CURRICULUM AND DETAILED SYLLABI

FOR

M.E DEGREE (Computer Science and Engineering) PROGRAMME

FIRST SEMESTER

FOR THE STUDENTS ADMITTED FROM THE

ACADEMIC YEAR 2016 - 2017 ONWARDS

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

MADURAI – 625 015, TAMILNADU

Phone: 0452 – 2482240, 41
Fax: 0452 2483427
Web: www.tce.edu

Thiagarajar College of Engineering, Madurai-625015

Department of Computer science and Engineering

Scheduling of Courses for M.E. (CSE)

Semester	Theory						Practical	Credits
	1	2	3	4	5	6	7	
I	15CG110 Randomized and Approximation Algorithms 3:1	15CG120 Modern Operating Systems 3:1	15CG130 Cryptography : Theory and Practice 3:1	15CG140 Parallel Computing Systems 4:0	15CG150 Optimization Techniques 3:0	15CG160 Agile Software Development and Usability Engineering 3:0	15CG170 Design and Analysis of Algorithms Lab 0:1	23
II	15CG210 Performance Modeling 3:1	15CG220 Machine Learning 4:0	15CGPX0 Elective 1 4:0	15CGPX0 Elective 2 4:0	15CGPX0 Elective 3 4:0	15CGPX0 Elective 4 4:0	15CG270 Seminar 0:1	25
III	15CG310 Protocol Design and Verification 4:0	15CGPX0 Elective 5 4:0	15CGPX0 Elective 6 4:0	-	-	-	15CG340 Project - I 0:4	16
IV	-	-	-	-	-	-	15CG410 Project - II 0:12	12

Approved in Board of Studies Meeting on 25.04.15

Approved in 50th Academic Council Meeting on 30.05.2015

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015
M.E Degree (Computer Science and Engineering) Programme
COURSES OF STUDY
(For the candidates admitted from the academic year 2016 - 2017)

I SEMESTER

Course Code	Name of the Course	Category	No. of Hours / Week			Credits
			L	T	P	
THEORY						
15CG110	Randomized and Approximation Algorithms	PC	3	1	-	4
15CG120	Modern Operating Systems	PC	3	1	-	4
15CG130	Cryptography: Theory and Practice	PC	3	1	-	4
15CG140	Parallel Computing Systems	PC	4	-	-	4
15CG150	Optimization Techniques	PC	3	-	-	3
15CG160	Agile Software Development and Usability Engineering	PC	3	-	-	3
PRACTICAL						
15CG170	Design and Analysis of Algorithms Lab	PC	-	-	2	1
Total			**19**	**3**	**2**	**23**

II SEMESTER

Course Code	Name of the Course	Category	No. of Hours / Week			Credits
			L	T	P	
THEORY						
15CG210	Performance Modeling	PC	3	1	-	4
15CG220	Machine Learning	PC	4	-	-	4

15CGPX0	Elective 1	PE	4	-	-	4
15CGPX0	Elective 2	PE	4	-	-	4
15CGPX0	Elective 3	PE	4	-	-	4
15CGPX0	Elective 4	PE	4	-	-	4
PRACTICAL						
15CG270	Seminar	PC	-	-	2	1
Total			**23**	**1**	**2**	**25**

III SEMESTER

Course Code	**Name of the Course**	**Category**	**No. of Hours / Week**			**Credits**
			L	**T**	**P**	
THEORY						
15CG310	Protocol Design and Verification	PC	4	-	-	4
15CGPX0	Elective 5	PE	4	-	-	4
15CGPX0	Elective 6	PE	4	-	-	4
PRACTICAL						
15CG340	Project - I	PC	-	-	8	4
Total			**12**	**-**	**8**	**16**

IV SEMESTER

Course Code	**Name of the Course**	**Category**	**No. of Hours / Week**			**Credits**
			L	**T**	**P**	
PRACTICAL						
15CG410	Project - II	PC	-	-	24	12
Total			-	**-**	**24**	**12**

Total No. of credits to be earned for the award of degree: 76

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) Programme
SCHEME OF EXAMINATIONS
(For the candidates admitted from 2016 - 2017 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	15CG110	Randomized and Approximation Algorithms	3	50	50	100	25	50
2	15CG120	Modern Operating Systems	3	50	50	100	25	50
3	15CG130	Cryptography: Theory and Practice	3	50	50	100	25	50
4	15CG140	Parallel Computing Systems	3	50	50	100	25	50
5	15CG150	Optimization Techniques	3	50	50	100	25	50
6	15CG160	Agile Software Development and Usability Engineering						
PRACTICAL								
7	15CG170	Design and Analysis of Algorithms Lab	3	50	50	100	25	50

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	15CG210	Performance	3	50	50	100	25	50

		Modeling						
2	15CG220	Machine Learning	3	50	50	100	25	50
3	15CGPX0	Elective 1	3	50	50	100	25	50
4	15CGPX0	Elective 2	3	50	50	100	25	50
5	15CGPX0	Elective 3	3	50	50	100	25	50
6	15CGPX0	Elective 4	3	50	50	100	25	50
PRACTICAL								
7	15CG270	Seminar	-	50	50	100	25	50

III 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	15CG310	Protocol Design and Verification	3	50	50	100	25	50
2	15CGPX0	Elective 5	3	50	50	100	25	50
3	15CGPX0	Elective 6	3	50	50	100	25	50
PRACTICAL								
4	15CG340	Project - I	-	150	150	300	75	150

IV SEMESTER

S.No.	Course Code	Name of the Course	Duration of Terminal Exam. in Hrs.	Marks			Minimum Marks for Pass	
				Continuous Assessment *	Terminal Exam **	Max. Marks	Terminal Exam	Total
PRACTICAL								
1	15CG410	Project - II	-	150	150	300	75	150

* 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
15CG110	**RANDOMIZED AND APPROXIMATION ALGORITHMS**	PC	3	1	0	4

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:

i) Design randomized algorithms for solving complex problems and estimate their expected running time and error probability.

ii) Design approximation algorithms for hard problems and compute their ratio-bounds.

Prerequisites

- Data Structures
- Algorithms
- Discrete Probability Theory
- Combinatorics
- Number Theory and Algebra

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)	Analyze
Construct Monte-Carlo algorithms for a given problem and compute the probability of getting an incorrect output. (CO2)	Analyze
Design solutions for complex problems using randomization design paradigms like Foiling the Adversary, Abundance of Witnesses, Fingerprinting, Random Sampling, Amplification and Random Rounding. (CO3)	Evaluate
Analyze NP-hard problems from the view-point of approximability. (CO4)	Analyze
Develop approximation algorithms for a given problem by evaluating various possibilities, techniques and design trade-offs. (CO5)	Evaluate
Compute ratio-bounds while designing combinatorial approximation algorithms and approximation algorithms based on Linear Programming techniques and Semi-definite Programming. (CO6)	Analyze

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	M	M							
CO5	S	S	S	S							
CO6	S	S	M	M							

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	10	5	5	10
Understand	10	10	10	20
Apply	20	20	20	40
Analyse	10	10	10	20
Evaluate	0	5	5	10
Create	0	0	0	0

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)) $\geq$ 1/3 for every argument x of F. Assume that oneis aware of the fact that Prob(A(x) = α) $\leq$ 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 $\rightarrow$ 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 $\subseteq$ {0, 1}^{n},where |Si| $\leq$ k for all i$\in$ {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.

3. 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**.

4. 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 $\rightarrow$ IN − {0} determines themultiplicity of the edges of G.

5. 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?

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

Course Outcome (CO4):

1. Let A be an Algorithm for a minimization NP-Optimization problem π, such that the expected cost of the solution produced by A is ≤ αOPT, for a constant α > 1. Analyze this scenario and compute the best approximation guarantee you can establish for π using algorithm A.

2. Show that if the vertex cover problem is in co-**NP**, then **NP** = co-**NP**.

3. Let Π_1 and Π_2 be two minimization problems such that there is anapproximation factor preserving reduction from Π_1 to Π_2. Show that if thereis an α factor approximation algorithm for Π_2 then there is also an α factorapproximation algorithm for Π_1.

4. Is the following an **NP**-optimization problem? Given an undirectedgraph $G = (V,E)$, a cost function on vertices $c : V \rightarrow \mathbf{Q}+$, and a positiveinteger k, find a minimum cost vertex cover for G containing at most $k$vertices.

5. Show that if SAT has been proven **NP**-hard, and SAT has been reduced,via a polynomial time reduction, to the decision version of vertex cover, thenthe latter is also **NP**-hard.

6. The hardness of the Steiner tree problem lies in determining the optimalsubset of Steiner vertices that need to be included in the tree. Show thisby proving that if this set is provided, then the optimal Steiner tree can becomputed in polynomial time.

Course Outcome (CO5):

1. Given a finite alphabet Σ, and aset of n strings, $S = \{s_1, \ldots, s_n\} \subseteq \Sigma^+$, find a shortest string s that containseach $s_i$as a substring. Without loss of generality, we may assume that nostring $s_i$is a substring of another string s_j, $j \neq i$. Construct a $2H_n$ factor approximation algorithm using the greedy set cover algorithm.

2. Consider variants on the metric TSP problem inwhich the object is to find a simple path containing all the vertices of thegraph. Three different problems arise, depending on the number (0, 1, or 2) ofendpoints of the path that are specified. Obtain the following approximationalgorithms.

- If zero or one endpoints are specified, obtain a 3/2 factor algorithm.
- If both endpoints are specified, obtain a 5/3 factor algorithm.

3. Construct the following approximation algorithms.

a) $H_n$factor for set multicover.

b) $H_m$factor for multisetmulticover, where m is the size of the largestmultiset in the given instance (the size of a multiset counts elementswith multiplicity).

4. Construct a polynomial time algorithm for the following problem. Given a graph G with nonnegative vertex weights and a valid, though not necessarily optimal, coloring of G, find a vertex cover of weight ≤ (2−2/k)OPT,where k is the number of colors used.

5. Construct an algorithm using semi-definite programming for the MAX-2SAT problem.

Course Outcome (CO6):

1. Given an undirected graph $G = (V,E)$, the *cardinality maximum cutproblem* asks for a partition of V into sets S and S'so that the number ofedges running between these sets is maximized. Consider the following greedyalgorithm for this problem. Here v_1 and v_2 are arbitrary vertices in G, andfor $A \subset V$, $d(v,A)$ denotes the number of edges running between vertex $v$and set A.

Algorithm:

a. Initialization:

$A \leftarrow \{v1\}$

$B \leftarrow \{v2\}$

b. For $v \in V - \{v1, v2\}$ do:

if$d(v,A) \geq d(v,B)$ then $B \leftarrow B \cup \{v\}$,

else$A \leftarrow A \cup \{v\}$.

c. Output *A* and *B*.

Show that this is a factor 1/2 approximation algorithm and give a tightexample. What is the upper bound on OPT that you are using? Give examplesof graphs for which this upper bound is as bad as twice OPT. Generalize theproblem and the algorithm to weighted graphs.

2. Consider the following algorithm for the maximum cut problem, based on the technique of local search. Given a partition of V into sets, the basic step of the algorithm, called flip, is that of moving a vertex from one side of the partition to the other. The following algorithm finds a locally optimal solution under the flip operation, i.e., a solution which cannot be improved by a single flip.

The algorithm starts with an arbitrary partition of V. While there is a vertex such that flipping it increases the size of the cut, the algorithm flips such a vertex. (Observe that a vertex qualifies for a flip if it has more neighbors in its own partition than in the other side.) The algorithm terminates when no vertex qualifies for a flip. Show that this algorithm terminates in polynomial time, and achieves an approximation guarantee of 1/2.

3. Consider the following algorithm for computing minimum k-cuts:

Algorithm Minimum k-cut

a. Compute a Gomory–Hu tree T for G.

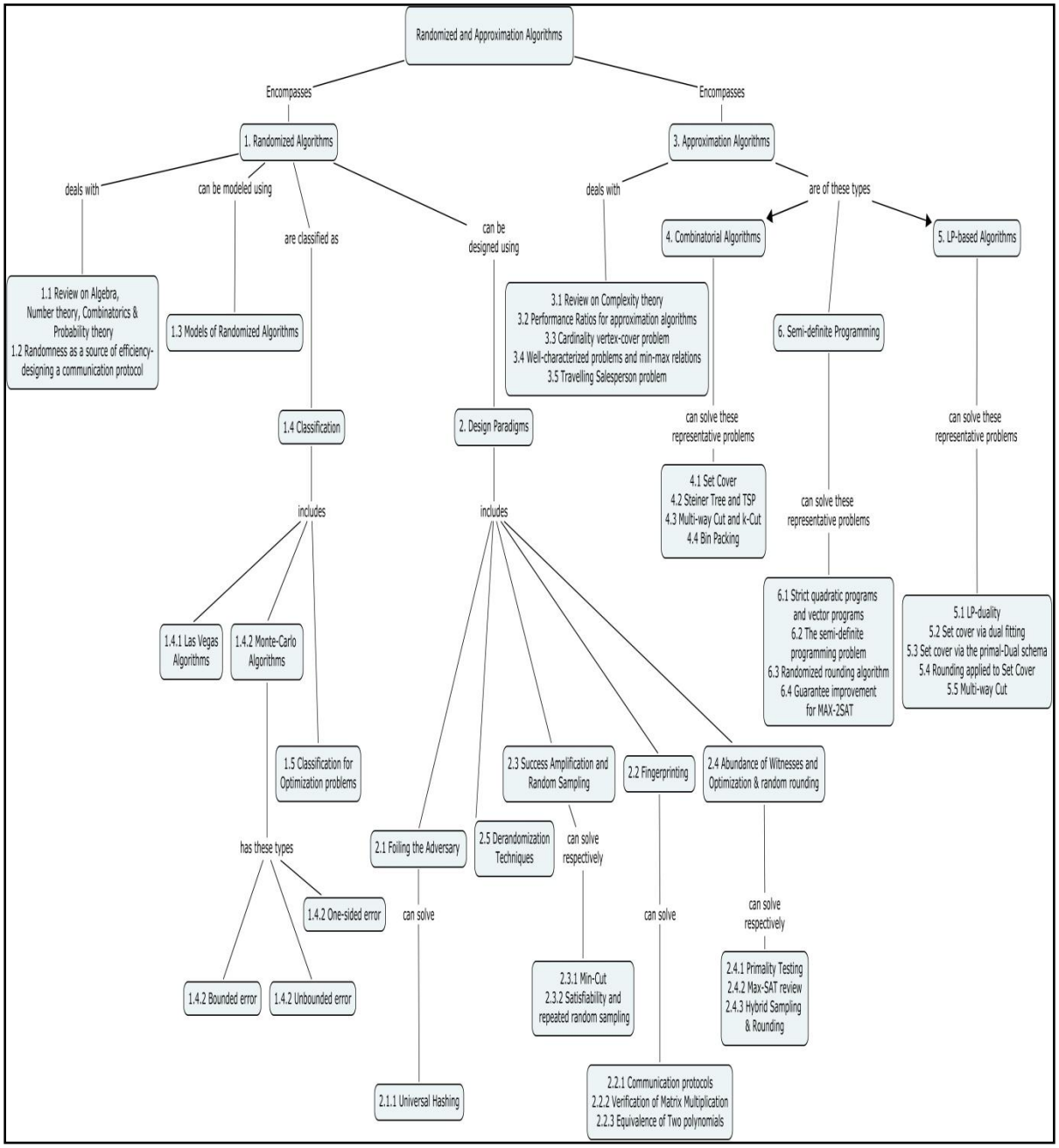
b. Output the union of the lightest k − 1 cuts of the n − 1 cuts associated with edges of T in G; let C be this union.

Show that the minimum k-cut algorithm *achieves an approximation factor of* $2 - 2/k$.

4. Show that the approximation guarantee of the greedy set cover algorithm is H_n.

5. Consider the problem of finding aminimum *k*-vertex connected subgraph of a directed graph. Construct an approximation algorithmfor achieving a factor 1+2/*k* for this problem.

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.

Introduction to Approximation Algorithms: Review on Complexity theory, Performance Ratios for approximation algorithms, Cardinality vertex-cover problem, Well-characterized problems and min-max relations, Travelling Salesperson problem. **Combinatorial Algorithms:** Set Cover, Steiner Tree and TSP, Multi-way Cut and k-Cut, Bin Packing. **LP-based Algorithms**: LP-duality, Set cover via dual fitting, Set cover via the primal-dual schema, Rounding applied to Set Cover, Multi-way Cut **Semi-definite Programming**: Strict quadratic programs and vector programs, The semi-definite programming problem, Randomized rounding algorithm, Guarantee improvement for MAX-2SAT.

Text Books

1. Vijay V. Vazirani – Approximation Algorithms, First edition, Springer, 2001.
2. JurajHromkovic– Design and Analysis of Randomized Algorithms, First edition, Springer, 2005.

Reference Books

1. The Design of Approximation Algorithms - David P. Williamson, David B. Shmoys, Cambridge University Press, 2011.
2. Randomized Algorithms – Rajeev Motwani, PrabhakarRaghavan, Cambridge University Press, 1995.
3. Introduction to Algorithms –Charles E. Leiserson, Thomas H. Cormen, Ronald L. Rivest and Clifford Stein, third edition, PHI, 2010
4. Gilles Brassard and Paul Bratley - Fundamentals of Algorithmics - PHI, 2000.
5. 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	2
1.2	Randomness as a source of efficiency-designing a	1

	communication protocol	
1.3	Models of Randomized Algorithms	1
1.4	Classification	1
1.4.1	Las Vegas	
1.4.2	Monte-Carlo (one-sided error, bounded-error and unbounded-error)	
1.5	Classification of Randomized Algorithms for Optimization problems	1
2	**Design Paradigms and Representative Algorithms**	
2.1	Foiling the Adversary	1
2.1.1	Universal Hashing	
2.2	Fingerprinting	2
2.2.1	Communication protocols	
2.2.2	Verification of Matrix Multiplication	
2.2.3	Equivalence of Two polynomials	
2.3	Success Amplification and Random Sampling	2
2.3.1	Min-Cut	
2.3.2	Satisfiability and repeated random sampling	
2.4	Abundance of Witnesses and Optimization & random rounding	2
2.4.1	Primality Testing	
2.4.2	Max-SAT	
2.4.3	Hybrid Sampling &Rounding	
2.5	Derandomization Techniques	1
Tutorial for Randomized Algorithms		6
3.	**Introduction to Approximation Algorithms**	
3.1	Review on Complexity theory	1

3.2	Performance Ratios for approximation algorithms	1
3.3	Cardinality vertex-cover problem	1
3.4	Well-characterized problems and min-max relations	1
3.5	Travelling Salesperson problem	1
4.	**Combinatorial Algorithms**	
4.1	Set Cover	1
4.2	Steiner Tree and TSP	1
4.3	Multi-way Cut and k-Cut	1
4.4	Bin Packing	1
5.	**LP-based Algorithms**	
5.1	LP-duality	1
5.2	Set cover via dual fitting	2
5.3	Set cover via the primal-dual schema	2
5.4	Rounding applied to Set Cover	2
5.5	Multi-way Cut	2
6.	**Semi-definite Programming**	
6.1	Strict quadratic programs and vector programs	1
6.2	The semi-definite programming problem	1
6.3	Randomized rounding algorithm	1
6.4	Guarantee improvement for MAX-2SAT	1
Tutorial for Approximation Algorithms		6
Total		48*

*The apportioning of the total contact hours for lectures and tutorials would be 36:12respectively

Course Designer:

1. Mr. KarthickSeshadri skcse@tce.edu

15CG120	MODERN OPERATING SYSTEMS	Category	L	T	P	Credit
		PC	3	1	0	4

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

Apply the concepts of operating system to a distributed environment and identify the features specific to distributed systems. (CO1)	Apply
Apply the process synchronization concepts for the given scenario in distributed environment. (CO2)	Apply
Illustrate the different consistency model, replacement strategy in distributed shared memory (DSM). (CO3)	Apply
Apply the distributed file system concepts for a given scenario. (CO4)	Apply
Identify the role of operating system in cloud and mobile environment. (CO5)	Apply

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	30	20	20	20
Understand	40	50	40	40

Apply	30	30	40	40
Analyze	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

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.

