Department of Computer Science and Engineering

Vision

Excellence in Computer Science and Engineering education and research.

Mission

1. Strive for academic excellence in Computer Science and Engineering through a creative teaching-learning process.
2. Transform students into technically competent, socially responsible and ethical Computer Science professionals.
3. Create Centres of Excellence in leading areas of Computer Science and Engineering.
4. Incubate, apply and spread innovative ideas by collaborating with relevant industries and R&D labs through focused research groups.
5. Attain these through continuous team work by a group of committed faculty, transforming the Computer Science and Engineering department as a leader in imparting Computer Science and Engineering education and research.

Programme Educational Objectives (PEOs) for M.E. Computer Science and Engineering

1. To provide the students with specialized and sound knowledge in some recent areas of Computer Science and engineering so that they can be successful in their doctoral research.
2. To provide the students with an ability to spot contemporary research domains and to contribute significantly to these domains through innovative research.
3. To prepare and equip students for advanced careers in research in leading institutions, labs and industries as well as academics in many areas of computer science and Engineering and related domains.
4. To provide the students with an ability to work in a team to solve problems in the design, development and maintenance of complex systems.

Mapping of the M.E. (CSE) PEOs with Mission statements

Mission/PEO	1	2	3	4
1	✓	✓		✓
2		✓	✓	
3	✓	✓	✓	✓
4	✓	✓	✓	
5	✓	✓	✓	✓

Programme Outcomes for M.E. Computer Science and Engineering

1. Ability to discriminate, evaluate, analyze and synthesize existing and new knowledge, and integration of the same for enhancement of knowledge in Computer Science and Engineering.
2. Ability to critically analyze complex problems and apply independent judgment for fusing information to conduct research in a wider theoretical, practical and policy context in Computer Science and Engineering.
3. Ability to think laterally and originally to identify, formulate and solve an engineering problem in Computer Science and Engineering and effectively utilize appropriate scientific and engineering techniques and methodologies in the problem solving process.
4. Ability to apply appropriate research methodologies, techniques and tools, design, conduct experiments, analyze and interpret data, demonstrate higher order skill and contribute individually or in groups to the development of technological knowledge in Computer Science and Engineering.
5. Ability to apply usage of tools from optimization, probability, statistics, simulation, and engineering economic analysis, including fundamental applications of those tools in IT industry involving uncertainty and scarce or expensive resources.
6. Ability to possess knowledge and understanding of group dynamics, recognize opportunities and contribute positively to collaborative-multidisciplinary scientific research, demonstrate a capacity for self-management and teamwork, decision-making based on open-mindedness, objectivity and rational analysis in order to achieve common goals.
7. Ability to develop diverse technical knowledge and skills to formulate problems and projects and to plan a process for solution including engineering economic analysis for project which involving uncertainty and scarce or expensive resources.
8. Ability to comprehend the complex engineering problems and write effective reports and design documentation by adhering to appropriate standards, make effective presentations, and give and receive clear instructions.
9. Ability to engage in life-long learning by spotting contemporary research domains and to make innovative contributions to these domains with a high level of enthusiasm and commitment to improve knowledge and competence continuously

10. Ability to understand the relevance of the research to the society by the ethical and economic connotations of research outcomes on professional practices and an understanding of responsibility to contribute to the community for sustainable development of society.
11. Ability to review and consolidate learning, to evaluate performance, to plan future learning based on past learning experience and self-learning.

Mapping of PEOs with POs for M.E. CSE

PEO\PO	1	2	3	4	5	6	7	8	9	10	11
1	✓				✓	✓	✓				✓
2	✓		✓	✓	✓	✓	✓	✓			✓
3								✓		✓	✓
4		✓	✓						✓		

Graduate Attributes:

1. Scholarship of Knowledge
2. Critical Thinking
3. Problem Solving
4. Research Skill
5. Usage of modern tools
6. Collaborative and Multidisciplinary work
7. Project Management and Finance
8. Communication
9. Life-long Learning
10. Ethical Practices and Social Responsibility
11. Independent and Reflective Learning

PO Vs Graduate Attributes

PO\GA	1	2	3	4	5	6	7	8	9	10	11
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											

Thiagarajar College of Engineering, Madurai-625015

Department of Computer science and Engineering

Scheduling of Courses for the M.E. (CSE)

Semester	Theory						Practical	Credits
	1	2	3	4	5	6	7	8
I	14CG110 Computer Architecture 4:0	14CG120 Data Structures and Algorithms 3:1	14CG130 Object Oriented Analysis and Design 3: 0	14CG140 Network Technology 3:1	14CG150 Compiler Design 3:1	14CG160 Graphs and Combinatorial Algorithms 3:1	14CG170 Analysis and Design Lab 0:1	24
II	14CG210 Modeling and Simulation 3:1	14CG220 Software Engineering Theory and Practice 3:0	14CGPX0 Elective 1 4:0	14CGPX0 Elective 2 4:0	14CGPX0 Elective 3 4:0	14CGPX0 Elective 4 4:0	14CG270 Seminar 0:1	24
III	14CG310 Data Warehousing and Mining Techniques 4:0	14CGPX0 Elective 5 4:0	14CGPX0 Elective 6 4:0	-	-	-	14CG340 Project - I 0:4	16
IV	-	-	-	-	-	-	14CG410 Project - II 0:12	12

Approved in Board of Studies Meeting on 08.11.2014

Approved in 49th Academic Council Meeting on 04.12.2014

M.E. (CSE) - Programme Electives

Sl.No	Course Code	Course Name
1.	14CGPA0	Database Systems
2.	14CGPB0	Information Storage And Networking
3.	14CGPC0	Machine Learning
4.	14CGPD0	Wireless Adhoc Networks
5.	14CGPE0	Distributed Operating Systems Concepts And Principles
6.	14CGPF0	Intelligent Optimization Algorithms
7.	14CGPG0	Agent Based Intelligent Systems
8.	14CGPH0	Cryptography And Network Security
9.	14CGPJ0	Design And Analysis of Parallel Algorithms
10.	14CGPK0	Distributed And Grid Computing
11.	14CGPL0	Cloud Computing

CURRICULUM AND DETAILED SYLLABI

FOR

M.E. DEGREE (Computer Science and Engineering) PROGRAMME

FIRST SEMESTER

FOR THE STUDENTS ADMITTED FROM THE

ACADEMIC YEAR 2014-2015 ONWARDS

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

MADURAI – 625 015, TAMILNADU

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Thiagarajar College of Engineering, Madurai-625015

Department of Computer science and Engineering

Scheduling of Courses for the M.E. (CSE)

Semester	Theory						Practical	Credits
	1	2	3	4	5	6	7	8
I	14CG110 Computer Architecture 4:0	14CG120 Data Structures and Algorithms 3:1	14CG130 Object Oriented Analysis and Design 3: 0	14CG140 Network Technology 3:1	14CG150 Compiler Design 3:1	14CG160 Graphs and Combinatorial Algorithms 3:1	14CG170 Analysis and Design Lab 0:1	24
II	14CG210 Modeling and Simulation 3:1	14CG220 Software Engineering Theory and Practice 3:0	14CGPX0 Elective 1 4:0	14CGPX0 Elective 2 4:0	14CGPX0 Elective 3 4:0	14CGPX0 Elective 4 4:0	14CG270 Seminar 0:1	24
III	14CG310 Data Warehousing and Mining Techniques 4:0	14CGPX0 Elective 5 4:0	14CGPX0 Elective 6 4:0	-	-	-	14CG340 Project - I 0:4	16
IV	-	-	-	-	-	-	14CG410 Project - II 0:12	12

Approved in BOS Meeting on 08.11.2014 Approved in 49th Academic Council Meeting on 04.12.2014

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 2014-2015)

I SEMESTER

Course Code	Name of the Course	Category	No. of Hours / Week			Credits
			L	T	P	
THEORY						
14CG110	Computer Architecture	PC	4	-	-	4
14CG120	Data Structures and Algorithms	PC	3	1	-	4
14CG130	Object Oriented Analysis and Design	PC	3	-	-	3
14CG140	Network Technology	PC	3	1	-	4
14CG150	Compiler Design	PC	3	1	-	4
14CG160	Graphs and Combinatorial Algorithms	BS	3	1	-	4
PRACTICAL						
14CG170	Analysis and Design Laboratory	PC	-	-	2	1
Total			**19**	**4**	**2**	**24**

II SEMESTER

Course Code	Name of the Course	Category	No. of Hours / Week			Credits
			L	T	P	
THEORY						
14CG210	Modeling and Simulation	BS	3	1	-	4
14CG220	Software Engineering Theory and Practice	PC	3	0	-	3
14CGPX0	Elective 1	PE	4	-	-	4
14CGPX0	Elective 2	PE	4	-	-	4
14CGPX0	Elective 3	PE	4	-	-	4
14CGPX0	Elective 4	PE	4	-	-	4
PRACTICAL						
14CG270	Seminar	PC	-	-	2	1
Total			**22**	**1**	**2**	**24**

III SEMESTER

Course Code	Name of the Course	Category	No. of Hours / Week			Credits
			L	T	P	
THEORY						
14CG310	Data Warehousing and Mining Techniques	PC	4	-	-	4
14CGPX0	Elective 5	PE	4	-	-	4
14CGPX0	Elective 6	PE	4	-	-	4
PRACTICAL						
14CG340	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						
14CG410	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 2014-2015 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	14CG110	Computer Architecture	3	50	50	100	25	50
2	14CG120	Data Structures and Algorithms	3	50	50	100	25	50
3	14CG130	Object Oriented Analysis and Design	3	50	50	100	25	50
4	14CG140	Network Technology	3	50	50	100	25	50
5	14CG150	Compiler Design	3	50	50	100	25	50
6	14CG160	Graphs and Combinatorial Algorithms						
PRACTICAL								
7	14CG170	Analysis and Design Laboratory	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	14CG210	Modeling and	3	50	50	100	25	50

		Simulation						
2	14CG220	Software Engineering Theory and Practice	3	50	50	100	25	50
3	14CGPX0	Elective 1	3	50	50	100	25	50
4	14CGPX0	Elective 2	3	50	50	100	25	50
5	14CGPX0	Elective 3	3	50	50	100	25	50
6	14CGPX0	Elective 4	3	50	50	100	25	50
PRACTICAL								
7	14CG270	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	14CG310	Data Warehousing and Mining Techniques	3	50	50	100	25	50
2	14CGPX0	Elective 5	3	50	50	100	25	50
3	14CGPX0	Elective 6	3	50	50	100	25	50
PRACTICAL								
4	14CG340	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	14CG410	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

		L	T	P	Credit
14CG110	**COMPUTER ARCHITECTURE**	4	0	0	4

Preamble

The computer architecture has evolved—from a world of mainframes, minicomputers, and microprocessors, to a world dominated by microprocessors, and now into a world where microprocessors themselves are encompassing all the complexity of mainframe computer. The computer architect's role is to combine a thorough understanding of the state of the art of what is possible, a thorough understanding of the historical and current styles of what is desirable, a sense of design to conceive a harmonious total system, and the confidence and energy to marshal this knowledge and available resources to go out and get something built. To accomplish this, the architect needs a tremendous density of information with an in-depth understanding of the fundamentals. This course introduces the taxonomies of computer design and the basic concerns of computer architecture, gives an overview of the technology trends that drive the industry, and lays out the methods to using all this information in the art of computer design.

Prerequisite

Course Outcomes

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

Explain the design of a pipelined CPU and cache (CO1)	Understand
Describe the performance of CPU and memory hierarchy (CO2)	Apply
Apply dynamic scheduling methods to traditional architectures (CO3)	Apply

Mapping with Programme Outcomes

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

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	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. List the limitations of symmetric shared memory multiprocessors.
2. Define Thread Level parallelism.
3. Which cache optimization improves temporal locality to reduce misses?

Course Outcome 2 (CO2):

1. Your company has just bought a new dual Pentium processor, and you have been tasked with optimizing your software for this processor. You will run two applications on this dual Pentium, but the resource requirements are not equal. The first application needs 80% of the resources, and the other only 20% of the resources.
   Given that 40% of the first application is parallelizable, how much speedup would you achieve with that application if run in isolation?
2. Illustrate the working of the Classic Five-Stage Pipeline for RISC processor.
3. Demonstrate the working of Cache optimization techniques to reduce Hit Time and to increase Cache Bandwidth.

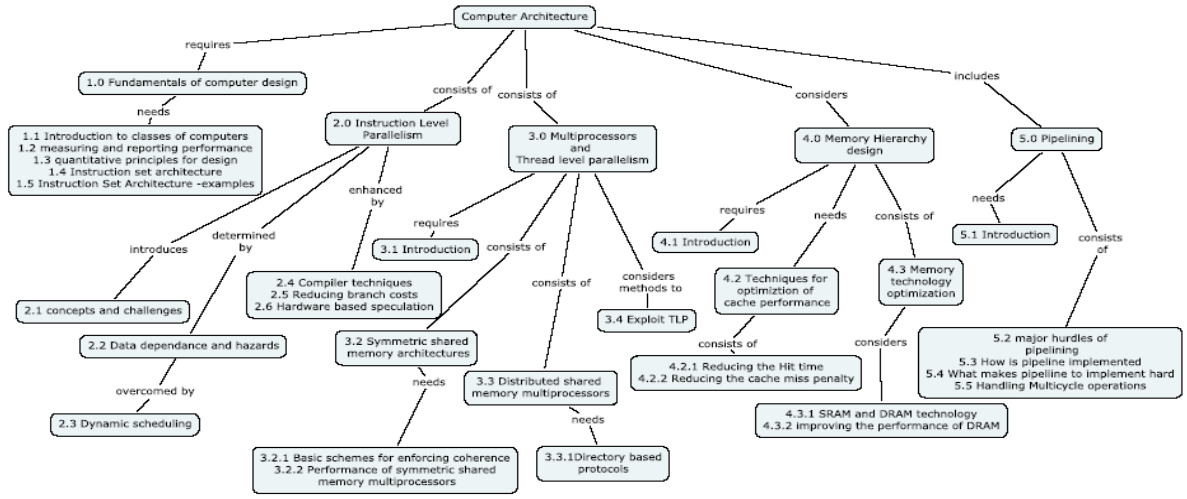
Course Outcome 3 (CO3)

1. Demonstrate the implementation of Dynamic Scheduling using Tomasulo's approach. Apply Tomasulo's Algorithm for the following code sequence and show the status of information tables when only two loads are complete and have written its result.

   ```
   L.D     F6, 25 (R1)
   L.D     F2, 40 (R2)
   MUL.D   F0, F2, F4
   SUB.D   F8, F2, F6
   DIV.D   F10, F0, F6
   ADD.D   F6, F8, F2
   ```

2. Report on the various complications related to instruction execution and instruction sets, that makes pipelining harder to implement.
3. State the advantages of Dynamic Scheduling.

Concept Map



Syllabus

Fundamentals of Computer Design-Introduction to classes of computers, Defining computer architecture- PowerPC architecture.-Measuring and reporting performance-Quantitative principles of computer design-Instruction set Architecture- classification. Instruction Set Architecture – examples. **Instruction Level Parallelism-**Concepts and challenges, Data dependence and hazards- Basic Compiler techniques for exposing ILP-Reducing branch costs with predictions-Dynamic scheduling- Hardware based speculation. **Multiprocessors and Thread level parallelism-**Introduction-Symmetric shared memory architectures-Basic schemes for enforcing coherence-Performance of symmetric shared memory multiprocessors-Distributed shared memory multiprocessors-Directory based protocols-Exploiting Thread level parallelism-future trends of processors. **Memory hierarchy design-**Introduction-Techniques for optimization of cache performance-Reducing the Hit time-Reducing cache miss penalty-Memory technology optimization-SRAM and DRAM technology-Improving the performance of DRAM. **Pipelining-**Introduction-Major hurdles of pipelining-How is pipeline implemented-What makes pipeline to implement hard-Handling multicycle operations.

Reference Books

1. John L Hennessy and David A. Patterson, Computer Architecture- A Quantitative Approach, Morgan Kauffman publishers, Fourth Edition, 2007
2. William stallings , Computer Organization and architecture, Prentice Hall, Fifth Edition, 2002
3. Kai Hwang, Advanced Computer Architecture, Tata McGrawhill, Eighteenth Reprint, 2008.
4. John Paul shen,Mikko H Lipasti, Modern Processor design, Tata McGrawhill, 2005.

Course Contents and Lecture Schedule

Module No.	Topics	No. of Lecture Hours
1.0	**Fundamentals of Computer Design**	
1.1	Introduction to classes of computers, Defining computer architecture, PowerPC architecture	2
1.2	Measuring and reporting performance	2
1.3	Quantitative principles of computer design	2
1.4	Instruction set Architecture- classification	2
1.5	Instruction Set Architecture – examples	1
2.0	**Instruction Level Parallelism**	
2.1	Concepts and challenges	1
2.2	Data dependence and hazards	2
2.3	Dynamic scheduling	2
2.4	Basic Compiler techniques for exposing ILP	2
2.5	Reducing branch costs with predictions	2
2.6	Hardware based speculation	2
3.0	**Multiprocessors and Thread level parallelism**	
3.1	Introduction	1
3.2	Symmetric shared memory architectures	1
3.2.1	Basic schemes for enforcing coherence	2
3.2.2	Performance of symmetric shared memory multiprocessors	1
3.3	Distributed shared memory multiprocessors	2
3.3.1	Directory based protocols	2
3.4	Exploiting Thread level parallelism –future trend of processors	1
4.0	**Memory hierarchy design**	
4.1	Introduction	1
4.2	Techniques for optimization of cache performance	1
4.2.1	Reducing the Hit time	1
4.2.2	Reducing cache miss penalty	2
4.3	Memory technology optimization	1
4.3.1	SRAM and DRAM technology	1
4.3.2	Improving the performance of DRAM	2
5.0	**Pipelining**	

5.1	Introduction	1
5.2	Major hurdles of pipelining	2
5.3	How is pipeline implemented	2
5.4	What makes pipeline to implement hard	2
5.5	Handling multicycle operations	2
	Total	**48**

Course Designer:

1. Dr. P.Chitra pccse@tce.edu

14CG120 DATA STRUCTURES AND ALGORITHMS

L	T	P	Credit
3	1	0	4

Preamble

This course will facilitate the Students to identify, formulate and solve real world engineering problems that require usage of algorithms. Students learn different algorithmic techniques like greedy algorithm, dynamic programming, divide and conquer as part of tree and graph algorithms. They use these techniques to solve problems both in theoretical design and practical implementations.

Prerequisite

Course Outcomes

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

Illustrate the growth of functions in average, worst and best case using asymptotic notations. (CO1)	Understand
Solve any recurrence equation using divide and conquer strategies (CO2)	Apply
Examine the behaviour of different tree data structure after insertion, deletion and rotation operations.(CO3)	Analyze
Inspect algorithms such as Dynamic programming, Greedy and Backtracking and apply the suitable technique for solving a given problem. (CO4)	Analyze
Make use of graph as a data structure for solving problems.(CO5)	Apply
Analyze the Complexity of the NP problem and prove it by reduction techniques. (CO6)	Analyze

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1.	L		L								
CO2.	M		L								
CO3.	M	L									
CO4.	M	M	S	M	L			L	L		
CO5.	S	S	S	M	L			L	L		
CO6.	S	S	S	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	30	20	20	10
Understand	30	20	20	10
Apply	20	30	50	40

Analyse	20	30	10	40
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1: (Understand)

1. List out the methods to analyze an algorithm.
2. Write short notes on Asymptotic notations.
3. Estimate the time complexity for the following:

```
a)  Algorithm RSum (int a [ ], int n)
        {
            if (n > 0)
             return RSum (a, n-1) + a[n-1];
             return 0;
        }
```

b) $n^3 + 10^6 n^2$

4. How Amortized Analysis differs from Average case analysis?
5. Which of these is the correct big-O expression for 1+2+3+...+n?

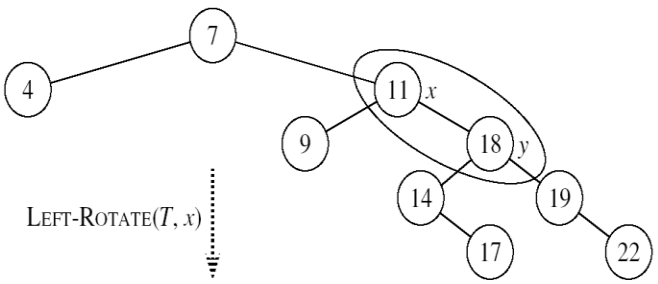
A. O(log n)
B. O(n)
C. O(n log n)
D. O(n^2)

Course Outcome 2: (Apply)

1. What is the use of Master's theorem?
2. Use Substitution method to solve the given recurrence equation: T (n) = 2 T (n-1) + 1 And T (1) =1
3. Solve the recurrence $t_n - 3\ t_{n-1} + 7$; $n \geq 1$ with initial conditions $t_0 = 5$.
4. Identify the general formula for the Fibonacci sequence, $f_n = f_{n-1} + f_{n-2}$ with $f_0 = 0$ and $f_1 = 1$
5. Build a recursion tree for the following recurrence equation; T (n) = T(n/3) + 2T (n/3) + n

Course Outcome 3: (Analyze)

1. Illustrate the operation of Max-Heapify (A, 3) on the array
   A = [27, 17, 3, 16, 13, 10, 2, 5, 7, 12, 4, 8, 9, 1]
2. Analyze the Linear search in best, worst and in average case with suitable input.
3. Examine the behavior of Quick sort when the array A contains distinct element and is sorted in decreasing order. Express its running time.
4. What is the resultant tree after the following rotations?



5. Construct a 5-way B tree by inserting the following keys in order:
   3, 7, 9, 23, 45, 1, 5, 14, 25, 24, 13, 11, 8, 19, 4, 31, 35, 56

   a) Add these keys 2, 6, 12 further to the tree.
   b) Delete these keys 4, 5, 7, 3, 14 from the tree after performing the above insertion.

6. Examine the structure of the hash table when we insert the keys 10, 22, 31, 4, 15, 28, 17, 88, 59 into a hash table of length m = 11 using open addressing with the primary hash function h' (k) = k mod m. Illustrate the result of inserting these keys using linear probing, using quadratic probing with C1 = 1 and C2 =3.
7. Conclude that a successful search in a hash table in which collisions are resolved by chaining takes Θ (1 + α) average case time under the assumption of simple uniform hashing

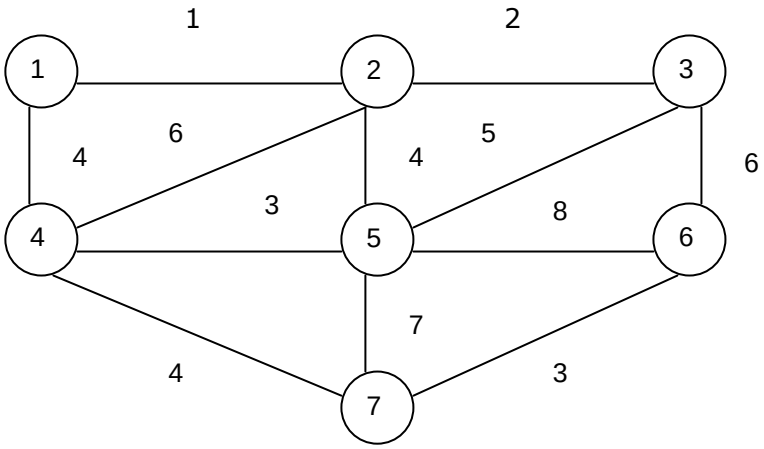
Course Outcome 4: (Analyze)

1. State the principle of optimal substructure property.
2. Differentiate Dynamic programming from Greedy concept.
3. Specify the design steps of Dynamic programming approach
4. Test the given input ABCD matrices and find their product by applying chained matrix multiplication and analyze the time complexity.
   A is 30* 1 C is 40 * 10
   B is 1 * 40 D is 10 * 25

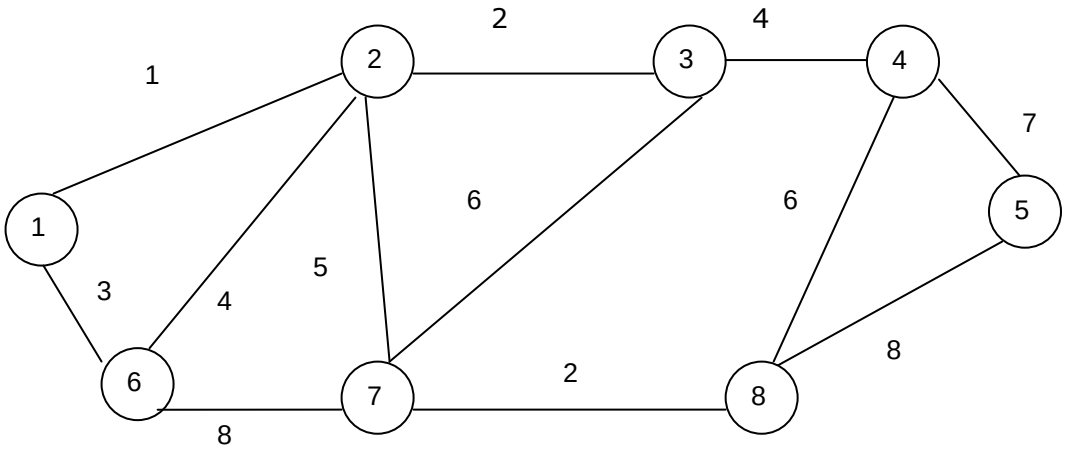
5. Identify an optimal Huffman code for the following set of frequencies , based on Greedy approach
   a:1 b: 1 c:2 d:3 e:5 f:8 g:13 h:21
6. Solve 8-Queen's problem using Backtracking approach.

Course Outcome 5: (Apply)

1. Define the term Spanning tree.
2. Build a minimum spanning tree for the given graph using Kruskal's algorithm:

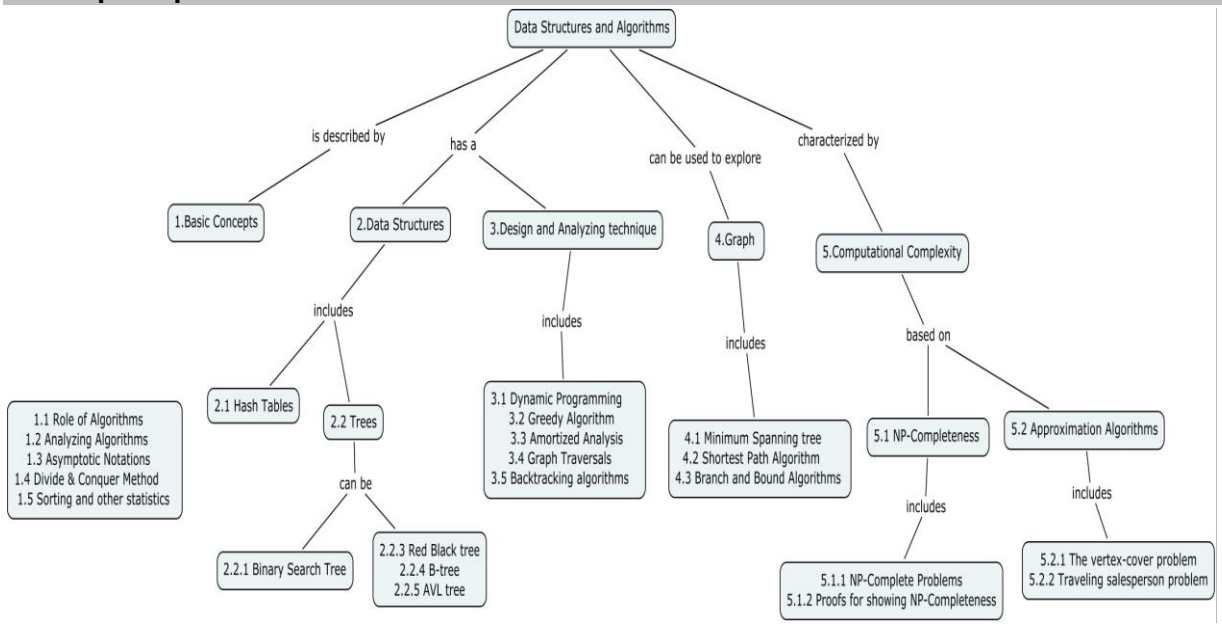


3. Apply suitable Minimum spanning tree algorithm for the given graph and find optimal solution for it:



4. Apply shortest path algorithm for the given graph and analyze its time complexity.

Concept Map



Syllabus

Review of Basic concepts: The role algorithms in computing, Analyzing algorithms, Growth of functions, Basic concepts in Divide and Conquer, Sorting and order statistics- Heap Sort and Quick sort. **Data Structures:** Hash Tables, Binary Search Trees, Red Black Trees, B-Trees, AVL Tree. **Advanced Design and Analysis Technique:** Dynamic Programming, Greedy Algorithms, Amortized Analysis, Exploring Graphs, Backtracking. **Graph algorithms:** Minimum Spanning trees, Shortest Path Algorithms, Branch and Bound Techniques. **Computational Complexity:** NP- Completeness, and Approximation algorithms

Reference Books

1.Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, “I ntroduction to Algorithms”, PHI Learning Private Limited, Third Edition, 2009.

2.Sartaj Sahni, " Data Structures, Algorithms and Applications in C++", Tata McGraw Hill, 2000.

3.Richard F. Gilberg , Behrouz A. Forouzan: Data Structures: A Pseudocode Approach With C, 2nd Edition, Thomson Learning, 2003

4.Gilles Brassard and Paul Bratley, "Fundamentals of Algorithms", Prentice Hall of India, 2007.

