apply
CO6:	Implement file transfer through hashing and message digests.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	L	-	-
CO2	M	-	-
CO3	L	L	-
CO4	M	M	L
CO5	S	S	S
CO6	S	S	S

S- Strong; M-Medium; L-Low

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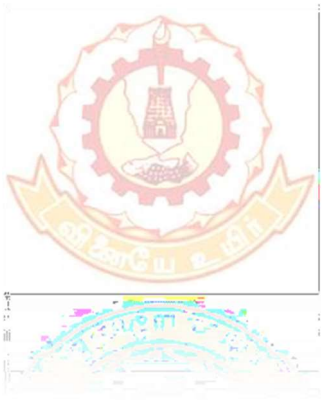
List of Experiments

1. Handling Authentication, Authorization and Access Rights.
2. Design of a Client server application for a basic cryptosystem.
3. Implementation of RSA cryptosystem.
4. Authentication of File transfer using Hashing / Message digests.
5. Digital signature, generation and verification.
6. Password authentication.
7. Securing transaction by defending SQL Injection attacks.
8. Cross - Site scripting.
9. Handling Software vulnerabilities.
10. Security testing for applications.
11. Analysis and removal of vulnerabilities from a web application.



		Category	L	T	P	Credit
21DS910	**WEB ANALYTICS**	PC	3	1	0	4

Preamble

The aim of the course is to enable the students to understand the different facets of webdata analysis and get exposed to various web analytics tools.

Prerequisite

- 21DS420- Database Managemet
- 21DS450 – Predictive Analytics
- 21DS520 – Web Technology

Course Outcomes

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

CO1:	Explain the foundations of Web analytics.	Understand
CO2:	Compare and contrast the clickstream data collection techniques, their impact on metrics, and their inherent limitations.	Apply
CO3:	Apply web analytics techniques to effectively use the resulting insights to support website design decisions, campaign optimisation, search analytics, etc.	Apply
CO4:	Understand the basics of software tools, techniques, and reports that are relevant to web analytics apply them to solve problems.	Understand
CO5:	Analyze and interpret web channel data and understand the difficulties and issues involved in it.	Analyze
CO6:	Identify the role of web analytics in the real world scenario.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	-	-	-
CO2	L	L	-
CO3	L	L	-
CO4	M	M	-
CO5	S	S	S
CO6	S	S	S

S- Strong; M-Medium; L-Low

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	20	10	20
Understand	20	10	20
Apply	40	50	40
Analyze	20	30	20
Evaluate	0	0	0
Create	0	0	0

Syllabus

INTRODUCTION: Understanding web analytics – The foundations of Web analytics: Techniques and Technologies – Present and Future of Web analytics. **DATA COLLECTION:** Importance and Options –Web server log files: Click stream data – User submitted information – Web server performance data – Page tags –First and third party tracking. **WEB ANALYTICS STRATEGY:** Key performance indicators – Web analytics process – Heuristics evaluations – Site visits – Surveys – Measuring reach – Measuring acquisition – Measuring conversion – Measuring retention – Security and privacy implications of Web analytics. **WEB ANALYTICS TOOLS:** Content organization tools – Process measurement tools – Visitor segmentation tools – Campaign analysis tools – Commerce measurement tools – Google analytics – Omniture – Web trends – Yahoo! Web analytics. **GOOGLE ANALYTICS:** Key features and capabilities – Quantitative and qualitative data - Working of Google analytics – Privacy - Tracking visitor clicks, Outbound links and Non HTML files.

Reference Books

1. Bernard J. Jansen, ―Understanding User-Web Interactions via Web analytics‖, Morgan and Claypool, 2009.
2. Avinash Kaushik, ―Web Analytics2.0‖, John Wiley and Sons, 2010.
3. Brian Clifton, ―Advanced web metrics with Google analytics‖, John Wiley and Sons, 2012.
4. Justin Cutroni, ―Google Analytics‖, O‟Reilly, 2015.
5. Jerri L. Ledford, Joe Teixeira and Mary E. Tyler, ―Google Analytics‖, John Wiley and Sons, 2013.

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21DS920	NATURAL LANGUAGE PROCESSING	Category	L	T	P	Credit
		PC	4	0	0	4

Preamble

The aim of the course is to make students understand syntactic and semantic elements natural language processing and to conceive basics of knowledge representation and inference.

Prerequisite

- 21DS540- Machine Learning
- 21DS610 – Deep Learning
- 21DS810 – Reinforcement Learning

Course Outcomes

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

CO1:	Explain the approaches for syntax and semantics in NLP.	Understand
CO2:	Understand the concepts of morphology, syntax, semantics and pragmatics of the language.	Understand
CO3:	Apply machine learning techniques used in NLP, including hidden Markov models and probabilistic context-free grammars.	Apply
CO4:	Analyze the current methods for statistical approaches to machine translation.	Analyze
CO5:	Compare and contrast the clustering and unsupervised methods, log-linear and discriminative models and the EM algorithm as applied within NLP.	Apply
CO6:	Identify the applications of NLP in real world scenario.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	-	-	-
CO2	L	-	-
CO3	L	L	-
CO4	M	M	M
CO5	S	S	M
CO6	S	S	S

S- Strong; M-Medium; L-Low

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	20	20	20
Understand	30	20	20
Apply	50	40	40
Analyze	0	20	20
Evaluate	0	0	0
Create	0	0	0

Syllabus

INTRODUCTION: Applications of NLP techniques and key issues - MT - grammar checkers – dictation - document generation - NL interfaces - Natural Language Processing key issues - The different analysis levels used for NLP: morpho-lexical - syntactic – semantic - pragmatic - markup (TEI, UNICODE) - finite state automata - Recursive and augmented transition networks – open problems. **LEXICAL LEVEL:** Error-tolerant lexical processing (spelling error correction) - Transducers for the design of morphologic analyzers Features - Towards syntax: Part-of-speech tagging (Brill, HMM) - Efficient representations for linguistic resources (lexica, grammars,...) tries and finite-state automata. **SYNTACTIC LEVEL:** Grammars (e.g. Formal/Chomsky hierarchy, DCGs, systemic, case, unification, stochastic) - Parsing (top- down, bottom-up, chart (Earley algorithm), CYK algorithm) - Automated estimation of probabilistic model parameters (inside-outside algorithm) - Data Oriented Parsing - Grammar formalisms and treebanks - Efficient parsing for context-free grammars (CFGs) - Statistical parsing and probabilistic CFGs (PCFGs) - Lexicalized PCFGs. **SEMANTIC LEVEL:** Logical forms - Ambiguity resolution - Semantic networks and parsers - Procedural semantics - Montague semantics
- Vector Space approaches - Distributional Semantics - Lexical semantics and Word Sense Disambiguation - Compositional semantics. Semantic Role Labeling and Semantic parsing. **PRAGMATIC LEVEL:** Knowledge representation – Reasoning - Plan/goal recognition - speech acts/intentions - belief models- discourse – reference. **NATURAL LANGUAGE GENERATION:** content determination - sentence planning - surface realization. **SUBJECTIVITY AND SENTIMENT ANALYSIS:** Information extraction - Automatic summarization - Information retrieval and Question answering - Named entity recognition and relation extraction - IE using sequence labeling - Machine translation: Basic issues in MT - Statistical translation - word alignment - phrase-based translation and synchronous grammars.

Reference Books

1. Daniel Jurafsky and James H. Martin, ¯Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition‖, Prentice Hall, 2009.
2. Ian H. Witten and Eibe Frank, Mark A. Hall, ¯Data Mining: Practical Machine Learning Tools and Techniques‖, Morgan Kaufmann, 2013.
3. Christopher Manning and Hinrich Schütze, ¯Foundations of Statistical Natural Language Processing‖, MIT Press, 2008.
4. James Allen, ¯Natural Language Understanding‖, Addison Wesley, 1995.
   Steven Bird, Ewan Klein, and Edward Loper, ¯Natural Language Processing withPython - Analyzing Text with the Natural Language Toolkit‖, O'Reilly Media, Sebastopol, 2009.

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21DS930	COMPUTER VISION	Category	L	T	P	Credit
		PC	3	1	0	4

Preamble

The course aims to introduce students the fundamentals of image formation and techniques of computer vision and pattern recognition; Also the course aims to develop an appreciation for various issues in the design of computer vision and object recognition systems.

Prerequisite

- 21DS 340- Advanced Data Structures; Fundamentals of mathematics

Course Outcomes

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

CO1:	Explain low level processing of image and transformation techniques applied to images.	Understand
CO2:	Explain the feature extraction, segmentation and object recognition methods.	Understand
CO3:	Apply vision techniques to real time applications.	Apply
CO4:	Apply cognitive vision application to track the driver eye movement.	Apply
CO5:	Apply ANN Model for diagnosing the computer vision problems.	Apply
CO6:	Identify the supervised and semi supervised techniques applicable to real word problems.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	L	-	-
CO2	L	-	-
CO3	L	M	-
CO4	M	M	S
CO5	M	S	S
CO6	S	S	S

S- Strong; M-Medium; L-Low

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	30	20	20
Understand	40	40	40
Apply	30	40	40
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

Syllabus

Digital Image Formation and low-level processing: Overview, Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective, Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing.Feature Extraction and Image Segmentation : Edges - Canny, LOG, DOG; Corners, Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, Image Pyramids and Gaussian derivative filters, Gabor Filters - Region Growing, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, MRFs, Texture Segmentation; Object detection. Object Recognition: Structural, model-based, appearance and shape- based methods; probabilistic paradigms; discriminative part-based models; BOW, ISM, Learning methods. Pattern Analysis: Clustering: K-Means, K-Medoids, Mixture of Gaussians, Classification:

Discriminant Function, Supervised, Un-supervised, Semi-supervised; Classifiers: Bayes, KNN, ANN models; Dimensionality Reduction: PCA, LDA, ICA; Non-parametric methods. Case Studies: Applications: CBIR, CBVR, Activity Recognition, Biometrics, cognitive vision.

Reference Books

1. D. A. Forsyth, J. Ponce, ¯Computer Vision: A Modern Approach‖, Pearson Education, 2003.

2. Richard Szeliski, ¯Computer Vision: Algorithms and Applications‖, Springer Verlag London Limited,2011

21DS970	NATURAL LANGUAGE PROCESSING LAB	Category	L	T	P	Credit
		PC	0	0	4	2

Preamble

The aim of the course is to provide programming skills on Natural Language Processing methodologies.