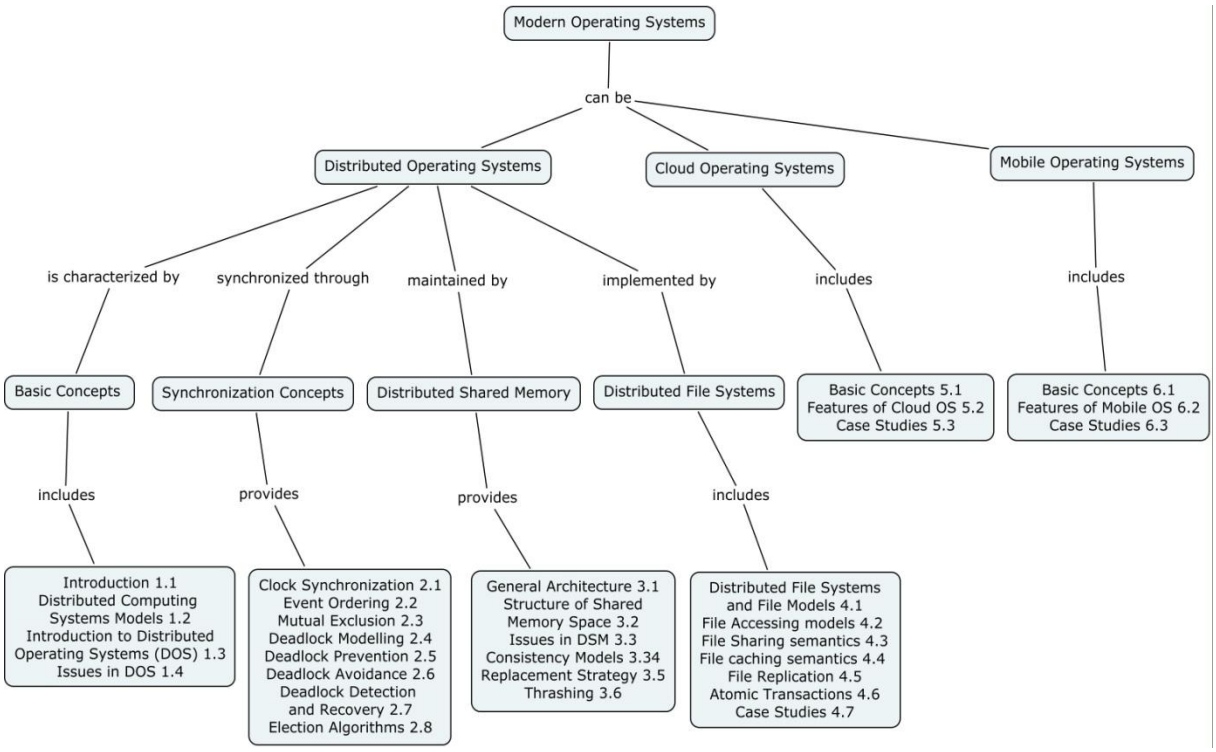
Course Outcome 4 (CO4)

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. Illustrate the features of any one cloud operating system.
3. Summarize the benefits of android operating systems.

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 **Cloud OS** - Introduction to Cloud Computing, Features of Cloud OS, Case Studies **Mobile OS** - Introduction to Mobile Computing, Features of 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. Fundamentals Of Mobile Computing, Pattnaik, Prasant, Kumar , Mall, Rajib, PHI, 2012.
4. Mobile Computing - Technology, Applications, and Service Creation – 1st edition, Asoke K Talukder,Roopa Yavagal, McGraw-Hill, 2006.
5. 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.
6. Cloud Computing: Concepts, Technology & Architecture, Thomas Erl , Ricardo Puttini , Zaigham Mahmood , Prentice Hall; 1st Edition, 2013.

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 (13)**	
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	2
2.7	Deadlock Detection and Recovery	1
2.8	Election Algorithms	1
	Tutorial on Deadlocks and Election algorithm	4
3	**Distributed Shared Memory (6)**	
3.1	General Architecture	1
3.2	Structure of shared memory space	1
3.3	Issues in design and implementation of distributed shared memory	

Module No.	Topic	No. of Lectures
3.4	Consistency models	2
3.5	Replacement strategy	1
3.6	Thrashing	
	Tutorial	1
4	**Distributed File Systems (12)**	
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	2
4.6	Atomic transactions	2
4.7	Case Studies	1
	Tutorial	3
5	**Cloud Operating Systems (6)**	
5.1	Introduction to Cloud Computing	1
5.2	Features of Cloud OS	2
5.3	Case Studies	1
	Tutorial on virtualization	2
6	**Mobile Operating Systems (6)**	
6.1	Introduction to Mobile Computing	1
6.2	Features of Mobile OS	2
6.3	Case Studies	1
	Tutorial on mobile application development	2
	Total	**48**

Course Designers:

1. Mrs. G.Madhupriya gmadhupriya@tce.edu
2. Mrs.B.Subbulakshmi bscse@tce.edu

		Category	L	T	P	Credit
15CG130	**CRYPTOGRAPHY: THEORY AND PRACTICE**	PC	3	1	0	4

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

- Number Theory
- 15CG110 - Randomized and Approximation Algorithms

Course Outcomes

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

Demonstrate the fundamental theory of cryptography in network security (CO1)	Apply
Select and apply appropriate cipher techniques like Data Encryption Standard, RSA Encryption to ensure the secrecy of data (CO2)	Analyse
Apply Hash, MAC algorithms to ensure integrity of data. (CO3)	Apply
Select and apply appropriate attacks like chosen Plain text attack, Birthday attack, Differential anlaysis, etc. to cryptanalyse the cryptographic techniques (CO4)	Analyse
Relate the recent trends in cryptography with legacy methods (CO5)	Apply

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	0	0	0
Understand	20	20	20	20
Apply	60	40	40	40
Analyse	0	40	40	40
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Compare and contrast attack and a threat.
2. Explain Shannon's theory.
3. Illustrate probability theory.

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

Course Outcome 3 (CO3):

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 4 (CO4):

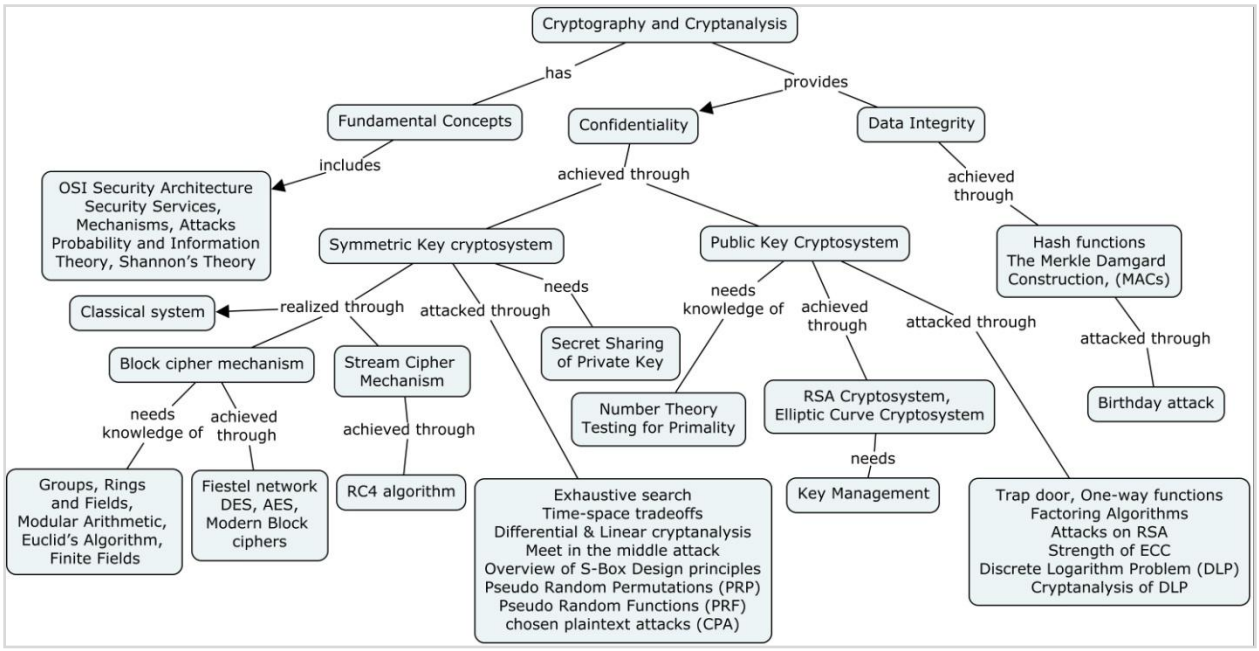
1. Suppose that someone suggests the following way to confirm that the two of you are both in possession of the same secret key. You create a random bit string the length of the key, XOR it with the key and send the result over the channel. Your partner XORs the incoming block with his key and sends 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 5 (CO5):

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 - Key Management: Secret Sharing of private key.

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 Cryptosystem - Key Management: Distribution of Public Key.

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

Hash Functions and MACs: Hash functions - The MerkleDamgard Construction, Message Authentication Codes (MACs) - Birthday Attack.

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

Reference Books

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

Course Contents and Lecture Schedule

Module No.	Topic	No of Lectures
1	**Fundamental Concepts (4)**	
1.1	OSI Security architecture	1
1.2	Security Services, Mechanisms and attacks	1
1.3	Shannon’s Theory	1
1.4	Tutorial on Probability theory	1
2	**Symmetric Key Ciphers (16)**	
2.1	Introduction to Classical Cryptosystems	2
2.1.1	Tutorial	1
2.2	Groups, Rings and Fields, Modular Arithmetic, Euclid’s Algorithm, Finite Fields	1
2.2.1	Tutorial on Finite Fields	1
2.3	Feistel networks	1
2.3.1	Data Encryption Standard (DES)	1
2.4	Advanced Encryption Standard (AES)	2
2.5	Tutorial on DES, AES problem instances	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
2.8.1	Tutorial on RC4 Problem instance	1

2.9	Key Management: Secret Sharing of private key	1
3	**Cryptanalysis of Symmetric Key Ciphers (8)**	
3.1	Exhaustive search	1
3.2	Time-space tradeoffs	
3.3	Linear cryptanalysis	1
3.4	Differential Cryptanalysis	1
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
3.7	security against chosen plaintext attacks (CPA)	1
3.8	Tutorial on chosen plaintext attacks and block cipher attacks	2
4	**Asymmetric Key Ciphers (6)**	
4.1	Number Theory	1
4.2	Primality Testing	1
4.3	The RSA Cryptosystem	1
4.4	Elliptic curve Cryptosystem	1
4.5	Tutorial on RSA and ECC Problem instances	1
4.6	Key Management: Distribution of Public Key	1
5	**Cryptanalysis of Asymmetric Key Ciphers (6)**	
5.1	Trap door, One-way functions	1
5.2	Factoring Algorithms	1
5.3	Attacks on RSA	1
5.4	The Discrete Logarithm Problem (DLP)	1
5.5	Tutorial on Factoring algorithms and DLP	2
7	**Hash Functions and MACs (6)**	
7.1	Hash functions	1
7.2	The MerkleDamgard Construction	2
7.3	Message Authentication Codes (MACs)	1
7.4	Birthday Attack	1
7.5	Tutorial on Message digest generation using MD5	1
8	**Recent trends in cryptography (2)**	
8.1	Identity based Encryption, Homomorphic Encryption	1
8.2	Provable Security	1
	Total	**48**

Course Designers:

1. M.Suguna mscse@tce.edu

15CG140	PARALLEL COMPUTING SYSTEMS	Category	L	T	P	Credit
		PC	4	0	0	4

Preamble

This course provides an understanding of the fundamental principles and engineering trade-offs involved in designing modern parallel computing systems as well as to teach parallel programming techniques necessary to effectively utilize these machines. Because writing good parallel programs requires an understanding of key machine performance characteristics, this course will cover both parallel hardware and software design.

Prerequisite

Introductory level Computer Architecture, Algorithms.

Course Outcomes

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

Select the appropriate parallel programming model for the given application. (CO1)	Apply
Apply the constructs of parallel programming model to convert a sequential program to parallel program. (CO2)	Apply
Design protocols for ensuring cache coherence using the directory based and snooping class of protocols. (CO3)	Apply
Develop parallel programs using OpenMP and MPI constructs (CO4)	Apply
Characterize the benefits of using a GPU versus CPU for a typical parallel application (CO5)	Apply

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	10	10	10	20
Understand	20	15	15	30
Apply	20	25	25	50
Analyse				
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. Demonstrate the requirements and the features of a programming model for an image processing application? (Apply)

Course Outcome 2 (CO2):

1. Give the usage of the DECOMP statement in the data parallel model with an example. (Understand)
2. Illustrate the method to achieve global event synchronization while orchestrating using the message passing model for the equation solver kernel application? (Apply)

Course Outcome 3 (CO3)

1. Consider the state of the cache block in "Modified". Find out the necessary state transitions and signals generated for the following when MSI protocol is used:
   (i) There is a write made to the block by the same processor
   (ii)There is a write made by the other processor to the same block. (Understand)
2. Write a block of code using sense reversal to overcome the limitation with the traditional barrier. (Apply)

Course Outcome 4 (CO4)

1. Give the syntax of MPI_Ireceive. (Remember)
2. Use OpenMP directives for parallelization, write a program in C to illustrate the usage of work sharing constructs. (Apply)
3. Write a simple program to illustrate the Blocking and Non-Blocking message passing directives. (Apply)

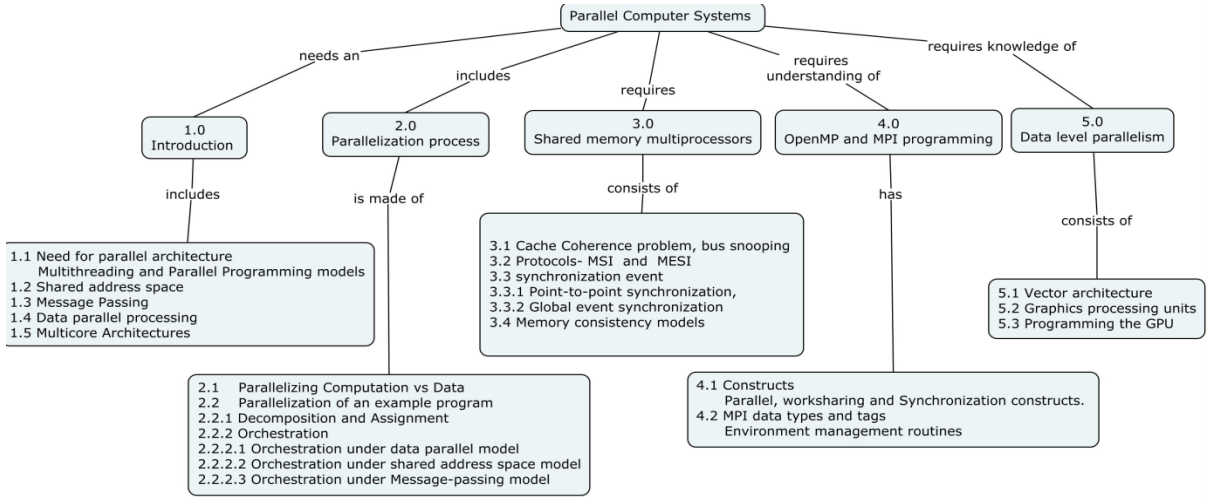
Course Outcome 5 (CO5)

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)

1. A company builds a vector computer with eight parallel processors at a clock rate of 400 MHz. If one of the vector instructions generates a scalar by multiplying two vectors and summing the products, what FLOPS rate can the vendor claim? What is the memory bandwidth (in words/sec) required to support each processor. (Understand)

Concept Map



Syllabus

Introduction-need for parallel architecture- multithreading- parallel programming models- shared address space-message passing-data parallel processing – Multicore architectures. **Parallelization process-** parallelizing computation vs data- Parallelization of an example program- Decomposition-Assignment- Orchestration- data parallel model, shared address space model, Message-passing model. **Shared memory multiprocessors**- cache coherence problem-snooping protocols- synchronization event- Point-to-point synchronization, Global event synchronization - Memory consistency models. **OpenMP and MPI programming-** Constructs –Parallel, work sharing and Synchronization constructs. MPI data types and tags, environment management routines. **Data level parallelism** - Vector architecture- Graphics processing units- Programming the GPU.

Reference Books

1. John L. Hennessey and David A. Patterson, " Computer Architecture – A Quantitative Approach", Morgan Kaufmann / Elsevier, 5th. edition, 2012.
2. David E. Culler, Jaswinder Pal Singh, "Parallel Computing Architecture : A Hardware/ Software Approach" , Morgan Kaufmann / Elsevier Science (reprint Technical Science & Engineering) , 2009
3. Ben Abdallah, Abderazek, "Multicore Systems On-Chip: Practical Software/Hardware Design", Springer, 2013.
4. Peter S. Pacheco, "An Introduction to Parallel Programming", Morgan Kaufmann / Elsevier, 2011.
5. Michael J Quinn, Parallel Programming in C with MPI and OpenMP, Tata McGraw Hill, 2004.

Course Contents and Lecture Schedule

Module No.	Topics	No. of Lectures
1.0	**Introduction**	
1.1	Need for parallel architecture Multithreading and Parallel Programming models	2
1.2	Shared address space	1

1.3	Message passing	1
1.4	Data parallel processing	1
1.5	Multicore architectures	3
2.0	**Parallelization process**	
2.1	Parallelizing computation versus data	1
2.2	Parallelization of an Example program	1
2.2.1	Decomposition and Assignment	1
2.2.2	Orchestration	1
2.2.2.1	Orchestration under data parallel model	2
2.2.2.2	Orchestration under shared address space model	2
2.2.2.3	Orchestration under Message-passing model	2
3.0	**Shared Memory Multiprocessors**	
3.1	Cache Coherence problem, bus snooping	2
3.2	Protocols- MSI and MESI	4
3.3	synchronization event	1
3.3.1	Point-to-point synchronization	1
3.3.2	Global event synchronization	2
3.4	Memory consistency models	2
4.0	**OpenMP and MPI programming**	
4.1	Constructs –Parallel, worksharing and Synchronization constructs	4
4.2	MPI data types and tags , environment management routines	4
5.0	**Data level Parallelism**	
5.1	Vector architecture	4
5.2	Graphics Processing unit	4
5.3	Programming the GPU	4
	Total	**48**

Course Designers:

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

		Category	L	T	P	Credit
15CG150	**OPTIMIZATION TECHNIQUES**	PC	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

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

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	10	10	10	10

Understand	10	10	10	10
Apply	30	30	30	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. Solve the following Integer Programming Problem using Cutting Plane Method.

   Maximize $Z = x_1 + 2x_2$

   subject to

   $2x_2 \leq 7$

   $x_1 + x_2 \leq 7$

   $2x_1 \leq 11$

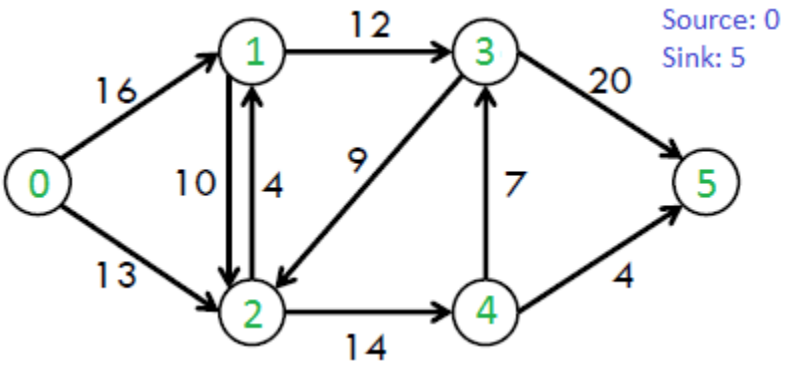
   x_1, x_2 are integers ≥ 0

Course Outcome 2 (CO2):

1. State the Ford and Fulkerson's rule for numbering nodes in a network?
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:
   1. Avoid the over utilization of skilled labor since it is hard to obtain in the labor market.
   2. Minimize the under utilization of unskilled labor.
   3. Meet the demand as much as possible.
   4. Limit over utilization of unskilled labor to 100 hours.

   Interpret the above as a goal programming problem.

3. 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.



Use Ford-Fulkerson Algorithm for Maximum Flow from s to t.

