Thiagarajar College of Engineering, Madurai-625015

M.E./M.Tech Programme Structure (CBCS)

Credit Distribution:

S.No	Category		Credits
A.	**Foundation Course**		**3 - 6**
B.	**Porgrmme Core Courses***		**19 – 25**
C.	**Elective Courses**		**17 – 23**
	a.	Programme Elective	15 – 21
	b.	Open Elective	2 – 6
D.	**Common Core Course**		**2**
E.	**Mini Project and Dissertation**		**27**
E	Value Added Courses (Not to be included in CGPA) - Mandatory		**4**
	Minimum Credits to be earned for the award of the degree		**68** (from A to E) and 4 (from F)

*TCP and Laboratory courses are Mandatory in the Programme Core Courses.

Credit Details:

Theory: 3 Credits
Theory Cum Practical (TCP): 3 Credits,
Lab: 2 Credits
Open Elective: 2 Credits
Mini Project: 2 Credits
Dissertation Phase I: 10 Credits
Dissertation Phase I: 15 Credits
Common Core: Research Methodology and IPR: 2 Credits

Thiagarajar College of Engineering, Madurai-625015

Department of Computer science and Engineering

Scheduling of Courses for M.E. (CSE) Programme – 2021 – 2022

Semester	Theory					Theory cum Practical	Practical	Project	Credits
	1	2	3	4	5	6	7	8	
I	18CG110 Performance Modelling 3:0	18CG121 Modern Operating Systems 3:0	18CG131 Cryptography: Theory and Practice 3:0	18CGPA1 Parallel Computing Systems 3:0	18CGPB1 Operations Research 3:0	18CG161 Agile Software Development 3:0	18CG171 Systems Programming Lab 0:2	-	20
II	18CG210 Randomized Algorithms 3:0	18CG PX0 Elective 3 3:0	18CGPX0 Elective 4 3:0	-	18PG250 Research Methodology and IPR 2:0	18CG260 Intelligent Systems: Theory and Practice 3:0	18CG270 Design and Analysis of Algorithms Lab 0:2	18CG280 Mini Project with Seminar 0:2	18
III	18CG PX0 Elective 5 3:0	-	-	-	18PGPX0 Open Elective 2:0	-	-	18CG380 Dissertation Phase I 0:10	15
IV	-	-	-	-	-	-	-	18CG480 Dissertation Phase II 0:15	15

Passed in Board of Studies Meeting on 16.11.2019 Approved in 59th Academic Council Meeting on 07.12.2019

M.E. (CSE) Categorization of Courses (CBCS)

A. Foundation Courses: (3 – 6)

- 18CG110 – Performance Modelling (3 Credits)

B. Programme Core Courses: (19 – 25)

Theory:

- 18CG121 – Modern Operating Systems (3 Credits)
- 18CG131 – Cryptography Theory and Practice (3 Credits)
- 18CG210 – Randomized Algorithms (3 Credits)

Theory cum Practical:

- 18CG161 – Agile Software Development (3 Credits)
- 18CG260 – Intelligent Systems: Theory and Practice (3 Credits)

Practical:

- 18CG171 – Systems Programming Lab (2 Credits)
- 18CG270 – Design and Analysis of Algorithms Lab (2 Credits)

C. Elective Courses: (17 – 23)

i. Programme Electives: (15 – 21)

- 18CGPA1 – Parallel Computing Systems (3 Credits)
- 18CGPB1 – Operations Research (3 Credits)
- 18CGPC0 - Machine Learning (3 Credits)
- 18CGPD0 - Protocol Design and Verification (3 Credits)
- 18CGPE0 - Information Storage and Management Systems (3 Credits)
- 18CGPF0 - Design and Analysis of Parallel Algorithms (3 Credits)
- 18CGPG0 - Formal Verification and Model Checking (3 Credits)
- 18CGPH0 - Computer Security and Forensics (3 Credits)
- 18CGPJ0 - Natural Language Processing (3 Credits)
- 18CGPK0 - Network Performance and Vulnerability Analysis (3 Credits)
- 18CGPL0 - Cloud Computing Systems and Services (3 Credits)

- 18CGPM0 - Data Sciences and Analytics (3 Credits)
- 18CGPN0 - Product and Service - Strategy and Development (3 Credits)
- 18CGPP0 - Computational Geometry (3 Credits)
- 18CGPQ0 - Fault Tolerant Computing Systems (3 Credits)
- 18CGPR0 - Storage and Server Security (3 Credits)
- 18CGPS0 - Probabilistic Graphical Modelling (3 Credits)
- 18CGPT0 - Real Time Systems (3 Credits)
- 18CGPU1 - Software Defined Networking (3 Credits)
- 18CGPV0 - Data Centre Design and Management (3 Credits)
- 18CGPW0 - Data Visualization (3 Credits)
- 18CGPY0 - Software Product Development for Mobile Devices (3 Credits)

ii. Open Electives: (2 – 6)

- 18CGGA0 – Evolutionary Algorithms (2 Credits)

D. Common Core Course: (2)

- 18PG250 – Research Methodology and IPR (2 Credits)

E. Mini Project and Dissertation: (27)

- Mini Project with Seminar (2 Credits)
- Dissertation Phase – I (10 Credits)
- Dissertation Phase – II (15 Credits)

F. Value Added Courses (Not to be included in CGPA) - Mandatory (4)

Total – 68 credits (from A to E) and 4 (from F)

CURRICULUM AND DETAILED SYLLABI

FOR

M.E DEGREE (Computer Science and Engineering) PROGRAMME

FIRST SEMESTER

FOR THE STUDENTS ADMITTED FROM THE

ACADEMIC YEAR 2021 - 2022 ONWARDS

THIAGARAJAR COLLEGE OF ENGINEERING

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

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THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015
M.E Degree (Computer Science and Engineering) Program
COURSES OF STUDY
(For the candidates admitted from the academic year 2021 - 2022)

I SEMESTER

Course Code	Name of the Course	Category	No. of Hours / Week			Credits
			L	T	P	
THEORY						
18CG110	Performance Modelling	FC	3	-	-	3
18CG121	Modern Operating Systems	PC	3	-	-	3
18CG131	Cryptography: Theory and Practice	PC	3	-	-	3
18CGPX0	Program Elective - I	PE	3	-	-	3
18CGPX0	Program Elective - II	PE	3	-	-	3
THEORY CUM PRACTICAL						
18CG161	Agile Software Development	PC	2	-	2	3
PRACTICAL						
18CG171	Systems Programming Lab	PC	-	-	4	2
Total			**17**	**-**	**6**	**20**

FC : Foundation Core
PC : Programme Core
PE : Programme Elective

Note:

1 Hour Lecture/Tutorial is equivalent to 1 credit
2 Hours Practical is equivalent to 1 credit

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015
M.E Degree (Computer Science and Engineering) Program
SCHEME OF EXAMINATIONS
(For the candidates admitted from 2021 - 2022 onwards)

I SEMESTER

S.No.	Course Code	Name of the Course	Duration of Terminal Exam. in Hrs.	Marks			Minimum Marks for Pass	
				Continuous Assessment *	Terminal Exam **	Max. Marks	Terminal Exam	Total
THEORY								
1	18CG110	Performance Modelling	3	50	50	100	25	50
2	18CG121	Modern Operating Systems	3	50	50	100	25	50
3	18CG131	Cryptography: Theory and Practice	3	50	50	100	25	50
4	18CGPX0	Program Elective - I	3	50	50	100	25	50
5	18CGPX0	Program Elective - II	3	50	50	100	25	50
THEORY CUM PRACTICAL								
6	18CG161	Agile Software Development	3	50	50	100	25	50
PRACTICAL								
7	18CG171	Systems Programming Lab	3	50	50	100	25	50

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

		Category	L	T	P	Credit
18CG110	**PERFORMANCE MODELING**	FC	3	0	0	3

Preamble

This course introduces students to the basic concepts of modelling and performance evaluation of computer systems. On completion of this course students will be able to:

i) Model a computer system or a component using mathematical modelling techniques like Markov Chains, Queuing Theory and Networks of Queues and discrete event simulation.

ii) Design experiments, characterize workloads, measure performance metrics, analyze and present the results of the performance evaluation of a computer system.

Prerequisites

Probability and Statistics

Course Outcomes

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

Course Outcomes	Bloom's Level
Formulate performance models for a given computer and a communication system by applying modeling techniques like Markov Chains, Queuing theory and Queue networks. **(CO1)**	Analyze
Analyze the performance of a queuing system by suitably using queuing theory. **(CO2)**	Analyze
Model, characterize and reproduce workloads to a computer system. **(CO3)**	
Design experiments to measure the performance of a computer system with an understanding of the appropriate performance metrics to be used. **(CO4)**	Analyze
Analyze, present and interpret the experimental results to evaluate alternative system implementations. **(CO5)**	Analyze
Construct capacity planning and other system upgrade estimates by instrumenting the system, monitoring its usage, characterizing workloads, predicting the performance and selecting the cost-efficient highest performance alternative. **(CO6)**	Analyze

Mapping with Programme Outcomes

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

CO6	S	S	M	M	L						

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Assignment		Terminal Examination
	Test 1	Test 2	1	2	
Remember	20	20	-	-	10
Understand	20	20	-	-	20
Apply	40	30	100	100	40
Analyze	20	30	-	-	30
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Course Level Assessment Questions

Course Outcome (CO1):

1. Consider a computer system with one CPU and 2 devices. A process runs on the CPU for one time unit and then requests one of the two I/O devices with probability of 0.25 and 0.35 respectively. When the process finishes execution in the current time unit on the CPU, another waiting process is run on the CPU. Each process spends an average of 10 time units being serviced by device 1 and an average of 5 time units being serviced by device 2. Model the system as a Discrete-time Markov Chain. What is the average utilization of each disk, under steady-state conditions?

2. You have been asked to stand in front of a popular college and count the arriving cars that drop the college students. After measuring for over a week, you find that the average number of cars arriving per hour equals the variance of the number of cars per hour. What random variable distribution will accurately model the number of cars arriving per hour?

3. Consider the slotted Aloha MAC protocol used for a channel shared by N nodes. Let λ denote the Poisson packet arrival rate per slot, to a node's transmitter queue. Let Pb denote the retranmission probability of a backlogged node in a given slot. Assume that each node's transmit buffer can hold at most three packets, including the one for which transmission is being attempted. Use a Markov model to represent the node's behavior. Using this model, explain how we can determine the system throughput and average packet delay

Course Outcome (CO2):

1. Show the Markov Chain model for an M/M/1 queue with an arrival rate of λ, service rate of μ. Assume that λ < μ. Derive the expression for Var[n].

2. Consider a single-server queuing system with discouraged arrival rates: the Poisson arrival rate when there are n customers in the system is λ/(n + 1). Let the service time be exponential with parameter μ. Derive the expression for E[n], i.e. average number of customers in the system, and E[r]. Is the system always stable? If E[n] = 2 and μ = 1, what is the value of λ?

3. Consider a cluster computer which can hold at most B batch jobs in memory. The job execution time is exponentially distributed with an average of 8 milliseconds. If the number of arrivals is 90 jobs/second (with Poisson distribution) and the blocking probability should be less than 0.001, what should be the minimum value of B? For a general M/M/1/B queue with arrival rate of λ and service rate of μ, derive E[r] for $\lambda \rightarrow \infty$

4. Consider a system with three M/M/1 queues in tandem defined by the parameters: λ = 2; μ1 = 3; μ2 = 4; μ3 = 6. Determine: (i) the probability that the system is idle; and (ii) the average total delay between entering and departing the system.

5. For an M/G/1 system with Poisson arrival parameter of λ, average service time of E[s], determine the probability that the server is idle using the residual time analysis.

Course Outcome (CO3):

1. Implement the Sieve workload in a language of your choice, run it on systems available to you, and report the results.

2. Select an area of computer systems (for example, processor design, networks, operating systems, or databases), review articles on performance evaluation in that area, and make a list of benchmarks used in those articles.

3. Decide the metric and workload you would choose to compare the following:

a. Two systems for very different applications: IBM PC versus Macintosh
b. Two systems with identical functionality: IBM PC versus PCjr
c. Two versions of the same operating systems: MS-DOS V1 versus MSDOS V2
d. Two hardware components: two floppy drives
e. Two languages: C versus Pascal

4. The CPU time and disk I/O of seven programs are shown in the following Table. Determine the equation for principal factors.

Program Name	Function	CPU Time	I/O's
TKB	Linker	14	2735
MAC	Assembler	13	253
COBOL	Compiler	8	27
BASIC	Compiler	6	27
Pascal	Compiler	6	12
EDT	Text editor	4	91
SOS	Text editor	1	33

Course Outcome (CO4):

1. Prove that for a 2^2 factorial design: SST = SSA + SSB + SSAB.

2. Consider the results of a performance study where network throughput (MB) is measured by varying Buffer Size (KB), Packet Size (Bytes) and Scheduling Algorithm (FCFS, WFQ).

- 4KB Buffer, Packet size 1024, FCFS: 11
- 4KB Buffer, Packet size 4096, FCFS: 18
- 8KB Buffer, Packet size 1024, FCFS: 23
- 8KB Buffer, Packet size 4096, FCFS: 38
- 4KB Buffer, Packet size 1024, WFQ: 17
- 4KB Buffer, Packet size 4096, WFQ: 22
- 8KB Buffer, Packet size 1024, WFQ: 29
- 8KB Buffer, Packet size 4096, WFQ: 45

Determine the proportion of variation that can be explained by the different effects.

3. The performance of a system being designed depends upon the following three factors:

a. CPU type: 68000, 8086, 80286
b. Operating system type: CPM, MS-DOS, UNIX
c. Disk drive type: *A*, *B*, *C*

How many experiments are required to analyze the performance if

a. There is significant interaction among factors.
b. There is no interaction among factors.
c. The interactions are small compared to the main effects.

4. Analyze the 2^3 design shown in the following table

a. Quantify main effects and all interactions.
b. Quantify percentages of variation explained.
c. Sort the variables in the order of decreasing importance.

	A_1		A^2	
	C_1	C_2	C_1	C_2
B_1	100	15	120	10
B_2	40	30	20	50

5. The following Table lists measured CPU times for two processors on two workloads. Each experiment was repeated three times. Analyze the design.

Workload	Processor A	Processor B
I	(41.16, 39.02, 42.56)	(63.17, 59.25, 64.23)
J	(51.50, 52.50, 50.50)	(48.08, 48.98, 47.10)

Course Outcome (CO5):

1. Consider two systems, A and B, for which the mean time to failures is measured over several failures. For System A, 972 failures were recorded with mean time between failures being 124.10 and the standard deviation being 198.20; For System B, 153 failures were recorded with mean time between failures being 141.47 and the standard deviation being

226.11. Which system is better (with 95% confidence) using the t-test? Present all details that support your answer.

2. Two algorithms are run on the same set of 10 data files and the respective mean runtimes are 10.34 and 23.90 milliseconds (with corresponding standard deviation of 5.6 and 2.8 milliseconds). If we would like to state that the first algorithm is better than the second with 95% confidence, how many data files should be compared?

3. For a computer system of your choice, list a number of HB and LB metrics and draw a typical Kiviat graph using data values of your choice.

4. A system consists of three resources, called A, B, and C. The measured utilizations are shown in the following Table. A zero in a column indicates that the resource is not utilized. Draw a Gantt chart showing utilization profiles.

A	B	C	Time Used(%)
0	0	0	25
0	0	1	10
0	1	0	20
0	1	1	5
1	0	0	5
1	0	1	15
1	1	0	5
1	1	1	15
			100

Course Outcome (CO6):

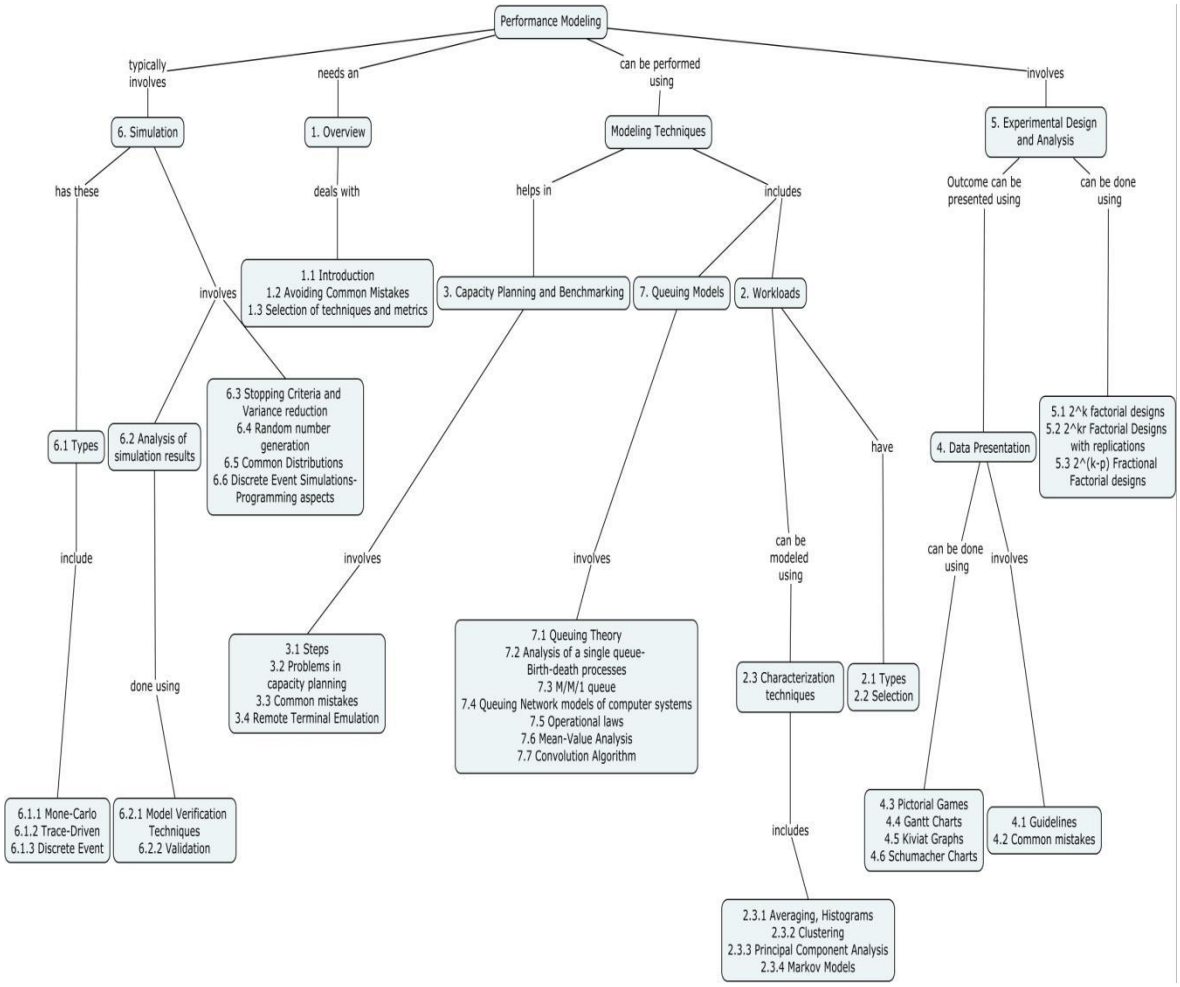
1. Select an area or application of computer systems, for example, Image processing, Mail, Networking and Medical diagnosis. List the characteristics of workloads that a load driver for that area should implement. Discuss how you would specify the required characteristics to the load driver and whether there are any difficulties in implementing it in a representative manner.

2. Review a few articles or reports presenting results of performance measurements. Check if any of the common mistakes listed in this course were made in the study.

3. Illustrate with suitable examples, some of the ways that the results of a benchmarking study may be misleading or biased.

4. Illustrate the steps involved in capacity planning and management of computer and communication systems. Also outline the typical problems encountered by the capacity planners.

Concept Map



Syllabus

Overview of Performance Modeling: introduction, Avoiding common mistakes, Selection of techniques and metrics **Workloads:** Types, Selection, Characterization techniques-Averaging, Histograms, Clustering, Principal Component Analysis, Markov Models. **Capacity Planning and Benchmarking:** Steps, Problems in capacity planning, Common mistakes, Remote Terminal Emulation. **Data Presentation:** Guidelines, Common mistakes, Pictorial Games, Gantt Charts, Kiviat Graphs-Shapes & Applications, Schumacher Charts. **Experimental Design and Analysis**: 2^k factorial designs, $2^k r$ Factorial Designs with replications, 2^{k-p} Fractional Factorial designs **Simulation**: Types (Monte-Carlo, Trace-Driven, Discrete Event), Analysis of simulation results – Model Verification Techniques, Validation, Stopping Criteria and Variance reduction, Random number generation, Common distributions–review, Discrete Event Simulations-Programming aspects. **Queuing Models**: Queuing Theory, Analysis of a single queue- Birth-death processes, M/M/1 queue, Queuing Network models of computer systems, Operational laws, Mean-Value Analysis, Convolution Algorithm.

Text Books

1. Mor Harchol-Balter, Performance Modeling and Design of Computer Systems: Queueing Theory in Action, Cambridge University Press, 2013
2. Raj Jain, "The Art of Computer Systems Performance Analysis: Techniques for Experimental Design, Measurement, Simulation, and Modeling", Wiley-Interscience, 1991.

Reference Books

1. K.S. Trivedi, "Probability and Statistics with Reliability, Queuing and Computer Science Applications", John Wiley and Sons, 2001.
2. Lieven Eeckhout, “Computer Architecture Performance Evaluation Methods”, Morgan and Claypool Publishers, 2010.
3. Paul J. Fortier and Howard E. Michel, “Computer Systems Performance Evaluation and Prediction”, Elsevier, 2003.
4. David J. Lilja, “Measuring Computer Performance: A Practitioner’s Guide”, Cambridge University Press, 2000.
5. Krishna Kant, “Introduction to Computer System Performance Evaluation”, McGraw-Hill, 1992

Course Contents and Lecture Schedule

Module no.	Topic	No. of lectures
1.	**Overview of Performance Modeling**	
1.1	Introduction	2
1.2	Avoiding common mistakes	
1.3	Selection of techniques and metrics	1
2.	**Workloads**	
2.1	Types	1
2.2	Selection	
2.3	Characterization techniques	5
2.3.1	Averaging, Histograms	
2.3.2	Clustering	
2.3.3	Principal Component Analysis	
2.3.4	Markov Models	
3	**Capacity Planning and Benchmarking**	
3.1	Steps	1
3.2	Problems in capacity planning	

3.3	Common mistakes	
3.4	Remote Terminal Emulation	1
4.	**Data Presentation**	
4.1	Guidelines	2
4.2	Common mistakes	
4.3	Pictorial Games	
4.4	Gantt Charts	
4.5	Kiviat Graphs-Shapes & Applications	
4.6	Schumacher Charts	
5.	**Experimental Design and Analysis**	
5.1	2^k factorial designs	2
5.2	2^kr Factorial Designs with replications	2
5.3	2^{k-p} Fractional Factorial designs	2
6.	**Simulation**	
6.1	Types	2
6.1.1	Monte-Carlo	
6.1.2	Trace-Driven	
6.1.3	Discrete Event	
6.2	Analysis of simulation results	2
6.2.1	Model Verification Techniques	
6.2.2	Validation	
6.3	Stopping Criteria and Variance reduction	1
6.4	Random number generation	1
6.5	Common Distributions-review	1
6.6	Discrete Event Simulations-Programming aspects	1
7.	**Queuing Models**	
7.1	Queuing Theory	1

7.2	Analysis of a single queue-Birth-death processes	
7.3	M/M/1 queue	2
7.4	Queuing Network models of computer systems	1
7.5	Operational laws	2
7.6	Mean-Value Analysis	1
7.7	Convolution Algorithm	2
	Total	**36**

Course Designers:

1. Dr. Karthick Seshadri skcse@tce.edu

18CG121 MODERN OPERATING SYSTEMS

Category	L	T	P	Credit
PC	3	0	0	3

Preamble

The student will be able to understand the concepts of operating system to distributed environment like cloud computing, mobile computing etc. This course also includes set of case studies that provides insight into some existing distributed operating systems.

Prerequisite

Operating Systems Concepts

Course Outcomes

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

Course Outcomes	Bloom's Level
Apply the concepts of operating system to a distributed environment and identify the design issues specific to distributed systems. (CO1)	Apply
Develop the suitable methods for prevention, avoidance and recovery from deadlock in a distributed environment .(CO2)	Apply
Apply suitable consistency model and replacement strategy for the given distributed shared memory environment. (CO3)	Apply
Select the appropriate file replication and file access model for the distributed file system. (CO4)	Apply
Choose the suitable features of mobile operating system to build a mobile application for the given specification. (CO5)	Apply
Identify suitable cloud service model to meet out the requirements of the organization. (CO6)	Apply

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessments Test		Assignment		Terminal Examination
	1	2	1	2	
Remember	30	20	-	-	20
Understand	40	30	20	20	40
Apply	30	50	80	80	40
Analyze	-	-	-	-	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Define Network OS and Distributed OS.
2. Name the three important features used to differentiate the distributed OS and Network OS.
3. Discuss about the advantages and disadvantages of commonly used models in configuring Distributed Operating Systems.
4. Identify the design issues specific to distributed operating systems.

Course Outcome 2 (CO2):

1. Illustrate the method of event ordering in Distributed Systems.
2. Model a distributed deadlock using graphical method.
3. Demonstrate the Distributed deadlock detection algorithms.
4. Construct a resource allocation graph for the given scenario.
5. Illustrate the purpose of election algorithm in distributed systems.

Course Outcome 3 (CO3)

1. Demonstrate the structure of the shared memory space.
2. Discuss in detail about different consistency models.
3. Illustrate the different replacement strategies used in DSM.

Course Outcome 4 (CO4)

1. Illustrate the principles of Distributed File Systems with SUN NFS.
2. Discuss about the Distributed File System Models.
3. Discuss in detail about atomic transactions in DSM.

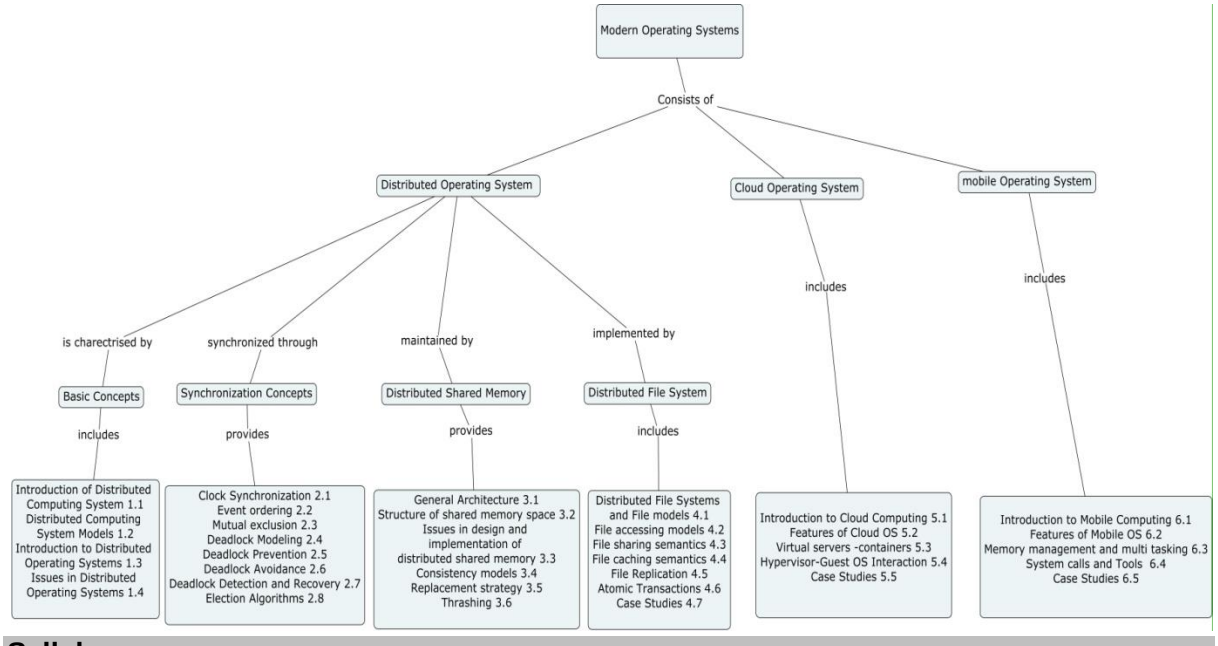
Course Outcome 5 (CO5)

1. Explain the constraints and requirements for operating systems to be used in mobile devices.
2. Summarize the benefits of android operating systems.
3. Compare the features in Android and Symbian OS and justify the suitability of it in handheld devices.
4. Illustrate how mobile OS support internal system call between inter process communication

Course Outcome 6 (CO6)

1. Illustrate the features of any one cloud operating system.
2. Describe the different service models of cloud computing system.
3. Set up a cloud model using the virtualization concepts of cloud OS.
4. Illustrate how Dockers are implemented in containers
5. Explain how a guest or a virtual OS interact with the load sharing hypervisor effectively

Concept Map



Syllabus

Distributed Systems – Introduction of Distributed Computing System – Distributed Computing System Models – Distributed Operating Systems – Issues In Distributed Operating Systems. **Synchronization** – Clock Synchronization – Event Ordering – Mutual Exclusion – Deadlock Modelling – Deadlock Prevention – Deadlock Avoidance – Deadlock Detection and Recovery - Election Algorithms **Distributed Shared Memory** – General Architecture – Structure of Shared Memory Space – Issues in design and implementation of Distributed Shared Memory - Consistency Models – Replacement Strategy – Thrashing. **Distributed File Systems -** Distributed File Systems **–** File Models – File Accessing Models – File Sharing

Semantics – File Caching Semantics – File Replication – Atomic Transactions – Case Studies - Hadoop Distributed File System (HDFS) - **Cloud OS** - Introduction to Cloud Computing, Features of Cloud OS, Virtual server ,Containers ,Infrastructure and connectivity, Hypervisor-Guest OS Interaction, Case Studies ,**Mobile OS** - Introduction to Mobile Computing, Features of Mobile OS, Memory Management ,Multitasking, System calls and tools, Conventional OS and Mobile OS, Case Studies.

Text Book

1. Distributed Operating Systems Concepts and Design, Pradeep K. Sinha, Prentice Hall of India Private Limited, 2008.

Reference Books

1. Advanced Concepts in Operating Systems, M. Singhal, N. Shivaratri, Tata McGraw-Hill, 2008.
2. Distributed Systems Principles and Paradigms, Andrew S. Tanenbaum, Maarten Van Steen , Pearson Education, 2007.
3. The Practice of Cloud System Administration: Designing and Operating Large Distributed Systems, Thomas A. Limoncelli Strata R. Chalup , Christina J. Hogan , Addison-Wesley Professional; 1st Edition ,2014.
4. Cloud Computing: Concepts, Technology & Architecture, Thomas Erl , Ricardo Puttini , Zaigham Mahmood , Prentice Hall; 1st Edition, 2013.
5. Mobile Operating System: Blokdyk,G.,CreateSpace Independent Publishing Platform, Third Edition, 2017

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1	**Distributed Operating System (5)**	
1.1	Introduction of Distributed Computing System	2
1.2	Distributed Computing System Models	1
1.3	Introduction to Distributed Operating Systems	1
1.4	Issues in Distributed Operating Systems	1
2	**Synchronization (8)**	
2.1	Clock Synchronization	1
2.2	Event ordering	1
2.3	Mutual exclusion	1
2.4	Deadlock Modeling	1
2.5	Deadlock Prevention	1
2.6	Deadlock Avoidance	1
2.7	Deadlock Detection and Recovery	1
2.8	Election Algorithms	1
3	**Distributed Shared Memory (5)**	

Module No.	Topic	No. of Lectures
3.1	General Architecture	1
3.2	Structure of shared memory space	1
3.3	Issues in design and implementation of distributed shared memory	
3.4	Consistency models	2
3.5	Replacement strategy	1
3.6	Thrashing	
4	**Distributed File Systems (8)**	
4.1	Distributed File Systems and File models	1
4.2	File accessing models	1
4.3	File sharing semantics	1
4.4	File caching semantics	1
4.5	File Replication	1
4.6	Atomic Transactions	2
4.7	Case Studies - Hadoop Distributed File System (HDFS)	1
5	**Cloud Operating Systems (5)**	
5.1	Introduction to Cloud Computing	1
5.2	Features of Cloud OS	1
5.3	Virtual servers -containers	1
5.4	Hypervisor-Guest OS Interaction	1
5.5	Case Studies	1
6	**Mobile Operating Systems (5)**	
6.1	Introduction to Mobile Computing	1
6.2	Features of Mobile OS	1
6.3	Memory management and multi tasking	1
6.4	System calls and Tools	1
6.5	Case Studies	1
	Total	**36**

Course Designers:

1. Dr. G.Madhupriya gmadhupriya@tce.edu
2. Dr. B.Subbulakshmi bscse@tce.edu
3. Dr.K.NarasimhaMallikarjunan arjunkambaraj@tce.edu

		Category	L	T	P	Credit
18CG131	**CRYPTOGRAPHY: THEORY AND PRACTICE**	PC	3	0	0	3

Preamble

Cryptography is the science of information and communication security. This course will discuss common security weaknesses, vulnerabilities, attack methods and mitigation approaches. The course deals with the construction and cryptanalysis of block ciphers, stream ciphers and hash functions.

Prerequisite

Basics of Number Theory and Algorithms

Course Outcomes

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

Demonstrate the fundamental theory and mathematical foundations of cryptography(CO1)	Apply
Encrypt and Decrypt messages using Symmetric cipher techniques like Advanced Encryption Standard, RC4 to ensure confidentiality of data (CO2)	Apply
Apply Asymmetric cipher techniques like RSA, ECC to ensure confidentiality and non-repudiation of data (CO3)	Apply
Apply algorithms like Hash, MAC to ensure integrity of data. (CO4)	Apply
Select and apply appropriate attacks like chosen Plain text attack, Birthday attack, Differential anlaysis, etc. to cryptanalyse the cryptographic techniques (CO5)	Analyse
Relate the recent trends in cryptography with legacy methods (CO6)	Apply

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Assignment		Terminal Examination
	CAT1	CAT2	1	2	
Remember	-	-	-	-	-
Understand	20	20	-	-	20
Apply	60	40	100	100	40
Analyse	20	40	-	-	40
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Compare and contrast attack and a threat.
2. Explain Shannon's theory.
3. Find the elements of GF(2^3)

Course Outcome 2 (CO2):

1. Eve captures Bob's Hill cipher machine, which uses a 2-by-2 matrix M mod 26. She tries a chosen plaintext attack. She finds that the plaintext ba encrypts to HC and the plaintext zz encrypts to GT. What is the matrix M?
2. Double DES is not used in practice. State reason
3. Illustrate the usage of DHKX algorithm to share secret key for secure symmetric encryption.

Course Outcome 3 (CO3):

1. Generate the key pairs of Alice and Bob in RSA cryptosystem. Using the respective keys show how Alice encrypts the Plaintext 'HELLO' and sends to Bob.
2. Show how ECC is used to securely share secret key between two users.
3. Describe the Kerberos protocol and demonstrate how session keys are managed.

Course Outcome 4 (CO4):

1. Apply MD5 algorithm to generate digest for the message PAYRANSOM.
2. Compare and contrast Hash and MAC authentication schemes

3. Illustrate HMAC procedure.

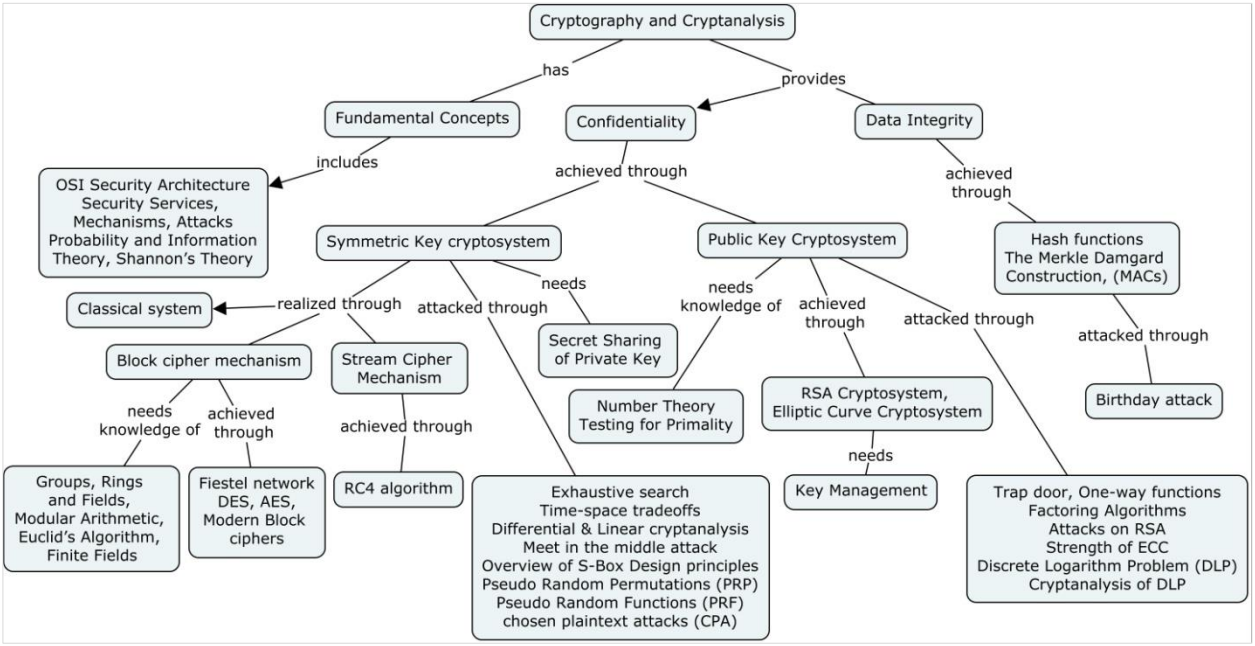
Course Outcome 5 (CO5):

1. Suppose that someone suggests the following way to confirm that the two of you are both in possession of the same secret key. You create a random bit string the length of the key, XOR it with the key and send the result over the channel. Your partner XORs the incoming block with his key and sends it back. You check and if what you receive is your original random string, you have verified that your partner has the same secret key, yet neither of you has ever transmitted the key. Is there a flaw in this scheme? If so, what can be done to overcome this flaw?
2. Explain Meet in the middle attack.
3. Define Discrete Logarithm problem.

Course Outcome 6 (CO6):

1. Define Homomorphic encryption.
2. Compare and contrast Identity based encryption scheme with RSA encryption procedure.
3. List some of the modern encryption methods which are used for public key encryption.