Prerequisite

- 21DS680 – Deep Learning Lab
- 21DS810 – Reinforcement Learning

Course Outcomes

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

CO1:	Implement client server communication using socket programming for various applications.	Apply
CO2:	Configure networking components and installing device drivers and build a Local Area Network.	Apply
CO3:	Perform port scanning and identify IP Address.	Apply
CO4:	Implement Remote Method Invocation.	Apply
CO5:	Simulate a network topology using NS3.	Apply
CO6:	Implement the lexical Analyzer, semantic Analyzer, sentiment Analyzer.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	L	L	-
CO2	M	-	-
CO3	L	M	-
CO4	M	M	S
CO5	M	S	S
CO6	S	S	S

S- Strong; M-Medium; L-Low

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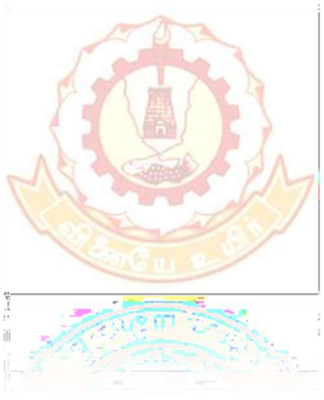
List of Experiments:

1. Implementing word similarity.
2. Implementing simple problems related to word disambiguation.
3. Simple demonstration of part of speech tagging.
4. Lexical analyzer.
5. Semantic analyzer.
6. Sentiment Analysis.



		Category	L	T	P	Credit
21DS980	**WEB ANALYTICS LAB**	PC	0	0	4	2

Preamble

The aim of the course is to enable the students to different web analytics tools and implement the data collection, acquisition and processing in terms of web analytics.

Prerequisite

- 21DS580 -Web Technology Lab
- 21DS370 - Applied Statistics and Python Programming Lab

Course Outcomes

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

CO1:	Compare and contrast retain ratio computation, report generation.	Apply
CO2:	Apply different data analytics tools for data collection.	Apply
CO3:	Implement Google analytics.	Apply
CO4:	Implement Yahoo analytics.	Apply
CO5:	Apply the working of omniture.	Apply
CO6:	Implement the web login analysis.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	-	-	-
CO2	L	-	-
CO3	L	M	-
CO4	M	M	S
CO5	S	M	S
CO6	S	S	S

S- Strong; M-Medium; L-Low

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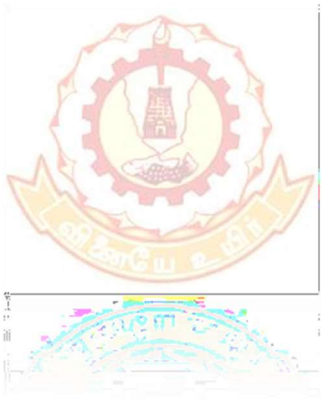
List of Experiments

1. Data collection using different analytics tools.
2. Web log analysis.
3. Identifying reach.
4. Measuring acquisition.
5. Calculating the conversion from search to purchase.
6. Retain ratio computation.
7. Report generation.
8. Implementing the working of Google analytics.
9. Implementing the working of Yahoo! Analytics.
10. Implementing the working of Omniture.



21DSPA0	HIGH PERFORMANCE COMPUTING	Category	L	T	P	Credit
		PE	3	0	0	3

Preamble

The course aims to enable students to understand the architecture of several types of high performance computers and parallel programming environments and the implications on the performance of algorithms on these architectures.

Prerequisite

- 21DS350 - Computer Organization
- 21DS440 - Operating Systems

Course Outcomes

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

CO1:	Explain the fundamentals of computer organisation.	Understand
CO2:	Describe the basic concepts of paging,cache,etc.	Understand
CO3:	Apply high performance versions of standard single threaded algorithms.	Apply
CO4:	Deploy large scale parallel programs on tightly coupled parallel Systems using the message passing paradigm.	Apply
CO5:	Compare and contrast the architectural features in the GPU and MIC hardware accelerators.	Apply
CO6:	Analyze the maximum performance in a multicore, shared Memory execution environment processor.	Analyze

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	-	-	-
CO2	L	-	-
CO3	L	-	-
CO4	M	M	M
CO5	M	S	M
CO6	S	S	S

S- Strong; M-Medium; L-Low

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	20	20	20
Understand	30	20	30
Apply	40	50	40
Analyze	10	10	10
Evaluate	0	0	0
Create	0	0	0

Syllabus

Program execution: Program, Compilation, Object files, Function call and return, Address space, Data and its representation. Computer organization: Memory, Registers, Instruction set architecture, Instruction processing. Pipelined processors: Pipelining, Structural, data and control hazards, Impact on programming. Virtual memory: Use of memory by programs, Address translation, Paging Cache memory: Organization, impact on programming, virtual caches Operating systems: Processes and system calls, Process management Program profiling File systems: Disk management, Name management, Protection Parallel architecture: Inter-process communication, Synchronization, Mutual exclusion, Basics of parallel architecture, Parallel programming with message passing using MPI.

Reference Books

1. J. L. Hennessy and D. A. Patterson, Computer Architecture: A Quantitative Approach, Morgan Kaufmann, 2013.

2. A. Silberschatz, P. B. Galvin, G. Gagne, Operating System Concepts, John Wiley, 2011.

3. R. E. Bryant and D. R. O'Hallaron, Computer Systems: A Programmer's Perspective, Prentice Hall, 2010.

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		Category	L	T	P	Credit
21DSPB0	**MOBILE APPLICATION DEVELOPMENT**	PE	3	0	0	3

Preamble

This course provides knowledge and skill on recent technologies in native mobile application development frameworks such as Android, iOS, Windows Mobile

Prerequisite

- 21DS520 - Web Technology
- 21DS570: Java Programming Lab

Course Outcomes

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

CO1:	Explain the object oriented concepts, packages and interfaces in java.	Apply
CO2:	Describe the Android features, architecture, environment etc.	Understand
CO3:	Compare and contrast various APIs of Android.	Understand
CO4:	Apply various user interface components with Activities for any real-time mobile application scenarios.	Apply
CO5:	Implement services, database and location-based services for the given mobile app scenario.	Apply
CO6:	Identify the application of mobile application in the real world.	Analyze

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	L	-	-
CO2	L	-	-
CO3	L	L	-
CO4	M	M	S
CO5	S	M	S
CO6	S	S	S

S- Strong; M-Medium; L-Low

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	20	20	20
Understand	30	20	20
Apply	50	50	50
Analyze	0	10	10
Evaluate	0	0	0
Create	0	0	0

Syllabus

Mobile Application Development Framework: Types- Features- challenge. Android: Introduction – Architecture -Installation and configuration- ADE- APIs User Interfaces: Components-views-Layouts and its types- Menus and its types – Dialogues and its types - Notifications and its types Data Storage: SQLite database-Files- shared preferences-Content Providers Location Based Services: Location Provider- Geo Coder- Map Multimedia: Audio-Video- Animations- Drawing. Phone Gap and HTML5: Phone Gap Introduction – Architecture- Installation and configuration, HTML5 Introduction -Data list control- Validation feature -Application Cache in HTML 5. Events: Listener and its types-handler and its types. Geo location, Media, Storage.

Reference Books

1. RetoMeier, ¯Professional Android Application Development‖, Wrox, 2010.
2. Thomas Myer, ¯Beginning PhoneGap‖,Wrox, 2012.
3. Mark Murphy, ¯Beginning Android‖,Apress, 2009.
4. Rick Rogers et.al, ¯Android - Application Development‖, O'Reilly, 2009.
5. Jochen Schiller, ¯Mobile Communications‖, Addison Wesley, 2011.

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21DSPC0	PARALLEL AND DISTRIBUTED COMPUTING	Category	L	T	P	Credit
		PE	3	0	0	3

Preamble

The aim of this course is to introduce the fundamentals of parallel and distributed processing and focus on the basic architectural, programming, and algorithmic concepts in the design and implementation of parallel and distributed applications.

Prerequisite

- 21DS350 - Computer Organization
- 21DS440 - Operating Systems

Course Outcomes

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

CO1:	Explain the fundamentals of parallel programming platforms, principles of design and parallel algorithm models.	Understand
CO2:	Develop parallel algorithms for executing applications in a cluster computer with appropriate mapping and scheduling techniques.	Apply
CO3:	Compare and contrast the complexities involved in searching for an optimal solution for intelligent games	Apply
CO4:	Explain the characteristics, models and design issues related to distributed systems.	Understand
CO5:	Develop Remote Procedure Call based client-server programs.	Apply
CO6:	Analyze the message complexity of various deadlock detection and prevention algorithms.	Analyze

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	L	-	-
CO2	L	-	-
CO3	M	L	-
CO4	L	M	M
CO5	M	S	M
CO6	S	S	S

S- Strong; M-Medium; L-Low

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	20	10	10
Understand	40	10	10
Apply	40	50	50
Analyze	0	30	30
Evaluate	0	0	0
Create	0	0	0

Syllabus

INTRODUCTION: Concepts and Terminology – Generic Processor / ASIC Processor Architecture – Pipeline Architecture – Instruction Set Architecture - Types of Parallelism - Flynn‟s Classical Taxonomy – Terminology. **PARALLEL COMPUTER MEMORY ARCHITECTURES:** Shared Memory - Distributed Memory -Hybrid Distributed-Shared Memory Multiprocessors: Communication and Memory issues - Message Passing Architectures - Vector Processing and SIMD Architectures. **PARALLEL PROGRAMMING MODELS:** Overview -Shared Memory Model - Threads Model - Message Passing Model - Data Parallel Model - Other Models. **DESIGNING PARALLEL PROGRAMS:** Automatic vs. Manual Parallelization - Understand the Problem and the Program - Partitioning - Communications - Synchronization -Data Dependencies - Load Balancing -Granularity -I/O -Limits and Costs of Parallel Programming - Performance Analysis and Tuning - Parallel Examples -Array Processing – Compiler Transformation techniques for High performance computing: - Transformations for parallel Machines. **PRAM ALGORITHMS& BSP: PRAM** model of computation- Work-Time formalism and Brent‟s Theorem; algorithm design techniques-parallel prefix, pointer jumping, Euler tours, divide and conquer, symmetry breaking; survey of data-parallel algorithms; relative power of PRAM models - Bulk synchronous parallel model. **HIGH PERFORMANCE COMPUTING ARCHITECTURES -** Latency Hiding Architectures -Multithreading Architectures -Dataflow Architectures - **GPGPU Architecture-** Overview of basic Accelerators /GPU / GPGPU and its programming model – CUDA - OpenCL. **DISTRIBUTED COMPUTING:** Introduction -- Definitions, motivation - Communication Mechanisms - Communication protocols,- RPC- RMI- Distributed Algorithms – snapshots - leader election – Synchronization -Traditional synchronization - lock free - clocks. Replication and Coherence - Consistency models and protocols –overview of Fault Tolerance. **DENSE LINEAR ALGEBRA:** Matrix transposition - Matrix product - Gaussian elimination - Data distribution - Parallel linear algebra libraries.

Reference Books

1. Andrew S. Tanenbaum and Maarten van Steen, ¯ Distributed Systems, Principles and Paradigm‖ Prentice Hall, 2013.
2. Michael J Quinn, ¯Parallel Computing : Theory And Practice‖ , Tata Mcgraw-Hill,2004
3. Joel M.Crichlow, ¯Distributed And Parallel Computing‖ , Prentice Hall Of India, 2004
4. Jason Sanders, Edward Kandrot, ¯CUDA by Example: An Introduction to General-Purpose GPU Programming‖, Pearson Education, 2011

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21DSPD0	EMBEDDED SYSTEMS	Category	L	T	P	Credit
		PE	3	0	0	3

Preamble

The aim of the course is to provide knowledge of Embedded systems design, Embedded programming and their operating systems with suitable case studies.