Course Outcome 3 (CO3):

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 4 (CO4):

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:

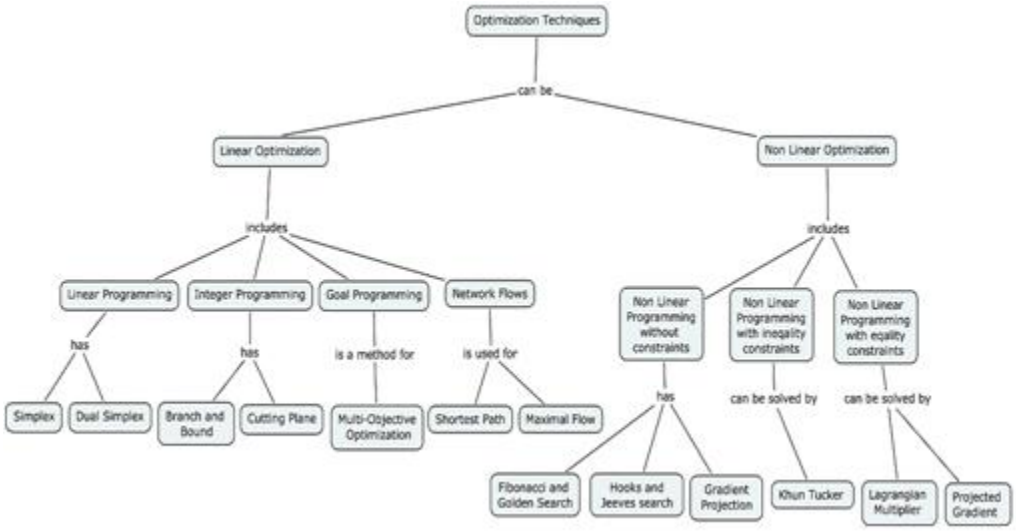
min $Z = (x_1 - 1)^2 + (x_2 - 2)^2$

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 - Shortestroute problems, Maximal Flow problems; **Nonlinear Programming (Unconstrained Problem) -**Basic Concepts – Fibonacci and Golden Section search - Hooks and Jeeves search - Gradient Projection – **Nonlinear Programming (with Equality Constraints)** Lagrangian Multiplier - Equality constrained optimization -Projected Gradient Methods with equality constraints; **Nonlinear Programming (Inequality Constraints):** Khun concept - Khun Tucker conditions;

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

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**	

Module No.	Topic	No. of Lectures
4.1	Network Construction, Terminologies, Shortestroute problems	2
4.2	Maximal Flow problems	2
5	**Nonlinear Programming (Unconstrained Problem)**	
5.1	Basic Concepts – Fibonacci and Golden Section search	2
5.2	Hooks and Jeeves search	2
5.3	Gradient Projection	2
6	**Nonlinear Programming (with Equality Constraints)**	
6.1	Lagrangian Multiplier for equality constrained optimization	3
6.2	Projected Gradient Methods with equality constraints	3
7	**Nonlinear Programming (Inequality Constraints)**	
7.1	Khun concept - Khun Tucker conditions	3
	Total Hours	36

Course Designers:

1. S.Sudha ssj@tce.edu

15CG160	AGILE SOFTWARE DEVELOPMENT AND USABILITY ENGINEERING	Category	L	T	P	Credit
		PC	3	0	0	3

Preamble

To impart a thorough understanding of the principles and practices used in agile software development & User interface design and to explore these techniques by solving problems.

Prerequisite

Course Outcomes

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

Write user stories for given software specification. (CO1)	Apply
Plan iterations based on relative effort and business value. (CO2)	Apply
Create backlogs and burn-down charts to monitor progress of a project. (CO3)	Apply
Increase quality with test-driven development. (CO4)	Apply
Design an interface by applying usability guidelines and standards for given system development problems. (CO5)	Apply
Design a usability test plan based on requirements specification. (CO6)	Apply

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	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			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	20	20	20	20
Apply	60	60	60	60
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

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

Course Outcome 2 (CO2):

1. What are the causes for variations in project estimates? (Remember)
2. Explain the methods to prioritize and divide features into tasks. (Understand)
3. Compute cost and effort for ATM using empirical estimation models. (Apply)

Course Outcome 3 (CO3):

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 4 (CO4):

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)

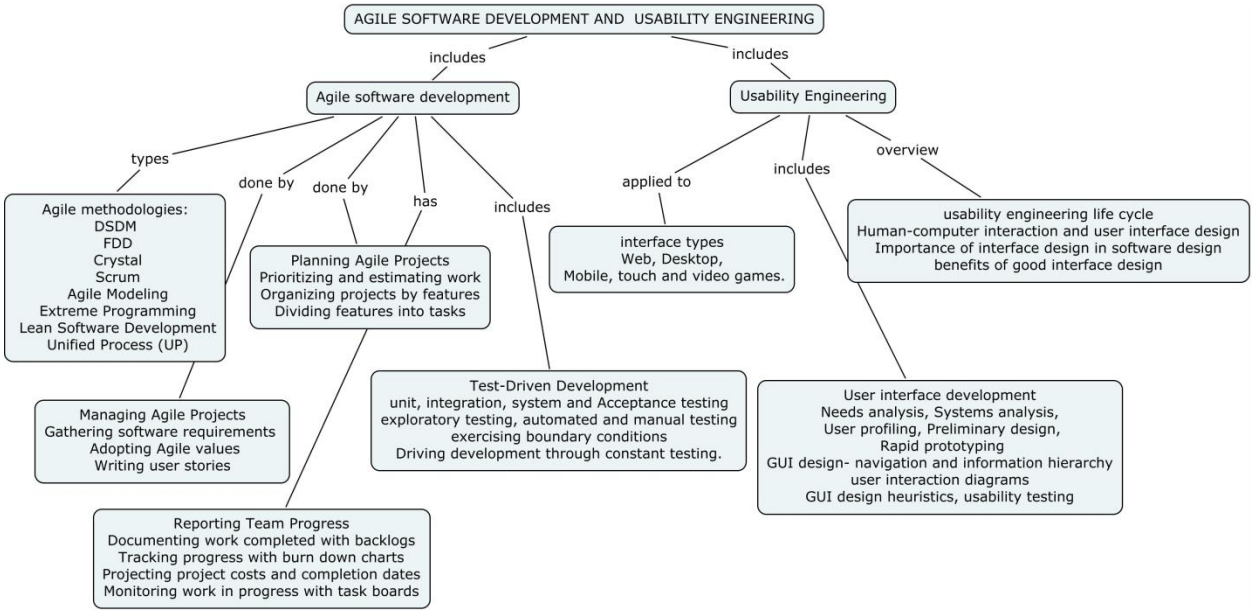
Course Outcome 5 (CO5):

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)

Course Outcome 6 (CO6):

1. Recall about user profiling (Remember)
2. Compare and evaluate strengths and weaknesses of various approaches, methods and techniques for evaluating usability. (Understand)
3. Prepare questionnaires to gather information from participants for a usability test. (Apply)

Concept Map



Syllabus

Agile software development: Agile vs Traditional models, Agile manifesto, **Agile methodologies-** DSDM, FDD, Crystal, Scrum, Agile Modeling, Extreme Programming, Lean Software Development, Unified Process (UP). **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:** usability engineering life cycle , Human-computer interaction and user interface design, Importance of interface design in software design, benefits of good interface design, **User interface development** - Needs analysis, Systems analysis, User profiling, Preliminary design, Rapid prototyping. GUI design- navigation and information hierarchy, user interaction diagrams, GUI design heuristics, usability testing. **Usability across interface types**: Web, Desktop, Mobile, touch and video games.

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 Lectures
1	**Agile software development**	
1.1	Agile vs Traditional models, Agile manifesto	1
1.2	**Agile methodologies**	
1.3	DSDM, FDD	1
1.4	Crystal, Scrum, Agile Modeling	1
1.5	Extreme Programming	1
1.6	Lean Software Development	1
1.7	Unified Process (UP)	1
2	**Managing Agile Projects**	
2.1	Gathering software requirements -Eliciting requirements from users	2
2.2	Adopting Agile values, Writing user stories	2
3	**Planning Agile Projects**	
3.1	Prioritizing and estimating work	2
3.2	Organizing projects by features, Dividing features into tasks	1
4	**Reporting Team Progress**	
4.1	Documenting work completed with backlogs	2
4.2	Tracking progress with burn down charts, Projecting	2

Module No.	Topic	No. of Lectures
	project costs and completion dates	
4.3	Monitoring work in progress with task boards.	2
5	**Test-Driven Development**	
5.1	Unit, integration, system and Acceptance testing,	2
5.2	Exploratory testing, automated and manual testing, exercising boundary conditions,	1
5.3	Driving development through constant testing.	2
6	**Usability Engineering**	
6.1	usability engineering life cycle, Human-computer interaction and user interface design	1
6.2	Importance of interface design in software design, benefits of good interface design	1
7	**User interface development**	
7.1	Needs analysis, Systems analysis, User profiling	1
7.2	Preliminary design, Rapid prototyping	1
7.3	GUI design- navigation and information hierarchy	2
7.4	user interaction diagrams, GUI design heuristics	2
7.5	Usability testing.	2
8	**Usability across interface types**	
8.1	Web, Desktop	1
8.2	Mobile, touch and video games	1
	Total	**36**

Course Designer:

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

		Category	L	T	P	Credit
15CG170	**DESIGN AND ANALYSIS OF ALGORITHMS LAB**	PC	0	0	1	1

Preamble

The laboratory course will facilitate the students to apply the concepts of approximation and 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

Develop algorithms on encryption, decryption and distributed mutual exclusion and deadlock concepts. (CO1)	Apply
Develop approximation, randomization, linear and non-linear algorithms for various problems like scheduling, graph, network, string and subsequence problems. (CO2)	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		

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 Lamport's Distributed Mutual Exclusion Algorithm
11. Implement Banker's algorithm used for deadlock avoidance.
12. Develop an approximation algorithm for the problems like Graph coloring, Vertex cover problem, maximal flow, shortest path problems, maximum subsequence generation etc.

13. Implement the randomized quick sort using divide and conquer strategy for the given scenario.

Course Designers:

1. Dr.S.Padmavathi spmcse@tce.edu
2. Mrs.S.Sudha ssj@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 2016 - 2017 ONWARDS

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

MADURAI – 625 015, TAMILNADU

Phone: 0452 – 2482240, 41
Fax: 0452 2483427
Web: www.tce.edu

Thiagarajar College of Engineering, Madurai-625015

Department of Computer science and Engineering

Scheduling of Courses for M.E. (CSE)

Semester	Theory						Practical	Credits
	1	2	3	4	5	6	7	
I	15CG110 Randomized and Approximation Algorithms 3:1	15CG120 Modern Operating Systems 3:1	15CG130 Cryptography : Theory and Practice 3:1	15CG140 Parallel Computing Systems 4:0	15CG150 Optimization Techniques 3:0	15CG160 Agile Software Development and Usability Engineering 3:0	15CG170 Design and Analysis of Algorithms Lab 0:1	23
II	15CG210 Performance Modeling 3:1	15CG220 Machine Learning 4:0	15CGPX0 Elective 1 4:0	15CGPX0 Elective 2 4:0	15CGPX0 Elective 3 4:0	15CGPX0 Elective 4 4:0	15CG270 Seminar 0:1	25
III	15CG310 Protocol Design and Verification 4:0	15CGPX0 Elective 5 4:0	15CGPX0 Elective 6 4:0	-	-	-	15CG340 Project - I 0:4	16
IV	-	-	-	-	-	-	15CG410 Project - II 0:12	12

		Category	L	T	P	Credit
15CG210	**PERFORMANCE MODELING**	PC	3	1	0	4

Preamble

This course introduces students to the basic concepts of modeling 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 modeling 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

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)	Analyze
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)	Evaluate
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)	Evaluate

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	S	S	L						
CO6	S	S	S	S	L						

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	10	5	5	10
Understand	10	10	10	20
Apply	20	25	25	40
Analyze	10	10	10	30
Evaluate	0	0	0	0
Create	0	0	0	0

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 $\lambda < \mu$. 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 $\lambda/(n + 1)$. 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 $\mu = 1$, 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 λ → ∞

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, andreport the results.

2. Select an area of computer systems (for example, processor design, networks, operating systems, ordatabases), review articles on performance evaluation in that area, and make a list of benchmarks usedin 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 datafiles 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 datafiles should be compared?

3. For a computer system of your choice, list a number of HB and LB metrics and draw a typicalKiviat 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):

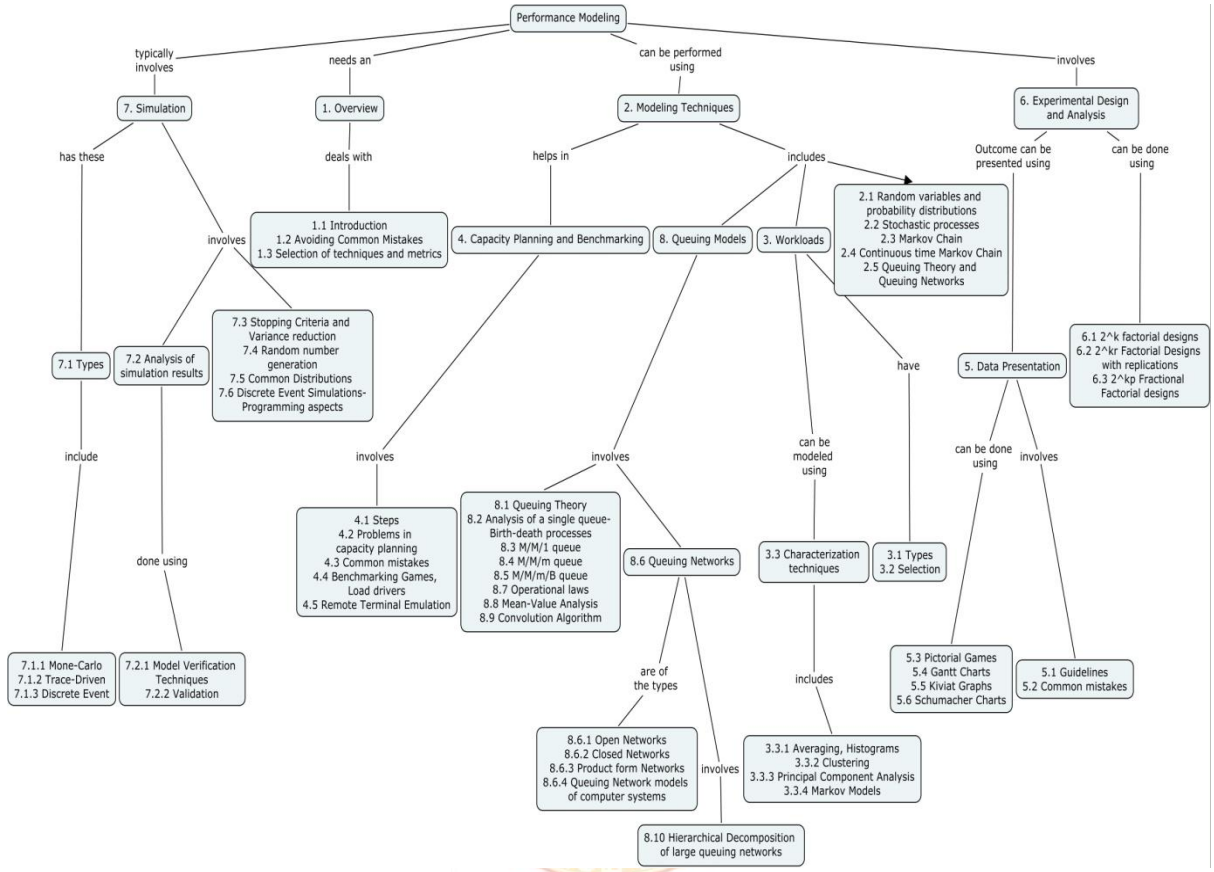
1. Select an area or application of computer systems, for example, Image processing, Mail, Networkingand Medical diagnosis. List the characteristics of workloads that a load driver for that areashould implement. Discuss how you would specify the required characteristics to the load driver andwhether 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 misleadingor 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 **Modeling Techniques:**Random variables and probability distributions, Stochastic processes, Markov Chain, Continuous time Markov Chain, Queuing Theory, Queuing Networks, **Workloads:** Types, Selection, Characterization techniques-Averaging, Histograms, Clustering, Principal Component Analysis, Markov Models. **Capacity Planning and Benchmarking:** Steps, Problems in capacity planning, Common mistakes, Benchmarking Games, Load drivers, 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^kr Factorial Designs with replications, 2^kp 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, M/M/m queue, M/M/m/B queue, Queuing Networks-Open, Closed and Product form Networks, Queuing Network models of computer

systems, Operational laws, Mean-Value Analysis, Convolution Algorithm, Hierarchical Decomposition of large queuing networks.

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.	**Modeling Techniques**	
2.1	Random variables and probability distributions	1
2.2	Stochastic processes	
2.3	Markov Chain	1
2.4	Continuous time Markov Chain	1
2.5	Queuing Theory and Queuing Networks-Introduction	1
3.	**Workloads**	
3.1	Types	1
3.2	Selection	
3.3	Characterization techniques	3

3.3.1	Averaging, Histograms	
3.3.2	Clustering	
3.3.3	Principal Component Analysis	
3.3.4	Markov Models	
4	**Capacity Planning and Benchmarking**	
4.1	Steps	1
4.2	Problems in capacity planning	
4.3	Common mistakes	
4.4	Benchmarking Games, Load drivers	1
4.5	Remote Terminal Emulation	
5.	**Data Presentation**	
5.1	Guidelines	2
5.2	Common mistakes	
5.3	Pictorial Games	
5.4	Gantt Charts	
5.5	Kiviat Graphs-Shapes & Applications	
5.6	Schumacher Charts	
Tutorial on Modeling Techniques, Workload Characterization, Benchmarking and Presentation		6
6.	**Experimental Design and Analysis**	
6.1	2^k factorial designs	1
6.2	2^kr Factorial Designs with replications	1
6.3	2^kp Fractional Factorial designs	1
7.	**Simulation**	
7.1	Types	2
7.1.1	Monte-Carlo	
7.1.2	Trace-Driven	
7.1.3	Discrete Event	

7.2	Analysis of simulation results	2
7.2.1	Model Verification Techniques	
7.2.2	Validation	
7.3	Stopping Criteria and Variance reduction	1
7.4	Random number generation	1
7.5	Common Distributions-review	1
7.6	Discrete Event Simulations-Programming aspects	1
8.	**Queuing Models**	
8.1	Queuing Theory	1
8.2	Analysis of a single queue-Birth-death processes	
8.3	M/M/1 queue	2
8.4	M/M/m queue	
8.5	M/M/m/B queue	
8.6	Queuing Networks	2
8.6.1	Open Networks	
8.6.2	Closed Networks	
8.6.3	Product form Networks	
8.6.4	Queuing Network models of computer systems	1
8.7	Operational laws	1
8.8	Mean-Value Analysis	1
8.9	Convolution Algorithm	1
8.10	Hierarchical Decomposition of large queuing networks	1
Tutorial on Experimental Design, Queuing Models and Simulation		6
	Total	48*

*The apportioning of the total contact hours for lectures and tutorials would be 36:12 respectively

Course Designer:

1. Mr. Karthick Seshadri skcse@tce.edu

15CG220 **MACHINE LEARNING**

Category	L	T	P	Credit
PC	4	0	0	4

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

Course Outcomes

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

Illustrate the steps involved in designing a machine learning algorithm. (CO1)	Apply
Construct training and prediction algorithms for classification using decision trees,artificial neural networks and Support Vector Machines.(CO2)	Apply
Construct learning algorithms using Bayesian probabilistic models for complex applications. (CO3)	Apply
Illustrate the fundamentals of computational learning theory with an understanding of the mistake bounds. (CO4)	Apply
Construct learning algorithms which involves linear regression with a comprehension of regularization, bias-variance and evidence approximation.(CO5)	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. (CO6)	Analyze
Construct parallel algorithms for learning models from massive data sets. (CO7)	Apply

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	15	10	10	10
Understand	15	10	10	10
Apply	10	15	15	50
Analyze	10	15	15	30
Evaluate	0	0	0	0
Create	0	0	0	0

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.

Course Outcome (CO2):

1. Define Entropy measures in identifying the best classifier.
2. Demonstrate the ID3 algorithm specialised to learn Boolean valued functions.
3. Illustrate how will you avoid overfitting data in decision tree algorithm?
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. State Bayes theorem.
2. Apply the concept of Bayes rule to medical diagnosis problem.
3. Apply the Bayes learning methods for classifying text documents.

Course Outcome (CO4):

1. Define a Probably Approximately Correct learning model.
2. Demonstrate the significance of mistake bounds in the computational learning theory.
3. Illustrate the need for PAC learning theory with appropriate justifications.

Course Outcome (CO5):

1. Explain how Bias-variance trade-off is used to handle model complexity.
2. Define linear model for regression.
3. Explain how evidence approximation is used to learn models of regression.
4. Illustrate the use of regularization in avoiding over-fitting.