Concept Map



Syllabus

Fundamental Concepts: OSI Security architecture - Security Services, Mechanisms and attacks - Security Services, Mechanisms and attacks - Shannon's Theory.
Symmetric Key Ciphers: Introduction to Classical Cryptosystems - Groups, Rings and Fields, Modular Arithmetic, Euclid's Algorithm, Finite Fields - Feistel networks - Data Encryption Standard (DES), Advanced Encryption Standard (AES), Modern Block ciphers - Modes of operation of Block Ciphers - Pseudo random number generators - RC4 Stream Cipher **Cryptanalysis of Symmetric Key Ciphers:** Exhaustive search, time-space tradeoffs,

linear cryptanalysis, differential cryptanalysis, meet in the middle attack, Overview of S-Box Design principles, Pseudo Random Permutations (PRP) - Pseudo Random Functions (PRF) - security against chosen plaintext attacks (CPA).

Asymmetric Key Ciphers: Number Theory - Primality Testing - The RSA Cryptosystem – Elliptic curve arithmetic, Elliptic Curve Cryptosystem

Cryptanalysis of Asymmetric Key Ciphers: Trap door, One-way functions - Factoring Algorithms - Attacks on RSA - The Discrete Logarithm Problem (DLP).

Key Management: Types of keys – Key Predistribution – Diffie-Hellman Key Exchange - Needham Schroeder Scheme - Multiparty secure communication.

Hash Functions and MACs: Hash functions - The Merkle Damgard Construction, Message Authentication Codes (MACs) - Digital Signature schemes - Birthday Attack.

Recent trends in cryptography: Identity Based Encryption - Homomorphic Encryption – Obfuscation - Provable security.

Reference Books

1. Douglas Stinson, "Cryptography Theory and Practice", 2nd Edition, Chapman & Hall/CRC, 2003.
2. W. Stallings, "Cryptography and Network Security", 5th Edition, Pearson Education
3. B. A. Forouzan, "Cryptography & Network Security", Tata Mc Graw Hill, 2007.
4. J. Katz and Y. Lindell, “Introduction to Modern Cryptography”, Chapman & Hall/CRC, 2007

Course Contents and Lecture Schedule

Module No.	Topic	No of Lectures
1	**Fundamental Concepts (2)**	
1.1	OSI Security architecture	1
1.2	Security Services, Mechanisms and attacks	
1.3	Shannon’s Theory	1
2	**Symmetric Key Ciphers (11)**	
2.1	Introduction to Classical Cryptosystems	2
2.2	Groups, Rings and Fields, Modular Arithmetic, Euclid’s Algorithm, Finite Fields	2
2.3	Feistel networks - Data Encryption Standard (DES)	2
2.4	Advanced Encryption Standard (AES)	2
2.6	Modern Block ciphers – Modes of operation of Block Ciphers	1
2.7	Pseudo random number generators	1
2.8	RC4 Stream Cipher	1
3	**Cryptanalysis of Symmetric Key Ciphers (5)**	
3.1	Exhaustive search	1
3.2	Time-space tradeoffs	
3.3	Linear cryptanalysis	1
3.4	Differential Cryptanalysis	
3.5	Meet in the middle attack	1
3.6	Overview of S-Box Design principles	
3.7	Pseudo Random Permutations (PRP) – Pseudo Random Functions (PRF)	1

3.8	Security against chosen plaintext attacks (CPA)	1
4	**Asymmetric Key Ciphers (4)**	
4.1	Number Theory	1
4.2	Primality Testing	
4.3	The RSA Cryptosystem	1
4.4	Elliptic curve Arithmetic	1
4.5	Elliptic curve Cryptosystem	1
5	**Cryptanalysis of Asymmetric Key Ciphers (3)**	
5.1	Trap door, One-way functions	1
5.2	Factoring Algorithms	
5.3	Attacks on RSA Cryptosystem	1
5.4	The Discrete Logarithm Problem (DLP)	1
6	**Key Management (4)**	
6.1	Types of keys – purpose	1
6.2	Key predistribution	
6.3	Diffie Hellman Key Exchange algorithm	1
6.4	Needham Schroeder Scheme	1
6.5	Multiparty secure communication	1
7	**Hash Functions and MACs (5)**	
7.1	Hash functions	1
7.2	The Merkle Damgard Construction	2
7.3	Message Authentication Codes (MACs)	1
7.4	Birthday Attack	1
8	**Recent trends in cryptography (2)**	
8.1	Identity Based Encryption, Homomorphic Encryption	1
8.2	Obfuscation	1
8.3	Provable security	
	Total	**36**

Course Designers:

1. Dr. M. Suguna mscse@tce.edu

18CG161	AGILE SOFTWARE DEVELOPMENT

Category	L	T	P	Credit
PC	2	0	2	3

Preamble

To impart a thorough understanding of the principles and practices used in agile software development. This course focuses on providing hands-on experience in designing and developing software systems using agile methodologies. Besides theory sessions, practical sessions are included as part of the study. Consequently students undertake a project, working through a number of stages of the development of medium size software.

Course Outcomes

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

Course Outcomes	Bloom's Level
Analyse various agile software development methods, practices, and their appropriate application (CO1)	Apply
Write user stories for given software specification (CO2)	Apply
Plan iterations based on relative effort and business value (CO3)	Apply
Create backlogs and burn-down charts to monitor progress of a project (CO4)	Apply
Increase quality with test-driven development (CO5)	Apply
Design an interface by applying usability guidelines and standards for given system development problems (CO6)	Apply

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Assignment		Terminal Examination
	1	2	1	2	
Remember	20	20	-	-	-
Understand	20	20	-	-	40
Apply	60	60	100	100	60

Analyze	-	-	-	-	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. List the benefits of agile modelling. (Remember)
2. Explain about agile manifesto and principles. (Understand)
3. Choose an agile methodology which preserves customer values with less work to implement online shopping system and justify your answer. (Apply)

Course Outcome 2 (CO2):

1. State the purpose of defining user stories. (Remember)
2. Why should we embrace changing requirements? (Understand)
3. Write user stories for attendance monitoring system such as TCENET. (Apply)

Course Outcome 3 (CO3):

1. What are the causes for variations in project estimates? (Remember)
2. Explain the methods to prioritize and divide features into tasks. (Understand)
3. Develop release plan for ATM application. (Apply)

Course Outcome 4 (CO4):

1. Recall about task boards. (Remember)
2. Explain about project scheduling and tracking using burn down charts. (Understand)
3. Create backlogs and burn down chart to monitor the progress of the project. (Apply)

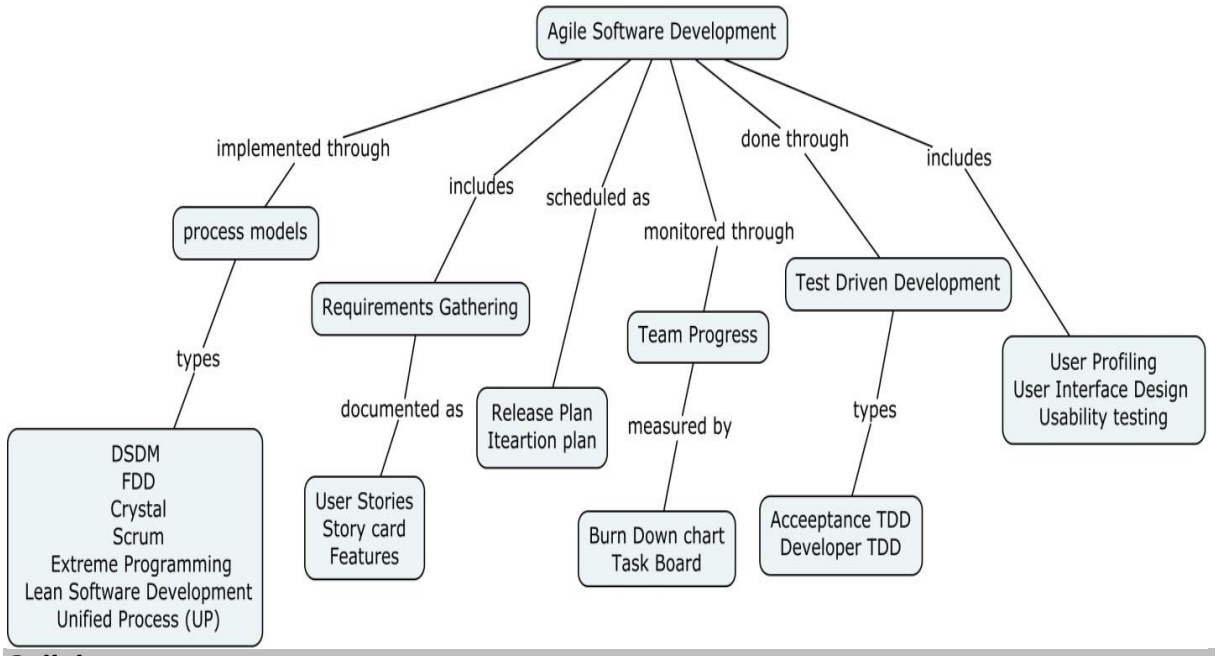
Course Outcome 5 (CO5):

1. Write the significances of Test driven development. (Remember)
2. Suggest how unit tests and acceptance tests can assist in the evaluation of software projects. (Understand)
3. Select any two development tasks for TCENET and develop them using TDD. (Apply)

Course Outcome 6 (CO6):

1. List the benefits of good interface design. (Remember)
2. Compare and contrast the usability engineering life cycle to other software engineering methodologies (Understand)
3. Determine the applicability of usability heuristics, guidelines and standards for given system development problems (Apply)

Concept Map



Syllabus

Agile software development: Agile Vs Traditional models, Agile manifesto, **Agile methodologies-** DSDM, FDD, Crystal, Scrum, Agile Modelling, Extreme Programming, Lean Software Development, Unified Process (UP). **Agility and Knowledge Management:** Agile information systems – agile decision making - Earl's schools of KM – institutional knowledge evolution cycle – development, acquisition, refinement, distribution, deployment , leveraging – KM in software engineering – managing software knowledge – challenges of migrating to agile methodologies – agile knowledge sharing – role of story cards – Story card Maturity Model (SMM). **Managing Agile Projects**- Gathering software requirements -Eliciting requirements from users, Adopting Agile values, writing user stories. **Planning Agile Projects**- Prioritizing and estimating work, organizing projects by features, dividing features into tasks. **Reporting Team Progress**- Documenting work completed with backlogs, tracking progress with burn down charts, Projecting project costs and completion dates, Monitoring work in progress with task boards. **Test-Driven Development-** unit, integration, system and Acceptance testing, exploratory testing, automated and manual testing, exercising boundary conditions, driving development through constant testing. **Usability engineering and agile software development -** Need for usability**,** Agile Usability Processes**,** Customer Focus Vs End-User**,** Working Software Vs Usable Software, Up-front User design - Light weight Usage Centered Design, Usability Testing. **Usability across interface types**: Web, Desktop, Mobile, touch and video games.

Lab Content:

1. Write User Stories for given software specification.
2. Develop release and iteration plans for given software specification.
3. Use burndown charts to monitor the progress of the project.
4. Develop software partially through Test Driven Development with unit test.
5. Develop user interface design for given software specification.

Reference Books

1. Mike Holcombe, "Running an Agile Software Development Project" Wiley, 2008
2. Laura M. Leventhal, Julie A. Barnes "Usability Engineering: Process, Products, and Examples,", Pearson/Prentice Hall, 2008
3. Orit Hazzan, Yael Dubinsky, "Agile software engineering", Springer,2014
4. Jakob Nielsen, "Usability Engineering", Academic Press, 1993

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours
1	**Agile software development**	
1.1	Agile Vs Traditional models, Agile manifesto	1
1.2	**Agile methodologies**	
1.3	DSDM, FDD, Crystal	1
1.4	Scrum, Agile Modelling, Extreme Programming	2
1.5	Lean Software Development, Unified Process (UP)	1
2	**Agility and Knowledge Management**	
2.1	Agile information systems – agile decision making - Earl's schools of KM	1
2.2	Institutional knowledge evolution cycle – development, acquisition, refinement, distribution, deployment , leveraging	1
2.3	KM in software engineering – managing software knowledge – challenges of migrating to agile methodologies	1
2.4	Agile knowledge sharing – role of story cards – Story card Maturity Model(SMM).	1
3	**Managing Agile Projects**	
3.1	Gathering software requirements -Eliciting requirements from users	1
3.2	Adopting Agile values, Writing user stories	1
4	**Planning Agile Projects**	
4.1	Prioritizing and estimating work	1
4.2	Organizing projects by features, Dividing features into tasks	1
5	**Reporting Team Progress**	
5.1	Documenting work completed with backlogs, Tracking progress with burn down charts, Projecting project costs and completion dates	1
5.2	Monitoring work in progress with task boards.	1
6	**Test-Driven Development**	
6.1	Unit, integration, system and Acceptance testing,	1
6.2	Exploratory testing, automated and manual testing, exercising boundary conditions,	1
6.3	Driving development through constant testing.	1
7	**Usability engineering and agile software development**	
7.1	Need for usability, Agile Usability Processes, Customer Focus Vs End-User	1
7.2	Working Software Vs Usable Software, Up-front User design - Light weight Usage Centered Design	2
7.3	Usability Testing	1
8	**Usability across interface types**	
8.1	Web, Desktop	1
8.2	Mobile, touch and video games	1

Module No.	Topic	No. of Lectures
1.	Write User Stories for given software specification.	4

Module No.	Topic	No. of Hours
2.	Develop release plan for given software specification.	4
3.	Develop iteration plan for given software specification.	4
4.	Use burn down charts to monitor the progress of the project.	4
5.	Develop software partially through Test Driven Development with unit test.	4
6.	Develop user interface design for given software specification.	4

Course Designers:

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

		Category	L	T	P	Credit
18CG171	**SYSTEMS PROGRAMMING LAB**	PC	0	0	4	2

Preamble

The laboratory course will facilitate the students to apply the concepts of Shell Scripting and Server–side scripting. This course also provides an understanding on code flow analysis and code optimization.

Prerequisite

Nil

Course Outcomes

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

Develop programs on shell scripting languages. (CO1)	Apply
Develop programs on searching and sorting algorithms. (CO2)	Apply
Develop programs on Graph Traversals (CO3)	Apply
Develop programs on Synchronization and Semaphores (CO4)	Apply
Develop Socket programming and Server-side scripting (CO5)	Apply
Develop programs for flow analysis and code optimization. (CO6)	Apply

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

List of Experiments

1. Write a shell script program to check and list attributes of processes.
2. Implement the applications of Queue and Stack.
3. Implementation of Searching and Sorting algorithms.
4. Implementation of Graph Representation and Traversal algorithms.
5. Implement Threading & Synchronization Applications.
6. Implement Semaphores and Deadlock detection.
7. Develop the stream and datagram socket programming.
8. Implement the Connection establishment, read from database and insert the records to access database using server-side scripting.
9. Implement control flow analysis and data flow analysis.
10. Implementation of simple code optimization techniques.

Course Designers:

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REVISED CURRICULUM AND DETAILED SYLLABI

FOR

M.E DEGREE (Computer Science and Engineering) PROGRAMME

PROGRAMME ELECTIVES

FOR THE STUDENTS ADMITTED FROM THE

ACADEMIC YEAR 2021 - 2022 ONWARDS

THIAGARAJAR COLLEGE OF ENGINEERING

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

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18CGPA1	PARALLEL COMPUTING SYSTEMS	Category	L	T	P	Credit
		PE	3	0	0	3

Preamble

This course provides an understanding of the fundamental principles for the design of parallel programs that are necessary to effectively utilize the modern parallel computing systems. It covers the aspects related to design, analyze, implement, and benchmark parallel programs in C using MPI, OpenMP and CUDA

Prerequisite

Introductory level Computer Architecture, Algorithms.

Course Outcomes

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

	Course Outcomes	Bloom's Level
CO1	Select an appropriate parallel programming model for a given application.	Apply
CO2	Construct a parallel algorithm for a given problem by exploiting the features of the different network interconnect models.	Apply
CO3	Analyze the cost optimality and efficiency of parallel algorithms constructed to solve numerical problems and problems requiring searching, sorting and selection.	Analyze
CO4	Develop parallel programs using shared memory programming	Apply
CO5	Develop parallel programs using distributed memory programming	Apply
CO6	Develop parallel programs suitable to be run on GPU	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO3.	S	M	M	L							
CO4.	S	M	M	L							
CO3	S	S	S	M							
CO4	S	M	M	M	S						
CO5	S	M	M	M	S						
CO6	S	M	M	M	S						

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Assignment		Terminal Examination
	Test 1	Test 2	1	2	
Remember	-	-	-	-	20
Understand	30	20	-	-	30
Apply	60	60	80	80	35
Analyze	10	20	20	20	15
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Interpret the critical factors which will affect the performance of Shared Address Space and Message Passing Architectures. (Apply)
2. In our discussion of parallel hardware, we used Flynn's taxonomy to identify three types of parallel systems: SISD, SIMD, and MIMD. None of our systems were identified as multiple instruction, single data, or MISD. How would an MISD system work? Give an example (Understand)

Course Outcome 2 (CO2):

1. Suppose the faculty are going to have a party for the students in the department. a. Identify tasks that can be assigned to the faculty members that will allow them to use task-parallelism when they prepare for the party. Work out a schedule that shows when the various tasks can be performed. b. We might hope that one of the tasks in the preceding part is cleaning the house where the party will be held. How can we use data-parallelism to partition the work of cleaning the house among the faculty? c. Use a combination of task- and data-parallelism to prepare for the party. (If there's too much work for the faculty, you can use TAs to pick up the slack.
   (Apply)
2. Sketch a four-dimensional hypercube. (Apply)

Course Outcome 3 (CO3)

1. Consider an SMP with a distributed shared-address-space. Consider a simple cost model in which it takes 10 ns to access local cache, 100 ns to access local memory, and 400 ns to access remote memory. A parallel program is running on this machine. The program is perfectly load balanced with 80% of all accesses going to local cache, 10% to local memory, and 10% to remote memory. What is the effective memory access time for this computation? If the computation is memory bound, what is the peak computation rate? Now consider the same computation running on one processor. Here, the processor hits the cache 70% of the time and local memory 30% of the time. What is the effective peak

computation rate for one processor? What is the fractional computation rate of a processor in a parallel configuration as compared to the serial configuration?

2. Suppose a program must execute 10^{12} instructions in order to solve a particular problem. Suppose further that a single processor system can solve the problem in 10^6 seconds (about 11.6 days). So, on average, the single processor system executes 10^6 or a million instructions per second. Now suppose that the program has been parallelized for execution on a distributed-memory system. Suppose also that if the parallel program uses p processors, each processor will execute 10^{12}/p instructions and each processor must send 10^9 (p − 1) messages. Finally, suppose that there is no additional overhead in executing the parallel program. That is, the program will complete after each processor has executed all of its instructions and sent all of its messages, and there won't be any delays due to things such as waiting for messages. a. Suppose it takes 10^{-9} seconds to send a message. How long will it take the program to run with 1000 processors, if each processor is as fast as the single processor on which the serial program was run? b. Suppose it takes 10^{-3} seconds to send a message. How long will it take the program to run with 1000 processors?

(Analyze)

Course Outcome 4 (CO4)

1. Explain the basic OpenMP constructs (Understand)
2. Use OpenMP directives for parallelization, write a program in C to illustrate the usage of worksharing constructs. (Apply)

Course Outcome 5 (CO5)

1. Give the syntax of MPI_Ireceive. (Remember)
2. Write a simple program to illustrate the Blocking and Non-Blocking message passing directives. (Apply)

Course Outcome 6 (CO6)

1. Write a program that will get an input *N* and generate a randomized vector *V* of length *N.* It should then compute the maximum value in *V* on the CPU and on the GPU. The program should output the two computed maximum values as well as the time taken to find each value

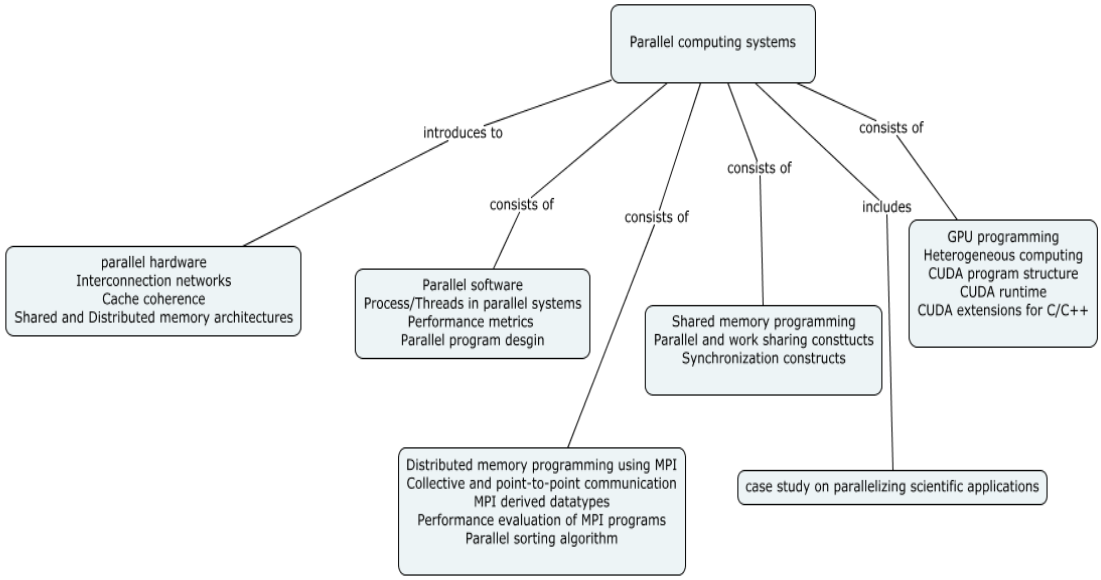
(Apply)

2.Discuss the differences in how a GPU and a vector processor might execute the following code:

```
sum = 0.0;
 for (i = 0; i < n; i++)
{ y[i] += a∗x[i];
sum += z[i]∗z[i]; }
```

(Apply)

Concept Map



Syllabus

Introduction-Why parallel computing-parallel hardware-SIMD systems-MIMD systems-Interconnection networks- cache coherence-shared Vs distributed memory architectures. **parallel software**- coordinating the process/threads in shared and distributed memory-performance metrics-speedup and efficiency-Parallel program design. **Distributed memory programming with MPI-** MPI programs-Collective and point-to-point communication- MPI derived datatypes-performance evaluation of MPI programs- parallel sorting algorithm. **Shared memory programming with OpenMP**- parallel, work-sharing, synchronization constructs-case study on parallelizing scientific computational problems - sorting. **Heterogeneous processing model and GPU programming**- difference between CPU and GPU-heterogeneous computing-CUDA program structure- CUDA runtime-device memory- shared memory-CUDA extensions for C/C++.

Reference Books

1. Peter S. Pacheco and Matthew Malensek, “An Introduction to Parallel Programming”, Second Edition, Morgan Kaufmann / Elsevier, 2020.
2. Michael J Quinn, “Parallel Programming in C with MPI and OpenMP”, Tata McGraw Hill, 2008.
3. David B. Kirk, Wen-mei W. Hwu, “Programming Massively Parallel Processors: A Hands-on Approach”, Morgan Kaufmann / Elsevier, 2010.

Course Contents and Lecture Schedule

Module No.	Topics	No. of Lectures
1.0	**Introduction (8)**	
1.1	Why parallel computing	1
1.2	parallel hardware-SIMD systems-MIMD systems	2
1.3	Interconnection networks	2
1.4	cache coherence	1
1.5	shared Vs distributed memory architectures.	1

2.0	**Parallel software (6)**	
2.1	coordinating the process/threads in shared and distributed memory	2
2.2	performance metrics-speedup and efficiency	2
2.3	Parallel program design	2
3.0	**Distributed memory programming with MPI (8)**	
3.1	MPI programs-Collective and point-to-point communication-	2
3.2	MPI derived datatypes	2
3.3	performance evaluation of MPI programs	2
3.4	parallel sorting algorithm	2
4.0	**Shared memory programming with OpenMP (7)**	
4.1	Constructs –Parallel, work-sharing Synchronization constructs	2
4.2	Synchronization constructs	2
4.3	Case Study-Parallelizing scientific computational problems	3
5.0	**GPU programming (7)**	
5.1	Difference between CPU and GPU	1
5.2	Heterogeneous computing-CUDA program structure-	2
5.3	CUDA runtime-device memory- shared memory-	2
5.4	CUDA extensions for C/C++.	2
Total No. of hours		36

Course Designers:

1. Chitra.P <pccse@tce.edu>

18CGPB1 OPERATIONS RESEARCH

Category	L	T	P	Credit
PE	3	0	0	3

Preamble

This course aims to formulate and solve problems using linear programming, non linear programming and intelligent optimization algorithms. Eventually, the course provides a thorough understanding towards problem formulation and modeling/solving real world problems by choosing appropriate problem solving techniques.

Prerequisite

Nil

Course Outcomes

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

CO1	Construct and solve optimization problems using linear programming techniques like Simplex method, Dual Simplex Method	Apply
CO2	Construct and solve optimization problems using integer optimization techniques like Branch and Bound Method and Cutting Plane Method.	Apply
CO3	Construct and solve multi-objective problems using goal programming	Apply
CO4	Construct and solve network flow problems using Shortest route problems, Maximal Flow problems	Apply
CO5	Construct and solve unconstrained non linear optimization problems using Fibonacci, Golden Section search, Hooks and Jeeves search and Gradient Projection methods.	Apply
CO6	Construct and solve non linear optimization problems using with equality constraints using Lagrangian Multiplier and projected Gradient Methods and inequality constraints using Kuhn Tucker conditions.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO5.	S	S	S	S							
CO6.	S	S	S	S							
CO3	S	S	S	S							
CO4	S	S	S	S							
CO5	S	S	S	S							
CO6	S	S	S	S							

S- Strong; M-Medium; L-Low

Assessment Pattern

	Continuous Assessment Tests	Assignment	

Bloom's Category	1	2	1	2	Terminal Examination
Remember	20	20	-	-	10
Understand	20	20	-	-	10
Apply	60	60	100	100	80
Analyze	-	-	-	-	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. State the Primal and Dual relationship?
2. Explain the computational procedure used in simplex method for solving LPP
3. A manufacturer produces three models of bicycles. The time (in hours) required for assembling, painting, and packaging each model is as follows.

	Model A	Model B	Model C
Assembling	2	2.5	3
Painting	1.5	2	1
Packaging	1	0.75	1.25

4. The total time available for assembling, painting, and packaging is 4006 hours, 2495 hours and 1500 hours, respectively. The profit per unit for each model is \$45 (Model A), \$50 (Model B), and \$55 (Model C). How many of each type should be produced to obtain a maximum profit?

Course Outcome 2 (CO2):

1. Describe Gomory's integer programming problem method and its algorithm
2. Solve the following ILP using branch and bound method.
    a. Maximize Z = 2x1 + 2x2
    b. Subject to
        i. 5x1 + 3x2 ≤ 8, x1 + 2x2 ≤ 4, and x1, x2 ≥ 0 and integers
3. Solve the following Integer Programming Problem using Cutting Plane Method.
    a. Maximize $Z = x_1 + 2x_2$
        i. subject to

$$2x_2 \leq 7$$
$$x_1 + x_2 \leq 7$$
$$2x_1 \leq 11$$

    a. x_1, x_2 are integers ≥ 0

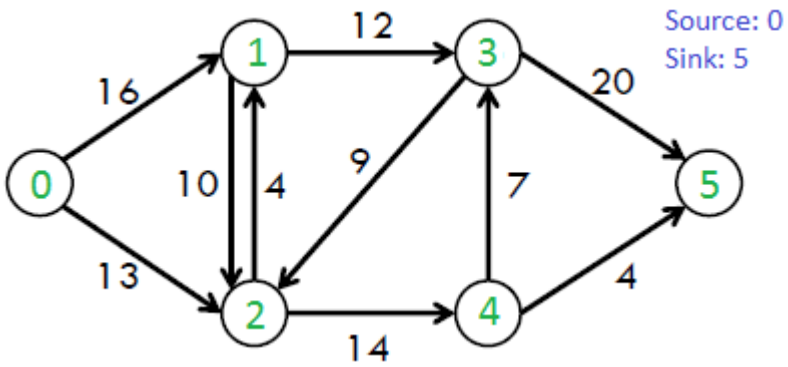
Course Outcome 3 (CO3):

1. What is meant by multi objective programming problems?
1. A firm has two products A& B. Each must be processed through departments namely d1 and d2. d1 has 30 hours of production capacity per day and d2 has 60 hours. Each unit of A requires 2 hours in d1 and 6 hours in d2. Each unit of B needs 3 hours in d1 and 4 hours in d2. Management has rank ordered the following goals, it would like to achieve in determining the daily product mix:
   P1: minimize underachievement of joint total production of 10 units.
   P2: minimize underachievement of producing 7 units of B.
   P3: minimize underachievement of producing 8 units of A.
   Formulate the problem as GP model**.**

2. An electronics company produces two types of television sets, color and black-and-white. The production of a color set requires 10 hours of skilled and 100 hours of unskilled labor. The production of a black-and-white set requires 5 hours of skilled and 150 hours of unskilled labor. The company has 100 hours of skilled labor and 1,500 hours of unskilled labor normally available per month for the production of television sets. The maximum number black-and-white and color sets that can be sold each month are 45 and 70, respectively. The profit margin from the sale of a color set is $20, whereas it is $15 from a black-and-white set. The company has set the following goals:
   Avoid the over utilization of skilled labor since it is hard to obtain in the labor market.
   Minimize the under utilization of unskilled labor.
   Meet the demand as much as possible.
   Limit over utilization of unskilled labor to 100 hours.
   Interpret the above as a goal programming problem.

Course Outcome 4 (CO4):

1. State the Ford and Fulkerson's rule for numbering nodes in a network?
2. Write Dijikstra's shortest path algorithm and explain with proper example.
   Given a graph which represents a flow network where every edge has a capacity. Also given two vertices *source* 's' and *sink* 't' in the graph, find the maximum possible flow from s to t with following constraints:
   a) Flow on an edge doesn't exceed the given capacity of the edge.
   b) Incoming flow is equal to outgoing flow for every vertex except s and t.



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

product to different retail shops in such a way so that the total transportation cost is minimum?

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

Course Outcome 5 (CO5):

1. List out the cases for calculating the extremum candidates.
2. Find the stationary points of the following function using the method of constrained variation optimize: $y(x) = x_1 x_2$, subejct to: $f(x) = x^2_1 + {}^2_2 - 1 = 0$
3. Calculate the minimum point of a multi-variable function using the Hooke-Jeeves directional search method for the following function
   $y = 10 + (X(1) - 2)^2 + (X(2) + 5)^2$

Course Outcome 6 (CO6):

1. For the given NLP with equality constraints, how Lagrange multipliers are used?
2. Illustrate how the following inequality constraints are converted into equality constraints?
3. Use the K-T conditions to find the optimal solution to the following NLP:

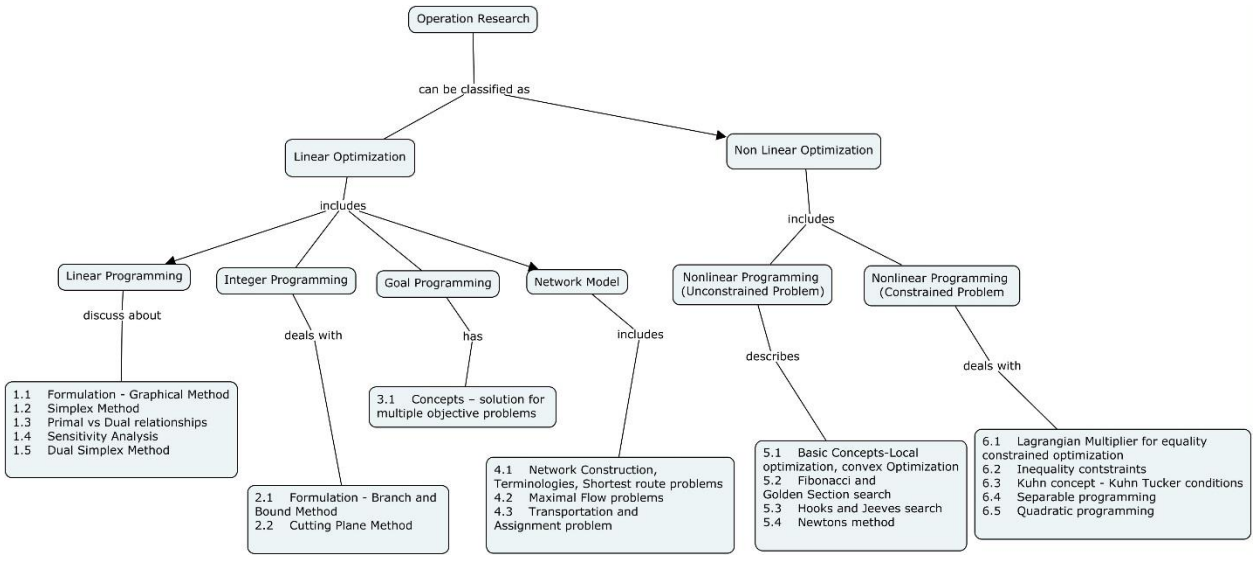
$$\min Z = (x_1 - 1)^2 + (x_2 - 2)^2$$

Show that $-x_1 + x_2 = 1$

$x_1 + x_2 \leq 2$

$x_1 , x_2 \geq 0$

Concept Map



Syllabus

Linear Programming: Formulation - Graphical Method and Simplex Method – Primal vs Dual relationships - Sensitivity Analysis-Dual Simplex Method; **Integer Programming:** Formulation - Branch and Bound Method - Cutting Plane Method; **Goal Programming** – Concepts – solution for multiple objective problems; **Network Model:** Network Construction – Terminologies - Shortest route problems, Maximal Flow problems, Transportation and Assignment problem; **Nonlinear Programming (Unconstrained Problem) -**Basic Concepts – Local optimization, convex Optimization -Fibonacci and Golden Section search - Hooks and Jeeves search – Newtons method ; **Nonlinear Programming (Constrained problem)** Lagrangian Multiplier - Equality constrained optimization –Inequality constraints- Kuhn concept - Kuhn Tucker conditions, Separable programming, Quadratic programming;

Reference Books

1. Hamdy A. Taha, “Operations Research - An Introduction”, MacMillan Co., Eighth Edition 2010.
2. Ravindran, Don. T. Phillips, and James J. Solberg, “Operations Research - Principles and Practice”, John Wiley and Sons, Second Edition, Copy right 2007.
3. Hiller and Lieberman, “ Introduction to Operations Research” Tata McGraw Hill, Eighth Edition, 2005
4. Ronald L Rardin, “Optimisation in Operations Research” Pearson Education Asia, First Indian reprint, 2013
5. Kalyanmoy Deb, “Optimisation for Engineering Design – Algorithms and Examples”, Eastern Economy Edition, Prentice Hall of India Private Limited, New Delhi, 2013
6. Luenberger, David G., Ye, Yinyu, “Linear and Nonlinear Programming”, 3rd Ed, International Series in Operations Research & Management Science, 2008

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1	**Linear Programming**	
1.1	Formulation - Graphical Method	2
1.2	Simplex Method	2
1.3	Primal vs Dual relationships	2
1.4	Sensitivity Analysis	2
1.5	Dual Simplex Method	2
2	**Integer Programming**	
2.1	Formulation - Branch and Bound Method	2
2.2	Cutting Plane Method	2
3	**Goal Programming**	
3.1	Concepts – solution for multiple objective problems	3
4	**Network Model**	
4.1	Network Construction, Terminologies, Shortest route problems	1
4.2	Maximal Flow problems	2
4.3	Transportation and Assignment problem	2
5	**Nonlinear Programming (Unconstrained Problem)**	

Module No.	Topic	No. of Lectures
5.1	Basic Concepts – Local optimization, convex Optimization	2
5.2	Fibonacci and Golden Section search	1
5.3	Hooks and Jeeves search	1
5.4	Newtons method	1
6	**Nonlinear Programming (Constrained Problem)**	
6.1	Lagrangian Multiplier for equality constrained optimization	2
6.2	Inequality contstraints	1
6.3	Kuhn concept - Kuhn Tucker conditions	2
6.4	Separable programming	2
6.5	Quadratic programming	2
	Total Hours	36

Course Designers:

1. Dr.M.K.Kavitha Devi mkkdit@tce.edu
2. Raja Lavanya rlit@tce.edu

CURRICULUM AND DETAILED SYLLABI

FOR

M.E DEGREE (Computer Science and Engineering) PROGRAMME

SECOND SEMESTER

FOR THE STUDENTS ADMITTED FROM THE

ACADEMIC YEAR 2021 - 2022 ONWARDS

THIAGARAJAR COLLEGE OF ENGINEERING

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

MADURAI – 625 015, TAMILNADU

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Passed in Board of Studies Meeting on 01.12.2018 Approved in 57th Academic Council Meeting on 05.01.2019

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015
M.E Degree (Computer Science and Engineering) Program
COURSES OF STUDY
(For the candidates admitted from the academic year 2021 - 2022)

II SEMESTER

Course Code	Name of the Course	Category	No. of Hours / Week			Credits
			L	T	P	
THEORY						
18CG210	Randomized Algorithms	PC	3	-	-	3
18CGPX0	Program Elective - III	PE	3	-	-	3
18CGPX0	Program Elective - IV	PE	3	-	-	3
18PG250	Research Methodology and IPR	CC	2	-	-	2
THEORY CUM PRACTICAL						
18CG260	Intelligent Systems :Theory and Practice	PC	2	-	2	3
PRACTICAL						
18CG270	Design and Analysis of Algorithms Lab	PC	-	-	4	2
18CG280	Mini Project with Seminar	PC	-	-	4	2
Total			**13**	**-**	**10**	**18**

Note:

1 Hour Lecture/Tutorial is equivalent to 1 credit
2 Hours Practical is equivalent to 1 credit

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015
M.E Degree (Computer Science and Engineering) Program
SCHEME OF EXAMINATIONS
(For the candidates admitted from 2021 - 2022 onwards)

II SEMESTER

S.No.	Course Code	Name of the Course	Duration of Terminal Exam. in Hrs.	Marks			Minimum Marks for Pass	
				Continuous Assessment *	Terminal Exam **	Max. Marks	Terminal Exam	Total
THEORY								
1	18CG210	Randomized Algorithms	3	50	50	100	25	50
2	18CGPX0	Program Elective - III	3	50	50	100	25	50
3	18CGPX0	Program Elective - IV	3	50	50	100	25	50
4	18PG250	Research Methodology and IPR	3	50	50	100	25	50
THEORY CUM PRACTICAL								
5	18CG260	Intelligent Systems: Theory and Practice	3	50	50	100	25	50
PRACTICAL								
6	18CG270	Design and Analysis of Algorithms Lab	3	50	50	100	25	50
7	18CG280	Mini Project with Seminar	-	50	50	100	25	50

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

18CG210	RANDOMIZED ALGORITHMS	Category	L	T	P	Credit
		PC	2	1	0	3

Preamble

This course introduces students to the design and analysis of randomized and approximation algorithms. On completion of this course students will be able to design randomized algorithms for solving complex problems and estimate their expected running time and error probability.