Prerequisite

- 21DS130 - Digital Electronics
- 21DS440 - Operating Systems

Course Outcomes

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

CO1:	Describe the general computing system from the embedded system.	Understand
CO2:	Compare and contrast the basic properties of a real-time operating system.	Understand
CO3:	Apply the assembly, C and Java languages to produce efficient code for embedded systems.	Apply
CO4:	Analyze the debugging and testing methodologies of embedded systems..	Analyze
CO5:	Apply embedded software development tools for embedded system designs.	Apply
CO6:	Identify the embedded system usage in real time scenario .	Analyze

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	L	-	-
CO2	M	-	-
CO3	L	L	-
CO4	M	M	L
CO5	S	S	M
CO6	S	S	S

S- Strong; M-Medium; L-Low

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	3	
Remember	20	20	20
Understand	30	20	20
Apply	40	40	40
Analyze	10	20	20
Evaluate	0	0	0
Create	0	0	0

Syllabus

Embedded Computing Need for embedded systems, Challenges of Embedded Systems, Embedded system design process, Introduction to microprocessors and microcontrollers, embedded processors, 8051 Microcontroller, ARM processor, Architecture, Instruction sets and programming. Real – Time Operating System Introduction to RTOS; RTOS - Inter Process communication, Interrupt driven Input and Output -Non maskable interrupt, Software interrupt; Thread - Single, Multithread Concept. Interface with Communication Protocol Design methodologies and tools, design flows, designing hardware and software Interface, RTC interfacing and programming. Embedded Software Software abstraction using Mealy-Moore FSM controller, Layered software development, Basic concepts of developing device driver, Programming embedded systems in assembly, C and Java, Meeting real time constraints, Embedded software development tools – Emulators and debuggers. Embedded System Development Design issues and techniques – Hands On, Case studies – Robot, Complete design of embedded systems – digital camera, smart card.

Reference Books

1. Wayne Wolf, ¯Computers as Components: Principles of Embedded Computer System Design‖, 2nd edition, 2008.

2. Raj Kamal, ¯Embedded Systems- Architecture, Programming and Design‖, Tata McGraw Hill, 2nd edition, 2009.

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		Category	L	T	P	Credit
21DSPE0	**MARKETING ANALYTICS**	PE	3	0	0	3

Preamble

This course aims to provide knowledge on elements of market analysis and to use marketing analytics to predict outcomes and systematically allocate resources.

Prerequisite

- 21DS450- Predictive Analytics
- 21DS640 - Optimization Techniques

Course Outcomes

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

CO1:	Gain a solid understanding of key marketing concepts and skills	Understand
CO2:	Identify and demonstrate the dynamic nature of the environment in which marketing decisions are taken and appreciate the implications for marketing analytics strategy determination and implementation.	Apply
CO3:	Develop the students' skills in applying the analytic perspectives, decision tools, and concepts of marketing to decisions involving segmentation, targeting and positioning	Apply
CO4:	Develop an understanding of the underlying concepts, strategies and the issues involved in the exchange of products and services and control the marketing mix variables in order to achieve organizational goals.	Apply
CO5:	Develop strong marketing plans and persuasively communicate your recommendations and rationale.	Apply
CO6:	Apply the concept of Sales analytics in E commerce sales and metrics	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	L	M	M
CO2	L	S	S
CO3	L	S	S
CO4	L	S	S
CO5	L	S	S
CO6	L	S	S

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	3	
Remember	10	10	10
Understand	30	20	20
Apply	60	70	70
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

Syllabus

INTRODUCTION: Marketing Analytics, Models and metrics- Market Insight – Market data sources, sizing, PESTLE trend analysis, and porter five forces analysis – Market segment identification and positioning.**COMPETITIVE ANALYSIS AND BUSINESS STRATEGY:** Competitor identification, Intelligence gathering, analysis and strategy- Analytics based strategy selection, with strategic models and metrics , Forecasting, balanced scorecard, and critical success factors.**PRODUCT, SERVICE AND PRICE ANALYTICS:** Conjoint analysis model, decision tree model, portfolio resource allocation, Pricing techniques, pricing assessment, pricing for business markets, price discrimination.**DISTRIBUTION AND PROMOTION ANALYTICS:** Retail location selection, distribution channel evaluation, and multi-channel distribution, Promotion budget estimation and allocation, promotion metrics for traditional media and social media.**SALES ANALYTICS**: E Commerce sales mode, sales metrics, profitability metrics and support metrics.

Reference Books

1. Stephan Sorger, ¯Marketing Analytics - Strategic Models and Metrics‖, Admiral Press, 2013.
2. Mark Jeffery, ¯Data Driven Marketing: The 15 Metrics Everyone in Marketing should know‖, Wiley, 2013.
3. Paul W. Farris, Neil T. Bendle, Phillip E. Pfeifer, David J. Reibstein ¯Marketing Metrics: The Definitive Guide to Measuring Marketing Performance‖, Pearson FT press, 2012.

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		Category	L	T	P	Credit
21DSPF0	**GRAPHICAL MODELS**	PE	3	0	0	3

Preamble

The students will be able to:

1. Develop a graphical model to represent the real time problem.
2. Apply markov models & Bayesian networks in the real world problems.
3. Fix and Estimate the parameter in Bayesian and Markov Networks.
4. Learn to solve application problems related to Markovian Logic Networks.

Prerequisite

Nil

Course Outcomes

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

CO1:	Develop a graphical model to represent the real time problem.	Understand
CO2:	Apply markov models & Bayesian networks in the real world problems.	Apply
CO3:	Apply the concept of Inference in variable elimination	Apply
CO4:	Apply the concept of sampling and its different types in real time problems.	Apply
CO5:	Fix and Estimate the parameter in Bayesian and Markov Networks.	Apply
CO6:	Learn to solve application problems related to Markovian Logic Networks.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	L	M	M
CO2	L	S	S
CO3	L	S	S
CO4	L	S	S
CO5	L	S	S
CO6	L	S	S

S- Strong; M-Medium; L-Low

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	10	10	10
Understand	30	20	20
Apply	60	70	70
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

Syllabus

Basics: Introduction. Undirected and Directed Graphical Models. Bayesian Networks. Markov Networks. Exponential Family Models. Factor Graph Representation. Hidden Markov Models. Conditional Random Fields. Triangulation and Chordal Graphs. **Other pecial Cases**:Chains, Trees. **Inference**: Variable Elimination (Sum Product and Max-Product). Junction Tree Algorithm. Forward Backward Algorithm (for HMMs). Loopy Belief Propagation. Markov Chain Monte Carlo. Metropolis Hastings. Importance Sampling. Gibbs Sampling. Variational Inference. **Learning**: Discriminative Vs. Generative Learning. Parameter Estimation in Bayesian and Markov Networks. Structure Learning. **EM**: Handling Missing Data. Applications in Vision, Web/IR, NLP and Biology. Advanced Topics: Statistical Relational Learning, Markov Logic Networks.

Reference Books

1. Probabilistic Graphical Models: Principles and Techniques. Daphne Koller and Nir Friedman. First Edition, MIT Press, 2009.
2. Probabilistic Reasoning in Intelligent Systems. Judea Pearl. Morgan Kaufmann, 1988.

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		Category	L	T	P	Credit
21DSPG0	**SOFT COMPUTING**	PE	3	0	0	3

Preamble

Soft Computing represents a collection or set of computational techniques in computerscience and engineering, which investigate, simulate, and formalize the human ability to make rational decisions in an environment of uncertainty, imprecision, partial truth, and approximation. The course is designed to introduce students to soft computing concepts and techniques and foster their abilities in analyzing soft computing based solutions for real- world problems.

Prerequisite

- 21DS340 – Advanced Data Structures

Course Outcomes

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

CO1:	Describe the basic concepts of genetic algorithm like encoding, permutation.	Understand
CO2:	Explain various parts of fuzzy logic based decision making process.	Understand
CO3:	Describe various processes of Genetic Algorithms such as initialization, selection, reproduction.	Apply
CO4:	Apply Genetic Algorithms to combinatorial optimization problems.	Apply
CO5:	Apply Genetic Algorithms to combinatorial optimization problems.	Apply
CO6:	Analyze the problem nature and select the method to find solution.	Analyze

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	L	-	-
CO2	L	-	-
CO3	L	M	-
CO4	M	S	L
CO5	S	S	S
CO6	S	S	S

S- Strong; M-Medium; L-Low

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	20	20	20
Understand	30	20	20
Apply	50	40	40
Analyze	0	20	20
Evaluate	0	0	0
Create	0	0	0

Syllabus

ARTIFICIAL INTELLIGENCE AND SOFT COMPUTING: Subject of AI – Problem solving by intelligent search – Breadth First Search, Depth First Search, Iterative Deepening, Hill Climbing, Iterative Deepening, A*, Best First Search. **GENETIC ALGORITHM:** Basic Concepts – Encoding – Binary, Permutation, Tree, Value – Fitness Function – Reproduction – Roulette Wheel, Boltzmann, Tournament, Rank, Elitism – Operators – Crossover – Single point, Two point, Multi point, Uniform, Matrix, Partially Matched, Order and Cycle – Mutation – Flip, Swap, Inverse – Application. **FUZZY SET THEORY:** Basic Definitions and Terminologies – Set theory operations – Membership function formulation and parameterization – Fuzzy rules and reasoning – Extension principle and fuzzy relations, Fuzzy if then rules, Fuzzy reasoning – Fuzzy Inference Systems – Mamdani fuzzy model, Sugeno Fuzzy models, Tsukamoto fuzzy models.

Reference Books

1. Amit Konar, ¯Artificial Intelligence and Soft Computing : Behavioral and Cognitive Modeling of the Human Brain‖, CRC Press, 2008.
2. Ross Timothy J., ¯Fuzzy Logic with Engineering Applications‖, John Wiley and Sons, 2010.
3. Laurene Fausett, ¯Fundamentals of Neural Networks: Architectures, Algorithms and Applications‖, Pearson Education, 2011.
4. Nils J. Nilsson, ¯Artificial Intelligence: A New Synthesis‖, Morgan Kaufmann,2003.
5. Rajasekaran S., Vijayalaskhmi Pai G. A., ¯Neural Networks, Fuzzy Logic and Genetic Algorithms‖, Prentice Hall, 2006.
6. David E. Goldberg, ¯Genetic Algorithms in search, optimization and machine learning‖, Addison Wesley, 2012.
7. Jang J. S. R., Sun C. T. and Mizutani E., ¯Neuro-fuzzy and Soft Computing‖, Prentice Hall, 2010.

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		Category	L	T	P	Credit
21DSPH0	**MATHEMATICAL MODELING**	PE	3	0	0	3

Preamble

The students will be able to:

1. Learn the basic concepts of modelling and its different kinds.
2. Fit data with polynomials, splines and time series models for univariate and multivariate.
3. Apply the concepts of Mean variance portfolio optimization, Markowitz model and efficient frontier calculation algorithm
4. Learn and apply the concepts of fundamental theorem of asset pricing and Cox-Ross-Rubinstein (CRR) model.
5. Apply the concepts of Brownian motion, martingales, risk neutral measure, Girsanov's theorem, Feynman-Kac formula
6. Apply the concepts of bioinformatics and model the real world problem using genetic algorithm and hidden markov models.