Course Contents and Lecture Schedule

Module No.	Topic	No of Lectures
1.	**Basics (10)**	
1.1	The role of algorithms in computing	1
1.2	Analyzing algorithms- Best, Worst and Average case	1
1.3	Growth of functions- Asymptotic Notations - **Tutorial** on Asymptotic Complexities	2
1.4	Divide and Conquer concepts for solving Recurrences	2
	Tutorial	1
1.5	Sorting and order statistics-Heap Sort - **Tutorial**	2
1.6	Quick sort	1
2.	**Data Structures (11)**	
2.1	Hash Tables	2
2.2	Trees- Unbalanced and Unbalanced	1
2.2.1	Binary Search Trees – **Tutorial**	2
2.2.2	Red Black Trees	2
2.2.3	B-Trees – **Tutorial** on deletion	2
2.2.4	AVL Tree	2
3.	**Advanced Design and Analysis Techniques (11)**	
3.1	Dynamic Programming- Matrix-chain Multiplication	1
3.1.1	Elements of Dynamic Programming	1
3.2	Greedy Algorithm - Elements of Greedy strategy	1
3.2.1	Huffman Codes – **Tutorial**	2
3.3	Amortized Analysis	2
3.4	Exploring Graphs and Traversals – **Tutorial**	2
3.5	Backtracking-Traveling Salesperson, The Queen's Problem	2
4	**Graph Algorithms (7)**	
4.1	Minimum Spanning Trees- Kruskal's and Prim's Algorithm	1
4.2	Single Source Shortest path algorithm – Dijkstra' s Algorithm, All Pair's Shortest Path Algorithm – **Tutorial**	2
4.3	Branch and Bound Algorithms	1
4.3.1	Traveling Salesperson Problem – **Tutorial**	2
4.3.2	Job Scheduling Problem	1
5	**Computational Complexity (9)**	
5.1	NP - Completeness	1
5.1.1	NP Complete Problems	1

5.1.2	NP-Completeness and Reducibility	1
	Tutorial	2
5.2	Approximation Algorithms	1
5.2.1	The vertex - cover problem	1
5.2.2	The Traveling salesperson problem – **Tutorial**	2
	Total Periods	**48**

Course Designers:

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

14CG130	OBJECT ORIENTED ANALYSIS AND DESIGN	L	T	P	Credit
		3	0	0	3

Preamble

The Objective of this subject is to promote the practice of object oriented analysis and design concepts at a higher level of abstraction. This subject covers the object oriented techniques, representations and patterns used to analyze and model a system and it also deals with all important Unified Modeling Language(UML) elements for good object oriented analysis and design

Prerequisite

Course Outcomes

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

Gather the requirements and perform the analysis of the software-to-be-developed using an object oriented approach (CO1)	Apply
Construct an initial model that depicts the object oriented design for the software-to-be-developed (CO2)	Apply
Construct a final design model for the software-to-be-developed (CO3)	Apply
Use the graphical modeling language called UML to aid the object oriented analysis and design (CO4)	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1.	M	M	S	L							L
CO2.	M	M	S	L	L						L
CO3.	M	M	S	L	L						L
CO4.	M	M	S	L	S						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	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Prepare the atomic irreducible requirements for an E-Voting System. (Apply)

2. Prepare the use case scenario 'System assisted reservation' for a Train Reservation system. (Apply)
3. Prepare a list of entities relevant to a piece of software concerned with the subject matter **Online Exam System**. Test and Assess the entities and prepare a refined list of entities and their attributes. (Apply)

Course Outcome 2 (CO2):

1. Select the object types and their interfaces, taking as input the use case scenario 'System assisted reservation' for a Train Reservation system. (Apply)
2. Explain in detail about CRC workshops. (Understand)
3. Explain the Law of Demeter. (Understand)

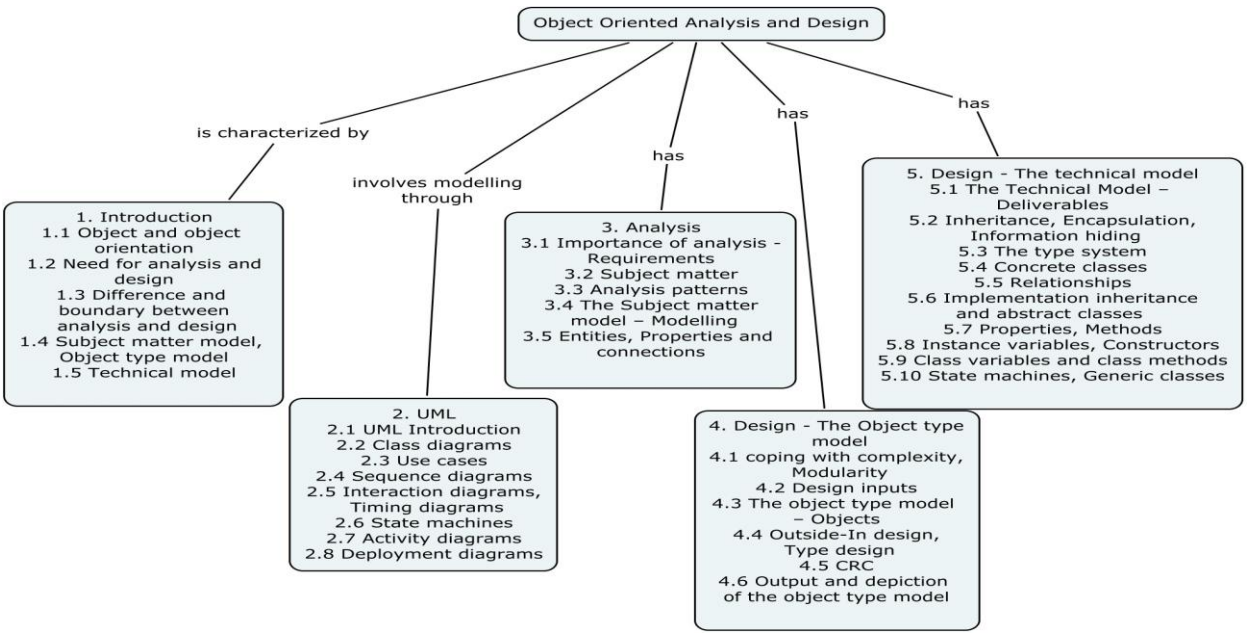
Course Outcome 3 (CO3):

1. Draw the Structure diagram relevant to the Technical model, taking as input the use case scenario 'System assisted reservation' for a Train Reservation system. (Apply)
2. Illustrate the implementation inheritance and abstract classes used in the Technical model with sample code fragments. (Apply)
3. Explain the ways to reduce method coupling. (Understand)

Course Outcome 4 (CO4):

1. Construct Sequence diagram for an **Online Exam System.** (Apply)
2. Construct Activity diagram for Airline Reservation system. (Apply)
3. Construct Class diagram for Airline Reservation System. (Apply)

Concept Map



Syllabus

Introduction – Object and object orientation –Need for analysis and design – Difference and boundary between analysis and design – **Three models –** Subject matter model – Object type model – Technical model – UML introduction – Class diagrams **-** Use cases **-** Sequence diagrams **-** Interaction diagrams **-** Timing diagrams **-** State machines **-** Activity diagrams **-** Deployment diagrams **Analysis** – Importance of analysis – Requirements – Subject matter – Analysis patterns – **The Subject matter model –** Modelling – Entities – Properties and connections –**Design –** coping with complexity – Modularity –Design inputs - **The object type model –** Objects – Outside-In design – Type design – CRC - Output and depiction of the object type model –**The Technical Model** – Deliverables – Inheritance – Encapsulation – Information hiding – The type system – Concrete classes – Relationships – Implementation inheritance and abstract classes – Properties – Methods– Instance variables – Constructors – Class variables and class methods – State machines – Generic classes

Reference Books

1. John Deacon, Object Oriented Analysis and Design, First Edition, Addison Wesley, 2005.

2. Brett McLaughlin, Gary Pollice, David West, Head First Object-Oriented Analysis and Design, O'Reilly Media, 2006.

3. Grady Booch, Robert A.Maksimchuk, Michael W.Engel, Bobbi J.Young, Jim Conallen, Kelli A. Houston, Object-Oriented Analysis and Design with Applications, Third Edition, Addison-Wesley, 2011.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1	**Introduction(5)**	
1.1	Object and object orientation	1
1.2	Need for analysis and design	1
1.3	Difference and boundary between analysis and design	1
1.4	Subject matter model, Object type model	1
1.5	Technical model	1
2	**UML(9)**	
2.1	UML introduction	1
2.2	Class diagrams	1
2.3	Use cases	1
2.4	Sequence diagrams	2
2.5	Interaction diagrams, Timing diagrams	1
2.6	State machines	1
2.7	Activity diagrams	1
2.8	Deployment diagrams	1
3	**Analysis(5)**	
3.1	Importance of analysis -Requirements	1

3.2	Subject matter	1
3.3	Analysis patterns	1
3.4	The Subject matter model **–** Modelling	1
3.5	Entities, Properties and connections	1
4	**Design – The object type model(6)**	
4.1	coping with complexity, Modularity	1
4.2	Design inputs	1
4.3	**The object type model –** Objects	1
4.4	Outside-In design, Type design	1
4.5	CRC	1
4.6	Output and depiction of the object type model	1
5	**Design – The Technical model(11)**	
5.1	**The Technical Model** – Deliverables	1
5.2	Inheritance, Encapsulation, Information hiding	1
5.3	The type system	1
5.4	Concrete classes	1
5.5	Relationships	1
5.6	Implementation inheritance and abstract classes	2
5.7	Properties, Methods	1
5.8	Instance variables, Constructors	1
5.9	Class variables and class methods	1
5.10	State machines, Generic classes	1
	Total	**36**

Course Designers:

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

14CG140	NETWORK TECHNOLOGY	L	T	P	Credit
		3	1	0	4

Preamble

Network Technology is needed to make sure the computers are interconnected properly and the communication between the systems are done effectively so that the underlying process is understandable and data is transferred in a secured manner.

Prerequisite

Course Outcomes

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

Explain the basic data communication model (CO1)	Understand
Detect and correct error in data that may occur during transmission (CO2)	Apply
Differentiate different protocols used in network and transport layers. (CO3)	Understand
Select a specific routing algorithm based on application need (CO4)	Analyze
Identify methods to minimise congestion in the network. (CO5)	Apply
Select a specific algorithm for maintaining Quality of Service. (CO6)	Analyze

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

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

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Draw the OSI reference model
2. Define: CSMA/CD
3. State the need for TCP.

Course Outcome 2 (CO2):

1. Show how a bit String '0111101111101111110' is being transmitted at the data link layer after performing bit stuffing?
2. Find out the reminder obtained by dividing X^7+X^5+1 by the generator polynomial X^3+1?
3. What is the Hamming code for the bit sequence 1011001?

Course Outcome 3 (CO3):

1. Compare OSI and TCP Reference models
2. Compare TCP and UDP protocols.
3. Compare two way and three way handshake in TCP connection management

Course Outcome 4 (CO4):

1. Compare the merits and demerits of distance vector and link state routing
2. Analyze the working principle of Hybrid routing protocol and its impact on size of routing table..
3. Distinguish the salient features of IPV6 compared to IPV4.

Course Outcome 5 (CO5):

1. Suppose that the TCP congestion window is set to 18KB and a timeout occurs. How big will the window be if the next 4 transmission bursts are all successful assuming that the maximum segment size is 1KB?

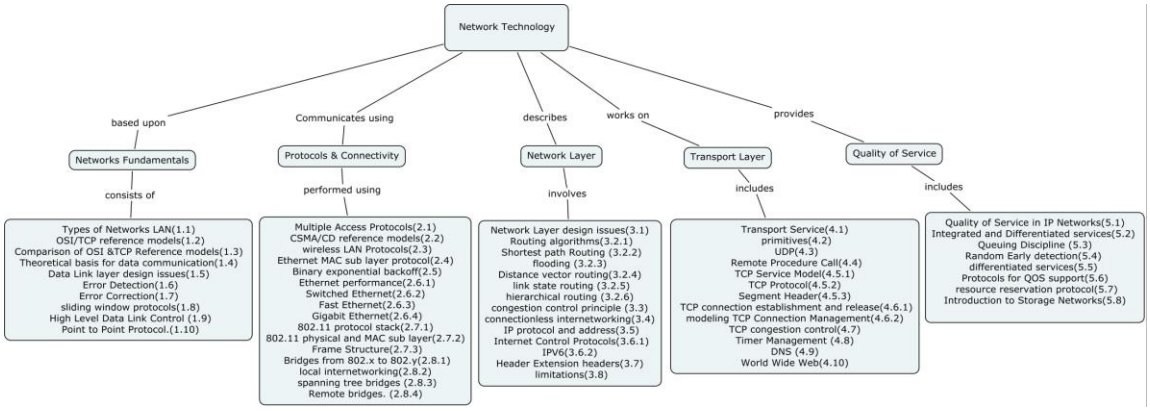
2. A network on the Internet has a subnet mask of 255.255.240.0.predict the maximum number of hosts it can handle?

3. Identify congestion control mechanisms used in packet switched networks.

Course Outcome 6 (CO6):

1. Identify the salient features of RED algorithm to support QOS
2. Choose the queuing discipline best suited for inelastic traffic
3. Model the Different components in Integrated services architecture.

Concept Map



Syllabus

Network Fundamentals: Types of Networks, LAN, OSI reference models, TCP reference models, Comparison between OSI &TCP Reference models, Theoretical basis for data communication, Data Link layer design issues, Error Detection, Error Correction, sliding window protocols, High Level Data Link Control & Point to Point Protocol. **Protocols and Connectivity**: Multiple Access Protocols, CSMA/CD reference models, wireless LAN Protocols, Ethernet MAC sub layer protocol, Binary exponential back off, Ethernet performance, Switched Ethernet, Fast Ethernet, Gigabit Ethernet,*02.11 protocol stack,802.11 physical and MAC sub layer ,Frame Structure, Bridges from 802.x to 802.y,local internetworking, spanning tree bridges ,Remote bridges. **Network Layer:** Network Layer design issues, Routing algorithms, Shortest path Routing ,flooding ,Distance vector routing, link state routing , hierarchical routing, congestion control principle, connectionless internetworking, IP protocol and address, Internet Control Protocols,IPV6,Header Extension headers, limitations. **Transport Layer and DNS:** Transport Service, primitives, UDP, Remote Procedure Call, TCP Service Model ,TCP Protocol, Segment Header, TCP connection establishment and release, modelling TCP Connection Management ,TCP congestion control, Timer Management ,DNS , World Wide Web. **Quality of Services:** Quality of Service in IP Networks, Integrated and Differentiated services, Queuing Discipline, Random Early detection, differentiated services, Protocols for QOS support, resource reservation protocol, Introduction to Storage Networks, recent advancements in networks

Reference Books

1. Andrew S. Tanenbaum, Computer Networks, 4th Edition, Pearson Education , 2003
2. William Stallings, High Speed Networks and Internet, 2nd Edition Pearson Education, 2003.
3. William Stallings, Data and Computer Communication, 7th Edition Pearson Education , 2003

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1	**Network Fundamentals (8)**	
1.1	Types of Networks ,LAN ,WAN	1
1.2	OSI /TCP reference models and comparison	
1.3	Theoretical basis for data communication - **Tutorial**	2
1.4	Data Link layer design issues	1

1.5	Error Detection and Error Correction-**Tutorial**	2
1.6	sliding window protocols	1
1.7	High Level Data Link Control &	1
1.8	Point to Point Protocol	
2	**Protocols and Connectivity**	**(9)**
2.1	Multiple Access Protocols	1
2.2	CSMA/CD reference Models	1
2.3	wireless LAN Protocols and Ethernet MAC sub layer protocol - **Tutorial**	2
2.4	Binary exponential back off	1
2.5	Ethernet performance Switched Ethernet Fast Ethernet Gigabit Ethernet	1
2.6	802.11 protocol stack,802.11 physical and MAC sub layer, Frame Structure	1
2.7	Bridges from 802.x to 802.y,local internetworking spanning tree bridges Remote bridges – **Tutorial**	2
3	**Network Layer:**	**(13)**
3.1	Network Layer design issues	1
3.2	Routing algorithms, Shortest path Routing	
3.2.1	flooding & Distance vector routing	1
3.2.2	link state routing & hierarchical routing -	1
	Tutorial	2
3.3	congestion control principle	1
3.4	connectionless internetworking	1
3.5	IP protocol and address	1
	Tutorial	2
3.6	Internet Control Protocols,IPV6	1
3.7	Header Extension headers & limitations – **Tutorial**	2
4	**Transport Layer and DNS**	**(10)**

4.1	Transport Service and its primitives	1
4.2	User Datagram Packets	
4.3	Remote Procedure Call	1
4.4	TCP Service Model	1
4.5	TCP Protocol and Segment Header	1
	Tutorial	1
4.6	TCP connection establishment and release	1
4.7	modelling TCP Connection Management	1
4.8	TCP congestion control and Timer Management	1
4.9	Domain Name Services & World Wide Web – **Tutorial**	2
5	**Quality of Services**	**(8)**
5.1	Quality of Service in IP Networks,	1
5.2	Integrated and Differentiated services,	1
5.3	Queuing Discipline and Random Early detection	1
5.4	differentiated services	1
5.5	Protocols for QOS support	1
5.6	resource reservation protocol	1
5.7	Introduction to Storage Networks – **Tutorial**	2
	Total	**48**

Course Designers:

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

		L	T	P	Credit
14CG150	**COMPILER DESIGN**	3	1	0	4

Preamble

This course gives an overview of the various phases of compiler and explains how a high level program is translated to a machine language program.

Prerequisite

Course Outcomes

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

Describe the role of each phase of a compiler, the various construction tools, symbol-table management and error handling (CO1)	Understand
Perform Lexical Analysis and Using Syntax Analysis, Build a statement by constructing parsers like top down, bottom up, LR, SLR, CLR and LALR Parsers (CO2)	Apply
Solve Backpatching and build intermediate representation as three-address code (CO3)	Apply
Apply code optimization for Parallel Applications and generate Target Code (CO4)	Apply

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	10	10	20	10
Understand	30	20	50	20
Apply	60	70	30	70
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Define Compiler. List the phases of the Compiler? Explain with a neat diagram.
2. Describe the Compiler Construction Tools? Explain its specifications in detail.

3. Describe the error recovery actions in a lexical analyzer?
4. Define the role of input buffer in lexical analysis.
5. Describe the function of syntax directed translation.

Course Outcome 2 (CO2):

1. Compute SLR parsing table for the grammar.

   E->E+T/T

   T->T*F/F

   F->(E)/id

2. Compute the predictive parser for the following grammar.
   S->a|↑|(T)
   T->T,S|S
   Write down the necessary algorithms and define FIRST and FOLLOW.
   Show the behaviour of the parser in the sentences:
   (i)(a,(a,a))
   (ii)(((a,a), ↑,(a),a).
3. Predict whether the following grammar is a LL(1) grammar
   S->iEtS| iEtSeS' |a
   E->b
4. Compute NFA, DFA for the expression aa* ¦ bb*
5. Compute a parse tree to the string-(id+id) using left most derivation

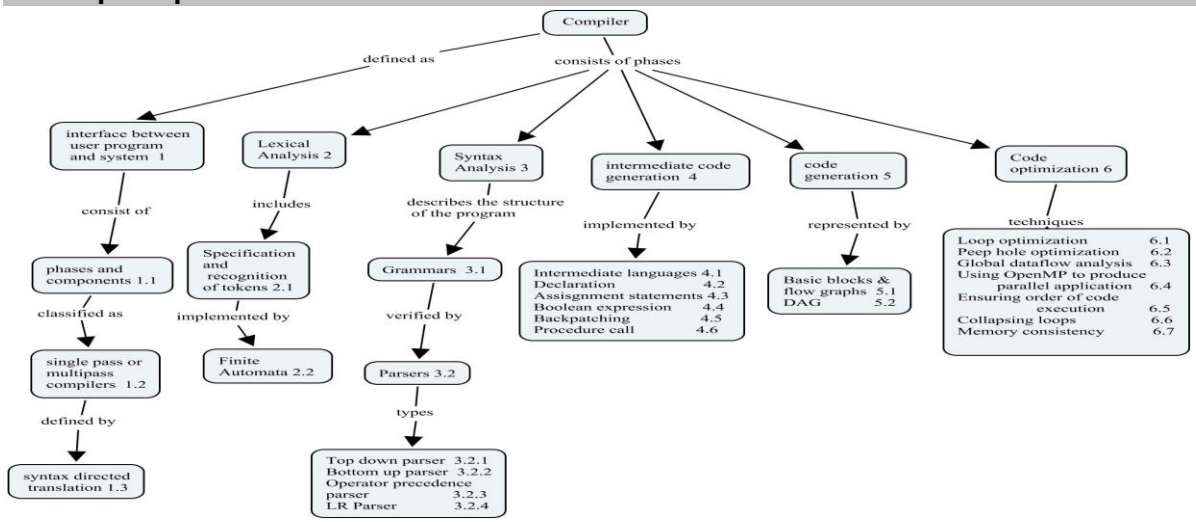
Course Outcome 3 (CO3):

1. Compute three address code to the statement A=-B*(C+D).
2. Compute an activation record for a given scenario.
3. For the input expression (4* 7 +1) *2, construct an annotated parse tree
4. Apply back-patching to Boolean expression.

Course Outcome 4(CO4):

1. Compute loops in a flowgraph
2. Construct a flow graph from the three-address statements
3. Apply the criteria to the selection of optimizing transformations.
4. Compute induction variable for matrix multiplication programme.

Concept Map



Syllabus

Introduction to compiling: Compilers, Analysis of the source program, Phases of a compiler, Cousins of a compiler, Grouping of Phases, Compiler – construction tools. **A Simple one pass compiler:** Overview, syntax definition, syntax-directed translation, Parsing, A translator for simple expressions. **Lexical Analysis:** The role of the lexical analyzer, Input buffering, specification of tokens , recognition of tokens ,A language for specifying lexical analyzers, Finite Automata. **Syntax Analysis :** The role of a parser, Context-free grammars, Writing a grammar, Top-down Parsing, Bottom-up parsing, Operator-precedence parsing , SLR parser, CLR parser, LALR parser. **Intermediate Code Generation:** intermediate languages, declarations, assignment statements, Boolean expression, procedure call, Back patching **Code Generation:** Issues in the design of a code generator, basic blocks and flow graphs, The DAG representation of basic blocks, Code generation from DAG's. **Introduction to Code Optimization:** The principal sources of optimization, Peephole Optimization, Loops in flow graphs using OpenMP to produce parallel application , ensuring code in parallel environment , collapsing loops to improve workload balance, enforcing memory consistency, an example of parallelization

Reference Books

1. Alfred V. Aho, Ravi Sethi, Jeffrey D Ullman, Lam – Compiler Principles, Techniques and Tools, Pearson Education, 2007.
2. Darryl Gove - Multicore Application programming: For Windows,Linux and oracle solaris, Addison Wesley Publisher , 2007
3. Steven S. Muchnick: Advanced Compiler Design & Implementation – Harcourt Asia, Morgan Kaufmann,2001.
4. J. P. Bennet: Introduction to Compiling Techniques, Tata McGraw-Hill Publishing-2002.

Course Contents and Lecture Schedule

Module No.	Topics	No. of Lectures
1.	**Introduction to Compiling (5)**	
1.1	Phases and components of a compiler	1
1.2	One pass compiler	2
1.3	Syntax-directed translation	1
	Tutorial	1
2.	**Lexical Analysis (9)**	
2.1	Specification and recognition of tokens	2
2.1.1	Design of Lex and Yacc – **Tutoria**l	2
2.2	Finite Automata	3
2.2.1	**Tutorial**	2
3.	**Syntax Analysis (11)**	
3.1	Grammar	1

3.2	Parsers	1
3.2.1	Top-down Parsing – **Tutorial**	2
3.2.2	Bottom-up parsing	1
3.2.3	Operator-precedence parsing	2
3.2.4	LR – SLR parser,CLR Parser, LALR parser	2
	Tutorial	2
4.	**Intermediate Code Generation(7)**	
4.1	Intermediate Language	1
4.2	Declaration	1
4.3	Assignment statement	1
4.4	Boolean Expression	1
4.5	Back patching – **Tutorial**	2
4.6	Procedure Call	1
5.	**Code Generation (6)**	
5.1	Basic blocks and flow graphs	2
	Tutorial	2
5.2	The DAG representation	2
6	**Introduction to Code Optimisation (10)**	
6.1	Loop optimization	1
	Tutorial	2
6.2	Peephole Optimization	1
6.3	Global data flow analysis	1
6.4	Using OpenMP to produce a parallel application	1
6.5	Ensuring that code in a parallel region is executed in order	1
6.6	Collapsing loops to improve workload balance	1
6.7	Enforcing memory consistency	1
6.8	An example of parallelization	1
	Total	**48**

Course Designers:

1. Dr.K.Sundarakantham kskcse@tce.edu
2. Mr.R.Chellamani rcmcse@tce.edu

14CG160	GRAPHS AND COMBINATORIAL ALGORITHMS	L	T	P	Credit
		3	1	0	4

Preamble

Combinatorial reasoning underlies all analysis of computer systems. Two of the most basic mathematical aspects of computer science concern the speed and logical structure. Speed involves enumeration of the number of times each step in a program can be performed. Logical structure involves flow charts, a form of graphs. In graph theory, combinatorial arguments are made a little easier by the use of pictures of the graphs. Natural form of graphs is sets with logical or hierarchical sequencing, such as computer flow charts. In case of network flows, we shall see that the flow optimization algorithm can also be used to prove several well-known combinatorial theorems. The general counting methods involve permutations and combinations. These methods are very useful in constructing computer programs and in mastering many theoretical topics of computer science. Recurrence relations are one of the simplest ways to solve counting problems. The methods for solving recurrence relations appeared originally in the development of the theory of difference equations, cousins of differential equations.

Prerequisite

Course Outcomes

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

Determine the Isomorphism of Graphs (CO1)	Understand
Find out Chromatic number of Graph to assess the complexity of Graphs (CO2)	Apply
Find Min-cut for the Max flow in Network Algorithms (CO3)	Understand
Apply the rearrangements and selection procedure for fitting password (CO4)	Apply
Structure the suitable recurrence relation for a case study and able to get analytical solution. (CO5)	Apply

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	30	30	10	10
Understand	0	0	20	20
Apply	70	70	70	70
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. State Konigsberg bridge problem?
2. Describe Edge-disjoint path in a graph
3. Define complete graph

Course Outcome 2 (CO2):

1. Compute the chromatic number of K_5
2. Use Euler's formula and find the relation between 'r' and 'f' in Planar Graph
3. Demonstrate the circle-chord method and to show $K_{3,3}$ is nonplanar.

Course Outcome 3 (CO3):

1. Define shortest path problem.
2. Predict the capacity of a network
3. Distinguish between Dijkstra's and Prims algorithm

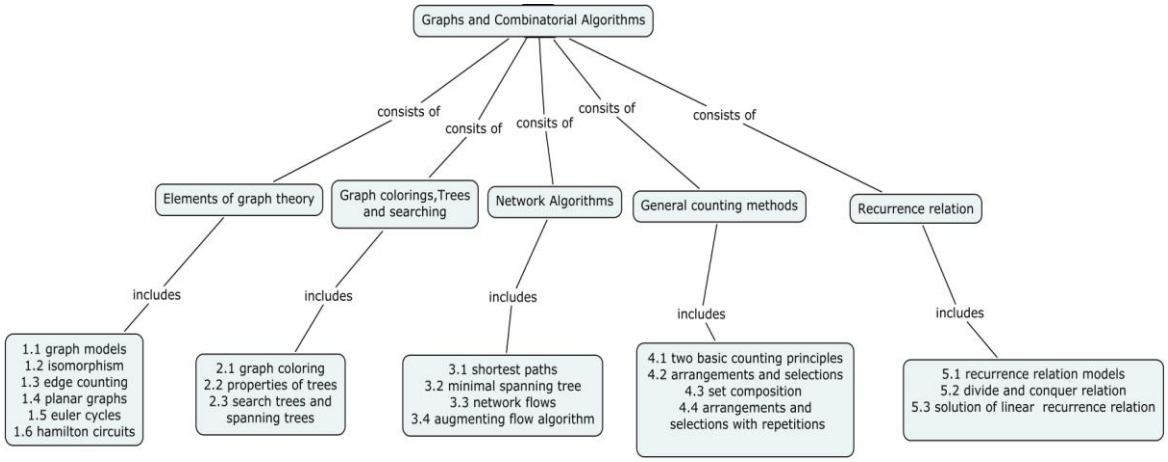
Course Outcome 4 (CO4):

1. Produce different numbers which can be formed by various arrangement of the six digit 1,1,1,1,2,3?
2. Compute the probability that an integer between 1 &10,000 has exactly one 8 and one 9?
3. Calculate the sum $1^3 + 2^3 + 3^3 + 4^3 + 5^3 + \ldots + n^3$.

Course Outcome 5 (CO5):

1. Prepare a recurrence relation for the number of ways to distribution n distinct objects into five boxes. What is the initial condition?
2. Produce a suitable recurrence relation for the number of sequences of 1s,3s,&5s whose term sum to n
3. Predict a formula for a_n , satisfying $a_n = -2a_{n-2} - a_{n-4}$ with $a_0 = 0$, $a_1 = 1$,$a_2 = 2$, $a_3 = 3$.

Concept Map



Syllabus

Module-I: Elements of graph theory Graph models, isomorphism, Edge counting, Planar graphs, Euler cycles, Hamilton circuits. **Module-II: Coloring, trees and searching** Graph coloring, Chromatic polynomial, Properties of Trees, Cayley's theorem, Depth first and breadth first search, Spanning Trees**. Module-III: Network Algorithms** Shortest paths Algorithms , Minimal spanning trees, Network flows , Augmenting flow Algorithm, Max flow-Min cut theorem, Undirected networks-flow networks with supplies and demands . **Module-IV: Counting principles** Two basic counting principles , Simple Arrangements and selections, Set composition principle, Arrangements and selections with Repetitions , Generating permutation and combinations. **Module-V: Recurrence Relations** Recurrence Relations Models, Fibonacci number, Divide and conquer Relations, Solution of linear Recurrence Relations, Solution of in Homogeneous Recurrence Relations.

Reference Books

Alan Thucker, "Applied Combinatories " , John Wiley and Sons, Inc, New York, Third Edition,1995.

2. CL Lin, " Introduction to Combinatorial Mathematics", Mcgraw Hill Book Company, New York, 1968.

3. Richard A.Brualdi, "Introductory Combinatories", North Holland, New York

Course Contents and Lecture Schedule

Module No.	Topics	No. of Lectures
	Elements of graph theory (10)	
1.1	Review of the concepts of Set theory, relations &	1

	functions	
1.2	Graph models, Isomorphism	2
1.3	Edge counting	1
1.4	Planar graphs	2
1.5	Euler cycles	1
1.6	Hamilton circuits	1
	Tutorial	2
	Coloring , trees and searching(12)	
2.1	Graph coloring	2
2.2	Chromatic polynomial	1
2.3	Properties of Trees	2
2.4	Cayley's theorem	1
2.5	Depth first and breadth first search	2
2.6	Spanning Trees	1
	Tutorial	3
	Network Algorithms(10)	
3.1	Shortest paths Algorithms	1
3.2	Minimal spanning trees	2
3.3	Network flows	1
3.4	Augmenting flow Algorithms	1
3.5	Max flow- Min cut theorem	1
3.6	Undirected networks-flow networks with supplies and demands	1
	Tutorial	3
	Counting principles(7)	
4.1	Two basic counting principles	1
4.2	Simple Arrangements and selections	1
4.3	Set composition principle	1
4.4	Arrangements and selections with Repetitions	1
4.5	Generating permutation and combinations	1
	Tutorial	2
	Recurrence Relations(9)	
5.1	Recurrence Relations Models	1
5.2	Fibonacci number	1

5.3	Divide and conquer Relations	1
5.4	Solution of linear Recurrence Relations	2
5.5	Solution of in Homogeneous Recurrence Relations	2
	Tutorial	2
	Total	**48**

Course Designers:

1. Dr. V.Mohan vmohan@tce.edu
2. Dr. S.Jeya Bharathi sjbmat@tce.edu

14CG170 ANALYSIS AND DESIGN LABORATORY

L	T	P	Credit
0	0	1	1

Preamble

With a dynamic learn-by-doing focus, this laboratory course encourages students to explore software analysis and design methods by implementing them, a process through which students discover how software analysis and design can be done.