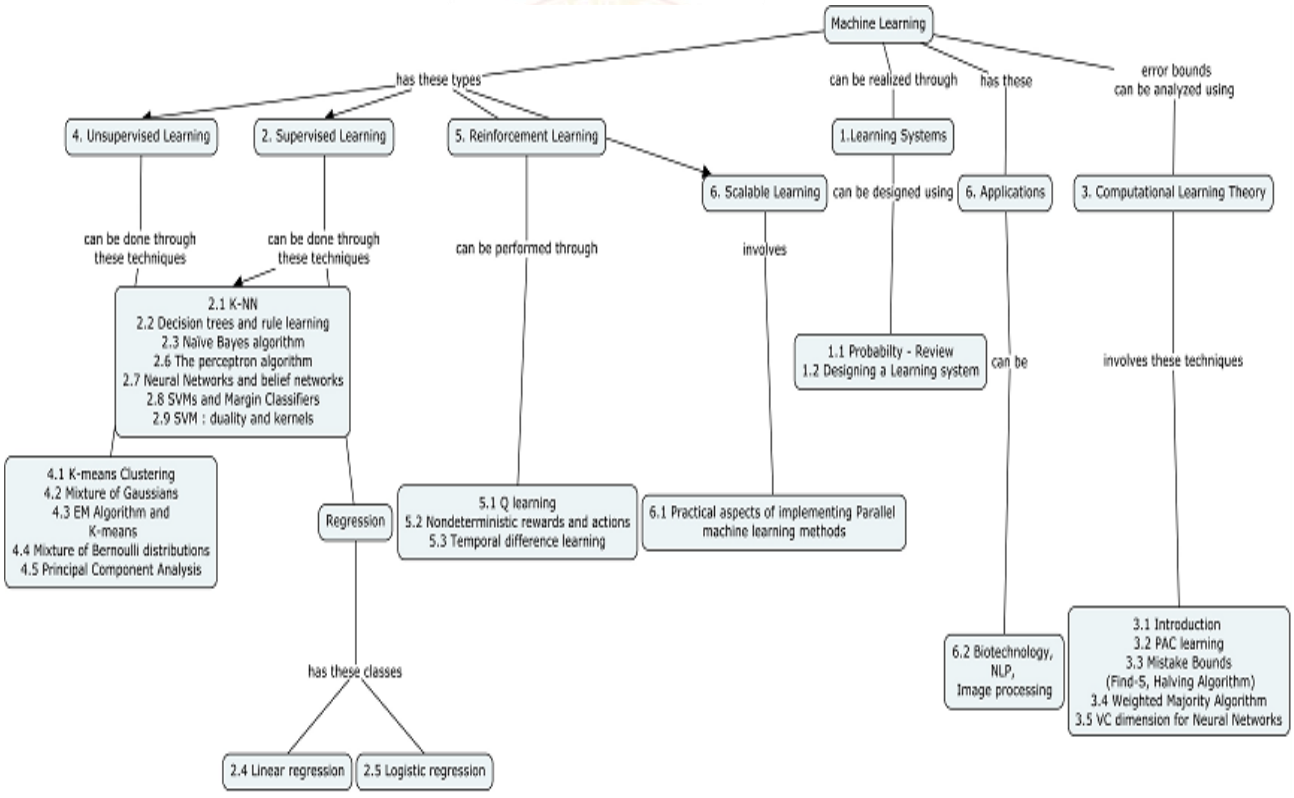
Course Outcome (CO6):

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 (CO7):

1. Examine the various strategies to be considered for implementing parallel machine learning algorithm in Hadoop framework.
2. Explain how parallel machine learning algorithms are implemented using Hadoop frame work.
3. Design and implement a parallel machine learning algorithm on top of the Hadoop framework for a research problem (Assignment)

Concept Map



Syllabus

Introduction - Probability-Review, Designing a Learning system.
Supervised learning– K-NN, Decision trees and rule learning, Naïve Bayes algorithm, Linear regression, Logistic regression, The Perceptron Algorithm, Neural Networks and Belief Networks, SVMs and Margin Classifiers, SVM : duality and kernels.
Computational Learning Theory: Introduction, PAC learning, Mistake Bounds (Find-S, Halving Algorithm), 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, Biotechnology, NLP, Image processing

Reference Books

1. Christopher M.Bishop, “Pattern recognition and machine learning”, Springer,2007.
2. Tom M. Mitchell, “Machine learning”, McGraw Hill,1997.
3. Kevin Murphy, Machine Learning - A Probabilistic Perspective, Adaptive Computation and Machine Learning, MIT Press, 2012.
4. Ethem Alpaydin, “Introduction to machine learning”, The MIT Press,2004.
5. Stephen Marsland, “Machine learning: An algorithmic perspective”,CRC,2009.

Course Contents and Lecture Schedule

Sl No.	Topics	No.of Lectures
1	**Introduction to learning system**	
1.1	Probability-Review	2
1.2	Designing a Learning system	1
2	**Supervised Learning**	
2.1	K-NN	1
2.2	Decision trees and rule learning	2
2.3	Naïve Bayes algorithm	2
2.4	Linear regression	2
2.5	Logistic regression	2
2.6	The Perceptron Algorithm	1
2.7	Neural Networks and Belief Networks	3

2.8	SVMs and Margin Classifiers	2
2.9	SVM : duality and kernels	2
3	**Computational Learning Theory**	
3.1	Introduction	1
3.2	PAC learning	1
3.3	Mistake Bounds (Find-S, Halving Algorithm)	2
3.4	Weighted Majority Algorithm	1
3.5	Complexity for infinite hypotheses spaces: VC dimension for Neural Networks	1
4	**Unsupervised learning**	
4.1	K-means Clustering	2
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	2
5.2	Nondeterministic rewards and actions	2
5.3	Temporal difference learning	2
6	**Scalable Learning and Applications**	
6.1	Practical aspects of implementing parallel Machine Learning methods	3
6.2	Biotechnology, NLP, Image processing	4
	Total	**48**

Course Designer:

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

CURRICULUM AND DETAILED SYLLABI

FOR

M.E DEGREE (Computer Science and Engineering) PROGRAMME

THIRD SEMESTER

FOR THE STUDENTS ADMITTED FROM THE

ACADEMIC YEAR 2016 - 2017 ONWARDS

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

MADURAI – 625 015, TAMILNADU

Phone: 0452 – 2482240, 41
Fax: 0452 2483427
Web: www.tce.edu

Thiagarajar College of Engineering, Madurai-625015

Department of Computer science and Engineering

Scheduling of Courses for M.E. (CSE)

Semester	Theory						Practical	Credits
	1	2	3	4	5	6	7	
I	15CG110 Randomized and Approximation Algorithms 3:1	15CG120 Modern Operating Systems 3:1	15CG130 Cryptography : Theory and Practice 3:1	15CG140 Parallel Computing Systems 4:0	15CG150 Optimization Techniques 3:0	15CG160 Agile Software Development and Usability Engineering 3:0	15CG170 Design and Analysis of Algorithms Lab 0:1	23
II	15CG210 Performance Modeling 3:1	15CG220 Machine Learning 4:0	15CGPX0 Elective 1 4:0	15CGPX0 Elective 2 4:0	15CGPX0 Elective 3 4:0	15CGPX0 Elective 4 4:0	15CG270 Seminar 0:1	25
III	15CG310 Protocol Design and Verification 4:0	15CGPX0 Elective 5 4:0	15CGPX0 Elective 6 4:0	-	-	-	15CG340 Project - I 0:4	16
IV	-	-	-	-	-	-	15CG410 Project - II 0:12	12

15CG310 PROTOCOL DESIGN AND VERIFICATION

Category	L	T	P	Credit
PC	4	0	0	4

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

Course Outcomes

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

Apply CSP descriptions and rules and synchronize services (CO1)	Apply
Apply basic protocol Mechanisms for multiplexing and segmenting (CO2)	Apply
Achieve integrity by adopting Integrity and authentication (CO3)	Apply
Compare and contrast and select relevant encoding mechanisms. (CO4)	Analyze
Compare and contrast distributed transaction processing protocols (CO5)	Analyze

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	20	40
Analyse	-	-	10	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)

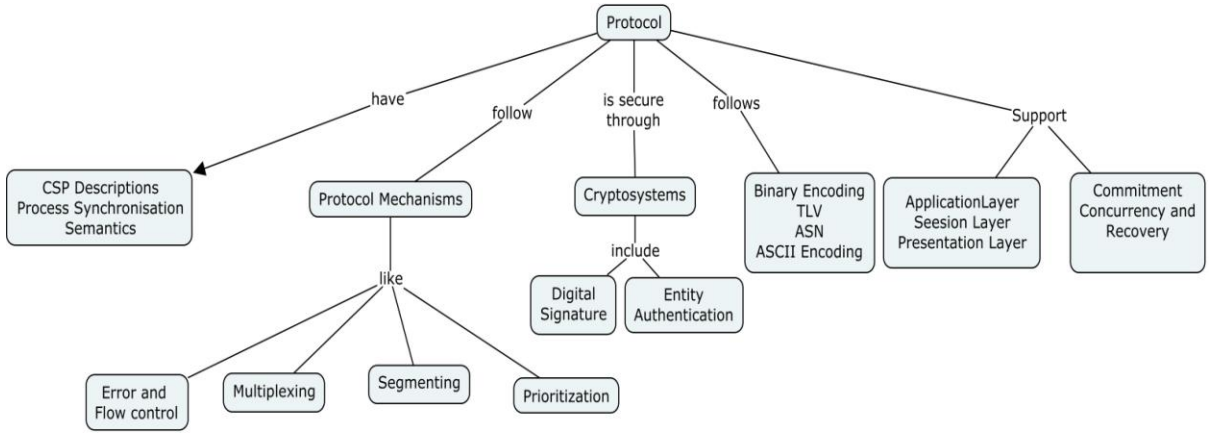
Course Outcome 4 (CO4):

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

Course Outcome 5 (CO5):

1. Analyze the behaviour of a protocol on concurrency and recovery. (Analyze)
   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.

Reference Books

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** (9)	
1.1	CSP Descriptions and Proof Rules	1
1.2	Processes and Process Synchronisation	2
1.3	Channel History Semantics .	1

Module No.	Topic	No. of Lectures
1.4	Failure Semantics	1
1.5	Protocols and Services	2
1.6	Providing a service-Service Features -	1
1.7	OSI and other layered architectures	1
2	**Basic Protocol Mechanisms** (10)	
2.1	Sequence Error and Flow control	1
2.2	Change of service- Multiplexing	1
2.3	Splitting – Segmenting	2
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	2
3	**Security** (10)	
3.1	Crypto systems	1
3.2	Integrity – Digital Signature	2
3.3	Entity Authentication Key Exchange	2
3.4	Naming Addressing and Routing	1
3.5	General Principle , Addressing Structures	2
3.6	Routing ,Congestion	2
4	**Protocol Encoding** (9)	
4.1	Simple binary encoding	1
4.2	TLV - ASN.1 - ASCII Encoding	3
4.3	Protocols in the OSI Lower Layers	2
4.4	Data Link Layer - Network layer - Transport Layer.	3
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	**48**

Course Designers:

1. Mr.S.Prasanna sprcse@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 2016 - 2017 ONWARDS

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II	15CG210 Performance Modeling 3:1	15CG220 Machine Learning 4:0	15CGPX0 Elective 1 4:0	15CGPX0 Elective 2 4:0	15CGPX0 Elective 3 4:0	15CGPX0 Elective 4 4:0	15CG270 Seminar 0:1	25
III	15CG310 Protocol Design and Verification 4:0	15CGPX0 Elective 5 4:0	15CGPX0 Elective 6 4:0	-	-	-	15CG340 Project - I 0:4	16
IV	-	-	-	-	-	-	15CG410 Project - II 0:12	12

Approved in Board of Studies Meeting on 25.04.15

Approved in 50th Academic Council Meeting on 30.05.2015

15CGPA0	INFORMATION STORAGE AND MANAGEMENT SYSTEMS	Category	L	T	P	Credit
		PE	4	0	0	4

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.

Prerequisite

- Basics of Computer Networks

Course Outcomes

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

Explain the components and functions of Information Storage Systems. (CO1)	Understand
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)	Understand
Analyze the working of Information Storage Systems (CO5)	Analyze

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	P07	PO8	PO9	PO10	PO11
CO1											
CO2	S	M									
CO3	S	M									
CO4											
CO5	M	M		M							

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	40	40	40	40
Apply	20	20	20	20
Analyse	20	20	20	20
Evaluate	0	0	0	0
Create	0	0	0	0

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.

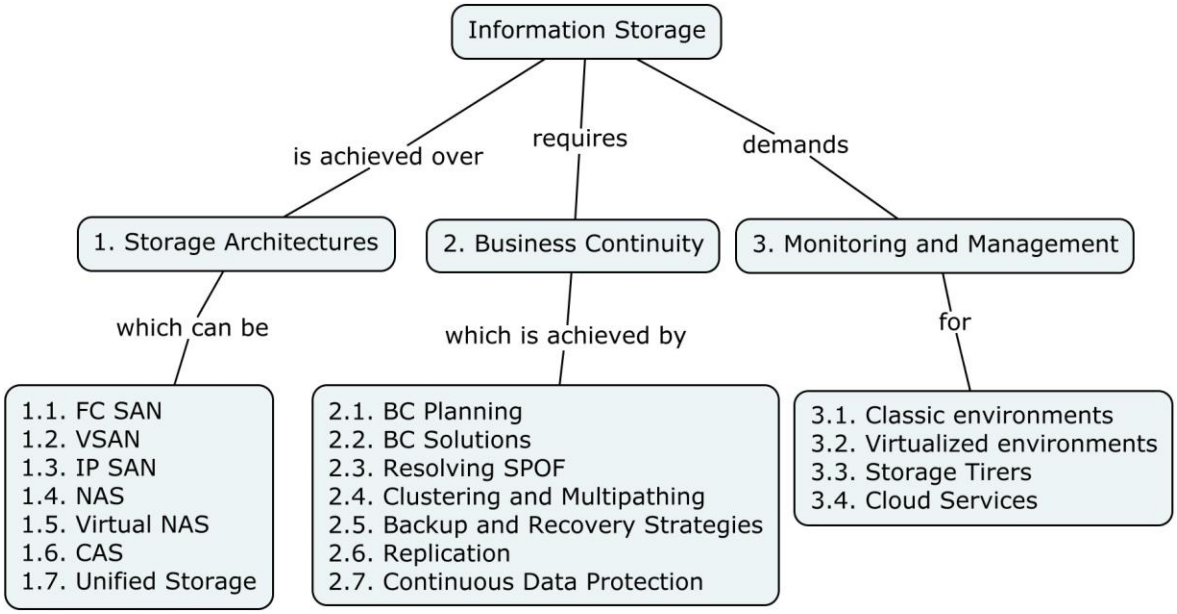
Course Outcome 5 (CO5):

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.

Concept Map



Syllabus

Storage Networking Technologies: Fibre Channel SAN - SAN-based virtualization – VSAN - IP SAN - Storage access over IP network - Network Attached Storage – File level virtualization in NAS – Integration of NAS and SAN - CAS –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 - Continuous Data Protection - **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 Book

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.

Storage Area Network Essentials: A Complete Guide to Understanding and Implementing SANs, Richard Barker, Paul Massiglia, Wiley, 2001

Storage Networks: The Complete Reference, Robert Spalding,Tata McGraw Hill, 2003.

Disaster Recovery and Business Continuity, Thejendra BS, Shroff Publishers, 2006.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1.	**Storage Architectures**	

Module No.	Topic	No. of Lectures
1.1	FC SAN	4
1.2	Virtual SAN	2
1.3	IP SAN	3
1.4	Network Attached Storage	3
1.5	Virtual Network Attached Storage	2
1.6	CAS	3
1.7	Unified Storage	1
2.	**Business Continuity**	
2.1	BC Planning - Information availability and Business Continuity	3
2.2	BC Solutions	3
2.3	Resolving SPOF	2
2.4	Clustering and Multipathing	3
2.5	Backup and Recovery Strategies	3
2.6	Replication	3
2.7	Continuous Data Protection	2
3	**Monitoring and Management**	
3.1	Classic environments	3
3.2	Virtualized environments	3
3.3	Storage Tirers	3
3.4	Cloud Services	2
	Total	**48**

Course Designer:

1. Dr.G.S.R.Emil Selvan emil@tce.edu

15CGPB0	DESIGN AND ANALYSIS OF PARALLEL ALGORITHMS	Category	L	T	P	Credit
		PE	4	0	0	4

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 like divide-and-conquer, pipelining and to subsequently analyze their asymptotic efficiency. (CO3)	Analyze
Construct pseudo-code for parallel algorithms to solve well-known problems like matrix operations, solving equations and graph based computation problems. (CO4)	Apply
Construct implementations of parallel algorithms on top of parallel programming frameworks like MPI, OpenMP. (CO5)	Apply

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	10	5	5	10
Understand	15	15	15	30
Apply	20	20	15	30
Analyze	5	10	15	30
Evaluate	0	0	0	0
Create	0	0	0	0

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):

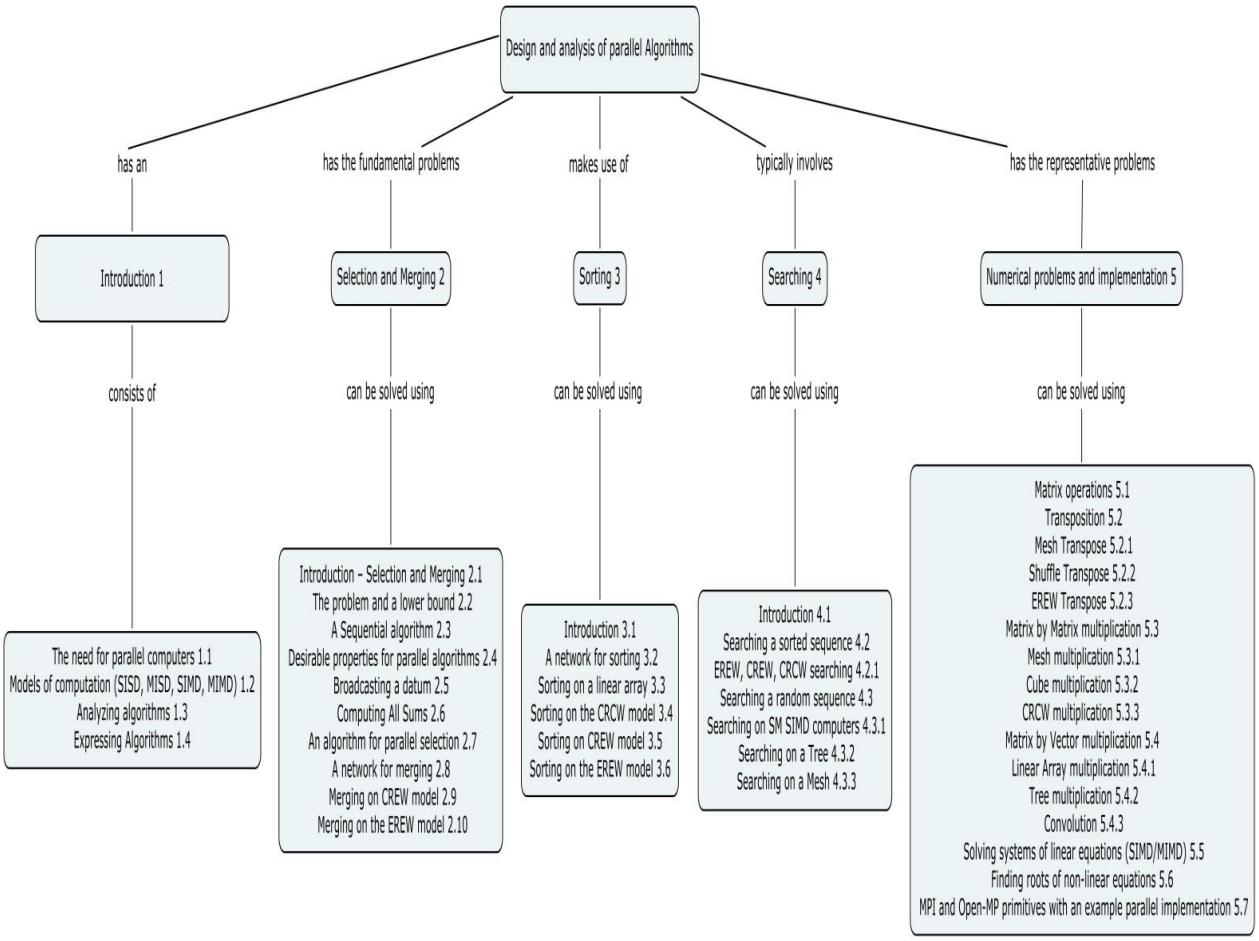
1. Construct a pseudo-code for a parallel algorithm to perform matrix transpose on a mesh
2. Construct a pseudo-code for a parallel algorithm to find the roots of non-linear equations using a parallel algorithm based on Newton-Raphson's method
3. Paraphrase a parallel algorithm to perform Shuffle transpose.