Prerequisite

- Basic concepts in Calculus, Statistics and Financial engineering.

Course Outcomes

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

CO1:	Understand the concepts of modelling and its different kinds	Understand
CO2:	Apply the concept of modelling in Fitting data with polynomials, splines	Apply
CO3:	Apply the concept of modelling with regression analysis and time series models for univariate and multivariate	Apply
CO4:	Apply the concepts of Mean variance portfolio optimization, Markowitz model and efficient frontier calculation algorithm	Apply
CO5:	Learn and apply the concepts of fundamental theorem of asset pricing and Cox-Ross- Rubinstein (CRR) model.	Apply
CO6:	Apply the concepts of Brownian motion, martingales, risk neutral measure, Girsanov's theorem, Feynman-Kac formula	Apply
CO7:	Apply the concepts of bioinformatics and model the real world problem using genetic algorithm and hidden markov models	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	L	M	M
CO2	L	S	S
CO3	L	S	S
CO4	L	S	S
CO5	L	S	S
CO6	L	S	S
CO7	L	S	S

S- Strong; M-Medium; L-Low

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	10	10	10
Understand	30	20	20
Apply	60	70	70
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

Syllabus

INTRODUCTION TO MODELING: Modeling process, Overview of different kinds of model.**EMPIRICAL MODELING WITH DATA FITTING:** Error function, least squares method; fitting data with polynomials and splines.**CAUSAL MODELING AND FORECASTING:** Introduction, Modeling the causal time series, forecasting by regression analysis, predictions by regression. Planning, development and maintenance of linear models, trend analysis, modeling seasonality andtrend, trend removal and cyclical analysis, decomposition analysis. Modeling financial time series. Econometrics and time seriesmodels. Non seasonal models: ARIMA process for univariate and multivariate.**PORTFOLIO MODELING AND ANALYSIS:**Portfolios, returns and risk, risk-reward analysis, asset pricing models, mean variance portfolio optimization, Markowitz model and efficient frontier calculation algorithm, Capital Asset Pricing Models (CAPM).**DISCRETE-TIME FINANCE:** Pricing by arbitrage, risk-neutral probability measures, valuation of contingent claims, and fundamental theorem of asset pricing, Cox-Ross-Rubinstein (CRR) model, pricing and hedging of European and American derivatives as well as fixed-income derivatives in CRR model, general results related to prices of derivatives. **STOCHASTIC CALCULUS:** Brownian motion, martingales, Itô‟s formula, Itô integral, risk-neutral measure, SDE; Risk-neutral measure, Girsanov's theorem for change of measure, martingale representation theorems, representation of Brownian martingales, Feynman-Kac formula.**MODELING WITH BIOINFORMATICS:** Introduction, Biological data- types, mode of collection, documentation and submission. Sequence alignment-Definition, significance, dot matrix method, dynamic programming- Global and local alignment tools, scoring matrices and gap penalties. Multiple sequence alignment: Iterative methods. Genetic algorithm, Hidden Markovian models, statistical methods, position specific scoring matrices.

Reference Books

1. Giordano F. R., Weir M. D., and Fox W. P., ¯A First Course in Mathematical Modeling‖. Brooks/Cole, Belmont, 2014.
2. Christoffersen P., ¯Elements of Financial Risk Management‖, Academic Press, 2012.
3. Capinski M. and ZastawniakT,¯Mathematics for Finance: An Introduction to Financial Engineering‖, Springer, 2011.
4. Mount D.W., ¯Bioinformatics Sequence and genome analysis‖, Cold Spring Harbor Laboratory, Press, 2006.

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21DSPJ0	SOFTWARE ENGINEERING	Category	L	T	P	Credit
		PE	3	0	0	3

Preamble

This course aims at introducing to the students about the product that is to be engineered and the process that provides a framework for the engineering technology. The course facilitates the students to analyze risk in software design and quality and to plan, design, develop and validate the software project.

Prerequisite

Nil

Course Outcomes

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

CO1:	Compare and contrast the traditional and agile software process models.	Understand
CO2:	Identify the functional and non-functional requirements for a given problem.	Apply
CO3:	Apply appropriate technique to design documents for the given requirements.	Apply
CO4:	Examining the appropriate testing techniques for an application using the test cases.	Analyze
CO5:	Estimate a given project based on Lines of code, Function points and user stories.	Apply
CO6:	Apply the testing techniques to evaluate the software projects.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	L	-	-
CO2	L	-	-
CO3	L	M	-
CO4	M	M	S
CO5	M	S	S
CO6	S	S	S

S- Strong; M-Medium; L-Low

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	20	20	20
Understand	30	20	20
Apply	50	40	40
Analyze	0	20	20
Evaluate	0	0	0
Create	0	0	0

Syllabus

Software Process and Life Cycle Models: Introduction to Software Engineering, Software Process, Life cycle models: water fall, incremental, spiral, WINWIN spiral, evolutionary, prototyping, object oriented, Aspect oriented, Agile Process Models. Requirements Engineering tasks: Software Requirements: Functional and Non-Functional, User requirements, System requirements, Software Requirements Document. Requirement Engineering Process: Feasibility Studies, Requirements elicitation and analysis,requirements validation, requirements management, Data Modelling, OO analysis Software Project Management: Software Project Management: Estimation, LOC and FP Based Estimation, COCOMO Model, Project Scheduling: Scheduling, Earned Value Analysis - Risk Management. Software Design: Design process: Design concepts, Data design elements: Pattern based Software Design. Software Testing: Software testing strategies:fundamentals, Internal and external views of Testing-white box testing, basis path testing, control structure testing, black box testing, Regression Testing, Unit Testing, Integration Testing, Validation Testing, System Testing And Debugging.

Reference Books

1. Roger Pressman, Software Engineering: A Practitioners Approach, (8th Edition), McGraw Hill, 2015
2. Eric J. Braude and Micheal E. Bernstein, Software Engineering Modern Approach, second edition, Wiley, 2011.
3. Ian Somerville, Software Engineering, 9th edition, Addison Wesley, 2011.

		Category	L	T	P	Credit
21DSPK0	**GRAPH ALGORITHMS**	PE	3	0	0	3

Preamble

The students will be able to:

1. Learn the basic concepts of graphs and algorithm time-space complexity.
2. Design using the concepts of VLSI physical design algorithms.
3. Learn the concepts of graph homomorphism, cop-win graphs and polynomial algorithm.
4. Apply and model the plane sweep algorithm, Max min cut theorem and The Edmonds – Karp algorithm.

Prerequisite

- Basics in Graphs, Algorithms and VLSI.

Course Outcomes

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

CO1:	Understand the basic concepts of graphs with algorithm time-space complexity	Understand
CO2:	Apply the concepts of graphs in Euclidean minimum spanning tree algorithm and art gallery problem	Apply
CO3:	Design using the concepts of VLSI physical design algorithms.	Apply
CO4:	Learn and apply the concepts of graph homomorphism, cop-win graphs and polynomial algorithm.	Apply
CO5:	Design using the concepts of Voronoi diagrsms in fortune's algorithms	Apply
CO6:	Apply and model the plane sweep algorithm, Max min cut theorem and The Edmonds – Karp algorithm	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	L	M	M
CO2	L	S	S
CO3	L	S	S
CO4	L	S	S
CO5	L	S	S
CO6	L	S	S

S- Strong; M-Medium; L-Low

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	10	10	10
Understand	30	20	20
Apply	60	70	70
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

Syllabus

BASIC CONCEPTS: Graphs – representations, Planar graphs- Euler‟s formula, crossing number, doubly connected edge list data structure, Algorithm complexity – time and space.**GEOMETRIC GRAPHS:** Planar straight line graph, Euclidean minimum spanning tree algorithm, Art gallery problem, visibility graphs, Computing point visibility for polygons with and without holes.**VLSI PHYSICAL DESIGN:** Manhattan distance, overlap graph, containment graph, interval graph, neighborhood graph, hypergraphs, Rectilinear minimum spanning tree, Rectilinear Steiner minimum tree, Kernighan-Lin partitioning algorithm, Partitioning based algorithms for floorplanning and placement, Lee‟s algorithm for routing, Shadow propagation algorithm for compaction.**VERTEX-PURSUIT GAME:** Graph homomorphism, retracts, cops and robbers - cop number (k), bounds, cop-win graphs. Polynomial algorithm for fixed k, NP-hard with k not fixed.**VORONOI DIAGRAMS:** plane sweep algorithm, Voronoi Diagram – definition and properties, Fortune‟s algorithm. Delaunay triangulation. NETWORK FLOW: Flow networks and Flows – Flow networks with multiple sources and sinks, The Ford – Fulkerson Method, Augmenting paths – Max Flow min cut theorem, The Edmonds – Karp algorithm.

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Reference Books

1. Thomas H. Cormen, Charles E. Leiserson and Ronald L. Rivest, ¯Introduction to Algorithms‖, PHI Learning, 2013.
2. Naveed A. Sherwani, Algorithms for VLSI Physical Design Automation, Springer, 2013.
3. Anthony Bonato, The Game of Cops and Robbers on Graphs, AMS, 2011.

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21DSPL0	ARTIFICIAL INTELLIGENCE	Category	L	T	P	Credit
		PE	3	0	0	3

Preamble

The aim of the course is to present an overview of artificial intelligence (AI) principles and develop a basic understanding of the building blocks of AI as presented in terms of intelligent agents: Search, Knowledge representation, inference, logic, reasoning and learning.

Prerequisite

- 21DS150 - Discrete Structures

Course Outcomes

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

CO1:	Explain the key characteristics of intelligent agents.	Understand
CO2:	Describe the pre-processing methods for Information Retrieval.	Understand
CO3:	Apply the suitable search strategy to solve the search problems.	Apply
CO4:	Apply adversarial search to find the optimal move for a given game.	Apply
CO5:	Construct a plan graph for the given problem like Constraints satisfaction problems and STRIPS problems.	Apply
CO6:	Construct knowledge representations using logic to facilitate inference in the given problem domain.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	L	-	-
CO2	L	-	-
CO3	L	M	-
CO4	M	M	S
CO5	M	S	S
CO6	S	S	S

S- Strong; M-Medium; L-Low

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	30	20	20
Understand	30	30	30
Apply	40	50	50
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

Syllabus

INTRODUCTION: The foundations of AI - The History of AI- Intelligent agents- Agent based system. **PROBLEM SOLVING:** Searching for solution- Uninformed/Blind search - Informed/ Heuristic search - A* search - Hill-climbing search -Constraint satisfaction problem. **KNOWLEDGE REPRESENTATION AND REASONING**: Logics – First order logic, Inference in first order logic, Knowledge representation. **PLANNING:** The planning problem - Planning with state space search - Partial order search - Planning with proportional logic - Planning and acting in the real world. Adversarial planning. **UNCERTAIN KNOWLEDGE AND PROBABILISTIC REASONING**: Uncertainty- Probabilistic reasoning - Semantics of Bayesian network -Approximate inference in Bayesian network, Exact inference in Bayesian network - Probabilistic reasoning over time. **LEARNING:** Learning from observation - Knowledge in learning -Statistical learning methods - Reinforcement learning. **DECISION-MAKING**: basics of utility theory, decision theory, sequential decision problems, elementary game theory, sample applications. **ROBOTICS:** Introduction

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Reference Books

1. Stuart Russell and Peter Norvig, ¯Artificial Intelligence: A Modern Approach‖, Pearson Education, 2014.
2. David Pool, Alan Mackworth, ¯Artificial Intelligence: Foundations of Computational agents‖, Cambridge University, 2011.
3. Christopher M.Bishop, ¯Pattern Recognition and Machine Learning‖, Springer, 2013.
4. Nils J. Nilsson, ¯The Quest for Artificial Intelligence: A History of Ideas and achievements‖, Cambridge University Press, 2010.