Prerequisite

Course Outcomes

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

Design a graphical modelling language called UML to take control of the software development. (CO1)	Create
Compute the time complexity of algorithms for sorting (insertion, selection, merge, quick sort and heap sort), dynamic programming, searching (binary search tree and red black tree) and graphs (directed and undirected) applied to average, worst and best cases. (CO2)	Apply
Apply algorithms for shortest path, matrix multiplication, minimum spanning tree, and traveling salesman problems (CO3)	Apply

Mapping with Programme Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	M	S	M		S						
CO2	M	S	M	M	M						
CO3	M	M	S	M	M						

S- Strong; M-Medium; L-Low

List of Experiments

1. Implementation of hash function
2. Implementation of Linked list, doubly linked list and Circular linked list.
3. Implementation of sorting and searching algorithms.
4. Implementation of Binary search tree, Red Black tree.
5. Implementation of graph traversal techniques.
6. Implementation of Use Case Diagram
7. Implementation of Class Diagram
8. Implementation of State Diagram
9. Implementation of Activity Diagram
10. Implementation of Sequence Diagram
11. Implementation of Collaboration Diagram
12. Implementation of Deployment Diagram

Course Designers:

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2. Dr. S. Padmavathi spmcse@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 2014-2015 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
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Thiagarajar College of Engineering, Madurai-625015

Department of Computer science and Engineering

Scheduling of Courses for the MECSE

Semester	Theory						Practical	Credits
	1	2	3	4	5	6	7	8
I	14CG110 Computer Architecture 4:0	14CG120 Data Structures and Algorithms 3:1	14CG130 Object Oriented Analysis and Design 3: 0	14CG140 Network Technology 3:1	14CG150 Compiler Design 3:1	14CG160 Graphs and Combinatorial Algorithms 3:1	14CG170 Analysis and Design Lab 0:1	24
II	14CG210 Modeling and Simulation 3:1	14CG220 Software Engineering Theory and Practice 3:0	14CGPX0 Elective 1 4:0	14CGPX0 Elective 2 4:0	14CGPX0 Elective 3 4:0	14CGPX0 Elective 4 4:0	14CG270 Seminar 0:1	24
III	14CG310 Data Warehousing and Mining Techniques 4:0	14CGPX0 Elective 5 4:0	14CGPX0 Elective 6 4:0	-	-	-	14CG340 Project - I 0:4	16
IV	-	-	-	-	-	-	14CG410 Project - II 0:12	12

Approved in BOS Meeting on 08.11.2014

Approved in 49th Academic Council Meeting on 04.12.2014

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 2014-2015)

I SEMESTER

Course Code	Name of the Course	Category	No. of Hours / Week			Credits
			L	T	P	
THEORY						
14CG110	Computer Architecture	PC	4	-	-	4
14CG120	Data Structures and Algorithms	PC	3	1	-	4
14CG130	Object Oriented Analysis and Design	PC	3	-	-	3
14CG140	Network Technology	PC	3	1	-	4
14CG150	Compiler Design	PC	3	1	-	4
14CG160	Graphs and Combinatorial Algorithms	BS	3	1	-	4
PRACTICAL						
14CG170	Analysis and Design Laboratory	PC	-	-	2	1
Total			**19**	**4**	**2**	**24**

II SEMESTER

Course Code	Name of the Course	Category	No. of Hours / Week			Credits
			L	T	P	
THEORY						
14CG210	Modeling and Simulation	BS	3	1	-	4
14CG220	Software Engineering Theory and Practice	PC	3	0	-	3
14CGPX0	Elective 1	PE	4	-	-	4
14CGPX0	Elective 2	PE	4	-	-	4
14CGPX0	Elective 3	PE	4	-	-	4
14CGPX0	Elective 4	PE	4	-	-	4
PRACTICAL						
14CG270	Seminar	PC	-	-	2	1
Total			**22**	**1**	**2**	**24**

III SEMESTER

Course Code	Name of the Course	Category	No. of Hours / Week			Credits
			L	T	P	
THEORY						
14CG310	Data Warehousing and Mining Techniques	PC	4	-	-	4
14CGPX0	Elective 5	PE	4	-	-	4
14CGPX0	Elective 6	PE	4	-	-	4
PRACTICAL						
14CG340	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						
14CG410	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 2014-2015 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	14CG110	Computer Architecture	3	50	50	100	25	50
2	14CG120	Data Structures and Algorithms	3	50	50	100	25	50
3	14CG130	Object Oriented Analysis and Design	3	50	50	100	25	50
4	14CG140	Network Technology	3	50	50	100	25	50
5	14CG150	Compiler Design	3	50	50	100	25	50
6	14CG160	Graphs and Combinatorial Algorithms						
PRACTICAL								
7	14CG170	Analysis and Design Laboratory	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	14CG210	Modeling and	3	50	50	100	25	50

		Simulation						
2	14CG220	Software Engineering Theory and Practice	3	50	50	100	25	50
3	14CGPX0	Elective 1	3	50	50	100	25	50
4	14CGPX0	Elective 2	3	50	50	100	25	50
5	14CGPX0	Elective 3	3	50	50	100	25	50
6	14CGPX0	Elective 4	3	50	50	100	25	50
PRACTICAL								
7	14CG270	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	14CG310	Data Warehousing and Mining Techniques	3	50	50	100	25	50
2	14CGPX0	Elective 5	3	50	50	100	25	50
3	14CGPX0	Elective 6	3	50	50	100	25	50
PRACTICAL								
4	14CG340	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	14CG410	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

14CG210 MODELING AND SIMULATION

L	T	P	Credit
3	1	0	4

Preamble

Modeling and Simulation refers analysis tool and design tool for various systems. Models can be constructed in mathematical ways to solve any network system. Random numbers can be generated and test the properties of random numbers by various method. In addition to this, random variate for various distributions is also generated. In analysis of simulation, input values are generated and used for experiment. It includes the verification and validation of simulation model. Finally the modeling and simulation concept is applied in CPU simulation, memory simulation

Prerequisite

- Probability and Statistics
- Queuing theory

Course Outcomes

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

Generate random numbers for simulation experiments (CO1)	Apply
Test the properties of random numbers (CO2)	Apply
Produce the input data to simulation experiment using random numbers (CO3)	Apply
Test the goodness of fit for the given input data (CO4)	Understand
Understand the structure the CPU and memory unit in computer system (CO5)	Understand

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	10	10	10	0
Understand	30	30	30	30
Apply	60	60	60	70
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Using the linear congruential method, generate a sequence of three–digits random numbers with $X_o = 0, a = 8, c = 47, m = 100$
2. Generate a discrete uniform variate with pmf $p(x) = \frac{2x}{k(k+1)}, x = 1,2,3....$
3. Calculate the generator for triangular distribution with range (1,10) and mode at x=4

Course Outcome 2 (CO2):

1. Use Chi-square test with $\alpha = 0.05$ to test whether the data shown below are uniformly distributed

   0.34 0.90 0.25 0.89 0.87 0.44 0.12 0.21 0.46 0.67 0.83 0.76 0.79 0.64 0.70
   0.81 0.94 0.74 0.22 0.74 0.96 0.99 0.77 0.67 0.56 0.41 0.52 0.73 0.99 0.02 0.74
   0.30 0.17 0.82 0.56 0.05 0.45 0.31 0.78 0.05 0.79 0.71 0.23 0.19 0.82 0.93
   0.65 0.37 0.39 0.42 0.99 0.17 0.99 0.46 0.05 0.66 0.10 0.42 0.18 0.49 0.37
   0.51 0.54 0.01 0.81 0.28 0.69 0.34 0.75 0.49 0.72 0.43 0.56 0.97 0.30 0.94
   0.96 0.58 0.73 0.05 0.06 0.39 0.84 0.24 0.40 0.64 0.40 0.19 0.79 0.62 0.18
   0.26 0.97 0.88 0.64 0.47 0.60 0.11 0.29 0.78

2. Apply auto-correlation test to test whether the 5th , 10th, 15th and so on numbers in the sequence are auto correlated with $\alpha = 0.5$

   0.68 0.89 0.94 0.74 0.91 0.55 0.62 0.36 0.27 0.19 0.72 0.75 0.08 0.54 0.02 0.01 0.36
   0.16 0.28 0.18 0.01 0.95 0.69 0.18 0.47 0.23 0.32 0.82 0.53 0.31 0.42 0.73 0.04 0.83
   0.45 0.13 0.57 0.63 0.29

3. Use K.S Test for the uniformity of following random numbers with $\alpha = 0.5$ 0.64
   0.50 0.66 0.01 0.24 0.81 0.94 0.73 0.15 0.45 0.10 0.18 0.82 0.96 0.43 0.57
   0.94 0.27 0.34 0.65

Course Outcome 3 (CO3)

1. Suppose that the lead time associated with 20 orders have been measured as follows. Calculate the parameters of Gamma distribution for the data

   70.292, 10.107, 48.386, 20.48, 13.053, 25.292, 14.713, 39.166, 17.421, 13.905, 30.215, 17.137, 44.024, 10.552, 37.298, 16.314, 28.073, 39.019, 32.33, 36.547

2. Compute the parameters of normal distribution for the following data

   1.691, 1.437, 8.221, 5.976, 1.116, 4.435, 2.345, 1.782, 3.810, 4.589, 5.313, 10.90, 2.646, 2.432, 1.581, 2.432, 1.843, 2.466, 2.833, 2.361

3. Calculate the parameters of Exponential distribution for the data
   30.215, 17.137, 44.024, 10.552, 37.298, 16.314, 28.073, 39.019, 32.33, 36.547, 14.713, 39.166, 17.421, 13.905, 70.292, 10.107, 48.386, 20.48, 13.053, 25.292

Course Outcome 4 (CO4)

1. Suppose that 50 interarrival times are collected over the following 100 minute interval
   0.44 0.53 2.04 2.74 2.00 0.30 2.54 0.52 2.02 1.89 1.53 0.21 2.80 0.04 1.35
   8.32 2.34 1.95 0.10 1.42 0.46 0.07 1.09 0.76 5.55 3.93 1.07 2.26 2.88 0.67
   1.12 0.26 4.57 5.37 0.12 3.19 1.63 1.46 1.08 2.06 0.85 0.83 2.44 1.02 2.24
   2.11 3.15 2.90 6.58 0.64
   Identify whether data follows exponential distribution or not by Kolmogrov-Smirnov test.Use $\alpha = 0.05$

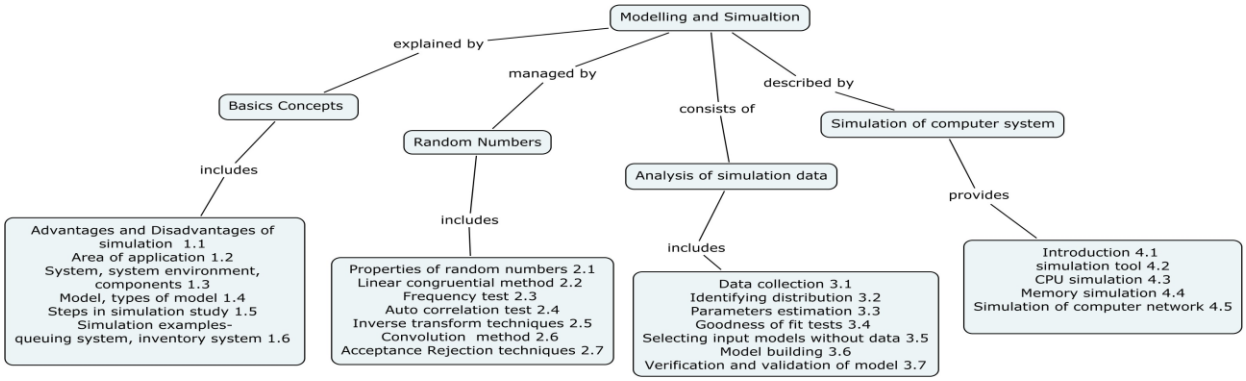
2. Consider the following data
   79.919 3.081 0.062 1.961 5.845 3.027 6.505 0.021 0.013 0.123 6.769 59.899 1.192 34.760 5.009 18.387 0.141 43.565 24.420 0.433 144.695 2.663 17.967 0.091 9.003 0.941 0.878 3.371 2.157 7.579 0.624 5.380 3.148 7.078 23.960 0.590 1.928 0.300 0.002 0.543 7.004 31.764 1.005 1.147 0.219 3.217 14.382 1.008 2.336 4.562
   Predict whether the data follows exponential distribution or not by Chi-square test. Use $\alpha = 0.05$

3. Describe the goodness of fit test

Course Outcome 5 (CO5)

1. Discuss about CPU simulation
2. Define the structure of memory unit
3. Explain the concept of TCP

Concept Map



Syllabus

Basic concepts in simulation: Simulation is the appropriate tool, not appropriate tool, advantages and disadvantages of simulation, Area of application, System, system environment, components, Model, types of model, Steps in simulation study, Simulation examples- queuing system, inventory system. **Random Numbers:** Properties of random numbers, Pseudo random numbers, linear congruential method, Frequency test, Auto correlation test, random variate generation-Inverse transform technique, convolution method, Acceptance Rejection technique, **Analysis of simulation data**: input modeling-Data collection, identifying the distribution with data, Parameters estimation, Goodness of fit tests. Selecting input models without data, Model building, Verification and validation of simulation models **Simulation of computer system**: Introduction, simulation tool, CPU simulation, memory simulation, simulation of computer network

Reference Books

1. Jerry Bank, John S. Carson II, Barry L. Nelson, David M. Nicol, P. Shahabudeen , " Discrete Event System Simulation ", Pearson, 2007
2. Narasingh Deo, "System Simulation with Digital Computer", PHI, New Delhi, 1997
3. Averill M.Law, W.David Kelton," Simulation Modeling and Analysis", McGraw Hill, New Delhi, 2000

Course Contents and Lecture Schedule

Module No.	Topics	No. of Lectures
1.	**Basic concepts in simulation**	
1.1	Simulation is the appropriate tool, not appropriate tool, advantages and disadvantages of simulation	1
1.2	Area of application	1
1.3	System, system environment, components	1
1.4	Model, types of model	1
1.5	Tutorial	1
1.6	Steps in simulation study	1
1.7.	Simulation examples-queuing system, inventory system	2
1.8	Tutorial	1
2	**Random Numbers**	
2.1	Properties of random numbers, Pseudo random numbers	1
2.2	Linear congruential method	1
2.3	Frequency test	1
2.4	Tutorial	1
2.5	Auto correlation test	2
2.6	Inverse transform techniques	2
2.7	Tutorial	2
2.8	Convolution method	1
2.9	Acceptance Rejection techniques	2
2.10	Tutorial	2
3	**Analysis of simulation data**	
3.1	Introduction, Data collection	1
3.2	Identifying distribution	1
3.3	Parameters estimation	2
3.4	Tutorial	1
3.5	Goodness of fit tests	3
3.6	Tutorial	1
3.7	Selecting input models without data	1
3.8	Model building	1
3.9	Verification and validation of simulation models	2
3.10	Tutorial	1
4	**Simulation of computer system**	
4.1	Introduction	1
4.2	simulation tool	1
4.3	CPU simulation	2
4.4	Tutorial	1
4.5	Memory simulation	2
4.6	Simulation of computer network	2
4.7	Tutorial	1
	Total	**48**

Course Designers:

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14CG220	SOFTWARE ENGINEERING THEORY AND PRACTICE	L	T	P	Credit
		3	0	0	3

Preamble

The main objective of this subject is to promote the practice of software engineering concepts at a higher level of abstraction, in a more engineering-like fashion.

Prerequisite

Course Outcomes

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

Perform scheduling and tracking, manage risks, manage quality, test the internal workings of the software during software development (CO1)	Create
Illustrate the software development models, illustrate Software Configuration Management, compute effort and cost estimates for the software and apply the testing strategies and testing tactics during software development. (CO2)	Apply
Prepare Software Requirement Specification, illustrate the design of a client server system and to illustrate software and business process Reengineering. (CO3)	Apply
Understand the software process and architectures (CO4)	Apply

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

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

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Develop a Risk Mitigation, Monitoring and Management strategy for the Risk **Late Delivery** and also develop a Risk Information Sheet. (Create)

2. Prepare a risk table for a next-generation word-processing software. Write the Risk Mitigation strategy for any one of the risks identified. (Apply)
3. Draw the CFG and calculate the cyclomatic complexity for the following program

```
int compute_gcd(x, y)
int x, y;
{
while (x! = y){
if (x>y) then
x= x – y;
else y= y – x;
 }
 return x;
}
```

(Apply)

4. Prepare the earned value statistics for a small software project of your choice. (Create)

Course Outcome 2 (CO2):

1. Illustrate a model that is applicable to all types of software development and provides an accurate picture of the current state of the project. (Apply)
2. Prepare a statement of software scope that describes the lawn-mowing robot software Do a functional decomposition and estimate the size of each function in LOC. Use the software equation to estimate the minimum development time and effort. The value of special skills factor is 0.16 for small projects (i.e KLOC = 5 to 15) and the value is 0.39 for large projects. Assume the value of productivity parameter to be 8000. (Apply)
3. Using Boundary value analysis, design the black-box test suite for a software that computes the square root of an input integer which can assume values in the range of 0 to 5000 (Apply)

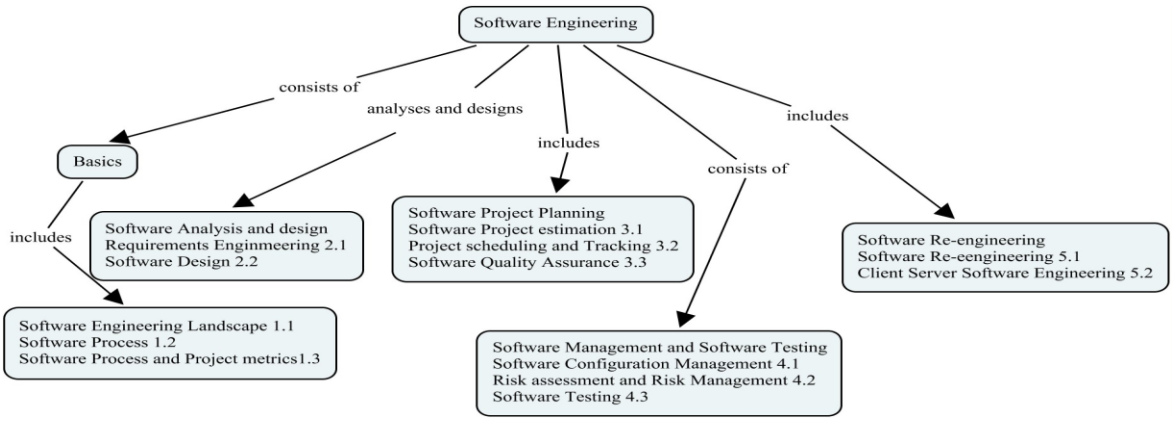
Course Outcome 3 (CO3):

1. Prepare SRS for an online course registration system. (Apply)
2. Illustrate the tasks involved in Reengineering. (Apply)
3. Illustrate the design of any client/server system. (Apply)

Course Outcome 4 (CO4):

1. Illustrate the working principles of call and return architecture. (Understand)
2. Brief about domain specific architecture with neat diagram. (Understand)
3. Explain in detail about the ETVXM architecture. (Understand)

Concept Map



Syllabus

Software Engineering Landscape – Software engineering components – Software development problems – CMM – Software standards. **Software Process** – ETVXM Architecture – Profiles – Development Process – Lifecycle model – Clean room process model – Universal software process model. **Software Process and Project Metrics** – Measures, Metrics and Indicators – Software measurement – Metrics for Software Quality.**Software Analysis: Requirements Engineering** – Problem Analysis – Software Requirements Specification – Object Oriented Requirement Analysis – Function Oriented Analysis - Development Methods. **Software Design: Architecture** – Software Architectures – Architectural Styles – Families of Software Architecture. **Software Project Planning -** Software Project Estimation – Decomposition Techniques- Empirical Estimation Models- Make/Buy Decision – Automated Estimation Tools. **Project Scheduling and Tracking –** Defining a task network – Scheduling – Earned Value Analysis- Error Tracking. **Software Quality Assurance** – Quality Concepts – Quality Movement – Software Quality Assurance – Software Reviews – Formal Technical Reviews – Statistical Software Quality Assurance.**Software Configuration Management** – Identification – Version Control – Change Control – Configuration Audit – Status Reporting – SCM Standards. **Risk Analysis and Risk Management** – Risk Strategies – Software Risks- Risk Identification – Risk Projection – Risk Refinement – RMMM. **Software Testing** – Software Testing Fundamentals – Test Case Design – White Box Testing – Basis Path Testing – Control Structure testing - Black Box Testing.**Reengineering:** Software Reengineering: Business process reengineering, Software Reengineering, Reverse Engineering, Restructuring, Forward Engineering, Reengineering Economics. Client / Server Software Engineering: Structure of client server systems, Software engineering for C/S systems, Analysis modeling issues, Design for C/S systems, Testing issues

Reference Books

1. James F. Peters , “Software Engineering – An Engineering Approach”, John Wiley & Sons. 2004.
2. Roger S. Pressman, Software Engineering A Practitioner's Approach, sixth Edition, McGraw Hill International Edition, 2007.
3. Roger S. Pressman, Software Engineering A Practitioner's Approach, Fifth Edition, McGraw Hill International Edition.,2000
4. Ian Somerville-Software Engineering, John Wiley and sons, 2003

5. Pankaj Jalote: An Integrated Approach to Software Engineering - Narosa Publishers - 1994.
6. Stephen R. Schach: Classical and Object Oriented Software Engineering, Irwin, McGraw Hill - 1996.

Course Contents and Lecture Schedule

Module No.	Topic	No of Lectures
1.	**Software Engineering**	
1.1	**Software Engineering Landscape**	
1.1.1	Software engineering components , Software development problems	1
1.1.2	CMM, Software standards	1
1.2	**Software Process**	
1.2.1	ETVXM Architecture	1
1.2.2	Profiles, Development Process	1
1.2.3	Lifecycle model	1
1.2.4	Clean room process model	1
1.2.5	Universal software process model.	
1.3	**Software Process and Project Metrics**	
1.3.1	Measures, Metrics and Indicators,	1
1.3.2	Metrics for Software Quality.	1
2.	**Software Analysis and Design**	
2.1	**Requirements Engineering**	
2.1.1	Software Requirements Specification	1
2.1.2	Object Oriented Requirement Analysis	1
2.1.3	Function Oriented Analysis	1
2.1.4	Development Methods	1
2.2	**Software Design**	
2.2.1	Software Architectures	1
2.2.2	Architectural Styles	1
2.2.3	Families of Software Architecture	1
3.	**Software Project Planning**	
3.1	**Software Project Estimation**	
3.1.1	Decomposition Techniques	1
3.1.2	Empirical Estimation Models	
3.1.3	Make/Buy Decision, Automated Estimation Tools	1
3.2	**Project Scheduling and Tracking**	
3.2.1	Defining a task network	1
3.2.3	Scheduling, Earned value analysis, Error Tracking	1
3.3	**Software Quality Assurance**	
3.3.1	Quality Concepts, Quality Movement	1
3.3.2	Software Quality Assurance, Software Reviews	1
3.3.2	Formal Technical Reviews, Statistical Software Quality Assurance	1
4	**Software Management and Testing**	
4.1	**Software Configuration Management**	
4.1.1	Identification, Version Control	1
4.1.2	Change Control	1
4.1.3	Configuration Audit, Status Reporting, SCM Standards	1

4.2	**Risk Analysis and Risk Management**	
4.2.1	Risk Strategies, Software Risks	1
4.2.2	Risk Identification, Risk Projection	1
4.2.3	Risk Refinement, RMMM	1
4.3	**Software Testing**	
4.3.1	Software Testing Fundamentals, Test Case Design	1
4.3.2	White Box Testing, Basis Path Testing	1
4.3.3	Control Structure testing	1
4.3.4	Black Box Testing	1
5	**Reengineering**	
5.1	**Software Reengineering**	
5.1.1	Business process reengineering	1
5.1.2	Software Reengineering, Reverse Engineering	1
5.1.3	Restructuring, Forward Engineering	1
5.1.4	Reengineering Economics	
5.2	**Client / Server Software Engineering**	1
	Total	**36**

Course Designers:

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

		L	T	P	Credit
14CGPA0	**DATABASE SYSTEMS**	3	1	0	4

Preamble

This course aims at facilitating the student to understand the concepts of database systems, design methods, querying and managing databases.

Prerequisite

Course Outcomes

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

Develop an E-R Model to meet the requirements of any database application. (CO1)	Create
Build relational and object oriented databases using SQL and manipulate data using relational and structured query languages. (CO2)	Apply
Design a normalized database application using constraints. (CO3)	Create
Construct data storage structures like indices and hashing for the fast retrieval of data. (CO4)	Create
Understand the concepts of concurrent transaction execution and apply them to ensure consistency of database. (CO5)	Apply
Create portable databases using XML standards. (CO6)	Apply
Explain the working principle of distributed database systems and the concepts of temporal, spatial, image and NOSQL databases. (CO7)	Understand

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	S	S	S	L	L						
CO2	S	S	S	L	M						
CO3	S	S	S	M	L						
CO4	S	S	S	M							
CO5	M	M	M	L							
CO6	M	L	L	L							
CO7	M	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	10
Understand	20	20	40	30
Apply	50	40	40	40
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	10	20	0	20

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Consider a database used to record the marks that students get in different exams of different course offerings. Construct an E-R diagram that models exams as entities, and uses a ternary relationship for the database.
2. Design a generalization-speciation hierarchy for a motor vehicle sales company. The company sells motor cycles, passenger cars, vans, and buses. Identify the attributes at each level of the hierarchy.
3. Define the concept of aggregation. Give two examples of where this concept is useful.

Course Outcome 2 (CO2):

1. Consider the following schema and write the SQL for the following:

   Country(name,cont,pop,gdp,life-exp)

   River(name,origin,lenth)

   City(name, country, pop)

   a. Find all countries 8whose GDP is greater than $700 billion but less than $3 trillion.
   b. List the life expentency in countries that have river originating in them
   c. Find all cities that are either in south america or whose population is less than 4 million.
   d. List all cities which are not in south America
2. Consider the following schema and write the following queries in relational algebra.

   Suppliers (sid, sname, address)

   Parts (pid, pname,color)

   Catelog (sid,pid,cost)

   a. Find the names of suppliers who supply some red part.
   b. Find the sids of suppliers who supply some red and green part.
   c. Find the sids of suppliers who supply every part.
   d. Find the pids of the most expensive parts supplied by supplier named Sham

Course Outcome 3 (CO3)

1. Why BCNF is stronger than 3NF? Justify.
2. What is the need for normalization?
3. Consider a relation R with five attributes ABCDE. You are given the following dependencies: A→B, BC→E, and ED→A.
   a. List all keys for R.
   b. Is R in 3NF?
   c. Is R in BCNF?

4. Design the database for banking environment by following the design phases including normalization.

Course Outcome 4 (CO4)

1. Suppose that we are using extendable hashing on a file that contains records with the following search-key values: 2, 3, 5, 7, 11, 17, 19, 23, 29, and 31. Show the extendable hash structure for this file if the hash function is h(x) = x mod 8 and buckets can hold three records.
2. What is dense and sparse index?
3. Differentiate static and dynamic hashing.

Course Outcome 5 (CO5)

1. Define ACID properties.
2. How do you implement atomicity in transactions?
3. Consider the following two transactions:

T1: Read (A);
Read (B);
If A = 0 then B:= B +1;
Write (B);

T2: Read (B);
Read (A);
If B = 0 then A:= A +1;
Write (A);

Let the consistency requirement be A = 0 V B = 0, with A = B = 0 the initial values.

a. Show that every serial execution involving these two transactions preserves the consistency of the database.
b. Show a concurrent execution of T1 and T2 that produces a non serializable schedule.

Course Outcome 6 (CO6)

1. Mention the purpose of XML namespace
2. Explain with your own example, how XML schema address the limitations of DTD
3. Consider the following non - 1NF 'books' relation:

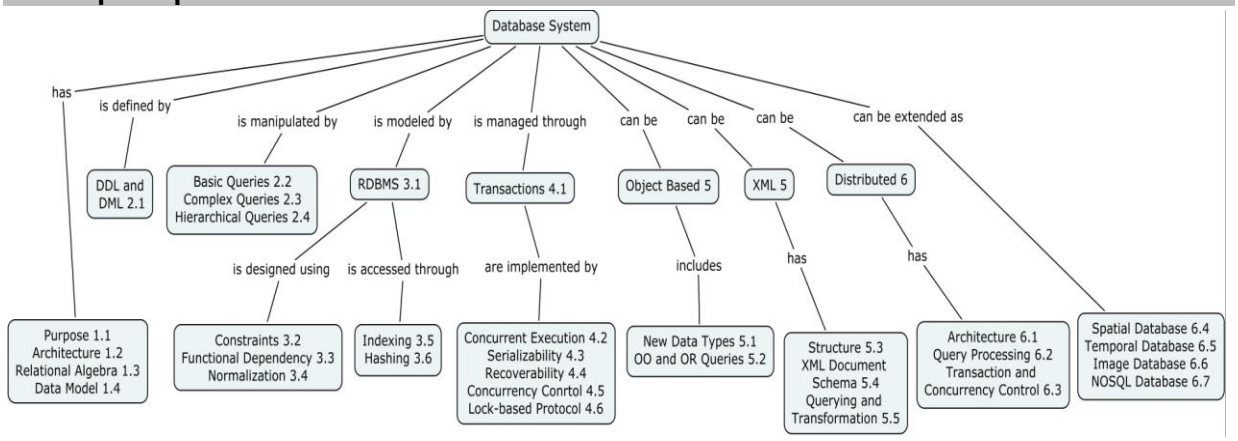
Title	Author-array	Publisher	Keyword_set
		(name, branch)	
Compilers	[Smith, Jones]	(McGraw-Hill, NewYork)	{parsing, analysis}
Networks	[Jones, Frick]	(oxford, London)	{LAN, protocol}

Show how to represent the above relation using XML, by giving a DTD.

Course Outcome 7 (CO7)

1. What are the advantages of distributed database?
2. What are the new data types used in spatial application?
3. How might a distributed database designed for local area network differ from one designed for wide area network?
4. Explain different spatial operations used in spatial queries?

Concept Map



Syllabus

Introduction: Purpose, Architecture, Relational Algebra, Data Model. **Structured Query Language**: DDL and DML, Basic Queries, Complex Queries, Hierarchical Queries **Relational Database Design:** RDBMS Concepts, Constraints, Functional Dependency, Normalization, Indexing, Hashing. **Transaction Management:** Transaction – Concepts, Concurrent Execution, Serializability, Recoverability, Concurrency Control, and Lock based Protocol. **Object Based Databases and XML:** New Data Types in SQL, Object Oriented and Object Relational Queries, Structure of XML Data, XML Document Schema, Querying and Transformation. **Distributed Database and New Applications:** Distributed Database – Architecture, Query Processing, Transaction and Concurrency Control, Spatial Database, Temporal Database, Image Database and NOSQL database.

Reference Books

1. Silberschatz, Korth, Sudarshan, "Database System Concepts", 5th Edition, Tata McGrawHill, 2006.
2. Thomas Connolly, Carolyn Begg, "Database Systems – A practical Approach to Design, Implementation and Management", 3rd Edition, Pearson Eduction, 2003.
3. Ramez Elmasri, Shamkant B. Navathe, "Fundamentals of Database System", 4th edition, Pearson Education, 2004.
4. Raghu Ramakrishnan and Johannes Gehrke, "Database Management System", 3rd edition, TMH, 2003.
5. Shashi Shekhar and Sanjay Chawla, "Spatial Database – A Tour", Pearson Education, 2003.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1	**Introduction**	
1.1	Purpose	1
1.2	Architecture	1
1.3	Relational Algebra	2
	Tutorial	**1**
1.4	Data Model	1
	Tutorial	**1**
2.	**Structured Query Language**	
2.1	DDL and DML	1
2.2	Basic Queries	1
2.3	Complex Queries	2
2.4	Hierarchical Queries	1
	Tutorial	**3**
3	**Relational Database Design**	
3.1	RDBMS - Concepts	1
3.2	Constraints	
3.3	Functional Dependency	1
3.4	Normalization	2
	Tutorial	**2**
3.5	Indexing	2
3.6	Hashing	2
	Tutorial	**2**
4	**Transaction Management**	
4.1	Transactions – Concepts	1
4.2	Concurrent Execution	1
4.3	Serializability	2
4.4	Recoverability	1
4.5	Concurrency Control	1
4.6	Lock-based protocol	1
	Tutorial	**1**
5	**Object Based Databases and XML**	
5.1	New Data Types in SQL	1
5.2	Object Oriented and Object Relational Queries	1
5.3	Structure of XML Data	1
5.4	XML Document Schema	1
5.5	Querying and Transformation	1
	Tutorial	**1**
6	**Distributed Database and New Applications**	
6.1	Distributed Database - Architecture	1
6.2	Query Processing	1
6.3	Transaction and Concurrency Control	1
6.4	Spatial Database	1
6.5	Temporal Database	
6.6	Image Database	1
6.7	NOSQL Database	1
	Tutorial	**1**
	Total	**48**

Course Designers:

1. Mr. M. Sivakumar mskcse@tce.edu
2. Ms. B. Subbulakshmi bscse@tce.edu

14CGPB0	INFORMATION STORAGE AND NETWORKING	L	T	P	Credit
		4	0	0	4

Preamble

The course on Information Storage and Networking aims to emphasize the need for information storage, provide an in depth coverage of various technologies used in the networked storage.

Prerequisite

Course Outcomes

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

Describe the components and protocols used in the Information Storage Systems and functionality of existing storage systems. (CO1)	Understand
Identify the Disk Failure and use of Backup technologies for Recovery. (CO2)	Apply
Create storage system based on interaction with storage user (CO3)	Create

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

S- Strong; M-Medium; L-Low

Assessment Pattern

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

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. What are the different categories of data?
2. List the demerits of centralized data storage.
3. Describe the key requirements of storage systems with their functionalities.
4. Describe the disk drive components and its operation in detail
5. Describe the evolution of date storage systems.

Course Outcome 2 (CO2):

1. Explain how remote replication technology is helpful in disaster recovery.
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.