Course Outcome (CO5):

[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. **Performance Analysis:** Amdahl's Law, Gustafson Barsis's law- Karp Flatt metric- Iso efficiency metric. **Numerical problems and implementation**: Matrix operations, Transposition, Mesh Transpose, Shuffle Transpose, EREW Transpose, Matrix by Matrix multiplication, Mesh

multiplication, Cube multiplication, CRCW multiplication, Matrix by Vector multiplication, Linear Array multiplication, Tree multiplication, Convolution, 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**	
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**	
2.1	Introduction – Selection and Merging	2
2.2	The problem and a lower bound	1
2.3	A Sequential algorithm	1
2.4	Desirable properties for parallel algorithms	1
2.5	Broadcasting a datum	1
2.6	Computing All Sums	1
2.7	An algorithm for parallel selection	2

No.	Topic	No. of Lectures
2.8	A network for merging	1
2.9	Merging on CREW model	1
2.10	Merging on the EREW model	1
3	**Sorting**	
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	1
3.6	Sorting on the EREW model	1
4	**Searching**	
4.1	Introduction	1
4.2	Searching a sorted sequence	1
4.2.1	EREW, CREW, CRCW searching	1
4.3	Searching a random sequence	1
4.3.1	Searching on SM SIMD computers	1
4.3.2	Searching on a Tree	1
4.3.2	Searching on a Mesh	1
5	**Numerical problems and implementation**	
5.1	Matrix operations	1
5.2	Transposition	1
5.2.1	Mesh Transpose	1
5.2.2	Shuffle Transpose	1

No.	Topic	No. of Lectures
5.2.3	EREW Transpose	1
5.3	Matrix by Matrix multiplication	1
5.3.1	Mesh multiplication	1
5.3.2	Cube multiplication	1
5.3.3	CRCW multiplication	1
5.4	Matrix by Vector multiplication	1
5.4.1	Linear Array multiplication	1
5.4.2	Tree multiplication	1
5.4.3	Convolution	1
5.5	Solving systems of linear equations (SIMD/MIMD)	2
5.6	Finding roots of non-linear equations	2
5.7	MPI and Open-MP primitives with an example parallel implementation	2
	Total	**48**

Course Designer:

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

2. Mr. S. Karthick skcse@tce.edu

15CGPC1	FORMAL VERIFICATION AND MODEL CHECKING	Category	L	T	P	Credit
		PE	4	0	0	4

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)	Analyze
Compute regular safety properties and ω-regular properties using automata-based algorithms (CO4)	Apply
Apply model checking using Linear Temporal Logic (LTL) and Computation Tree Logic (CTL) (CO5)	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

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	10	10	10	10

Understand	10	10	10	10
Apply	30	10	30	60
Analyse		20		20
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

$x := 0;$

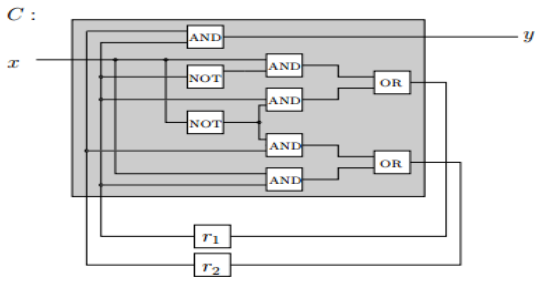
$P_1 \parallel P_2 \parallel P_3$

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
2. 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.

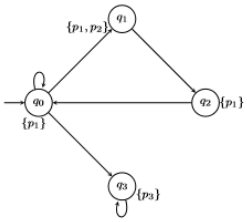
```
  1 | 2 | 3
____|___|____
  4 | 5 | 6
____|___|____
  7 | 8 | 9
    |   |
```

Course Outcome 3 (CO3):

1. Consider the set AP of atomic propositions defined by AP = { x = 0, x > 1 } and consider a nonterminating 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):

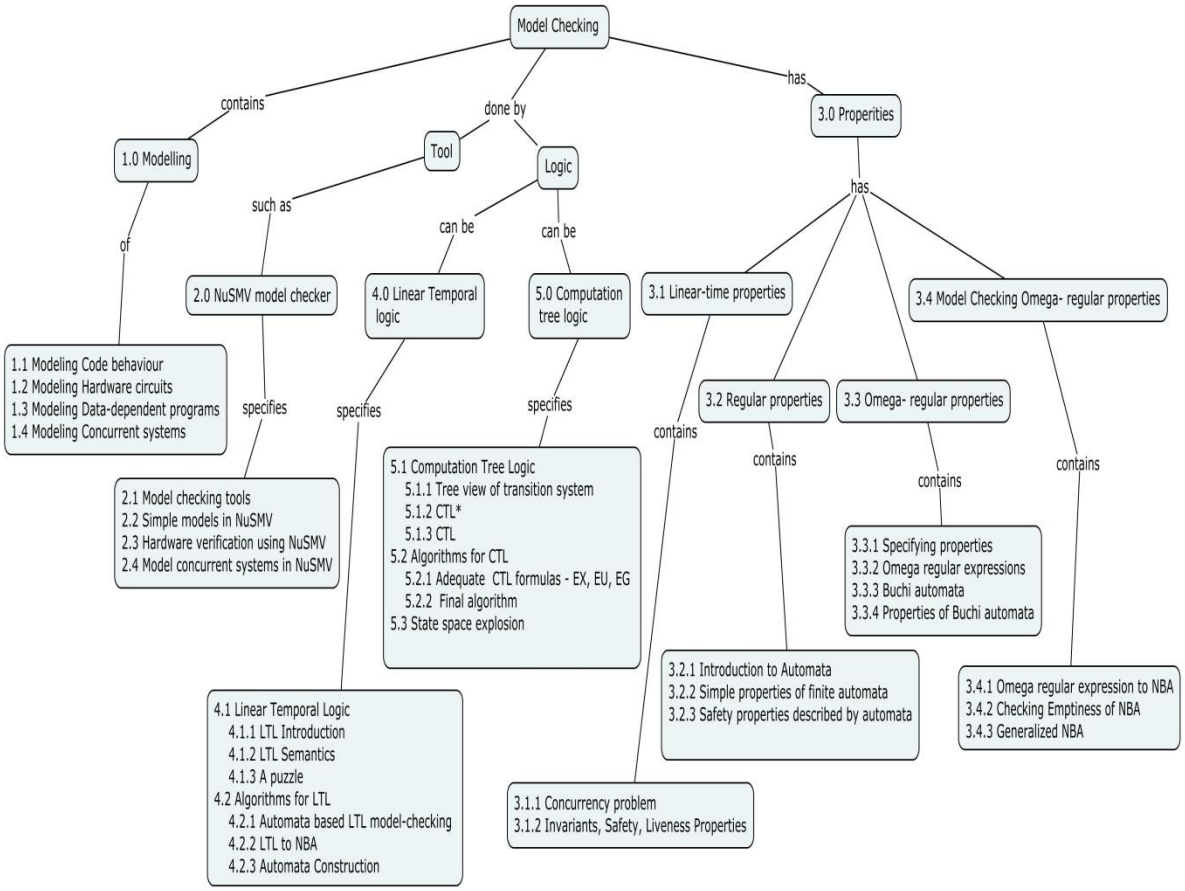
1. Using algorithmic approach, construct automaton for the LTL formula $p_1 \; U \; p_2$.
2. Construct a NBA for the language represented by the ω-regular expression $100(001)^{\omega} + 0^{\omega}$.

3. Using formula expansion method, show that which of the following traces violates the formula $p1 \rightarrow X(p2)$
    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. 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. Let the atomic propositions be AP = {p1, p2, p3}. Which of the following formulas is equivalent to (GFp1) -> (GFp2)
    a. (FG!p2) -> (FG!p1)
    b. G(p1 -> Fp2)
    c. G(Fp1 -> Fp2)
    d. GF!p1
3. Consider a lift system that services N > 0 floors numbered 0 through N − 1. There is a lift door at each floor with a call-button and an indicator light that signals whether or not the lift has been called. In the lift cabin there are N send-buttons (one per floor) and N indicator lights that inform to which floor(s) is sent.
   For simplicity consider N = 4. Present a set of atomic propositions – try to minimize the number of propositions – that are needed to describe the following properties of the lift system as LTL-formulas and give the corresponding LTL-formulas:
    a. The doors are “safe”, i.e., a floor door is never open if the cabin is not present at a given floor.
    b. A requested floor will be served sometime.
    c. Again and again the lift returns to floor 0.
    d. When the top floor is requested, the lift serves it immediately and does not stop on the way there.

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. ChristelBaier 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	2
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	2
	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	2
	3.4.1	Omega regular expression to NBA	2
	3.4.2	Checking Emptiness of NBA	1
	3.4.3	Generalized NBA	1
4.	**Linear Temporal Logic**		
	4.1	Linear Temporal Logic	1
	4.1.1	LTL Introduction	1
	4.1.2	LTL Semantics	1
	4.1.3	A puzzle	1
	4.2	Algorithms for LTL	2
	4.2.1	Automata based LTL model-checking	1
	4.2.2	LTL to NBA	2

Module No.		Topic	No. of Lectures
	4.2.3	Automata construction	1
5.	**Computation Tree Logic**		
	5.1	Computation Tree Logic	2
	5.1.1	Tree view of transition system	1
	5.1.2	CTL*	1
	5.1.3	CTL	1
	5.2	Algorithms for CTL	2
	5.2.1	Adequate CTL formulas - EX, EU, EG	1
	5.2.2	Final algorithm	1
	5.3	State space explosion	1
		Total	**48**

Course Designer:

1. Dr.M.K.KavithaDevi (mkkdit@tce.edu)

15CGPD0 COMPUTER SECURITY AND FORENSICS

Category	L	T	P	Credit
PE	4	0	0	4

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)	Analyze
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

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

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	50	40	40	40
Apply	30	40	40	40
Analyse	-	-	-	-
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):

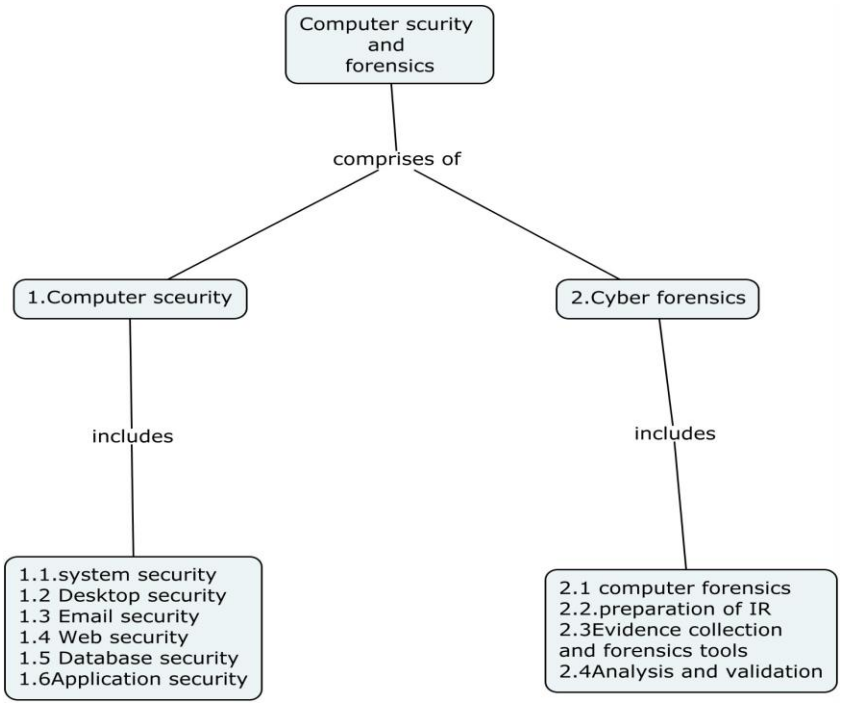
1. Explain the process of location all the DNS servers and their corresponding records for an organization
2. Differentiate Nslookup and DNSstuff
3. Describe stack overflows and heap overflows

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

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 (3 rd edition). Prentice-Hall. 2003. ISBN: 0-13-035548-8
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	3
1.2	Desktop Security	3
1.3	Email security	3
1.4	Web Security	3
1.5	Database Security	3
1.6	Application security	3
2	**Cyber Forensics**	
2.1	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.	6
2.2	Preparation for IR - Creating response tool kit and IR team. Forensics Technology and Systems, Understanding Computer Investigation, Data Acquisition.	6
2.3	Evidence collection and forensics tools - Processing Crime and Incident Scenes, Working with Windows and DOS Systems.	6
2.3.1	Current Computer Forensics Tools - Software/ Hardware Tools.	6
2.4	Analysis and validation - Validating Forensics Data, Data Hiding Techniques, Performing Remote Acquisition, Network Forensics, Email Investigations, Cell Phone and Mobile Devices Forensics.	6
	Total	**48**

Course Designers:

1. T.Manikandan tmcse@tce.edu

		Category	L	T	P	Credit
15CGPE0	**NATURAL LANGUAGE PROCESSING**	PE	4	0	0	4

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
- Information Retrieval

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

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	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							

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	10	10	10	20

Understand	20	20	20	30
Apply	20	20	10	30
Analyse	-	-	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

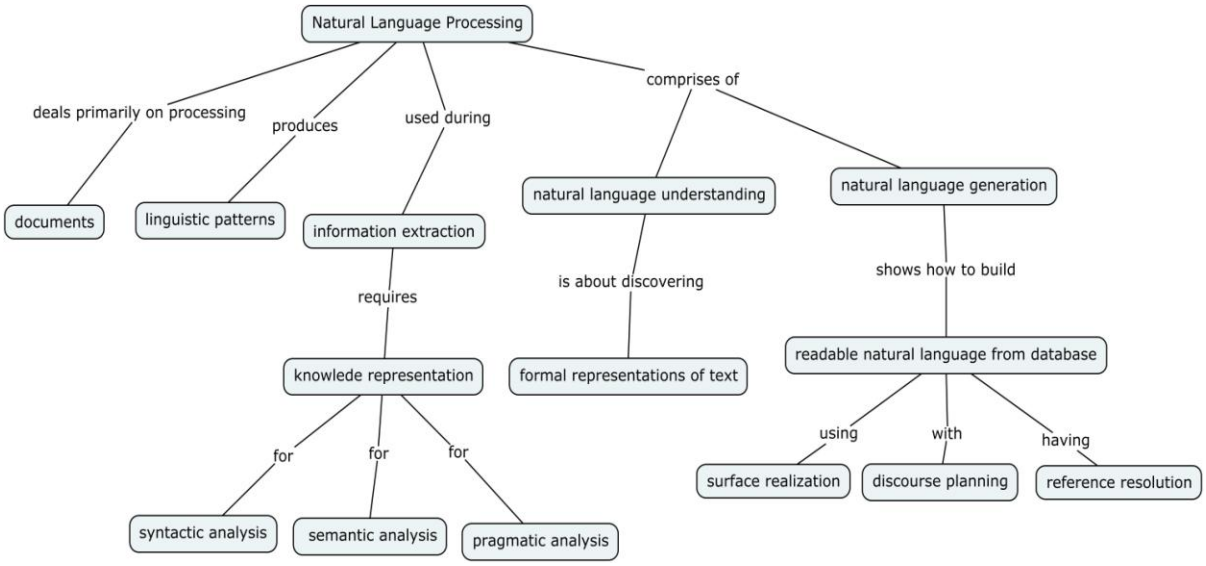
Course Outcome 5 (CO4):

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 4 (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

Concept Map



Syllabus

Introduction: Natural Language Processing - Different levels of Language Analysis- Linguistics Essentials - Grammars and Parsing- Parts of Speech 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

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.

WEB REFERENCES :

1. http://ocw.mit.edu/courses
2. www.statsoft.com/Textbook/Text-Mining

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1.	**Introduction**	
1.1	Natural Language Processing	2
1.2	Different levels of Language Analysis	1
1.3	Linguistics Essentials	1
1.4	Grammars and Parsing	1
1.5	Parts of Speech 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	2
2.4	Viterbi Algorithm	2
2.5	Ambiguity Resolution	1
3.	**Semantics**	
3.1	Logical form	3
3.2	Word senses and ambiguity	2
3.3	Encoding ambiguity in logical form	2
3.4	Defining semantic structures and semantic roles interpretation	2
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	2
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	2
5.6	Systemic Grammar	2
5.7	Functional Unification Grammar	1

Course Designers:

1. K.Sundarakantham kskcse@tce.edu

15CGPF0	NETWORK PERFORMANCE AND VULNERABILITY ANALYSIS	Category	L	T	P	Credit
		PC	4	0	0	4

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 and examine their reach of execution (CO5)	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						

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	10	10	10	10
Understand	20	20	20	20
Apply	50	50	40	40
Analyse	20	20	30	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

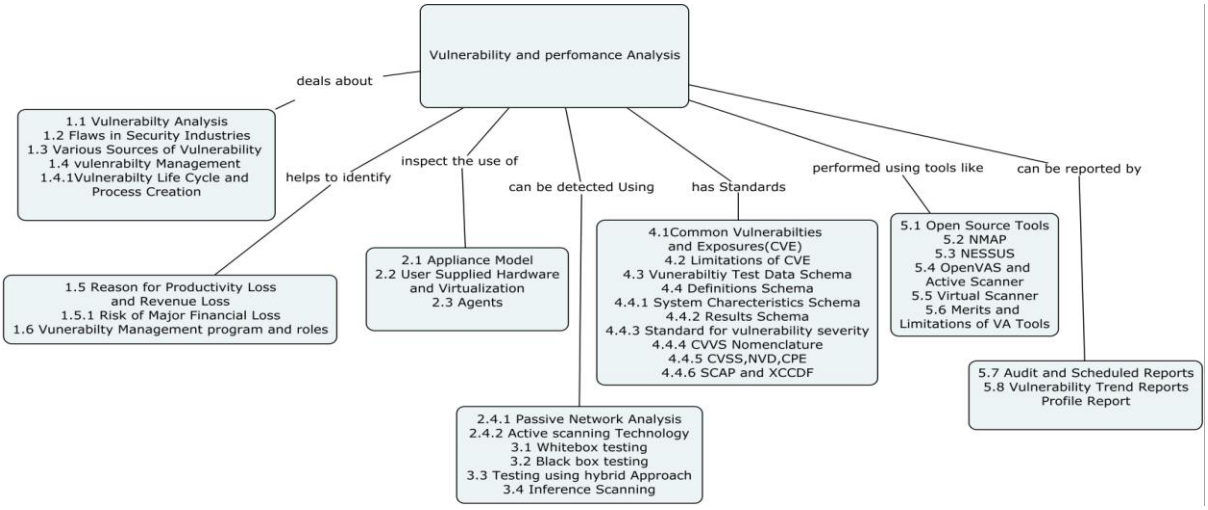
Course Outcome 4 (CO4):

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

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.
   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 (11)**	
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	1
1.4.1	The Vulnerability Creation Process	2
1.5	Risk of Major Financial Loss -	1
1.5.1	Loss of Revenue - Lost Productivity	1
1.6	The Vulnerability Management Program	1
1.6.1	Technology Development and Roles	1
2	**Hardware(9)**	
2.1	The Appliance Model -	1
2.2	User-Supplied Hardware and Virtualization	1
2.3	Agents , Agent Architecture -	1
2.3.1	Merits and Limitation of Hardware Architecture	1
2.4	Detection Methods	1
2.4.1	Passive Network Analysis	1
2.4.1.1	Advantages and Disadvantages of Passive Network Analysis	1
2.4.2	Active Scanning Technology	1
2.4.2.1	Advantages and Disadvantages of Active Scanning	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(10)**	

Module No.	Topic	No. of Lectures
4.1	CVE , Structure of vulnerability	1
4.2	Limitations of CVE	1
4.3	The Standard for Vulnerability Test Data	1
4.4	Definitions Schema	1
4.4.1	System Characteristics Schema	1
4.4.2	Results Schema	1
4.4.3	The Standard for Vulnerability Severity	1
4.4.4	Rating and CVSS Nomenclature	1
4.4.5	NVD ,CPE	1
4.4.6	XCCDF , SCAP-VA	1
5	**Tools(12)**	
5.1	Open source tools	1
5.2	NMAP	1
5.2.1	NMAP commands,NMAP Scripting	2
5.3	Nessus	1
5.4	Using Nessus,OpenVAS ,Active scanner	2
5.5	Deployment of Virtual Scanners	1
5.6	Advantages and Disadvantages of VA Tools	1
5.7	Audit and Scheduled Reports	2
5.8	Vulnerability Trend and Profile Report	1
	Total Hours	**48**

Course Designer:

1. K.NarasimhaMallikarjunan arjunkambaraj@tce.edu

15CGPG0	CLOUD COMPUTING SYSTEMS AND SERVICES	Category	L	T	P	Credit
		PE	4	0	0	4

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.