Prerequisites

- Data Structures
- Algorithms
- Discrete Probability Theory

Course Outcomes

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

Construct Las Vegas algorithms for a given problem and compute the expected running time. (CO1)	Apply
Construct Monte-Carlo algorithms for a given problem and compute the probability of getting an incorrect output. (CO2)	Apply
Design solutions for complex problems using randomization design paradigms like Foiling the Adversary and Abundance of Witnesses (CO3)	Apply
Apply randomized fingerprinting techniques for communication protocols and mathematical verification. (CO4)	Apply
Solve problems like sampling and rounding using Randomization techniques. (CO5)	Analyse
Apply derandomization techniques to appropriate problems.(CO6)	Apply

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous		Assignment		Terminal Examination
	1	2	1	2	
Remember	20	10	-	-	10
Understand	20	30	-	-	30
Apply	60	50	100	100	40
Analyze	-	10	-	-	20
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Course Level Assessment Questions

Course Outcome (CO1):

1. Show that the expected running time of randomized quicksort is O(n log n) to sort an array consisting of n elements.

2. Show that the expected running time of the randomized selection algorithm is O(n).

3. We have two computers RI and RII. The input of RI consists of ten strings,x1, x2, . . ., x10 ∈ {0, 1}^{n}, and RII also has ten strings, y1, y2, . . ., y10 ∈ {0, 1}^{n}.The task is to estimate whether there is a j ∈ {1, . . ., 10} such thatxj = yj .If such a j exists, then the protocol has to accept the input ((x1, . . ., x10),(y1, . . ., y10)), and if not, the input has to be rejected. Design a Las Vegas protocol that solves the task with communicationcomplexity of n + O(log n).

Course Outcome (CO2):

1. Let A be an MC algorithm that, for every input x, computesthe correct result F(x) with probability 1/2 + ε_x, where ε_x depends on|x|. Let δ be a constant, 0 < δ < 1/2. How many repetitions k = k(|x|) of thework of A on x are necessary to achieve
Prob(Ak(x) = F(x)) ≥ 1 − δ, if

(i) $\varepsilon_x = 1/|x|$,
(ii) $\varepsilon_x = 1/\log_2|x|$?

2. Let A be a randomized algorithm computing a function Fwith Prob(A(x) = F(x)) ≥ 1/3 for every argument x of F. Assume that oneis aware of the fact that Prob(A(x) = α) ≤ 1/4 for every wrong result α (i.e.,that the probability of computing any specific wrong result is at most 1/4).Can this knowledge be used to design a useful randomized algorithm for F?

3. Illustrate the difference between bounded-error and unbounded-error Monte-Carlo algorithms with the help of appropriate examples.

Course Outcome (CO3):

1. Let U be a finite set. Show that the class $H_{U,T}$ = {h | h : U → T }of all functions from U to T is universal.

2. Consider a network of m computers R1,R2, . . .,Rm in whicheach computer is directly connected via a communication link to each other.Let k be a positive integer. Assume that each Ri possesses a set Si ⊆ $\{0, 1\}^n$,where |Si| ≤ k for all i∈ {1, 2, . . ., m}. Design and analyze a randomizedcommunication protocol for deciding whether or not$\bigcap_{i=1}^{m} Si$ is empty. Thecommunication complexity is measured as the number of bits communicatedvia all links between the m computers.

Course Outcome (CO4):

1. Using the fingerprinting technique, construct a $O(n^2)$ randomized algorithm to verify whether A.B = C, given three n x n matrices A, B and C over a field **F**.

Course Outcome (CO5):

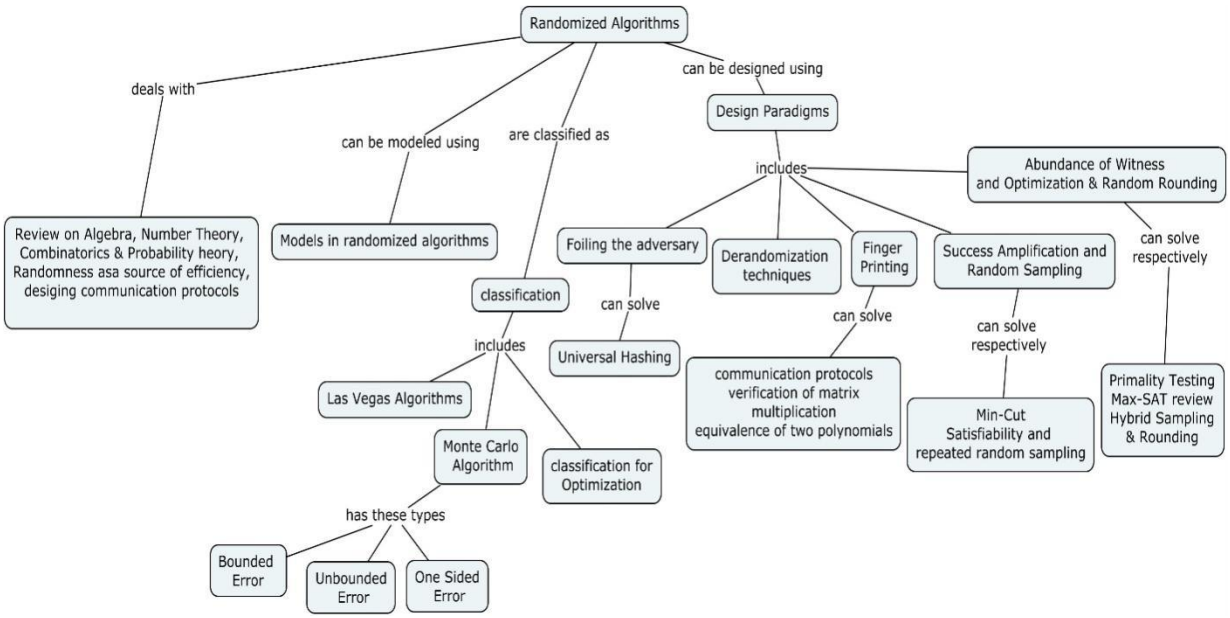
1. Illustrate the technique of amplification to maximize the success probability of a randomized algorithm to compute min-cuts in a multi-graph G. A multigraph G = (V, E, c), where c : E → IN − {0} determines themultiplicity of the edges of G.

2. Let F be a formula of n variables that is satisfied by exactlyk assignments to its variables. How many random samples from the set $\{0, 1\}^n$are necessary in order to find an assignment satisfying F with a probabilityof at least 1/2?

Course Outcome (CO6):

1. Show that the algorithm COMB is a polynomial-time, randomized E[4/3]-approximation algorithm for MAX-SAT.

Concept Map



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.

Text Books

1. Juraj Hromkovic– Design and Analysis of Randomized Algorithms, First edition, Springer, 2005.

Reference Books

1. Randomized Algorithms – Rajeev Motwani, PrabhakarRaghavan, Cambridge University Press, 1995.
2. Introduction to Algorithms –Charles E. Leiserson, Thomas H. Cormen, Ronald L. Rivest and Clifford Stein, third edition, PHI, 2010

3. Gilles Brassard and Paul Bratley - Fundamentals of Algorithmics - PHI, 2000.
4. Sara Baase - Computer algorithms: Introduction to Design and Analysis, AddisonWesley publication, 1998.

Course Contents and Lecture Schedule

Module no.	Topic	No. of lectures
1.	**Introduction to Randomized Algorithms**	
1.1	Review on Algebra, Number theory, Combinatorics and Probability theory	1
1.2	Randomness as a source of efficiency-designing a communication protocol	1
1.3	Models of Randomized Algorithms	1
1.4	Classification	1
1.4.1	Las Vegas	1
1.4.2	Monte-Carlo (one-sided error, bounded-error and unbounded-error)	1
1.5	Classification of Randomized Algorithms for Optimization problems	1
2	**Design Paradigms**	
2.1	Foiling the Adversary	1
2.2	Abundance of Witnesses	1
2.3	Fingerprinting	1
2.4	Random Sampling	1
2.5	Amplification.	1
2.6	Random Rounding	1
3	**Representative Algorithms**	
3.1	Foiling the Adversary	1
3.1.1	Universal Hashing	1
3.2	Fingerprinting	1

3.2.1	Communication protocols	1
3.2.2	Verification of Matrix Multiplication, Equivalence of Two polynomials	1
3.3	Success Amplification and Random Sampling, Min-Cut	1
3.3.1	Satisfiability and repeated random sampling	1
3.4	Abundance of Witnesses and Optimization & random rounding	1
3.4.1	Primality Testing, Max-SAT	1
3.4.2	Hybrid Sampling &Rounding	1
3.5	Derandomization Techniques	1
Tutorial for Randomized Algorithms		12
Total		36*

*The apportioning of the total contact hours for lectures and tutorials would be 24:12 respectively

Course Designer:

1. Dr. M. Vijayalakshmi mviji@tce.edu

18PG250	RESEARCH METHODOLOGY AND IPR

Category	L	T	P	Credit
CC	2	0	0	2

Preamble

The course on the Research Methodology and IPR is offered as common Core course. The objective of this course is to understand and analyze Research Methodology and IPR protection.

Prerequisite

NIL

Course Outcomes

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

1. Understand research problem formulation.
2. Analyze research related information
3. Follow research ethics
4. Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
5. Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
6. Understand that IPR protection provides an incentive to inventors for further research work and investment in R&D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

Assessment Pattern

Bloom's Category	Continuous Assessment		Assignment		Terminal Examination
	1	2	1	2	
Remember	20	20			20
Understand	40	40			40
Apply	40	40	100	100	40
Analyze	0	0			0
Evaluate	0	0			0
Create	0	0			0

Syllabus

Module 1: Meaning of research problem, Sources of research problem, Criteria, Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem, Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

Module 2: Effective literature studies approaches, analysis Plagiarism, Research ethics

Module 3: Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee
Module 4: Nature of Intellectual Property: Patents, Designs, Trade and Copyright, Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.
Module 5: Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.
Module 6: New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs

Reference Books

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'" 2nd Edition,
2. "Research Methodology: A Step by Step Guide for beginners"
3. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
4. Mayall, "Industrial Design", McGraw Hill, 1992.
5. Niebel, "Product Design", McGraw Hill, 1974.
6. Asimov, "Introduction to Design", Prentice Hall, 1962.
7. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016.
8. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

Course Designers:

1. Adapted from AICTE Model Curriculum for Postgraduate Degree Courses in Engineering & Technology, Volume-I, January 2018.

18CG260	INTELLIGENT SYSTEMS: THEORY AND PRACTICE	Category	L	T	P	Credit
		PC	2	0	2	3

Preamble

The course will help students to build intelligent systems with emphasis on its use to solve real world problems for which traditional algorithmic approach is difficult. It explores the essential theory behind developing systems that has the ability to demonstrate intelligent behaviour including searching, reasoning, knowing, interpreting, behaving and learning. Further, the course will help students determine which type of Intelligent System Methodology would be suitable for a given type of application problem. Lab-based experiments are included as part of the assessment requirements for the study. The lab-based examinations will test the candidate's ability to develop computer programs for a series of applications of varying complexity.

Course Outcomes

Develop Intelligent Systems that perform searching techniques to reach a goal (CO1)	(Apply)
Make use of Reasoning and knowledge in intelligent agents that gains basic understanding of the environment (CO2)	(Apply)
Illustrate the techniques for interpreting from visual information and Natural Language (CO3)	(Apply)
Develop systems which are capable of learning from the environment and refining it to make optimal decisions (CO4)	(Apply)
Analyze the validity of AI based approaches to model intelligent systems (CO5)	(Analyze)
Compare the various design options and problem solving strategies for real time applications (CO6)	(Analyze)

Mapping with Programme Outcomes

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1
CO1.	M	M	M	M	L	L					
CO2.	S	M	S	M	L	L					
CO3	S	M	S	M	L	L					
CO4	S	S	M	M	L	L					
CO5	S	S	M	M	L	L					
CO6	S	S	M	M	S	M	M	L	L	M	M

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous		Assignment		Terminal Examination
	1	2	1	2	
Remember	30	30	-	-	20
Understand	40	30	30	30	20
Apply	30	30	70	60	30
Analyze	-	10	-	10	30
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. List two common applications of intelligent systems (Remember)
2. List the characteristics that make a system intelligent. (Remember)
3. What is A* algorithm search method (Remember)
4. Compare Iterative Deepening DFS and bidirectional search algorithm (Understand)
5. Write a program to implement Breadth First Search (Apply)
6. Implement Uninformed Search for the Water Jug problem scenario (Apply)

Course Outcome 2 (CO2):

1. What are the various approaches to Knowledge representation (Remember)
2. Explain three ways of representing class membership while using predicate logic (Remember)
3. Compare inductive, deductive and abductive machine learning (Understand)
4. The classic example of non monotonic reasoning involves birds and flying. In particular, consider the following facts:
   - Most things do not fly.
   - Most birds do fly, unless they are too young or dead or have a broken wing.
   - Penguins and ostriches do not fly.
   - Magical ostriches fly.

- Tweety is a bird.
- Chirpy is either a penguin or an ostrich.
- Feathers is a magical ostrich.

Use one or more of the nonmonotonic reasoning systems to answer the following questions:

- Does Tweety fly?
- Does Chirpy fly?
- Does Feathers fly?
- □ Does Paul fly? (Apply)

Course Outcome 3 (CO3):

1. Apply Edge detection algorithm for classifying leaves. (Apply)
2. Discuss the advantages of Statistical Learning. (Understand)
3. Write a program for a robot to learn using reinforcement learning (Apply)

Course Outcome 4 (CO4):

1. What are bag of words (Remember)
2. Explain document clustering (Understand)
3. Discuss about Semantic and Pragmatic interpretation (Understand)
4. Design Machine Translation System framework using probabilistic modelling (Apply)
5. Construct a NLP framework for recommender system (Apply)

Course Outcome 5 (CO5):

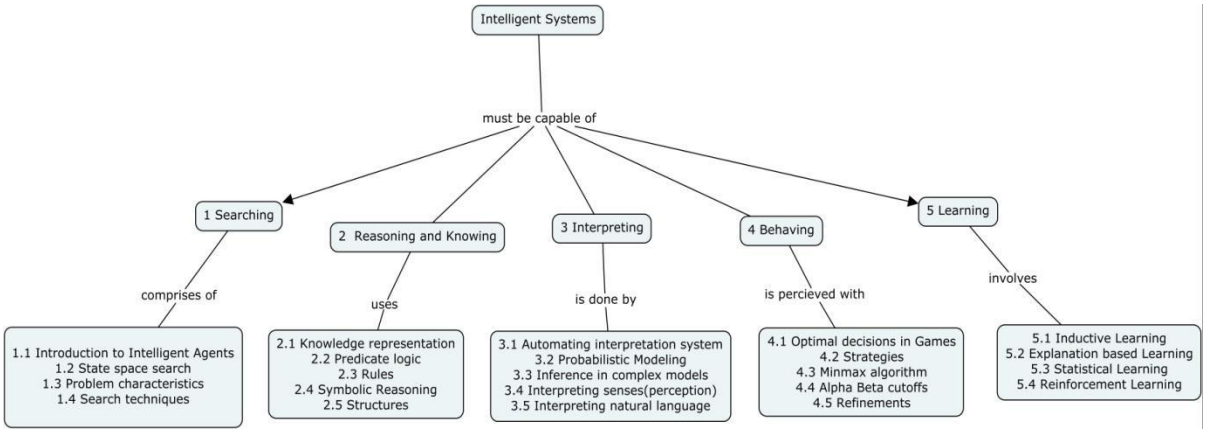
1. List the various Gaming strategies. (Remember)
2. Is the minimax procedure a depth-first or breadth-first search procedure (Understand)
3. Perform Alpha-Beta pruning for Tic-Tac-Toe Game scenario (Apply)
4. Analyze the suitability of various Gaming strategies to chatbot system. (Analyze)
5. Compare the various Statistical Learning techniques to autonomous vehicles lane identification use case. (Analyze)

Course Outcome 6 (CO6):

1. Test whether the minimax procedure is a depth-first or breadth-first search procedure in Two Player Game like Tic-Tac-Toe (Analyze)

2. Comprehend the appropriate technique a Robot Arm Control that learns using reinforcement learning (Analyze)
3. Compare the various problem solving strategies for Handwritten digit recognition (Analyze)

Concept Map



Syllabus

Searching-Introduction to Intelligent Systems – State space search – Problem characteristics – Search techniques -**Reasoning and Knowing -**Knowledge representation - Predicate logic - Rules - Symbolic reasoning – Structures – **Interpreting-** Automating interpretation systems- Probability modeling - Inference in complex models-Interpreting senses (perception) - Interpreting natural language – **Behaving** Optimal decisions in Games – Strategies – Minimax algorithm – Alpha Beta cutoffs – Adversarial game theoretic search-Refinements- **Learning-** Inductive learning – Explanation based learning – Statistical learning - Reinforcement learning- Use cases

Text Books

1. Stuart Russell and Peter Norvig. Artificial Intelligence: A Modern Approach, Third Edition Prentice Hall, 2009.
2. Elain Rich and Kevin Knight, “Artificial Intelligence”, Tata McGraw Hill, Third Edition, 2008.
3. Deepak Khemani. A First Course in Artificial Intelligence, McGraw Hill Education (India), 2013.

Reference Books

1. Eugene Charniak, Drew McDermott, “Introduction to Artificial Intelligence”, Third Indian reprint, Addison Wesley, 2000
2. Edison Wise,”Hands–on AI with Java Smart Gaming, Robotics and more”, Tata McGraw Hill, 2005

3. Journals- Artificial Intelligence, AI Magazine, IEEE Expert, Machine Learning, Computer Vision Image Processing and Graphics, IEEE Transactions on Neural Networks
4. NPTEL Lectures on Intelligent Systems and Control, Prof Laxmidhar Behera, IIT Kanpur

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1	**Searching (4)**	
1.1	Introduction to Intelligent Systems	1
1.2	State space search	1
1.3	Problem characteristics	1
1.4	Search techniques	1
2	**Reasoning and Knowing (5)**	
2.1	Knowledge representation	1
2.2	Predicate logic	1
2.3	Rules	1
2.4	Symbolic reasoning	1
2.5	Structures	1
3	**Interpreting (5)**	
3.1	Automating interpretation systems	1
3.2	Probability modeling	1
3.3	Inference in complex models	1
3.4	Interpreting senses (perception)	1
3.5	Interpreting natural language	1
4	**Behaving (5)**	
4.1	Optimal decisions in Games	1
4.2	Strategies	1
4.3	Minimax algorithm	1
4.4	Alpha Beta cutoffs	1
4.5	Adversarial game theoretic search -Refinements	1
5	**Learning (5)**	
5.1	Inductive learning	1
5.2	Explanation based learning	1

5.3	Statistical learning	1
5.4	Reinforcement learning	1
5.5	Use Cases	1
	Total	**24**

Module No	**Topic**	**No. of Lectures**
1	Write a program to help pacman find his food using A* search algorithm	4
2	Develop an appropriate reasoning algorithm for question answering system	4
3	Develop a hand written character recognition learning model progam	4
4	Use Minimax algorithm for solving Tic-Tac-Toe game (Tic-tac-toe can be played on a 5 x 5 grid with each player trying to get five in a row).	4
5	Construct an Object detection learning model for Robot Arm Tracking using open source frameworks	4
6	Construct a face recognition learning model using suitable open source framework	4
	Total	**24**

Course Designers:

1. Dr.S.Mercy Shalinie shalinie@tce.edu
2. Dr.K.Sundarakantham kskcse@tce.edu

		Category	L	T	P	Credit
18CG270	**DESIGN AND ANALYSIS OF ALGORITHMS LAB**	PC	0	0	4	2

Preamble

The laboratory course will facilitate the students to apply the concepts of randomized algorithms, linear and non linear optimization techniques for solving graph, string and network problems. This course also provides an insight to the students on developing algorithms for the concepts of cryptography and distributed systems considering various techniques and design trade-offs.

Prerequisite

Nil

Course Outcomes

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

Implement heuristic algorithms for Constraint Satisfaction Problems (CO1)	Apply
Develop linear algorithms for various problems like scheduling, graph, network and subsequence problems. (CO2)	Apply
Develop non-linear or heuristics algorithms for various problems like scheduling, graph, network and subsequence problems. (CO3)	Apply
Implement encryption and decryption algorithms(CO4)	Apply
Develop algorithms for clock synchronization and dead lock avoidance (CO5)	Analyze
Develop randomization algorithms for various problems like scheduling, graph, sorting, network and subsequence problems (CO6)	Apply

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

List of Experiments

1. Implement Crossword puzzles as Constraint Satisfaction problems
2. Solve the graph coloring problem by backtracking and constraint propagation (using heuristics)
3. Develop an algorithm for shortest path in multi-stage graph using dynamic programming
4. Implement Ford–Fulkerson algorithm to compute the maximum flow in a graph
5. Solve Maximum Clique Problem using Branch and Cut Method
6. Implement Boyer–Moore string search algorithm for substring search.

7. Implement Data Encryption Standard (DES), a Symmetric (secret key) encryption algorithm
8. Implement RSA, asymmetric (secret key) encryption algorithm
9. Implement any two clock synchronization algorithms and compare their performances. (Berkeley algorithm, Cristian's algorithm, Intersection algorithm, Marzullo's algorithm)
10. Implement Banker's algorithm used for deadlock avoidance.
11. Develop a randomization algorithm for anyone of the problems like Graph coloring, Vertex cover problem, maximal flow, shortest path problems, maximum subsequence generation etc.
12. Implement the randomized quick sort using divide and conquer strategy.

Course Designer:

1. Dr.S.Sudha ssj@tce.edu

CURRICULUM AND DETAILED SYLLABI

FOR

M.E DEGREE (Computer Science and Engineering) PROGRAMME

PROGRAMME ELECTIVES

FOR THE STUDENTS ADMITTED FROM THE

ACADEMIC YEAR 2021 - 2022 ONWARDS

THIAGARAJAR COLLEGE OF ENGINEERING

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

MADURAI – 625 015, TAMILNADU

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18CGPC0	MACHINE LEARNING	Category	L	T	P	Credit
		PE	3	0	0	3

Preamble

This course will present the key algorithms and theory that form the core of machine learning. Since machine learning draws on concepts and results from many fields such as statistics, information theory, computational complexity etc. the best way to learn the course is to view it from all these perspectives and understand the problem settings, algorithms and assumptions that underlie each. The primary goal of this course is to provide such an exposure to Post graduate students

Prerequisite

Review of Probability Theory and Statistics

Course Outcomes

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

Construct training and prediction algorithms for classification using decision trees, artificial neural networks, Deep Learning and Support Vector Machines.(CO1)	Apply
Construct learning algorithms using Bayesian probabilistic models for complex applications. (CO2)	Apply
Illustrate the fundamentals of computational learning theory with an understanding of the hypotheses spaces. (CO3)	Apply
Construct learning algorithms which involves linear regression with a comprehension of regularization, bias-variance and evidence approximation.(CO4)	Apply
Compare the available design options and apply supervised and unsupervised learning algorithms to solve complex problems with an understanding of the trade-offs involved. (CO5)	Analyze
Compare the parallel algorithms for various learning models from massive data sets. (CO6)	Analyze

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous		Assignment		Terminal Examination
	1	2	1	2	
Remember	30	30	-	-	10
Understand	40	30	30	30	10
Apply	30	30	70	60	50
Analyze	-	10	-	10	30
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Course Level Assessment Questions

Course Outcome (CO1):

1. Define a well posed learning problem.
2. Identify the task "*T*", performance measure "*P*", and experience "*E*" for a robotic learning problem.
3. Illustrate how the learning problem automatically alters its representation to improve its ability to represent and learn the target function
4. Classify the various types of training experience suitable for learning tasks.
5. Define Entropy measures in identifying the best classifier.
6. Demonstrate the ID3 algorithm specialised to learn Boolean valued functions.
7. Illustrate how will you avoid overfitting data in decision tree algorithm?

Course Outcome (CO2):

1. State Bayes theorem.
2. Apply binary class LSTMs to medical diagnosis problem.
3. Apply the Deep Learning methods for classifying text documents.
4. Define Perceptron Training Rule.
5. Construct a training rule for output unit weight and hidden unit weights for Back propagation algorithm.
6. Assume that you have to build a classifier based on SVM to classify a set of images into one of the given 100 types of different flowers. Analyze and Illustrate the Pros and Cons of each of the following techniques to perform a multi-class classification using SVM:

   (i) One-against-One
   (ii) One-against-All
   (iii) Directed Acyclic Graph (DAG) SVM.

Course Outcome (CO3):

1. Define the Weighted Majority Algorithm.
2 Apply the significance of hypotheses spaces to character recognition problem.

3. Illustrate the VC dimension for Neural Networks

Course Outcome (CO4):

1. Explain how K.Means Algorithm is applied for Classification problems.
2. Define EM Algorithm.
3. Explain how evidence approximation is used to learn models of regression.
4. Illustrate the use of regularization in avoiding over-fitting.

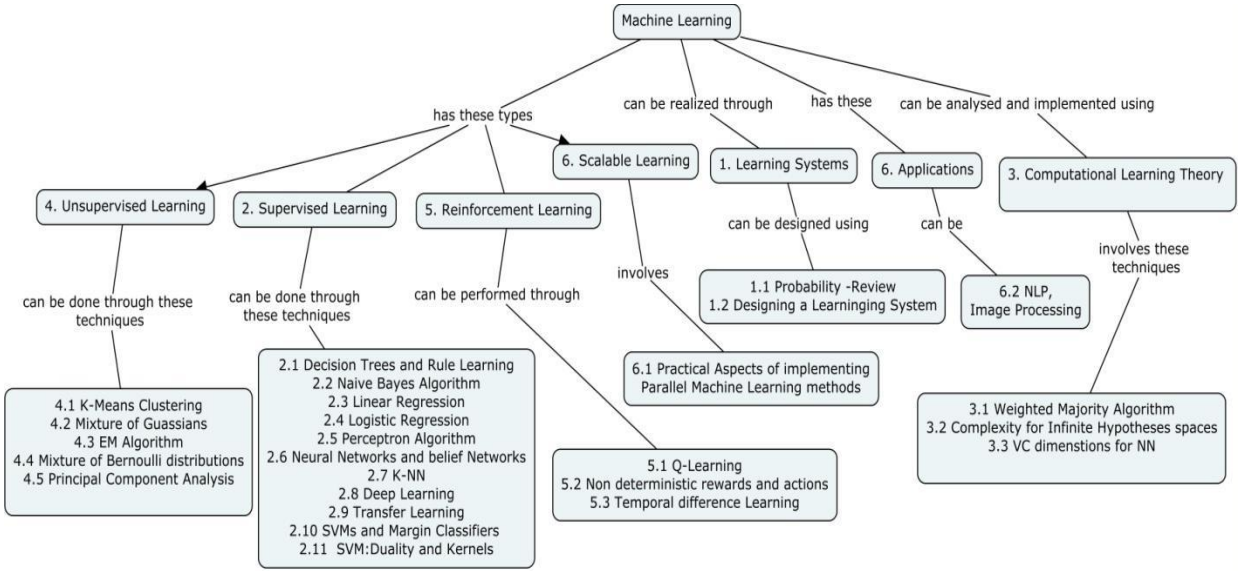
Course Outcome (CO5):

1. Evaluate how concept learning is viewed as task of searching through a large hypothesis space and find the best fit among the training examples.
2. Illustrate how *k*-means algorithm is applied to image segmentation and image compression.
3. Illustrate how *Q*-learning algorithm is used to estimate Q for an agent based problem.
4. Explain how Non-deterministic rewards and actions are obtained in Q-learning.
5. Apply the concept of machine learning problem in checkers playing game.
6. Illustrate how temporal difference learning learns by reducing discrepancies between estimates at different times.

Course Outcome (CO6):

1. Inspect the various strategies to be considered for implementing parallel machine learning algorithm in Hadoop framework.
2. Compare the various parallel machine learning algorithms are implemented using Hadoop frame work.
3. Analyze the parallel machine learning algorithms that run on top of the Hadoop framework for a given research problem (Assignment)

Concept Map



Syllabus

Introduction - Probability-Review. **Supervised learning**– Designing a Learning system, Decision trees and rule learning, Naïve Bayes algorithm, Linear regression, Logistic regression,

Perceptron Algorithm, Neural Networks and Belief Networks, K-NN, Deep Learning, Convolution Neural Networks, Long Short Term Memory Networks, Transfer Learning, SVMs and Margin Classifiers, SVM : duality and kernels.

Computational Learning Theory - Weighted Majority Algorithm, Complexity for infinite hypotheses spaces, VC dimension for Neural Networks

Unsupervised learning –K-means Clustering, Mixture of Gaussians, EM Algorithm and K-means, Mixture of Bernoulli distributions, Principal Component Analysis

Reinforcement learning – Q learning, Nondeterministic rewards and actions, Temporal difference Learning.

Scalable learning and Applications– Practical aspects of implementing parallel Machine Learning methods, NLP and Image processing

Text Books

1. Christopher M.Bishop, “Pattern recognition and machine learning”, Springer,2007.
2. Tom M. Mitchell, “Machine learning”, McGraw Hill,1997.
3. Ian Goodfellow, Yoshua Bengio, Aaron Courville, “Deep Learning”, MIT Press, 2016

Reference Books

1. Kevin Murphy, Machine Learning - A Probabilistic Perspective, Adaptive Computation and Machine Learning, MIT Press, 2012.
2. Ethem Alpaydin, “Introduction to machine learning”, The MIT Press,2004.
3. Stephen Marsland, “Machine learning: An algorithmic perspective”,CRC,2009.
4. NPTEL Lecture “ Introduction to Machine Learning” Prof.Balaraman Ravindran, IIT Madras, https://nptel.ac.in/courses/106106139/

Course Contents and Lecture Schedule

Sl No.	Topics	No.of Lectures
1	**Introduction to Machine Learning**	
1.1	Probability-Review	1
2	**Supervised Learning**	
2.1	Designing a Learning system	1
2.2	Decision trees and rule learning	1

2.3	Naïve Bayes algorithm	1
2.4	Linear regression	1
2.5	Logistic regression	1
2.6	Perceptron Algorithm	1
2.7	Neural Networks and Belief Networks	2
2.8	K-NN	1
2.9	Deep Learning	1
2.10	Convolution Neural Networks	1
2.11	Long Short Term Memory Networks	1
2.12	Transfer Learning	1
2.13	SVMs and Margin Classifiers	1
2.14	SVM : duality and kernels	1
3	**Computational Learning Theory**	
3.1	Weighted Majority Algorithm	1
3.2	Complexity for infinite hypotheses spaces	2
3.3	VC dimension for Neural Netowrks	2
4	**Unsupervised learning**	
4.1	K-means Clustering	1
4.2	Mixture of Gaussians	1
4.3	EM Algorithm and K-means	2
4.4	Mixture of Bernoulli distributions	2
4.5	Principal Component Analysis	2

5	**Reinforcement Learning**	
5.1	Q learning	1
5.2	Nondeterministic rewards and actions	1
5.3	Temporal difference learning	1
6	**Scalable Learning and Applications**	
6.1	Practical aspects of implementing parallel Machine Learning methods	2
6.2	NLP and Image processing	2
	Total	**36**

Course Designers:

1. Dr.S.Mercy Shalinie shalinie@tce.edu
2. Dr.K.Sundarakantham kskcse@tce.edu

18CGPD0	PROTOCOL DESIGN AND VERIFICATION			
Category	L	T	P	Credit
PE	3	0	0	3

Preamble

This syllabus is intended for the candidate who desires to learn Protocol and the design of computer protocols and verification of protocols in a precise manner. The syllabus emphasizes protocol design methodologies, verifications and validations. The intention is to provide sufficient depth in basic protocol mechanisms, security and the services offered. Besides the written papers, it provides an insight to a layered approach of protocol design and applications

The modules in the syllabus reflect overall protocol design based on layers and applications. Thus, modules collectively focus on protocol design mechanisms, security, encoding and services offered by protocols.

Prerequisite

NIL

Course Outcomes

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

CO 1	Apply CSP descriptions and rules and synchronize services	Apply
CO 2	Apply basic protocol Mechanisms for multiplexing and segmenting	Apply
CO 3	Achieve integrity by adopting Integrity and authentication	Apply
CO 4	Compare and contrast and select relevant encoding mechanisms	Analyze
CO 5	Compare and contrast application support protocols	Analyze
CO 6	Compare and contrast distributed transaction processing protocols	Analyze

Mapping with Programme Outcomes

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO1	S	M	L	L								
CO2	S	M	L	L								

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

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous		Assignment		Terminal Examination
	1	2	1	2	
Remember	20	20	-	-	20
Understand	20	20	-	-	20
Apply	60	40	100	100	40
Analyze	-	20	-	-	20
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Apply CSP descriptions to design a protocol. (Apply)
2. Apply process synchronisation and design a service protocol. (Apply)
3. Provide protocol services for a layered protocol. (Apply)

Course Outcome 2 (CO2):

1. Use basic protocol mechanisms and demonstrate Multiplexing (Apply)
2. Demonstrate Reliable broadcasts and Multipeer Consensus (Apply)
3. Explain Byzantine agreement and clock synchronization (Apply)

Course Outcome 3 (CO3):

1. Show how cryptosystems to provide security for Protocols. (Apply)
2. Explain in detail Entity authentication and key exchange in protocols. (Apply)
3. Apply Addressing and routing and demonstrate Congestion avoidance.(Apply)

Course Outcome 4 (CO4):

1. Compare and contrast various Protocol encoding techniques (Analyze)
2. Distinguish protocols based on a layered approach (Analyze)

Course Outcome 5 (CO5):

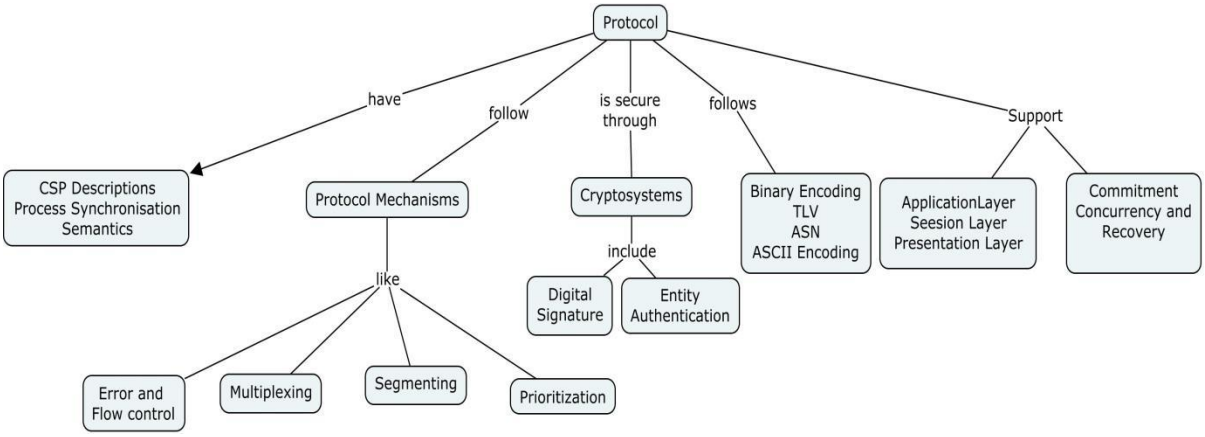
1. Compare and contrast various application support protocols. (Analyze)

2. Justify the need for commitment in protocol design. (Analyze)
3. Compare and contrast concurrency and recovery. (Analyze)

Course Outcome 6 (CO6):

1. Analyze the behaviour of a protocol on concurrency and recovery. (Analyze)
2. Identify and recommend a suitable application protocol to implement a distributed transaction. (Analyze)

Concept Map



Syllabus

Introduction - CSP Descriptions and Proof Rules - Processes and Process Synchronisation - Channel History Semantics - Failure Semantics - Protocols and Services - Providing a service- Service Features - OSI and other layered architectures.

Basic Protocol Mechanisms – Sequence Error and Flow control – change of service- Multiplexing – splitting –Segmenting – Reassembly – Prioritization- Multipeer Consensus – Reliable broadcasts – Election – Commitment – Byzantine Agreement – Clock Synchronization

Security - Crypto systems – Integrity – Digital Signature – Entity Authentication –Key Exchange - Naming Addressing and Routing – General Principle – Addressing Structures – routing – Congestion.

Protocol Encoding – Simple binary encoding – TLV –ASN.1 – ASCII Encoding - Protocols in the OSI Lower Layers – Data Link Layer– Network layer –Transport Layer.

Application Support Protocols-Session Layer- Presentation Layer –Application Layer – Commitment -Concurrency and recovery - Client Server Systems- Security Middle ware - Application Protocols – FTP – Distributed Transaction Processing Notation – Data types Inference Rules.

Text Book

1. Principles of Protocol Design : Robin Sharp: ISBN 978-3-540-77540-9 Springer-Verlag Berlin Heidelberg.

Reference Book

1. Design And Validation Of Computer Protocols : Gerard J. Holzmann. Prentice Hall; 1 edition.

2. Protocol Engineering : König, Hartmut ISBN 978-3-642-29145-6. Springer-Verlag Berlin Heidelberg

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1	**Introduction** (7)	
1.1	CSP Descriptions and Proof Rules	1
1.2	Processes and Process Synchronisation	1
1.3	Channel History Semantics .	1
1.4	Failure Semantics	1
1.5	Protocols and Services	1
1.6	Providing a service-Service Features -	1
1.7	OSI and other layered architectures	1
2	**Basic Protocol Mechanisms** (8)	
2.1	Sequence Error and Flow control	1
2.2	Change of service- Multiplexing	1
2.3	Splitting – Segmenting	1
2.4	Reassembly – Prioritization	1
2.5	Multipeer Consensus	1
2.6	Reliable broadcasts	1
2.7	Election – Commitment	1
2.8	Byzantine Agreement – Clock Synchronization	1
3	**Security** (6)	
3.1	Crypto systems	1
3.2	Integrity – Digital Signature	1
3.3	Entity Authentication Key Exchange	1
3.4	Naming Addressing and Routing	1
3.5	General Principle , Addressing Structures	1
3.6	Routing ,Congestion	1
4	**Protocol Encoding** (5)	
4.1	Simple binary encoding	1
4.2	TLV - ASN.1 - ASCII Encoding	1
4.3	Protocols in the OSI Lower Layers	1

4.4	Data Link Layer - Network layer - Transport Layer.	2
5	**Application Support Protocols** (10)	
5.1	Session - Presentation – Application Layer	3
5.2	Commitment -Concurrency and recovery	2
5.3	Client Server Systems- Security Middle ware	2
5.4	Application Protocols - FTP	1
5.5	Distributed Transaction Processing Notation – Data types Inference Rules.	2
	Total Hours	36

Course Designer:

1. Mr.S.Prasanna sprcse@tce.edu

Category	L	T	P	Credit
PE	3	0	0	3

18CGPE0 INFORMATION STORAGE AND MANAGEMENT SYSTEMS

Preamble

The course on Information Storage and Management aims at emphasizing the need for Information storage, provides an in depth coverage of technologies in the various phases of designing, building and sustaining an Information Storage System and to provide an overview of various management techniques.