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

   Current Situation/Issue:
   The corporation's mission critical Database application takes up 1 TB of storage on a high end Storage Array. In the past year, top management has become extremely concerned because they do not have DR plans which will allow for zero RPO recovery if there is a site failure. The primary DR Site is the 2nd Data Center 50 miles away. The company would like explore remote replication scenarios which will allow for near zero RPO and a minimal RTO. The company is aware of the large costs associated with network bandwidth.
   Develop a near zero RPO backup solution .

Course Outcome 3 (CO3):

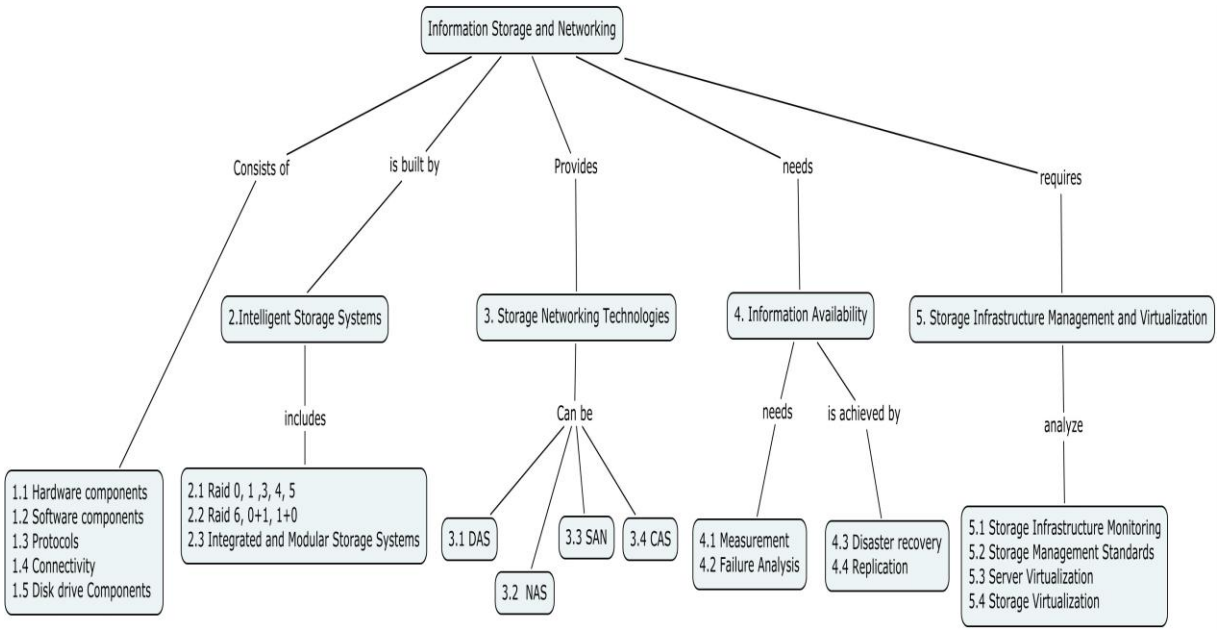
1. AirTel Telecom is involved in mobile wireless services across the India and has about 5000 employees worldwide. This company is Chennai based and has 7 regional offices across the country. Although AirTel is doing well financially, they continue to feel competitive pressure. As a result, the company 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.

Concept Map



Syllabus

Introduction - Hardware and software components of the host environment - Key protocols and concepts used by each component - Physical and logical components of connectivity environment - Physical Components of a disk drive - Logical constructs of a physical disk. **Intelligent Storage Systems -** RAID levels: RAID 0, RAID 1, RAID 3, RAID 4, RAID 5 - RAID 6 - RAID 0+1, RAID 1+0 - Integrated and Modular Storage Systems - Intelligent Storage System **Storage Networking Technologies-**Direct Attached Storage :Architecture and components - Network Attached Storage : Architecture and components and connectivity - Storage Area Network :Evolution, Architecture, components and connectivity - Need for long-term archiving solution: CAS : Object based data storage and Retrieval **Information Availability -**Information Availability and its measurement- causes and consequences of downtime - Failure Analysis: Single points of failure in a storage infrastructure and solutions for its mitigation- Fault Tolerance –Business continuity- Disaster Recovery (DR): Recovery Time Objective (RTO) and Recovery Point Objective (RPO) – Overview of backups : Direct-attached backups- LAN-based backups- LAN-free backups- Server less backups – Archival - Replication - Remote replication: Host-based, Storage Array-based**Storage Infrastructure Management and Virtualization** Storage Infrastructure Monitoring: Parameters, Components - key management activities- storage management standards and initiative - Virtualization technologies: Server Virtualization (LVM –based virtualization, Memory virtualization), Network (VLAN and VSAN), Storage (Disk virtualization, RAID, LUN masking, File and block level virtualization, Virtual Provisioning)

Reference Books

1. Information Storage and Management, EMC Corporation, Wiley 2009,
ISBN: 04702942134

2. Storage Networks: The Complete Reference - Robert Spalding - Tata McGraw Hill-Osborne- 2003.

3. Building Storage Networks - Marc Farley - Tata McGraw Hill-Osborne- 2001.

4. Disaster Recovery and Business Continuity - Thejendra BS- Shroff Publishers and Distributors-2006.

5. Storage Area Network Fundamentals- Meeta Gupta- Pearson Education Limited, 2002

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1	**Introduction**	
1.1	Hardware components of the host environment	2
1.2	Software components	2
1.3	Key protocols and concepts used by each component	2
1.4	Physical and logical components of Connectivity environment	2

Module No.	Topic	No. of Lectures
1.5	Physical Components of a disk drive - Logical constructs of a physical disk	2
2	**Intelligent Storage Systems**	
2.1	RAID levels- RAID 0, RAID 1, RAID 3, RAID 4, RAID 5	2
2.2	RAID 0+1, RAID 1+0, RAID 6	2
2.3	Integrated and Modular Storage Systems - Intelligent Storage System	2
3	**Storage Networking Technologies**	
3.1	Direct Attached Storage – Architecture and components	3
3.2	Network Attached Storage – Architecture and components and connectivity	3
3.3	Storage Area Network – Evolution, Architecture, components and connectivity	3
3.4	Need for long-term archiving solutions – CAS : Object based data storage and Retrieval	3
4	**Information Availability**	
4.1	Information Availability and its measurement- causes and consequences of downtime	2
4.2	Failure Analysis: Single points of failure in a storage infrastructure and solutions for its mitigation- Fault Tolerance –Business continuity	3
4.3	Disaster Recovery (DR): Recovery Time Objective (RTO) and Recovery Point Objective (RPO)- Overview of backups : Direct-attached backups- LAN-based backups- LAN-free backups- Server less backups – Archival	3
4.4	Replication - Remote replication: Host-based, Storage Array-based	3
5	**Storage Infrastructure Management and Virtualization**	
5.1	Storage Infrastructure Monitoring: Parameters, Components- key management activities	2
5.2	Storage management standards and initiative	2
5.3	Virtualization technologies: Server Virtualization (LVM –based virtualization, Memory virtualization)	2
5.4	Network (VLAN and VSAN), Storage (Disk virtualization, RAID, LUN masking, File and block level virtualization, Virtual Provisioning)	3
	Total	**48**

Course Designers:

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

		L	T	P	Credit
14CGPC0	**MACHINE LEARNING**	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.

Prerequisite

Course Outcomes

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

Outline the steps involved in designing a machine learning algorithm. (CO1)	Understand
Construct training and prediction algorithms for classification using decision trees and artificial neural networks (CO2)	Apply
Construct learning algorithms using Bayesian probabilistic models for complex applications. (CO3)	Apply
Outline the fundamentals of computational learning theory with an understanding of the mistake bounds (CO4)	Understand
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.	L										
CO2.	M	M	M	M	L						M
CO3.	M	M	M	M	L						M
CO4.	L	L	L								
CO5.	M	M	M	M	M						M
CO6.	S	S	S	S	S	S		M	L	S	S
CO7.	M	M	M	M	S	S		M	L	S	S

S- Strong; M-Medium; L-Low

Assessment Pattern

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

Apply	20	30	40	40
Analyse	20	30	40	40
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (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 2 (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.

Course Outcome 3 (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 4 (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 5 (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 6 (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 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.

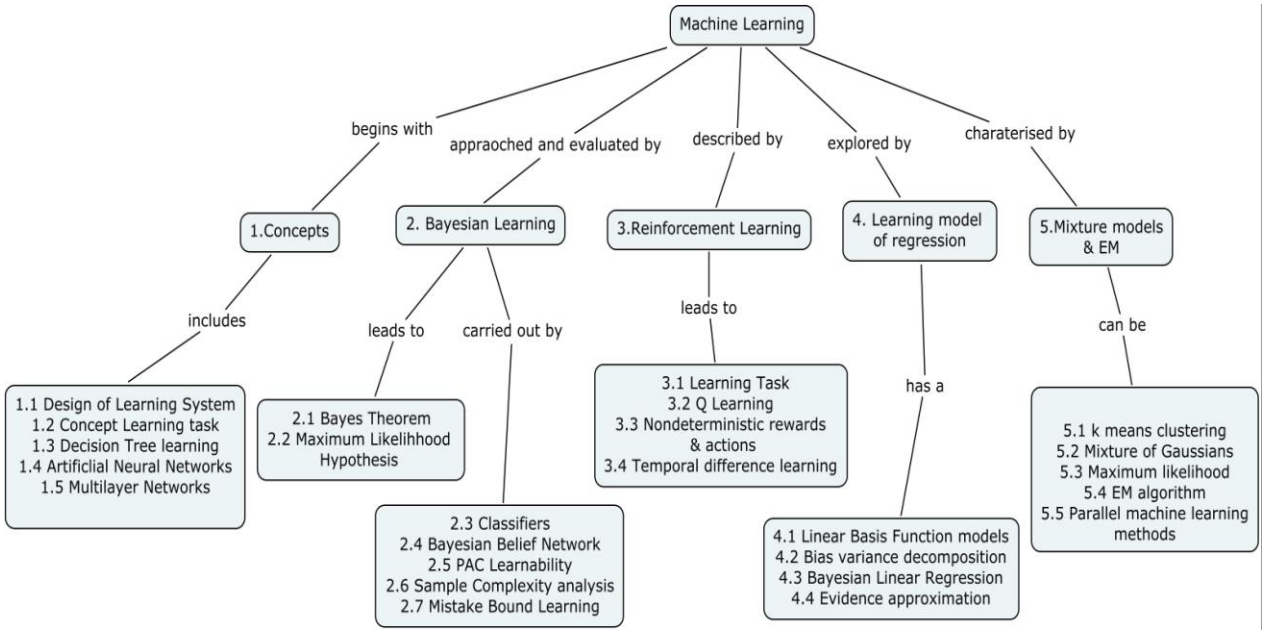
Course Outcome 7 (CO7):

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 – Designing a learning system, Concept learning based on symbolic or logical representations, Decision tree learning and the problem of overfitting data, Artificial Neural networks. **Bayesian Learning –** Optimal classifier – Belief networks - Computational learning theory - PAC learning model and Mistake bound learning. **Reinforcement learning** – Q learning, Nondeterministic Rewards and Actions- Temporal difference learning. **Linear Model of Regression** – Linear basis function models – Bias variance decomposition – Bayesian Linear Regression – Evidence approximation. **Mixture models and EM –** k means clustering – Mixture of Gaussians – EM algorithm - Practical aspects of implementing Parallel machine learning methods

Reference Books

1) Tom M. Mitchell, “Machine learning”, McGraw Hill,1997.

2) Ethem Alpaydin, “Introduction to machine learning”, The MIT Press,2004.

3) Christopher M.Bishop, “Pattern recognition and machine learning”, Springer,2007.

4) Stephen Marsland, “Machine learning: An algorithmic perspective”,CRC,2009

Course Contents and Lecture Schedule

Module No.	Topics	No.of Lectures
1	**Introduction to learning system(10)**	
1.1	Design of learning system	2
1.2	Concept learning task	2
1.3	Decision Tree learning	2
1.4	Artificial Neural networks	2
1.5	Multilayer networks	2
2	**Bayesian Learning (11)**	
2.1	Bayes Theorem	1
2.2	Maximum Likelihood hypothesis	1
2.3	Classifiers	2
2.4	Bayesian Belief networks	1
2.5	PAC learnability	2
2.6	Sample complexity analysis	2
2.7	Mistake bound learning	2
3	**Reinforcement Learning(10)**	
3.1	Learning Task	2
3.2	Q Learning	3
3.3	Nondeterministic rewards and actions	2
3.4	Temporal difference learning	2
4	**Learning model of regression (9)**	
4.1	Linear Basis Function Models	3
4.2	Bias variance decomposition	2
4.3	Bayesian Linear Regression	2
4.4	Evidence approximation	2
5	**Mixture models and EM (10)**	
5.1	k means clustering	2
5.2	Mixture of Gaussians	1
5.3	Maximum likelihood	2
5.4	EM algorithm	2
5.5	Practical aspects of implementing Parallel machine learning methods	2
	Total	**48**

Course Designers:

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

		L	T	P	Credit
14CGPD0	**WIRELESS AD HOC NETWORKS**	4	0	0	4

Preamble

The course aims at exploring the concepts of wireless networks, protocols, architectures and applications.

Prerequisite

Course Outcomes

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

Understand the basic principles of wireless networks and their standards. (CO1)	Understand
Understand the mobility and power management concepts. (CO2)	Understand
Calculate the congestion window size for different versions of TCP (CO3)	Apply
Compare the different TCP solutions for ad hoc wireless networks. (CO4)	Analyze
Compare the different routing protocols. (CO5)	Analyze

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	M										
CO2	M										
CO3	S	M	M								
CO4	S	M	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	10	10
Understand	30	20	10	10
Apply	0	10	10	10
Analyse	50	50	60	60
Evaluate	0	0	10	10
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. State the different propagation mechanisms.
2. Identify and list the limitation of Table driven routing protocols
3. Summarize the different issues in Ad hoc wireless networks

Course Outcome 2 (CO2):

1. State the different classifications of energy management schemes
2. Explain the principle of system power management scheme.
3. State the different schemes used for battery management schemes.

Course Outcome 3 (CO3):

1. In a military vehicular ad hoc wireless network using PRTMAC, formed by 500 nodes distributed uniformly in a battlefield area of 1000 m x 1000 m, calculate the number of nodes contending for the data channel and for control channel. The transmission range of data channel is 250 m.
2. Assume that when the current size of congestion window is 48 KB, the sender experiences a timeout. What will be the congestion window size of the next three transmission bursts are successful? Assume that MSS is 1 KB. Consider TCP TAHOE and TCP RENO.
3. Assume that when the current size of congestion window is 48 KB, the sender experiences a timeout. What will be the congestion window size of the next seven transmission bursts are successful? Assume that MSS is 1 KB. Consider TCP TAHOE and TCP RENO.

Course Outcome 4 (CO4):

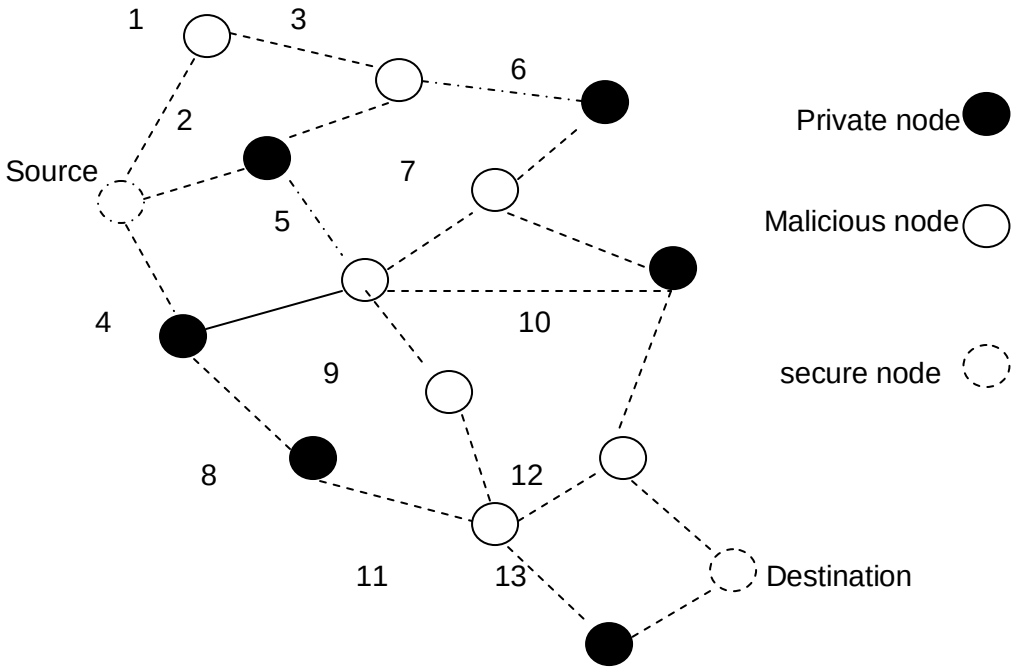
1. Compare the different TCP solutions for Ad hoc wireless networks
2. Compare the various secure routing methods used in Ad hoc networks.
3. Distinguish the salient features of TCP Bus compared to other schemes .

Course Outcome 5 (CO5):

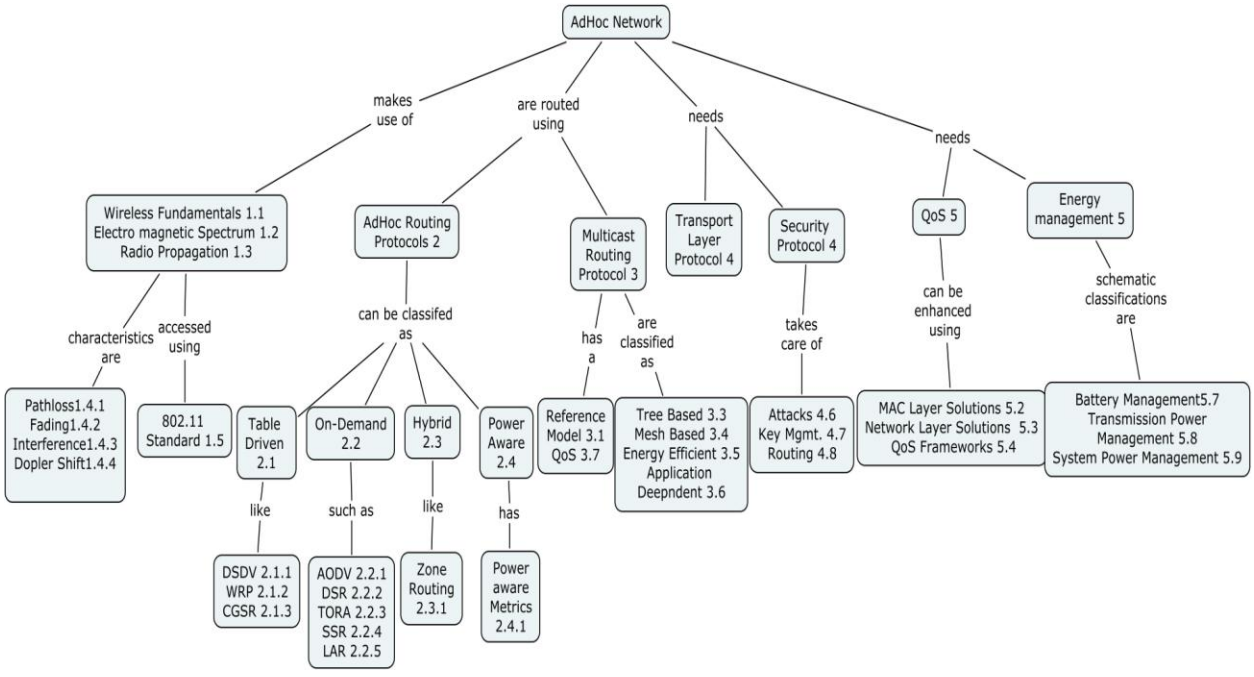
1. Compare topology reorganization in DSDV and CGSR routing protocols
2. Compare the various secure routing methods used in Ad hoc networks.
3. Examine the different phases of Associativity- Based Ad hoc Multicast routing.

Course Outcome 6 (CO6):

1. Nodes A and B want to establish a secure communication, and node A generates a random key 11001001. Suppose the functions used by both the nodes A and B for encryption is XOR, and let node A generate a random transport key 10010101 and let node B generate 00101011.Sketch the three pass Shamir protocol exchanges.
2. Predict the possible steps of the algorithms executed at the source and the intermediate nodes of an ad hoc wireless network that follow the following strategies: a) random energy b) pay-for-it strategy. Assume a session between source s and destination d. let R(s,d) be the set containing available routes between s and d , sympathy(k,r) be the the kth node in route r, and credit(k,r) and debit(k,r) be the credit and debit of kth node in route r respectively.
3. Mark the paths chosen by the following secure-routing protocols for the network topology shown in figure: a) Shortest path routing and b) SAR protocol. Assume that node 2 is secure node. C) If node 2 (which lies in the path chosen by SAR protocol) is suddenly attacked and becomes a malicious node, then mark an alternative path chosen by SAODV protocol.



Concept Map



Syllabus

Introduction :Introduction-Fundamentals of Wireless Communication Technology - The Electromagnetic Spectrum - Radio Propagation Mechanisms - Characteristics of the Wireless Channel - IEEE 802.11 Standard –**Ad Hoc Routing Protocols**: Issues and Challenges - Classifications of Routing Protocols-Table-Driven Routing Protocols - On-Demand Routing Protocols – Hybrid Routing Protocols- Power-Aware Routing

(PAR) - **Multicast routing In Ad Hoc Networks**: - An Architecture Reference Model for Multicast Routing Protocols -Classifications of Multicast Routing Protocols- Tree-Based Multicast Routing Protocols- Mesh-Based Multicast Routing Protocols-Energy-Efficient Multicasting - Multicasting with Quality of Service Guarantees – Application-Dependent Multicast Routing **Transport Layer, Security Protocols**: Designing a Transport Layer Protocol - Design Goals of a Transport Layer Protocol -Classification of Transport Layer Solutions - TCPOver Ad Hoc Wireless Networks -Other Transport Layer Protocols - Security Requirements - Issues and Challenges in Security Provisioning -Network Security Attacks - Key Management - Secure Routing **Qos and Energy Management**: Classifications of QoS Solutions - MAC Layer Solutions-Network Layer Solutions - QoS Frameworks for Ad Hoc Wireless Networks Energy Management in Ad Hoc Wireless Networks –Introduction - Need for Energy Management in Ad Hoc Wireless Networks - Classification of Energy Management Schemes - Battery Management Schemes - Transmission Power Management Schemes - System Power Management Schemes

Reference Books

1. C.Siva Ram Murthy and B.S. Manoj "Ad Hoc Wireless Networks:

Architectures and Protocols", Pearson education, 2008

2.Charles E. Perkins, Ad Hoc Networking, Addison Wesley, 2000

3.William Stallings, "Wireless Communications and Networks", Pearson education, 2003

4.J. Schiller, "Mobile Communications", Pearson education, 2003

5.Vijay K. Garg, "Wireless Communications and Networking", Elsevier, 2008.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1	**AdHoc Networks Introduction (7)**	
1.1	Fundamentals of Wireless Communication	2
1.2	The Electromagnetic Spectrum	1
1.3	Radio Propagation Mechanisms	2
1.4	Characteristics of the Wireless Channel	1
1.5	IEEE 802.11 Standard	1
2	**Ad Hoc Routing Protocols (11)**	
2.0	Issues and Challenges	2
2.1	Table-Driven Routing Protocols	3
2.2	On Demand Routing Protocols	2
2.3	Hybrid Routing Protocols	2
2.4	Power-Aware Routing	2
3	**Multicast routing In Ad Hoc Networks (10)**	
3.1	An Architecture Reference Model for Multicast Routing Protocols	2

3.2	Classifications of Multicast Routing Protocols	1
3.3	Tree-Based Multicast Routing Protocols	2
3.4	Mesh-Based Multicast Routing Protocols	2
3.5	Energy Efficient Routing Protocols	1
3.6	Application Dependent Protocols	1
3.7	Multicasting with QoS Guarantee	1
4	**Transport Layer, Security Protocols (10)**	
4.1	Designing a Transport Layer Protocol	2
4.2	Design Goals of a Transport Layer Protocol	1
4.3	TCP Over Ad Hoc Wireless Networks	2
4.4	Other Transport Layer Protocols	1
4.5	Security Requirements - Issues and Challenges in Security Provisioning	1
4.6	Network Security Attacks	1
4.7	Key Management	1
4.8	Secure Routing	1
5	**Qos and Energy Management (10)**	
5.1	Classifications of QoS Solutions	1
5.2	MAC Layer Solutions	1
5.3	Network Layer Solutions	1
5.4	QoS Frameworks	1
5.5	Energy Management	1
5.6	Classification of Energy Management Schemes	1
5.7	Battery Management Schemes	2
5.8	Transmission Power Management Scheme	1
5.9	System Power Management Schemes	1
	Total	**48**

Course Designers:

1. Mr. C.Senthilkumar cskcse@tce.edu
2. Mr. S.Prasanna sprcse@tce.edu

14CGPE0	DISTRIBUTED OPERATING SYSTEMS CONCEPTS AND PRINCIPLES	L	T	P	Credit
		4	0	0	4

Preamble

This course will facilitate the Students to understand the concepts of distributed operating systems components like transparency, or single system image, DOS Issues, RPC, and Server Management etc.. Distributed Operating Systems concludes with a set of case studies that provide real–world insights into different distributed file systems.

Prerequisite

- Operating System Concepts

Course Outcomes

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

Understand the Hardware, software concepts required for DOS and the issues in the DOS. (CO1)	Understand
Apply the concepts of Remote Procedure Call (RPC), Server Management, and Parameter passing semantics and call semantics for given scenario. (CO2)	Apply
Apply the concepts of Election algorithm, event ordering, and Mutual exclusion and deadlock in DOS environment. (CO3)	Apply
Illustrate the different consistency model, replacement strategy in distributed Shared Memory (DSM). (CO4)	Apply
Apply the fault tolerance concepts and Distributed file system concepts for a given scenario. (Case studies) (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	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. What is Multicomputer and Multiprocessor?
3. Name the three important features used to differentiate the distributed OS and Network OS
4. Discuss about the advantages and disadvantages of commonly used models in configuring Distributed Operating Systems.
5. Describe in detail about DCE

Course Outcome 2 (CO2):

1. What are the fields in RPC Call Message Format?
2. Implement RPC Mechanism
3. Apply the server implementation to stateful and stateless servers

Course Outcome 3 (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.
5. Illustrate Election algorithms in Distributed Systems

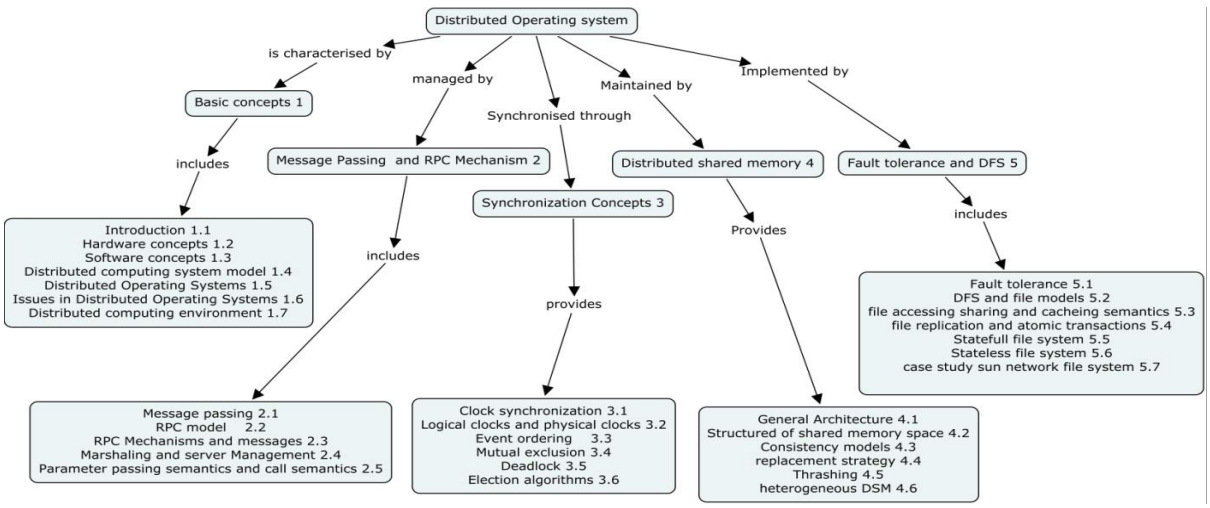
Course Outcome 4 (CO2):

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

Course Outcome 5 (CO2):

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.

Concept Map



Syllabus

Distributed Systems - Introduction, Hardware concepts software concepts – Distributed Computing System Models – Distributed Operating Systems – Issues in Distributed Operating Systems – Distributed Computing Environment **Message passing and RPC Mechanism** – Message passing – Remote Procedure call model – Implementing RPC mechanism – RPC Messages – Marshaling – Server Management Parameter passing semantics – call semantics **Synchronization** – Clock Synchronization – logical clocks – physical clocks – event ordering – mutual exclusion – deadlock – election algorithms – **Distributed Shared Memory** – General Architecture – structure of shared memory space – consistency models – replacement strategy – thrashing – heterogeneous Distributed Shared Memory. **Fault Tolerance and Distributed File Systems -** Fault tolerance – Distributed File Systems **–** File models – file accessing models – file sharing semantics – file caching semantics – file replication – atomic transactions – design principles – Stateful and Stateless File Systems - case studies –Network File Systems

Reference Books

1. Pradeep K. Sinha, Distributed Operating Systems Concepts and Design, Prentice Hall of India Private Limited, 2008
2. Andrew S. Tanenbaum, Maarten Van Steen, Distributed Systems Principles and Paradigms, Pearson Education, 2007
3. D M Dhamdhere, Operating Systems A Concept Based Approach: Tata McGraw-Hill Publishers, 2003, Second Reprint.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1	**Distributed System**	
1.1	Introduction of Distributed Systems	2
1.2	Hardware Concepts	1
1.3	Software Concepts	1
1.4	Distributed Computing System Models	1
1.5	Distributed Operating Systems	1
1.6	Issues in Distributed Operating Systems	2
1.7	Distributed Computing Environment	1
2	**Message Passing and RPC Mechanism**	
2.1	Message passing	2
2.2	Remote Procedure call model	2
2.3	Implementing RPC mechanism and RPC Messages	2
2.4	Marshaling and Server Management	2
2.5	Parameter passing semantics and call semantics	2
3	**Synchronization**	
3.1	Clock Synchronization	1
3.2	logical clocks and physical clocks	2
3.3	Event ordering	1
3.4	Mutual exclusion	2

3.5	Deadlock	3
3.6	Election algorithms	1
4	**Distributed Shared Memory**	
4.1	General Architecture	1
4.2	structure of shared memory space	1
4.3	consistency models	2
4.4	replacement strategy	2
4.5	Thrashing	2
4.6	Heterogeneous Distributed Shared Memory	1
Fault Tolerance and Distributed File Systems		
5.1	Fault Tolerance	2
5.2	Distributed File Systems and File models	2
5.3	file accessing models, file sharing semantics and file caching semantics	2
5.4	file replication and atomic transactions	1
5.5	Stateful file systems	1
5.6	Stateless file systems	1
5.7	case study - SUN Network File Systems	1
	Total	**48**

Course Designers:

1. Mr.R.Chellamani rcmcse@tce.edu

		L	T	P	Credit
14CGPF0	**INTELLIGENT OPTIMIZATION ALGORITHMS**	4	0	0	4

Preamble

Intelligent optimization Algorithms investigate several techniques commonly referred to as intelligent algorithms, and takes a pragmatic engineering approach to the design, evaluation, and implementation of intelligent systems. The algorithmic family includes genetic algorithms, hill-climbing, simulated annealing, ant colony optimization, particle swarm optimization, and so on. The course will enable the students to familiarize the various concepts of these intelligent optimization techniques, such as what they are, how they work, how to design, build and implement them.