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		Category	L	T	P	Credit
21DSPM0	**GAME THEORY**	PE	3	0	0	3

Preamble

The students will be able to:

1. Learn the basics of game theory and mixed strategies.
2. Apply the concept of Nash equilibrium, Stackelberg‘s model of duopoly
3. Apply the concept of Bayesian games and Signaling games.
4. Learn the Prisoner‟s dilemma and finitely repeated and infinitely repeated.
5. Model the real world problem using algebraic game theory.

Prerequisite

- Basics in Discrete Structures, Algebra, Probability and Statistics.

Course Outcomes

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

CO1:	Understand expected utility theory and the role of probabilities in explaining behaviour.	Understand
CO2:	Describe the predictions of non-cooperative game theory an evolutionary perspective.	Understand
CO3:	Apply game theoretic models to a variety of real-world scenarios in economics and in other areas.	Apply
CO4:	Analyze different games and use a variety of tools to find equilibria.	Analyze
CO5:	Apply models of bargaining and negotiation and how they can be applied to models of competition.	Apply
CO6:	Identify the methods of game theory to solve the real world problems	Analyze

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	L	-	-
CO2	L	-	-
CO3	L	M	-
CO4	M	M	-
CO5	S	S	M
CO6	S	S	S

S- Strong; M-Medium; L-Low

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	30	10	10
Understand	30	10	10
Apply	40	50	50
Analyze	0	30	30
Evaluate	0	0	0
Create	0	0	0

Syllabus

INTRODUCTION: Game theory the theory of rational choice – Interacting decision makers. **NASH EQUILIBRIUM**: Strategic games – Best response – Dominance – Examples from economics, business, environment, military- Symmetric games and symmetric equilibria. Illustrations: Cournot‟s model of oligopoly, Electoral competition. **MIXED STRATEGIES**: Dominance – Equilibrium – Illustrations: Expert diagnosis, Reporting a crime – Formation of players‟ beliefs. **EXTENSIVE GAMES WITH PERFECT INFORMATION**: Strategies and outcomes – Nash equilibrium – Subgame perfect equilibrium - Stackelberg‟s model of duopoly, Buying votes – Illustrations: Entry into a monopolized industry, Electoral competition with strategic voters, Committee decision making. **GAMES WITH IMPERFECT INFORMATION**: Bayesian games – Examples – Strategic information - Transmission – Agenda Control with imperfect Information – Signaling games - Education as a signal of ability. **REPEATED GAMES**: The prisoner‟s dilemma – Finitely repeated and infinitely repeated – Strategies – Nash equilibrium – Subgame – Perfect equilibria and the one – deviation – Property – General results – Finitely replaced games – Variation on a theme: Imperfect observability. **INTRODUCTION TO ALGORITHMIC GAME THEORY**: Auction and mechanism design basics - the Vickrey auction - Sponsored Search Auction - Social choice theory - VCG mechanism. Algorithmic Aspects of Equilibria: Existence and computational complexity equilibria - Market Equilibrium - Correlated Equilibrium. Quantifying the inefficiency of equilibria: Routing Games and Congestion Games - Network Formation - Price of Anarchy and Price of Stability - Bandwidth Sharing.

Reference Books

1. Martin J. Osborne, ―An Introduction to game theory‖, Oxford University Press, New York, 2004.
2. Nisan N., Roughgarden T., Tardos E., Vazirani V., ―Algorithmic Game Theory‖, Cambridge University Press, Cambridge, 2007.
3. Thomas L.C, ―Games, Theory and Applications‖, Dover Publications, New York, 2011.
4. Ken Binmore, ―Playing for Real: A Text on Game Theory‖, Oxford University Press, New York, 2007.
5. David Easley, Jon Kleinberg, ―Networks, Crowds, and Markets: Reasoning About a Highly Connected World‖, Cambridge University Press, New York, 2010.
6. Matthew O. Jackson, ―Social and Economic Networks‖, Princeton University Press, New Jersey, 2008.
7. YoavShoham, Kevin Leyton-Brown, ―Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations‖, Cambridge University Press, New York, 2008.

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		Category	L	T	P	Credit
21DSPN0	**SOCIAL MEDIA ANALYTICS**	PE	3	0	0	3

Preamble

The course aims to provide knowledge on key concepts of social media analytics, knowledge representation using ontology and the concept of semantic web and related applications.

Prerequisite

- 21DS250 - Graph Theory
- 21DS450 - Predictive Analytics

Course Outcomes

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

CO1:	Explain the basic concepts of Semantic web.	Understand
CO2:	Describe the key concepts in network analysis.	Understand
CO3:	Apply data extraction technique to the social networking data.	Apply
CO4:	Examine the aggregating and reasoning with social networking data.	Analyze
CO5:	Compare and contrast the methods in knowledge representation.	Apply
CO6:	Identify the application area of optimization, prediction and evaluation in real world scenario.	Analyze

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	L	-	-
CO2	L	-	-
CO3	L	M	-
CO4	M	M	S
CO5	M	S	S
CO6	S	S	S

S- Strong; M-Medium; L-Low

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	20	10	10
Understand	20	10	10
Apply	40	50	50
Analyze	20	30	30
Evaluate	0	0	0
Create	0	0	0

Syllabus

Introduction to Semantic Web: Limitations of current Web, Development of Semantic Web, Emergence of the Social Web. Social Network analysis: Development of Social Network Analysis -Key concepts and measures in network analysis. Electronic sources for network analysis: Electronic discussion networks, Blogs and online communities - Web-based networks. Knowledge representation on the Semantic web: Ontology and their role in the Semantic Web: Ontology-based knowledge Representation – Ontology languages for the Semantic Web: Resource Description Framework - Web Ontology Language. Modelling and aggregating social network data: State-of-the-art in network data representation - Ontological representation of social individuals - Ontological representation of social relationships - Aggregating and reasoning with social network data. Social-semantic applications: Generic Architecture- Sesame- Elmo – Graph util, Flink-Open academia. Socialnetwork extraction: Survey method-electronic data extraction- Data collection Optimiztion- prediction- Evaluation.

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Reference Books

1. Peter Mika, ¯Social Networks and the Semantic Web‖, First Edition, Springer 2007. (Chapters 1 to 7)
2. Guandong Xu ,Yanchun Zhang and Lin Li, ¯Web Mining and Social Networking – Techniques and applications‖, First Edition Springer, 2011.
3. Dion Goh and Schubert Foo, ¯Social information Retrieval Systems: Emerging Technologies and Applications for Searching the Web Effectively‖, IGI Global Snippet, 2008.

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		Category	L	T	P	Credit
21DSPP0	**CLOUD COMPUTING**	PE	3	0	0	3

Preamble

The aim of the course is to provide comprehensive and in-depth knowledge of Cloud Computing concepts, technologies, architecture and researching state-of-the-art in Cloud Computing fundamental issues, technologies, applications and implementations.

Prerequisite

- 21DS530 - Computer Networks

Course Outcomes

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

CO1:	Describe the key technologies, architecture, strengths, limitations and applications of cloud computing.	Understand
CO2:	Explain the types and service models of cloud.	Understand
CO3:	Describe the core issues such as security, privacy, and interoperability in cloud platform.	Understand
CO4:	Compare and contrast the technologies, algorithms, and applications in the cloud computing driven systems.	Apply
CO5:	Apply cloud computing solutions for the given real time scenario.	Apply
CO6:	Analyze the cloud deployments in real time scenarios.	Analyze

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	L	-	-
CO2	M	-	-
CO3	M	L	-
CO4	M	L	M
CO5	S	M	M
CO6	S	M	S

S- Strong; M-Medium; L-Low

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	20	20	20
Understand	50	20	20
Apply	30	40	40
Analyze	0	20	20
Evaluate	0	0	0
Create	0	0	0

Syllabus

Virtualization for Cloud: Need for Virtualization, Pros and cons of Virtualization, Types of Virtualization, System VM, Process VM, Virtual Machine monitor, Virtual machine properties, Interpretation and binary translation, HLL VM, Hypervisors : Xen, KVM , VMWare, Virtual Box, Hyper-V. Cloud Architecture: Definition, Characteristics, Service models, Deployment models, Types, Challenges, Three-layer architecture, Concepts & Terminologies - Virtualization, Load balancing, Scalability and elasticity, Deployment, Replication, Monitoring, Software defined networking, Network function virtualization, Service level agreement, Billing. Service Models:SaaS – Multitenant, OpenSaaS, SOA. PaaS – IT Evolution, Benefits, Disadvantages. IaaS – Improving performance, System and storage redundancy, Cloud based NAS devices, Advantages, Server types. IDaaS – Single Sign-on, OpenID.Database as a Service, Monitoring as a Service, Communication – asservices.Service providers - Google, Amazon, Microsoft Azure, IBM, Sales force. Cloud Storage: Overview of cloud storage, cloud storage providers, Cloud file system, Mapreduce. Case study: Walrus, Amazon S3, Hadoop. Securing the Cloud: Identity and access management, Data loss prevention, Web security, E-mail security, Security assessments, Intrusion management, Security information and event management, Encryption and BCDR implementation, Network Security. Deployment Tools: Eucalyptus, Nimbus, Openstack, Cloudstack, Open Nebula.

Reference Books

1. James E Smith, Ravi Nair, ¯Virtual Machines‖, Morgan Kaufmann Publishers, 2006.
2. John Rittinghouse & James Ransome, ¯Cloud Computing, Implementation, Management and Strategy‖, CRC Press, 2010.
3. T. Velte, A. Velte, R. Elsenpeter, ¯Cloud Computing, A Practical Approach‖, McGrawHill, 2009.
4. Cloud Security Alliance, ¯Providing greater clarity in Security as a Service‖, 2013.
5. RajkumarBuyya, Christian Vecchiola, S.ThamaraiSelvi, ¯Mastering cloud computing‖, Morgan Kaufman, 2013.

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21DSPQ0	DATA VISUALIZATION	Category	L	T	P	Credit
		PE	3	0	0	3

Preamble

The course is designed to enable students to know the basics of data visualization and understand the importance of data visualization and the design and use of visual components and basic algorithms.