Course Outcomes

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

Explain the components and functions of Information Storage Systems. (CO1)	Apply
Design the storage system for the given scenario (CO2)	Apply
Investigate the common issues in Storage Infrastructure. (CO3)	Apply
Outline the need and importance of Information Availability and Business Continuity (CO4)	Apply
Analyze the working of Information Storage Systems (CO5)	Analyze
Analyze the monitoring and management activities (CO6)	Analyze

Mapping with Programme Outcomes

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11
CO1.	M	L	-	-	-	-	-	L	L	-	-
CO2.	S	L	S	L	-	-	-	L	L	-	-
CO3	S	M	M	L	-	L	-	S	L	-	L
CO4	M	L	-	-	-	-	-	L	L	-	-
CO5	S	L	S	L	-	-	-	L	L	-	-
CO6	M	L	-	L	-	-	-	L	L	-	-

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment		Assignment		Terminal Examination
	1	2	1	2	
Remember	40	20	-	-	20
Understand	40	40	-	-	40
Apply	20	20	100	-	20

Analyze	-	20	-	100	20
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Describe the key requirements of storage systems with their functionalities
2. Define Platter
3. List the demerits of centralized data storage.

Course Outcome 2 (CO2):

1. The IT department of a bank promises customer access to the currency conversion rate table between 9am and 4pm from Monday to Friday. It updates the table everyday at 8am with a feed from the Mainframe system. The update process takes 35 minutes to complete. On Thursday, due to a database corruption, the rate table could not be updated. At 9.05 am, it was established that the table had errors. A rerun of the update was done and the table was recreated at 9.45 am. Verification was run for 15 minutes and the rate table became available to the bank branches. Compute the availability of the rate table for the week in which this incident took place assuming that there were no other issues.
2. ABC Corporation is trying to decide between an integrated or a gateway NAS solution. The existing SAN at ABC will provide capacity and scalability. The IT department is considering a NAS solution for the training department at ABC for training videos. The videos will only be used by the training department for evaluation of instructors. Pick a NAS solution.
3. A company is considering storage implementation. They do not have a current storage infrastructure to use, but they have a network that gives them good performance. Suggest whether native or bridged iSCSI should be used.

Course Outcome 3 (CO3):

1. An application specifies a requirement of 200GB to host a database and other files. It also specifies that the storage environment should support 5000 IOPS during its peak processing cycle. The disks available for configuration provide 66GB of usable capacity and the manufacturer specifies that they can support a maximum of 140 IOPS. The application is response time sensitive and the disk utilization beyond 60% will not meet

the response time requirements of the application. Compute the minimum number of disks that should be configured to meet the requirements of the application.

2. Consider a disk I/O system in which an I/O request arrives at the rate of 80 IOPS. The disk service time is 6ms.
    a. Compute the following
        i. Utilization of I/O controller
        ii. Total response time
        iii. Average queue size
        iv. Total time spent by a request in a queue
    b. Compute the preceding parameter if the service time is halved.

3. A 10k RPM drive is rated to perform 130 IOPS and a 15k RPM drive is rated to perform 180 IOPS for an application. The read/write ratio is 3:1. Compute the RAID-adjusted IOPS for the 10k and 15k drives for RAID 1, RAID 5 and RAID 6.

Course Outcome 4 (CO4):

1. Unitech Corporation has planned to setup a disaster recovery solution for its storage infrastructure. The Company houses 3000 workstations and 5 servers that run 24/7. The Company requires its DR solution to get activated immediately after an outage. Demonstrate a suitable DR solution to suite the company’s requirements.
2. Describe the benefits of storage array replication.
3. Discover the phases of Business Continuity planning life cycle.

Course Outcome 5 (CO5):

1. Develop a suitable Business Continuity Plan that may lead to provisioning of uninterrupted access to data at all times for the following situation:

    The busiest time of the day for the $1.5 billion Mirage Resorts Inc. in Las Vegas is between 10 p.m. and 2 a.m., which means the staff has four hours to back up more than 570 GB of data to tape before the day's first shift starts at 6 a.m. On top of its backup needs, the company is making a push toward a Web-based paperless office, which means managers need access to reports 24 x 7. And, Mirage Resorts Inc. also has to accommodate the requirements of Nevada Gaming Board auditors who demand complete access to every transaction during the most recent period under scrutiny. To add to that, the company's Las Vegas hotels run more than 5,000 desktops and servers, another 5,000 network printers, and track more than 6,000 slot machines daily. The company is ready to implement a Business Continuity solution.

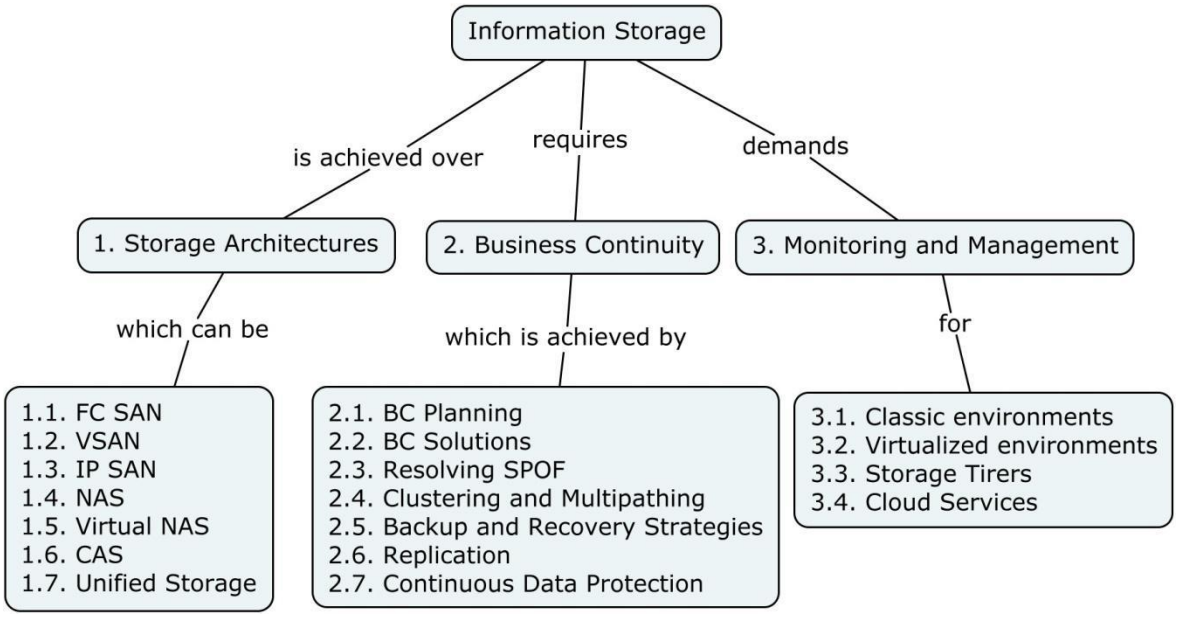
2. Examine the security implementation for a NAS based storage architecture.
3. Discover the process of archival in CAS.

Course Outcome 6 (CO6):

1. A performance problem has been reported on a database. Monitoring confirms that at 10am, a problem surfaced and access to the database is severely affected until 1pm every day. This timeslot is critical for business operations and an investigation has been launched. A reporting process that starts at 10pm contends for database resources and constrains the environment. Analyze the monitoring parameters and write the components that ensures accessibility, capacity,performance and security.

2. National Stock Exchange promises customer access to the electronic trading system between 9am and 4pm from Monday to Friday. It updates the equity table everyday at 8am with a feed from the Mainframe system. The update process takes 35 minutes to complete. On Thursday, due to a database corruption, the equity table could not be updated. At 9.05 am, it was established that the table had errors. A rerun of the update was done and the table was recreated at 9.45 am. Verification was run for 15 minutes and the equity table became available to the customers. Compute the availability of the equity table for the week in which this incident took place assuming that there were no other issues...
3. A storage array dials a support center automatically whenever an error is detected. The vendor's representative at the support center can log on to the service processor of the storage array through the Internet to perform diagnostics and repair. Show the impact of this feature in a secure storage environment and provide security methods that can be implemented to mitigate any malicious attacks through this gateway.

Concept Map



Syllabus

Storage Networking Technologies: Fibre Channel SAN – SAN based virtualization – Storage access over IP network - Network Attached Storage – File level virtualization in NAS – Integration of NAS and SAN - Object based storage - Unified Storage platform

Business Continuity: Information availability and Business Continuity - Business Continuity terminologies - Business Continuity Planning – Solutions - Clustering and Multipathing architecture - Single Points of Failure - Backup and Recovery - Methods, targets and topologies

- Data Deduplication and backup in virtualized environment - Fixed Content and Data Archive – Replication - Local Replication - Remote Replication - Three-Site Remote Replication

Monitoring and Management: Monitoring and managing storage infrastructure components in classic and virtual environments - Information lifecycle management (ILM) and Storage Tiering - Cloud service management

Text Books

1. Datacenter connectivity technologies: principles and practice, Frank Chang, River Publishers, 2018.
2. Information Storage and Management, Storing, Managing, and Protecting Digital Information in Classic, Virtualized, and Cloud Environments, 2nd Edition, EMC Educational Services, Wiley 2012

Reference Books

1. Designing Storage Area Networks, Tom Clark, Addison-Wesley Professional, 2 edition, 2003.
2. Storage Area Network Essentials: A Complete Guide to Understanding and Implementing SANs, Richard Barker, Paul Massiglia, Wiley, 2001
3. Storage Networks: The Complete Reference, Robert Spalding,Tata McGraw Hill, 2003.
4. Disaster Recovery and Business Continuity, Thejendra BS, Shroff Publishers, 2006.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1.	**Storage Architectures**	
1.1	FC SAN	2
1.2	Virtual SAN	2
1.3	IP SAN	2
1.4	Network Attached Storage	2
1.5	Virtual Network Attached Storage	2
1.6	CAS	2
1.7	Unified Storage	2
2.	**Business Continuity**	
2.1	BC Planning - Information availability and Business Continuity	2
2.2	BC Solutions	2
2.3	Resolving SPOF	2
2.4	Clustering and Multipathing	2
2.5	Backup and Recovery Strategies	2
2.6	Replication	2
2.7	Continuous Data Protection	2
3	**Monitoring and Management**	
3.1	Classic environments	2
3.2	Virtualized environments	2
3.3	Storage Tirers	2
3.4	Cloud Services	2
	Total	**36**

Course Designer:

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		Category	L	T	P	Credit
18CGPF0	**DESIGN AND ANALYSIS OF PARALLEL ALGORITHMS**	PE	3	0	0	3

Preamble

This course aims at facilitating students to design and analyze parallel algorithms for fundamental problems in computer science. This course also provides the student with an understanding of parallelization frameworks like MPI, Open-MP using which these algorithms can be implemented.

Course Outcomes

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

Construct and Analyze parallel algorithms with an understanding of the cost models associated with the underlying parallel interconnection network. (CO1)	Analyze
Apply the notion of cost, speed-up, efficiency and scalability to analyze Parallel algorithms and distinguish between candidate parallel algorithms to choose the most appropriate algorithm for solving the problem at hand. (CO2)	Analyze
Construct parallel algorithms for problems by applying algorithm design techniques and subsequently analyze their efficiency. (CO3)	Analyze
Analyze the applicability of searching and sorting parallel algorithms parallel algorithms on various parallel computing models and understand its speedup and efficiency (CO4)	Analyze
Construct pseudo-code for parallel algorithms to solve well-known problems like matrix operations and solving equations (CO5)	Apply
Construct implementations of parallel algorithms on top of parallel programming frameworks like MPI, OpenMP. (CO6)	Apply

Mapping with Programme Outcomes

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	S	S	S	M							
CO2	S	S	S	M							
CO3	S	S	S	M							
CO4	S	S	S	M							
CO5	S	M	M	L							

CO6	S	M	M	L	S	M	M	L	L	M	M

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous		Assignment		Terminal Examination
	1	2			
Remember	10	5			10
Understand	15	15			30
Apply	20	20	50	50	30
Analyze	15	20		50	30
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Course Level Assessment Questions

Course Outcome (CO1):

1. State the worst case time complexity and cost of performing matrix transpose using a shuffle-connected computer.
2. Paraphrase a parallel algorithm to perform mesh transpose.
3. A q-dimensional cube connected SIMD computer with n = 2^q processors P0, P1, …, Pn-1 is given. Each processor Pi holds a datum xi. Construct a parallel algorithm to replace x0 with x0+x1+ … + xn-1 and analyze its time complexity and cost.

Course Outcome (CO2):

1. State the difference between EREW and CREW SM SIMD computers.
2. State the desirable properties of a parallel algorithm with respect to the no. of processors.
3. A satellite picture is represented as an n x n array of pixels each taking an integer value between 0 and 9, thus providing various gray levels. It is required to smooth the picture, that is the value of pixel (i,j) is to be replaced by the average of its value and those of its eight neighbors. Illustrate a special purpose parallel architecture to solve this problem. Assume that m the number of processors available is less than n^2 the no. of pixels. Construct two different implementations of the smoothing process and analyze their running times.

4. Analyze the suitability of each of the SM SIMD models to solve the systems of linear equations using a parallel algorithm
5. Analyze and compare the worst case time complexities of different algorithms to perform searching on a random sequence using different models of SM SIMD machines

Course Outcome (CO3):

1. State the purpose of the 'folding' stage while searching on a mesh.
2. A tree connected computer with n leaves stores one integer of a sequence S per leaf. For a given k, 1<= k <= n, describe an algorithm that runs on this computer and selects the k^{th} smallest element of S and analyze its efficiency in terms of its time and cost.
3. Construct a parallel algorithm to find roots of non-linear equations using Newton-Raphson method and analyze the efficiency of the parallel algorithm.

Course Outcome (CO4):

1. Illustrate an algorithm for EREW sort and find its time complexity
2. Compare and contrast the various parallel computing models used for searching an element in a sorted sequence
3. Interpret the various operations supported by SIMD computers for random sequence search

Course Outcome (CO5):

1. Construct a pseudo-code for a parallel algorithm to perform matrix transpose on a mesh
2. Construct a pseudo-code for a parallel algorithm to find the roots of non-linear equations using a parallel algorithm based on Newton-Raphson's method
3. Paraphrase a parallel algorithm to perform Shuffle transpose.

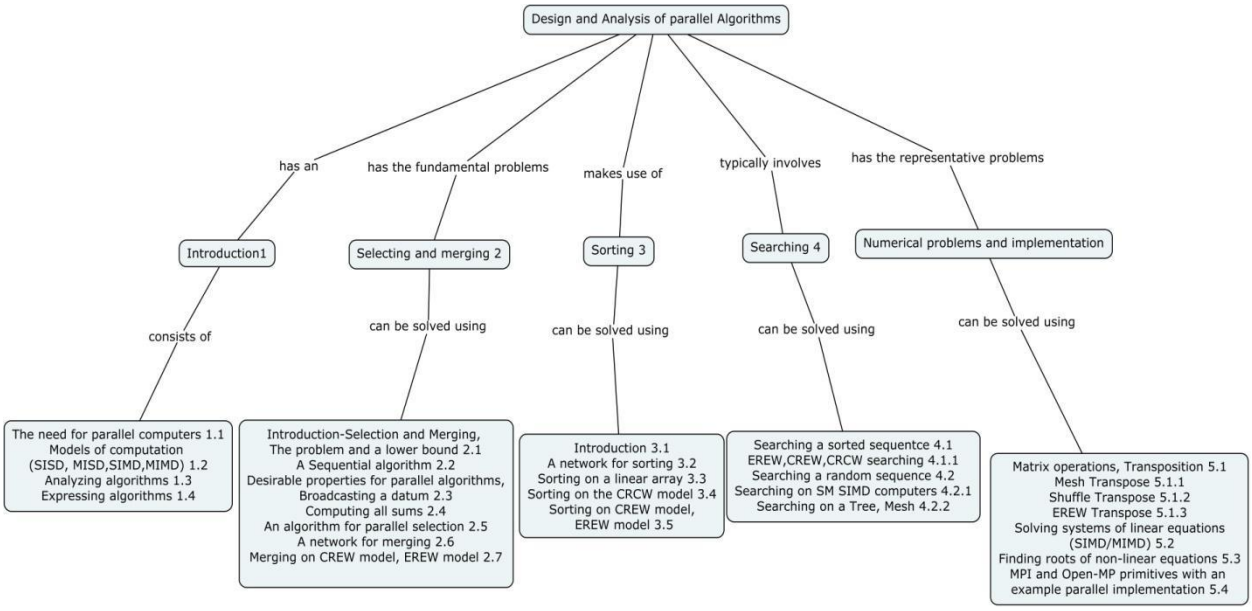
Course Outcome (CO6):

[Can be provided as an assignment]

1. Analyze the implications and advantages of combining MPI and OpenMP to implement parallel algorithms
2. Develop a parallel program for implementing Odd Even transposition sort using MPI/OpenMP primitives
3. Develop a parallel program on top of MPI/OpenMP primitives to implement the parallel select algorithm.

4. Develop a parallel program on top of MPI/OpenMP primitives to implement the parallel merge algorithm.

Concept Map



Syllabus

Introduction: The need for parallel computers, Models of computation (SISD, MISD, SIMD, MIMD), Analyzing algorithms, Expressing Algorithms. **Selection and Merging:** Introduction – Selection and Merging, The problem and a lower bound, A Sequential algorithm, Desirable properties for parallel algorithms, Broadcasting a datum, Computing All Sums, An algorithm for parallel selection, A network for merging, Merging on CREW model, Merging on the EREW model. **Sorting:** Introduction, A network for sorting, Sorting on a linear array, Sorting on the CRCW model, Sorting on CREW model, Sorting on the EREW model. **Searching:** Introduction, Searching a sorted sequence, EREW, CREW, CRCW searching, Searching a random sequence, Searching on SM SIMD computers, Searching on a Tree, Searching on a Mesh. **Numerical problems and implementation**: Matrix operations, Transposition, Mesh Transpose, Shuffle Transpose, EREW Transpose, Solving systems of linear equations (SIMD/MIMD), Finding roots of non-linear equations, MPI and Open-MP primitives with an example parallel implementation.

Reference Books

1. S.G. Akl, “The design and analysis of parallel algorithms”, Prentice Hall of India, 1989.
2. Michael Jay Quinn, “Parallel programming in C with MPI and OpenMP”, McGraw-Hill Higher Education, 2004.

3. S. Lakshmivarahan and S.K. Dhall, “Analysis and design of parallel algorithms – Arithmetic and Matrix problems”, McGraw Hill, 1990.

Course Contents and Lecture Schedule

No.	Topic	No. of Lectures
1	**Introduction (4)**	
1.1	The need for parallel computers	1
1.2	Models of computation (SISD, MISD, SIMD, MIMD)	1
1.3	Analyzing algorithms	1
1.4	Expressing Algorithms	1
2	**Selection and Merging (7)**	
2.1	Introduction – Selection and Merging, The problem and a lower bound	1
2.2	A Sequential algorithm	1
2.3	Desirable properties for parallel algorithms, Broadcasting a datum	1
2.4	Computing All Sums	1
2.5	An algorithm for parallel selection	1
2.6	A network for merging	1
2.7	Merging on CREW model, EREW model	1
3	**Sorting (5)**	
3.1	Introduction	1
3.2	A network for sorting	1
3.3	Sorting on a linear array	1
3.4	Sorting on the CRCW model	1
3.5	Sorting on CREW model, EREW model	1

4	**Searching (6)**	
4.1	Searching a sorted sequence	1
4.1.1	EREW, CREW, CRCW searching	1
4.2	Searching a random sequence	1
4.2.1	Searching on SM SIMD computers	1
4.2.2	Searching on a Tree, Mesh	2
5	**Numerical problems and implementation (14)**	
5.1	Matrix operations, Transposition	2
5.1.1	Mesh Transpose	2
5.1.2	Shuffle Transpose	2
5.1.3	EREW Transpose	2
5.2	Solving systems of linear equations (SIMD/MIMD)	2
5.3	Finding roots of non-linear equations	2
5.4	MPI and Open-MP primitives with an example parallel implementation	2
	Total	**36**

Course Designer:

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18CGPG0	FORMAL VERIFICATION AND MODEL CHECKING	Category	L	T	P	Credit
		PE	3	0	0	3

Preamble

Embedded software control many of the safety-critical systems that we deal with in everyday life: for instance, modern cars are equipped with software to automatically change gears; pacemakers come with a software controller to regulate heart beat; aircrafts have flight control software, and so on. Typically, these (software) controllers have to make decisions based on inputs coming from multiple interacting components. As the size and the number of interacting components increase, the design and verification of controllers becomes increasingly complex.
Model checking is a field of research that addresses this challenge by making use of mathematical models in the design and verification of controllers. The main idea is to look at the system as a mathematical model - commonly used models are extensions of finite-state machines. Design requirements on the controller then get translated to suitable questions on these mathematical models. The goal of this course is to understand some of the techniques and tools used in the process of model-checking.

Prerequisite

- Familiarity with basic algorithms and finite-state machines preferable

Course Outcomes

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

Construct transition systems for hardware circuits, data-dependent and concurrent programs (CO1)	Apply
Develop model checker using appropriate tools for verifying hardware and concurrent systems (CO2)	Create
Determine linear-time properties as safety and liveness for the given model (CO3)	Apply
Compute regular safety properties and ω-regular properties using automata-based algorithms (CO4)	Apply
Apply Computation Tree Logic (CTL) to specify properties of concurrent / reactive systems. (CO5)	Apply
Apply Linear Temporal Logic (LTL) to specify simple properties of systems for model checking (CO6)	Apply

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous		Assignment		Terminal Examination
	1	2	1	2	
Remember	20	20	-	-	20
Understand	20	20	-	-	20
Apply	60	60	100	100	60
Analyze	-	-	-	-	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Assume i is a natural number. The following process increments i arbitrarily and then decreases the variable to zero. The nondet() command non-deterministically returns a Boolean value.

Algorithm 1 Non-deterministic counter

```
while nondet() do
  i := i + 1;
end while
while i > 0 do
  i := i − 1;
end while
```

   a. Draw a program graph representation of this process.
   b. Draw the corresponding transition system.
      Hint: This is an infinite state system. So you only have to draw it up to some finite depth from where it is clear how it goes on.
   c. Give a precise definition of this transition system

2. We are given three (primitive) processes P1, P2, and P3 with shared integer variable x and local registers r1, r2 and r3. The program of process Pi is as follows**:**

Algorithm 2 Process P_i

```
for k_i = 1, ..., 10 do
  LOAD(r_i ← x);
  INC(r_i);
  STORE(r_i → x);
end for
```

That is, Pi executes ten times the assignment x := x+1. The assignment x: = x+1 is realized using the three actions LOAD, INC and STORE. Consider now the parallel program:

Algorithm 3 Parallel program P

$x := 0;$

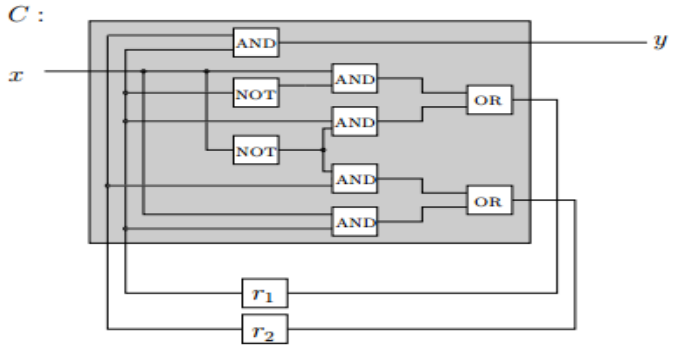
$P_1 \parallel P_2 \parallel P_3$

Does P have an execution that halts with the terminal value x = 2? Argue your point.

3. Consider the train crossing example. There it is possible that a train enters a crossing while the gate is open! We alter this system in the following ways:
   - A signal is added for the train. The signal can be green or red. The controller changes the signal to green when and only when the track gates are closed. The controller changes the signal to red before opening the gates again.
   - The train does not enter the crossing when the signal is red.
   - The controller still does not synchronize with the train on an enter action.

   a. Give the transition system representation of controller, gates, signal and train (Separately).
   b. Give the transition system representation of the combined system.
   c. Argue why the train never crosses the road when the train gates are still open.

4. Consider the following sequential hardware circuit:



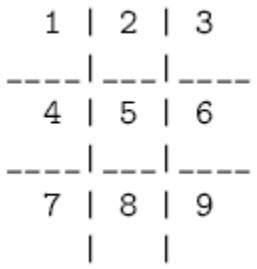
Give the transition system representation T of the circuit C. You need not specify (S, Act, →, I, AP, L) - a drawing suffices.

Course Outcome 2 (CO2):

1. Design model checking for Tower of Honai problem using model checking tool. The problem defined as: Mathematical game consisting of three poles and N disks of different sizes:
   a. it starts with the disks in a stack in ascending order of size on the left pole (the smallest at the top -> conical shape)
   b. the goal is to move the entire stack to the right pole:
      i. only one disk may be moved at a time

ii. each move consists of moving the upper disk from one pole to another one
iii. no disk may be placed on top
iv. of a smaller disk

4. Design model checking for Ferryman problem using model checking tool. The problem defined as: A ferryman has to bring a goat, a cabbage, and a wolf safely across a river. The ferryman can cross the river with at most one passenger on his boat. However he cannot leave unattended on the same side the cabbage and the goat or the goat and wolf (because the goat would eat the cabbage or the wolf would eat the goat).
   Can the ferryman transport all the goods to the other side safely?
3. Design model checking for Tic-tac-toe game using model checking tool. The problem defined as: Tic-tac-toe is a game for two players (X and O) who take turns marking the squares of a board (-> a 3 X 3 grid). The player who succeeds in placing three respective marks in a horizontal, vertical or diagonal row wins the game. The tic-tac-toe puzzle is modeled with an array of size nine.

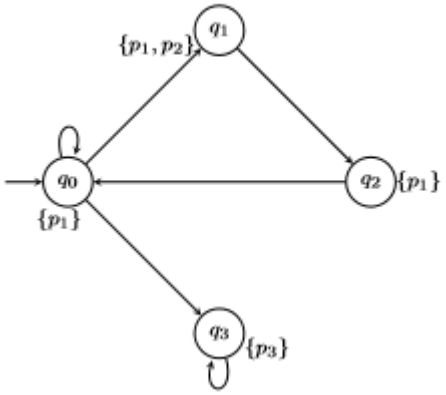


Course Outcome 3 (CO3):

1. Consider the set AP of atomic propositions defined by AP = { x = 0, x > 1 } and consider a non terminating sequential computer program P that manipulates the variable x. Formulate the following informally stated properties as LT properties:
   a. false
   b. initially x is equal to zero
   c. initially x differs from zero
   d. initially x is equal to zero, but at some point x exceeds one
   e. x exceeds one only finitely many times
   f. x exceeds one infinitely often
   g. the value of x alternates between zero and one
   h. true

   Determine which of the provided LT properties safety properties are. Justify your answers.

2. Which of the following traces is certainly a bad prefix for the safety property “p1,p2 should be not be true at the same time”
   a. {{p1},{p1},{p1},{p2},{p1},{p2},{p1}..}
   b. {{p2},{p2},{p2},{p2},{p2},{p2},{p2}..}
   c. {{p1},{p1},{p1},{p1},{p1,p2},{p1},{p1}..}
3. Which of the executions in the following TS does not satisfy the property “p2 is true infinitely often”?



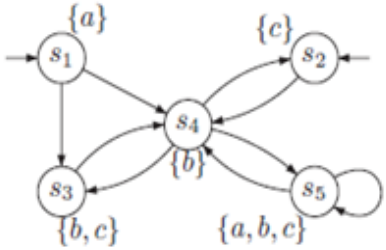
a. q0,q1,q2,q0,q1,q2,q0,q1,q2,q0,q1,q2...
b. q0,q3,q3,q3,q3,q3,q3,q3,q3.....For this exercise we give the following definition:

Course Outcome 4 (CO4):

1. Using algorithmic approach, construct automaton for the LTL formula $p_1\ U\ p_2$.
2. Construct a NBA for the language represented by the ω-regular expression $100(001)^{\omega} + 0^{\omega}$.
3. Using formula expansion method, show that which of the following traces violates the formula p1 → X(p2)
   a. {{p2},{p2},{p2},{p2},{p2},{p2},{p2}..}
   b. {{p1},{p2},{p2},{p2},{p2},{p2},{p2}..}
   c. {{p1},{p2},{p2},{p2},{p1},{p1},{p2},{p2},{p2},{p2},{p2},{p2},..}

Course Outcome 5 (CO5):

1. Consider the LTL formula $p_1 \cup p_2$
2. Show that the word $\{p_1\},\{p_1\},\{p_1\},\{p_1\},\{p_2\},\{p_1\},\{p_1\},\{p_1\},\{p_1, p_2\}$, ... accepted by the LTL formula using formula expansion. Construct automata for the formula expansion.
3. Consider the transition system TS over the set of atomic propositions AP ={ a, b, c }:



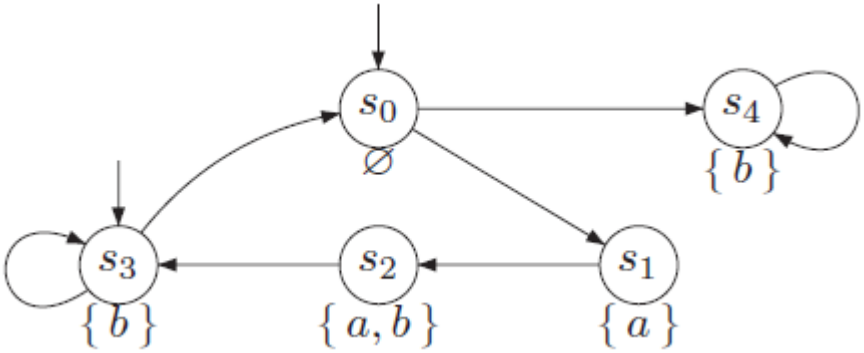
Decide for each of the LTL formulae φ_i below, whether $TS \models \varphi_i$ holds. Justify your answers! If $TS\ \varphi_i$, provide a path $\pi \in Paths(TS)$ such that $\pi\ \varphi_i$

a. $\varphi_1 = F\ G\ c$
b. $\varphi_2 = G\ F\ c$
c. $\varphi_3 = X \neg c \rightarrow X\ X\ c$
d. $\varphi_4 = G\ a$
e. $\varphi_5 = a \cup G\ (b \vee c)$

f. $\varphi_6 = (XXb) \cup (b \vee c)$

Course Outcome 6 (CO6):

1. Give a CTL-formula expressing the following property: “after the game show host opens the door with the goat, the contestant can still choose the door that will make him win and he can still choose the door that will make him lose”.
2. Consider the following CTL formulae and the transition system TS:



$$\Phi_1 = AGA(a \cup b)$$

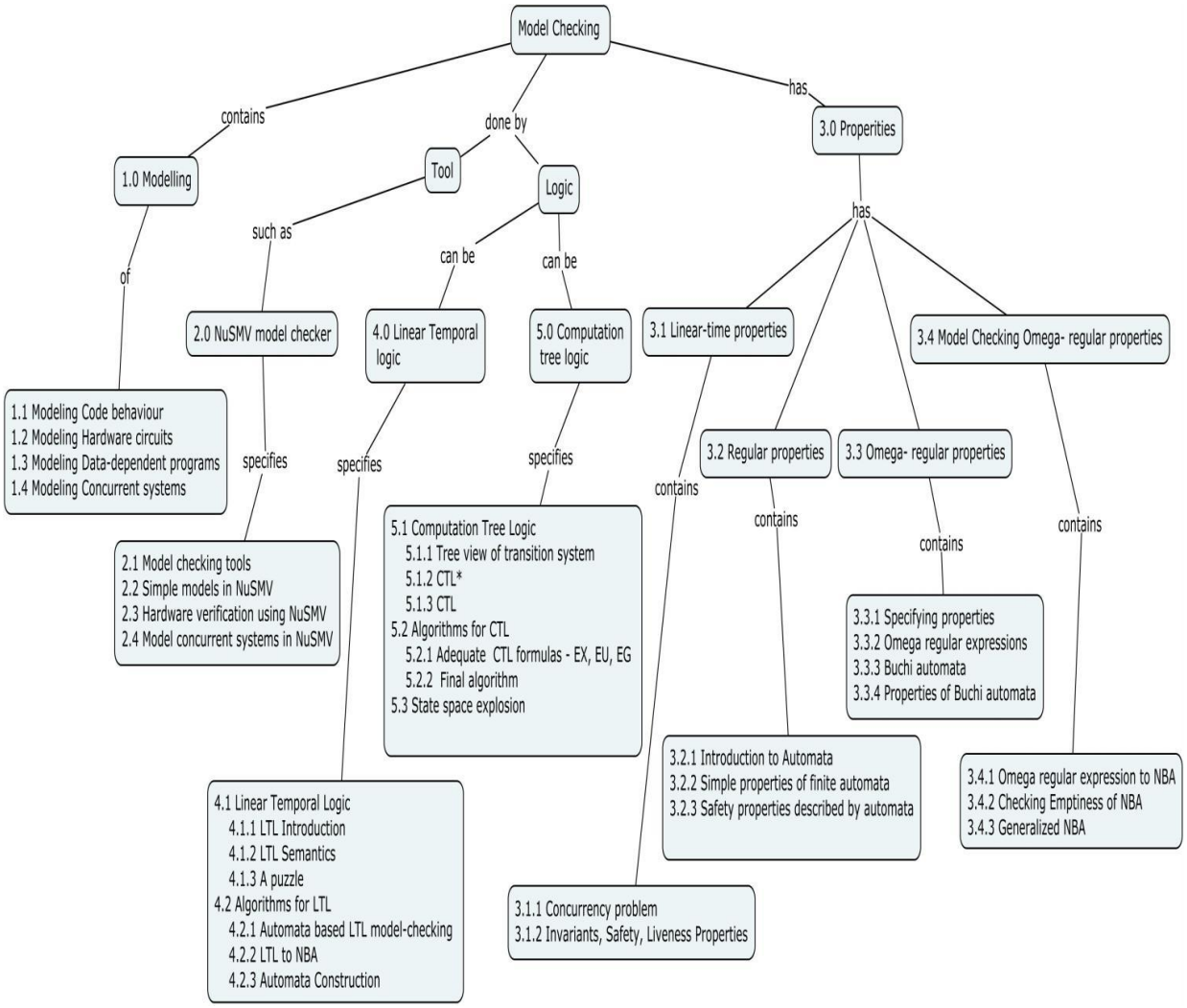
$$\Phi_2 = A(a \cup b) \vee EX(AGb)$$

Determine the satisfaction sets $Sat(\Phi_i)$ and decide whether $TS \vDash \Phi_i (1 \leq i \leq 2)$.

3. Which of the following equivalences for CTL$*$ are correct? Provide a proof or a counter example.
   a. $AXAG\Phi \equiv AXG\Phi$
   b. $EXEG\Phi \equiv EXG\Phi$
   c. $A(\varphi \wedge \psi) \equiv A\varphi \wedge A\psi$
   d. $E(\varphi \wedge \psi) \equiv E\varphi \wedge E\psi$
   e. $\neg A(\varphi \rightarrow \psi) \equiv E(\varphi \wedge \neg\psi)$
   f. $EGEX\Phi \wedge \neg AX\neg\Phi \equiv EG(\neg X\neg\Phi)$
   g. $A(F\Psi \wedge G\Phi) \equiv AF(\Psi \wedge AG\Phi) \wedge AG(\Phi \wedge AF\Psi)$
   h. $E(F\Psi \wedge G\Phi) \equiv EF(\Psi \wedge EG\Phi)$

   Here, Φ, Ψ are arbitrary CTL$*$ state formulae and $\varphi \wedge \psi$ are CTL$*$ path formulae.

Concept Map



Syllabus

Introduction to Model-Checking - Modeling code behaviour - Modeling hardware circuits - Modeling data-dependent programs - Modeling concurrent systems. **Model-checker NuSMV** - Model-checking tools - Simple models in NuSMV - Hardware verification using NuSMV - Modeling concurrent systems in NuSMV. **Linear-time properties** - A problem in concurrency - What is a property? - Invariants - Safety properties – Liveness. **Regular properties** - Introduction to automata - Simple properties of finite automata - Safety properties described by automata. **Omega-regular properties** - Specifying properties - Omega-regular expressions - Büchi automata - Simple properties of Büchi automata. **Model checking omega-regular properties** - Omega-regular expressions to NBA - Checking emptiness of NBA - Generalized NBA. **Linear Temporal Logic** - Introduction to LTL - Semantics of LTL - A puzzle. **Algorithms for LTL** -

Automata based LTL model-checking - LTL to NBA - Automaton construction. **Computation Tree Logic** - Tree view of a transition system - CTL* - CTL. **Algorithms for CTL** - Adequate CTL formulas - EX, EU, EG - Final algorithm - State-space explosion

Text Book

1. Christel Baier and Joost-Pieter Katoen, Principles of Model Checking, MIT Press, 2008.

Reference Books

1. E.M. Clarke, O. Grumberg, D.A. Peled: Model Checking, MIT Press, 1999
2. M. Huth and M.D. Ryan: Logic in Computer Science – Modelling and Reasoning about Systems, Cambridge University Press, 2nd edition, 2004
3. K. Schneider: Verification of Reactive Systems, Springer-Verlag, Texts in Theoretical Computer Science. An EATCS Series, 2004

Course Contents and Lecture Schedule

Module No.		Topic	No. of Lectures
1.	**Introduction to Model-Checking**		
	1.1	Modeling Code behavior	1
	1.2	Modeling Hardware circuits	1
	1.3	Modeling Data-dependent programs	1
	1.4	Modeling Concurrent systems	1
2.	**Model-checker NuSMV**		
	2.1	Model checking tools	1
	2.2	Simple models in NuSMV	1
	2.3	Hardware verification using NuSMV	1
	2.4	Model concurrent systems in NuSMV	1
3.	**Properties**		
	3.1	Linear- time properties	1
	3.1.1	Concurrency problem	1
	3.1.2	Invariants, Safety, Liveness Properties	1
	3.2	Regular Properties	1
	3.2.1	Introduction to Automata	1
	3.2.2	Simple properties of finite automata	1
	3.2.3	Safety properties described by automata	1
	3.3	Omega-regular properties	1
	3.3.1	Specifying properties	1
	3.3.2	Omega regular expressions	1
	3.3.3	Buchi Automata	1
	3.3.4	Properties of Buchi automata	1
	3.4	Model Checking Omega-regular properties	1
	3.4.1	Omega regular expression to NBA - Checking Emptiness of NBA	1
	3.4.2	Generalized NBA	1
4.	**Linear Temporal Logic**		
	4.1	Linear Temporal Logic	1
	4.1.1	LTL Introduction **-** Semantics	1

	4.1.3	A puzzle	1
	4.2	Algorithms for LTL	1
	4.2.1	Automata based LTL model-checking	1
	4.2.2	LTL to NBA	1
	4.2.3	Automata construction	1
5.	**Computation Tree Logic**		
	5.1	Computation Tree Logic	
	5.1.1	Tree view of transition system	1
	5.1.2	CTL* - CTL	1
	5.2	Algorithms for CTL	1
	5.2.1	Adequate CTL formulas - EX, EU, EG	1
	5.2.2	Final algorithm	1
	5.3	State space explosion	1
	Total		36

Course Designers:

1. Dr.M.K.Kavitha Devi (mkkdit@tce.edu)

Category	L	T	P	Credit
PE	3	0	0	3

18CGPH0 **COMPUTER SECURITY AND FORENSICS**

Preamble

This course develops an understanding of how illegal computer attacks are performed and how to counteract them. It covers all areas of cyber forensic investigation, data recovery and security systems design.