Prerequisite

Course Outcomes

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

Explain the need for intelligent optimization techniques and develop single-state algorithms for solving non linear optimization problems. (CO1)	Apply
Experiment with various population based Evolutionary algorithms with suitable solution representation for the given combinatorial problem and compare the performance of various algorithms. (CO2)	Analyze
Apply multi-objective optimization algorithms for real time optimization problems having more than one objective. (CO3)	Apply
Explain different parallelization and model fitting methods and choose the suitable method for the given real time problem and compare their performance. (CO4)	Analyze

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

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

Analyse	0	0	0	20
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Write the basics steps involved in metaheuristics algorithms to optimize the candidate solution? (Remember)
2. Use algorithmic steps to show that local optimization algorithm will become global optimization algorithm? (Understand)
3. Apply Tabu Search algorithm to find Minimum Spanning Tree? (Apply)

Course Outcome 2 (CO2):

1. What are the parameters used in PSO for exploration and exploitation? (Remember)
2. Write an algorithm for uniform crossover with an example. (Understand)
3. Construct an effective ACO algorithm for DNA sequencing problem? (Apply)
4. Analyze the performance of DE with PSO for TSP? (Analyze)

Course Outcome 3 (CO3):

1. What is point mutation? (Remember)
2. How does Tree-Style Genetic Programming Pipeline work? (Understand)
3. Identify the suitable representation, crossover and mutation techniques for Real Coded GA? (Apply)

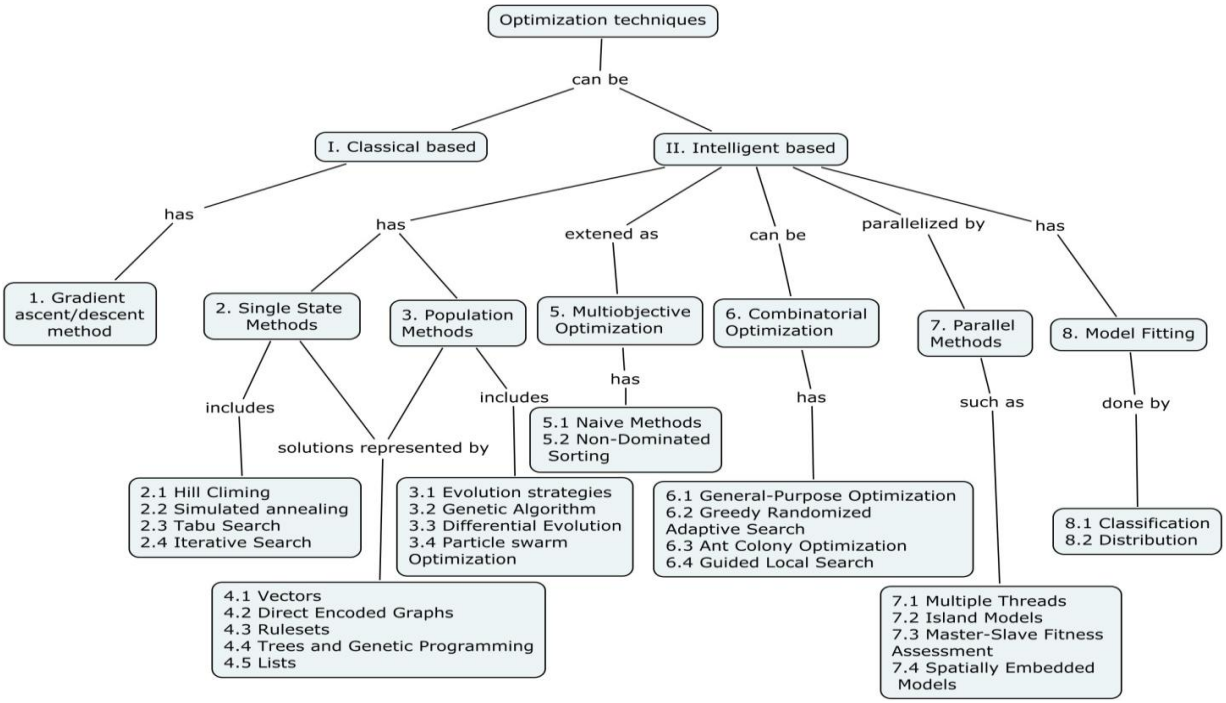
Course Outcome 4 (CO4):

1. What is crowding and niching? (Remember)
2. Explain how Pareto strength is maintained in Multi-objective problem? (Understand)
3. Design a multi-objective Scheduling Problem using PSO? (Apply)

Course Outcome 5 (CO5):

1. What are the ways to parallelize a problem? (Remember)
2. Explain model fitting by classification? (Understand)
3. Construct parallel DE for vertex coloring problem using Island models. (Apply)
4. Develop parallel GA for TSP using Island models and Master-Slave models and compare their performance. (Analyze)

Concept Map



Syllabus

Classical Optimization Techniques – Gradient Ascent/Descent Methods- Drawback of classical techniques – Need for Intelligent techniques- Single-State Methods – Hill Climbing - Simulated Annealing - Tabu Search -Iterated Local Search **Population Methods** - Evolution Strategies- The Genetic Algorithm- Differential Evolution - Particle Swarm Optimization **Representation** – Vectors - Direct Encoded Graphs – Rulesets - Trees and Genetic Programming - Lists, Machine-Language Genetic Programming, and Grammatical Evolution **Multiobjective Optimization** -Naive Methods - Non-Dominated Sorting - Combinatorial Optimization -General-Purpose Optimization and Hard Constraints- Greedy Randomized Adaptive Search Procedures - Ant Colony Optimization -Guided Local Search **Parallel Methods** - Multiple Threads- Island Models - Master-Slave Fitness Assessment - Spatially Embedded Models - Model Fitting - Model Fitting by Classification - Model Fitting with Distribution

Reference Books

1. Michel Gendreau, Jean-Yves Potvin, “Handbook of Metaheuristics”, Second Edition, International Series in Operations Research & Management Science ,Springer 2010.
2. Godfrey C. Onwubolu, B. V. Babu, “New optimization techniques in engineering”, Series: Studies in Fuzziness and Soft Computing, Vol. 141, Springer, 2004.
3. Sean Luke , “Essentials of Metaheuristics”, (Online Version 1.2), lulu.com (March 5, 2011).
4. Crina Grosan, Ajith Abraham, “Intelligent Systems: A Modern Approach”, Intelligent Systems Reference Library,Volume 17, Springer, 2011.
5. D.T. Pham , D. Karaboga, “Intelligent Optimisation Techniques”, Springer, 2000.

Course Contents and Lecture Schedule

Module No.	Topics	No of Lectures
I	**Classical Optimization Techniques**	
1	Gradient Ascent/Descent Methods– Drawback of classical techniques- Need for Intelligent techniques	3
II	**Intelligent Optimization Techniques**	
2	**Single-State Methods**	
2.1	Hill Climbing	1
2.2	Simulated Annealing	2
2.3	Tabu Search	2
2.4	Iterated Local Search	2
3	**Population Methods**	
3.1	Evolution Strategies	2
3.2	Genetic Algorithm	3
3.3	Differential Evolution	2
3.4	Particle Swarm Optimization	2

4	**Representation**	
4.1	Vectors	2
4.2	Direct Encoded Graphs	1
4.3	Rulesets	2
4.4	Trees and Genetic Programming	1
4.5	Lists, Machine-Language Genetic Programming, and Grammatical Evolution	2
5	**Multiobjective Optimization**	
5.1	Naive Methods	1
5.2	Non-Dominated Sorting	2
6	**Combinatorial Optimization**	
6.1	General-Purpose Optimization and Hard Constraints	1
6.2	Greedy Randomized Adaptive Search Procedures	2
6.3	Ant Colony Optimization	2
6.4	Guided Local Search	2
7	**Parallel Methods**	
7.1	Multiple Threads	2
7.2	Island Models	2
7.3	Master-Slave Fitness Assessment	2
7.4	Spatially Embedded Models	1
8	**Model Fitting**	
8.1	Model Fitting by Classification	2
8.2	Model Fitting with Distribution	2
	Total	**48**

Course Designers:

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

		L	T	P	Credit
14CGPG0	**AGENT BASED INTELLIGENT SYSTEMS**	4	0	0	4

Preamble

This course introduces representations, techniques, and architectures used to build applied systems and to account for intelligence from a computational point of view.

Prerequisite

Course Outcomes

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

Outline the behavior of different types of agents and their applications in the field of Artificial Intelligence. (CO1)	Understand
Apply various search techniques to solve gaming problem. (CO2)	Apply
Apply propositional and First Order Logic for designing logical agents. (CO3)	Apply
Illustrate the understanding of Uncertainty and Bayes Rules and apply them to design planning agents (CO4)	Apply
Apply the principles of probabilistic reasoning to design intelligent agents which uses Bayesian networks and Rule based methods. (CO5)	Apply
Apply appropriate learning algorithm for modelling intelligent agents. (CO6)	Apply

Mapping with Programme Outcomes

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

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	30	30	30	30
Apply	50	50	50	60
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Define rational agent?
2. Define inference
3. Differentiate single agent and multi agent

Course Outcome 2 (CO2):

1. What is Alpha Beta Pruning
2. Apply Optimal Strategies used for Game Problems

Course Outcome 3 (CO3):

1. Explain First Order Inference
2. Demonstrate Agent Based Propositional Logic with diagram

Course Outcome 4 (CO4):

1. Apply Baye's Rule for real world problem
2. Apply Baye's rule for combining evidence

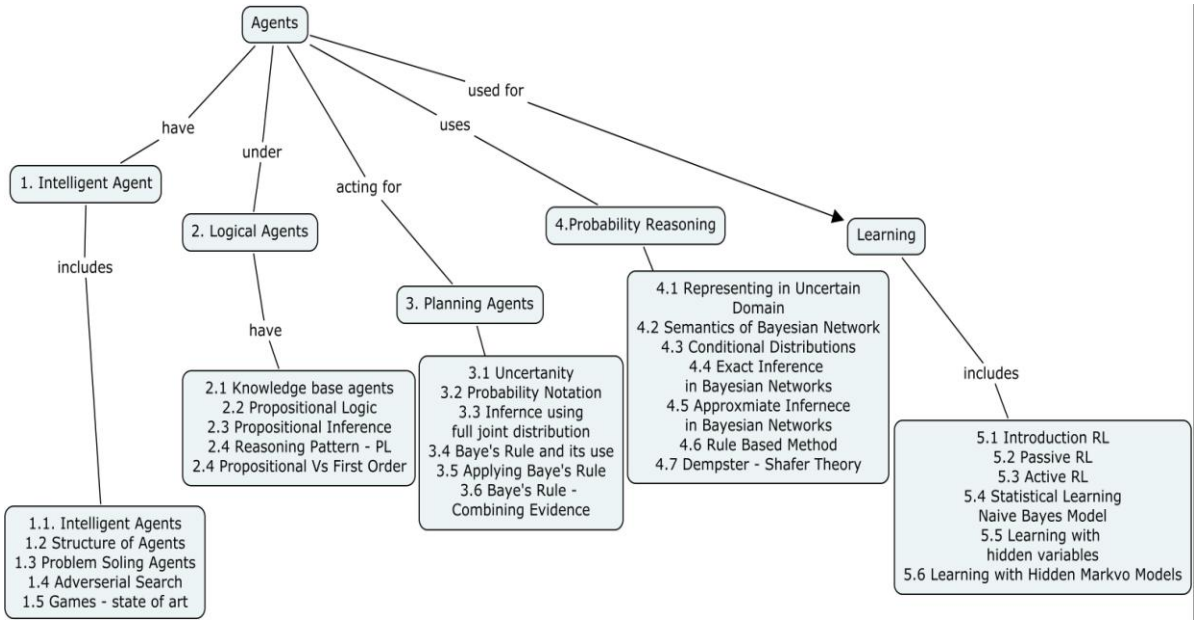
Course Outcome 5 (CO5):

1. Differentiate active and passive RL
2. What is mean by reward in RL
3. What is Bayesian learning
4. Explain Dempster-Shafer Theory
5. Demonstrate the exact inference in Bayesian Networks
6. Demonstrate the learning in Bayesian networks with EM algorithm

Course Outcome 6 (CO6):

1. Explain Q Learning
2. Explain statistical learning with Naïve Baye's Models
3. Why Hidden Markov Model is used
4. How EM is used for real time application

Concept Map



Syllabus

Intelligent Agents : Introduction – Intelligent Agent – Structure of Agents - Problem Solving Agents- Searching for solutions – Adversarial Search – Games, Optimal strategies, Alpha-Beta Pruning, Imperfect Real Time decisions, Games that include an Element of Chance, State of the Art Games Programs **Logical Agents:** Knowledge Based Agents – Propositional Logic – Reasoning patterns in propositional logic – Effective propositional inference – Agent based Propositional Logic, Propositional versus First Order Inference **Planning Agents:** Uncertainty – Acting under Uncertainty, Basic Probability Notation – Propositions, atomic events, prior probability, Axioms of Probability, Inference using Full Joint Distribution, Independence, Baye's Rule and its Use, Applying Baye's Rule, Using Baye's Rule: Combining Evidence **Probabilistic Reasoning:** Representing knowledge in an Uncertain Domain, Semantics of Bayesian Network, Efficient Representation of conditional distributions, Exact Inference in Bayesian Networks, Approximate Inference in Bayesian Networks, Extending probability to first order representation, Rule based methods for uncertain reasoning, Dempster-Shafer Theory **Learning:** Introduction, Passive Reinforcement Learning, Active Reinforcement Learning, Statistical Learning – Learning with complete data, Naïve Baye's Models, Learning with Hidden Variables : EM Algorithm, Learning Hidden Markov Models

Reference Books

1. Stuart Russell," Artificial Intelligence – A Modern Approach" Third Edition, Pearson Edition,2003
2. Elaine Rich, Kevin knight, Shivashankar B Nair, " Artificial Intelligence" Third Edition, Tata Mc Graw Hill,2011

Course Contents and Lecture Schedule

No	Topic	No of Lectures
1.	**Intelligent Agent (10)**	
1.1	Introduction	2
1.2	Intelligent Agent, Structure of Agents	2
1.3	Problem Solving Agent, Searching for solutions	1
1.4	Adversarial Search – Games, Optimal strategies	1
1.5	Alpha-Beta Pruning	1
1.6	Imperfect Real Time decisions	1
1.7	Games that include an Element of Chance	1
1.8	State of the Art Games Programs	1
2.	**Logical Agents (9)**	
2.1	Introduction	1
2.2	Knowledge Based Agents	2
2.3	Propositional Logic	2
2.4	Reasoning Patterns in Propositional logic, Effective propositional inference	1
2.5	Agent Based Propositional Logic	1
2.6	Propositional versus First Order Inference	2
3.	**Planning Agents (10)**	
3.1	Uncertainty – Acting under Uncertainty	2
3.2	Basic Probability Notation – Propositions, atomic events, prior probability	2
3.3	Axioms of Probability	1
3.4	Inference using Full Joint Distribution	1
3.5	Independence	1
3.6	Baye's Rule and its Use	1
3.7	Applying Baye's Rule	1
3.8	Using Baye's Rule: Combining Evidence	1
4	**Probabilistic Reasoning (10)**	
4.1	Representing knowledge in an Uncertain Domain	1
4.2	Semantics of Bayesian Network	2
4.3	Efficient Representation of conditional distributions	1
4.4	Exact Inference in Bayesian Networks	2

4.5	Approximate Inference in Bayesian Networks	1
4.6	Extending probability to first order representation	1
4.7	Rule based methods for uncertain reasoning	1
4.8	Dempster-Shafer Theory	1
5	**Learning (9)**	
5.1	Introduction	1
5.2	Passive Reinforcement Learning	1
5.3	Active Reinforcement Learning	1
5.4	Statistical Learning – Learning with complete data, Naïve Bayes Models	2
5.5	Learning with Hidden Variables : EM Algorithm	2
5.6	Learning Hidden Markov Models	2
	Total	**48**

Course Designers:

1. Dr. M.K.Kavitha Devi mkkditj@tce.edu

CURRICULUM AND DETAILED SYLLABI

FOR

M.E DEGREE (Computer Science and Engineering) PROGRAMME

THIRD AND FOURTH SEMESTER

FOR THE STUDENTS ADMITTED FROM THE

ACADEMIC YEAR 2014-2015 ONWARDS

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

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Department of Computer science and Engineering

Scheduling of Courses for the M.E. (CSE)

Semester	Theory						Practical	Credits
	1	2	3	4	5	6	7	8
I	14CG110 Computer Architecture 4:0	14CG120 Data Structures and Algorithms 3:1	14CG130 Object Oriented Analysis and Design 3: 0	14CG140 Network Technology 3:1	14CG150 Compiler Design 3:1	14CG160 Graphs and Combinatorial Algorithms 3:1	14CG170 Analysis and Design Lab 0:1	24
II	14CG210 Modeling and Simulation 3:1	14CG220 Software Engineering Theory and Practice 3:0	14CGPX0 Elective 1 4:0	14CGPX0 Elective 2 4:0	14CGPX0 Elective 3 4:0	14CGPX0 Elective 4 4:0	14CG270 Seminar 0:1	24
III	14CG310 Data Warehousing and Mining Techniques 4:0	14CGPX0 Elective 5 4:0	14CGPX0 Elective 6 4:0	-	-	-	14CG340 Project - I 0:4	16
IV	-	-	-	-	-	-	14CG410 Project - II 0:12	12

Approved in Board of Studies Meeting on 08.11.2014

Approved in 49th Academic Council Meeting on 04.12.2014

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 2014-2015)

I SEMESTER

Course Code	Name of the Course	Category	No. of Hours / Week			Credits
			L	T	P	
THEORY						
14CG110	Computer Architecture	PC	4	-	-	4
14CG120	Data Structures and Algorithms	PC	3	1	-	4
14CG130	Object Oriented Analysis and Design	PC	3	-	-	3
14CG140	Network Technology	PC	3	1	-	4
14CG150	Compiler Design	PC	3	1	-	4
14CG160	Graphs and Combinatorial Algorithms	BS	3	1	-	4
PRACTICAL						
14CG170	Analysis and Design Laboratory	PC	-	-	2	1
Total			**19**	**4**	**2**	**24**

II SEMESTER

Course Code	Name of the Course	Category	No. of Hours / Week			Credits
			L	T	P	
THEORY						
14CG210	Modeling and Simulation	BS	3	1	-	4
14CG220	Software Engineering Theory and Practice	PC	3	0	-	3
14CGPX0	Elective 1	PE	4	-	-	4
14CGPX0	Elective 2	PE	4	-	-	4
14CGPX0	Elective 3	PE	4	-	-	4
14CGPX0	Elective 4	PE	4	-	-	4
PRACTICAL						
14CG270	Seminar	PC	-	-	2	1
Total			**22**	**1**	**2**	**24**

III SEMESTER

Course Code	Name of the Course	Category	No. of Hours / Week			Credits
			L	T	P	
THEORY						
14CG310	Data Warehousing and Mining Techniques	PC	4	-	-	4
14CGPX0	Elective 5	PE	4	-	-	4
14CGPX0	Elective 6	PE	4	-	-	4
PRACTICAL						
14CG340	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						
14CG410	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 2014-2015 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	14CG110	Computer Architecture	3	50	50	100	25	50
2	14CG120	Data Structures and Algorithms	3	50	50	100	25	50
3	14CG130	Object Oriented Analysis and Design	3	50	50	100	25	50
4	14CG140	Network Technology	3	50	50	100	25	50
5	14CG150	Compiler Design	3	50	50	100	25	50
6	14CG160	Graphs and Combinatorial Algorithms						
PRACTICAL								
7	14CG170	Analysis and Design Laboratory	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	14CG210	Modeling and	3	50	50	100	25	50

		Simulation						
2	14CG220	Software Engineering Theory and Practice	3	50	50	100	25	50
3	14CGPX0	Elective 1	3	50	50	100	25	50
4	14CGPX0	Elective 2	3	50	50	100	25	50
5	14CGPX0	Elective 3	3	50	50	100	25	50
6	14CGPX0	Elective 4	3	50	50	100	25	50
PRACTICAL								
7	14CG270	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	14CG310	Data Warehousing and Mining Techniques	3	50	50	100	25	50
2	14CGPX0	Elective 5	3	50	50	100	25	50
3	14CGPX0	Elective 6	3	50	50	100	25	50
PRACTICAL								
4	14CG340	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	14CG410	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

14CG310	DATA WAREHOUSING AND MINING TECHNIQUES	L	T	P	Credit
		4	0	0	4

Preamble

This course aims at facilitating the student to understand the concepts of data warehousing and various techniques involved in mining the data from the data warehouse.

Prerequisite

- 14CGPA0 - Database Systems

Course Outcomes

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

Design data warehouse and apply various OLAP operations. (CO1)	Create
Construct the data for decision making process by using Discretization, transformation and normalization methods.(CO2)	Apply
Understand the concepts of mining techniques and distinguish data mining systems with database systems (CO3)	Understand
Construct association rules based on association technique and evaluate the rule using metrics. (CO4)	Apply
Construct a classifier based on supervised learning algorithms and evaluate the classifier using metrics. (CO5)	Apply
Apply unsupervised data mining algorithms to group the given multi-dimensional objects. (CO6)	Apply
Explain the concepts of spatial data mining, temporal data mining, text mining, web mining. (CO7)	Understand

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1.	S	M	M	M	M						
CO2.	S	S	S	M	M						
CO3.	L										
CO4.	S	S	S	S	M						
CO5.	S	S	S	S	M						
CO6.	S	S	S	S	M						
CO7.	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	20	20	10
Understand	30	20	20	30
Apply	30	60	60	45
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	20	0	0	15

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Give the star schema for the base cuboid (student, course, semester, instructor)
2. Suppose a data warehouse consists of the four dimensions date, spectator, location and game and two measures count and charge , where charge is the fare that a spectator pays when watching a game on a given date. Spectator may be students, adults, or seniors, with each category having its own charge rate. Draw the star schema diagram for the data warehouse.
3. Suppose that a data warehouse consists of the three dimensions time, doctor, and patient, and the two measures count and charge, where charge is the fee that a doctor charges a patient for a visit. Draw a snowflake schema diagram for the data warehouse.
4. Give the star schema for the base cuboid (employee, department, salary, attendance)
5. Suppose a data warehouse consists of the four dimensions date, spectator, location and game and two measures count and charge , where charge is the fare that a spectator pays when watching a game on a given date. Spectator may be students, adults, or seniors, with each category having its own charge rate. Give the cube definition using DMQL

Course Outcome 2 (CO2):

1. For the following Database, apply the entropy-based discretization for the numerical attribute and find the best split.

S.NO	Age	Credit rating
1.	25	Fair
2.	29	Excellent
3.	35	Fair
4.	42	Excellent
5.	47	Fair
6.	49	Excellent
7.	32	Fair
8.	34	Fair
9.	37	Excellent
10.	40	Fair
11.	44	Fair
12.	45	Excellent

2. Suppose a group of 12 sales price records has been stored as follows:
   5, 10, 11, 13, 15, 35, 50, 55, 72, 92, 204, 215. Partition them into 3 bins by equal width binning.
3. How to select an attribute for classification?

Course Outcome 3 (CO3)

1. Define Data Mining.
2. Compare and contrast the clustering and the classification.

Course Outcome 4 (CO4)

1. Define strong association rule.
2. Illustrate the significance of candidate set generation step of level wise algorithm.
3. For the given database find all the frequent item sets using Apriori method and list all the strong association rules that match the metarule

$\forall$ x € transaction , buys(X,item1) ^ buys(X,item2) $\Rightarrow$ buys(X,item3).

TID	Items bought
100	{f, a, c, d, g, i, m, p}
200	{a, b, c, f, l, m, o}
300	{b, f, h, j, o, w}
400	{b, c, k, s, p}
500	{a, f, c, e, l, p, m, n}

Minimum Support = 30%

Minimum Confidence = 70%

Course Outcome 5 (CO5)

1. How to select an attribute for classification?
2. For the following Database use ID3 algorithm to construct the decision tree and partition the database based on the classification rules obtained from the decision tree.

Name	Rank	Years	Turned
Mike	Assistant Professor	3	No
Mary	Assistant Professor	7	Yes
Bill	Professor	2	Yes
Jim	Associate Professor	7	Yes
Dave	Assistant Professor	6	No
Anne	Associate Professor	3	No

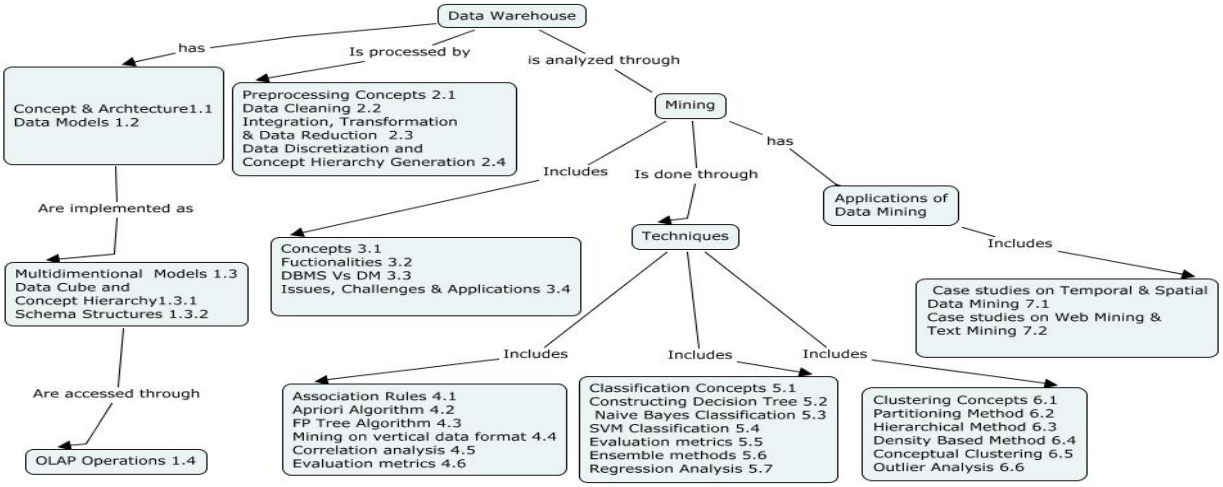
Course Outcome 6 (CO6)

1. Define cluster analysis.
2. Compare agglomerative and divisive hierarchical clustering
3. Given two objects A1(22,1,42,10) and A2(20,0,36,8) compute the distance by Euclidean measure.

Course Outcome 7 (CO7)

1. Can we do data mining on the data generated by the web? Justify
2. Explain the steps involved in generation of temporal association rules.
3. Illustrate the methods of preprocessing over text data.

Concept Map



Syllabus

Introduction to Data warehouse – Concepts, Architecture, Data Models, Multidimensional Models - Data Cube, Concept Hierarchy & Schema Structures, OLAP operations, **Preprocessing -** Preprocessing Concepts, Data Cleaning, Integration, Transformation and Data Reduction, Data Discretization and Concept Hierarchy Generation, **Introduction to Data Mining –** Concepts, Functionality, DBMS vs Data mining, Issues, Challenges and Applications, **Association Techniques -** Introduction to Association Rules, Apriori algorithm, FP Growth , Mining on vertical data format, Correlation Analysis, Evaluation Metrics, **Classification Techniques-** Introduction to Classification **-** Constructing decision tree, Naive Bayes Classification, SVM Classification, Evaluation Metrics, Ensemble methods , Regression analysis , **Clustering Techniques -** Introduction to Clustering, Partitioning Method, Hierarchical Method, Density Based Method, Conceptual clustering, Outlier Analysis, **Applications of Data Mining -** Case studies on Temporal and Spatial Data Mining, Case studies on Web and Text Mining.

Reference Books

1. Jiawei Han, Micheline Kamper, Data Mining: Concepts and Techniques Morgan Kaufman, 2011, 3rd Edition, ISBN: 1-55860-489-8.
2. K.P.Soman, Shyam Diwakar, V.Ajay, “Insight into Data Mining – Theory and Practice”, Prentice Hall of India, 2006.
3. Arun K.Pujari, “Data Mining Techniques”, Universities Press, 2001.
4. M.H Dunham, “Data Mining: Introductory and advanced topics”, Pearson Education, 2006.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1	**Introduction to Data warehouse (11)**	
1.1	Concepts & Architecture	1
1.2	Data Models	2
1.3	Multidimensional Models	2
1.3.1	Data Cube & Concept Hierarchy	2
1.3.2	Schema Structures	2
1.4	OLAP operations	2
2.	**Preprocessing (6)**	
2.1	Preprocessing Concepts	2
2.2	Data Cleaning	2
2.3	Integration , Transformation and Data Reduction	1
2.4	Data Discretization and Concept Hierarchy Generation	1
3.	**Introduction to Data Mining (4)**	
3.1	Concepts	1
3.2	Functionality	1
3.3	DBMS vs Data mining	1
3.4	Issues , Challenges and Applications	1
4	**Association Techniques(7)**	
4.1	Association Rules	1
4.2	Apriori algorithm	1
4.3	FP Growth tree	2
4.4	Mining on vertical data format	1
4.5	Correlation Analysis	1
4.6	Evaluation Metrics	1
5	**Classification Techniques (8)**	
5.1	Classification Concepts	1
5.2	Constructing decision tree – ID3 algorithm	2
5.3	Naive Bayes Classification	1
5.4	SVM Classification	1
5.5	Evaluation Metrics	1
5.6	Ensemble methods	1
5.7	Regression analysis	1
6	**Clustering Techniques (8)**	
6.1	Clustering Concepts	1
6.2	Partitioning Method	1
6.3	Hierarchical Method	2
6.4	Density Based Method	1
6.5	Conceptual clustering	2
6.6	Outlier Analysis	1
7	**Applications of Data Mining (4)**	
7.1	Case studies on Temporal and Spatial Data Mining	2
7.2	Case studies on Web and Text Mining	2
	Total	**48**

Course Designers:

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

14CGPH0	CRYPTOGRAPHY AND NETWORK SECURITY	L	T	P	Credit
		3	1	0	4

Preamble

Cryptography is the science of information and communication security. It is used for authentication, encryption and access control. The objective of the course is to introduce some of the known security problems related to networking and to overview the contemporary solutions to these problems. The focus of the course is on Authentication, authorization, confidentiality, data integrity and non-repudiation. Network security and system security issues are also addressed here.

Prerequisite

- 14CG140 - Network Technology

Course Outcomes

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

Explain the threats and vulnerabilities of information systems. (CO1)	Understand
Understand the techniques that protect and defend information and information systems by ensuring authentication and authorization (CO2)	Understand
Select and apply appropriate techniques to ensure the secrecy of the data (CO3)	Analyze
Select methods to ensure non-repudiation for the data (CO4)	Apply
Explain the suitability of security algorithms for real time applications (CO5)	Understand

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1.	L	L	M								
CO2.	M	L	L								
CO3.	S	S	S	M							
CO4.	S	S	S	M							
CO5.	L					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	10
Apply	40	40	40	60

Analyse	20	20	20	10
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. Define active attack and its types.
3. Draw the basic network security model

Course Outcome 2 (CO2):

1. Define Entity authentication
2. Define Password Salting
3. State the different Biometrics techniques

Course Outcome 3 (CO3):

1. Eve captures Bob's Hill cipher machine, which uses a 2-by-2 matrix M mod 26. She tries a chosen plaintext attack. She finds that the plaintext ba encrypts to HC and the plaintext zz encrypts to GT. What is the matrix M?
2. Double DES is not used in practice. State reason
3. State reasons for naming the Blowfish algorithm named so.
4. 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?