Prerequisite

Course Outcomes

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

Identify the real time cloud providers and their service levels. (CO1)	Apply
Illustrate the design of on-demand and scalable Cloud Computing Infrastructure. (CO2)	Apply
Apply the various forms of virtualization technique to the enterprise architecture. (CO3)	Apply
Illustrate the security issues of the enterprise adapting cloud computing principles.(CO4)	Apply
Illustrate the data availability, data replication, data protection and data footprint reduction techniques of cloud storage services. (CO5)	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			

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	30	20	20	20
Understand	30	30	20	20
Apply	40	50	60	60
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

Sample 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)

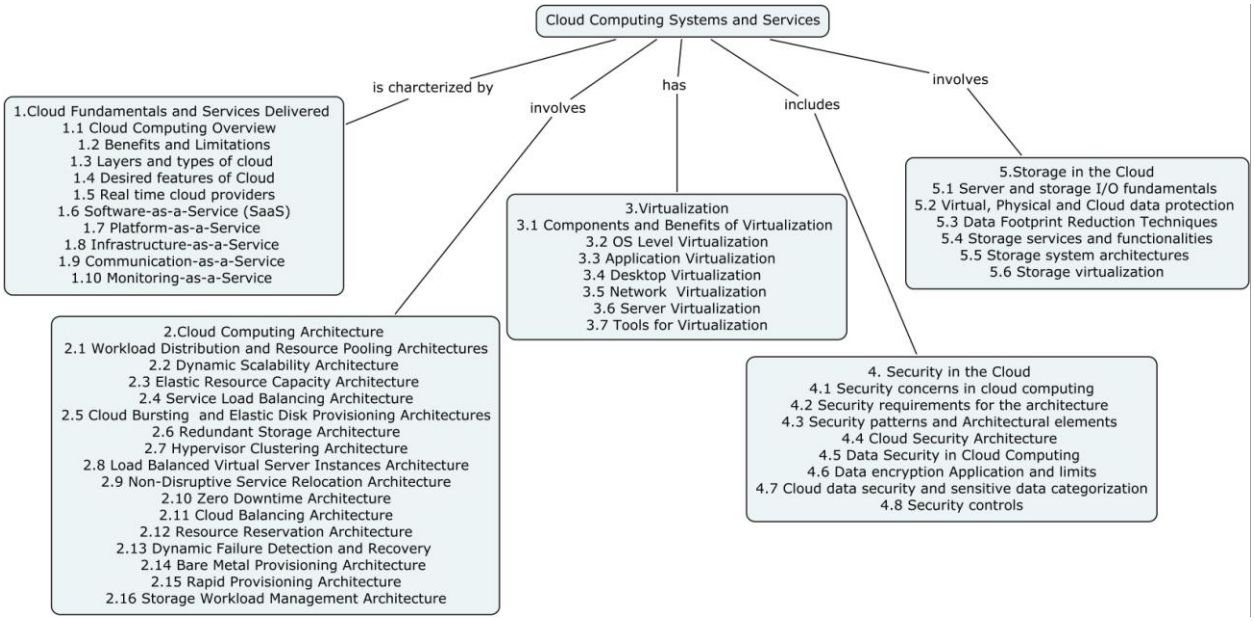
Course Outcome 4 (CO4)

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)

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) with case studies - Platform-as-a-Service (PaaS) with case studies - Infrastructure-as-a-Service (IaaS) with case studies - Communication-as-a-Service (CaaS) with case studies - Monitoring-as-a-Service (MaaS) with case studies - **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, functionalities and challenges – Storage system architectures – Storage virtualization

Reference Books

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

Module No	Topic	No. of Lectures
1	**Cloud Fundamentals and Services Delivered (10)**	
1.1	Cloud Computing Overview	1
1.2	Benefits and Limitations	1
1.3	Layers and types of cloud	1
1.4	Desired features of Cloud	1
1.5	Real time cloud providers	1
1.6	Cloud Services Model - Software-as-a-Service (SaaS) with case studies	1
1.7	Platform-as-a-Service (PaaS) with case studies	1
1.8	Infrastructure-as-a-Service (IaaS) with case studies	1
1.9	Communication-as-a-Service (CaaS) with case	1

	studies	
1.10	Monitoring-as-a-Service (MaaS) with case studies	1
2	**Cloud Computing Architecture (16)**	
2.1	Workload Distribution Architecture – Resource Pooling Architecture	1
2.2	Dynamic Scalability Architecture	1
2.3	Elastic Resource Capacity Architecture	1
2.4	Service Load Balancing Architecture	1
2.5	Cloud Bursting Architecture - Elastic Disk Provisioning Architecture	1
2.6	Redundant Storage Architecture	1
2.7	Hypervisor Clustering Architecture	1
2.8	Load Balanced Virtual Server Instances Architecture	1
2.9	Non-Disruptive Service Relocation Architecture	1
2.10	Zero Downtime Architecture	1
2.11	Cloud Balancing Architecture	1
2.12	Resource Reservation Architecture	1
2.13	Dynamic Failure Detection and Recovery Architecture	1
2.14	Bare Metal Provisioning Architecture	1
2.15	Rapid Provisioning Architecture	1
2.16	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 (8)**	
4.1	Security concerns in cloud computing	1
4.2	Security requirements for the architecture	1
4.3	Security patterns and Architectural elements	1
4.4	Cloud Security Architecture	1
4.5	Data Security in Cloud Computing	1
4.6	Data encryption Application and limits	1
4.7	Cloud data security and sensitive data categorization	1

4.8	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, functionalities and challenges	1
5.5	Storage system architectures	1
5.6	Storage virtualization	1
	Total No of Hours	**48**

Course Designers:

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

15CGPH0 DATA SCIENCES AND ANALYTICS

Category	L	T	P	Credit
PE	3	1	0	4

Preamble

The course on Data sciences and Analytics aims to emphasize to learn the methods and algorithms for data analytics. This course aims at facilitating the student to understand the basic concepts of the growing field of data analytics, choose appropriate methods for specific tasks and apply these in their projects which will allow them to keep pace and to actively contribute to the advancement of the field.

Prerequisite

- Data Bases ,Data Mining

Course Outcomes

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

Apply the Hadoop, Map Reduce algorithms for big data analysis. (CO1)	Apply
Apply the Madp reduce algorithm for Page rank application. (CO2)	Apply
Perform Data Analytics using Pig, Hive and YARN. (CO3)	Apply
Analyze the performance of Big data analytical tools for text data. (CO4)	Analyze
Analyze the Retail Complaints Analysis data in Hadoop Eco-system and get the number of complaints filed under each products. (CO5)	Analyze

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	30	30	20	10
Understand	30	30	20	30
Apply	40	40	30	30
Analyse	0	0	30	30
Evaluate	0	0	0	0
Create	0	0	0	0

Sample Course Level Assessment Questions

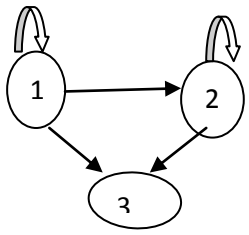
Course Outcome 1 (CO1):

1. Consider a simple social network dataset, where key = person and value = s some friend of that person. Describe a MapReduce algorithm to count the number of friends each person has.
2. Consider a set of sequences where key = sequence id and value = a string of nucleotides, e.g., GCTTCCGAAATGCTCGAA.... Describe an algorithm to trim the last 10 characters from each read, then remove any duplicates generated..
3. Explain the Word Count implementation via Hadoop framework? Assume there are two files each having a sentence : Hello World Hello World (In file 1)
   Hello World Hello World (In file 2)

Course Outcome 2 (CO2):

1. Consider a web graph with three nodes 1,2 , 3 and 4.The links are as follows : 1 to 2, 3 to 1, 2 to 1, 2 to 3, 4 to 1, 4, 2 , 3 to ,4 and 3 to 1. Write down the transition probability matrices for the surfers walk with teleporting value =0.5 and find the page rank vector.

2. Find HITS score for the following graph



3. Apply Map reduce concept using 3 Mappers and 2 Reducers for the following:
   Doc1: A rose is a beautiful flower
   Doc2: Red rose and white rose
   Doc3: White rose is a flower

Course Outcome 3 (CO3):

1. Compare SAS, R, Python, Perl
2. Apply Hive to run SQL-like queries to perform data analysis.
3. How to make sure a map reduce application has good load balance? What is load balance?

Course Outcome 4 (CO4):

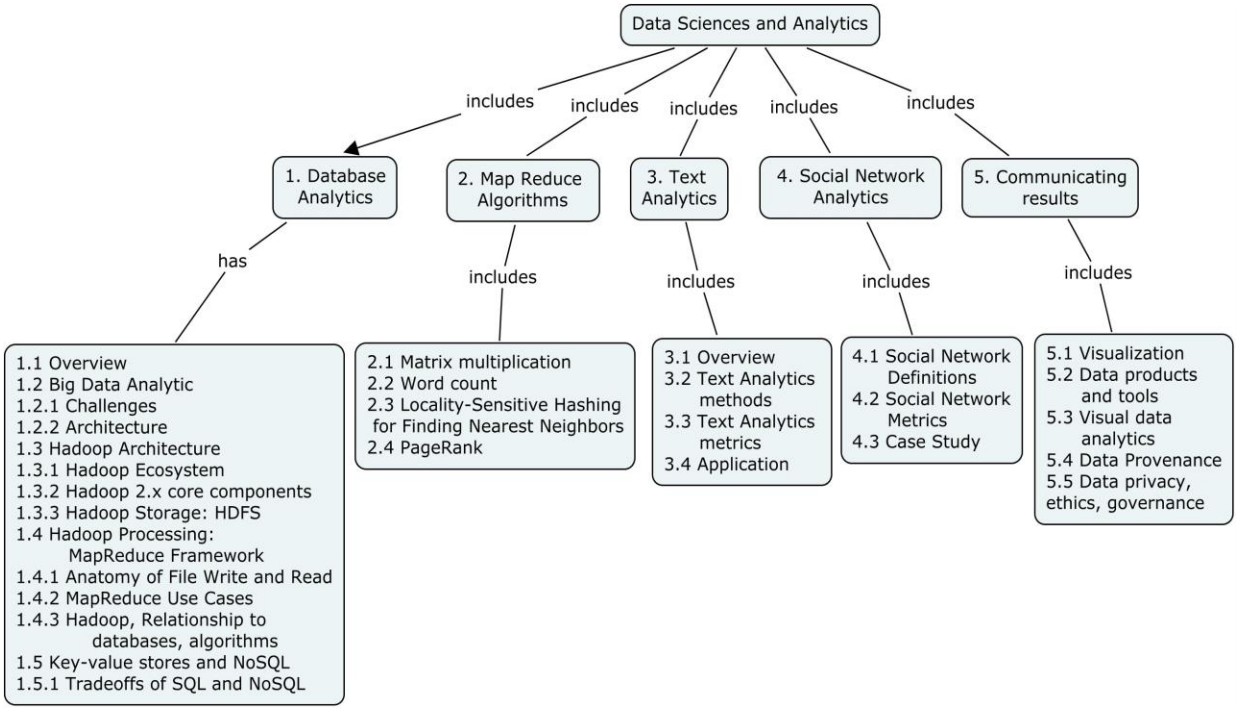
1. Analyze the following text and find the fingerprint using simhash technique: **"lotus is a flower"** .
2. Analyze the performance of SPSS and R tools for customer sentiment analysis.(any product from twitter data.
3. Analyze the airlines data which contains the flight details of various airlines like : Airport id, Name of the airport, Main city served by airport, Country or territory where airport is located, Code of Airport, Decimal degrees, Hours offset from UTC, Timezone, . Analyze the data to find list of Airports operating in the Country and find list of Airlines having zero stops.

Course Outcome 5 (CO5):

1. Analyze Loan Dataset for Banking which contains complete details of all the loans issued, including the current loan status (Current, Late, Fully Paid, etc.) and latest payment information. Find the number of cases per location and categorize the count with respect to reason for taking loan and display the average risk score.

2. Analyze Retail Complaints Analysis which, containing attributes like: CustomerId, Payment Mode, Product Details, Complaint, Location, Status of the complaint, etc. Analyze the data in Hadoop Eco-system to get the number of complaints filed under each products
3. Analyze YouTube data which contains attributes like : VideoID, Uploader, Age, Category, Length, views, ratings, comments, etc. Find out the top 5 categories in which the most number of videos are uploaded, the top 10 rated videos, the top 10 most viewed videos.

Concept Map



Syllabus

Database analytics –Introduction, overview - Big Data, Limitations and Solutions of existing Data Analytics Architecture, Hadoop, Hadoop Features, Hadoop Ecosystem, Hadoop 2.x core components, Hadoop Storage: HDFS, **Hadoop Processing**: MapReduce Framework, Anatomy of File Write and Read, Rack Awareness., MapReduce Use Cases, Traditional way Vs MapReduce way, Why MapReduce, Hadoop 2.x MapReduce Architecture, Hadoop 2.x MapReduce Components, MapReduce, Hadoop, relationship to databases, algorithms,
Key-value stores and NoSQL; tradeoffs of SQL and NoSQL- **Map reduce algorithm**-Matrix multiplication, Word count, Locality-Sensitive Hashing for Finding Nearest Neighbors , PageRank **Text Analytics**- Text Analytics methods-metrics-Application, **Social Network Analytics**-Metrics-case study **Communicating Results** :Visualization, data products, visual data analytics -Provenance, privacy, ethics, governance

Reference Books

1. Bart Baesens, “Analytics in a Big Data World”, The Essential Guide to Data Science and its Applications, Wiley, First edition,2014.
2. Thomas H. Davenport, Jeanne G. Harris, “Competing on Analytics: The New Science of Winning”, Harvard Business Review Press ,First edition,2007
3. Paul C. Zikopoulos, Chris Eaton, “Understanding Big Data”, McGraw-Hill, 2012 (eBook from IBM)

Websites

1. http://www.bigdatauniversity.com

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1.	**Data base Analytics**	
1.1	Overview	1
1.2	Big Data Analytic	1
1.2.1	Challenges	1
1.3	Hadoop Architecture	1
1.3.1	Hadoop Ecosystem	1
1.3.2	Hadoop 2.x core components	1
1.3.3	Hadoop Storage: HDFS, Rack Awareness	1
1.4	Hadoop Processing: MapReduce Framework	1
	Tutorial	2
1.4.1	Anatomy of File Write and Read	2
1.4.2	MapReduce Use Cases	2
1.4.3	Hadoop, relationship to databases	1
1.5	Key-value stores and NoSQL	2
1.5.1	Tradeoffs of SQL and NoSQL	1
2	**Map reduce Algorithms**	
2.1	Matrix Multiplication	1
	Tutorial	3
2.2	Word count	1
	Tutorial	2
2.3	Locality-Sensitive Hashing for Finding Nearest Neighbors	2
2.4	PageRank	1
	Tutorial	3
3	**Text Analytics**	
3.1	Overview	1
3.2	Text Analytics methods	1
	Tutorial	2
3.3	Text Analytics Metrics	1
3.4	Application	1

Module No.	Topic	No. of Lectures
4	**Social Network Analytics**	
4.1	Overview	1
4.2	Metrics	1
4.3.	Case Study	2
5	***Communicating Results***	
5.1	Visualization	2
5.2	Data products and tools	1
5.3	Visual data analytics	2
5.4	Data Provenance	1
5.5	Data privacy, ethics, governance	1
Total Lectures		**48**

Course Designers:

1. Dr. C.Deisy cdcse@tce.edu

15CGPJ0	PRODUCT AND SERVICE : STRETAGY AND DEVELOPMENT	Category	L	T	P	Credit
		PE	4	0	0	4

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

Nil

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
Understand customer problems, approaches to define product / service concepts and apply trade off analysis to concepts(CO2)	Apply
Understand the sales forecasting and concept evaluation(CO3)	Understand
Apply Quality function deployment in Produce development(CO4)	Apply
Develop strategic launch plan and apply launch management for the new Product/ Service(CO5)	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
CO5.						L			S	M	S

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	50	50	50	40

Apply	30	30	30	40
Analyze	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

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

Course Outcome 2 (CO2):

1. What is a product concept?
2. Identify the ways of gathering the Problems
3. Why customers buy a product?
4. How to analyze product attributes in concept generation and evaluation?
5. Develop a suitable Trade-Off Analysis and Qualitative Techniques in Concept Testing.

Course Outcome 3 (CO3):

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.

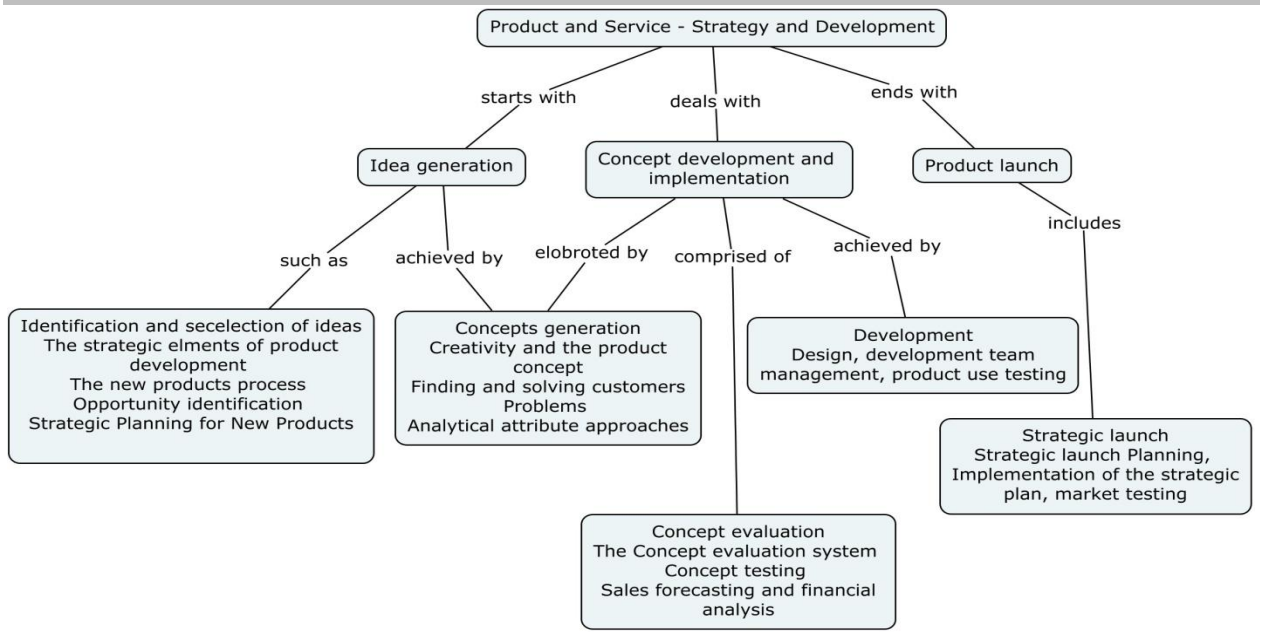
Course Outcome 4 (CO4):

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

Course Outcome 5 (CO5):

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, Product Portfolio Analysis: The New Product's Strategic Fit

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, **Sales Forecasting and Financial Analysis**, Sales Forecasting for New Products, Problems with Sales Forecasting, **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**, The Role of Marketing During Development, Product Use Testing, Knowledge Gained from Product Use Testing, Decisions in Product Use Testing.