Prerequisite

- Cryptography
- Network Security
- Network Performance and Vulnerability Analysis

Course Outcomes

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

Identify the basic concepts of computer security mechanisms (CO1)	Apply
Select the suitable computer forensic techniques for a given scenario (CO2)	Apply
Examine the process involved to retrieve evidence for use in criminal investigations. (CO3)	Apply
Identify the incidence response methodology related to an incidence (CO4)	Apply
Apply a number of different computer forensic tools to a given scenario. (CO5)	Apply
Examine the process involved during validation of Forensic data. (CO6)	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1.	M										
CO2.	L										
CO3.	S	M	M	L	M			L	L		
CO4.	S	M	M	L	M			L	L		
CO5.	M	M	M	L	M			M	M	M	M
C06.	M	M	M	L	M			M	M	M	M

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Assignment		Terminal Examination
	1	2	1	2	
Remember	20	20	-	-	20
Understand	50	40	-	-	40
Apply	30	40	100	100	40
Analyze	-	-	-	-	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Describe about the E-Mail security.
2. Write down the uses of Database security.
3. Identify the shortcoming of email security.

Course Outcome 2 (CO2):

1. Define computer crime
2. List the types of computer forensic techniques.
3. Select the appropriate computer forensic technique for the given scenario.

Course Outcome 3 (CO3):

1. Describe about the types of forensic investigations.
2. State the different types of evidence.
3. Examine the different types of frauds.

Course Outcome 4 (CO4):

1. Explain the process of location all the DNS servers and their corresponding records for an organization
2. Differentiate Nslookup and DNSstuff

3. Describe stack overflows and heap overflows
4. Explain the different types of email threats

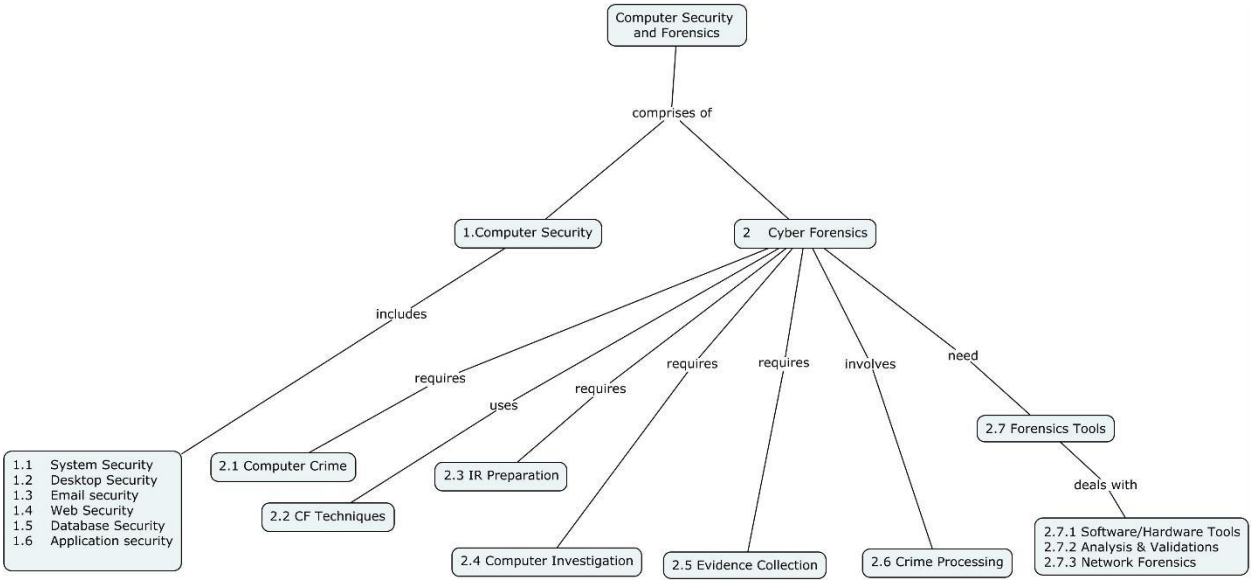
Course Outcome 5 (CO5):

1. Illustrate the different types of access control mechanisms to find dichotomy between companies and to implement layers of security
2. Demonstrate Zachman framework
3. Exhibit the ways to perform an application and code review penetration test for web based and web services applications

Course Outcome 6 (CO6):

1. List the different data hiding techniques.
2. Examine the investigation process of email application.

Concept Map



Syllabus

Computer Security: System Security - Desktop Security - Email security- Web Security - Database Security -Application security. **Cyber Forensics**: Computer Forensics - Introduction to Traditional Computer Crime, Traditional problems associated with Computer Crime, Introduction to Identity Theft & Identity Fraud, Types of CF techniques, Incident and incident response methodology, Forensic duplication and investigation. Preparation for IR - Creating response tool kit and IR team. Forensics Technology and Systems, Understanding Computer Investigation, Data Acquisition. Evidence collection and forensics tools - Processing Crime and Incident Scenes, Working with Windows and DOS Systems. Current Computer Forensics Tools - Software/

Hardware Tools. Analysis and validation - Validating Forensics Data, Data Hiding Techniques, Performing Remote Acquisition, Network Forensics, Email Investigations, Cell Phone and Mobile Devices Forensics.

Reference Books

1. Charles P. Pfleeger and Shari L. Pfleeger. Security in Computing (5th edition). Prentice-Hall. 2015.ISBN 978-0-13-408504-3
2. John R. Vacca, "Computer Forensics: Computer Crime Scene Investigation", 2nd Edition, CharlesRiver Media, 2008

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1	**Computer Security - Introduction**	
1.1	System Security	2
1.2	Desktop Security	2
1.3	Email security	2
1.4	Web Security	2
1.5	Database Security	2
1.6	Application security	2
2	**Cyber Forensics**	
2.1	Computer Forensics - Introduction to Traditional Computer Crime, Traditional problems associated with Computer Crime- Introduction to Identity Theft & Identity Fraud	3
2.2	Types of CF techniques- Incident and incident response methodology-Forensic duplication and investigation.	2
2.3	Preparation for IR - Creating response tool kit and IR team-Forensics Technology and Systems	3
2.4	Understanding Computer Investigation- Data Acquisition.	2
2.5	Evidence collection and forensics tools	3
2.6	Processing Crime and Incident Scenes-Working with Windows and DOS Systems.	2
2.7	Current Computer Forensics Tools.	
2.7.1	Software/ Hardware Tools	3
2.7.2	Analysis and validation -Validating Forensics Data-Data Hiding Techniques-Performing Remote Acquisition,	3
2.7.3	Network Forensics-Email Investigations -Cell Phone and Mobile Devices Forensics.	3
	Total	**36**

Course Designers:

1. T.Manikandan tmcse@tce.edu

18CGPJ0	NATURAL LANGUAGE PROCESSING	Category	L	T	P	Credit
		PE	3	0	0	3

Preamble

- To understand the mathematical foundations needed for language processing along with the representation and processing of Morphology and Part-of Speech Taggers
- To understand different aspects of natural language syntax and the various methods used for processing syntax
- To understand different methods of disambiguating word senses
- To perform ambiguity resolution and generate natural language

Prerequisite

- Probability and Statistics

Course Outcomes

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

Construct a morphological analyzer for a language of your choice using finite state automata concepts(CO1)	Apply
Construct a parser by providing suitable grammar and words(CO2)	Apply
Construct parse tree showing the semantic interpretations for the constituents(CO3)	Apply
Compare algorithms for word sense disambiguation(CO4)	Analyze
Construct natural language outputs from non-linguistic inputs using surface realization (CO5)	Apply
Construct Natural Language Processing application with Python (CO6)	Apply

Mapping with Programme Outcomes

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11
CO1.	M	M	L								
CO2.	S	M	S	M							
CO3	S	M	S	M							
CO4	S	S	L	M							
CO5.	S	M	S	S							
CO6	S	M	S	S	M	M	L	L	L	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern

	Continuous Assessment Tests	Assignment	

Bloom's Category	1	2	1	2	Terminal Examination
Remember	30	20	-	-	20
Understand	40	30	-	30	30
Apply	30	30	30	60	30
Analyze	-	20	70	10	20
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Define a Lexicon
2. State the goals of NLP
3. Differentiate between Natural Language Processing and Natural Language Understanding
4. Discuss Stochastic POS tagging
5. Define Morphological Analyzer
6. Construct the Algorithm for Morphological Analyzer

Course Outcome 2 (CO2):

1. Construct an algorithm for parsing a finite –state transducer
2. Explain the elements in a language
3. Construct an algorithm for converting an arbitrary CFG into Chomsky Normal Form
4. Define stemmer

Course Outcome 3 (CO3):

1. Construct a small lexicon showing the SEM features
2. Construct Parse tree for Jill saw the dog using SUBJ features
3. Define Hierarchical lexicon
4. Define model structure
5. Define possible worlds semantics

Course Outcome 4 (CO4):

1. Explain semantic filtering
2. Compare the approaches to disambiguation
3. State the Selectional restrictions
4. Discuss Reference resolution
5. Design an algorithm for pronoun resolution

6. Between the words eat and find which would you expect to be more effective in selection restriction-based sense disambiguation

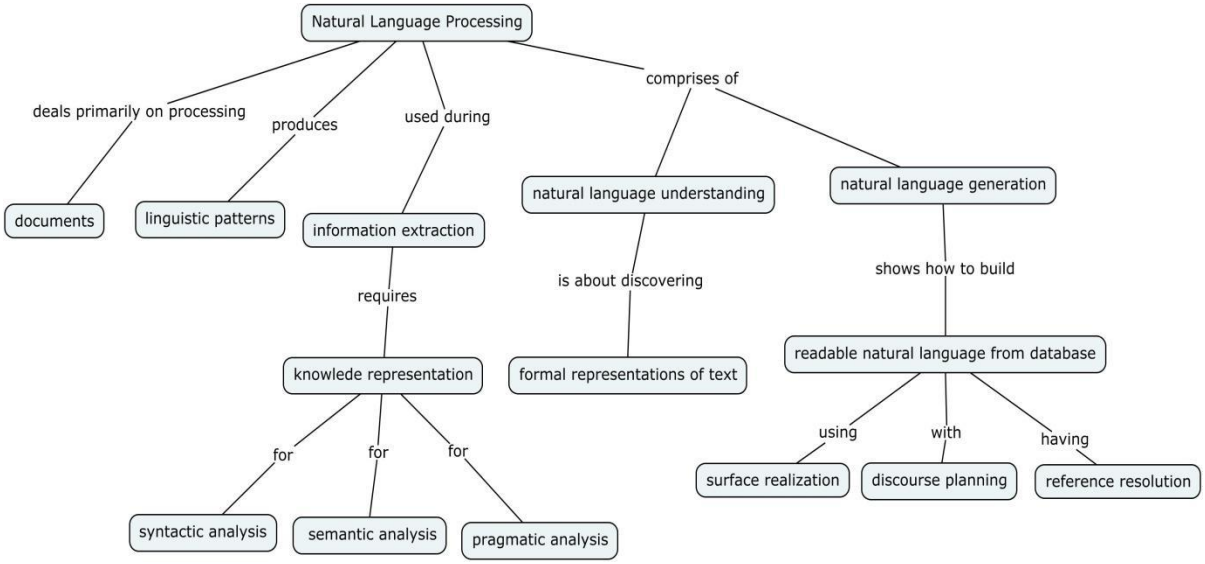
Course Outcome 5 (CO5):

1. Explain the architecture for NLG systems
2. Define systemic functional linguistics
3. Define Bidirectional Grammars
4. Construct an augmented transition network for discourse planning
5. Explain Rhetorical relations with a text plan operator

Course Outcome 6 (CO6):

1. Develop a program in python for Tokenizing text
2. Construct a program with python for Removing Stopwords
3. Write a program in python for Identifying Bigrams
4. Construct an python program for stemming and POS
5. Develop an python program for disambiguating word meanings

Concept Map



Syllabus

Introduction: Natural Language Processing - Different levels of Language Analysis- Linguistics Essentials - Grammars and Parsing- Parts of Speech Tagging and Morphology -Phrase Structure-Morphological Parsing-Corpus Based Work-Syntactic Processing **Parsing with features:**Feature Systems and Augmented Grammar-Grammars for Natural Language-Viterbi Algorithm-Ambiguity Resolution **Semantics**-Logical form-Word senses and ambiguity-Encoding ambiguity in logical form -Defining semantic structures and semantic roles interpretation **Statistical word sense disambiguation:** Word Sense Hierarchy-Collocations -Mutual information- Selectional Restrictions-Semantic Filtering Using Selectional Restrictions-Semantic Networks-Statistical Semantic Preferences-Combining approaches to disambiguation **Natural Language generation System:** Introduction to Language generation-Content selection and Lexical selection-Sentence structure and Discourse Structure-Discourse Planner-Surface Realizer-Systemic Grammar-Functional Unification Grammar- Demonstrations in Python

Text Book

1. James Allen “Natural Language Understanding”, Pearson Education, 2003
2. Christopher D.Manning and HinrichSchutze, “ Foundations of Statistical Natural Language Processing “, MIT Press, 1999.
3. Daniel Jurafsky and James H. Martin, “ Speech and Language Processing” , Pearson, 2008.

Reference Books

1. Ron Cole, J.Mariani, et.al “Survey of the State of the Art in Human Language Technology”, Cambridge University press, 1997.
2. Michael W. Berry, “ Survey of Text Mining: Clustering, Classification and Retrieval”, Springer Verlag, 2003.
3. Steven Bird, Ewan Klein, Edward Loper, “Natural Language Processing with Python: Analyzing Text with the Natural Language Toolkit”. First Edition, O’REILLY, 2009.
4. Christopher D. Manning. 2015. Computational Linguistics and Deep Learning. *Computational Linguistics* 41(4): 701-707. *http://nlp.stanford.edu/~manning/papers/Manning-Last-Words-COLI_a_00239.pdf*

Web References

1. http://ocw.mit.edu/courses
2. NLTK Toolkit http://www.nltk.org
3. www.statsoft.com/Textbook/Text-Mining
4. https://courses.edx.org/courses/course-v1:Microsoft+DEV288x+3T2018/course/

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1.	**Introduction**	
1.1	Natural Language Processing	1
1.2	Different levels of Language Analysis	1
1.3	Linguistics Essentials	1
1.4	Grammars and Parsing	1
1.5	Parts of Speech Tagging and Morphology	1
1.6	Phrase Structure	1
1.7	Morphological Parsing	1
1.8	Corpus Based Work	1
2.	**Syntactic Processing**	
2.1	Parsing with features	2
2.2	Feature Systems and Augmented Grammar	2
2.3	Grammars for Natural Language	1
2.4	Viterbi Algorithm	1
2.5	Ambiguity Resolution	1
3.	**Semantics**	
3.1	Logical form	2
3.2	Word senses and ambiguity	1
3.3	Encoding ambiguity in logical form	2
3.4	Defining semantic structures and semantic roles interpretation	1
4	**Statistical Word sense Disambiguation**	
4.1	Word Sense Hierarchy	1

4.2	Collocations	1
4.3	Mutual information	1
4.4	Selectional Restrictions	1
4.5	Semantic Filtering Using Selectional Restrictions	1
4.6	Semantic Networks	1
4.7	Statistical Semantic Preferences	1
4.8	Combining approaches to disambiguation	1
5	**Natural Language Generation System**	
5.1	Introduction to Language generation	1
5.2	Content selection and Lexical selection	1
5.3	Sentence structure and Discourse Structure	1
5.4	Discourse Planner	1
5.5	Surface Realizer	1
5.6	Systemic Grammar	1
5.7	Functional Unification Grammar - Demos	1

Course Designers:

1. Dr.K.Sundarakantham kskcse@tce.edu

18CGPK0	NETWORK PERFORMANCE AND VULNERABILITY ANALYSIS	Category	L	T	P	Credit
		PE	3	0	0	3

Preamble

The various known vulnerabilities and how they affect the performance of the network is studied and methods to identify and report the identified vulnerabilities is studied

Prerequisite

Computer Networks: Basic Knowledge of Networks and How Communication between systems is established and the different packet formats has to be known.

Course Outcomes

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

Construct the vulnerability life cycle using available standards and models. (CO1)	Apply
Identify the agents and perform active and passive scanning (CO2)	Apply
Diagnose the vulnerabilities and their impacts using various testing methods (CO3)	Apply
Examine the various vulnerability Assessment Tools and its effect in a given network (CO4)	Analyze
Survey with different tools to report detected vulnerabilities (CO5)	Analyze
Examine the existence of vulnerability and their reach of execution (CO6)	Analyze

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1.	M			M	M						
CO2.	M		M	M	M						
CO3.	M		M	M	M						
CO4.	M	M		M	M						
CO5.	M	M		M	M						
C06	M	M		M	M						

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Assignment		Terminal Examination
	1	2	1	2	
Remember	20	20	-	-	10
Understand	40	40	-	-	20
Apply	30	30	100	100	40
Analyze	10	10	-	-	30
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

1. List the various Sources of Vulnerability
2. Explain the Vulnerability Creation Process
3. Illustrate how policies and Information flow are framed for Vulnerability Process.

Course Outcome 2 (CO2):

1. Describe the steps to perform Active Scanning
2. Explain the Architecture of Appliance Model
3. Demonstrate the vulnerability detection methods use for Passive network Analysis

Course Outcome 3 (CO3):

1. List the Discovery process in Vulnerability Management
2. Summarize the performance issues in vulnerability Management
3. Illustrate the use of Finger Printing with TCP/IP and ICMP packets

Course Outcome 4 (CO4):

1. State the different modes of scanning
2. Illustrate the use of NMAP and its various command line paramneters
3. Sketch the working of nessus Tool

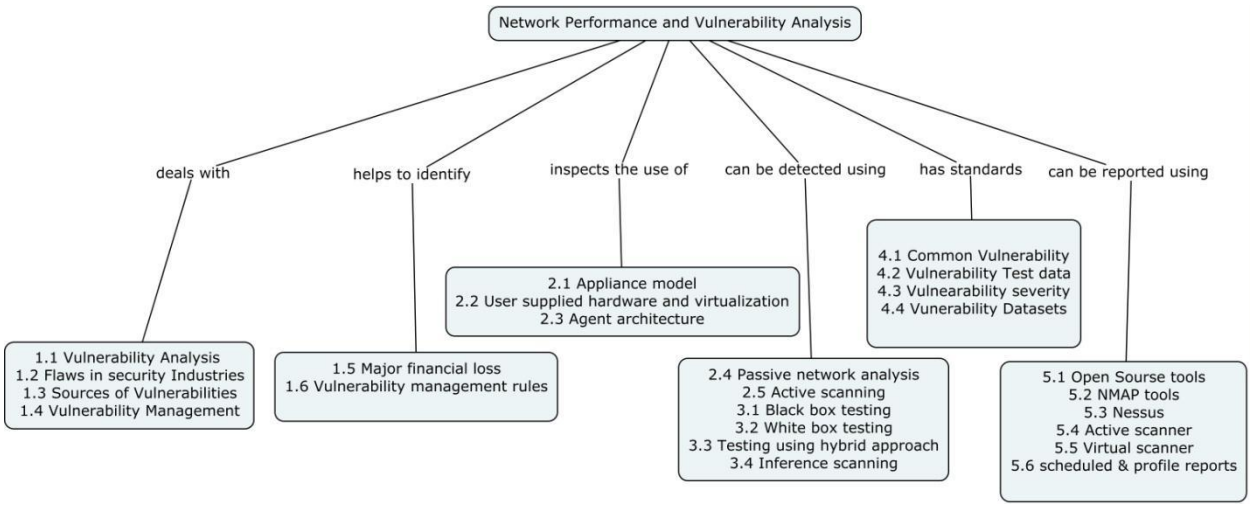
Course Outcome 5 (CO5)

1. Define Profile Report.
2. Diagnose the causes of vulnerability based on Audit reports
3. Examine the Use of Discovery Reports

Course Outcome 6 (CO6)

1. Define vulnerability impact factor .
2. Diagnose the impact of vulnerability based on Analysis reports
3. Infer the coverage of Discovery Reports

Concept Map



Syllabus

Introduction-VA -life cycle - Origins of VM - Introducing the Security Industry and Its Flaws - Sources of Vulnerabilities - Why VM Is Important - The Vulnerability Creation Process - Risk of Major Financial Loss - Loss of Revenue - Lost Productivity - The VM Program and Technology Development and Roles-Hardware: The Appliance Model - User-Supplied Hardware and Virtualization - Agents - Agent Architecture - Advantages and Disadvantages - Detection Methods - Passive Network Analysis - Advantages and Disadvantages - Detection Methods - Active Scanning Technology - Advantages and Disadvantages - Detection Methods - Discovery - Black Box Testing - White Box Testing - Web Application Testing - Hybrid Approach - Inference Scanning-Standards-CVE - Structure - Limitations of CVE - The Standard for Vulnerability Test

Data - Definitions Schema - System Characteristics Schema - Results Schema -The Standard for Vulnerability Severity Rating - CVSS Nomenclature - NVD - CPE - XCCDF - SCAP-VA tools-Open source tools - NMAP - NMAP commands – NMAP Scripting - Nessus - Advantages and Disadvantages of VA Tools - Scan Modes - Using Nessus – OpenVAS – SCAN Modes - Active Scanner Deployment -Virtual Scanners.

Text Book

1. Park Foremann, “Vulnerability Management”, CRC Press., 2010.

Reference Books

1. Abhishek Singh , Baibhav Singh , Hirosh Joseph “Vulnerabilty Analysis and Defence for the Internet “,Springer Science+Business Media,2008.
2. Thomos Bonold,Mathieu Feuillet,”Network Performance Analysis”,Wiley Publication, 2011.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1.	**Introduction-Vulnerability Analysis (8)**	
1.1	Origin and life cycle of Vulnerability Management	1
1.2	- Introducing the Security Industry and Its Flaws	1
1.3	Sources of Vulnerabilities	2
1.4	Importance of Vulnerability Management	2
1.5	Risk of Major Financial Loss -	1
1.6	The Vulnerability Management Program	1
2	**Hardware(7)**	
2.1	The Appliance Model -	1
2.2	User-Supplied Hardware and Virtualization	1
2.3	Agents , Agent Architecture -	2
2.3.1	Merits and Limitation of Hardware Architecture	1
2.4	Passive Network Analysis	1
2.5	Active Scanning Technology	1
3	**Testing (6)**	
3.1	Discovery of Vulnerability and Black Box Testing	1
3.2	White Box Testing ,Web Application Testing	2
3.3	Hybrid Approach	2
3.4	Inference Scanning	1
4	**Standards(7)**	

4.1	Common Vulnerability & Exposure (CVE), Structure of vulnerability	1
4.1.1	Limitations of CVE	1
4.2	The Standard for Vulnerability Test Data	1
4.2.1	Definitions Schema	1
4.3	The Standard for Vulnerability Severity	1
4.4	Vulnerability Datasets	
4.4.1	Rating and CVSS Nomenclature	1
4.4.2	NVD ,CPE , XCCDF , SCAP-VA	1
5	**Tools(8)**	
5.1	Open source tools	1
5.2	NMAP commands,NMAP Scripting	2
5.3	Nessus	1
5.4	Using Open VAS ,Active scanner	1
5.5	Deployment of Virtual Scanners	1
5.6	Audit and Scheduled Reports , Vulnerability Trend and Profile Report	2
	Total Hours	**36**

Course Designer:

1. K.NarasimhaMallikarjunan arjunkambaraj@tce.edu

18CGPL0	CLOUD COMPUTING SYSTEMS AND SERVICES	Category	L	T	P	Credit
		PE	3	0	0	3

Preamble

This course is offered as an elective for the Post Graduate students of Computer Science and Engineering. This course is aimed at introducing cloud computing, the services offered by the cloud, Cloud Architectures, Virtualization, Cloud Storage and Security.

Course Outcomes

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

C01. Identify the real time cloud providers and their service levels.	Apply
C02. Illustrate the design of on-demand and scalable Cloud Computing Infrastructure	Apply
C03. Apply the various forms of virtualization technique to the enterprise architecture.	Apply
C04. Illustrate the security issues of the enterprise adapting cloud computing principles.	Apply
C05. Illustrate the data availability, data replication, data protection and data footprint reduction techniques of cloud storage services.	Apply
CO6. Explore tools available for building and managing cloud	Apply

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Assignment		Terminal Examination
	1	2	1	2	

Remember	20	20	-	-	20
Understand	40	30	-	-	20
Apply	40	50	100	100	60
Analyze	-	-	-	-	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Course Level Assessment Questions

Course Outcome 1 (CO1)

1. Illustrate the Infrastructure-as-a-Service offering provided by Amazon. (Apply)
2. Identify the service offered by GoogleApps and illustrate that service. (Apply)
3. Explain the key characteristics of Cloud Computing. (Understand)

Course Outcome 2 (CO2)

1. Design a Cloud Computing Architecture that suits Type 1 virtualization. (Apply)
2. Illustrate how the cloud architecture overcomes the difficulties faced by traditional architecture. (Apply)
3. State the advantages of Cloud Architectures. (Remember)

Course Outcome 3 (CO3)

1. Demonstrate the type of virtualization that is supported by the virtualization tool named 'PlateSpin Power Recon'. (Apply)
2. Illustrate the steps to add the OpenSolaris Guest OS to Sun xVM VirtualBox.(Apply)
3. Define Internal Network Virtualization. (Remember)

Course Outcome 4 (CO4)

1. Summarize the Cloud Security Requirements for Identity Management and Cloud-wide Time Service. (Apply)
2. Illustrate the security controls developed by NIST that can be adopted by Cloud Service Providers and Cloud Developers. (Apply)

3. Explain the security concerns around the use of virtualization in cloud computing. (Understand)

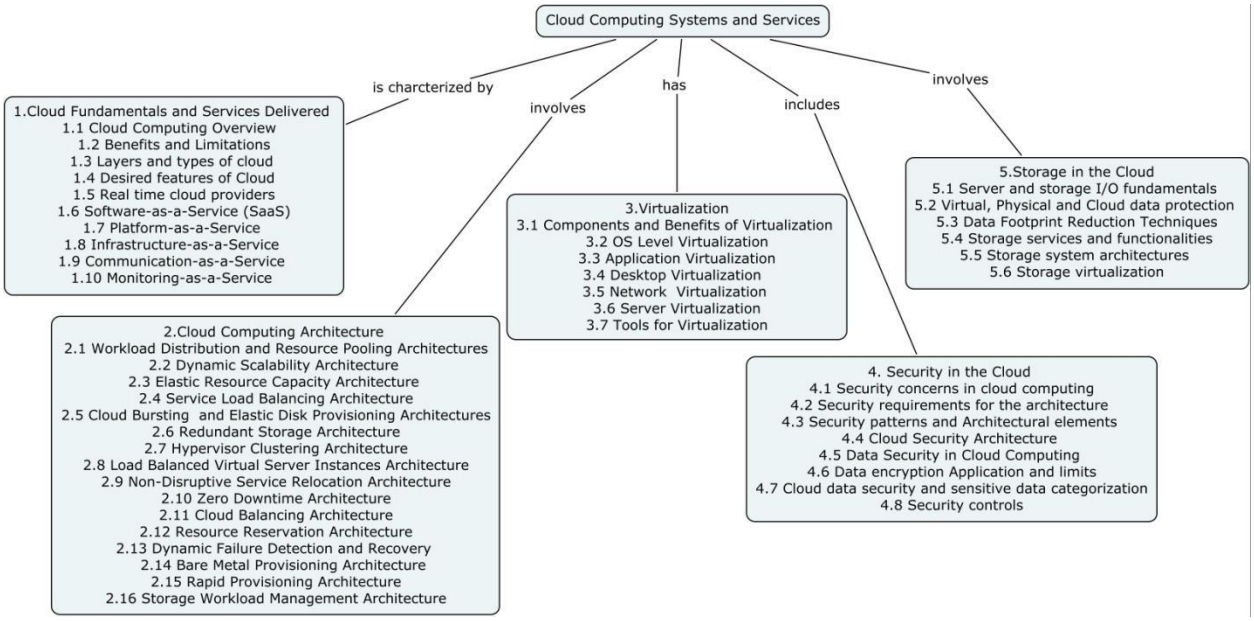
Course Outcome 5 (CO5)

1. Explain how the DFR techniques can be applied to your cloud to provide capacity optimization. (Apply)
2. Illustrate the design of storage solutions that focus on the architecture or packaging of storage system. (Apply)
3. Define a space-saving snapshot. (Remember)

Course Outcome 6 (CO6)

1. Explain how the open source virtualization technology namely KVM allows the host machine to run multiple virtual machines.
2. Illustrate how a private cloud can be built using Eucalyptus.
3. Explain how Deltacloud allows to use a single web application to administer instances on many different cloud providers.

Concept Map



Syllabus

Cloud Fundamentals and Services Delivered - Cloud Computing Overview – benefits – limitations – Layers and types of cloud – Desired features of Cloud – Real time cloud providers - Cloud Services Model - Software-as-a-Service (SaaS) - Platform-as-a-Service (PaaS) - Infrastructure-as-a-Service (IaaS) - **Cloud Computing Architecture** Workload Distribution

Architecture – Resource Pooling Architecture – Dynamic Scalability Architecture – Elastic Resource Capacity Architecture – Service Load Balancing Architecture – Cloud Bursting Architecture – Elastic Disk Provisioning Architecture – Redundant Storage Architecture – Hypervisor Clustering Architecture – Load Balanced Virtual Server Instances Architecture – Non-Disruptive Service Relocation Architecture – Zero Downtime Architecture – Cloud Balancing Architecture – Resource Reservation Architecture – Dynamic Failure Detection and Recovery Architecture – Bare Metal Provisioning Architecture – Rapid Provisioning Architecture – Storage Workload Management Architecture **Virtualization –** Components and Benefits of Virtualization - OS Level Virtualization - Application Virtualization - Desktop Virtualization - Network Virtualization - Server Virtualization – Tools for Virtualization - **Security in the Cloud -** Security concerns in cloud computing - Security requirements for the architecture - Security patterns and Architectural elements - Cloud Security Architecture – Data Security in Cloud Computing - Data encryption Application and limits – Cloud data security and sensitive data categorization – Security controls – **Storage in the Cloud –** Server and storage I/O fundamentals – Virtual, Physical and Cloud data protection - Data Footprint Reduction Techniques – Storage services and functionalities – Storage system architectures – Storage virtualization

References

1. Thomas Erl, Zaigham Mahmood, Ricardo Puttini, “Cloud Computing: Concepts, Technology & Architecture”, Prentice Hall Service Technology Series, 2013.
2. John Rittinghouse, James Ransome, “Cloud Computing: Implementation, Management and Security”, CRC Press 2010.
3. Vic (J.R.) Winkler, “Securing the Cloud: Cloud Computer Security Techniques and Tactics, Elsevier, 2011
4. Greg Schulz, “Cloud and Virtual Data Storage Networking”, CRC Press, 2012.
5. Nelson Ruest, Danielle Ruest, “Virtualization, A Beginner’s Guide”, McGraw-Hill Companies, 2009

Course contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Cloud Fundamentals and Services Delivered (6)**	
1.1	Cloud Computing Overview	1

1.2	Benefits, Limitations, Layers and types of cloud	1
1.3	Desired features of Cloud, Real time cloud providers	1
1.4	Cloud Services Model - Software-as-a-Service (SaaS)	1
1.5	Platform-as-a-Service (PaaS)	1
1.6	Infrastructure-as-a-Service (IaaS)	1
2	**Cloud Computing Architecture (9)**	
2.1	Workload Distribution Architecture – Resource Pooling Architecture	1
2.2	Dynamic Scalability Architecture, Elastic Resource Capacity Architecture, Service Load Balancing Architecture	1
2.3	Cloud Bursting Architecture - Elastic Disk Provisioning Architecture	1
2.4	Redundant Storage Architecture, Redundant Storage Architecture	1
2.5	Hypervisor Clustering Architecture, Load Balanced Virtual Server Instances Architecture	1
2.6	Non-Disruptive Service Relocation Architecture, Zero Downtime Architecture	1
2.7	Cloud Balancing Architecture, Resource Reservation Architecture	1
2.8	Dynamic Failure Detection and Recovery Architecture, Bare Metal Provisioning Architecture	1
2.9	Rapid Provisioning Architecture, Storage Workload Management Architecture	1

3	**Virtualization (7)**	
3.1	Components and Benefits of Virtualization	1
3.2	OS Level Virtualization	1
3.3	Application Virtualization	1
3.4	Desktop Virtualization	1
3.5	Network Virtualization	1
3.6	Server Virtualization	1
3.7	Tools for Virtualization	1
4	**Security in the Cloud (7)**	
4.1	Security concerns in cloud computing	1
4.2	Security requirements for the architecture, Cloud Security Architecture	1
4.3	Security patterns and Architectural elements	1
4.4	Data Security in Cloud Computing	1
4.5	Data encryption Application and limits	1
4.6	Cloud data security and sensitive data categorization	1
4.7	Security controls	1
5	**Storage in the Cloud(7)**	
5.1	Server and storage I/O fundamentals	1
5.2	Virtual, Physical and Cloud data protection	1
5.3	Data Footprint Reduction Techniques	2
5.4	Storage services and functionalities	1

5.5	Storage system architectures, Storage virtualization	1
	Total No of Hours	**36**

Course Designer

1. Ms.J.Jane Rubel Angelina janerubel@tce.edu

18CGPM0	DATA SCIENCES AND ANALYTICS	Category	L	T	P	Credit
		PE	3	0	0	3

Preamble

The course on Data sciences and Analytics aims to build computational abilities, inferential thinking, and practical skills for tackling core data scientific challenges. It explores foundational concepts in data management, processing, statistical computing, and dynamic visualization using modern programming tools. Students will learn about modern data analytic techniques and develop skills for importing and exporting, cleaning and fusing, modeling and visualizing, analyzing and synthesizing complex datasets.

Prerequisite

- Database Management Systems

Course Outcomes

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

Courses Outcomes	Blooms Level
Identify exploratory and statistical analysis methods to prepare the big data (CO1)	Apply
Choose basic tools to carry out exploratory data analysis and produce effective visualization of given data (CO2)	Apply
Perform parallel data processing and duplication with Hadoop and Map-Reduce. (CO3)	Apply
Identify suitable data model and algorithms for mining data streams. (CO4)	Apply
Use descriptive analytical methods to get insights of the historical and real time data. (CO5)	Apply
Solve real time business problems by applying variants of big data analytics (CO6)	Analyze

Mapping with Programme Outcomes

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1.	S	M	L	L	M			L	L		
CO2.	S	M	L	L	M			L	L	L	L
CO3.	S	M	L	L	M			L	L	L	L
CO4.	S	M	L	L	M			L	L	L	L
CO5	S	M	L	L	M			L	L	L	L
CO6	S	S	M	L	S	L		L	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern

	Continuous Assessment Tests	Assignment	

Bloom's Category	1	2	1	2	Terminal Examination
Remember	20	20	-	-	20
Understand	40	30	-	-	20
Apply	40	40	100	80	50
Analyze	-	10	-	20	10
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Query /select a subset of data using a set of criteria using the following operators: =, !=, >, <, >=, <=.
2. Consider a simple social network dataset, Manipulate and extract data using column headings and index locations. Employ slicing to select sets of data from a Data Frame.
3. Illustrate typical graphical techniques used in EDA.

Course Outcome 2 (CO2):

1. Define Big Data visualization principles and explain two dimensional and multi-dimensional data visualizations
2. Consider a data set with continuous/discreet/categorical data types. Extract important input variables for the analysis and Identify outliers. Use the following for data analysis.(i)Box-Plot, (ii)Histogram, (iii) Trend analysis and (iv) Scatter Plots.
3. Typically, large data sets include errors. For example, respondents may fill fields incorrectly or skip them accidentally. Find the methods to make sure that there are no such errors.

Course Outcome 3 (CO3):

1. Illustrate the Hadoop Eco System components and its architecture and List the highlights of Hadoop in handling big data
2. Consider a Hadoop cluster with one name node and two racks named R1 and R2 in a data center D1. Each rack has 4 nodes and they are uniquely identified as R1N1, R1N2 and so on. The replication factor is set to 3 and the HDFS block size is set to 64 MB(128MB in Hadoop V2) by default. File is sample.txt of size 194MB. Illustrate the Anatomy of file Read in hadoop for the above scenario. Perform file write in hadoop for the given scenario.
3. Design the map reduce use case for you tube data analysis.
4. Consider Matrix A (2X3),Matrix B(3X3) and CPU Count is 6. Use Map reduce procedure to perform matrix multiplication

Course Outcome 4 (CO4):

1. Discuss about different streaming data types , processing Models and A Stream Cube Architecture
2. Consider the sequence f = (2, 5, 8, 9, 7, 4, −1, 1). Apply the Haar transform.
3. A router is interested in all flows: whose frequency is at least 1% (σ) of the entire traffic stream seen so far and feels that 1/10 of σ (ε = 0.1%) error is comfortable How to mine frequent patterns with good approximation? Lossy Counting Algorithm is able to compute the frequency of items with an error not bigger than ε
4. Illustrate CluStream- A Framework 48 for Clustering Evolving Data Streams
5. Compare the Strengths and Weaknesses of Hoeffding Tree

Course Outcome 5 (CO5):

1. Explain the Big data predictive analytics life cycle
2. Consider a data set of around 5000 features. For that data use Chi Square test for feature selection; after that, get the reduced set of variables which shows the significance relationship with the response variable. Use the logistic regression model. Analyze the results with other predictive models.
3. Compare Predictive Model Performance Against Random Results With Lift Charts and Decile Tables
4. Illustrate An All-Pair Quantum SVM Approach for Big Data Multiclass Classification

Course Outcome 6 (CO6):

1. Consider the following Scenario and provide a solution. “Social nets contributing into target web traffic, the dimensions are clear ‘visits’ and ‘pages per visit’, numeric. Yet the clustering might be done with other non-numerical parameters as: how the posts/ads in

those nets are inserted or the difficulty-degree/man-power of putting backlinks in those nets and others".