Prerequisite

- 21DS630 - Big Data Systems

Course Outcomes

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

CO1:	Explain the basics of data visualization.	Understand
CO2:	Understand the importance of data visualization and the design and use of many visual components.	Understand
CO3:	Apply visualisations techniques for different types of data sets and application scenarios.	Apply
CO4:	Apply the basics of colours, views, and other popular and important visualization-based issues.	Apply
CO5:	Apply visualization structures such as tables, spatial data, time-varying data, tree and network, etc.	Apply
CO6:	Analyze the basic algorithms in data visualization.	Analyze

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	L	-	-
CO2	L	-	-
CO3	L	M	-
CO4	M	M	S
CO5	M	S	S
CO6	S	S	S

S- Strong; M-Medium; L-Low

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	20	10	15
Understand	20	10	15
Apply	40	50	50
Analyze	20	30	20
Evaluate	0	0	0
Create	0	0	0

Syllabus

INTRODUCTION: Information visualization – Theoretical foundations – Information visualization types – Design principles - A framework for producing data visualization. **STATIC DATA VISUALIZATION** – tools – working with various data formats. **DYNAMIC DATA DISPLAYS** : Introduction to web based visual displays – deep visualization – collecting sensor data – visualization D3 framework - Introduction to Many eyes and bubble charts.**MAPS** – Introduction to building choropleth maps. **TREES** – Network visualizations – Displaying behavior through network graphs. **BIG DATA VISUALIZATION** – Visualizations to present and explore big data – visualization of text data and Protein Sequences

Note: Explore softwares like R, Python, Google Vision, Google Refine, and ManyEyes ; Data sets are available on Gap minder, Flowing data

1. Visualization of static data.
2. Visualization of web data.
3. Visualization of sensor data.
4. Visualization of protein data.

Reference Books

1. Ware C and Kaufman M ‖Visual thinking for design‖, Morgan Kaufmann Publishers, 2008.
2. Chakrabarti, S ¯Mining the web: Discovering knowledge from hypertext data ¯, Morgan Kaufman Publishers, 2003.
3. Fry ,‖Visualizing data‖, Sebastopo‖, O"Reily, 2007.

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21DSPR0	COMPUTATIONAL FINANCE	Category	L	T	P	Credit
		PE	3	0	0	3

Preamble

This course aims to introduce the basics of computational finance and the numerical techniques used in computational finance, for derivative pricing, for the evaluation of bonds and for portfolio optimization.

Prerequisite

- 21DS310 - Applied Statistics
- 21DSPV0 - Accounting And Financial Management

Course Outcomes

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

CO1:	Formulating finance problems into computational problems.	Understand
CO2:	Describe the role of derivative pricing in risk management.	Understand
CO3:	Apply the role of optimisation in computational finance such as single and multi-period mean-variance portfolio management.	Apply
CO4:	Analyze the strength and limitations of mathematical models in finance.	Analyze
CO5:	Apply numerical techniques for valuation, pricing and hedging of financial investment instruments such as options.	Apply
CO6:	Compare and contrast the emerging variants of crypto currency-based decentralized systems.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	-	-	-
CO2	L	-	-
CO3	L	M	-
CO4	M	M	S
CO5	M	M	S
CO6	S	S	S

S- Strong; M-Medium; L-Low

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	30	10	10
Understand	30	10	10
Apply	40	50	50
Analyze	0	30	30
Evaluate	0	0	0
Create	0	0	0

Syllabus

INTRODUCTION : Law of one price – Risk neutral pricing – Arbitrage and Hedging – Financial Products and capital markets - Futures, Forwards and options - Options pricing problem and three types of solutions. **MATHEMATICAL PRELIMINARIES** : Conditional expectation – Sigma Algebra – Filtrations, Time series analysis - Covariance stationary – autocorrelations - MA(1) and AR(1) models, Stochastic Calculus - Random walk – Brownian motion – Martingales – Ito‟s Lemma. **PORTFOLIO THEORY** - Introduction - Portfolio theory with matrix algebra - Review of constrained optimization methods, Markowitz algorithm, Markowitz Algorithm using the solver and matrix algebra – Portfolio choice and linear pricing – Statistical analysis of efficient portfolios. **BASIC OPTIONS THEORY** – Definitions – Pay off diagrams – Single period binomial options theory – Multi period binomial options theory – Real options – American options, Simulation methods for options pricing – Random variable generation – simulation of stochastic processes. **THE CAPITAL ASSET PRICING (CAP) AND RISK BUDGETING -** Mean variance portfolio theory – Asset returns – Variance as a risk measure - The one and two fund theorems, The capital market line – CAP as a pricing formula – Systematic and unsystematic risk – Euler‟s theorem – Asset contributions to volatility – beta as a measure of portfolio risk , Limitations of mathematical models in finance.

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Reference Books

1. David Ruppert, ―Statistics and Data Analysis for Financial Engineering‖, Springer-Verlag, 2011.

2. Edwin J. Elton, Martin J. Gruber, Stephen J. Brown and William N. Goetzmann ―Modern Portfolio Theory and Investment Analysis‖, Wiley, 2014.

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21DSPS0	ENTERPRISE INFORMATION SYSTEM	Category	L	T	P	Credit
		PE	3	0	0	3

Preamble

This course aims to enable the students to make or influence decisions related to the selection, design and support of Enterprise information systems.

Prerequisite

Nil

Course Outcomes

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

CO1:	Explain the design, construction and management of relational database systems.	Understand
CO2:	Describe the strengths and weaknesses of different approaches to data management.	Understand
CO3:	Apply knowledge of processes, tools and techniques involved in information management within an enterprise.	Apply
CO4:	Compare and contrast the range of database technologies and methods of database construction.	Apply
CO5:	Apply the knowledge of database-driven systems within a business context.	Apply
CO6:	Analyze the information and data technologies in the context of organizational needs.	Analyze

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	L	-	-
CO2	M	L	-
CO3	L	-	-
CO4	M	M	S
CO5	M	S	S
CO6	S	S	S

S- Strong; M-Medium; L-Low

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	3	
Remember	20	20	20
Understand	20	20	20
Apply	50	30	40
Analyze	10	30	20
Evaluate	0	0	0
Create	0	0	0

Syllabus

Organizations, Management, and the Networked Enterprise: the role of information systems in Business today, Perspectives on Information Systems, contemporary approaches to information systems. **Information Systems, Organizations, and Strategy:** organizations and information systems, information systems impact organizations and business firms, using information systems to achieve competitive advantage, using systems for competitive advantage: management issues**. IT Infrastructure and Emerging Technologies:** IT infrastructure, infrastructure components, contemporary hardware platform trends, contemporary software platform trends. **Managing Knowledge:** the knowledge management landscape, enterprise-wide knowledge management systems, knowledge work systems. **Enhancing Decision Making:** decision making and information systems, business intelligence in the enterprise, business intelligence constituencies. **Building Information Systems:** Systems as planned organizational change, overview of systems development systems, alternative systems-building approaches, application development for the digital firm. **Managing Global Systems:** the growth of international information systems, organizing international information systems.

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Reference Books

1. Kenneth C. Laudon Jone & P. Laudon, ¯Management Information Systems‖, Thirteenth Edition, Pearson Education Limited 2014.
2. Terry Lucey, ¯Management Information Systems‖, Ninth Edition, 2005, Thompson. Effy Oz ¯Management Information Systems‖, Fourth International Student Edition, Thomson, 6th Edition, 2008.

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		Category	L	T	P	Credit
21DSPT0	**RANDOMIZED ALGORITHMS**	PE	3	0	0	3

Preamble

This course aims to introduce the power of randomization in the design and analysis of algorithms.

Prerequisite

- 21DS430 - Design And Analysis Of Algorithms
- 21DS510 -Numerical Methods
- 21DS640 - Optimization Techniques

Course Outcomes

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

CO1:	Understand the concept of randomized algorithm and Construct Las Vegas algorithms for a given problem and compute the expected running time.	Understand
CO2:	Construct Monte-Carlo algorithms for a given problem and compute the probability of getting an incorrect output	Apply
CO3:	Design solutions for complex problems using randomization design paradigms like Foiling the Adversary, Abundance of Witnesses, Fingerprinting, Random Sampling, Amplification and Random Rounding	Apply
CO4:	Apply the concept of approximation algorithms on cardiality vertex-cover problem	Apply
CO5:	Develop approximation algorithms for a given problem by evaluating various possibilities, techniques and design trade-offs	Apply
CO6:	Compute ratio-bounds while designing combinatorial approximation algorithms and approximation algorithms based on Linear Programming techniques and Semi-definite Programming	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	L	M	M
CO2	L	S	S
CO3	L	S	S
CO4	L	S	S
CO5	L	S	S
CO6	L	S	S

S- Strong; M-Medium; L-Low

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	10	10	10
Understand	30	20	20
Apply	60	70	70
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

Syllabus

Introduction to Randomized Algorithms:Review on Algebra, Number theory, Combinatorics and Probability theory, Randomness as a source of efficiency-designing a communication protocol, Models of Randomized Algorithms, Classification-Las Vegas, Monte-Carlo (one-sided error, bounded-error and unbounded-error), Classification of Randomized Algorithms for Optimization problems. **Design Paradigms**: Foiling the Adversary, Abundance of Witnesses, Fingerprinting, Random Sampling, Amplification, Random Rounding. **Representative Algorithms**: Foiling the Adversary – Universal Hashing, Fingerprinting – Communication protocols, Verification of Matrix Multiplication, Equivalence of Two polynomials, Success Amplification and Random Sampling – Min-Cut, Satisfiability and repeated random sampling, Abundance of Witnesses and Optimization & random rounding – Primality Testing, Max-SAT review, hybrid sampling & rounding, Derandomization Techniques. **Introduction to Approximation Algorithms**: Review on Complexity theory, Performance Ratios for approximation algorithms, Cardinality vertex- cover problem, Well-characterized problems and min-max relations, Travelling Salesperson problem. **Combinatorial Algorithms**: Set Cover, Steiner Tree and TSP, Multi-way Cut and k-Cut, Bin Packing. **LP-based Algorithms**: LP-duality, Set cover via dual fitting, Set cover via the primal-dual schema, Rounding applied to Set Cover, Multi-way Cut **Semi-definite Programming**: Strict quadratic programs and vector programs, The semi-definite programming problem, Randomized rounding algorithm, Guarantee improvement for MAX-2SAT.

Exercises for PRACTICE:

1. Implementation of randomized quick sort and solve real time problems using it.
2. Find solution for s-t min-cut problem adapting min cut algorithm.
3. Implementation of randomized selection and problems related to it.
4. Implementation of treap data structure.
5. Problems using randomized hash table.
6. Implement the shortest path and fast min-cut algorithms.
7. Implementation of randomized primality testing.
8. Implement the K-server on-line algorithms.

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Reference Books

1. Vijay V. Vazirani – Approximation Algorithms, First edition, Springer, 2001.
2. JurajHromkovic- Design and Analysis of Randomized Algorithms, First edition, Springer, 2005.
3. The Design of Approximation Algorithms - David P. Williamson, David B. Shmoys, Cambridge University Press, 2011.

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		Category	L	T	P	Credit
21DSPU0	**PRINCIPLES OF MANAGEMENT**	PE	3	0	0	3

Preamble

This course aims to enable students to understand management principles, processes and procedures in consideration of their effort on individual actions.