LAUNCH

Strategic Launch Planning, Revisiting the Strategic Goals, Strategic Platform Decisions, The Target Market Decision, Product Positioning, Branding and Brand Management, **Implementation of the Strategic Plan**, The Launch Cycle, Launch Tactics, A-T-A-R Requirements, **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. 14 th 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	
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
1.5	Product Portfolio Analysis: The New Product's Strategic Fit	2
2	**CONCEPT GENERATION**	
2.1	Creativity and the Product/Service Concept	2
2.2	Finding and Solving Customers' Problems, Gathering the Problems	2
2.3	Understanding Why Customers Buy a Product, Gap Analysis	2
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
3.3	Sales Forecasting and Financial Analysis, Sales Forecasting for New Products, Problems with Sales Forecasting.	2
3.4	Product Protocol, Protocol and Quality Function Deployment, QFD and the House of Quality.	2
4	**PRODUCE 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, The Role of Marketing During Development, Product use Testing,	2

Module No.	Topic	No. of Lectures
4.5	Knowledge Gained from Product Use Testing, Decisions in Product Use Testing.	2
5	**PRODUCT LAUNCH**	
5.1	Strategic Launch Planning, Revisiting the Strategic Goals, Strategic Platform Decisions,	2
5.2	The Target Market Decision, Product Positioning, Branding and Brand Management,	2
5.3	Implementation of the Strategic Plan, The Launch Cycle, Launch Tactics, A-T-A-R Requirements,	2
5.4	Launch Management, The Launch Management System, Effective Metrics:	2
5.5	Learning from Experience, Product Failure	2
	Total lectures	46

4. Course Designers:

1. Mr.N.Shivakumar shiva@tce.edu

		Category	L	T	P	Credit
15CGPK0	**COMPUTATIONAL GEOMETRY**	PE	4	0	0	4

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

Apply 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
Apply 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

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	L	M	M	L						
CO4	S	M	M	M	L						
CO5	S	S	S	M	M						

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	30	20	30	20
Apply	50	60	50	40

Analyse	-	-	-	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 counterclockwise 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):

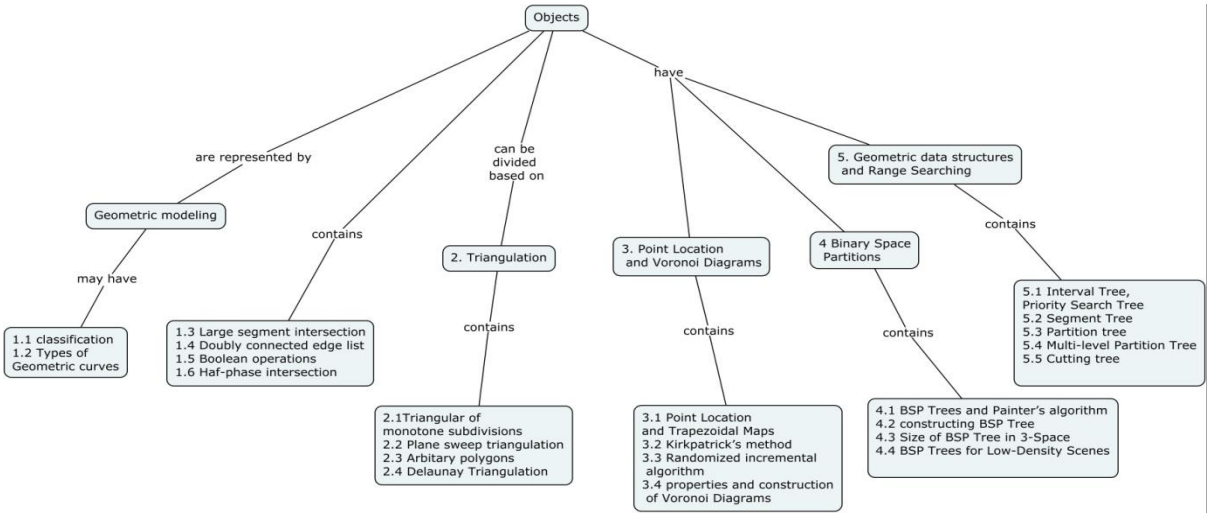
1. List out the applications of painter's algorithm.
2. Let S be a set of m polygons in the plane with n vertices in total. Let T be a BSP tree for S of size k. Prove that the total complexity of the fragments generated by the BSP is $O(n+k)$.
3. Give a deterministic divide-and-conquer algorithm that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

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 Book

1. Mark de Berg, Otfrid Chenog, Marc van Kreveld , Mark Overmars : Computational Geometry : Algorithms and Applications, Springer- Verlag, Third Edition, 2008.

Reference Books

1. J.O Rourke: Computational Geometry in C,Cambridge University Press, 1993.
2. F. P. Preparata and M. I. Shamos: Computational Geometry: An Introduction, Springer-Verlag, 1985.
3. J.-D. Boissonnat and M. Yvinec: Algorithmic Geometry, Cambridge University Press, 1995.

4. K. Mulmuley: Computational Geometry: An Introduction through Randomized Algorithms, , Prentice Hall, 1994.

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	3
2.4	Delaunay Triangulation	3
3.	**Point Location and Voronoi Diagrams**	
3.1	Point Location and Trapezoidal Maps	2
3.2	Kirkpatrick's method	2
3.3	Randomized incremental algorithm	3
3.4	properties and construction of Voronoi Diagrams	2
4.	**Binary Space Partitions**	
4.1	BSP Trees and Painter's algorithm	2
4.2	constructing BSP Tree	2
4.3	Size of BSP Tree in 3-Space	3
4.4	BSP Trees for Low-Density Scenes	3
5.	**Geometric data structures and Range Searching**	
5.1	Interval Tree, Priority Search Tree	3
5.2	Segment Tree	2
5.3	Partition tree	2
5.4	Multi-level Partition Tree	2
5.5	Cutting tree	1
	Total	**48**

Course Designers:

1. S.Sridevi sridevi@tce.edu

		Category	L	T	P	Credit
15CGPL0	**FAULT TOLERANT COMPUTING SYSTEMS**	PE	4	0	0	4

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.

Prerequisite

Course Outcomes

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

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
To analyze merits and limitations of fault-tolerant systems with case studies (CO5)	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	L

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1		3	
Remember	20	20	20	20
Understand	20	20	20	20
Apply	60	60	-	40
Analyse	-	-	60	20

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 preferrable? (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 diffferent 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)

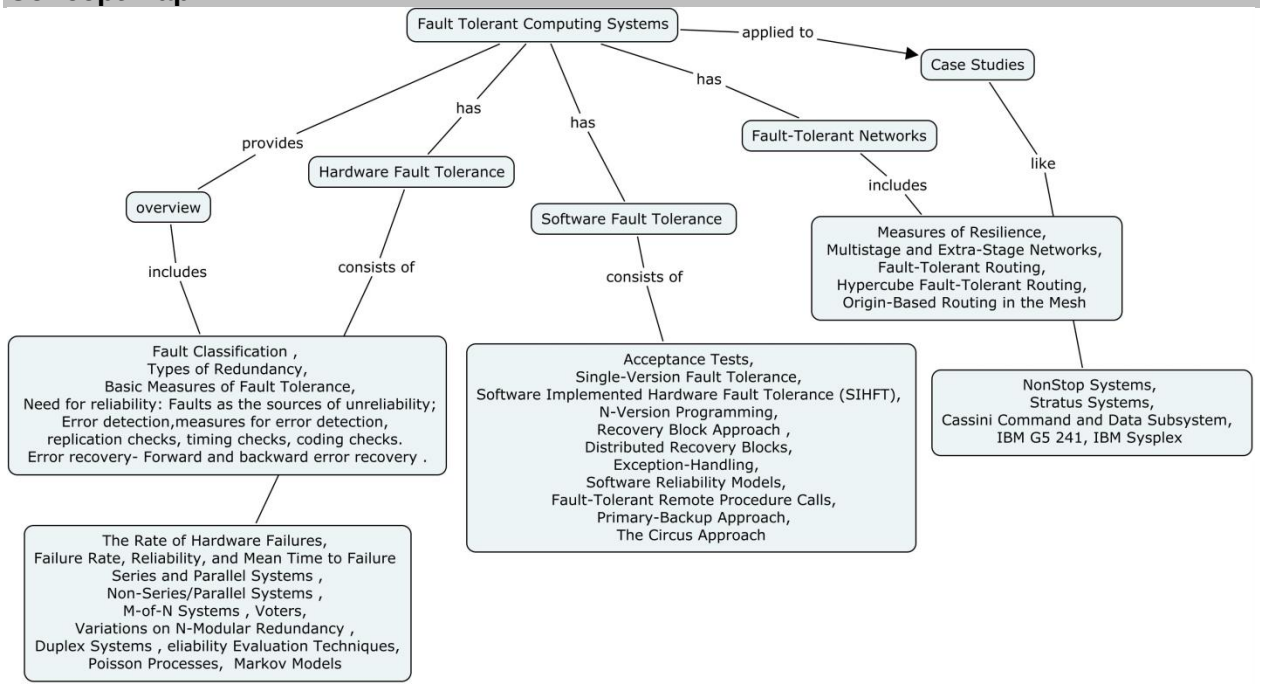
Course Outcome 4 (CO4):

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 benefits of stratus systems. (Remember)
2. Compare and contrast IBM G5 241 and IBM sysplex (Understand)
3. 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	2
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	2
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)	2
3.3	*N*-Version Programming, Consistent Comparison Problem, Version Independence,	2
3.4	Recovery Block Approach , Basic Principles, Success Probability Calculation,	2
3.5	Distributed Recovery Blocks, Preconditions, Postconditions, and Assertions,	2
3.6	Exception-Handling, Requirements from Exception-Handlers, Basics of Exceptions and Exception-Handling, Language Support,	3

Module No.	Topic	No. of Lectures
3.7	Software Reliability Models, Jelinski–Moranda Model, Littlewood–Verrall Model,	2
3.8	Musa–Okumoto Model, Model Selection and Parameter Estimation,	2
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,	3
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	2
4.4	Fault-Tolerant Routing, Hypercube Fault-Tolerant Routing, Origin-Based Routing in the Mesh	2
5	**Case Studies**	
5.1	NonStop Systems, Architecture, Maintenance and Repair Aids, Software, Modifications to the NonStop Architecture	2
5.2	Stratus Systems	2
5.3	Cassini Command and Data Subsystem, IBM G5 241, IBM Sysplex	2
	Total	**48**

Course Designers:

1. Mr. M.Sivakumar mskcse@tce.edu
2. Mrs. A. Malini amcse@tce.edu

		Category	L	T	P	Credit
15CGPM0	**STORAGE AND SERVER SECURITY**	PE	4	0	0	4

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.

Prerequisite

- Information Storage and Management Systems

Course Outcomes

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

Explain the elements of Data center infrastructure. (CO1)	Understand
Outline the impact of RAID in disk performance. (CO2)	Understand
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

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	-	-

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20

Understand	20	20	20	20
Apply	40	40	40	40
Analyse	20	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

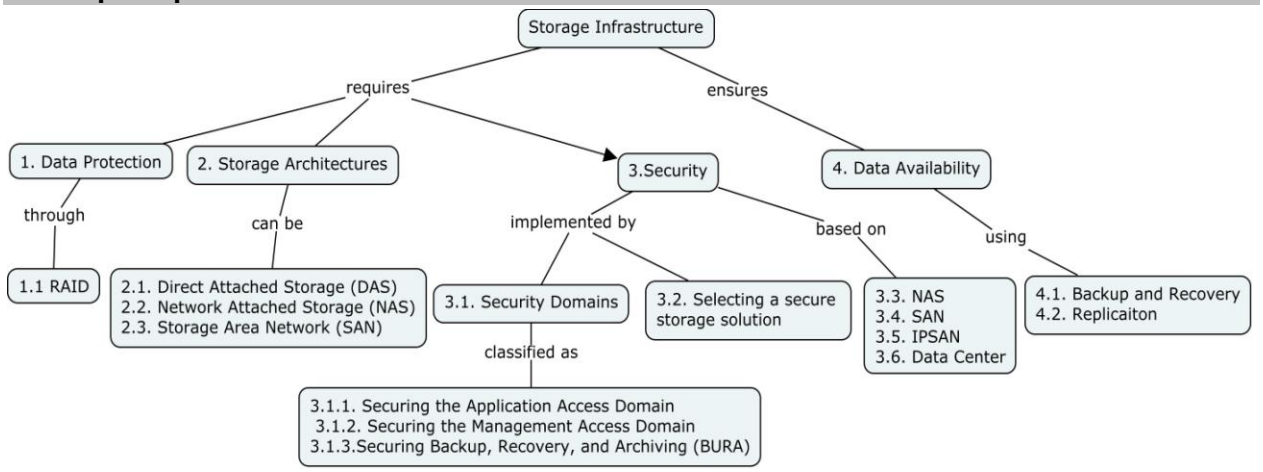
iii. Average queue size

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.

Concept Map



Syllabus

Storage Infrastructure: Data protection: RAID Array components, RAID levels, 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. “Storage Networks: The Complete Reference”, Robert Spalding, Tata McGraw Hill-Osborne, 2003.
2. “Data Center Fundamentals”, Mauricio Arregoces, Maurizio Portolani,Cisco Press, 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 Array components	2
1.2	RAID levels	2
1.3	RAID impact on disk performance	2
2	Storage Architectures	1
2.1	Direct Attached Storage (DAS)	1
2.2	Network Attached Storage (NAS)	2
2.3	Storage Area Network (SAN)	2
3.1	Storage Security Domains	1
3.1.1	Securing the Application Access Domain	1
3.1.2	Securing the Management Access Domain	2
3.1.3	Securing Backup, Recovery, and Archiving (BURA)	2
3.2	Selecting a Secure Storage Solution	1
3.2.1	Data center Security Framework	2
3.2.2	Risk Triad: Assets, Threats, Vulnerability	1
	Security Implementations in Storage Networking	
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	2
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	2
4.2.2	Remote replication	2

Course Designer:

1. M.P.Ramkumar ramkumar@tce.edu

		Category	L	T	P	Credit
15CGPN0	**PROBABILISTIC GRAPHICAL MODELING**	PE	4	0	0	4

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)	Analyze
Perform variable elimination by using inference. (CO3)	Apply
Perform parameter estimation for structured and incomplete data. (CO4)	Apply
Develop solutions for real world problems using probabilistic graphical model (CO5)	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								

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	10	10	10

Understand	40	30	30	30
Apply	40	60	60	60
Analyse	-	-	-	-
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):

2. **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.

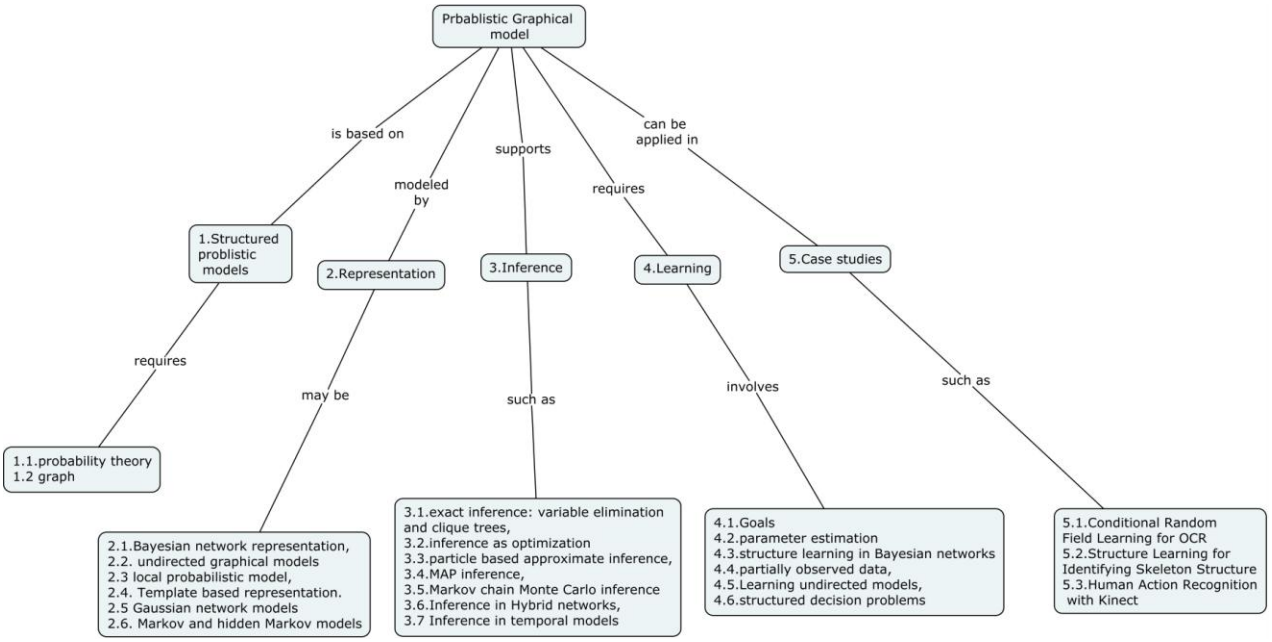
Course Outcome 4 (CO4):

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 $X_1; : : : ;X_n$. 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. 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. Kiran Karkal , 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	2
2.3	Template based representation	2
2.4	Gaussian network models	2
2.5	Markov and hidden Markov models	3
3	**Inference**	
3.1	exact inference: variable elimination and clique trees	3
3.2	inference as optimization	2
3.3	particle based approximate inference	2
3.4	MAP inference	2
3.5	Markov chain Monte Carlo inference	2
3.6	Inference in Hybrid networks	2
3.7	Inference in temporal models	2
4	**Learning**	
4.1	Goals	1
4.2	parameter estimation	2
4.3	structure learning in Bayesian networks	3
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,	2
5.2	Structure Learning for Identifying Skeleton Structure	2
5.3	Human Action Recognition with Kinect	2
	Total	**48**

Course Designers:

1. C.Senthilkumar cskcse@tce.edu

		Category	L	T	P	Credit
15CGPP0	**REAL TIME SYSTEMS**	PE	4	0	0	4

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
Handle dependencies among tasks and prioritizes and shares resources. (CO3)	Apply
Schedule tasks across multi-processor and distributed environment. (CO4)	Apply
Design a real time database for the application understanding the characteristics of commercial real time systems. (CO5)	Apply

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	40	40	40	40
Apply	40	40	40	40
Analyse				
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?
3. What do you understand by optimal scheduling algorithm?
4. What is the sufficient condition for EDF schedulability of a set of periodic task whose Period and deadline are different?

Course Outcome3 (CO3):

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)

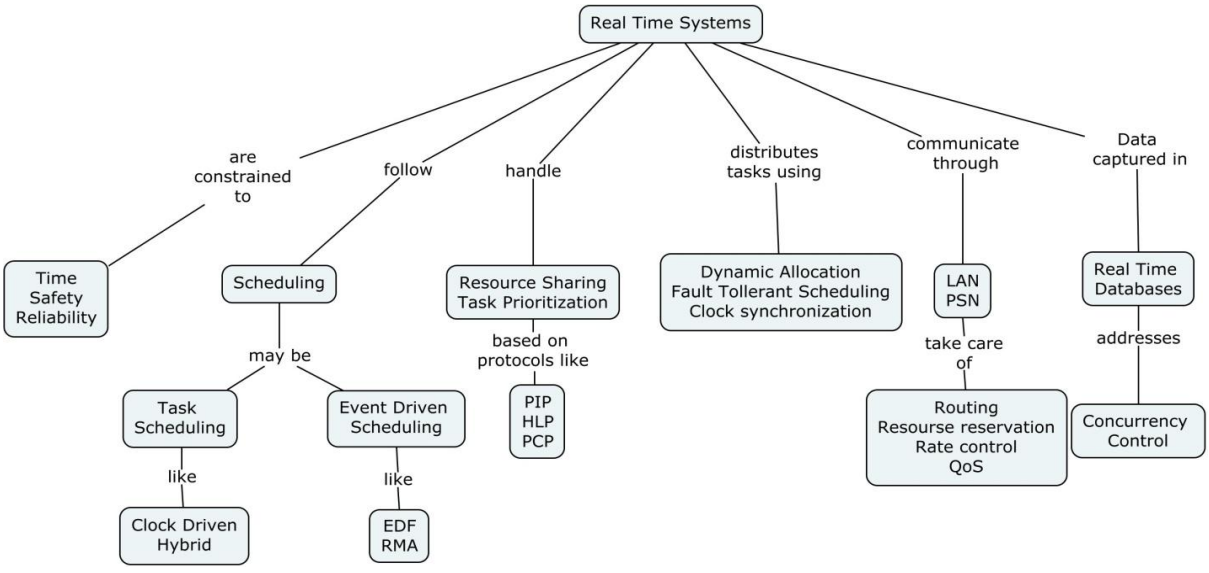
Course Outcome 4 (CO4):

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 5 (CO5):

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-Timing constraints-modeling Timing constraints. **Real-Time Task Scheduling-**Types of RTS and their characteristics - Task Scheduling -Clock driven scheduling – hybrid schedulers - Event-driven scheduling - Earlier Detection 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 - Handling task dependencies **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 - Centralized and distributed clock synchronization.**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-Routing-Resource reservation-Rate control-Qos Model. **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 - Commercial 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(8)**	
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
1.4	Timing constraints-modeling Timing constraints.	2
2	**Real-Time Task Scheduling(8)**	
2.1	Types of RTS and their characteristics-Task	2

Module No.	Topic	No. of Lectures
	Scheduling	
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(8)**	
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-Handling task dependencies	2
4	**Scheduling Real-Time Task in Multiprocessor and distributed systems(8)**	
4.1	Multiprocessor Task allocation- Dynamic allocation of tasks	3
4.2	Fault-tolerant scheduling of tasks-Clocks in Distributed Real-Time Systems	2
4.3	Centralized and distributed clock synchronization.	3
5	**Real-Time Communication(8)**	
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	2
5.4	Routing-Resource reservation-Rate control-Qos Model.	2
6	**Real-Time Databases(8)**	
6.1	Applications of Real-Time Databases-Review of basic Database Concepts	2

Module No.	Topic	No. of Lectures
6.2	Real-Time Databases-Characteristics of Temporal data	3
6.3	Concurrency control in Real-Time Databases-Commercial Real-Time Databases.	3
	Total	**48**

Course Designers:

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

15CGPQ0	4GN AND SOFTWARE DEFINED NETWORKING	Category	L	T	P	Credit
		PE	4	0	0	4

Preamble

The Syllabus is designed to understand the key features of 4th Generation Networks. Primarily, the main focus is on the reason, genesis and working principle of Software Defined Networking (SDN). 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

Identify the appropriate feature of 4GN applicable for the scenario given. (CO1)	Apply
Analyze the drawbacks of traditional networks. (CO2)	Analyze
Apply the concepts of Software Defined Networking for the given scenario (CO3)	Apply
Make use of Open flow standards to manage Network Components for the given scenario. (CO4)	Apply
Apply the concept of Software Defined Networking in the given environment. (e.g. Campus Network). (CO5)	Apply