2. Consider a simple social network dataset, where key = person and value = s some friend of that person. Describe CLIQUE and PROCLUS algorithm to count the number of friends each person has.
3. Consider the following document and perform the text analytics

   D1: The game of life is everlasting learning

   D2: The unexamined life is not worth living

   D3: never stop learning

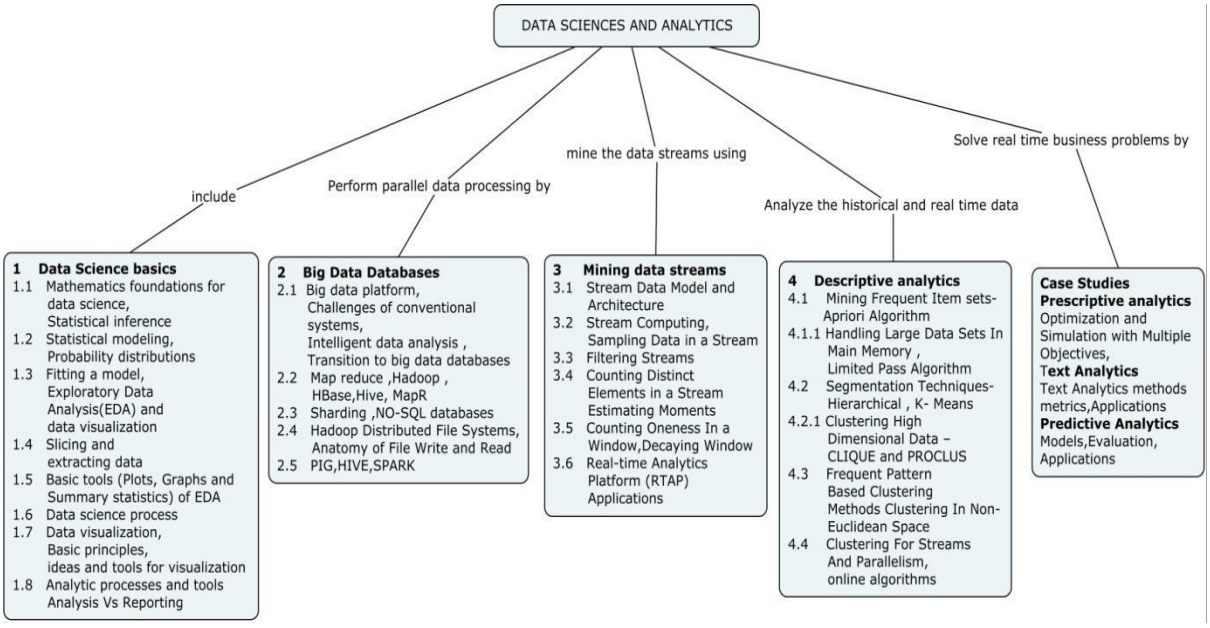
4. Use Locality sensitive hashing for the following queries

   "Who was the first ruler of India"

   "Who was the first king of India"

   "Who was the first ruler of America"

Concept Map



Syllabus

Data Science basics -Mathematics foundations for data science, Statistical inference – Statistical modeling, Probability distributions, Fitting a model, Exploratory Data Analysis(EDA) and data visualization - Basic tools (Plots, Graphs and Summary statistics) of EDA, Data science process, Data visualization – Basic principles, ideas and tools for visualization, Analytic processes and tools - Analysis Vs Reporting

Big Data Databases- Big data platform – Challenges of conventional systems - Intelligent data analysis - Transition to big data databases-Map reduce – Hadoop, HBase,Hive, MapR –Sharding – NO-SQL databases – Hadoop distributed file systems - Anatomy of file write and read – PIG,HIVE,SPARK.

Mining data streams – Stream data model and architecture – Stream computing, sampling data in a stream – Filtering streams – Counting distinct elements in a stream – Estimating moments – Counting oneness in window – Decaying window – Real-time analytics platform (RTAP) applications.

Descriptive analytics - Mining frequent item sets – Apriori algorithm – Handling large data sets in main memory – Limited pass algorithm – Segmentation techniques – Hierarchical – K- Means – Clustering high dimensional data – CLIQUE and PROCLUS – Clustering in non-Euclidean space – Clustering for streams and parallelism, online algorithms

Case Studies -Prescriptive analytics- Optimization and Simulation with Multiple Objectives, **Text Analytics**- Text Analytics methods-metrics-Applications, **Predictive Analytics** – Models – Evaluation – Applications

Reference Books

1. Cathy O'Neil and Rachel Schutt. Doing Data Science, Straight Talk From The Frontline.O'Reilly. 2014.
2. Jure Leskovek, AnandRajaraman and Je_rey Ullman. Mining of Massive Datasets. v2.1,Cambridge University Press. 2014.
3. Foster Provost and Tom Fawcett. Data Science for Business: What You Need to Know about Data Mining and Data-analytic Thinking. ISBN 1449361323. 2013.
4. Data Science & Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data, EMC Education Services, Wiley, 2015
5. Kevin P. Murphy. Machine Learning: A Probabilistic Perspective. ISBN 0262018020. 2013.

Websites

http://www.bigdatauniversity.com

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1	**Data Science basics**	
1.1	Mathematics foundations for data science, Statistical inference	2

1.2	Statistical modeling, Probability distributions	1
1.3	Fitting a model, Exploratory Data Analysis(EDA) and data visualization	2
1.4	Slicing and extracting data	1
1.5	Basic tools (Plots, Graphs and Summary statistics) of EDA	1
1.6	Data science process	1
1.7	Data visualization Basic principles, ideas and tools for visualization	2
1.8	Analytic processes and tools - Analysis Vs Reporting	2
2	**Big Data Databases**	
2.1	Big data platform – Challenges of conventional systems- Intelligent data analysis - Transition to big data databases	1
2.2	Map reduce – Hadoop -HBase,Hive, MapR	2
2.3	Sharding – NO-SQL databases	1
2.4	Hadoop Distributed File Systems- Anatomy of File Write and Read	1
2.5	PIG,HIVE,SPARK	1
3	**Mining data streams**	
3.1	Stream Data Model and Architecture	1
3.2	Stream Computing, Sampling Data in a Stream	1
3.3	Filtering Streams	1
3.4	Counting Distinct Elements in a Stream,Estimating moments	1
3.5	Counting Oneness In A Window, Decaying Window	1
3.6	Real-time Analytics Platform (RTAP) Applications	1

4	**Descriptive analytics**	
4.1	Mining Frequent Item sets- Apriori Algorithm	1
4.1.1	Handling Large Data Sets In Main Memory , Limited Pass Algorithm	1
4.2	Segmentation Techniques- Hierarchical , K- Means	1
4.2.1	Clustering High Dimensional Data – CLIQUE and PROCLUS	1
4.3	Frequent Pattern Based Clustering Methods Clustering In Non-Euclidean space Euclidean Space	1
4.4	Clustering For Streams and Parallelism,online algorithms	2
	Case Studies -Prescriptive analytics- Optimization and Simulation with Multiple Objectives, **Text Analytics**- Text Analytics methods-metrics-Applications, **Predictive Analytics** – Models – Evaluation - Applications	5
	Total Lectures	**36**

Course Designers:

1. Mrs.B.Subbulakshmi bscse@tce.edu

2. Mrs.M.Nirmala Devi mnit@tce.edu

Category	L	T	P	Credit
PC	3	0	0	3

18CGPN0 **PRODUCT AND SERVICE : STRATEGY AND DEVELOPMENT**

Preamble

New products and services are important to all organizations. The success of new products and services can drive growth, shareholder value and leads the organization ahead of its competitors. However, innovation is risky and most new products fail in the marketplace. Often, failure is due to an ineffective process. The course covers the new product development process, strategic opportunity identification, how to generate new product concepts and ideas, mapping customer perceptions, segmentation, product positioning, forecasting market demand, product design, market entry strategies, and testing.

Prerequisite

- No prerequisite

Course Outcomes

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

Design and develop strategic plan for product/Service development process (CO1)	Apply
Develop trade-off analysis and Perceptual Mapping in concept generations(CO2)	Apply
Perform problem analysis based on customer complaints in opportunity identification (CO3)	Apply
Outline the methods of sales forecasting and concept evaluation (CO4)	Understand
Apply Quality function deployment in Produce development(CO5)	Apply
Develop strategic launch plan and apply launch management for the new Product/ Service(CO6)	Apply

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests	Assignment	Terminal Examination

	1	2	1	2	
Remember	20	20	-	-	20
Understand	30	30	50	50	40
Apply	50	50	50	50	40
Analyze	-	-	-	-	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. How Product Development Is Different?
2. Discuss the phases in the new products process.
3. What is the purpose of having a Produce Innovation Center(PIC)?
4. Derive a plan for a product/ service development.

Course Outcome 2 (CO2):

1. How to usetrade-off analysis to generate concepts?
2. Develop a conjoint analysis report with suitable trade-off analysis in concept development

Course Outcome 2 (CO3):

1. Identify the ways of gathering the Problems
2. Why customers buy a product?
3. How to analyze product attributes in concept generation and evaluation?
4. Develop a suitable perceptual mapping technique in concept testing.

Course Outcome 3 (CO4):

1. Discuss the evaluation system for the basic new products process
2. What are the importance of up-front evaluations
3. Discuss the purposes of concept testing.

Course Outcome 4 (CO5):

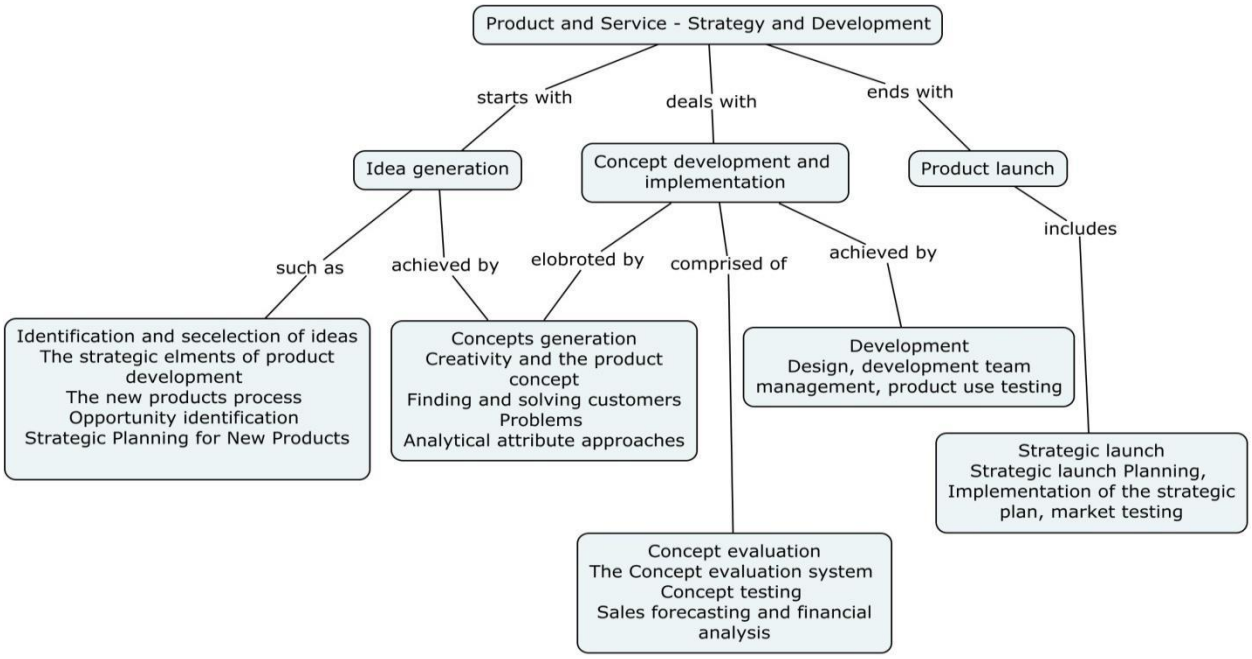
1. Apply house of quality for product development
2. Suggests come methods for market testing

Course Outcome 5 (CO6):

1. Explain the steps involved in launch management

2. Develop a launch management plan for a produce

Concept Map



Syllabus

IDENTIFICATION/SELECTION

The Strategic Elements of Product Development, The Importance of New Products, Globalization and New Product Development, **The New Product/ Service Process**, The Phases in the New Products Process, Evaluation Tasks Throughout the New Products Process. **Opportunity Identification and Selection,** Strategic Planning for New Products/ Service New Product Strategy Inputs and Identifying Opportunities,

CONCEPT GENERATION

Creativity and the Product/Service Concept, Finding and Solving Customers' Problems, Gathering the Problems, Analytical Attribute Approaches: Introduction and Perceptual Mapping, Understanding Why Customers Buy a Product, Gap Analysis, Analytical Attribute Approaches: Trade-Off Analysis and Qualitative Techniques

CONCEPT/PROJECT EVALUATION

The Concept Evaluation System, New Products Process, Planning the Evaluation System, The A-T-A-R Model, Concept **Testing**, The Importance of Up-Front Evaluations, **Product Protocol,** Protocol and Quality Function Deployment
(QFD), QFD and the House of Quality.

DEVELOPMENT

Design, The Role of Design in the New Products Process, Product Architecture, Prototype Development, **Team Management**, Building a Team, Managing the Team, **Product Use Testing**, Product Use Testing, Knowledge Gained from Product Use Testing.

LAUNCH

Strategic Launch Planning,The Target Market Decision, Product Positioning, Branding and Brand Management,**Implementation of the Strategic Plan**, **Launch Management,** The Launch Management System, Effective Metrics: Learning from Experience, Product Failure.

Reference Books:

1. New Products Management, Merle Crawford, Anthony Di Benedetto, Tenth Edition, McGraw-Hill
2. Product Life Cycle Management A Guide to New Product DevelopmentI. Komninos, D. Milossis, N. Komninos, INTERREG IIIC.
3. Operations And Supply Chain Management by Chase, Shankar, Jacobs Tata McGraw-Hill. 14th Edition 2014

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1	**IDENTIFICATION/SELECTION**	
1.1	The Strategic Elements of Product Development, The Importance of New Products, Globalization and New Product Development	2
1.2	The New Product/ Service Process, The Phases in the New Products Process, Evaluation Tasks Throughout the New Products Process.	2
1.3	Opportunity Identification and Selection, Strategic Planning for New Products/ Service	2
1.4	New Product Strategy Inputs and Identifying Opportunities,	2
2	**CONCEPT GENERATION**	
2.1	Creativity and the Product/Service Concept	1
2.2	Finding and Solving Customers' Problems, Gathering the Problems	2
2.3	Understanding Why Customers Buy a Product, Gap Analysis	1
2.4	Analytical Attribute Approaches: Introduction and Perceptual Mapping	2
2.5	Analytical Attribute Approaches: Trade-Off Analysis and Qualitative Techniques	2
3	**CONCEPT/PROJECT EVALUATION**	
3.1	The Concept Evaluation System, New Products Process, Planning the Evaluation System, The A-T-A-R Model.	2
3.2	Concept Testing, The Importance of Up-Front Evaluations.	2
3.4	Product Protocol, Protocol and Quality Function Deployment, QFD and the House of Quality.	1
4	**PRODUCT DEVELOPMENT**	
4.1	Design, The Role of Design in the New Products Process,	2
4.2	Product Architecture, Prototype Development	2
4.3	Development Team Management, Building a Team, Managing the Team,	2
4.4	Product Use Testing.	1
4.5	Knowledge Gained from Product Use Testing,	1
5	**PRODUCT LAUNCH**	
5.1	The Target Market Decision, Product Positioning, Branding and Brand Management,	2
5.2	Implementation of the Strategic Plan,	2
5.3	Launch Management, The Launch Management System, Effective Metrics:	1
5.4	Learning from Experience, Product Failure	2
	Total lectures	36

Course Designers:

1. Mr.N.SHIVAKUMAR SHIVA@TCE.EDU

18CGPP0 COMPUTATIONAL GEOMETRY

Category	L	T	P	Credit
PE	3	0	0	3

Preamble

This course will cover fundamental structures, techniques and how to model or solve problems in geometric fashion.

Prerequisite

- Design and Analysis of Algorithms
- Computer Graphics

Course Outcomes

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

Course Outcomes	Bloom's Level
Identify appropriate algorithms for finding line segments intersections and computing overlays for the given problem in order to satisfy the user specified time complexity. (CO1)	Apply
Develop triangulation algorithms for solving special classes of polygons.(CO2)	Apply
Apply randomized algorithms to develop trapezoidal map, search tree and voronoi diagrams for the given problem. (CO3)	Apply
Perform hidden surface removal by applying painter's algorithm for the given scenario.(CO4)	Apply
Analyze the performance of range searching algorithms in terms of storage and query time for the given problem. (CO5)	Analyze
Design and Develop geometric structures and techniques to solve simple or moderately difficult problems (CO6)	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1.	S	M	M	M	L						
CO2.	S	M	M	M	L						
CO3.	S	M	L	L	L						
CO4.	S	M	M	M	L						
CO5.	S	S	S	M	M						

CO6.	S	S	S	M	M	M	L	M	M	M	

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Assignment		Terminal Examination
	Test 1	Test 2	1	2	
Remember	-	-	-	-	20
Understand	30	20	-	-	20
Apply	60	60	80	80	40
Analyze	10	20	20	20	20
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Suppose that that a simple polygon with n vertices is given. The vertices are given in counter clockwise order along the boundary. Give an efficient algorithm to determine all edges that are intersected by a given line.
2. List out the application areas of computational geometry.
3. Explain the procedure for computing the overlay of two subdivisions.

Course Outcome 2 (CO2):

1. The degree of a point in a triangulation is the number of edges incident to it. Give an example of a set of n points in the plane such that, no matterhow the set is triangulated, there is always a point whose degree is n-1. Prove that any two triangulations of a planar point set can be transformedinto each other by edge flips.
2. A Euclidean minimum spanning tree (EMST) of a set P of points in the plane is a tree of minimum total edge length connecting all the points.EMST's are interesting in applications where we want to connect sites in a planar environment by communication lines (local area networks), roads, railroads, or the like.
   a.Prove that the set of edges of a Delaunay triangulation of P contains, an EMST for P.
   b. Use this result to give an O(nlogn) algorithm to compute an EMST for P.
3. Define Steiner triangulation.
4. Define Polygon Triangulation.

Course Outcome 3 (CO3):

1. Given a convex polygon P as an array of its n vertices in sorted order along the boundary. Show that, given a query point q, it can be tested in time $O(\log n)$ whether q lies inside P.
2. Explain randomized incremental algorithm with an example.
3. Show that the farthest point Voronoi diagram on n points in the plane has at most $2n-3$ (bounded or unbounded) edges. Also give an exact bound on the maximum number of vertices in the farthest point Voronoi diagram.

Course Outcome 4 (CO4):

1. List out the applications of painter's algorithm.
2. Let S be a set of m polygons in the plane with n vertices in total. Let T be a BSP tree for S of size k. Prove that the total complexity of the fragments generated by the BSP is $O(n+k)$.
3. Give a deterministic divide-and-conquer algorithm that constructs a BSP tree of size $O(n \log n)$ for a set of n line segments in the plane.

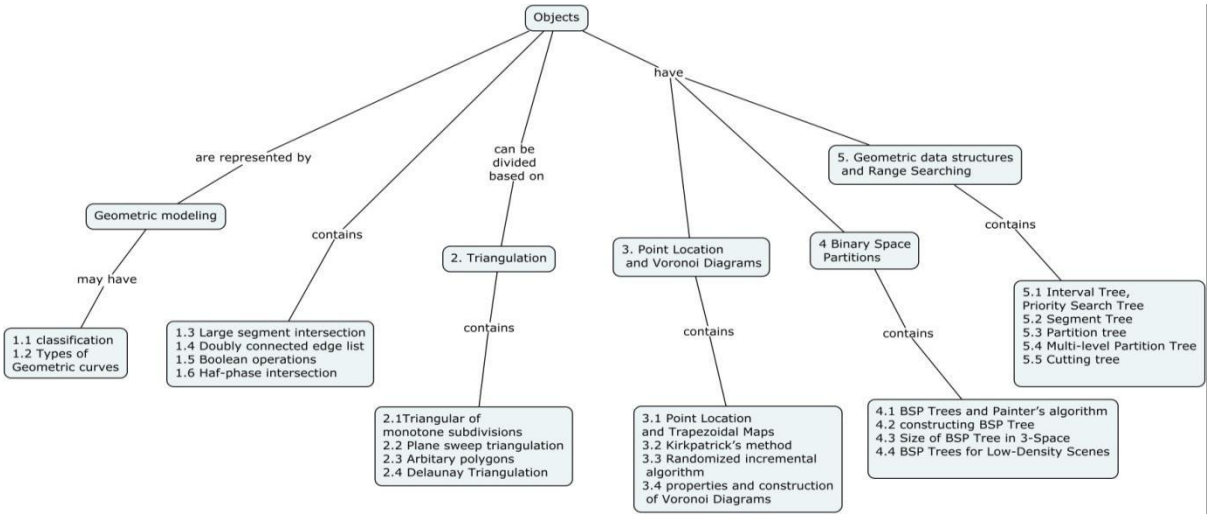
Course Outcome 5 (CO5):

1. Define stabbing query.
2. Differentiate orthogonal range searching from simple range searching.
3. Design a data structure for triangular range searching that has $O(\log^3 n)$ query time. Describe the data structure as well as the query algorithm precisely, and analyze both storage and query time.

Course Outcome 6 (CO6):

1. Generate the Bezier curve given by the following set of control points: P0= (8, 10, 0), P1=(15,20,0), P2 = (22,21,0) , P3 =(22,21,0) and P4 =(28,8,0)
    i. Evaluate the curve at different u values.
    ii. Sketch the curve, control points and defining polygon.
    iii. List out the properties of the above Bezier curve.
2. In many situations we need to compute convex hulls of objects other than points.
    a. Let S be a set of n line segments in the plane. Prove that the convex hull of S is exactly the same as the convex hull of the 2n endpoints of the segments.
    b. b.* Let P be a non-convex polygon. Describe an algorithm that computes the convex hull of P in O(n) time. Hint: Use a variant of algorithm CONVEXHULL where the vertices are not treated in lexicographical order, but in some other order.
3. Let P be a simple polygon with n vertices, which has been partitioned into monotone pieces. Prove that the sum of the number of vertices of the pieces is O(n).

Concept Map



Syllabus

Introduction to Computational Geometry: Introduction, Geometric modelling forms and its classification, Types of geometry curves, **Intersection:** Line segment Intersection, The Doubly –connected Edge List, Doubly-Connected Edge List and Boolean Operations, Half-Plane intersection. **Triangulation:** Triangulation of monotone subdivisions, plane-sweep triangulation of simple polygons, Triangulation of arbitrary polygons, Delaunay Triangulation. **Point Location and Voronoi Diagrams:** Point Location and Trapezoidal Maps, Kirkpatrick's method, andomized incremental algorithm, properties and construction of Voronoi Diagrams. **Binary Space Partitions:** BSP Trees and Painter's algorithm, constructio ng BSP Tree, Size of BSP Tree in 3-Space, BSP Trees for Low-Density Scenes. **Geometric data structures and Range Searching:** Interval Tree, Priority Search Tree, Segment Tree, Partition tree, Multi-level Partition Tree and Cutting tree.

Text Books

1. Mark de Berg, Otfrid Chenog, Marc van Kreveld , Mark Overmars : Computational Geometry : Algorithms and Applications, Springer- Verlag, Third Edition, 2008.
2. S.L. Devadoss and J. O'Rourke, Discrete and Computational Geometry, Princeto University Press, 2011.

Reference Books

1. J.O Rourke: Computational Geometry in C,Cambridge University Press, 2004.
2. T. Cormen, et.al., Introduction to Algorithm,3rd ed., MIT Press, 2009.
3. B. Casselman, Mathematical Illustrations: A Manual of Geometry and PostScript , Springer-Verlag, 2005

Course Contents and Lecture Schedule

Module No.	Topic	No. Of Lectures
1.	**Introduction to Computational Geometry**	
1.1	Geometric modelling forms and its classification	1
1.2	Types of geometry curves	1
1.3	Line segment Intersection	2

1.4	The Doubly –connected Edge List	2
1.5	Doubly-Connected Edge List and Boolean Operations.	1
1.6	Half-Plane intersection	2
2.	**Triangulation**	
2.1	Triangulation of monotone subdivisions	2
2.2	plane-sweep triangulation of simple polygons	2
2.3	Triangulation of arbitrary polygons	2
2.4	Delaunay Triangulation	1
3.	**Point Location and Voronoi Diagrams**	
3.1	Point Location and Trapezoidal Maps	2
3.2	Kirkpatrick's method	1
3.3	Randomized incremental algorithm	2
3.4	properties and construction of Voronoi Diagrams	1
4.	**Binary Space Partitions**	
4.1	BSP Trees and Painter's algorithm	1
4.2	constructing BSP Tree	2
4.3	Size of BSP Tree in 3-Space	2
4.4	BSP Trees for Low-Density Scenes	1
5.	**Geometric data structures and Range Searching**	
5.1	Interval Tree, Priority Search Tree	2
5.2	Segment Tree	2
5.3	Partition tree	2
5.4	Multi-level Partition Tree	1
5.5	Cutting tree	1
	Total	**36**

Course Designers:

1. Dr.R.Leena Sri rlsit@tce.edu

FAULT TOLERANT COMPUTING SYSTEMS

18CGPQ0

Category	L	T	P	Credit
PE	3	0	0	3

Preamble

To impart a thorough understanding of the principles of reliability, and a systems approach to the design, evaluation, and implementation of fault tolerance in computer systems, exemplified by case studies of present-day systems.

Course Outcomes

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

Develop skills in modeling and evaluating fault-tolerant architectures in terms of reliability (CO1)	Apply
Apply techniques to solve the fundamental issues involved with providing fault-tolerance in hardware. (CO2)	Apply
Apply techniques for constructing fault-tolerant software. (CO3)	Apply
Apply techniques for constructing fault tolerant communication system. (CO4)	Apply
Apply alternative system designs for a specific set of requirements (CO5)	Apply
Analyze merits and limitations of existing fault-tolerant systems (CO6)	Analyze

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Assignment		Terminal Examination
	1	2	1	2	
Remember	20	20	-	-	20
Understand	20	20	-	-	20
Apply	60	40	100	80	50
Analyze	-	20	-	20	10
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Fault can have five attributes. Give two examples of faults and illustrate these attributes(Remember)
2. What are temporary faults? Differentiate between Transient faults and intermittent faults. Which one is preferable? (Understand)
3. Explain the difference between fault, error, and failure and related them to the three universe (physical, information, and external) model. Take three different examples from three very different application areas and show the correspondence. (Apply)

Course Outcome 2 (CO2):

1. Define failure rate. (Remember)
2. Write the need for self checking circuits. (Understand)
3. Illustrate the principles of markov model for the Reliability Evaluation Techniques.(Apply)

Course Outcome 3 (CO3):

1. Define Assertion. (Remember)
2. W rite the principles of Fault-Tolerant Remote Procedure Calls . (Understand)
3. Describe Jelinski–Moranda Model of Software Reliability. (Apply)

Course Outcome 4 (CO4):

1. Write the significances of *Measures of Resilience* (Remember)
2. Write the uses of Computer Networks Measures (Understand)
3. Illustrate the basic principles of *Hypercube Fault-Tolerant Routing* . (Apply)

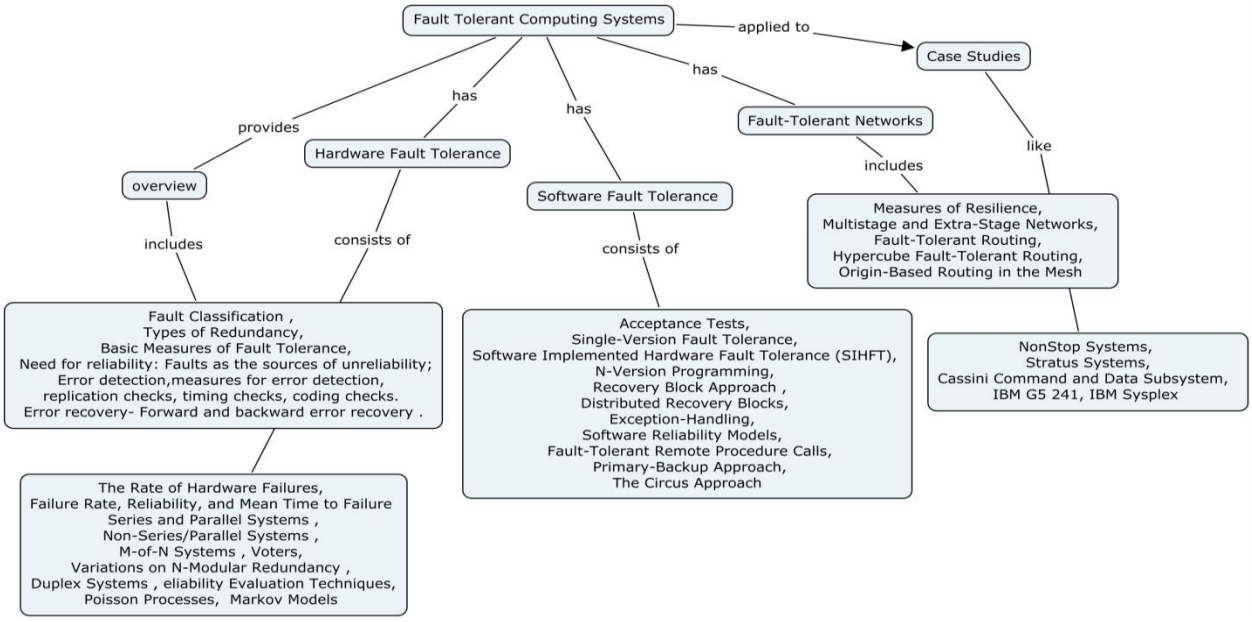
Course Outcome 5 (CO5):

1. List the approaches used to achieve reliability in a software system (Remember)
2. Compare stratus and MARS (Understand)
3. Suppose you are designing a check pointing scheme for a distributed system specified to be single-fault tolerant. That is, the system need only guarantee successful recovery from any one failure: a second failure before the system has recovered from the first one is assumed to be of negligible probability. You decide to take checkpoints and carry out message-logging. Show that it is sufficient for each processor to simply record the messages it sends out in its volatile memory. (Apply)

Course Outcome 6 (CO6):

3. List the benefits of stratus systems. (Remember)
4. Compare and contrast IBM G5 241 and IBM sysplex (Understand)
5. Analyse the advantages of NonStop systems other systems. (Analyze)

Concept Map



Syllabus

Fault Classification , Types of Redundancy, Basic Measures of Fault Tolerance, Need for reliability: Faults as the sources of unreliability; Error detection - measures for error detection, replication checks, timing checks, coding checks. Error recovery- Forward and backward error recovery .

Hardware Fault Tolerance- The Rate of Hardware Failures, Failure Rate, Reliability, and Mean Time to Failure Canonical and Resilient Structures, Series and Parallel Systems , Non-Series/Parallel Systems , *M*-of-*N* Systems , Voters, Variations on *N*-Modular Redundancy , Duplex Systems , Other Reliability Evaluation Techniques,Poisson Processes, Markov Models

Software Fault Tolerance - Acceptance Tests, Single-Version Fault Tolerance, Wrappers, Software Rejuvenation, Data Diversity, Software Implemented Hardware Fault Tolerance (SIHFT), *N*-Version Programming, Consistent Comparison Problem, Version Independence, Recovery Block Approach , Basic Principles, Success Probability Calculation, Distributed Recovery Blocks, Preconditions, Postconditions, and Assertions, Exception-Handling, Requirements from Exception-Handlers, Basics of Exceptions and Exception-Handling, Language Support, Software Reliability Models, Jelinski–Moranda Model ,Littlewood–Verrall Model, Musa–Okumoto Model, Model Selection and Parameter Estimation, Fault-Tolerant Remote Procedure Calls, Primary-Backup Approach, The Circus Approach

Fault-Tolerant Networks- Measures of Resilience, Graph-Theoretical Measures, Computer Networks Measures, Common Network Topologies and Their Resilience, Multistage and Extra-Stage Networks, Crossbar Networks, Rectangular Mesh and Interstitial Mesh, Hypercube Network, Cube-Connected Cycles Networks, Loop Networks, Ad hoc Point-to-Point Networks, Fault-Tolerant Routing, Hypercube Fault-Tolerant Routing, Origin-Based Routing in the Mesh

Case Studies- NonStop Systems, Architecture, Maintenance and Repair Aids, Software, Modifications to the NonStop Architecture , Stratus Systems, Cassini Command and Data Subsystem, IBM G5 241, IBM Sysplex

Text Books

1. Israel Koren and C. Mani Krishna , “Fault-Tolerant Systems”, , Morgan Kaufmann Publishers, 2007.
2. Elena Dubrova ,“Fault-Tolerant Design”, Springer, 2013.

Reference Books

1. Levi & Agrawala, "Fault Tolerant Systems Design, McGraw hill, 1994.

2 . MA. Breuer and A.D.Friedman, "Diagnosis and Reliable design of Digital Systems", Computer Sci. Press, 1976

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1	**Overview**	
1.1	Fault Classification , Types of Redundancy, Basic Measures of Fault Tolerance, Need for reliability: Faults as the sources of unreliability	2
1.2	Error detection - measures for error detection, replication checks, timing checks, coding checks.	2
1.3	Error recovery- Forward and backward error recovery	1
2	**Hardware Fault Tolerance**	
2.1	The Rate of Hardware Failures, Failure Rate, Reliability, and Mean Time to Failure Canonical and Resilient Structures	2
2.2	Series and Parallel Systems , Non-Series/Parallel Systems , *M*-of-*N* Systems , Voters	2
2.3	Variations on *N*-Modular Redundancy, Duplex Systems	1
2.4	Reliability Evaluation Techniques, Poisson Processes, Markov Models	2
3	**Software Fault Tolerance**	
3.1	Acceptance Tests, Single-Version Fault Tolerance, Wrappers, Software Rejuvenation, Data Diversity	2
3.2	Software Implemented Hardware Fault Tolerance (SIHFT)	1
3.3	*N*-Version Programming, Consistent Comparison Problem, Version Independence	2
3.4	Recovery Block Approach , Basic Principles, Success Probability Calculation	1
3.5	Distributed Recovery Blocks, Preconditions, Postconditions, and Assertions	1
3.6	Exception-Handling, Requirements from Exception-Handlers, Basics of Exceptions and Exception-Handling, Language Support	2
3.7	Software Reliability Models, Jelinski–Moranda Model, Littlewood–Verrall Model	2
3.8	Musa–Okumoto Model, Model Selection and Parameter Estimation	1
3.9	Fault-Tolerant Remote Procedure Calls, Primary-Backup Approach, The Circus Approach	2
4	**Fault-Tolerant Networks**	

4.1	Measures of Resilience, Graph-Theoretical Measures, Computer Networks Measures, Common Network Topologies and Their Resilience	2
4.2	Multistage and Extra-Stage Networks, Crossbar Networks, Rectangular Mesh and Interstitial Mesh, Hypercube Network	2
4.3	Cube-Connected Cycles Networks, Loop Networks, Ad hoc Point-to-Point Networks	1
4.4	Fault-Tolerant Routing, Hypercube Fault-Tolerant Routing, Origin-Based Routing in the Mesh	1
5	**Case Studies**	
5.1	NonStop Systems, Architecture, Maintenance and Repair Aids, Software, Modifications to the NonStop Architecture	2
5.2	Stratus Systems	1
5.3	Cassini Command and Data Subsystem, IBM G5 241, IBM Sysplex	1

Course Designers:

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

		Category	L	T	P	Credit
18CGPR0	**STORAGE AND SERVER SECURITY**	PE	3	0	0	3

Preamble

The course on Storage and Server Security to emphasize the need for securing storage infrastructure, provide an in depth coverage of technologies in the various phases of designing and building an Information Storage System and to provide an overview of various security aspects.

Course Outcomes

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

Explain the elements of Data center infrastructure. (CO1)	Apply
Outline the impact of RAID in disk performance. (CO2)	Apply
Construct the network storage model for the given specification (CO3)	Apply
Design the secured storage system for the given domain specification.(CO4)	Apply
Examine Security Implementations in Storage Networking.(CO5)	Analyze
Investigate the Backup or Replication process suitable for the Storage Environment (CO6)	Analyze

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Assignment		Terminal Examination
	1	2	1	2	
Remember	30	20	-	-	20
Understand	30	20	-	-	20

Apply	40	40	100	80	40
Analyze	-	20	-	20	20
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Mention the categories of data.
2. What do you mean by downtime?
3. List the demerits of centralized data storage.
4. Define Platter.
5. Describe how you can control Application access, User access and Host access.

Course Outcome 2 (CO2):

1. List the challenges of NAS.
2. Define fixed content.
3. Explain how CAS stores and retrieves data objects.
4. Mention the benefits of CAS.
5. Describe the functionalities of FC Switch and Hub with necessary diagrams.

Course Outcome 3 (CO3):

1. Explain how remote replication technology can be helpful in disaster recovery.
2. Write the use of Backup?
3. Classify Replication.
4. Define RPO and RTO.
5. Differentiate Disaster Recovery and Disaster Restart.

Course Outcome 4 (CO4):

1. AirTel Telecom is involved in mobile wireless services across the India and has about

5000 employees worldwide. This company is Chennai based and has 7 regional offices across the country. Although AirTel is doing well financially, they continue to feel competitive pressure. As a result, the company needs to ensure that the IT infrastructure takes advantage of fault tolerant features.

Current Situation/Issues:

i. The company uses a number of different applications for communication, accounting, and management. All the applications are hosted on individual servers with disks configured as RAID 0.
ii. All financial activity is managed and tracked by a single accounting application. It is very important for the accounting data to be highly available.
iii. The application performs around 15% write operations, and the remaining 85 % are reads.
iv. The accounting data is currently stored on a 5-disk RAID 0 set. Each disk has an advertised formatted capacity of 200 GB, and the total size of their files is 730 GB.
v. The company performs nightly backups and removes old information—so the amount of data is unlikely to change much over the next 6 months. The company is approaching the end of the financial year and the IT budget is depleted. Buying even one new disk drive will not be possible. Design an infrastructure for the company to suit the new requirements. Justify your design based on cost, performance, and availability.

2. A manufacturing corporation uses tape as their primary backup storage media throughout the entire organization.

   Current Situation/Issue:

   Full backups are run every Sunday. Incremental backups are run from Monday through Saturday. There are many backup servers in the environment, backing up different groups of servers. Their e-mail and database applications have to be shut down during the backup process. The main concerns facing the corporation are:

   i. Due to the de-centralized backup environment, recoverability of the backup servers is compromised.
   ii. Key applications have to be shut down during the backup process.
   iii. Too many tapes need to be mounted in order to perform a full recover, in case of a complete failure. The company would like to:
      a. Deploy an easy-to-manage backup environment.
      b. Reduce the amount of time the email and database applications need to be shutdown.
      c. Reduce the number of tapes required to fully recover a server in case of failure.

      Create a network based on IP SAN topology.

3. The Information Department of a departmental store uses tape to archive data. The data once created may be accessed within 30 days and when it crosses that period, the frequency of access is less than 1%. Design a CAS solution.

Course Outcome 5 (CO5) :

1. An application specifies a requirement of 200GB to host a database and other files. It also specifies that the storage environment should support 5000 IOPS during its peak processing cycle. The disks available for configuration provide 66GB of usable capacity and the manufacturer specifies that they can support a maximum of 140 IOPS. The application is response time sensitive and the disk utilization beyond 60% will not meet

the response time requirements of the application. Compute the minimum number of disks that should be configured to meet the requirements of the application.