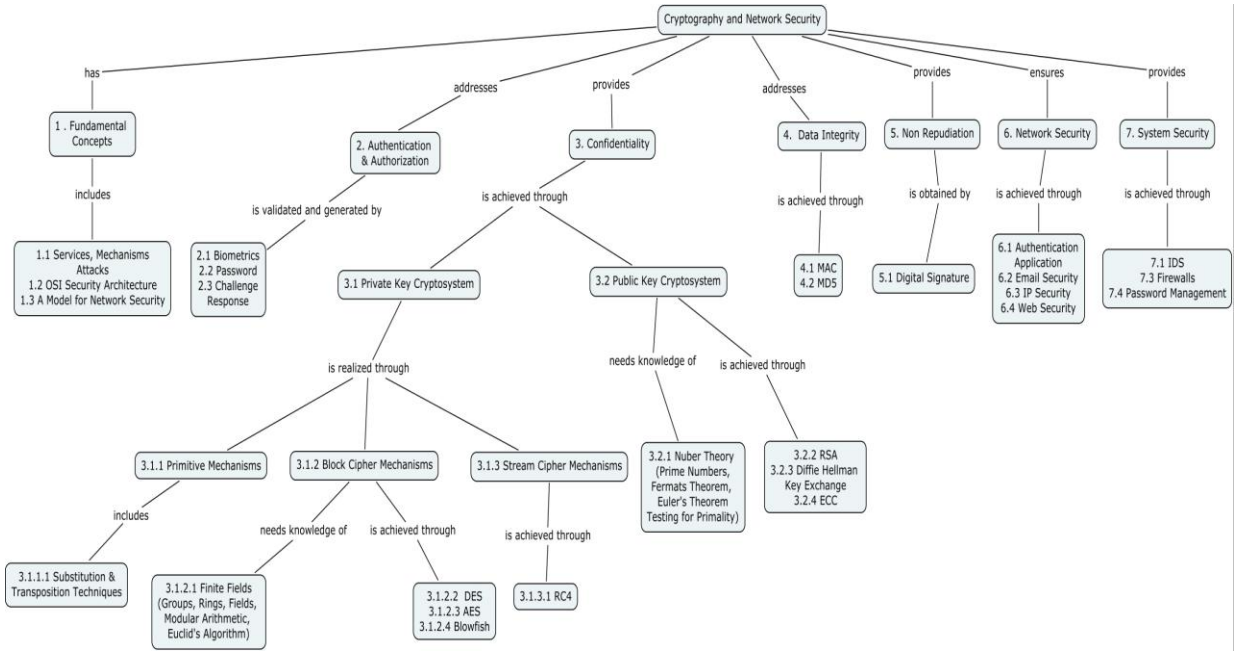
Course Outcome 4 (CO4):

1. Apply RSA algorithm to sign digitally the message PAYRANSOM.
2. Apply PGP authentication and confidentiality services to give message M = 73A56F49257…. K_S=47524635. Given KU_b=5, KR_a=317 n_b=437, KU_a=11, KR_a=35 and n_a=221.
3. Compare and contrast Hash and MAC authentication schemes

Course Outcome 5 (CO5):

1. List the uses of Firewalls.
2. Define any one scheme used in Electronic Mail security.
3. Describe the working of Kerberos 4 authentication protocol with a neat diagram.

Concept Map



Syllabus

Introduction: Services, Mechanisms and Attacks, The OSI Security Architecture, A Model for Network Security. **Authentication and Authorization:** Biometrics, Password, Challenge Response. **Confidentiality: Symmetric Ciphers:** Symmetric Cipher Model, Substitution and Transposition Techniques. **Block Cipher Mechanisms:** DES, Block cipher modes of operation. Introduction to Finite Fields: Groups, Rings and Fields, Modular Arithmetic, Euclid's Algorithm, Finite Fields, Advanced Encryption Standard, Blowfish. **Stream Cipher Mechanism:** RC4 Stream Cipher. **Public Key Encryption**: Introduction to Number Theory: Prime Numbers, Fermat's and Euler's Theorem, Testing for Primality, RSA, Diffie – Hellman Key Exchange, Elliptic Curve Cryptography. **Message Authentication and Integrity:** Message Authentication Codes, MD5 Message Digest Algorithm. **Non-Repudiation:** Digital Signature and Digital Signature Standard. **Network Security Practice: Authentication Application**- Kerberos**. Electronic Mail Security -** PGP. **IP Security -** IP Security Architecture**. Web Security**- Secure Socket Layer and Transport layer, Secure Electronic Transaction. **System Security:** Intruders- Intrusion Detection, Password Management. Malicious Software - Viruses and related Threats. Firewalls- Firewal Design Principles.

Reference Books

1. William Stallings, Cryptography and Network Security Principles and Practices, Fourth Edition, Pearson Education, 2008.
2. Behrouz A. Foruzan, Cryptography and Network Security, TataMcGraw Hill, 2007
3. William Stallings, Cryptography and Network Security Principles and Practices, Third Edition, Pearson Education, 2006.

Course Contents and Lecture Schedule

Module No.	Topic	No of Lectures
1	**Fundamental Concepts (3)**	
1.1	Services, Mechanisms and Attacks	1
1.2	The OSI Security Architecture	1
1.3	A Model for Network Security.	1
2	**Authentication and Authorization (2)**	
2.1	Biometrics	1
2.2	Passwords	1
2.3	Challenge Response Schemes	
3	**Confidentiality (26)**	
3.1	Private Key Cryptosystem:	
3.1.1	**Primitive Mechanisms :** Symmetric Cipher Model	1
3.1.1.1	Substitution and Transposition Techniques.	1
3.1.1.2	Tutorial	2
3.1.2	**Block Cipher Mechanisms:**	
3.1.2.1	**Introduction to Finite Fields:** Groups, Rings Fields,Modular Arithmetic, Euclid's Algorithm, Finite Fields	2
3.1.2.2	Tutorial	1
3.1.2.3	DES	1
3.1.2.4	Tutorial	1
3.1.2.5	Advanced Encryption Standard	1
3.1.2.6	Tutorial	2
3.1.2.7	Blowfish	1
3.1.2.8	Tutorial	1
3.1.3	**Stream Cipher Mechanism:**	
3.1.3.1	RC4 Stream Cipher.	1
3.1.3.2	Tutorial	1
3.2	**Public Key Encryption**:	
3.2.1	Introduction to Number Theory: Prime Numbers, Fermat's and Euler's Theorem Testing for Primality	3
3.2.2	RSA	2
3.2.3	Tutorial	2
3.2.4	Diffie – Hellman Key Exchange	1
3.2.5	Elliptic Curve Cryptography	1
3.2.6	Tutorial	1
4	**Message Authentication and Integrity (4)**	
4.1	Message Authentication Codes	2
4.2	MD5 Message Digest Algorithm.	1

4.3	Tutorial	1
5	**Non-Repudiation (1)**	
5.1	Digital Signature and Digital Signature Standard.	1
6	**Network Security Practice** (8)	
6.1	**Authentication Application**- Kerberos**.**	1
6.2	**Electronic Mail Security-** PGP**.**	2
6.3	**IP Security-** IP Security Architecture**.**	2
6.4	**Web Security**- Secure Socket Layer and Transport layer, Secure Electronic Transaction	1
7	**System Security (6)**	
7.1	Intruders- Intrusion Detection,	1
7.2	Malicious Software- Viruses and related Threats.	2
7.3	Firewalls- Firewall Design Principles.	2
7.4	Password Management.	1
	Total	**48**

Course Designers:

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

14CGPJ0	DESIGN AND ANALYSIS OF PARALLEL ALGORITHMS	L	T	P	Credit
		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.

Prerequisite

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 and analyze parallel algorithms for 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.	M	M	M								
CO2.	M	M	M								
CO3,	M	M	M								
CO4.	L	L	L								
CO5.	L	L	L		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	30	30	30	30
Apply	50	40	40	40

Analyse	0	20	20	20
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (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.

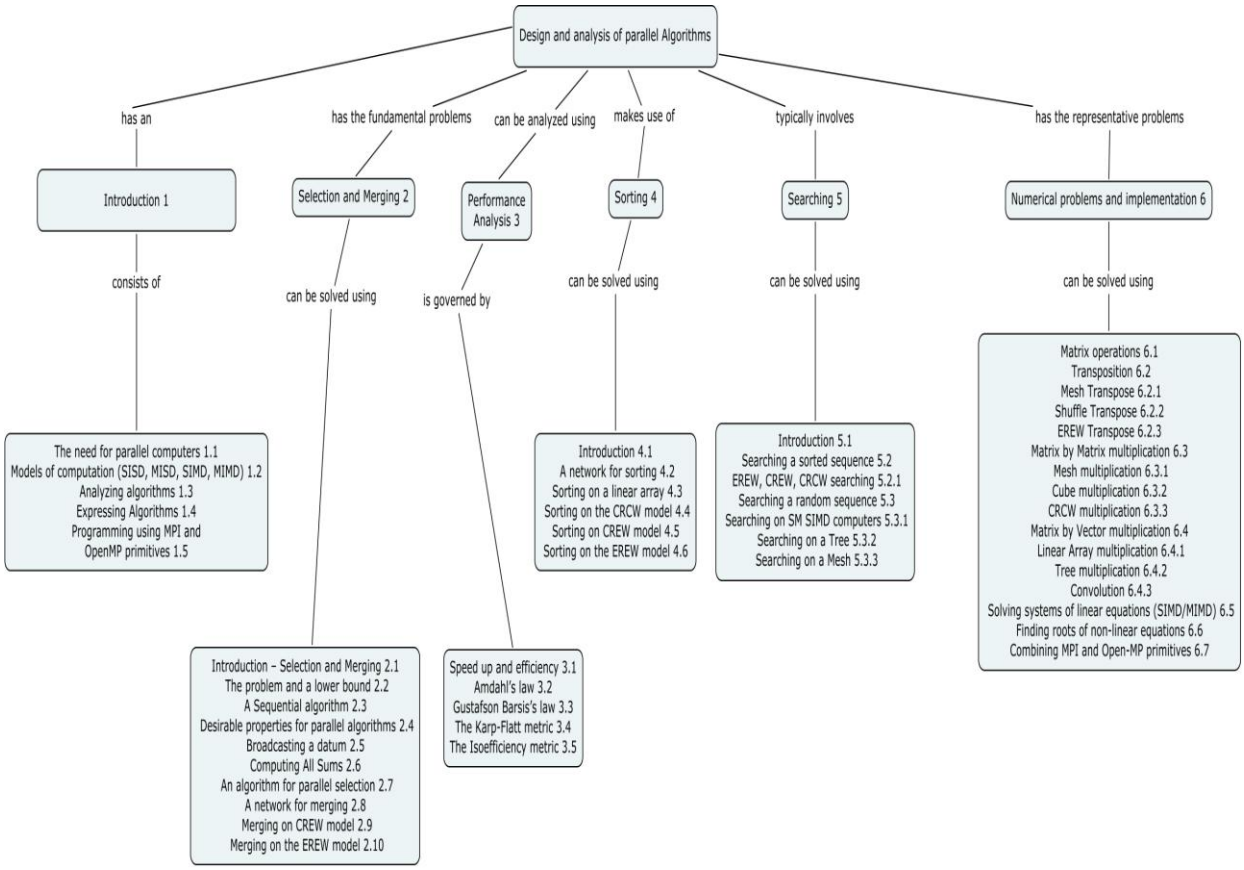
Course Outcome (CO4):

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, Programming using MPI and Open-MP primitives. **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. **Performance Analysis:** Speed up and efficiency, Amdahl's law, Gustafson Barsis's law, The Karp-Flatt metric, The Isoefficiency metric. **Sorting:** Introduction, A network for sorting, Sorting on a linear array, Sorting on the CRCW model, Sorting on CREW model, Sorting on the EREW model. **Searching:** Introduction, Searching a sorted sequence, EREW, CREW, CRCW searching, Searching a random sequence, Searching on SM SIMD computers, Searching on a Tree, Searching on a Mesh. **Numerical problems and implementation**: Matrix operations, Transposition, Mesh Transpose, Shuffle Transpose, EREW Transpose, 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, Combining MPI and Open-MP primitives.

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

Module 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
1.5	Programming using MPI and Open-MP primitives	1
2	**Selection and Merging**	
2.1	Introduction – Selection and Merging	1
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

Module No.	Topic	No. of Lectures
2.6	Computing All Sums	1
2.7	An algorithm for parallel selection	1
2.8	A network for merging	1
2.9	Merging on CREW model	1
2.10	Merging on the EREW model	1
3	**Performance Analysis**	
3.1	Speed up and efficiency	1
3.2	Amdahl's law	1
3.3	Gustafson Barsis's law	1
3.4	The Karp-Flatt metric	1
3.5	The Isoefficiency metric	1
4	**Sorting**	
4.1	Introduction	1
4.2	A network for sorting	1
4.3	Sorting on a linear array	1
4.4	Sorting on the CRCW model	1
4.5	Sorting on CREW model	1
4.6	Sorting on the EREW model	1
5	**Searching**	
5.1	Introduction	1
5.2	Searching a sorted sequence	1
5.2.1	EREW, CREW, CRCW searching	1
5.3	Searching a random sequence	1
5.3.1	Searching on SM SIMD computers	1
5.3.2	Searching on a Tree	1
5.3.3	Searching on a Mesh	1
6	**Numerical problems and implementation**	
6.1	Matrix operations	1
6.2	Transposition	1
6.2.1	Mesh Transpose	1
6.2.2	Shuffle Transpose	1
6.2.3	EREW Transpose	1
6.3	Matrix by Matrix multiplication	1
6.3.1	Mesh multiplication	1
6.3.2	Cube multiplication	1
6.3.3	CRCW multiplication	
6.4	Matrix by Vector multiplication	1
6.4.1	Linear Array multiplication	1
6.4.2	Tree multiplication	1
6.4.3	Convolution	1
6.5	Solving systems of linear equations (SIMD/MIMD)	1
6.6	Finding roots of non-linear equations	2
6.7	Combining MPI and Open-MP primitives	
	Total	**48**

Course Designers:

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		L	T	P	Credit
14CGPK0	**DISTRIBUTED AND GRID COMPUTING**	4	0	0	4

Preamble

This course aims at facilitating students to understand the design issues and implementation details behind distributed computing and grid computing middlewares. The prerequisites for this course are operating systems and networks. A previous course on Distributed systems would be an added advantage.

Prerequisite

Course Outcomes

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

Understand the hardware and software building blocks of a distributed system. (CO1)	Understand
Understand the design issues involved in designing a distributed system in terms of networking/OS/middleware. (CO2)	Understand
Understand the limitations of a distributed system like absence of a global state, clock drift and so on. (CO3)	Understand
Apply Service Oriented Architecture (SOA) principles to design a compute or data grid. (CO4)	Apply
Understand the design trade-offs involved in selecting a grid computing toolkit and select a toolkit to be used for a specific application. (CO5)	Apply
Construct pseudo-code for running parallel algorithms using application programming interfaces offered by distributed kernels. (CO6)	Apply
Demonstrate an understanding of distributed static and dynamic scheduling algorithms and their impacts on the performance of a distributed system. (CO7)	Apply
Construct distributed systems and protocols with an understanding of the security issues involved. (CO8)	Apply
Construct distributed systems which uses distributed file systems (DFS) and programming models for DFS like Map-Reduce and Dryad. (CO9)	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1.	L										
CO2.	L										
CO3.	L										
CO4.	M	L	L								
CO5.	M	L	L		M						
CO6.	M	L	L		M						
CO7.	M	L	L								
CO8.	M	L	L								
CO9.	M	L	L		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	30	30	30	30
Apply	50	60	60	60
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome (CO1):

1. Summarize any five Collection of Processes (COP) based approaches to distributed programming.
2. Describe the various distributed system architectures like Client-Server, Thin-Client and P2P

Course Outcome (CO2):

1. a. Illustrate ways to synchronize the clocks in two computers that are linked by a local network without reference to an external time source.
   b. Summarize the factors that limit the accuracy of the procedure you have described.
   c. Describe ways in which the clocks in a large number of computers connected by the Internet be synchronized.
2. State the differences between centralized and hierarchical meta-scheduling schemes.
3. Illustrate any six types of transparency to be supported by a good distributed system as identified by the ISO's reference model for open distributed processing.

Course Outcome (CO3):

1. Discuss some of the design requirements while building a distributed system. In specific discuss regarding the following requirements: Throughput, Performance issues, Load balancing, Caching and Replication

2. Discuss the different types of failures and recovery options in distributed systems. Discuss in specific about Byzantine failures, timing failures, Masking failures and Omission failures.

Course Outcome (CO4):

1. Identify the SOAP features which have to be implemented for the following grid service endpoint:
The endpoint accepts a secure purchase order as a request and responds with a status indicating whether the order got placed successfully; Once it returns this response, the endpoint periodically sends a status update to the client indicating the current status of the order (Under process, Shipped, Delivered).

a. Illustrate the two different mechanisms provided by SOAP, to implement these SOAP features and demonstrate the pros and cons of both these implementation schemes.

b. Construct a new MEP to cater to the use case mentioned.
c. Construct a SOAP Header (as per the WS-Security standard) which can be used to check the integrity of the messages transferred to the server which processes the secure purchase order.

Course Outcome (CO5):

1. Different server machines are currently being used to host an array of applications of an IT services company. The management would like to cut down the costs incurred by the company in procuring high-end servers and would like to reuse its infrastructure as much as possible across these applications. When the management wants to launch a new product/application, there is a need for procuring a server machine, provisioning the machine in its data centre and deploying the application. This severely increases the time-to-market a product for the IT services firm. Identify a suitable technology enabler behind grid computing to solve this problem and illustrate the features of the identified technology which can be leveraged in solving this problem.

2. a. Construct a relationship diagram depicting various legion objects for the following grid application which is deployed on top of the Legion middleware: Given a XLS, TXT, DOC, PPT or a PS document, the grid application converts the document to a PDF format and stores it for later reference. The grid application also takes into account the geographical proximity of the user to the database in which the PDF will be stored to leverage 'data locality optimization'.

b. Illustrate the functionalities provided by the different layers of the legion application architecture (with a neat sketch) on top of which the application has been deployed.

Course Outcome (CO6):

1. Assume that there is a distributed system formed to collect and query the data archives accumulated as a result of the experiments conducted using the Large Hadron Collider at the Centre for Nuclear research (CERN). Researchers and administrators of this distributed system, would like to periodically monitor the resource's availability to schedule tasks on a resource. Demonstrate the way to apply parsets for such resource monitoring.

2. Illustrate how SPMD parallelism can be applied to solve the below mentioned problem using parsets. (Compose your solution as a C code snippet)

"There is an array containing 109 integers. The array must be sorted in the ascending order and de-duplicated."

3. a. A gray-scale image can be expressed as a 2-D array consisting of pixel intensities. An image transformation function operates on a single line in the image. The array must be transformed into a simple parset which can exploit the SPMD parallelism inherently present in the problem statement. Illustrate the use of grain control mechanism in solving the problem mentioned above.

b. Assume that the problem statement requires a programmer to perform scaling, shearing and rotation functions in parallel on the gray scale image. Identify the type of parallelism that can be exploited in the redefined problem statement and Illustrate the use of polymorphic functions and untyped parsets in exploiting the parallelism identified.

c. Identify the limitations of your solution to [3 b] and Illustrate with the help of a pseudo code snippet the use of function parsets in overcoming these limitations.

Course Outcome (CO7):

1. Assume that there are six machines on a grid M = {m1, m2, m3, m4, m5, m6}. The predicted execution times (in sec) of three tasks T = {t1, t2, t3} on the machines in set M is given by the following table:

tasks/machines	m_1	m_2	m_3	m_4	m_5	m_6

t_1	2	1	6	7	1	1
t_2	6	2	1	2	1	2
t_3	3	10	2	1	2	5

Assume the following:

Job queue of all the machines is empty to begin with.
The grid scheduler has a prior knowledge about the set of tasks to be mapped.
t1 ~ {insertion sort on 100 numbers} with best case complexity O(n)
t2 ~ {quick sort on 512 numbers} with best case complexity O(nlog2 n)
t3 ~ {searching on a binary tree having 1024 leaf nodes} with best case complexity O(log2 n)
m1, m3 ,m5 ~ have a processing speed of 1.5 GHz
m2, m4, m6 ~ have a processing speed of 2 GHz
Simplification assumption: each instruction requires four machine cycles to complete.

Construct the task-machine mapping using the A* heuristic.

2. Construct a scheduler hierarchy for catering to about 1000 resources. The overall scheduling latency of your design should be less than 4 seconds from the root scheduler to any leaf-level scheduler. Assume the following: If a scheduler has to make a scheduling decision among 100 resources/schedulers, it takes a latency of about 10 seconds. Assume that scheduling latency is proportional to the number of resources/schedulers among which a scheduler must schedule a job.

Course Outcome (CO8):

1. Construct a SOAP module to satisfy the below mentioned security requirements:
A banking firm has exposed a grid service, which users can contact to download and view account statements (contains credits/debits which took place in the account within a specific time period). Before downloading the account statement the end points have to mutually authenticate each other through Kerberos V5 ticket. The integrity of the messages transferred should be checked at both the client and the server.

2. Illustrate the trust establishment process with respect to the following grid application:
A user from the domain tce.edu wants to collaborate and work with a user from the domain stanford.edu and hence assume that a grid has been established across both the domains. Both of these domain controllers trust the VeriSign certificate authority.

Course Outcome (CO9):

1. a. Assume that a DFS has been formed using HDFS which spans two data centers D1 and D2. D1 contains 3 racks each containing 20 nodes numbered n1 to n20. D2 contains 4 racks each containing 15 nodes numbered n1 to n15. A file chunk has been replicated on the following data nodes by HDFS: d1/r1/n3, d1/r3/n18, d2/r2/n3, and d2/r4/n15. A client HDFS daemon running on d2/r2/n2, issues a read request for this file chunk. Illustrate the calculation of the distance metric which is used in sorting the data node locations by the name node before the name node returns the list of data node locations to the DFS daemon running in the client.

b. Assume that the same HDFS daemon also issues a write request to append a file chunk at the end of the file mentioned in question [1 a]. Illustrate the anatomy of the read

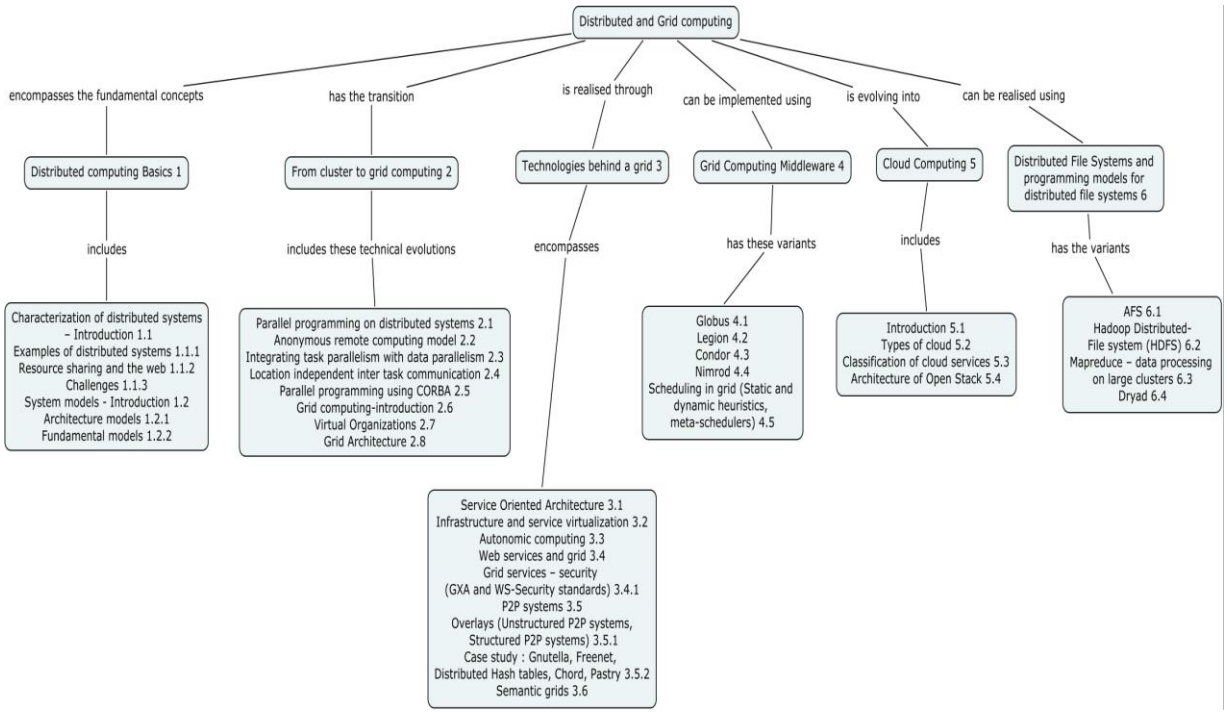
and write operations issued by the HDFS client daemon with neat sketches of the HDFS component pipelines.

2. Design a data grid to solve the following problem using a Map-Reduce algorithm which is to be run on top of the Hadoop framework:

Weather sensors all over the world collect the temperature, humidity, air pressure, wind direction at periodic intervals throughout the year and log the readings in a file present in HDFS in the following format <Weather station Id, Timestamp at which the reading is taken, temperature, humidity, air pressure, wind direction>. The size of the file is huge (~100 PB). The task is to analyze this data and output the minimum temperature recorded for each year in the past decade.

Compose snippets of code for the mapper, reducer functions and also the Hadoop job which invokes the MR code snippets. [You can use any programming language of your choice which is supported by the Hadoop framework]

Concept Map



Syllabus

Introduction – Distributed computing: Characterization of distributed systems – Introduction, Examples of distributed systems, Resource sharing and the web, Challenges, System models – Introduction, Architecture models, Fundamental models. **From cluster to grid computing:** Parallel programming on distributed systems, Anonymous remote computing model, Integrating task parallelism with data parallelism, Location independent inter task communication, Parallel programming using CORBA, Grid computing-introduction, Virtual Organizations, Grid Architecture. **Technologies behind a grid**: Service Oriented Architecture, Infrastructure and service virtualization, Autonomic computing, Web services and grid, Grid services – security (GXA and WS-Security standards), P2P systems – Overlays (Unstructured P2P systems, Structured P2P systems), Case study : (Gnutella, Freenet,

Distributed Hash tables, Chord, Pastry), Semantic grids. **Grid Computing Middleware**: Globus, Legion, Condor, Nimrod, Scheduling in grid (Static and Dynamic heuristics, meta-schedulers). **Cloud Computing:** Introduction, Types of cloud, Classification of cloud services, Architecture of Open Stack. **Distributed File Systems and programming models for distributed file systems:** AFS, Hadoop Distributed File system (HDFS), Mapreduce – data processing on large clusters, Dryad.

Reference Books

1.George Coulouris, Jean Dollimore, Tim Kindberg: "Distributed Systems – concepts and design", Third edition, Pearson Education, 2001.

2.Joshy Joseph, Craig Fellenstein: "Grid Computing", First Edition, Pearson Education, 2004.

3.Ian Foster and Carl Kesselman: "The Grid2 - Blueprint for a new computing infrastructure", Second Edition, Morgan Kaufmann, 2006.

4.Andrew S. Tanenbaum: "Distributed Operating Systems", First Edition, Pearson Education, 2008.

5.Mukesh Singhal, Niranjan G. Shivaratri: "Advanced concepts in Operating Systems", First Edition, Tata McGraw-Hill, 2006.

6.Andrew S. Tanenbaum, Maarten Van Steen: "Distributed Systems – Principles and Paradigms", Second Edition, Pearson Education, 2008.

7.Maozhen Li, Mark Baker: "The Grid Core Technologies", First Edition, John Wiley & Sons, 2005.

8.D. Janakiram: "Grid Computing", Tata Mc-Graw Hill, First edition, 2005.

9.Tom White: "Hadoop: The definitive guide Map reduce for the cloud", O'Reilly media, First edition, 2009.

10.Frederic Magoules, Thi-Mai-Huong Nguyen, Lei Yu: "Grid Resource Management: Toward Virtual and Services Compliant Grid Computing", First Edition, CRC Press, 2008.

11.http://openstack.org/

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1	**Distributed computing Basics**	
1.1	Characterization of distributed systems – Introduction	1
1.1.1	Examples of distributed systems	1
1.1.2	Resource sharing and the web	1
1.1.3	Challenges	1
1.2	System models – Introduction	1
1.2.1	Architecture models	1
1.2.2	Fundamental models	1
2	**From cluster to grid computing**	

Module No.	Topic	No. of Lectures
2.1	Parallel programming on distributed systems	2
2.2	Anonymous remote computing model	2
2.3	Integrating task parallelism with data parallelism	2
2.4	Location independent inter task communication	2
2.5	Parallel programming using CORBA	2
2.6	Grid computing-introduction	2
2.7	Virtual Organizations	1
2.8	Grid Architecture	2
3	**Technologies behind a grid**	
3.1	Service Oriented Architecture	2
3.2	Infrastructure and service virtualization	1
3.3	Autonomic computing	1
3.4	Web services and grid	1
3.4.1	Grid services – security (GXA and WS-Security standards)	1
3.5	P2P systems	1
3.5.1	Overlays (Unstructured P2P systems, Structured P2P systems)	1
3.5.2	Case study : Gnutella, Freenet, Distributed Hash tables, Chord, Pastry	2
3.6	Semantic grids	
4	**Grid Computing Middleware**	
4.1	Globus	1
4.2	Legion	1
4.3	Condor	1
4.4	Nimrod	
4.5	Scheduling in grid (Static and dynamic heuristics, meta-scheduling schemes)	3
5	**Cloud Computing**	
5.1	Introduction	1
5.2	Types of cloud	
5.3	Classification of cloud services	1
5.4	Architecture of Open Stack	
6	**Distributed File Systems and programming models for distributed file systems**	
6.1	AFS	2
6.2	Hadoop Distributed File system (HDFS)	2
6.3	Mapreduce – data processing on large clusters	2
6.4	Dryad	2

Course Designers:

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		L	T	P	Credit
14CGPL0	**CLOUD COMPUTING**	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, building cloud networks, virtualization, distributed storage and security.