Prerequisite

Nil

Course Outcomes

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

CO1:	Explain the fundamental concepts and principles of management.	Understand
CO2:	Apply theories to improve the practice of management.	Apply
CO3:	Identify the key competencies required of effective managers.	Understand
CO4:	Discuss the importance of managerial ethics and social responsibility in management.	Apply
CO5:	Explain the complexity of real life organization and management.	Understand
CO6:	Demonstrate critical thinking when presented with managerial issues and problems.	Understand

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	-	-	-
CO2	L	-	-
CO3	L	M	-
CO4	M	M	L
CO5	S	M	S
CO6	S	S	S

S- Strong; M-Medium; L-Low

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	20	0	20
Understand	50	20	30
Apply	30	80	50
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

Syllabus

PRINCIPLES OF MANAGEMENT: Meaning, Definition and Significance of Management, Basic Functions of Management – Planning, Organizing, Staffing, Directing and Controlling. Organizational Environment - Social, Economic, Technological and Political. Corporate Social Responsibility - Case discussion. **INDUSTRIAL AND BUSINESS ORGANIZATION:** Growth of Industries (Small Scale, Medium Scale and Large Scale Industries). Forms of Business Organizations. Resource Management – Internal and External Sources. **GLOBALISATION: I**ssues for global competitiveness, proactive and reactive forces of globalization. Cross cultural management – Management of work force diversity. **HUMAN RESOURCE MANAGEMENT:** Objectives and Functions, Selection and Placement, Training and Development – Conflict management – Stress management - Human resource management in global environment - Human resource information system(HRIS) - Case discussion.

Reference Books

1. Harold Koontz, Heinz Weihrich and Ramachandra Aryasri, ¯Principles of Management‖, Tata McGraw Hill, 2014.
2. Mamoria C B, ¯Personnel Management‖, Sultan Chand & Sons, 2005.
3. John W Newstrom and Keith Davis, ¯Organizational Behavior‖, Tata McGraw Hill, 2010.
4. Stephen P Robbins, ‖Organisational behavior‖, Prentice Hall, 2010.
5. Khanna O P, ¯Industrial Engineering & Management‖, Dhanpat Rai Publications, 2010.

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21DSPV0	ACCOUNTING AND FINANCIAL MANAGEMENT	Category	L	T	P	Credit
		PE	3	0	0	3

Preamble

This course aims in introducing concepts of accounting and enables an engineer in taking useful financial and costing related decisions by providing scientific tools and techniques

Prerequisite

Nil

Course Outcomes

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

CO1:	Explain the basic concepts and process of accounting and finance.	Understand
CO2:	Develop trail balance and financial statements like Trading, Profit and Loss accounts, Balance sheet and Cost sheet.	Apply
CO3:	Demonstrate the concepts and operations of budgetary control.	Understand
CO4:	Apply techniques like break event analysis and budgeting for an organization.	Apply
CO5:	Select the right sources of finance and mobilize the right quantum of finance and make use of them in most profitable investment avenues.	Apply
CO6:	Apply the concepts if accounting in the real time applications.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	L	-	-
CO2	L	-	-
CO3	M	M	-
CO4	M	M	L
CO5	S	S	M
CO6	S	S	S

S- Strong; M-Medium; L-Low

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	20	20	20
Understand	30	30	30
Apply	50	50	50
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

Syllabus

Accounting -Meaning and Scope, Need for Accounting, Definition, Principles, Accounting Functions-Recording, Classifying, Summarizing, Analysis and Interpretations. Final Accounts- Manufacturing , Profit and Loss Accounts, Balance Sheet, Depreciation causes and methods. Financial Management-Meaning, Evolution, Objectives and Sources of Finance Financial Statement Analysis- Comparative Statement, Common Size Statement, Trend Analysis, Ratio Analysis. Working Capital Management- Meaning, need and requirements of Working Capital Estimation. Capital Budgeting- Definition, Methods of Evaluation

Reference Books

1. M.C.Sukhla, T.S.Grewal, ¯Advanced Accounts Vol I‖, S.Chand and Publications, New Delhi, 2012
2. Prasanna Chandra, ¯Fundamentals of Financial Management‖, Tata McGraw Hill, 2012.
3. Pandey, ¯Financial Management‖ , Vikas Publishing House Pvt. Ltd., 2010

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		Category	L	T	P	Credit
21DSPW0	**WIRELESS NETWORKS**	PE	3	0	0	3

Preamble

The course aims at exploring the concepts of wireless adhoc networks, functionalities and protocols of various layer, architectures and applications of framework creation, Qos and security implementation.

Prerequisite

- 21DS430 - Design And Analysis Of Algorithms
- 21DS530 - Computer Networks

Course Outcomes

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

CO1:	Explain the propagation mechanisms, generations, wireless transmission techniques, power management, principles and standards of cellular and ad hoc networks.	Understand
CO2:	Apply multiple access technique which enables the maximum number of concurrent users for a given specification.	Apply
CO3:	Develop a suitable mechanism to increase the channel Utilisation for the given transmission range.	Apply
CO4:	Compare and contrast suitable hand off algorithm for the given scenario.	Apply
CO5:	Identify the current location of mobileusers using agent advertisements.	Apply
CO6:	Apply different key sizes for enhancement in security for the given scenario.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	M	-	-
CO2	M	-	-
CO3	L	L	-
CO4	L	M	L
CO5	M	S	M
CO6	S	S	M

S- Strong; M-Medium; L-Low

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	30	20	20
Understand	50	40	40
Apply	20	40	40
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

Syllabus

Introduction: Introduction-Fundamentals of Wireless Communication Technology - The Electromagnetic Spectrum - Radio Propagation Mechanisms - Characteristics of the Wireless Channel - IEEE 802.11 Standard. Ad Hoc Routing Protocols: Issues and Challenges - Classifications of Routing Protocols-Table-Driven Routing Protocols - On-Demand Routing Protocols – Hybrid Routing Protocols- PowerAware Routing (PAR).Multicast routing In Ad Hoc Networks: An Architecture Reference Model for Multicast Routing Protocols -Classifications of Multicast Routing Protocols- TreeBased Multicast Routing Protocols- Mesh-Based Multicast Routing Protocols-Energy-Efficient Multicasting - Multicasting with Quality of Service Guarantees – Application-Dependent Multicast Routing Transport Layer, Security Protocols: Designing a Transport Layer Protocol - Design Goals of a Transport Layer Protocol -Classification of Transport Layer Solutions - TCPOver Ad Hoc Wireless Networks -Other Transport Layer Protocols - Security Requirements - Issues and Challenges in Security Provisioning - Network Security Attacks - Key Management - Secure Routing Qos and Energy Management: Classifications of QoS Solutions - MAC Layer Solutions-Network Layer Solutions - QoS Frameworks for Ad Hoc Wireless Networks Energy Management in Ad Hoc Wireless Networks -Introduction - Need for Energy Management in Ad Hoc Wireless Networks - Classification of Energy Management Schemes
- Battery Management Schemes - Transmission Power Management Schemes - System Power Management Schemes.

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Reference Books

1. C. Siva Ram Murthy and B.S. Manoj ¯Ad Hoc Wireless Networks: Architectures and Protocols‖, Pearson education, 2010.
2. Charles E. Perkins, Ad Hoc Networking, Addison Wesley, 2010.
3. William Stallings, ¯Wireless Communications and Networks‖, Pearson education, 2010
4. J. Schiller, ¯Mobile Communications‖, Pearson education, 2010.
5. Vijay K. Garg, ¯Wireless Communications and Networking‖, Elsevier, 2010

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		Category	L	T	P	Credit
21DSPX0	**NETWORK SCIENCE**	PE	3	0	0	3

Preamble

The course aims to identify, construct, visualize, and analyze networks by applying appropriate methods and algorithms. Students will be able to both mathematically and conceptually explain the key concepts and results of network science.

Prerequisite

- 21DS310 - Applied Statistics
- 21DS530 - Computer Networks

Course Outcomes

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

CO1:	Explain the basics of computer networks.	Understand
CO2:	Describe the concepts of assortativity and disassortativity, Measuring degree correlations, Structural cutoffs in network..	Understand
CO3:	Apply the functionalities and protocols of various layers used in Network model.	Apply
CO4:	Examine the usage of bose-einstein condensation in network working.	Analyze
CO5:	Apply appropriate access control, congestion control and congestion avoidance technique for a given traffic scenario.	Apply
CO6:	Identify the usage of statistical science in networks to reduce the congestion.	Analyze

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	L	-	-
CO2	M	-	-
CO3	L	M	-
CO4	M	-	S
CO5	M	S	S
CO6	S	S	S

S- Strong; M-Medium; L-Low

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	20	20	20
Understand	30	20	20
Apply	40	30	30
Analyze	10	30	30
Evaluate	0	0	0
Create	0	0	0

Syllabus

INTRODUCTION: Basics of networks and graphs, random network model - degree distribution, evolution, small world property, six degrees of separation, Watts-Strogatz model, local clustering coefficient, random networks and network science. **BARABÁSI-ALBERT MODEL:** Growth and preferential attachment, Barabási-Albert model, degree dynamics, degree distribution, diameter and the clustering coefficient, preferential attachment - absence of growth, measure, non-linearity, the origins. **SCALE-FREE PROPERTY:** Power laws and scale-free networks, Hubs, Universality, Ultra-small property, role of the degree exponent, Generating networks with a pre-defined degree distribution. **EVOLVING NETWORKS:** Bianconi-Barabási model, measuring fitness, Bose-Einstein condensation, evolving networks. **DEGREE CORRELATIONS:** Assortativity and disassortativity, Measuring degree correlations, Structural cutoffs, Degree correlations in real networks, Generating correlated networks, impact of degree correlations. **NETWORK ROBUSTNESS:** Percolation theory, robustness of scale-free networks, attack tolerance, cascading failures, modeling cascading failures, building robustness.

Reference Books

1. Ted G. Lewis, ¯Network Science: Theory and Practice‖, Wiley, 2013
2. Estrada, E., Fox, M., Higham, D.J. and Oppo, G.L., ¯Network Science - Complexity in Nature and Technology‖, Springer, 2010.
3. Laszlo Barabasi, Network Science, http://barabasilab.neu.edu/networksciencebook/downlPDF.html

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		Category	L	T	P	Credit
21DSPY0	**INFORMATION RETRIEVAL**	PE	3	0	0	3

Preamble

The aim of this course is to present the basic concepts in information retrieval and to enable students to understand how information retrieval principles are implemented in various digital information environments.