2. Consider a disk I/O system in which an I/O request arrives at the rate of 80 IOPS. The disk service time is 6ms.
   a. Compute the following
      i. Utilization of I/O controller
      ii. Total response time
      iii. Average queue size
      iv. Total time spent by a request in a queue

   Compute the preceding parameter if the service time is halved.

3. A 10k RPM drive is rated to perform 130 IOPS and a 15k RPM drive is rated to perform 180 IOPS for an application. The read/write ratio is 3:1. Compute the RAID-adjusted IOPS for the 10k and 15k drives for RAID 1, RAID 5 and RAID 6.
4. An application has 1000 heavy users at a peak of 2 IOPS each and 2000 typical users at a peak of 1 IOPS each, with a read/write ratio of 2:1. It is estimated that the application also experiences an overhead of 20% for other workloads. Calculate the IOPS requirement for RAID 1, RAID 3, RAID 5 and RAID 6.

Course Outcome 6 (CO6) :

1. A Manufacturing Corporation maintains the storage of their mission critical applications on high-end Storage Arrays on RAID 1 volumes. The corporation has two data centers which are 50 miles apart.

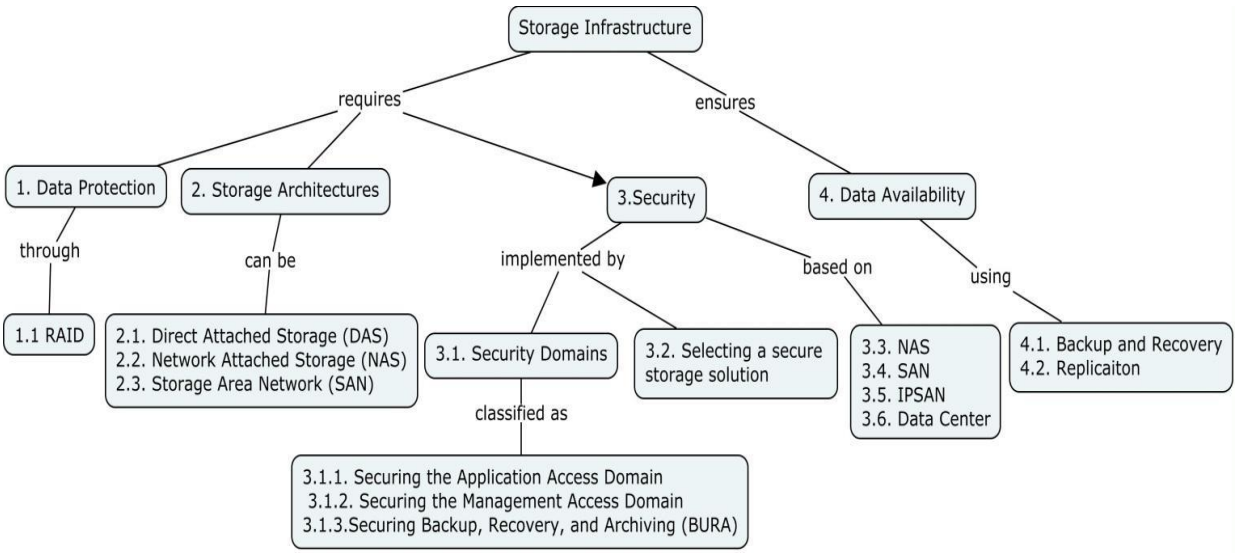
   Current Situation/Issue:

   The corporation's mission critical Database application takes up 1 TB of storage on a high end Storage Array. In the past year, top management has become extremely concerned because they do not have DR plans which will allow for zero RPO recovery if there is a site failure. The primary DR Site is the 2nd Data Center 50 miles away. The company would like explore remote replication scenarios which will allow for near zero RPO and a minimal RTO. The company is aware of the large costs associated with network bandwidth. Analyze the various remote replication technologies and suggest the suitable technology that ensures zero RPO.
2. Analyze the data center to identify systems that are susceptible to a single point of failure and implement suitable fault-tolerance mechanisms.

3. Investigate the following remote replication schemes and their corresponding recovery options:

   Multihop – Synchronous + Asynchronous
   Multihop – Synchronous + Disk buffered

Concept Map



Syllabus

Data protection: RAID impact on disk performance

Storage Architectures: Direct Attached Storage (DAS) - Network Attached Storage (NAS)- Storage Area Network (SAN)

Storage Security Domains: Securing the Application Access Domain, Securing the Management Access Domain, Securing Backup, Recovery, and Archiving (BURA),Selecting a Secure Storage Solution: Data Center Security Framework-Risk Triad: Assets, Threats, Vulnerability, Security Implementations in Storage Networking **:** SAN, NAS, IP SAN - Data center security overview: Need for a secure data center-Vulnerabilities and comman attacks- Network security infrastructure- Security protocols and technologies: Authentication protocols and technologies-Network management security-Integrating security into the infrastructure

Data Availability: Backup and Recovery - Replication: local and remote replication

Text Books

1. “Data Protection for Virtual Data Centers”, Jason Buffington, John Wiley & Sons, 2010
2. “Handbook on Data Centers”, Samee Ullah Khan, Zomaya, Albert Y, Springer-Verlag New York, 2015
3. “Storage Networks: The Complete Reference”, Robert Spalding, Tata McGraw Hill- Osborne, 2003.

Reference Books

1. "Storage Security: Protecting SANs, NAS and DAS", John Chirillo, Scott Blaul, ISBN: 978-0-7645-1688-7,December 2002
2. “Disaster Recovery and Business Continuity”, Thejendra BS, Shroff Publishers and Distributors, 2006.
3. Information Storage and Management: Storing, Managing, and Protecting Digital Information in Classic, Virtualized, and Cloud Environments, EMC Education Services, John Wiley and Sons, 2012, ISBN: 9781118094839

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1	Data protection	1
1.1	RAID impact on disk performance	1
2	Storage Architectures	1
2.1	Direct Attached Storage (DAS)	1
2.2	Network Attached Storage (NAS)	1
2.3	Storage Area Network (SAN)	1
3	Storage infrastructure security	1
3.1	Storage Security Domains	1
3.1.1	Securing the Application and Management Access Domain	1
3.1.2	Securing Backup, Recovery, and Archiving (BURA)	2
3.2	Selecting a Secure Storage Solution	1
3.2.1	Risk Triad: Assets, Threats, Vulnerability	1
3.3	Security Implementations in SAN	2
3.4	Security Implementations in NAS	1
3.5	Security Implementations in IP SAN	2
3.6	Data center security overview	1
3.6.1	Need for a secure data center	1
3.6.2	Vulnerabilities and comman attacks	1
3.6.3	Network security infrastructure	1
3.6.4	Security protocols and technologies	2
3.6.5	Authentication protocols and technologies	2
3.6.6	Network management security	2
3.6.7	Integrating security into the infrastructure	1
4	Data Availability	1
4.1	Backup and Recovery	2
4.2	Replication	1
4.2.1	Local replication	1
4.2.2	Remote replication	2
	Total	**36**

Course Designers:

1. M.P.Ramkumar ramkumar@tce.edu
2. GSR.Emil Selvan emil@tce.edu

18CGPS0 PROBABILISTIC GRAPHICAL MODELING

Category	L	T	P	Credit
PE	3	0	0	3

Preamble

The course on Probabilistic graphical models aims to emphasize the need for applying the probability, Graph theory and machine learning concepts for solving structured decision problems in the real world.

Prerequisite

- Probability theory
- Graph theory
- Machine learning

Course Outcomes

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

Apply the basic concepts of probability and graph theory in structured probabilistic models. (CO1)	Apply
Classify the different graphical models and examine their working principle.(CO2)	Apply
Perform variable elimination by using inference. (CO3)	Apply
Perform parameter estimation for structured data. (CO4)	Apply
Perform parameter estimation for incomplete partial data. (CO5)	Apply
Develop solutions for real world problems using probabilistic graphical model (CO6)	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1.	S	S									
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

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Assignment		Terminal Examination
	1	2	1	2	
Remember	20	10	-	-	10
Understand	40	30	-	-	30
Apply	40	60	100	100	60
Analyze	-	-	-	-	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. State the difference between Bayesian and Markov network.
2. Explain in detail about expectation and variance with suitable examples.
3. Suppose that a tuberculosis (TB) skin test is 95 percent accurate. That is, if the patient is TB-infected ,then the test will be positive with probability 0:95, and if the patient is not infected, then the test will be negative with probability 0:95. Now suppose that a person gets a positive test result. What is the probability that he is infected?.

Course Outcome 2 (CO2):

1. Discuss about Markov network independencies.
2. Show that a multinet where each Bayesian network Bc is acyclic always defines a coherent probability distribution — one where all of the probabilities sum to 1. Your proof should apply even when the induced Bayesian network that contains the union of all of the edges in the networks Bc contains a cycle.
3. Compare Markov and Hidden markov models.

Course Outcome 3 (CO3):

1. Define Conditional Probability distribution.
2. Explain the variable elimination algorithm.

3. Consider a fully persistent DBN over n state variables X. Show that any clique tree over X(t);X(t+1) that we can construct for performing the belief-state propagation step has induced width at least n + 1.

Course Outcome 4 (CO4):

1. State the maximum likelihood principle.
2. Explain the steps involved in Bayesian parameter estimation.
3. Consider using the structural EM algorithm to learn the structure associated with a hidden variable H; all other variables are fully observed. Assume that we start our learning process by performing an E-step in a network where H is not connected to any of X1; : : : ;Xn. Show that, for any initial parameter assignment to P(H), the SEM algorithm will not connect H to the rest of the variables in the network.

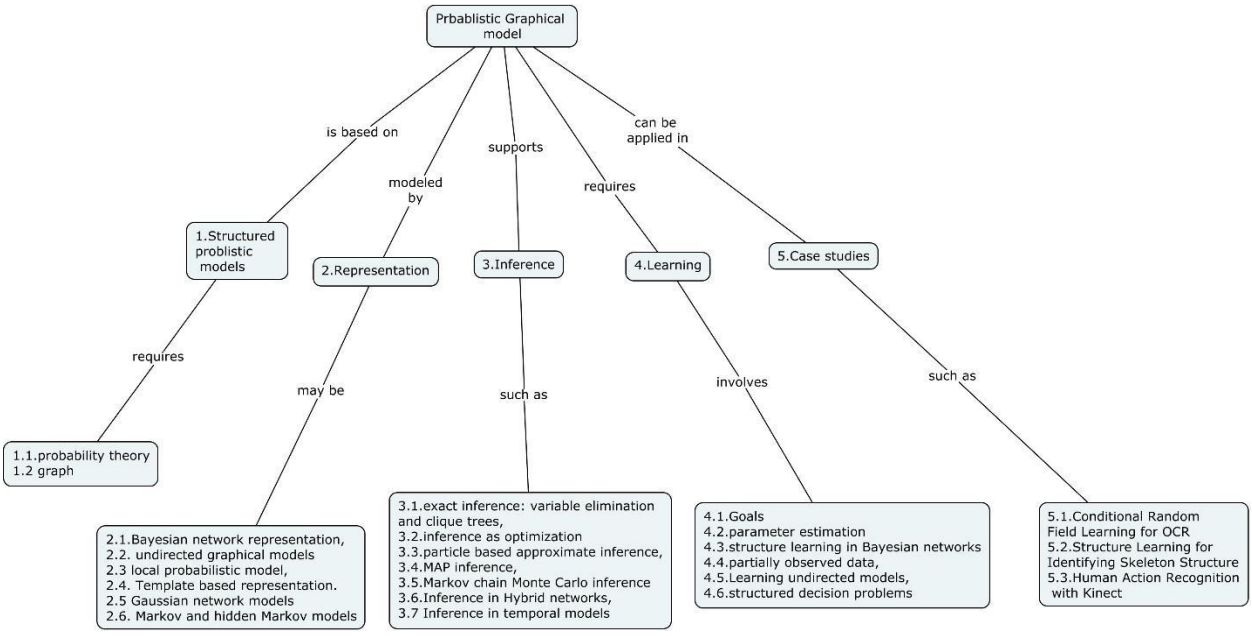
Course Outcome 5 (CO5):

1. State the need for parameter estimation.
2. Explain the steps involved in learning undirected models.

Course Outcome 6 (CO6):

1. Define Decision tree.
2. With suitable case study discuss about Human Action Recognition with Kinect
3. Extend the algorithm of Iterated optimization for influence diagrams with acyclic relevance graphs to find a globally optimal solution even in influence diagrams with cyclic relevance graphs. Your algorithm will have to optimize several decision rules simultaneously, but it should not always optimize all decision rules simultaneously. Explain precisely how you jointly optimize multiple decision rules, and how you select the order in which decision rules are optimized.

Concept Map



Syllabus

Structured probabilistic models-Introduction, probability theory, graph **Representations** - Bayesian network representation, undirected graphical models, local probabilistic model, Template based representation. Gaussian network models, Markov and hidden Markov models- **Inference** –exact inference: variable elimination and clique trees, inference as optimization, particle based approximate inference, MAP inference, Markov chain Monte Carlo inference ,Inference in Hybrid networks, Inference in temporal models **Learning** –Goals, parameter estimation, structure learning in Bayesian networks, partially observed data, Learning undirected models, structured decision problems **Case studies** Conditional Random Field Learning for OCR, Structure Learning for Identifying Skeleton Structure, Human Action Recognition with Kinect

Text Book

1. Daphne Koller , N Friedman ,Probabilistic Graphical Models - Principles and Techniques (Adaptive Computation and Machine Learning Series) ,MIT Press, 2009

Reference Books

1. Kevin Murphy,Machine Learning - A Probabilistic Perspective (Adaptive Computation and Machine Learning Series) MIT Press, 2012

2. KiranKarkal ,Building Probabilistic Graphical Models with Python - Packt Publishing, 2014

3. https://www.coursera.org/course/pgm

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1.	**Structured probabilistic models**-Introduction	
1.1	probability theory	2
1.2	graph	2
2.	**Representations**	
2.1	Bayesian network representation	2
2.2	local probabilistic model	1
2.3	Template based representation	1
2.4	Gaussian network models	2
2.5	Markov and hidden Markov models	2
3	**Inference**	
3.1	exact inference: variable elimination and clique trees	2
3.2	inference as optimization	2
3.3	particle based approximate inference	2
3.4	MAP inference	1
3.5	Markov chain Monte Carlo inference	1
3.6	Inference in Hybrid networks	1
3.7	Inference in temporal models	1
4	**Learning**	
4.1	Goals	1
4.2	parameter estimation	2
4.3	structure learning in Bayesian networks	2
4.4	partially observed data	2

4.5	Learning undirected models	2
4.6	structured decision problems	2
5	**Case studies**	
5.1	Conditional Random Field Learning for OCR,	1
5.2	Structure Learning for Identifying Skeleton Structure	1
5.3	Human Action Recognition with Kinect	1
	Total	**36**

Course Designers:

1. C.Senthilkumar cskcse@tce.edu

18CGPT0	REAL TIME SYSTEMS			
Category	L	T	P	Credit
PE	3	0	0	3

Preamble

The course is aimed at exposing student towards the characteristics of the RTS and their response to time constraints. The students will be able to schedule and priorities tasks over real time. Task can be scheduled with respect to deadlines over uniprocessor or multiprocessor DS.

Prerequisite

- Operating System Concepts

Course Outcomes

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

Understand the Characteristics, constraints and issues in Real Time Systems. (CO1)	Understand
Determine and apply suitable scheduler for real time systems.(CO2)	Apply
Determine and apply suitable Event driven scheduler for real time systems.(CO3)	Apply
Handle dependencies among tasks and prioritizes and shares resources. (CO4)	Apply
Schedule tasks across multi-processor and distributed environment. (CO5)	Apply
Design a real time database for the application understanding the characteristics of commercial real time systems. (CO6)	Apply

Mapping with Programme Outcomes

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11
CO1	S	M	L	L							
CO2	S	M	L	L							
CO3	S	M	L	L							
CO4	S	M	M	M							
CO5	S	M	M	M							
CO6	S	M	L	L							

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests	Assignment	Terminal Examination

	1	2	1	2	
Remember	20	20			20
Understand	20	20			40
Apply	60	60	100	100	40
Analyze					
Evaluate					
Create					

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. What do you understand by the term ”real-time”?
2. How is the concept of real-time different from the traditional notion of time?
3. What do you understand by “fail-safe” state of system?
4. Explain the key difference between the characteristics of soft real-time task Such as web browsing and a non-real-time task such as e-mail delivery.

Course Outcome 2 (CO2):

1. What do you understand by scheduling point of a task scheduling algorithm?
2. Identify the constraints that a set of periodic real-time tasks need to satisfy for RMA to be an optimal scheduler for the set of tasks?

Course Outcome 3 (CO3):

1.. What do you understand by optimal scheduling algorithm?
2. What is the sufficient condition for EDF schedulability of a set of periodic task whose Period and deadline are different?

Course Outcome 4 (CO4):

1. Define the term priority inversion and unbounded priority inversion.
2. What do you understand by inheritance-related inversion?
3. Explain the operation of priority ceiling protocol(PCP) in sharing resources among Real-time task.
4. Define Priority inheritance Protocol(PIP)

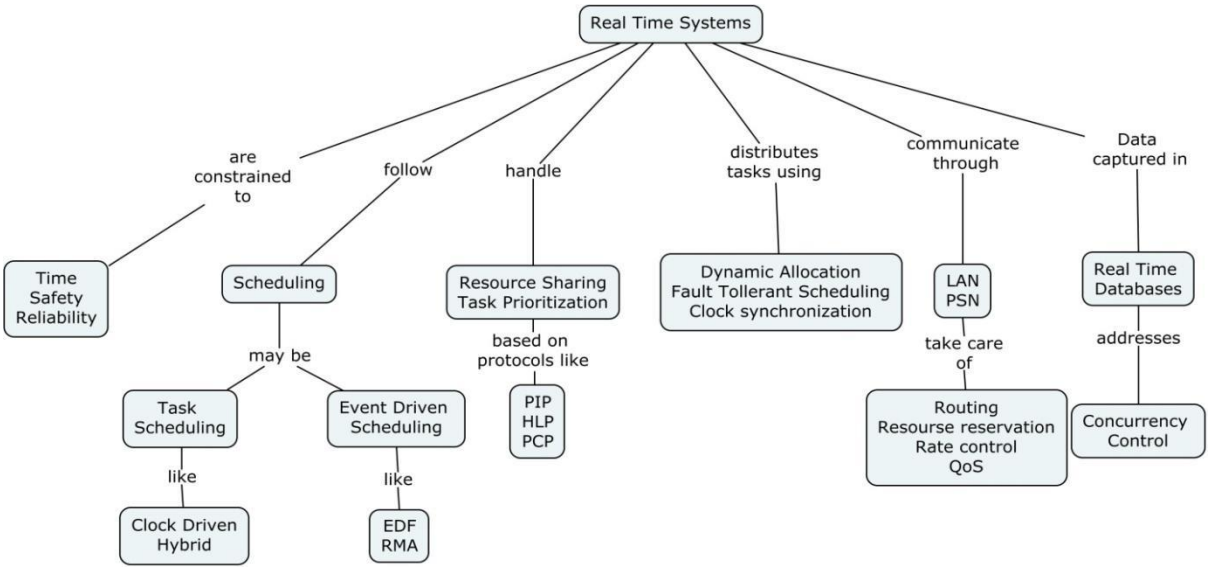
Course Outcome 5 (CO5):

1. List out the drawback of centralized clock synchronization.
2. Why is it necessary to synchronize the clocks in a distributed real-time system?
3. Define Universal coordinate time(UTC).
4. What do you understand about TAI.

Course Outcome 6 (CO6):

1. Explain how a real-time database differs from a conventional database.
2. Explain few practical applications requiring the use of a real-time database.
3. What do you understand by temporal data?
4. What is Optimistic concurrency control(OCC)?

Concept Map



Syllabus

Introduction- Real Time Systems -applications of Real Time Systems-Basic model of RTS.- Characteristics of RTS- Safety and reliability-Types of Real-time tasks. **Real-Time Task Scheduling-**Types of RTS and their characteristics - Task Scheduling -Clock driven scheduling – hybrid schedulers - Event-driven scheduling - Earlier Deadline First(EDF)scheduling – Rate Monotonic Algorithm(RMA)- Issues associated with RMA **Handling Resource sharing and Dependencies among Real - Time Tasks -** Resource sharing among Real-Time tasks-Priority Inversion - Priority Inheritance Protocol(PIP) - Highest Locker Protocol(HLP) - Priority ceiling Protocol(PCP) - Types of Priority Inversions Under PCP - Important Features of PCP - Issues in Using a Resource sharing Protocol. **Scheduling Real-Time Task in Multiprocessor and distributed systems-** Multiprocessor Task allocation - Dynamic allocation of tasks – Fault - tolerant scheduling of tasks - Clocks in Distributed Real-Time Systems. **Real-Time**

Communication- Basic concepts-Real-Time communication in a LAN- Soft and Hard Real-Time communication in a LAN-Performance comparison-RTC over Packet switched networks. **Real-Time Databases-** Applications of Real - Time Databases - Review of basic Database Concepts - Real-Time Databases - Characteristics of Temporal data - Concurrency control in Real-Time Databases.

Text Books

1. Rajib Mall "Real- Time Systems" Theory and Practice –Pearson Education-2007
2. C.M. Krishna, Kang G. Shin, "Real-Time Systems", McGraw-Hill International Editions, 1997.

Reference Books

1. Stuart Bennett, "Real Time Computer Control-An Introduction", Second edition Perntice Hall PTR, 1994.
2. R.J.A Buhur, D.L. Bailey, " An Introduction to Real-Time Systems", Prentice-Hall International, 1999.
3. Philip.A.Laplante "Real Time System Design and Analysis" PHI , III Edition, April 2004

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1	**Real Time Systems(6)**	
1.1	Real Time-applications of Real Time Systems	2
1.2	Basic model of RTS.- Characteristics of RTS	2
1.3	Safety and reliability-Types of Real-time tasks	2
2	**Real-Time Task Scheduling(8)**	
2.1	Types of RTS and their characteristics-Task Scheduling	2
2.2	clock driven scheduling –hybrid schedulers	2
2.3	event-driven scheduling Earlier Detection First(EDF)scheduling	2
2.4	Rate Monotonic Algorithm(RMA)-Issues associated with RMA	2
3	**Handling Resource sharing and Dependencies among Real-Time Tasks(7)**	
3.1	Resource sharing among Real-Time tasks-Priority Inversion	2
3.2	Priority Inheritance Protocol(PIP)-Highest Locker Protocol(HLP)	2

3.3	Priority ceiling Protocol(PCP)-Types of Priority Inversions Under PCP	2
3.4	Issues in Using a Resource sharing Protocol	1
4	**Scheduling Real-Time Task in Multiprocessor and distributed systems(5)**	
4.1	Multiprocessor Task allocation- Dynamic allocation of tasks	3
4.2	Fault-tolerant scheduling of tasks-Clocks in Distributed Real-Time Systems	2
5	**Real-Time Communication(5)**	
5.1	Basic concepts-Real-Time communication in a LAN	2
5.2	Soft and Hard Real-Time communication in a LAN	2
5.3	Performance comparison-RTC over Packet switched networks	1
6	**Real-Time Databases(5)**	
6.1	Applications of Real-Time Databases-Review of basic Database Concepts	2
6.2	Real-Time Databases-Characteristics of Temporal data	2
6.3	Concurrency control in Real-Time Databases.	1
	Total	**36**

Course Designers:

1. Mr. S.Prsanna sprcse@tce.edu
2. Mr.R.Chellamani rcmcse@tce.edu

18CGPU1 SOFTWARE DEFINED NETWORKING

Category	L	T	P	Credit
PE	3	0	0	3

Preamble

The Syllabus is designed to discuss the reason, genesis and working principle of Software Defined Networking (SDN). The basic features of traditional router architecture as well 5G networks are covered. Further SDN is explained with different versions of OpenFlow. Finally, Application of SDN in other environments is also taken into account.

Prerequisite

- Computer Networks

Course Outcomes

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

Construct autonomous and dynamic forwarding tables for SDN Switch (CO1)	Apply
Identify the appropriate feature of 5G applicable for the given scenario (CO2)	Apply
Solve the problems faced by today's data centre using SDN/ Virtualization techniques (CO3)	Apply
Demonstrate the techniques used to incorporate SDN (CO4)	Apply
Apply different versions of Open Flow standards to manage Network Components of SDN (CO5)	Apply
Apply the concept of Software Defined Networking in the given environment. (e.g. Campus Network). (CO6)	Apply

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Assignment		Terminal Examination
	1	2	1	2	

Remember	20	20	-	-	20
Understand	40	40	-	-	40
Apply	40	40	100	100	40
Analyze	-	-	-	-	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

1. **Draw traditional Switch Architecture (Remember)**
2. Differentiate traditional Router and Programmable Router. (Understand)
3. Construct dynamic forwarding table using any of the routing protocols? (Apply)

Course Outcome 2 (CO2):

1. List out the key features of 5GN (Remember)
2. Explain working principle of MIMO (Understand)
3. Consider that you are in a remote center, participating in a video conference. To participate without any interruption, 5th Generation Network is to be implemented with the following Quality of Services: Reliability, Resilience, Efficiency and Cost-Effectiveness. Identify the feature of 5GN to achieve the QoS. (Apply)

Course Outcome 3 (CO3)

1. **Define Software Defined Networking (Remember)**
2. Distinguish between SDN and Virtualization (Understand)
3. Illustrate the operation of SDN. (Understand)
4. An online financial services company faced a problem all too common in today's data centers. The company was running out of space to house physical servers, and its existing cooling infrastructure couldn't keep up. Examine and identify, which one is applicable (SDN/Virtualization). Comment on this. (Apply)

Course Outcome 4 (CO4)

1. List out the fundamental characteristics of SDN.(Remember)

2. Explain the working principle of SDN with necessary diagrams.(Understand)
3. Differentiate SDN Devices & Controller and traditional networking devices(Understand)
4. Demonstrate how other alternate techniques can adopted to SDN Methodologies.(Apply)

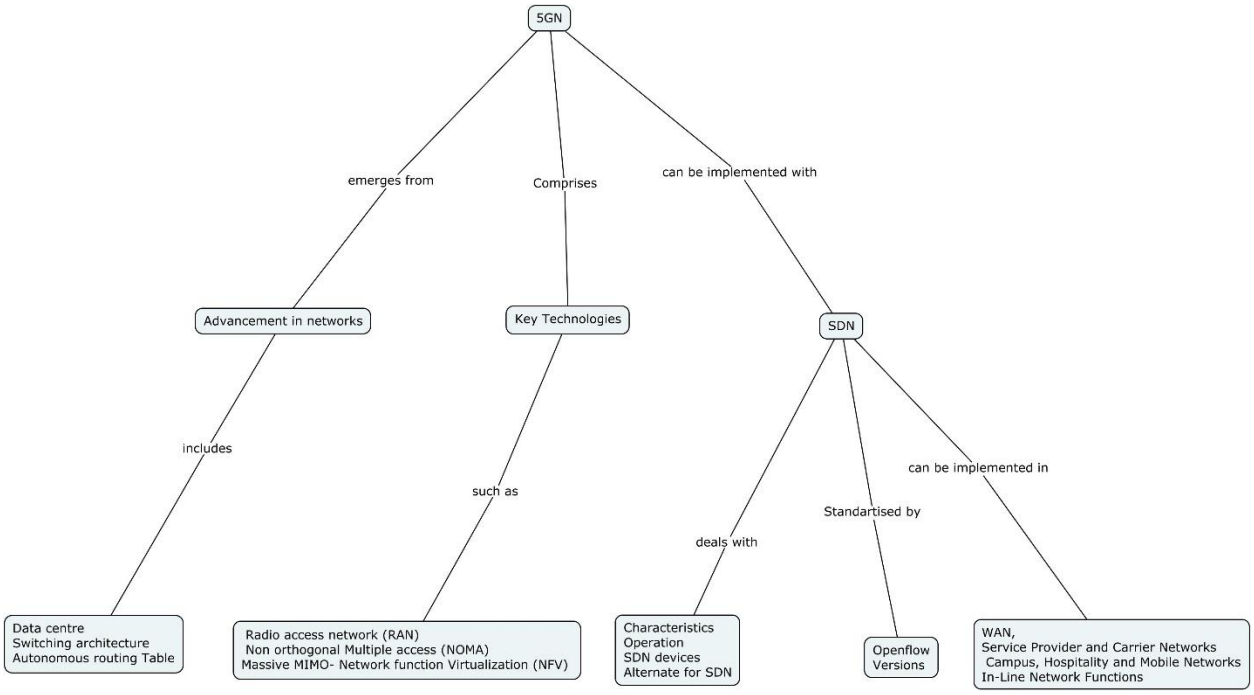
Course Outcome 5 (CO5)

1. **What is OpenFlow and List down its versions? (Remember)**
2. List out the unique characteristics of OpenFlow 1.0, 1.1, 1.2 and 1.3? (Understand)
3. Write OpenFlow1.3 code to connect 1 switch with 3 hosts. (Apply)

Course Outcome 6 (CO6)

1. **Write the exclusive feature of SDN Devices? (Remember)**
2. Write few applications of SDN (Understand)
3. Assume, a chain of community colleges are linked by a MAN. A single campus might use a CAN (Campus Area Network), but the entire academic institution use a MAN to track students' progress across different classrooms and majors. What are the shortcomings the network is expected to suffer from? What are all the SDN features you will adapt to rectify the identified problem. (Apply)

Concept Map



Syllabus

Reason for SDN: Basics and historical background for the Modern Data Center - Traditional Switch Architecture - Autonomous and Dynamic Forwarding Tables. **Introduction to 5GN:** Generation of Networks -Key Features of 5GN– IMT-2020 - 3GPP Standardization - Key Technologies: Radio access network (RAN) - Non orthogonal Multiple access (NOMA) - Massive MIMO- Network function Virtualization (NFV) **The Genesis of SDN Vs Network Virtualization:** The evolution of Networking Technology - Forerunners of SDN - Birth and Interoperability of SDN - Open Source Contributions and legacy mechanisms evolve toward SDN, Network Virtualization. **Working principle of SDN:** Fundamental characteristics of SDN - SDN Operation - SDN Devices and Controller - SDN Applications and alternate SDN Methods. **The OpenFlow Specification:** Terminologies and Overview - OpenFlow 1.0 and its basics - OpenFlow 1.1 and 1.2, OpenFlow 1.3 and Limitations. **SDN in other Environments:** WAN, Service Provider and Carrier Networks - Campus, Hospitality and Mobile Networks, In-Line Network Functions.

Reference Books

1. Paul Goransson and Chuck Black, “Software Defined Networks: A Comprehensive Approach”, Elsevier, First Edition, 2014.
2. Thomas D Nadeau and Ken Gray, “Software Defined Networks” First Edition, Oreilly, 2013.
3. Siamak Azodolmolky, “Software Defined Networking with OpenFlow”, Pack, October 2013.
4. Patricia Morreale and James M. Anderson, “Software Defined Networking: Design and Deployment” CRC Press, 2015.
5. 5G NR: The next generation wireless access technology , Erik Dahlman , Stefan Parkvall , Johan Skold ISBN: 9780128143230, First edition, Academic Press 2019
6. Fundamentals of 5G Mobile Networks, Jonathan Rodriguez, Wiley Telecom, 2014.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1	**Reason for SDN**	
1.1	Basics and historical background for the Modern Data Centre	2
1.2	Traditional Switch Architecture	1
1.3	Autonomous and Dynamic Forwarding Tables	2
2	**Introduction to 5GN**	
2.1	Generation of Networks	1
2.2	Key Features of 5GN	1

2.3	IMT-2020 - 3GPP Standardization	1
2.4	Radio access network (RAN)	1
2.5	Non orthogonal Multiple access (NOMA) - Massive MIMO	1
2.6	Network function Virtualization (NFV)	1
3	**The Genesis of SDN Vs Network Virtualization**	
3.1	The evolution of Networking Technology	1
3.2	Forerunners of SDN	2
3.3	Birth and Interoperability of SDN	1
3.4	Open Source Contributions and legacy mechanisms evolve toward SDN	2
3.5	Network Virtualization	2
4	**Working principle of SDN**	
4.1	Fundamental Characteristics of SDN	1
4.2	SDN Operation	2
4.3	SDN Devices and Controller	2
4.4	SDN Applications and alternate SDN Methods	2
5	**The OpenFlow Specification**	
5.1	Terminologies and Overview	1
5.2	Openflow 1.0 and its basics	1
5.3	OpenFlow 1.1 and 1.2,	2
5.4	Open Flow 1.3 and Limitations	1
6	**SDN in other Environments**	
6.1	WAN	1
6.2	Service Provider	1
6.3	Carrier Networks	1
6.4	Campus Networks	1
6.5	Hospitality and Mobile Networks, In-Line Network Functions	1
		36

Course Designer:

1. Dr.C.SenthilKumar cskcse@tce.edu

18CGPV0	DATA CENTRE DESIGN AND MANAGEMENT			
Category	L	T	P	Credit
PE	3	0	0	3

Preamble

The course will facilitate the Students to analyze and identify the various parts of a datacenter, techniques and infrastructures used generally. This course provides an insight to the students on design guidance, configurations examples and best practices with respect to data center design and management. This course also deals with current data center architectures, new technologies adopted to create modern data center. In addition, the student masters the principles of datacenters and is able to design a datacenter based on requirement definition taking into account restrictions.

Course Outcomes

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

Identify the suitable datacenter design model for a given purpose like high availability, load balance and computing power for a applications like university research, military services and for research laboratories	Apply
Make use of the Unified Computing System guidelines to integrate compute, data network access and storage network access of a datacenter	Apply
Build a mission critical Datacenter with energy efficient infrastructure.	Apply
Develop a smart grid-responsive datacenter by considering demand response strategies.	Apply
Analyze the datacenter problems	Analyze
Manage the operations through infrastructure management techniques	Analyze

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

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

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Define the term datacenter.
2. llustrate the layers of datacenter design.
3. Outline different datacenter cooling systems.
4. Build a mathematical model defining the relationship between the electrical losses at the four loading point.
5. Develop a suitable datacenter design for web based applications.

Course Outcome 2 (CO2):

1. What do you mean by unified computing system?
2. Explain the technology use cases considered for Unified computing system design for data center technology.
3. Compare and contrast traditional data center with service oriented infrastructure.
4. Summarize the characteristics and benefits of each stages of a datacenter.
5. Apply the unified computing system guidelines in datacenter deliver the expected levels of performance and availability to application end users.

Course Outcome 3 (CO3)

1. What do you mean by two and four-post racks?
2. What is the power factor of the server power supplies?
3. Explain the dependability theory
4. Solve the system dysfunctional and system weak-point identifications through system dependability analysis
5. Build a suitable datacenter for overcoming natural disasters by using structural and non-structural components**.**

Course Outcome 4 (CO4)

1. Outline the IaaS benefits for the datacenter.
2. Illustrate the network topologies in datacenter with suitable examples.
3. Develop a software defined environment for cloud enabled datacenter.
4. Explain the blade server architecture with a neat sketch.
5. Build a smart grid responsive datacenter by considering cooling, power delivery systems and lighting technologies.

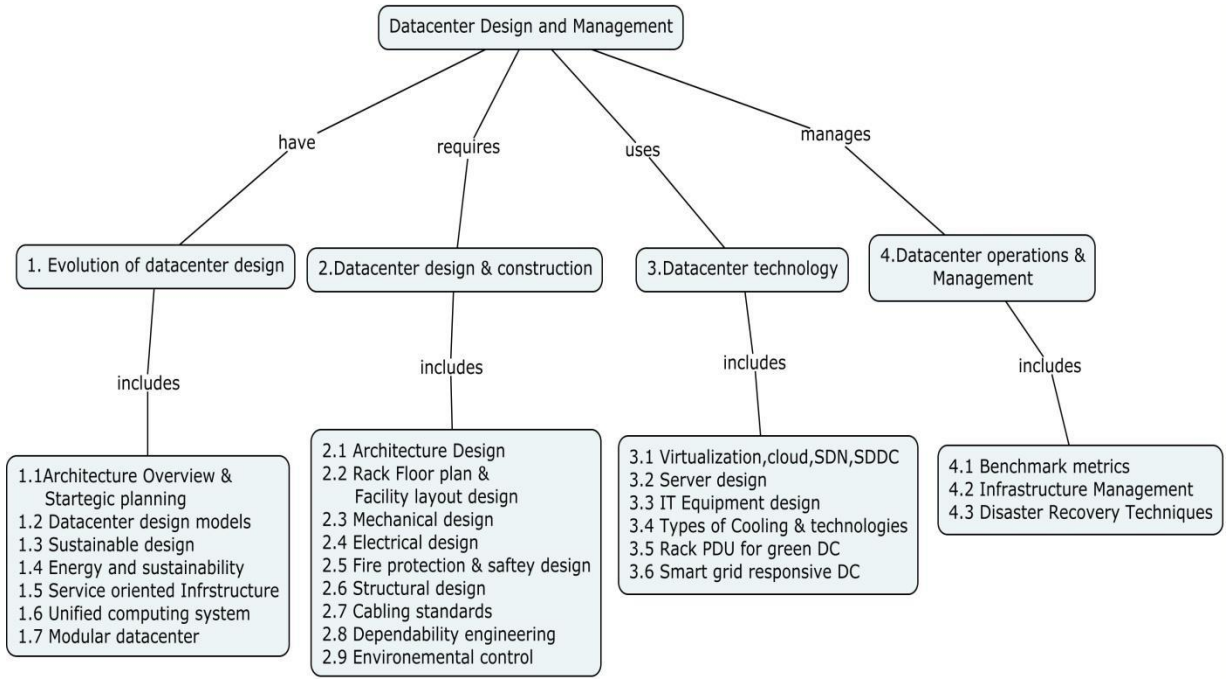
Course Outcome 5 (CO5)

1. Recall the term PUE and CUE.
2. What is DCiM?
3. Identify the modules of a DCiM Solution?

Course Outcome 6 (CO6)

1. Analyze the need for Computerized Maintenance Management System in a data center.
2. Identify the solution for meeting the core requirements for disaster recovery in Data center.
3. Define any two infrastructure management techniques

Concept Map



Syllabus

Evolution of data center design: Data center architecture overview and strategic planning-Datacenter design models-Sustainable Design- Energy and sustainability in Datacenters- Service Oriented Infrastructure (SOI) and unified computing system(UCS) - Modular Datacenter design and deployment. **Datacenter design and construction:** Architecture Design-Datacenter Rack Floor Plan and facility layout design – Mechanical design – Electrical design – Fire protection and Life safety design – Structural design – Telecommunication cabling –Dependability Engineering –Environmental Control. **Datacenter technology:** Virtualization –cloud, SDN and SDDC in Datacenters – Server design – Blade server architecture-Energy efficiency requirements in information technology equipment design- Raised floor versus overhead cooling – Hot versus cold aisle containment – Economizer - Free cooling technologies: Rack level and cold plate cooling – Rack PDU – Smart Grid Responsive DC. **Datacenter operations and Management:** Datacenter Benchmark Metrics – Infrastructure management – computerized maintenance management system in datacenters – disaster discovery and high availability - Fabric based disaster recovery

Reference Books

1. Hwaiyu Geng, “Data Center Handbook”, John Wiley & Sons, Hoboken, New Jersey, 2015.
2. Tom Clark, “The New Data Center”, First Edition, Brocade Communication Systems, August, 2010.
3. Reseach Papers:
   http://www-bcf.usc.edu/~minlanyu/teach/csci599-fall12/papers/volley-nsdi10.pdf
4. Network challenges:

http://webcourse.cs.technion.ac.il/236634/Spring2014/ho/WCFiles/2-Networking.pdf
5. CISCO-Unified Computing system-Technology design guide – August 2014 series
6. Jim cooke, “Service Oriented Infrastructure” – White paper,Cisco Systems Inc.,
7. “Datacenter architecture overview “ available in http://www.cisco.com/c/en/us/td/docs/solutions/Enterprise/Data_Center/DC_Infra2_5/DCInfra_1.html.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1.	**Evolution of data center design(7)**	
1.1	Datacenter architecture overview & strategic planning	1
1.2	Data center design models	1
1.3	Sustainable design	1
1.4	Energy and sustainability	1
1.5	Service oriented infrastructure	1
1.6	Unified computing system design	1
1.7	Modular data center design and deployment	1
2.	**Data center design and construction(10)**	
2.1	Architecture design	2
2.2	Rack floor plan & facility layout design	1
2.3	Mechanical design	1
2.4	Electrical design	1
2.5	Fire protection and life safety design	1
2.6	Structural design	1
2.7	Telecommunication cabling	1
2.8	Dependability engineering	1
2.9	Environmental control	1
3	**Data center technology (11)**	
3.1	Virtualization, cloud, SDN, SDDC	2
3.2	Server design	1
3.3	IT Equipment design for meeting energy efficiency requirements	1
3.4	Types of cooling	1
3.4.1	Raised Floor versus overhead cooling	1
3.4.2	Hot versus cold aisle containment	1
3.4.3	Economizer	1
3.5	Free cooling technologies	1
3.5.1	Rack level and Cold plate cooling	1
3.6	Rack PDU , Smart grid responsive Data center	1

4	**Data center operations and management(8)**	
4.1	Benchmark metrics	1
4.2	Infrastructure management	2
4.2.1	Computerized Maintenance management	1
4.3	Disaster recovery techniques	2
4.3.1	Fabric based disaster recovery	2
	Total Hours	**36**

Course Designers:

1. Dr.S.Mercy Shalinie shalinie@tce.edu

2. Mr.K.Narasimha Mallikarjunan arjunkambaraj@tce.edu

18CGPW0 DATA VISUALIZATION

Category	L	T	P	Credit
PE	2	1	0	3

Preamble

This course aims at facilitating the student to understand the principles and techniques for data visualization and there by improve comprehension, communication and decision making through graphical depictions of data.