Prerequisite

Course Outcomes

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

Explain the basics of cloud computing. (CO1)	Understand
Identify the real time cloud providers and their service levels. (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.	M	L	L	L	L	L	M	L	L	M	M
CO2.	M	L	L	M	L	M	M	L	M	L	L
CO3.	S	M	M	M	M	S	M	M	M	M	M
CO4.	L	L	L	L	L	M	M	L	L	L	L
CO5.	M	L	L	M	S	S	S	M	M	M	M

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	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Discuss on Infrastructure as a Service offering. (Understand)
2. Discuss on the Layers and types of cloud (Understand)

3. Explain the benefits of using a cloud model (Understand)
4. Explain the limitations of using a cloud model. (Understand)

Course Outcome 2 (CO2):

1. Illustrate the various services offered by Microsoft service provider. (Apply)
2. Illustrate the various Amazon web services. (Apply)
3. Illustrate the features of Google Cloud platform. (Apply)

Course Outcome 3 (CO3):

1. Demonstrate the steps to construct the virtual machine using a virtualization tool. (Apply)
2. Illustrate Application Virtualization using any one of the tools of your choice. (Apply)
3. Discuss on server virtualization. (Apply)

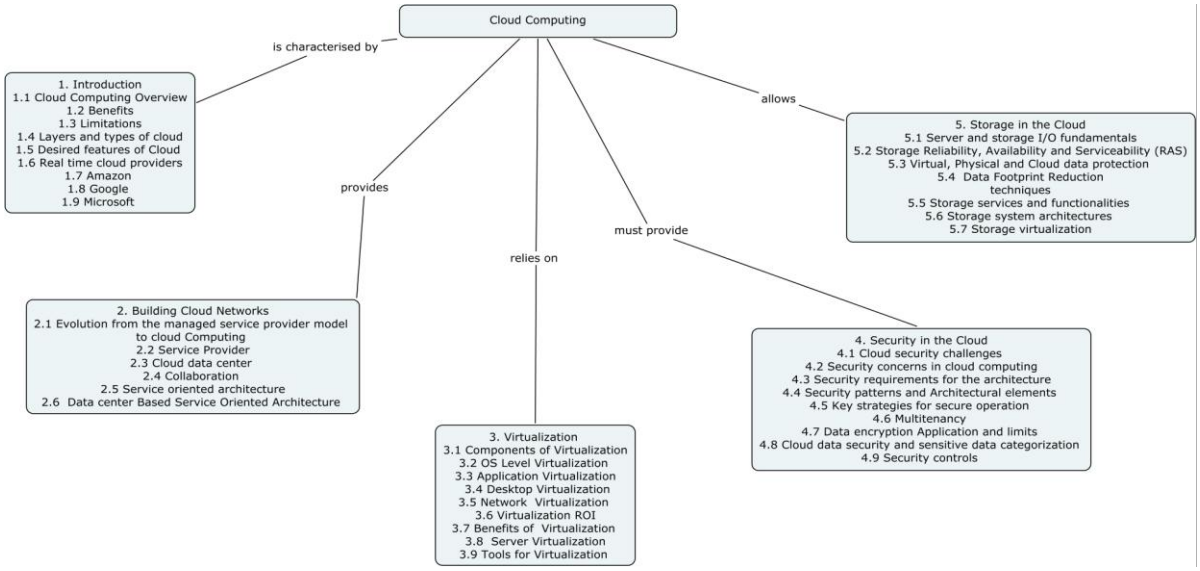
Course Outcome 4 (CO4):

1. Discuss the security concerns in Cloud Computing. (Understand)
2. Discuss the patterns and elements that contribute to cloud security. (Understand)
3. Illustrate the security services offered by any one of the Cloud Information security vendors. (Apply)

Course Outcome 4 (CO4):

1. Illustrate the disaster recovery techniques offered by storage services. (Apply)
2. Discuss on storage reliability, availability and serviceability. (Understand)
3. Explain the various DFR techniques available to address storage capacity optimization. (Understand)

Concept Map



Syllabus

Introduction – Cloud Computing Overview – benefits – limitations – Layers and types of cloud – Desired features of Cloud – Real time cloud providers – Amazon – Google – Microsoft - **Building Cloud Networks -** Evolution from the managed service provider model to cloud Computing - Service Provider - Cloud data center – Collaboration - Service oriented architecture - Data center Based Service Oriented Architecture **Virtualization -** Components of Virtualization - OS Level Virtualization - Application Virtualization - Desktop Virtualization - Network Virtualization - Virtualization ROI-Benefits of Virtualization - Server Virtualization – Tools for Virtualization - **Security in the Cloud -** Cloud security challenges - Security concerns in cloud computing - Security requirements for the architecture - Security patterns and Architectural elements - Key strategies for secure operation – Multitenancy – Data encryption Application and limits – Cloud data security and sensitive data categorization – Security controls – **Storage in the Cloud –** Server and storage I/O fundamentals – Storage Reliability, Availability and Serviceability (RAS) - Virtual, Physical and Cloud data protection - Data Footprint Reduction techniques – Storage services and functionalities – Storage system architectures – Storage virtualization

Reference Books

1. Rajkumar Buyya, James Brogerg, Andrzej Goscinski, "Cloud Computing Principles and Paradigms", John Wiley & Sons, Inc. Publications, 2011.
2. Anthony T.Velte, Toby J.Velte, Robert Elsenpeter,"Cloud Computing:A Practical Approach", McGraw Hill Publication, 2010.
3. John Rittinghouse, James F. Ransome, "Cloud Computing: Implementation, Management and Security", CRC Press 2010.
4. Vic (J.R.) Winkler, "Securing the Cloud: Cloud Computer Security Techniques and Tactics, Elsevier, 2011
5. Greg Schulz, "Cloud and Virtual Data Storage Networking", CRC Press, 2012.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1	**INTRODUCTION (12)**	
1.1	Cloud Computing Overview	1
1.2	Benefits	1
1.3	Limitations	1
1.4	Layers and types of cloud	1
1.5	Desired features of Cloud	1
1.6	Real time cloud providers	1
1.7	Amazon	2
1.8	Google	2
1.9	Microsoft	2
2	**BUILDING CLOUD NETWORKS (10)**	
2.1	Evolution from the managed service provider model to cloud Computing	1
2.2	Service Provider	1
2.3	Cloud data center	1

2.4	Collaboration	2
2.5	Service oriented architecture	2
2.6	Data center Based Service Oriented Architecture	1
3	**VIRTUALIZATION (10)**	
3.1	Components 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	Virtualization ROI	1
3.7	Benefits of Virtualization	1
3.8	Server Virtualization	1
3.9	Tools for Virtualization	2
4	**SECURITY IN THE CLOUD (10)**	
4.1	Cloud security challenges	1
4.2	Security concerns in cloud computing	1
4.3	Security requirements for the architecture	1
4.4	Security patterns and Architectural elements	1
4.5	Key strategies for secure operation	1
4.6	Multitenancy	1
4.7	Data encryption Application and limits	1
4.8	Cloud data security and sensitive data categorization	2
4.9	Security controls	1
5	**STORAGE IN THE CLOUD(8)**	
5.1	Server and storage I/O fundamentals	1
5.2	Storage Reliability, Availability and Serviceability (RAS)	1
5.3	Virtual, Physical and Cloud data protection	1
5.4	Data Footprint Reduction techniques	2
5.5	Storage services and functionalities	1
5.6	Storage system architectures	1
5.7	Storage virtualization	1
	Total	**48**

Course Designers:

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		L	T	P	Credit
14CGPA0	**DATABASE SYSTEMS**	3	1	0	4

Preamble

This course aims at facilitating the student to understand the concepts of database systems, design methods, querying and managing databases.

Prerequisite

Course Outcomes

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

Develop an E-R Model to meet the requirements of any database application. (CO1)	Create
Build relational and object oriented databases using SQL and manipulate data using relational and structured query languages. (CO2)	Apply
Design a normalized database application using constraints. (CO3)	Create
Construct data storage structures like indices and hashing for the fast retrieval of data. (CO4)	Create
Understand the concepts of concurrent transaction execution and apply them to ensure consistency of database. (CO5)	Apply
Create portable databases using XML standards. (CO6)	Apply
Explain the working principle of distributed database systems and the concepts of temporal, spatial, image and NOSQL databases. (CO7)	Understand

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	S	S	S	L	L						
CO2	S	S	S	L	M						
CO3	S	S	S	M	L						
CO4	S	S	S	M							
CO5	M	M	M	L							
CO6	M	L	L	L							
CO7	M	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	10
Understand	20	20	40	30
Apply	50	40	40	40
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	10	20	0	20

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Consider a database used to record the marks that students get in different exams of different course offerings. Construct an E-R diagram that models exams as entities, and uses a ternary relationship for the database.
2. Design a generalization-speciation hierarchy for a motor vehicle sales company. The company sells motor cycles, passenger cars, vans, and buses. Identify the attributes at each level of the hierarchy.
3. Define the concept of aggregation. Give two examples of where this concept is useful.

Course Outcome 2 (CO2):

1. Consider the following schema and write the SQL for the following:

   Country(name,cont,pop,gdp,life-exp)

   River(name,origin,lenth)

   City(name, country, pop)

   a. Find all countries 8whose GDP is greater than $700 billion but less than $3 trillion.
   b. List the life expentency in countries that have river originating in them
   c. Find all cities that are either in south america or whose population is less than 4 million.
   d. List all cities which are not in south America
2. Consider the following schema and write the following queries in relational algebra.

   Suppliers (sid, sname, address)

   Parts (pid, pname,color)

   Catelog (sid,pid,cost)

   a. Find the names of suppliers who supply some red part.
   b. Find the sids of suppliers who supply some red and green part.
   c. Find the sids of suppliers who supply every part.
   d. Find the pids of the most expensive parts supplied by supplier named Sham

Course Outcome 3 (CO3)

1. Why BCNF is stronger than 3NF? Justify.
2. What is the need for normalization?
3. Consider a relation R with five attributes ABCDE. You are given the following dependencies: A→B, BC→E, and ED→A.
   a. List all keys for R.
   b. Is R in 3NF?
   c. Is R in BCNF?

4. Design the database for banking environment by following the design phases including normalization.

Course Outcome 4 (CO4)

1. Suppose that we are using extendable hashing on a file that contains records with the following search-key values: 2, 3, 5, 7, 11, 17, 19, 23, 29, and 31. Show the extendable hash structure for this file if the hash function is h(x) = x mod 8 and buckets can hold three records.
2. What is dense and sparse index?
3. Differentiate static and dynamic hashing.

Course Outcome 5 (CO5)

1. Define ACID properties.
2. How do you implement atomicity in transactions?
3. Consider the following two transactions:

T1: Read (A);
Read (B);
If A = 0 then B:= B +1;
Write (B);

T2: Read (B);
Read (A);
If B = 0 then A:= A +1;
Write (A);

Let the consistency requirement be A = 0 V B = 0, with A = B = 0 the initial values.

a. Show that every serial execution involving these two transactions preserves the consistency of the database.
b. Show a concurrent execution of T1 and T2 that produces a non serializable schedule.

Course Outcome 6 (CO6)

1. Mention the purpose of XML namespace
2. Explain with your own example, how XML schema address the limitations of DTD
3. Consider the following non - 1NF 'books' relation:

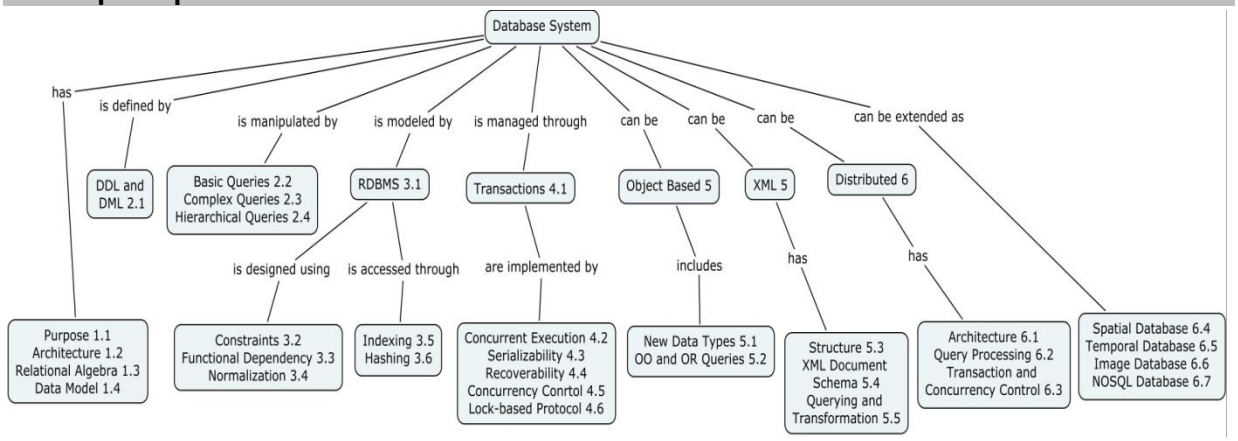
Title	Author-array	Publisher	Keyword_set
		(name, branch)	
Compilers	[Smith, Jones]	(McGraw-Hill, NewYork)	{parsing, analysis}
Networks	[Jones, Frick]	(oxford, London)	{LAN, protocol}

Show how to represent the above relation using XML, by giving a DTD.

Course Outcome 7 (CO7)

1. What are the advantages of distributed database?
2. What are the new data types used in spatial application?
3. How might a distributed database designed for local area network differ from one designed for wide area network?
4. Explain different spatial operations used in spatial queries?

Concept Map



Syllabus

Introduction: Purpose, Architecture, Relational Algebra, Data Model. **Structured Query Language**: DDL and DML, Basic Queries, Complex Queries, Hierarchical Queries **Relational Database Design:** RDBMS Concepts, Constraints, Functional Dependency, Normalization, Indexing, Hashing. **Transaction Management:** Transaction – Concepts, Concurrent Execution, Serializability, Recoverability, Concurrency Control, and Lock based Protocol. **Object Based Databases and XML:** New Data Types in SQL, Object Oriented and Object Relational Queries, Structure of XML Data, XML Document Schema, Querying and Transformation. **Distributed Database and New Applications:** Distributed Database – Architecture, Query Processing, Transaction and Concurrency Control, Spatial Database, Temporal Database, Image Database and NOSQL database.

Reference Books

1. Silberschatz, Korth, Sudarshan, “Database System Concepts”, 5th Edition, Tata McGrawHill, 2006.
2. Thomas Connolly, Carolyn Begg, “Database Systems – A practical Approach to Design, Implementation and Management”, 3rd Edition, Pearson Eduction, 2003.
3. Ramez Elmasri, Shamkant B. Navathe, “Fundamentals of Database System”, 4th edition, Pearson Education, 2004.
4. Raghu Ramakrishnan and Johannes Gehrke, “Database Management System”, 3rd edition, TMH, 2003.
5. Shashi Shekhar and Sanjay Chawla, “Spatial Database – A Tour”, Pearson Education, 2003.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1	**Introduction**	
1.1	Purpose	1
1.2	Architecture	1
1.3	Relational Algebra	2
	Tutorial	**1**
1.4	Data Model	1
	Tutorial	**1**
2.	**Structured Query Language**	
2.1	DDL and DML	1
2.2	Basic Queries	1
2.3	Complex Queries	2
2.4	Hierarchical Queries	1
	Tutorial	**3**
3	**Relational Database Design**	
3.1	RDBMS - Concepts	1
3.2	Constraints	
3.3	Functional Dependency	1
3.4	Normalization	2
	Tutorial	**2**
3.5	Indexing	2
3.6	Hashing	2
	Tutorial	**2**
4	**Transaction Management**	
4.1	Transactions – Concepts	1
4.2	Concurrent Execution	1
4.3	Serializability	2
4.4	Recoverability	1
4.5	Concurrency Control	1
4.6	Lock-based protocol	1
	Tutorial	**1**
5	**Object Based Databases and XML**	
5.1	New Data Types in SQL	1
5.2	Object Oriented and Object Relational Queries	1
5.3	Structure of XML Data	1
5.4	XML Document Schema	1
5.5	Querying and Transformation	1
	Tutorial	**1**
6	**Distributed Database and New Applications**	
6.1	Distributed Database - Architecture	1
6.2	Query Processing	1
6.3	Transaction and Concurrency Control	1
6.4	Spatial Database	1
6.5	Temporal Database	
6.6	Image Database	1
6.7	NOSQL Database	1
	Tutorial	**1**
	Total	**48**

Course Designers:

1. Mr. M. Sivakumar mskcse@tce.edu
2. Ms. B. Subbulakshmi bscse@tce.edu

Approved in BOS Meeting on 08.11.2014 Approved in 49th Academic Council Meeting on 04.12.2014

14CGPB0	INFORMATION STORAGE AND NETWORKING	L	T	P	Credit
		4	0	0	4

Preamble

The course on Information Storage and Networking aims to emphasize the need for information storage, provide an in depth coverage of various technologies used in the networked storage.

Prerequisite

Course Outcomes

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

Describe the components and protocols used in the Information Storage Systems and functionality of existing storage systems. (CO1)	Understand
Identify the Disk Failure and use of Backup technologies for Recovery. (CO2)	Apply
Create storage system based on interaction with storage user (CO3)	Create

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

S- Strong; M-Medium; L-Low

Assessment Pattern

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

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. What are the different categories of data?
2. List the demerits of centralized data storage.
3. Describe the key requirements of storage systems with their functionalities.
4. Describe the disk drive components and its operation in detail
5. Describe the evolution of date storage systems.

Course Outcome 2 (CO2):

1. Explain how remote replication technology is helpful in disaster recovery.
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.

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

   Current Situation/Issue:
   The corporation's mission critical Database application takes up 1 TB of storage on a high end Storage Array. In the past year, top management has become extremely concerned because they do not have DR plans which will allow for zero RPO recovery if there is a site failure. The primary DR Site is the 2nd Data Center 50 miles away. The company would like explore remote replication scenarios which will allow for near zero RPO and a minimal RTO. The company is aware of the large costs associated with network bandwidth.
   Develop a near zero RPO backup solution .

Course Outcome 3 (CO3):

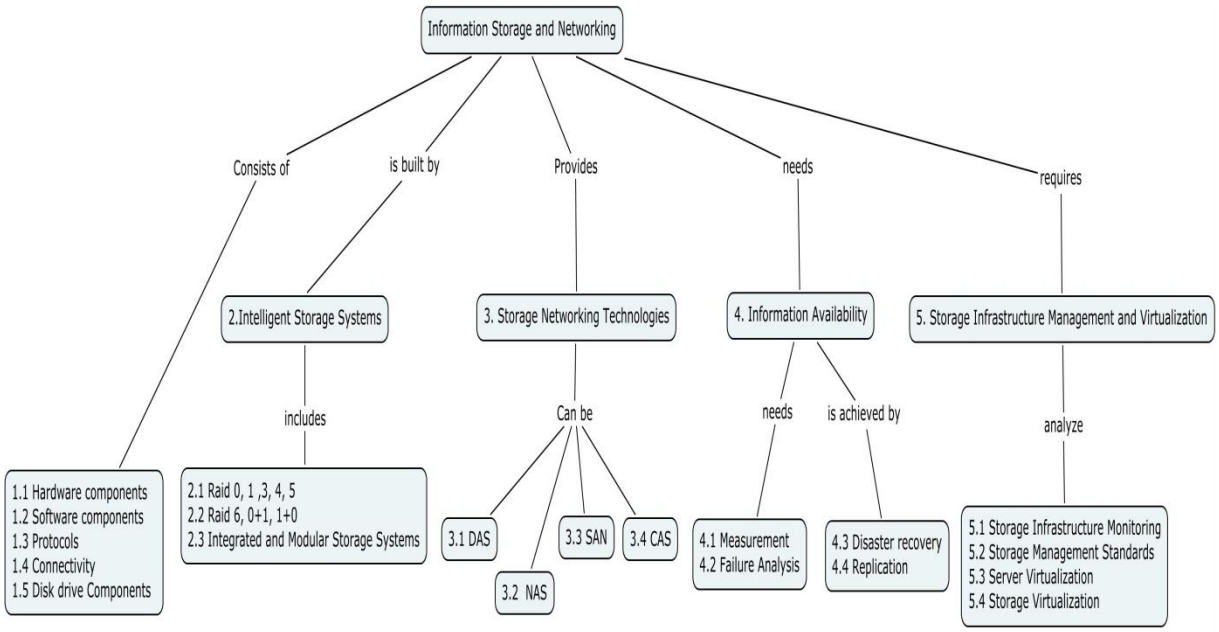
1. AirTel Telecom is involved in mobile wireless services across the India and has about 5000 employees worldwide. This company is Chennai based and has 7 regional offices across the country. Although AirTel is doing well financially, they continue to feel competitive pressure. As a result, the company 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.

Concept Map



Syllabus

Introduction - Hardware and software components of the host environment - Key protocols and concepts used by each component - Physical and logical components of connectivity environment - Physical Components of a disk drive - Logical constructs of a physical disk. **Intelligent Storage Systems -** RAID levels: RAID 0, RAID 1, RAID 3, RAID 4, RAID 5 - RAID 6 - RAID 0+1, RAID 1+0 - Integrated and Modular Storage Systems - Intelligent Storage System **Storage Networking Technologies-**Direct Attached Storage :Architecture and components - Network Attached Storage : Architecture and components and connectivity - Storage Area Network :Evolution, Architecture, components and connectivity - Need for long-term archiving solution: CAS : Object based data storage and Retrieval **Information Availability -**Information Availability and its measurement- causes and consequences of downtime - Failure Analysis: Single points of failure in a storage infrastructure and solutions for its mitigation- Fault Tolerance –Business continuity- Disaster Recovery (DR): Recovery Time Objective (RTO) and Recovery Point Objective (RPO) – Overview of backups : Direct-attached backups- LAN-based backups- LAN-free backups- Server less backups – Archival - Replication - Remote replication: Host-based, Storage Array-based**Storage Infrastructure Management and Virtualization** Storage Infrastructure Monitoring: Parameters, Components - key management activities- storage management standards and initiative - Virtualization technologies: Server Virtualization (LVM –based virtualization, Memory virtualization), Network (VLAN and VSAN), Storage (Disk virtualization, RAID, LUN masking, File and block level virtualization, Virtual Provisioning)

Reference Books

1. Information Storage and Management, EMC Corporation, Wiley 2009,
ISBN: 04702942134

2. Storage Networks: The Complete Reference - Robert Spalding - Tata McGraw Hill-Osborne- 2003.

3. Building Storage Networks - Marc Farley - Tata McGraw Hill-Osborne- 2001.

4. Disaster Recovery and Business Continuity - Thejendra BS- Shroff Publishers and Distributors-2006.

5. Storage Area Network Fundamentals- Meeta Gupta- Pearson Education Limited, 2002

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1	**Introduction**	
1.1	Hardware components of the host environment	2
1.2	Software components	2
1.3	Key protocols and concepts used by each component	2
1.4	Physical and logical components of Connectivity environment	2

Module No.	Topic	No. of Lectures
1.5	Physical Components of a disk drive - Logical constructs of a physical disk	2
2	**Intelligent Storage Systems**	
2.1	RAID levels- RAID 0, RAID 1, RAID 3, RAID 4, RAID 5	2
2.2	RAID 0+1, RAID 1+0, RAID 6	2
2.3	Integrated and Modular Storage Systems - Intelligent Storage System	2
3	**Storage Networking Technologies**	
3.1	Direct Attached Storage – Architecture and components	3
3.2	Network Attached Storage – Architecture and components and connectivity	3
3.3	Storage Area Network – Evolution, Architecture, components and connectivity	3
3.4	Need for long-term archiving solutions – CAS : Object based data storage and Retrieval	3
4	**Information Availability**	
4.1	Information Availability and its measurement- causes and consequences of downtime	2
4.2	Failure Analysis: Single points of failure in a storage infrastructure and solutions for its mitigation- Fault Tolerance –Business continuity	3
4.3	Disaster Recovery (DR): Recovery Time Objective (RTO) and Recovery Point Objective (RPO)- Overview of backups : Direct-attached backups- LAN-based backups- LAN-free backups- Server less backups – Archival	3
4.4	Replication - Remote replication: Host-based, Storage Array-based	3
5	**Storage Infrastructure Management and Virtualization**	
5.1	Storage Infrastructure Monitoring: Parameters, Components- key management activities	2
5.2	Storage management standards and initiative	2
5.3	Virtualization technologies: Server Virtualization (LVM –based virtualization, Memory virtualization)	2
5.4	Network (VLAN and VSAN), Storage (Disk virtualization, RAID, LUN masking, File and block level virtualization, Virtual Provisioning)	3
	Total	**48**

Course Designers:

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

		L	T	P	Credit
14CGPC0	**MACHINE LEARNING**	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.

Prerequisite

Course Outcomes

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

Outline the steps involved in designing a machine learning algorithm. (CO1)	Understand
Construct training and prediction algorithms for classification using decision trees and artificial neural networks (CO2)	Apply
Construct learning algorithms using Bayesian probabilistic models for complex applications. (CO3)	Apply
Outline the fundamentals of computational learning theory with an understanding of the mistake bounds (CO4)	Understand
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.	L										
CO2.	M	M	M	M	L						M
CO3.	M	M	M	M	L						M
CO4.	L	L	L								
CO5.	M	M	M	M	M						M
CO6.	S	S	S	S	S	S		M	L	S	S
CO7.	M	M	M	M	S	S		M	L	S	S

S- Strong; M-Medium; L-Low

Assessment Pattern

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

Apply	20	30	40	40
Analyse	20	30	40	40
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (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 2 (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.

Course Outcome 3 (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 4 (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 5 (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 6 (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 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.

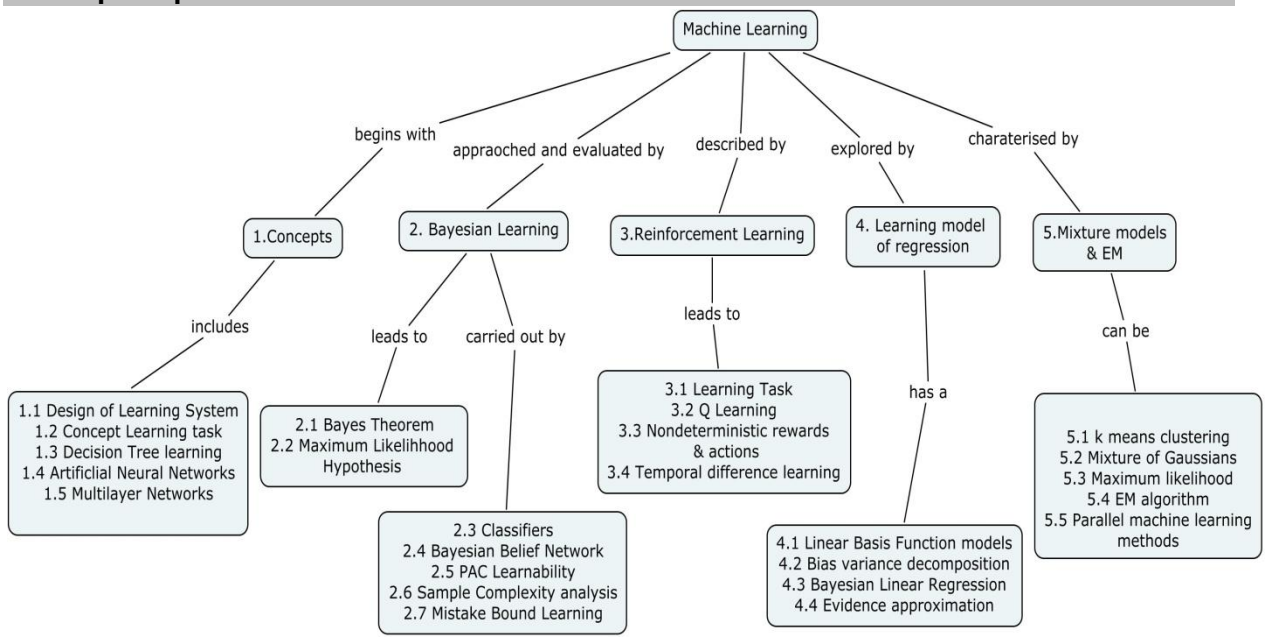
Course Outcome 7 (CO7):

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 – Designing a learning system, Concept learning based on symbolic or logical representations, Decision tree learning and the problem of overfitting data, Artificial Neural networks. **Bayesian Learning –** Optimal classifier – Belief networks - Computational learning theory - PAC learning model and Mistake bound learning. **Reinforcement learning** – Q learning, Nondeterministic Rewards and Actions- Temporal difference learning. **Linear Model of Regression** – Linear basis function models – Bias variance decomposition – Bayesian Linear Regression – Evidence approximation. **Mixture models and EM –** k means clustering – Mixture of Gaussians – EM algorithm - Practical aspects of implementing Parallel machine learning methods

Reference Books

1) Tom M. Mitchell, “Machine learning”, McGraw Hill,1997.

2) Ethem Alpaydin, “Introduction to machine learning”, The MIT Press,2004.

3) Christopher M.Bishop, “Pattern recognition and machine learning”, Springer,2007.

4) Stephen Marsland, “Machine learning: An algorithmic perspective”,CRC,2009

Course Contents and Lecture Schedule

Module No.	Topics	No.of Lectures
1	**Introduction to learning system(10)**	
1.1	Design of learning system	2
1.2	Concept learning task	2
1.3	Decision Tree learning	2
1.4	Artificial Neural networks	2
1.5	Multilayer networks	2
2	**Bayesian Learning (11)**	
2.1	Bayes Theorem	1
2.2	Maximum Likelihood hypothesis	1
2.3	Classifiers	2
2.4	Bayesian Belief networks	1
2.5	PAC learnability	2
2.6	Sample complexity analysis	2
2.7	Mistake bound learning	2
3	**Reinforcement Learning(10)**	
3.1	Learning Task	2
3.2	Q Learning	3
3.3	Nondeterministic rewards and actions	2
3.4	Temporal difference learning	2
4	**Learning model of regression (9)**	
4.1	Linear Basis Function Models	3
4.2	Bias variance decomposition	2
4.3	Bayesian Linear Regression	2
4.4	Evidence approximation	2
5	**Mixture models and EM (10)**	
5.1	k means clustering	2
5.2	Mixture of Gaussians	1
5.3	Maximum likelihood	2
5.4	EM algorithm	2
5.5	Practical aspects of implementing Parallel machine learning methods	2
	Total	**48**

Course Designers:

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

14CGPD0 WIRELESS AD HOC NETWORKS

L	T	P	Credit
4	0	0	4

Preamble

The course aims at exploring the concepts of wireless networks, protocols, architectures and applications.

Prerequisite

Course Outcomes

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

Understand the basic principles of wireless networks and their standards. (CO1)	Understand
Understand the mobility and power management concepts. (CO2)	Understand
Calculate the congestion window size for different versions of TCP (CO3)	Apply
Compare the different TCP solutions for ad hoc wireless networks. (CO4)	Analyze
Compare the different routing protocols. (CO5)	Analyze

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	M										
CO2	M										
CO3	S	M	M								
CO4	S	M	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	10	10
Understand	30	20	10	10
Apply	0	10	10	10
Analyse	50	50	60	60
Evaluate	0	0	10	10
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. State the different propagation mechanisms.
2. Identify and list the limitation of Table driven routing protocols
3. Summarize the different issues in Ad hoc wireless networks

Course Outcome 2 (CO2):

1. State the different classifications of energy management schemes
2. Explain the principle of system power management scheme.
3. State the different schemes used for battery management schemes.

Course Outcome 3 (CO3):

1. In a military vehicular ad hoc wireless network using PRTMAC, formed by 500 nodes distributed uniformly in a battlefield area of 1000 m x 1000 m, calculate the number of nodes contending for the data channel and for control channel. The transmission range of data channel is 250 m.
2. Assume that when the current size of congestion window is 48 KB, the sender experiences a timeout. What will be the congestion window size of the next three transmission bursts are successful? Assume that MSS is 1 KB. Consider TCP TAHOE and TCP RENO.
3. Assume that when the current size of congestion window is 48 KB, the sender experiences a timeout. What will be the congestion window size of the next seven transmission bursts are successful? Assume that MSS is 1 KB. Consider TCP TAHOE and TCP RENO.

Course Outcome 4 (CO4):

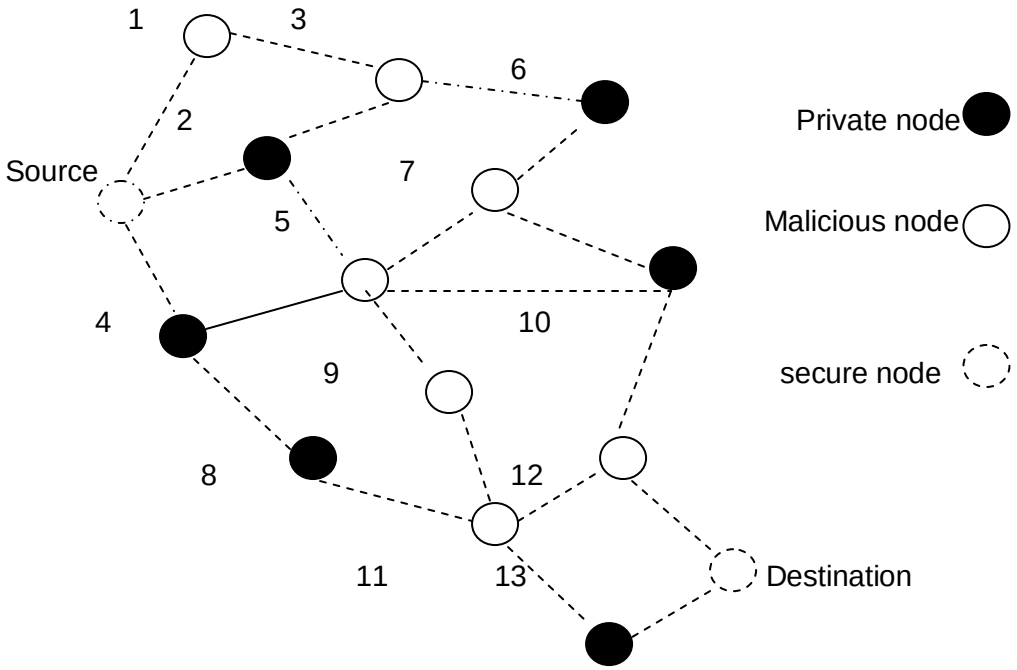
1. Compare the different TCP solutions for Ad hoc wireless networks
2. Compare the various secure routing methods used in Ad hoc networks.
3. Distinguish the salient features of TCP Bus compared to other schemes .