Prerequisite

21DS320 - Linear Algebra

21DS620 - Data Mining

Course Outcomes

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

CO1:	Explain the principles of Information Retrieval.	Understand
CO2:	Describe the pre-processing methods for Information Retrieval.	Understand
CO3:	Apply appropriate compression techniques for dictionary files, posting files, and text data.	Apply
CO4:	Examine the performance of IR system with various metrics like precision, recall and F-Measure.	Analyze
CO5:	Construct and parse XML documents for a given real time scenario.	Apply
CO6:	Identify near duplicate documents by generating finger prints using Shingling approach.	Analyze

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	L	-	-
CO2	L	-	-
CO3	L	M	-
CO4	M	M	S
CO5	M	S	S
CO6	S	S	S

S- Strong; M-Medium; L-Low

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	30	20	20
Understand	30	20	20
Apply	40	30	30
Analyze	0	30	30
Evaluate	0	0	0
Create	0	0	0

Syllabus

INTRODUCTION: Overview of IR Systems - Historical Perspectives - Goals of IR - The impact of the web on IR - The role of artificial intelligence (AI) in IR.**TEXT REPRESENTATION**: Statistical Characteristics of Text: Zipf's law; Porter stemmer; morphology; index term selection; using thesauri. **Basic Tokenizing, Indexing:** Simple tokenizing, stop-word removal, and stemming; inverted indices; Data Structure and File Organization for IR - efficient processing with sparse vectors.**RETRIEVAL MODELS:** Similarity Measures and Ranking - Boolean Matching – Extended Boolean models - Ranked retrieval - Vector Space Models -, text-similarity metrics - TF-IDF (term frequency/inverse document frequency) weighting - cosine similarity, Probabilistic Models, Evaluations on benchmark text collections.**QUERY PROCESSING**: **Query Operations and Languages**- Query expansion; Experimental Evaluation of IR: Performance metrics: recall, precision, and F-measure.**TEXT CATEGORIZATION AND CLUSTERING:** Categorization : Rocchio; Naive Bayes, kNN; Clustering: Agglomerative clustering; k- means; Expectation Maximization (EM); Dimension Reduction: LSI, PCA.**INFORMATION FILTERING TECHNIQUES:** Introduction to Information Filtering, Relevance Feedback - Applications of Information Filtering: **RECOMMENDER SYSTEMS**: Collaborative filtering and Content-Based recommendation of documents and products.**WEB SEARCH:** IR Systems and the WWW - Search Engines: Spidering, Meta Crawlers; Link analysis : Hubs and Authorities, Google PageRank, Duplicate Detection.**INFORMATION EXTRACTION AND INTEGRATION**: Extracting data from text; Basic Techniques: NE Recognition, Co- reference Resolution, Relation Extraction, Event Extraction; Extracting and Integrating specialized information on the web, Web Mining and Its Applications.

Reference Books

1. Christopher D. Manning, Prabhakar Raghavan and Hinrich Schütze, ¯Introduction to Information Retrieval‖, Cambridge University Press, 2012.
2. Ricardo Baeza-Yates and Berthier Ribeiro-Neto, ¯Modern Information Retrieval‖, Pearson Education, 2010.
3. Croft B., Metzler D., Strohman T., Information Retrieval in Practice, Pearson Education, 2010. (Digitized).

21DSPZ0	ETHICS FOR DATA SCIENCE	Category	L	T	P	Credit
		PE	3		0	3

Preamble

This course will enable students to

- recognize the ethical issues when applying data science to real world problems.
- learn about the ethical aspects of data science, including privacy, plagiarism, intellectual property rights, piracy, security and confidentiality

Prerequisite

- NIL

CourseOutcomes

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

CO1:	Identify potential harms of data collections, aggregation, and analysis typically found in applied data science contexts	Understand
CO2:	Write ethical assessments (e.g., a memorandum) of a data science analysis or an automated system incorporating data science.	Apply
CO3:	Articulate the reasoning behind the most important ethical challenges of data science as applied to course domains of privacy.	Apply
CO4:	Interpret professional code of ethics relevant to the data science profession.	Apply
CO5:	Explain how technical choices can have ethical implications (for better and worse), while at the same time understanding the wide societal impact of their work.	Understand

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	S	M	-
CO2	S	M	-
CO3	S	S	-
CO4	S	S	M
CO5	S	S	M
CO6	S	S	L

S-Strong;M-Medium;L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	10	20	20
Understand	30	30	30
Apply	60	50	50
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

Syllabus

Introduction to Data Science Ethics - The Rise of Data Science (Ethics)**,** Right and Wrong- Data Science Ethics Equilibrium- The FAT Flow Framework for Data Science Ethics. **Ethical Data Gathering-** Privacy as a Human Right- Privacy Mechanisms, Case study: Backdoors and Messaging Encryption-Dating, Happiness, and Ads, **Ethical Data Preprocessing** - Defining and Measuring Privacy, Re-identification - Defining and Selecting Variables Case study: Pregnancy and Face Recognition-Fair Relabeling**. Ethical Modelling: Privacy**-Preserving Data Mining, Discrimination-Aware Modelling Predicting Recidivism and Redlining, Comprehensible Models and Explainable AI, Including Ethical Preferences: Self-Driving Cars. **Ethical Evaluation:** Ethical Measurement, Ethical Interpretation of the Results, Ethical Reporting. **Ethical Deployment:** Access to the System, Different Treatments for Different Predictions. Censoring Search and Face Recognition

ReferenceBooks

1. Tales Rachel, DAVID MARTENS , "Data Science Ethics Concepts, Techniques and Cautionary", Oxford university press, 2021.
2. Mike Loukides, Hilary Mason and DJ Patil,"Ethics and Data Science",O'Reilly Media; 1st edition (25 July 2018)

Course Designers:

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2. <Dr. T. Chandrakumar> <tckcse@tce.edu>

		Category	L	T	P	Credit
21DS1A0	**DATA REPORTING**	EEC	1	0	0	1

Preamble

This course aims at providing introduction to data reporting tools and hands on training to report data in appropriate formats.

Prerequisite

- Nil

Course Outcomes

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

CO1: Explain the basics of data reporting and data integration — Understand

CO2: Use data reporting tools to generate reports with available data — Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	S	L	L
CO2	S	L	S

S-Strong;M-Medium;L-Low

Assessment Pattern

Bloom's Category	Terminal Examination
Remember	20
Understand	30
Apply	50
Analyse	0
Evaluate	0
Create	0

Syllabus

Basics of data reporting - Data integration from different sources - Generating reports / Dashboard - Measuring domain specific KPIs - Sample data and project work
Tools: Excel/ Tableau/ Power BI

Reference Books

Winston, W., "Microsoft Excel 2013 Data Analysis and Business Modeling: Data Analysis and Business Modeling", Pearson Education, 2014

1. Sleeper, R.,. "Practical tableau: 100 tips, tutorials, and strategies from a Tableau zen master. " O'Reilly Media, Inc.", 2018.

Course Designers:

1. <Ms. S. Suthaalakshmi> <sutha.lakkshmi@gmail.com>
2. <Dr. D.Anitha> anithad@tce.edu

		Category	L	T	P	Credit
21DS1B0	**TABLEAU IN DATA VISUALIZATION**	EEC	1	0	0	1

Preamble

This course aims at providing introduction to applications of tableau in data visualization and hands on training to visualize data in diverse formats using tableau.

Prerequisite

- Nil

Course Outcomes

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

CO1: Explain the basic visualization tools of Tableau — Understand

CO2: Use tableau to generate visualisation reports with available data — Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3
CO1	S	L	M
CO2	S	L	S

S-Strong;M-Medium;L-Low

Assessment Pattern

Bloom's Category	Terminal Examination
Remember	10
Understand	40
Apply	50
Analyse	0
Evaluate	0
Create	0

Syllabus

Basics of Business Intelligence-Introduction to Tableau - Connecting to Data Sources- Querying data from Data Sources- Data wrangling- Understanding the Workspace- Features (Attributes, Dimensions and Calculate fields)- Chart Features-Filters and Marks- Tableau Chart Demonstration Examples-Sample data and project work.

Reference Books

1. Marleen Meier, David Baldwin,"Mastering Tableau 2021: Implement advanced business intelligence techniques and analytics with Tableau",Packt Publishing,2021.
2. Knaflic, Cole Nussbaumer,"Storytelling with data a data visualization guide for business professionals",Wiley Publisher,2022.
3. Lindy Ryan,"Visual Data Storytelling with Tableau",Addison-Wesley Professional,2018.

Course Designers:

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2. <Mr.B.Ramprakash> <brhca@tce.edu>

21DSP10	PROJECT WORK- I	Category	L	T	P	Credit
		EEC	0		0	12

Preamble

The course is introduced to strengthen the student's career skill set in modeling the system by defining functions and architecture, choosing between alternative designs and conducting experiments or creating systems based on the chosen design. It enables the students to work in an industry/research environment and thereby developing the skills of teamwork and communication. This course gives an opportunity for the students to associate with potential employers and researchers.

Prerequisite

- Nil

Course Outcomes

On the successful completion of the Project work, students will be able to

CO1:	Model the system by defining function, concept and architecture for the chosen problem	Analyze
CO2:	Analyze alternatives in design leading to the final design considering the practical & regulation constraints and ethical values	Evaluate
CO3:	Use different experimental techniques, software/ computational/analytical tools in implementing the necessary solution to the problem	Create
CO4:	Draw logical conclusions from the results obtained after conducting experiments on existing/new data	Evaluate
CO5:	Work in a societal/research/industrial environment exhibiting teamwork and communication skills	Apply
CO6:	Write and present technical reports and research papers at national/international level	Create

MappingwithProgrammeOutcomes

COs	PO1	PO2	PO3
CO1	S	M	M
CO2	M	S	S
CO3	M	S	S
CO4	M	M	M
CO5	S	S	M
CO6	M	M	L

S-Strong;M-Medium;L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Reviews)			Terminal Examination
	1	2	3	(Viva voce)
Remember	0	0	0	0
Understand	0	0	0	0
Apply	50	20	0	10
Analyze	50	40	10	20
Evaluate	0	40	40	30
Create	0	0	50	40

21DSP20	PROJECT WORK- II	Category	L	T	P	Credit
		EEC	0		0	12

Preamble

The course is introduced to demonstrate the student's career skill set in modeling the system by defining functions and architecture, choosing between alternative designs and conducting experiments or creating systems based on the chosen design. It enables the students to work in an industry/research environment and thereby developing the skills of teamwork and communication.

Prerequisite

- Nil

Course Outcomes

On the successful completion of the Project work, students will be able to

CO1:	Model the system by defining function, concept and architecture for the chosen problem	Analyze
CO2:	Analyze alternatives in design leading to the final design considering the practical & regulation constraints and ethical values	Evaluate
CO3:	Use different experimental techniques, software/ computational/analytical tools in implementing the necessary solution to the problem	Create
CO4:	Draw logical conclusions from the results obtained after conducting experiments on existing/new data	Evaluate
CO5:	Work in a societal/research/industrial environment exhibiting teamwork and communication skills	Apply
CO6:	Write and present technical reports and research papers at national/international level	Create

MappingwithProgrammeOutcomes

COs	PO1	PO2	PO3
CO1	S	M	M
CO2	M	S	S
CO3	M	S	S
CO4	M	M	M
CO5	S	S	M
CO6	M	M	L

S-Strong;M-Medium;L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Reviews)			Terminal Examination
	1	2	3	(Viva voce)
Remember	0	0	0	0
Understand	0	0	0	0
Apply	50	20	0	10
Analyze	50	40	10	20
Evaluate	0	40	40	30
Create	0	0	50	40