Prerequisite

Course Outcomes

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

Experiment with multi dimensional data and understand the importance of data visualization. (CO1)	Apply
Identify suitable OLAP operation and solve the given problem. (CO2)	Apply
Understand and apply the strategies of data visualization (CO3)	Apply
Identify the meaning from multidimensional formats and presentation techniques. (CO4)	Apply
Identify and make use of appropriate data visualization techniques given particular requirements imposed by the data. (CO5)	Apply
Analyze the given multidimensional data, identify suitable visualization technique for data analytics and discover the knowledge. (CO6)	Analyze

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1.	S											
CO2.	S				M			L		L		
CO3.	S	M	L									
CO4.	S	M	M									
CO5.	S	M	M	M	M			L	L	L	L	
CO6.	S	M	M	M	M			L	L	L	L	

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Assignment		Terminal Examination
	1	2	1	1	
Remember	20	10	-	-	10
Understand	20	40	-	-	30
Apply	60	50	100	60	60
Analyze	-	-	-	40	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Build the KDD structure for hospital management system and identify few problems where data visualization is required.
2. Construct the schema structure for the given data set.
3. Explain OLAM architecture with a neat sketch.

Course Outcome 2 (CO2):

1. Compare OLAP operations with that of OLTP operations.
2. Explain the various OLAP operations with suitable example.
4. Suppose that a data warehouse for Big university consists of the following 4 dimensions: *student, course, semester and instructor,* and 2 measures *count and Avg_gra*de. Starting with the base cuboid *[student, course, semester, instructor]* , make use of the specific OLAP which will list the average grade ofCSE courses for each Big University student.

Course Outcome 3 (CO3):

1. List any two ways data visualization improves cognition.
2. Explain in detail the important aspect of visualization
3. Explain two specific techniques/paradigms for visualizing large data.

Course Outcome 4 (CO4):

1. What is the common way of visually representing multivariate datasets?
5. Explain basic elements of a graph and how they can be visualized.

6. Explain three multivariate visualization techniques.

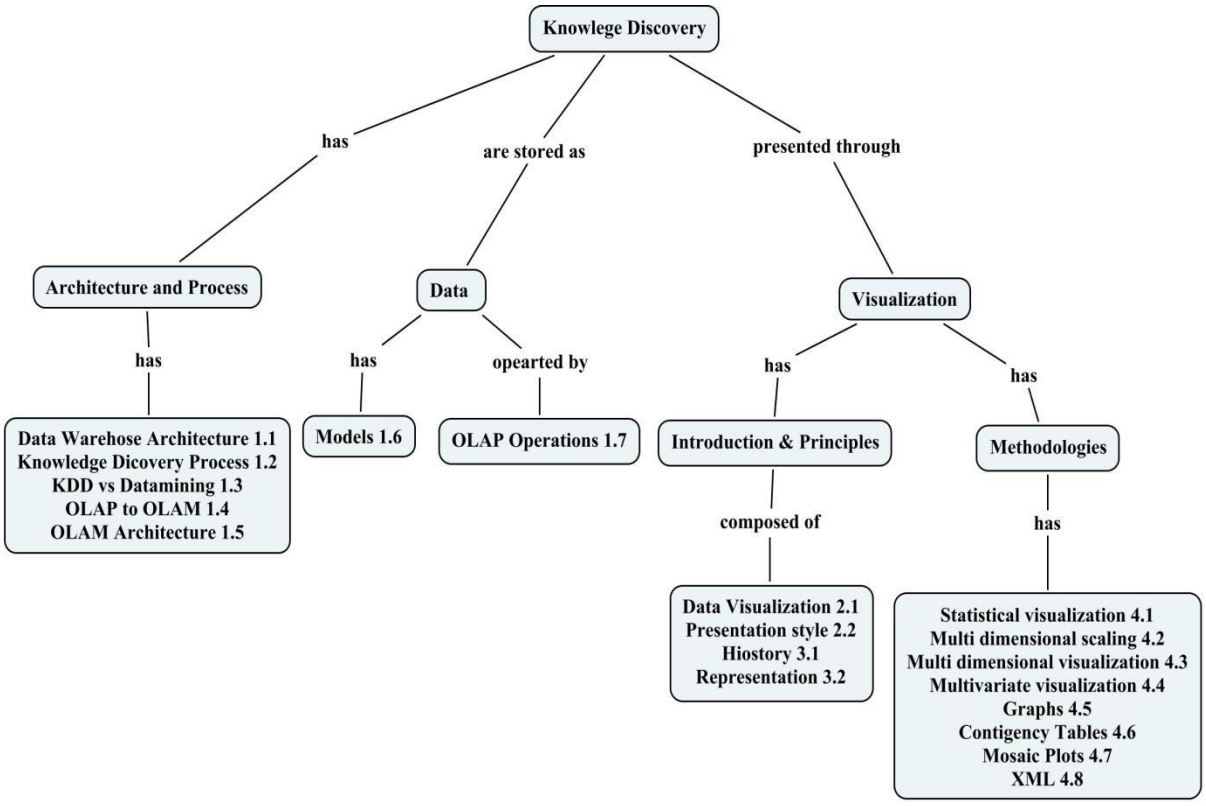
Course Outcome 5 (CO5):

1. What are two advantages and two drawbacks of the tree map method of visualization?
7. What are some issues that must be addressed in graph visualization?
8. What is a Scatter plot matrix? What kind of data is it used to represent?

Course Outcome 6 (CO6):

1. Identify and representation the model that will be suitable for the given scenario and explain it.
9. Construct the necessary model to visualize the given multi dimensional data set.
10. Construct mosaic plots for the given data set.

Concept Map



Syllabus

Knowledge Discovery - Introduction, data warehouse architecture, Knowledge discovery process, KDD Vs Data Mining, Multidimensional data model, Schema Structures, OLAP Operations, OLAP to OLAM, OLAM architecture. **Introduction to visualization** - Computational Statistics and Data Visualization - Data Visualization and Theory, Presentation and Exploratory Graphics, Graphics and Computing. **Principles -** A Brief History of Data Visualization, Good

Graphics, Static Graphics, data visualization through their graph representations, High-dimensional Data Visualization, Multivariate Data Glyphs - Principles and Practice, Visualizing Trees and Forests. **Methodologies -** Statistical visualizations (histograms, scatter plots) and times series data, Multidimensional Scaling, Huge Multidimensional Data Visualization: Back to the Virtue of Principal, Multivariate Visualization by Density Estimation, Structured Sets of Graphs, Visualizing Contingency Tables, Mosaic Plots and Their Variants, Matrix Visualization, Web-Based Statistical Graphics using XML Technologies.

Reference Books

1. Ralph Kimball, Margy Ross, "The Data Warehouse Toolkit: The Complete to Dimensional Modeling", Third Edition, John Wiley & Sons, Inc., 2013.
2. Jiawei Han, Micheline Kamper, "Data Mining: Concepts and Techniques Morgan Kaufman", 2011. (Chap1-3, 5-10).
3. C.Chen, W.Hardle, A.Unwin, "Hand book of Data Visualization", Springer, 2008.
4. Frits H. Post, Gregory M. Nielson, Georges-Pierre Bonneau, " Data Visualization - The State of the Art", Springer Science+Business Media, 2003.

Course Contents and Lecture Schedule

Module No.	Topics	No. of Lectures
1	**Architecture and Process (8)**	
1.1	Introduction to Data Warehouse and its Architecture	1
1.2	Knowledge Discovery Process	1
1.3	KDD vs Data mining	1
1.4	OLAP to OLAM	1
1.5	OLAM Architecture	1
1.6	Multidimensional data model – Schema Structures - TUTORIAL	2
1.7	OLAP Operations - TUTORIAL	1
2	**Introduction to visualization (2)**	
2.1	Computational Statistics and Data Visualization	1
2.2	Presentation and Exploratory Graphics	1
3	**Principles (9)**	
3.1	History of Data Visualization	1
3.2	Representations	2
3.2.1	Visualization through their graph representations -TUTORIAL	2

3.2.2	High-dimensional Data Visualization	2
3.2.3.	Visualizing Trees and Forests	2
4	**Methodologies (17)**	
4.1	Statistical visualizations (histograms, scatter plots) -TUTORIAL	2
4.2	Multidimensional Scaling	1
4.3	Multidimensional Data Visualization	3
4.4	Multivariate Visualization by Density Estimation	2
4.5	Structured Sets of Graphs	2
4.6	Visualizing Contingency Tables -TUTORIAL	2
4.7	Mosaic Plots and Their Variants -TUTORIAL	3
4.8	Web-Based Statistical Graphics using XML Technologies	2
		36

Course Designers:

1. Mrs. A.M.Rajeswari amrcse@tce.edu

18CGPY0	SOFTWARE PRODUCT DEVELOPMENT FOR MOBILE DEVICES			
Category	L	T	P	Credit
PE	3	0	0	3

Preamble

Mobile Technologies for Smart Phones and Tablets are the next big thing on Information Technology (IT) and as well as Telecom horizons. This course provides specialized knowledge on computing with focus on mobile application technology. Students will be trained in understanding the concepts of emerging technologies in development of mobile applications. He / She will learn the fundamental principles to design and develop a mobile application using android platform.

Prerequisite

- Basics of Networking
- Basics of Web programming

Course Outcomes

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

Construct HTML and JavaScript code for mobile programming (CO1)	Apply
Develop inter activity communications using intents(CO2)	Apply
Illustrate user interface design considerations. (CO3)	Apply
Demonstrate data storage and retrieval for mobile applications. (CO4)	Apply
Demonstrate peer to peer communication between mobile applications. (CO5)	Apply
Develop apps for Android devices (CO6)	Apply

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Assignment		Terminal Examination
	1	2	1	2	
Remember	20	20	-	-	20
Understand	20	20	-	-	20
Apply	60	60	100	100	60
Analyze	-	-	-	-	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Write a function **qualityPoints**that inputs a student's average and returns 4 if the student's average is 90–100, 3 if the average is 80–89, 2 if the average is 70–79, 1 if the average is 60–69 and 0 if the average is lower than 60. Incorporate the function into a script that reads a value from the user. Display the result of the function in the browser's status bar.
2. Write a script that simulates coin tossing. Let the program toss the coin each time the user clicks the "**Toss**" button. Count the number of times each side of the coin appears. Display the results. The program should call a separate function **flip** that takes no arguments and returns **false** for tails and **true** for heads. [*Note*: If the program realistically simulates the coin tossing, each side of the coin should appear approximately half the time.]

Course Outcome 2 (CO2):

1. Create Main activity and secondary activity. Provide link to each other.
2. Create two activities. Get information using Edit text from main activity and transfer to second activity using button click and display the same information in view text.

Course Outcome 3 (CO3):

1. Create and customize a web app in Access 2013.
2. Create a new Compass project that will contain your new Compass View, and an Activity to hold it. Now create a new CompassView class that extends View. Create constructors that will allow the View to be instantiated in code, or through inflation from a resource layout. Add a new initCompassView method that will be used to initialize the control and call it from each constructor.

Course Outcome 4 (CO4):

1. Create a new preferences.xml layout resource that lays out the UI for the Preferences Activity. Include a checkbox for indicating the “automatic update” toggle, and spinners to select the update rate and magnitude filter.
2. Create the database that will be used to store the earthquakes. Within the EathquakeProvider class, create a new SQLiteDatabase instance, and expose public variables that describe the column names and indexes. Include an extension of SQLiteOpenHelper to manage database creation and version control.

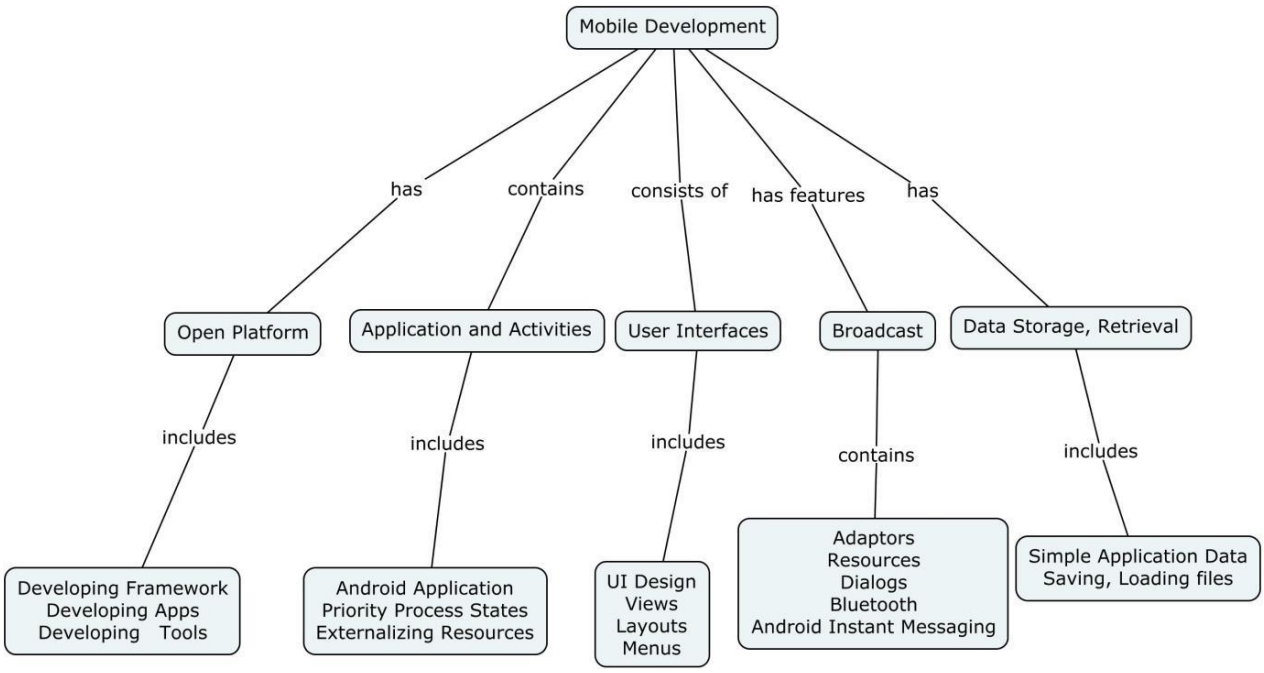
Course Outcome 5 (CO5):

1. Create main.xml layout resource. Include a List View to show the people requesting a status update and a series of buttons that users can press to send response SMS messages. Use external resource references to fill in the button text.
2. Update the external strings.xml resource to include the text for each button and default response messages to use when responding, with “I’m safe” or “I’m in danger” messages. You should also define the incoming message text to use when detecting requests for status responses.

Course Outcome 6 (CO6):

1. Update the testProviders method to check the enabled status of each provider and return the last known location; also request periodic updates for each provider to force Android to start updating the locations for other applications.
2. Create a new EmergencyResponder project that features an EmergencyResponder Activity and Add permissions for finding your location as well as sending and receiving incoming SMS messages to the project.

Concept Map



Syllabus

Introduction: An Open Platform for Mobile Development - Native Mobile Applications - Android SDK Features- Introducing the Development Framework-Developing for Android-Developing App for Mobile Devices. **Creating Applications and Activities:** Introducing the Application Manifest-Using the Manifest Edit-The Android Application Life Cycle - Understanding Application Priority and Process States. **Creating User Interfaces:** Fundamental Android UI Design- Views-Layouts- Creating and Using Menus.**Intents, Broadcast Receivers, Adapters, and the Internet:** Introducing Intents- Dialogs. **Data Storage, Retrieval, and Sharing:** Saving Simple Application Data- Databases in Android - **Peer-to-Peer Communication:** Android Instant Messaging- SMS. **Accessing Android Hardware:** Using the Media APIs- Sensor Manager- Bluetooth- Managing Network and Wi-Fi Connections.

Text Books

1. Reto Meier, “Professional Android Application Development” Wiley Publication,2009.

Reference Books

1. Wei-Meng Lee,” Beginning Android Application Development”, Wiley Publication,2011.
   Jeff McWherter, Scott Gowell, “Professional Mobile Application Development”, Wrox Publication,2012.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures

1	**Introduction**	
1.1	An Open Platform for Mobile Development	1
1.2	Native Mobile Applications	1
1.3	Android SDK Features	1
1.4	Introducing the Development Framework-Developing for Android	1
1.5	Developing app for Mobile Devices	2
2	**Creating Applications and Activities**	
2.1	Introducing the Application Manifest	1
2.2	Using the Manifest Edit	2
2.3	The Android Application Life Cycle	2
2.4	Understanding Application Priority and Process States	2
3	**Creating User Interfaces**	
3.1	Fundamental Android UI Design	1
3.2	Different UI Layouts	2
3.3	Creating New Views	1
3.4	Creating and Using Menus	2
4	**Intents, Broadcast Receivers, Adapters, and the Internet**	
4.1	Introducing Intents	1
4.2	Multiple intents	2
4.3	Notifications	1
4.4	Dialogs	1
5	**Data Storage, Retrieval, and Sharing**	
5.1	Saving Simple Application Data	2
5.2	Databases in Android	2
6	**Peer-to-Peer Communication**	
6.1	Android Instant Messaging	1
6.2	SMS	2
7	**Accessing Android Hardware**	
7.1	Using the Media APIs , Sensor Manager	2
7.2	Accessing Bluetooth	2
7.3	Managing Wi-Fi Connections	2
	Total	**36**

Course Designers:

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18CGPZ0	FOUNDATIONS OF SECURE MULTIPARTY COMPUTATION	Category	L	T	P	Credit
		PE	3	0	0	3

Preamble

The journey of Secure Computation had originated with the seminal work of Andew Chi Chih Yao published in Foundation of Computer Science (FOCS'82). The idea of secure computation is so groundbreaking that Yao was bestowed with the prestigious Turing Award in 2000. This course provides an introduction to multi-party computation for building privacy-preserving applications such as secure auctions, secure voting and privacy-preserving machine learning. The course is targeted towards post graduate students and researchers.

Prerequisite

Cryptography: Theory and Practice
Probability and Algebra

Course Outcomes

On successful completion of this course, students will be able to:

CO 1	Apply the real-world security notions and models of secure computation to a given scenario for ensuring security	Apply
CO 2	Construct a semi-honest and active security model using the secret sharing schemes and BGW /GMW protocols	Apply
CO 3	Build Yao construction, OT & Extensions and Circuit garbling for the given semi-honest security setting	Apply
CO 4	Develop commitment schemes and zero-knowledge proofs for active security setting	Apply
CO 5	Develop alternative threat models by using authenticated secret sharing schemes for privacy-preserving applications	Apply
CO 6	Examine the security of various MPC techniques and using the inferences, identify the suitable MPC technique for the applications like secure auction, privacy-preserving machine learning etc.	Analyze

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

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

Course Level Assessment Questions

Course Outcome (CO1):

1. Brief on the various adversarial models available in secure computation setting
2. Compare real-world security and ideal world notion of secure computation
3. State the static and adaptive models of computation
4. Describe the concept of information-theoretic security
5. Apply the multiparty computation in Denmark sugar factory bidding scenario

Course Outcome (CO2):

1. State the essential properties to be satisfied by secret-sharing scheme
2. Explain BGW protocol with addition gate
3. Brief about the two-party Boolean version of GMW protocol
4. Illustrate the use of GMW compiler in a semi-honest secure setting protocol
5. Experiment with the use of secret sharing mechanism to perform secure voting

Course Outcome (CO3):

1. Explain Yao's Garble Circuit generation
2. Describe the Garble Circuit protocol and analyse why it is celebrated to be the most efficient amongst other MPC protocols
3. Illustrate the use of 1-out-of-2 Oblivious Transfer (OT)
4. Define information-theoretic garbled circuits
5. Make use of OT for secure pseudorandom function evaluation

6. Make use of Yao two-party protocol together with OT for secure auction application

Course Outcome (CO4):

1. Illustrate the use of commitment scheme in cryptographic protocols
2. State the functionality of zero-knowledge proof
3. State the promising factor of Zero Knowledge Proof construct
4. Compare and contrast JKO and cut-and-choose 2PC protocols
5. Apply ZKP to prove that you are authorized for the application of driving license without revealing your date of birth and age

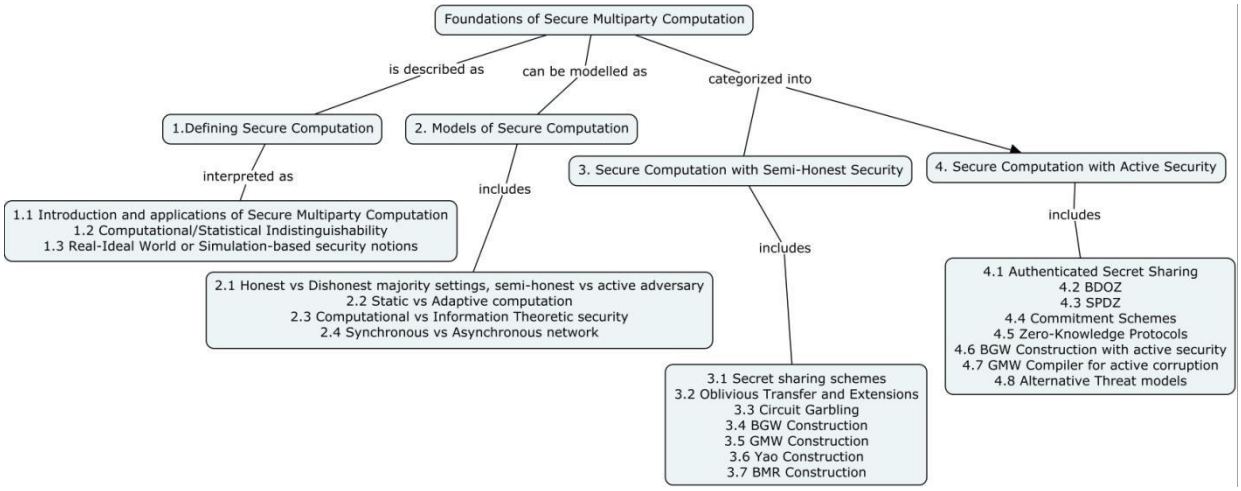
Course Outcome (CO5):

1. Demonstrate the use of covert two-party protocol
2. Discover the importance of Publicly Verifiable Covert (PVC) security model
3. Explain Asharov-Orlandi PVC Protocol
4. Choose an appropriate MPC protocol to perform privacy preserving prediction
5. State the remarkable characteristics of SPDZ protocol

Course Outcome (CO6):

1. Explain the available techniques (apart from MPC) in use to perform secure machine learning
2. Justify the appropriateness of MPC in contrast to other techniques
3. Explain the security of two-party Yao's protocol for privacy-preserving machine learning
4. Infer the use of SPDZ protocol for secure machine learning
5. Compare Yao's protocol and SPDZ protocol and investigate on the performance metrics such as execution time; adversarial model and number of participants

Concept Map



Syllabus

Defining Secure Computation: Introduction and applications of Secure Multiparty Computation, Computational/statistical Indistinguishability, Real-Ideal World or Simulation-based Security notions.

Models of Secure Computation: Honest vs. Dishonest majority settings, semi-honest vs active(malicious) adversary, static vs. adaptive computation, computational vs. information theoretic security, synchronous vs. asynchronous network.

Secure computation with semi-honest security: Secret Sharing Schemes, Oblivious Transfers (OT) and Extensions, Circuit Garbling, BenOr-Goldwasser-Wigderson (BGW) Construction, Goldreich-Micali-Wigderson (GMW) construction, Yao construction, BMR construction.

Secure computation with Active security: Authenticated Secret Sharing: BDOZ protocol and SPDZ protocol, Commitment Schemes, Zero-knowledge Protocols, BGW Construction with active security, GMW Compiler for active corruption, Alternative Threat Models: Honest Majority, Asymmetric Trust, Covert Security.

Case Studies: Role of secure MPC in blockchain privacy- distributed ledger; privacy-preserving machine learning.

Text Books

1. David Evans, Vladimir Kolesnikov and Mike Rosulek. A Pragmatic Introduction to Secure Multi-Party Computation, NOW Publishers, 2018.
2. Yehuda Lindell and Carmit Hazay, “Efficient Two-party Protocols- Techniques and Constructions”, Springer, 2010.

Reference Books

1. Ronald Cramer, Ivan Damgaard and Jesper Buus Nielsen, “Secure Multiparty Computation and Secret Sharing - An Information Theoretic Approach”, Cambridge Press, 2018.
2. Thomas Schneider, “Engineering Secure Two-Party Computation Protocols”, Springer, 2012.
3. Oded Goldreich, “Foundations of Cryptography Vol. 2”, Cambridge University Press, 2004.
4. http://videolectures.net/Top/Computer_Science/Information_Security/#l=en

Course Contents and Lecture Schedule

Sl No.	Topics	No.of Lectures
1	**Defining Secure Computation**	
1.1	Introduction and applications of Secure Multiparty Computation	1
1.2	Computational/statistical Indistinguishability	1
1.3	Real-Ideal World or Simulation-based Security notions	1
2	**Models of Secure Computation**	

2.1	Honest vs. Dishonest majority settings, semi-honest vs active(malicious) adversary	1
2.2	Static vs. adaptive computation	1
2.3	Computational vs. information theoretic security	1
2.4	Synchronous vs. asynchronous network.	1
3	**Secure computation with semi-honest security**	
3.1	Secret Sharing Schemes	2
3.2	Oblivious Transfers (OT) and Extensions	2
3.3	Circuit Garbling	2
3.4	BenOr-Goldwasser- Wigderson (BGW) Construction	2
3.5	Goldreich-Micali- Wigderson (GMW) construction	3
3.6	Yao construction	3
3.7	BMR construction	2
4	**Secure computation with Active security**	
4.1	Authenticated Secret Sharing	1
4.2	BDOZ	1
4.3	SPDZ	1
4.4	Commitment Schemes	2
4.5	Zero-knowledge Protocols	2
4.6	BGW Construction with active security	2
4.7	GMW Compiler for active corruption - Alternative Threat Models	2
4.8	Case Studies: Role of secure MPC in block chain privacy - distributed ledger; privacy - preserving machine learning.	2
	Total	**36**

Course Designer:

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CURRICULUM AND DETAILED SYLLABI

FOR

M.E DEGREE (Computer Science and Engineering) PROGRAMME

OPEN ELECTIVE

FOR THE STUDENTS ADMITTED FROM THE

ACADEMIC YEAR 2021 - 2022 ONWARDS

THIAGARAJAR COLLEGE OF ENGINEERING

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

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18CGGA0	EVOLUTIONARY ALGORITHMS			
Category	L	T	P	Credit
OE	2	0	0	2

Preamble

Evolutionary Algorithms (EA) tends to mimic nature in the way it approaches the solution of a problem. Evolutionary methods are typically used as an approximate solution to a problem (much like nature does) and is tinkered with, but with a sense of direction towards a goal, to suit the particular problem. Evolutionary methods can be thought of as experimental computing that simulates evolution. Its aims are the following:

- How to solve hard problems without using complex mathematical formulations
- Design algorithms that are robust yet easy to program

The objective of this course is to introduce the main concepts, techniques and case studies in the field of evolutionary computation.

Prerequisite

NIL

Course Outcomes

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

CO1	Choose a suitable representation scheme, fitness function and constraint handling technique, if necessary, for the given problem by learning various representation schemes, fitness functions and constraint handling techniques.	Apply
CO2	Apply a suitable selection algorithm for the given problem from various selection schemes like Fitness proportional selection, Ranking and Tournament selection scheme etc.	Apply
CO3	Select the appropriate recombination and mutation operators for the given a problem by learning different recombination and mutation techniques designed for discrete and real valued representations.	Apply
CO4	Apply Genetic Programming algorithm, when the representation scheme of a problem is other data structures like set, tree, list, map, graph, and expression etc.	Apply
CO5	Introduce proper hybrid techniques for a given problem in order to improve the performance of evolutionary algorithm.	Apply
CO6	Apply Evolutionary Computation methods to find solutions for complex problems and summarize the performance of different representation schemes, selection methods, and recombination and mutation operators of the given problem.	Analyze

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	S	S	S	S	M				M	L	

CO2	S	S	S	S	M				M	L	
CO3	S	S	S	S	M				M	L	
CO4	S	S	S	S	M				M	L	
CO5	S	S	S	S	M				M	L	
CO6	S	S	S	S	M				M	L	

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Assignment		Terminal Examination
	1	2	1	2	
Remember	20	20	-	-	10
Understand	40	20	-	-	20
Apply	40	50	100	100	60
Analyze	-	10	-	-	10
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Explain the basic steps involved in evolutionary algorithm. (Understand)
2. Identify suitable representation, fitness function and constraint handling technique for maximum subsequence problem. (Apply)

Course Outcome 2 (CO2):

1. Discuss the role of selection pressure in evolutionary search. (Understand)
2. Apply various ranking selection algorithms for the given problem and identify the more suitable one. Justify your answer. (Apply)

Course Outcome 3 (CO3):

1. Discuss the need for recombination and mutation operators. Explain how they work in getting optimal solutions. (Understand)

2. Choose the more suitable crossover and mutation operators for a real valued representation. Justify your answer. (Apply)

Course Outcome 4 (CO4):

1. What are the issues to be handled in Genetic Programming. Explain with examples (Understand)
2. Identify suitable evolutionary operators for solving Maze Program using Genetic Programming. (Apply)

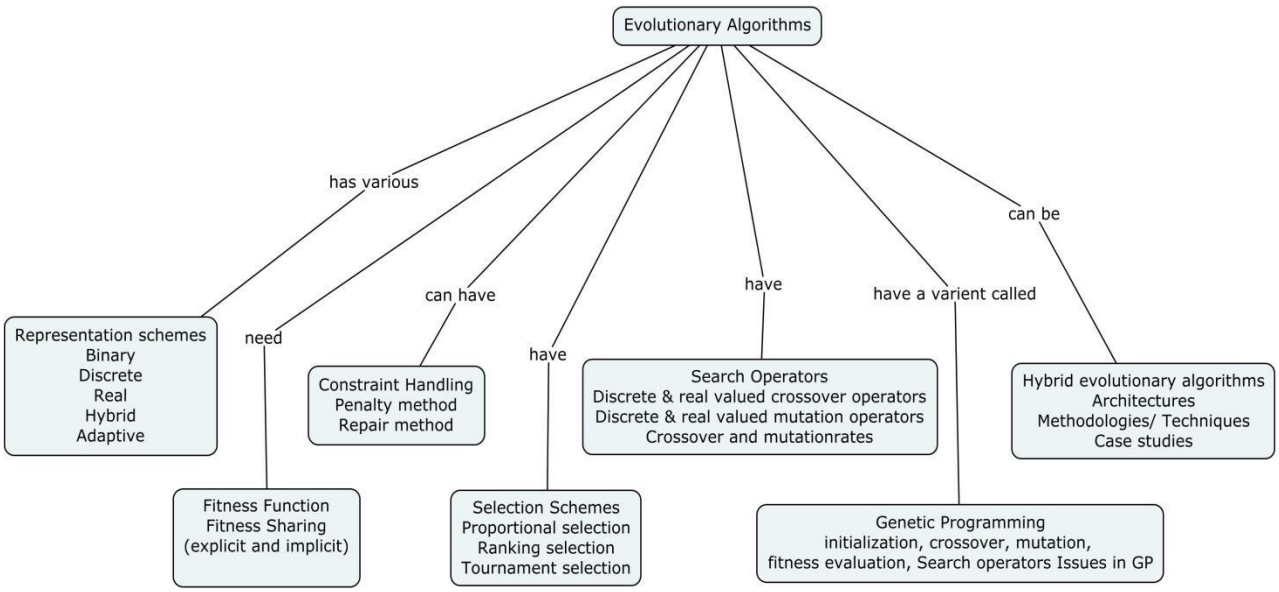
Course Outcome 5 (CO5):

1. Explain the architectures of Hybrid Evolutionary Algorithms (Understand)
2. Incorporate local search as a hybrid technique to solve graph coloring problem. (Apply)

Course Outcome 6 (CO6):

1. Identify suitable representation, selection, crossover and mutation operators for travelling salesman problem. Perform two iterations. (Apply)
2. Compare the performance of one point, multi-point, and uniform crossover operators for Max-One problem. (Analyze)

Concept Map



Syllabus

Introduction to Evolutionary Computation

Biological and artificial evolution -Evolutionary computation and AI -Different historical branches of EC, e.g., GAs, EP, ES, GP, etc.- A simple evolutionary algorithm

Representation schemes and Fitness function

The importance of representation; binary, discrete, real number representations, binary vs. real coding - hybrid coding, adaptive representations, fitness function, scaling, Fitness sharing (explicit and implicit) - Crowding and mating restriction, Constraint Handling, Common techniques-penalty methods, repair methods - Analysis - Some examples

Selection Schemes

Fitness proportional selection and fitness scaling - Ranking, including linear, power, exponential methods - Tournament selection - Selection pressure and its impact on evolutionary search

Search Operators

Recombination/Crossover - one-point, multi-point, and uniform crossover operators - Mutation - bit-flipping - Recombination/ Crossover and mutation rates - Recombination for real-valued representations - discrete and intermediate recombination - Mutation for real-valued representations-Gaussian and Cauchy mutations, self-adaptive mutations - Why and how a recombination or mutation operator works

Genetic Programming

Trees as individuals - Major steps of genetic programming- functional and terminal sets, initialization, crossover, mutation, fitness evaluation - Search operators on trees - Automatically defined functions - Issues in genetic programming- bloat, scalability- Examples

Hybrid evolutionary algorithms

Hybrid Evolutionary Algorithms -Methodologies and Architectures, Case studies in Evolutionary algorithms and Hybrid Evolutionary algorithms

Reference Books

1. Xinjie Yu, Mitsuo Gen, "Introduction to Evolutionary Algorithms", Springer, 2010. ISBN: 978-1-84996-128-8, 978-1-4471-2569-3
2. S.N. Sivanandam, S.N. Deepa, " Introduction to Genetic Algorithms", Springer 2008, ISBN: 9783540731894, 354073189X
3. Kenneth A. DeJong, "Evolutionary Computation: A Unified Approach", MIT Press, 2006, ISBN: 0262041944
4. T. Back, D. B. Fogel, and Z. Michalewicz, " Handbook on Evolutionary Computation", IOP Press, 1997.
5. Melanie Mitchell, "An introduction to genetic algorithms", MIT Press, 1996.
6. C. Grosan and A. Abraham, "Hybrid Evolutionary Algorithms: Methodologies, Architectures, and Reviews", Springer, Studies in Computational Intelligence (SCI) 75, 1–17 2007.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1	**Introduction to Evolutionary Computation**	

1.1	Biological and artificial evolution -Evolutionary computation and AI -Different historical branches	1
1.2	A simple evolutionary algorithm	1
2	**Representation schemes and Fitness function**	
2.1	Representation- binary, discrete, real representations, binary vs. real coding, hybrid coding, adaptive representations	2
2.2	fitness function, scaling, Fitness sharing (explicit and implicit) - Crowding and mating restriction	1
2.3	Constraint Handling, Common techniques-penalty methods, repair methods - Analysis	2
3	**Selection Schemes**	
3.1	Fitness proportional selection and fitness scaling - Ranking, including linear, power, exponential methods - Tournament selection	3
4	**Search Operators**	
4.1	Recombination/Crossover - one-point, multi-point, and uniform crossover operators - Mutation - bit-flipping - Crossover and mutation rates	2
4.2	Recombination for real-valued representations - discrete and intermediate recombination - Mutation for real-valued representations-Gaussian and Cauchy mutations, self-adaptive mutations	2
5	**Genetic Programming**	
5.1	Trees as individuals - Major steps of genetic programming- functional and terminal sets	1
5.2	initialization, crossover, mutation, fitness evaluation - Search operators on trees	2
5.3	Automatically defined functions - Issues in genetic programming- bloat, scalability- Examples	1
6	**Hybrid evolutionary algorithms**	
6.1	Hybrid Evolutionary Algorithms -Methodologies and Architectures	3
6.2	Case studies in Evolutionary algorithms and Hybrid Evolutionary algorithms	3
	Total	**24**

Course Designer:

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