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	30	20	20
Understand	40	40	40	40
Apply	30	30	40	40
Analyse	10	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

1. List out the key features of 4GN (Remember)
2. Explain working principle of Open Wireless Architecture (Understand)
3. Consider that you are in a remote center, participating in a video conference. To participate without any interruption, 4th Generation Network is to be implemented with the following Quality of Services: Reliability, Resilience, Efficiency and Cost-Effectiveness. Identify an appropriate feature of 4GN to achieve the above. (Apply)

Course Outcome 2 (CO2):

1. Draw traditional Switch Architecture (Remember)
2. Differentiate traditional Router and Programmable Router. (Understand)
3. Analyze the hotspots of transmitting data in traditional network and justify, how they can be rectified using Software Defined Network? (Analyze)

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. Analyze and identify, which one is applicable (SDN/Virtualization). Comment on this. (Apply)

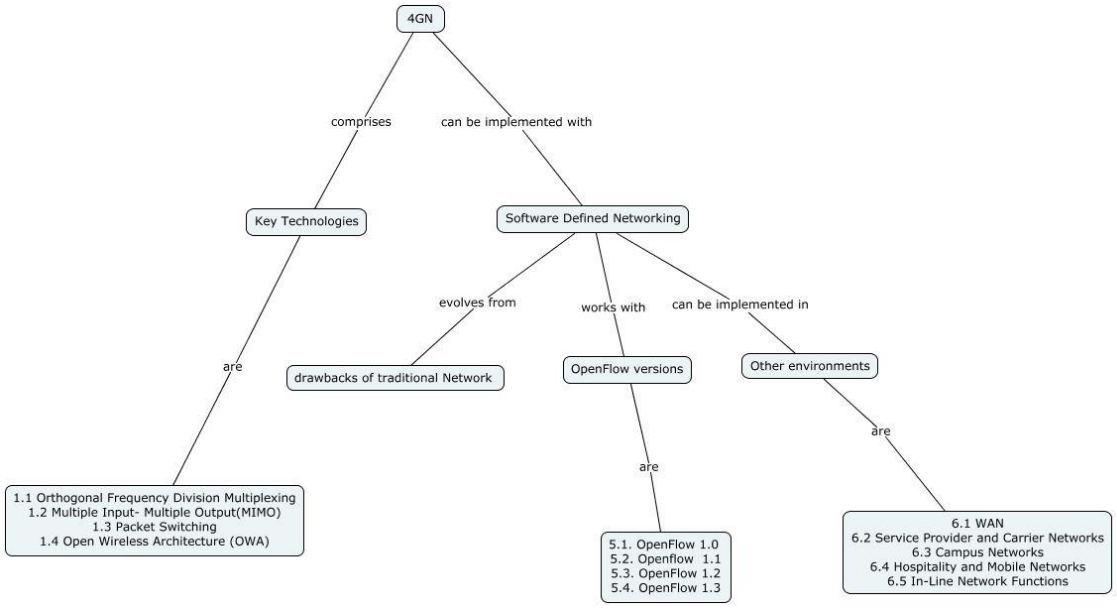
Course Outcome 4 (CO4)

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 5 (CO5)

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

Introduction to 4GN: Generation of Networks **-** Key Features of 4GN – *Key Technologies:* Orthogonal frequency-division multiplexing - Multiple-input and multiple-output, or MIMO – Packet Switching - Open Wireless Architecture (OWA). **Reason for SDN:** Basics and historical

background for the Modern Data Center - Traditional Switch Architecture - Autonomous and Dynamic Forwarding Tables. **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. Jochen H. Schiller, “Mobile communications”, Person Education, Second Edition, 2003.
6. http://arxiv.org/pdf/1406.0440.pdf
7. http://www.ijarcsse.com/docs/papers/Volume_3/3_March2013/V3I3-0383.pdf
8. http://202.114.89.42/resource/pdf/6134.pdf
9. http://home.iitj.ac.in/~ramana/ofdm-tutorial.pdf
10. http://www.lsr.com/white-papers/basics-of-mimo-radio-systems
11. http://pdcc.ntu.edu.sg/wands/seminar_files/MIMO_guo.pdf
12. http://profsite.um.ac.ir/~hyaghmae/ACN/PSN.pdf
13. http://www.cs.uccs.edu/~xzhou/teaching/CS522/LNCS/LEC7-NetworkLayer.pdf
14. http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=1295731
15. http://www.chinacommunications.cn/fileup/PDF/2009-6-2-020.pdf
16. http://people.ece.cornell.edu/haas/Publications/CM-jeong-haas-2007-04.pdf
17. https://www.google.co.in/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&cad=rja&uact=8&ved=0CCcQFjAB&url=http%3A%2F%2Fwww.ccsenet.org%2Fjournal%2Findex.php%2Fnct%2Farticle%2Fdownload%2F20035%2F13703&ei=ccs0VZ2dF8y4uAT5mYHQAQ

&usg=AFQjCNGkjgW9QtkhTnRJq5vmVKxciKMnUQ&sig2=bwq6O9eEW9IpxXIjWDWycQ&bvm=bv.91071109,d.c2E

18. http://www.chinacommunications.cn/fileup/PDF/2009-6-2-020.pdf

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1	**Introduction to 4GN**	
1.1	Generation of Networks	2
1.2	Key Features of 4GN	2
1.3	Orthogonal frequency-division multiplexing	2
1.4	Multiple-input and multiple-output, or MIMO	2
1.5	Packet Switching	2
1.6	Open Wireless Architecture (OWA)	3
2	**Reason for SDN**	
2.1	Basics and historical background for the Modern Data Center	2
2.2	Traditional Switch Architecture	1
2.3	Autonomous and Dynamic Forwarding Tables	2
3	**The Genesis of SDN Vs Network Virtualization**	
3.1	The evolution of Networking Technology	1
3.2	Forerunners of SDN	1
3.3	Birth and Interoperability of SDN	2
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	2
4.2	SDN Operation	1
4.3	SDN Devices and Controller	2
4.4	SDN Applications and alternate SDN Methods	3
5	**The OpenFlow Specification**	
5.1	Terminologies and Overview	1
5.2	Openflow 1.0 and its basics	2
5.3	OpenFlow 1.1 and 1.2,	2
5.4	open Flow 1.3 and Limitations	2
6	**SDN in other Environments**	
6.1	WAN	1

6.2	Service Provider	2
6.3	Carrier Networks	1
6.4	Campus Networks	1
6.5	Hospitality and Mobile Networks	1
6.6	In-Line Network Functions	2

Course Designer:

1. Thiraviaselvi.G gts@tce.edu

15CGPR0	DATA CENTRE DESIGN AND MANAGEMENT	Category	L	T	P	Credit
		PE	4	0	0	4

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.

Prerequisite

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 and 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		

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	20	20	20	20
Apply	60	60	60	60
Analyse	-	-	-	-
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**.**

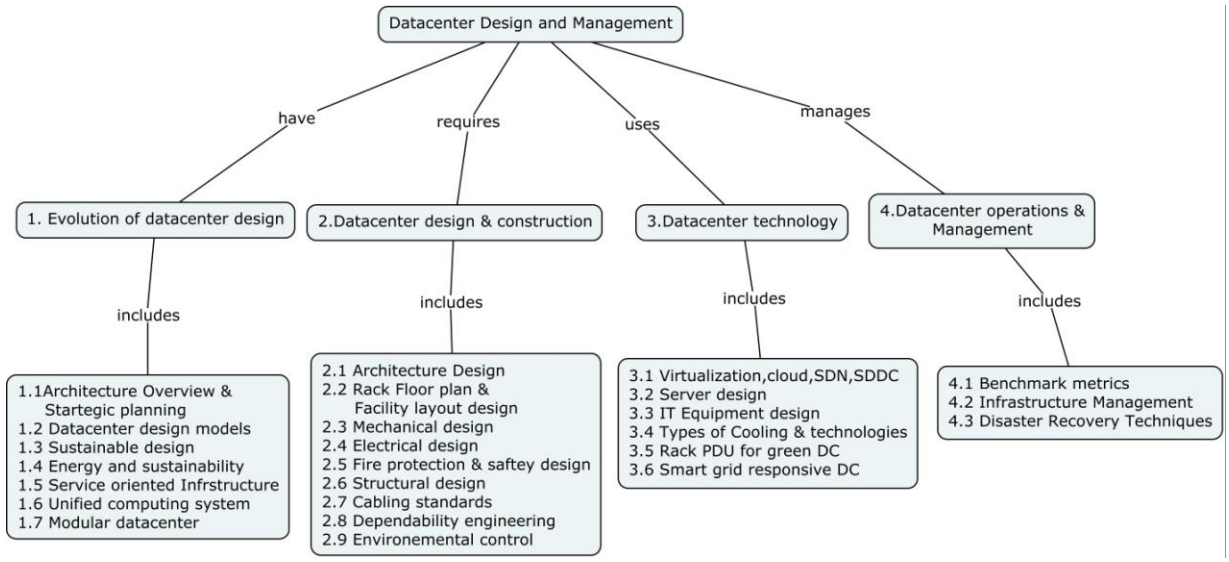
Course Outcome 4 (CO4)

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?
4. Analyze the need for Computerized Maintenance Management System in a datacenter.
5. Identify the solution for meeting the core requirements for disaster recovery in Data center.

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**	
1.1	Datacenter architecture overview & strategic planning	2
1.2	Data center design models	2
1.3	Sustainable design	1
1.4	Energy and sustainability	1
1.5	Service oriented infrastructure	1
1.6	Unified computing system design	2
1.7	Modular data center design and deployment	2
2.	**Data center design and construction**	
2.1	Architecture design	2
2.2	Rack floor plan & facility layout design	1

Module No.	Topic	No. of Lectures
2.3	Mechanical design	1
2.4	Electrical design	2
2.5	Fire protection and life safety design	1
2.6	Structural design	2
2.7	Telecommunication cabling	1
2.8	Dependability engineering	2
2.9	Environmental control	1
3	**Data center technology**	
3.1	Virtualization, cloud, SDN, SDDC	2
3.2	Server design	2
3.3	IT Equipment design for meeting energy efficiency requirements	1
3.4	Types of cooling	
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	
3.5.1	Rack level and Cold plate cooling	1
3.6	Rack PDU	1
3.7	Smart grid responsive Data center	2
4	**Data center operations and management**	
4.1	Benchmark metrics	1
4.2	Infrastructure management	3
4.3	Computerized Maintenance management	3
4.4	Disaster recovery techniques	3
4.4.1	Fabric based disaster recovery	2
	Total Hours	**48**

Course Designers:

1. Dr.S.Padmavathi spmcse@tce.edu

		Category	L	T	P	Credit
15CGPS0	**DATA VISUALIZATION**	PE	4	0	0	4

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

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	10
Understand	20	40	40	30
Apply	60	40	40	60
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

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

Course Outcome 2 (CO2):

1. List any two OLAP operations with example.
2. Compare OLAP operations with that of OLTP operations.
3. 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.
4. Identify and representation the model that will be suitable for the given scenario and explain it.

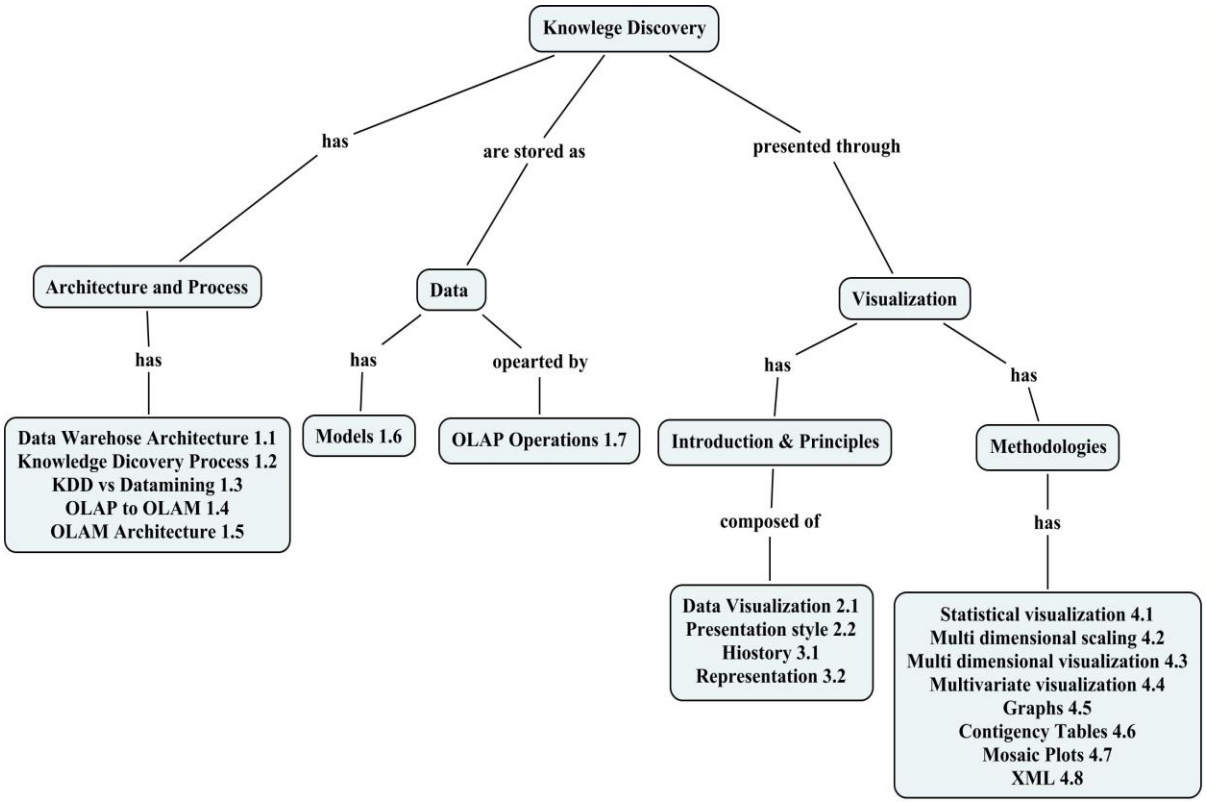
Course Outcome 4 (CO4):

1. What is the common way of visually representing multivariate datasets?
2. Explain basic elements of a graph and how they can be visualized.
3. Explain three multivariate visualization techniques.
4. Construct the necessary model to visualize the given multi dimensional data set.

Course Outcome 5 (CO5):

1. What are two advantages and two drawbacks of the tree map method of visualization?
2. What are some issues that must be addressed in graph visualization?
3. What is a Scatter plot matrix? What kind of data is it used to represent?
4. 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. Jiawei Han, Micheline Kamper, Data Mining: Concepts and Techniques Morgan Kaufman, 2000, ISBN: 1-55860-489-8. Chap1-3, 5-10.
2. C.Chen, W.Hardle, A.Unwin, “Hand book of Data Visualization”, Springer.
3. Frits H. Post, Gregory M. Nielson, Georges-Pierre Bonneau, “ Data Visualization - The State of the Art”, Springer Science+Business Media, LLC.

Course Contents and Lecture Schedule

Module No.	Topics	No. of Lectures
1	**Architecture and Process**	
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	2
1.7	OLAP Operations - TUTORIAL	1
2	**Introduction to visualization**	
2.1	Computational Statistics and Data Visualization	1
2.2	Presentation and Exploratory Graphics	1
3	**Principles**	
3.1	History of Data Visualization	1
3.2	Representations	1

Module No.	Topics	No. of Lectures
3.2.1	Visualization through their graph representations -TUTORIAL	3
3.2.2	High-dimensional Data Visualization	2
3.2.3.	Visualizing Trees and Forests	2
4	**Methodologies**	
4.1	Statistical visualizations (histograms, scatter plots)	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	2
4.7	Mosaic Plots and Their Variants	3
4.8	Web-Based Statistical Graphics using XML Technologies	2
		36

Course Designers:

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

15CGPT0	SOFTWARE PRODUCT DEVELOPMENT FOR MOBILE DEVICES	Category	L	T	P	Credit
		PE	4	0	0	4

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
Illustrate user interface design considerations. (CO2)	Apply
Demonstrate data storage and retrieval for mobile applications. (CO3)	Apply
Demonstrate peer to peer communication between mobile applications. (CO4)	Apply
Develop apps for Android devices (CO5)	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	M	L							
CO4.	S	S	S	M	S				L	L	
CO5.	S	S	S	M	S				L	L	

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyse	-	-	-	-
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 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 3 (CO3):

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.

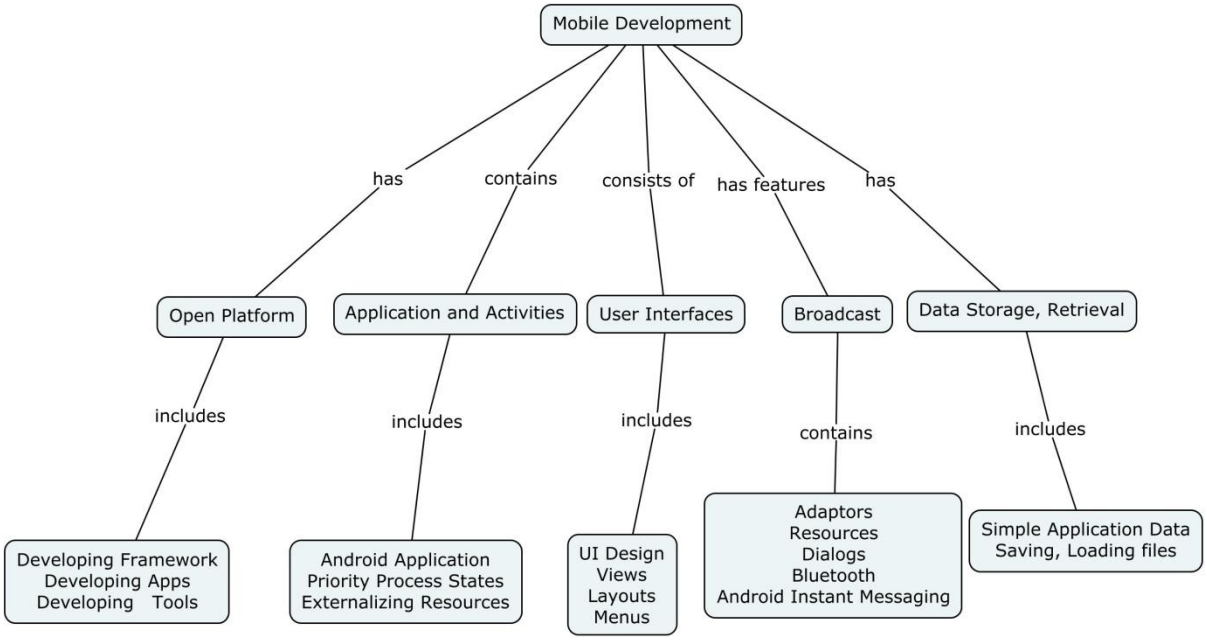
Course Outcome 4 (CO4):

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 5 (CO5):

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 for Mobile Devices-Android Development Tools. **Creating Applications and Activities:** Introducing the Application Manifest-Using the Manifest Edit-The Android Application Life Cycle - Understanding Application Priority and Process States-Externalizing Resources. **Creating User Interfaces:** Fundamental Android UI Design- Views- Layouts- Creating New Views- Creating and Using Menus. **Intents, Broadcast Receivers, Adapters, and the Internet:** Introducing Intents- Adapters- Resources- Dialogs. **Data Storage, Retrieval, and Sharing:** Saving Simple Application Data- Saving and Loading Files- 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
1.6	Android Development Tools	2
2	**Creating Applications and Activities**	
2.1	Introducing the Application Manifest	1
2.2	Using the Manifest Edit	1
2.3	The Android Application Life Cycle	1
2.4	Understanding Application Priority and Process States	2
2.5	Externalizing Resources	1
3	**Creating User Interfaces**	
3.1	Fundamental Android UI Design	2
3.2	Views	2
3.3	Layouts	2
3.4	Creating New Views	2
3.5	Creating and Using Menus	2
4	**Intents, Broadcast Receivers, Adapters, and the Internet**	
4.1	Introducing Intents	1
4.2	Adapters	2
4.3	Resources	2
4.4	Dialogs	2
5	**Data Storage, Retrieval, and Sharing**	
5.1	Saving Simple Application Data	2
5.2	Saving and Loading Files	2
5.3	Databases in Android	2
6	**Peer-to-Peer Communication**	
6.1	Android Instant Messaging	2

Module No.	Topic	No. of Lectures
6.2	SMS	2
7	**Accessing Android Hardware**	
7.1	Using the Media APIs	1
7.2	Sensor Manager	2
7.3	Bluetooth	2
7.4	Managing Network and Wi-Fi Connections	2
	Total	**48**

Course Designers:

1. M.Suguna mscse@tce.edu
2. V.Vignaraj Ananth vignaraj@tce.edu