Course Outcome 5 (CO5):

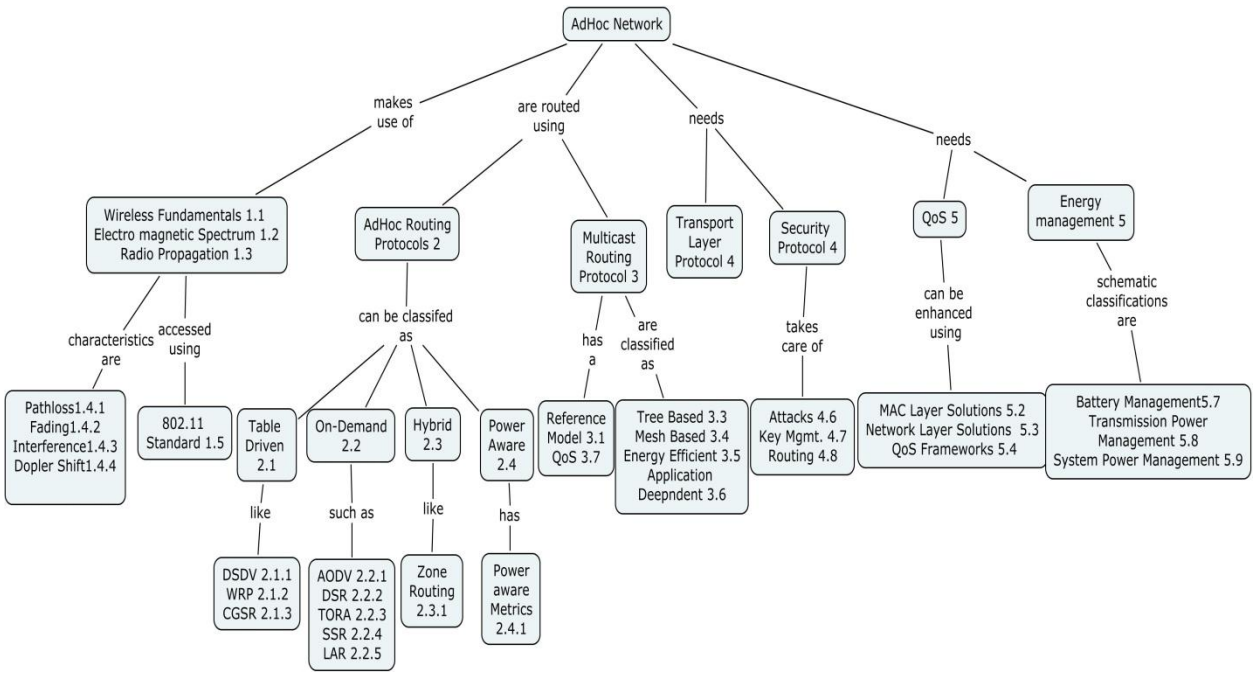
1. Compare topology reorganization in DSDV and CGSR routing protocols
2. Compare the various secure routing methods used in Ad hoc networks.
3. Examine the different phases of Associativity- Based Ad hoc Multicast routing.

Course Outcome 6 (CO6):

1. Nodes A and B want to establish a secure communication, and node A generates a random key 11001001. Suppose the functions used by both the nodes A and B for encryption is XOR, and let node A generate a random transport key 10010101 and let node B generate 00101011.Sketch the three pass Shamir protocol exchanges.
2. Predict the possible steps of the algorithms executed at the source and the intermediate nodes of an ad hoc wireless network that follow the following strategies: a) random energy b) pay-for-it strategy. Assume a session between source s and destination d. let R(s,d) be the set containing available routes between s and d , sympathy(k,r) be the the kth node in route r, and credit(k,r) and debit(k,r) be the credit and debit of kth node in route r respectively.
3. Mark the paths chosen by the following secure-routing protocols for the network topology shown in figure: a) Shortest path routing and b) SAR protocol. Assume that node 2 is secure node. C) If node 2 (which lies in the path chosen by SAR protocol) is suddenly attacked and becomes a malicious node, then mark an alternative path chosen by SAODV protocol.



Concept Map



Syllabus

Introduction :Introduction-Fundamentals of Wireless Communication Technology - The Electromagnetic Spectrum - Radio Propagation Mechanisms - Characteristics of the Wireless Channel - IEEE 802.11 Standard –**Ad Hoc Routing Protocols**: Issues and Challenges - Classifications of Routing Protocols-Table-Driven Routing Protocols - On-Demand Routing Protocols – Hybrid Routing Protocols- Power-Aware Routing

(PAR) - **Multicast routing In Ad Hoc Networks**: - An Architecture Reference Model for Multicast Routing Protocols -Classifications of Multicast Routing Protocols- Tree-Based Multicast Routing Protocols- Mesh-Based Multicast Routing Protocols-Energy-Efficient Multicasting - Multicasting with Quality of Service Guarantees – Application-Dependent Multicast Routing **Transport Layer, Security Protocols**: Designing a Transport Layer Protocol - Design Goals of a Transport Layer Protocol -Classification of Transport Layer Solutions - TCPOver Ad Hoc Wireless Networks -Other Transport Layer Protocols - Security Requirements - Issues and Challenges in Security Provisioning -Network Security Attacks - Key Management - Secure Routing **Qos and Energy Management**: Classifications of QoS Solutions - MAC Layer Solutions-Network Layer Solutions - QoS Frameworks for Ad Hoc Wireless Networks Energy Management in Ad Hoc Wireless Networks –Introduction - Need for Energy Management in Ad Hoc Wireless Networks - Classification of Energy Management Schemes - Battery Management Schemes - Transmission Power Management Schemes - System Power Management Schemes

Reference Books

1. C.Siva Ram Murthy and B.S. Manoj "Ad Hoc Wireless Networks:

Architectures and Protocols", Pearson education, 2008

2.Charles E. Perkins, Ad Hoc Networking, Addison Wesley, 2000

3.William Stallings, "Wireless Communications and Networks", Pearson education, 2003

4.J. Schiller, "Mobile Communications", Pearson education, 2003

5.Vijay K. Garg, "Wireless Communications and Networking", Elsevier, 2008.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1	**AdHoc Networks Introduction (7)**	
1.1	Fundamentals of Wireless Communication	2
1.2	The Electromagnetic Spectrum	1
1.3	Radio Propagation Mechanisms	2
1.4	Characteristics of the Wireless Channel	1
1.5	IEEE 802.11 Standard	1
2	**Ad Hoc Routing Protocols (11)**	
2.0	Issues and Challenges	2
2.1	Table-Driven Routing Protocols	3
2.2	On Demand Routing Protocols	2
2.3	Hybrid Routing Protocols	2
2.4	Power-Aware Routing	2
3	**Multicast routing In Ad Hoc Networks (10)**	
3.1	An Architecture Reference Model for Multicast Routing Protocols	2

3.2	Classifications of Multicast Routing Protocols	1
3.3	Tree-Based Multicast Routing Protocols	2
3.4	Mesh-Based Multicast Routing Protocols	2
3.5	Energy Efficient Routing Protocols	1
3.6	Application Dependent Protocols	1
3.7	Multicasting with QoS Guarantee	1
4	**Transport Layer, Security Protocols (10)**	
4.1	Designing a Transport Layer Protocol	2
4.2	Design Goals of a Transport Layer Protocol	1
4.3	TCP Over Ad Hoc Wireless Networks	2
4.4	Other Transport Layer Protocols	1
4.5	Security Requirements - Issues and Challenges in Security Provisioning	1
4.6	Network Security Attacks	1
4.7	Key Management	1
4.8	Secure Routing	1
5	**Qos and Energy Management (10)**	
5.1	Classifications of QoS Solutions	1
5.2	MAC Layer Solutions	1
5.3	Network Layer Solutions	1
5.4	QoS Frameworks	1
5.5	Energy Management	1
5.6	Classification of Energy Management Schemes	1
5.7	Battery Management Schemes	2
5.8	Transmission Power Management Scheme	1
5.9	System Power Management Schemes	1
	Total	**48**

Course Designers:

1. Mr. C.Senthilkumar cskcse@tce.edu
2. Mr. S.Prasanna sprcse@tce.edu

14CGPE0	DISTRIBUTED OPERATING SYSTEMS CONCEPTS AND PRINCIPLES	L	T	P	Credit
		4	0	0	4

Preamble

This course will facilitate the Students to understand the concepts of distributed operating systems components like transparency, or single system image, DOS Issues, RPC, and Server Management etc.. Distributed Operating Systems concludes with a set of case studies that provide real–world insights into different distributed file systems.

Prerequisite

- Operating System Concepts

Course Outcomes

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

Understand the Hardware, software concepts required for DOS and the issues in the DOS. (CO1)	Understand
Apply the concepts of Remote Procedure Call (RPC), Server Management, and Parameter passing semantics and call semantics for given scenario. (CO2)	Apply
Apply the concepts of Election algorithm, event ordering, and Mutual exclusion and deadlock in DOS environment. (CO3)	Apply
Illustrate the different consistency model, replacement strategy in distributed Shared Memory (DSM). (CO4)	Apply
Apply the fault tolerance concepts and Distributed file system concepts for a given scenario. (Case studies) (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	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. What is Multicomputer and Multiprocessor?
3. Name the three important features used to differentiate the distributed OS and Network OS
4. Discuss about the advantages and disadvantages of commonly used models in configuring Distributed Operating Systems.
5. Describe in detail about DCE

Course Outcome 2 (CO2):

1. What are the fields in RPC Call Message Format?
2. Implement RPC Mechanism
3. Apply the server implementation to stateful and stateless servers

Course Outcome 3 (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.
5. Illustrate Election algorithms in Distributed Systems

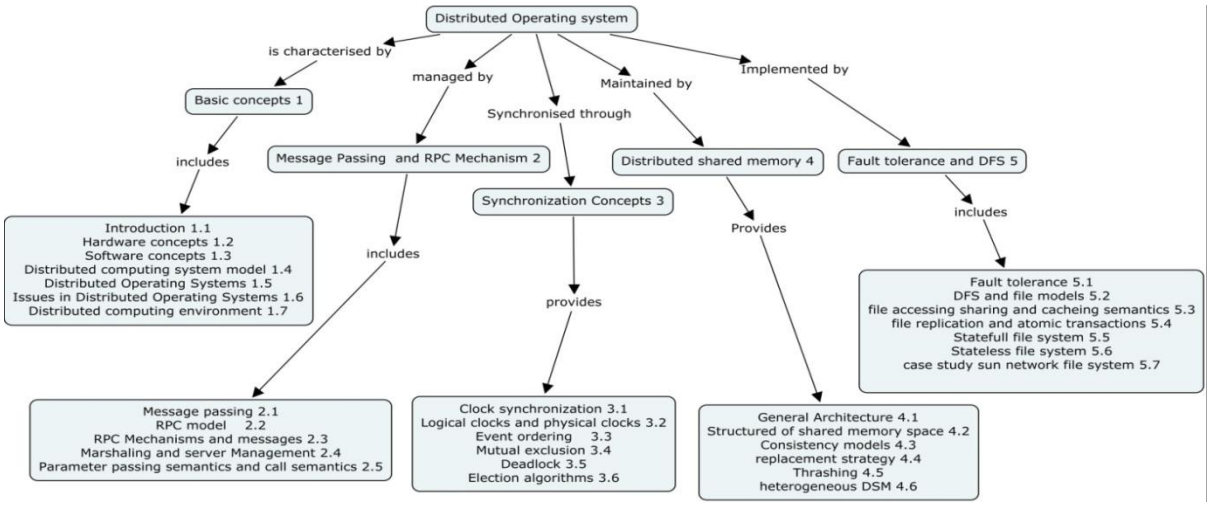
Course Outcome 4 (CO2):

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

Course Outcome 5 (CO2):

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.

Concept Map



Syllabus

Distributed Systems - Introduction, Hardware concepts software concepts – Distributed Computing System Models – Distributed Operating Systems – Issues in Distributed Operating Systems – Distributed Computing Environment **Message passing and RPC Mechanism** – Message passing – Remote Procedure call model – Implementing RPC mechanism – RPC Messages – Marshaling – Server Management Parameter passing semantics – call semantics **Synchronization** – Clock Synchronization – logical clocks – physical clocks – event ordering – mutual exclusion – deadlock – election algorithms – **Distributed Shared Memory** – General Architecture – structure of shared memory space – consistency models – replacement strategy – thrashing – heterogeneous Distributed Shared Memory. **Fault Tolerance and Distributed File Systems -** Fault tolerance – Distributed File Systems **–** File models – file accessing models – file sharing semantics – file caching semantics – file replication – atomic transactions – design principles – Stateful and Stateless File Systems - case studies –Network File Systems

Reference Books

1. Pradeep K. Sinha, Distributed Operating Systems Concepts and Design, Prentice Hall of India Private Limited, 2008
2. Andrew S. Tanenbaum, Maarten Van Steen, Distributed Systems Principles and Paradigms, Pearson Education, 2007
3. D M Dhamdhere, Operating Systems A Concept Based Approach: Tata McGraw-Hill Publishers, 2003, Second Reprint.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1	**Distributed System**	
1.1	Introduction of Distributed Systems	2
1.2	Hardware Concepts	1
1.3	Software Concepts	1
1.4	Distributed Computing System Models	1
1.5	Distributed Operating Systems	1
1.6	Issues in Distributed Operating Systems	2
1.7	Distributed Computing Environment	1
2	**Message Passing and RPC Mechanism**	
2.1	Message passing	2
2.2	Remote Procedure call model	2
2.3	Implementing RPC mechanism and RPC Messages	2
2.4	Marshaling and Server Management	2
2.5	Parameter passing semantics and call semantics	2
3	**Synchronization**	
3.1	Clock Synchronization	1
3.2	logical clocks and physical clocks	2
3.3	Event ordering	1
3.4	Mutual exclusion	2

3.5	Deadlock	3
3.6	Election algorithms	1
4	**Distributed Shared Memory**	
4.1	General Architecture	1
4.2	structure of shared memory space	1
4.3	consistency models	2
4.4	replacement strategy	2
4.5	Thrashing	2
4.6	Heterogeneous Distributed Shared Memory	1
Fault Tolerance and Distributed File Systems		
5.1	Fault Tolerance	2
5.2	Distributed File Systems and File models	2
5.3	file accessing models, file sharing semantics and file caching semantics	2
5.4	file replication and atomic transactions	1
5.5	Stateful file systems	1
5.6	Stateless file systems	1
5.7	case study - SUN Network File Systems	1
	Total	**48**

Course Designers:

1. Mr.R.Chellamani rcmcse@tce.edu

		L	T	P	Credit
14CGPF0	**INTELLIGENT OPTIMIZATION ALGORITHMS**	4	0	0	4

Preamble

Intelligent optimization Algorithms investigate several techniques commonly referred to as intelligent algorithms, and takes a pragmatic engineering approach to the design, evaluation, and implementation of intelligent systems. The algorithmic family includes genetic algorithms, hill-climbing, simulated annealing, ant colony optimization, particle swarm optimization, and so on. The course will enable the students to familiarize the various concepts of these intelligent optimization techniques, such as what they are, how they work, how to design, build and implement them.

Prerequisite

Course Outcomes

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

Explain the need for intelligent optimization techniques and develop single-state algorithms for solving non linear optimization problems. (CO1)	Apply
Experiment with various population based Evolutionary algorithms with suitable solution representation for the given combinatorial problem and compare the performance of various algorithms. (CO2)	Analyze
Apply multi-objective optimization algorithms for real time optimization problems having more than one objective. (CO3)	Apply
Explain different parallelization and model fitting methods and choose the suitable method for the given real time problem and compare their performance. (CO4)	Analyze

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

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

Analyse	0	0	0	20
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Write the basics steps involved in metaheuristics algorithms to optimize the candidate solution? (Remember)
2. Use algorithmic steps to show that local optimization algorithm will become global optimization algorithm? (Understand)
3. Apply Tabu Search algorithm to find Minimum Spanning Tree? (Apply)

Course Outcome 2 (CO2):

1. What are the parameters used in PSO for exploration and exploitation? (Remember)
2. Write an algorithm for uniform crossover with an example. (Understand)
3. Construct an effective ACO algorithm for DNA sequencing problem? (Apply)
4. Analyze the performance of DE with PSO for TSP? (Analyze)

Course Outcome 3 (CO3):

1. What is point mutation? (Remember)
2. How does Tree-Style Genetic Programming Pipeline work? (Understand)
3. Identify the suitable representation, crossover and mutation techniques for Real Coded GA? (Apply)

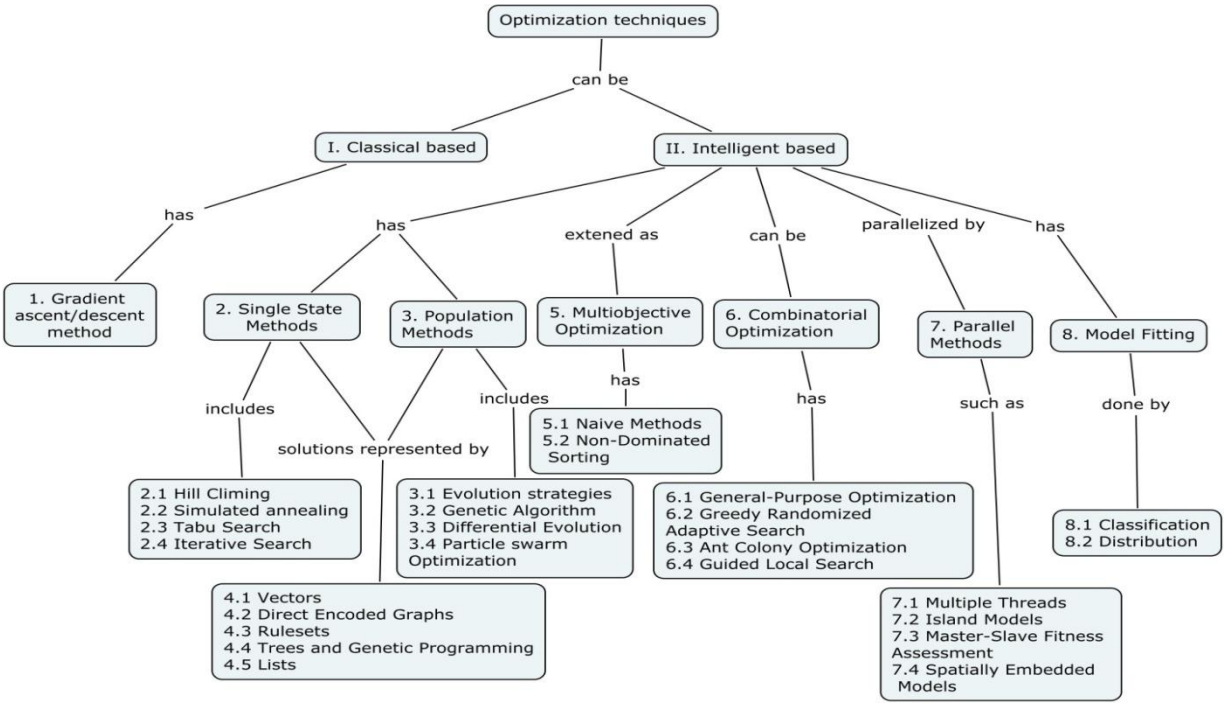
Course Outcome 4 (CO4):

1. What is crowding and niching? (Remember)
2. Explain how Pareto strength is maintained in Multi-objective problem? (Understand)
3. Design a multi-objective Scheduling Problem using PSO? (Apply)

Course Outcome 5 (CO5):

1. What are the ways to parallelize a problem? (Remember)
2. Explain model fitting by classification? (Understand)
3. Construct parallel DE for vertex coloring problem using Island models. (Apply)
4. Develop parallel GA for TSP using Island models and Master-Slave models and compare their performance. (Analyze)

Concept Map



Syllabus

Classical Optimization Techniques – Gradient Ascent/Descent Methods- Drawback of classical techniques – Need for Intelligent techniques- Single-State Methods – Hill Climbing - Simulated Annealing - Tabu Search -Iterated Local Search **Population Methods** - Evolution Strategies- The Genetic Algorithm- Differential Evolution - Particle Swarm Optimization **Representation** – Vectors - Direct Encoded Graphs – Rulesets - Trees and Genetic Programming - Lists, Machine-Language Genetic Programming, and Grammatical Evolution **Multiobjective Optimization** -Naive Methods - Non-Dominated Sorting - Combinatorial Optimization -General-Purpose Optimization and Hard Constraints- Greedy Randomized Adaptive Search Procedures - Ant Colony Optimization -Guided Local Search **Parallel Methods** - Multiple Threads- Island Models - Master-Slave Fitness Assessment - Spatially Embedded Models - Model Fitting - Model Fitting by Classification - Model Fitting with Distribution

Reference Books

1. Michel Gendreau, Jean-Yves Potvin, “Handbook of Metaheuristics”, Second Edition, International Series in Operations Research & Management Science ,Springer 2010.
2. Godfrey C. Onwubolu, B. V. Babu, “New optimization techniques in engineering”, Series: Studies in Fuzziness and Soft Computing, Vol. 141, Springer, 2004.
3. Sean Luke , “Essentials of Metaheuristics”, (Online Version 1.2), lulu.com (March 5, 2011).
4. Crina Grosan, Ajith Abraham, “Intelligent Systems: A Modern Approach”, Intelligent Systems Reference Library,Volume 17, Springer, 2011.
5. D.T. Pham , D. Karaboga, “Intelligent Optimisation Techniques”, Springer, 2000.

Course Contents and Lecture Schedule

Module No.	Topics	No of Lectures
I	**Classical Optimization Techniques**	
1	Gradient Ascent/Descent Methods– Drawback of classical techniques- Need for Intelligent techniques	3
II	**Intelligent Optimization Techniques**	
2	**Single-State Methods**	
2.1	Hill Climbing	1
2.2	Simulated Annealing	2
2.3	Tabu Search	2
2.4	Iterated Local Search	2
3	**Population Methods**	
3.1	Evolution Strategies	2
3.2	Genetic Algorithm	3
3.3	Differential Evolution	2
3.4	Particle Swarm Optimization	2

4	**Representation**	
4.1	Vectors	2
4.2	Direct Encoded Graphs	1
4.3	Rulesets	2
4.4	Trees and Genetic Programming	1
4.5	Lists, Machine-Language Genetic Programming, and Grammatical Evolution	2
5	**Multiobjective Optimization**	
5.1	Naive Methods	1
5.2	Non-Dominated Sorting	2
6	**Combinatorial Optimization**	
6.1	General-Purpose Optimization and Hard Constraints	1
6.2	Greedy Randomized Adaptive Search Procedures	2
6.3	Ant Colony Optimization	2
6.4	Guided Local Search	2
7	**Parallel Methods**	
7.1	Multiple Threads	2
7.2	Island Models	2
7.3	Master-Slave Fitness Assessment	2
7.4	Spatially Embedded Models	1
8	**Model Fitting**	
8.1	Model Fitting by Classification	2
8.2	Model Fitting with Distribution	2
	Total	**48**

Course Designers:

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

		L	T	P	Credit
14CGPG0	**AGENT BASED INTELLIGENT SYSTEMS**	4	0	0	4

Preamble

This course introduces representations, techniques, and architectures used to build applied systems and to account for intelligence from a computational point of view.

Prerequisite

Course Outcomes

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

Outline the behavior of different types of agents and their applications in the field of Artificial Intelligence. (CO1)	Understand
Apply various search techniques to solve gaming problem. (CO2)	Apply
Apply propositional and First Order Logic for designing logical agents. (CO3)	Apply
Illustrate the understanding of Uncertainty and Bayes Rules and apply them to design planning agents (CO4)	Apply
Apply the principles of probabilistic reasoning to design intelligent agents which uses Bayesian networks and Rule based methods. (CO5)	Apply
Apply appropriate learning algorithm for modelling intelligent agents. (CO6)	Apply

Mapping with Programme Outcomes

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

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	30	30	30	30
Apply	50	50	50	60
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Define rational agent?
2. Define inference
3. Differentiate single agent and multi agent

Course Outcome 2 (CO2):

1. What is Alpha Beta Pruning
2. Apply Optimal Strategies used for Game Problems

Course Outcome 3 (CO3):

1. Explain First Order Inference
2. Demonstrate Agent Based Propositional Logic with diagram

Course Outcome 4 (CO4):

1. Apply Baye's Rule for real world problem
2. Apply Baye's rule for combining evidence

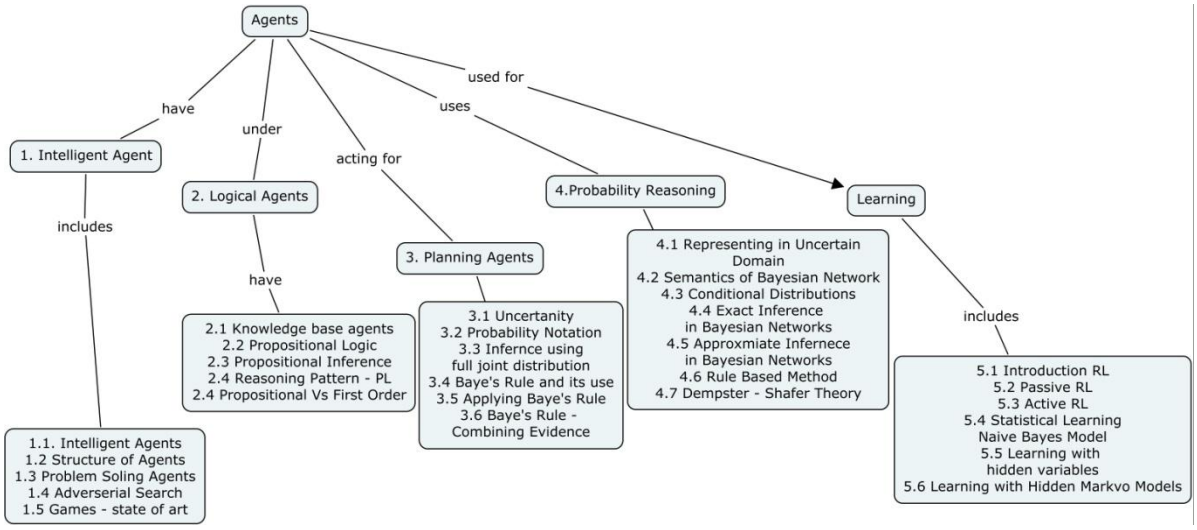
Course Outcome 5 (CO5):

1. Differentiate active and passive RL
2. What is mean by reward in RL
3. What is Bayesian learning
4. Explain Dempster-Shafer Theory
5. Demonstrate the exact inference in Bayesian Networks
6. Demonstrate the learning in Bayesian networks with EM algorithm

Course Outcome 6 (CO6):

1. Explain Q Learning
2. Explain statistical learning with Naïve Baye's Models
3. Why Hidden Markov Model is used
4. How EM is used for real time application

Concept Map



Syllabus

Intelligent Agents : Introduction – Intelligent Agent – Structure of Agents - Problem Solving Agents- Searching for solutions – Adversarial Search – Games, Optimal strategies, Alpha-Beta Pruning, Imperfect Real Time decisions, Games that include an Element of Chance, State of the Art Games Programs **Logical Agents:** Knowledge Based Agents – Propositional Logic – Reasoning patterns in propositional logic – Effective propositional inference – Agent based Propositional Logic, Propositional versus First Order Inference **Planning Agents:** Uncertainty – Acting under Uncertainty, Basic Probability Notation – Propositions, atomic events, prior probability, Axioms of Probability, Inference using Full Joint Distribution, Independence, Baye's Rule and its Use, Applying Baye's Rule, Using Baye's Rule: Combining Evidence **Probabilistic Reasoning:** Representing knowledge in an Uncertain Domain, Semantics of Bayesian Network, Efficient Representation of conditional distributions, Exact Inference in Bayesian Networks, Approximate Inference in Bayesian Networks, Extending probability to first order representation, Rule based methods for uncertain reasoning, Dempster-Shafer Theory **Learning:** Introduction, Passive Reinforcement Learning, Active Reinforcement Learning, Statistical Learning – Learning with complete data, Naïve Baye's Models, Learning with Hidden Variables : EM Algorithm, Learning Hidden Markov Models

Reference Books

1. Stuart Russell," Artificial Intelligence – A Modern Approach" Third Edition, Pearson Edition,2003
2. Elaine Rich, Kevin knight, Shivashankar B Nair, " Artificial Intelligence" Third Edition, Tata Mc Graw Hill,2011

Course Contents and Lecture Schedule

No	Topic	No of Lectures
1.	**Intelligent Agent (10)**	
1.1	Introduction	2
1.2	Intelligent Agent, Structure of Agents	2
1.3	Problem Solving Agent, Searching for solutions	1
1.4	Adversarial Search – Games, Optimal strategies	1
1.5	Alpha-Beta Pruning	1
1.6	Imperfect Real Time decisions	1
1.7	Games that include an Element of Chance	1
1.8	State of the Art Games Programs	1
2.	**Logical Agents (9)**	
2.1	Introduction	1

2.2	Knowledge Based Agents	2
2.3	Propositional Logic	2
2.4	Reasoning Patterns in Propositional logic, Effective propositional inference	1
2.5	Agent Based Propositional Logic	1
2.6	Propositional versus First Order Inference	2
3.	**Planning Agents (10)**	
3.1	Uncertainty – Acting under Uncertainty	2
3.2	Basic Probability Notation – Propositions, atomic events, prior probability	2
3.3	Axioms of Probability	1
3.4	Inference using Full Joint Distribution	1
3.5	Independence	1
3.6	Baye's Rule and its Use	1
3.7	Applying Baye's Rule	1
3.8	Using Baye's Rule: Combining Evidence	1
4	**Probabilistic Reasoning (10)**	
4.1	Representing knowledge in an Uncertain Domain	1
4.2	Semantics of Bayesian Network	2
4.3	Efficient Representation of conditional distributions	1
4.4	Exact Inference in Bayesian Networks	2
4.5	Approximate Inference in Bayesian Networks	1
4.6	Extending probability to first order representation	1
4.7	Rule based methods for uncertain reasoning	1
4.8	Dempster-Shafer Theory	1
5	**Learning (9)**	
5.1	Introduction	1
5.2	Passive Reinforcement Learning	1
5.3	Active Reinforcement Learning	1
5.4	Statistical Learning – Learning with complete data, Naïve Bayes Models	2
5.5	Learning with Hidden Variables : EM Algorithm	2
5.6	Learning Hidden Markov Models	2
	Total	**48**

Course Designers:

1. Dr. M.K.Kavitha Devi mkkditj@tce.edu

14CGPH0	CRYPTOGRAPHY AND NETWORK SECURITY	L	T	P	Credit
		3	1	0	4

Preamble

Cryptography is the science of information and communication security. It is used for authentication, encryption and access control. The objective of the course is to introduce some of the known security problems related to networking and to overview the contemporary solutions to these problems. The focus of the course is on Authentication, authorization, confidentiality, data integrity and non-repudiation. Network security and system security issues are also addressed here.

Prerequisite

- 14CG140 - Network Technology

Course Outcomes

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

Explain the threats and vulnerabilities of information systems. (CO1)	Understand
Understand the techniques that protect and defend information and information systems by ensuring authentication and authorization (CO2)	Understand
Select and apply appropriate techniques to ensure the secrecy of the data (CO3)	Analyze
Select methods to ensure non-repudiation for the data (CO4)	Apply
Explain the suitability of security algorithms for real time applications (CO5)	Understand

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1.	L	L	M								
CO2.	M	L	L								
CO3.	S	S	S	M							
CO4.	S	S	S	M							
CO5.	L					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	10
Apply	40	40	40	60
Analyse	20	20	20	10
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. Define active attack and its types.
3. Draw the basic network security model

Course Outcome 2 (CO2):

1. Define Entity authentication
2. Define Password Salting
3. State the different Biometrics techniques

Course Outcome 3 (CO3):

1. Eve captures Bob's Hill cipher machine, which uses a 2-by-2 matrix M mod 26. She tries a chosen plaintext attack. She finds that the plaintext ba encrypts to HC and the plaintext zz encrypts to GT. What is the matrix M?
2. Double DES is not used in practice. State reason
3. State reasons for naming the Blowfish algorithm named so.
4. 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?

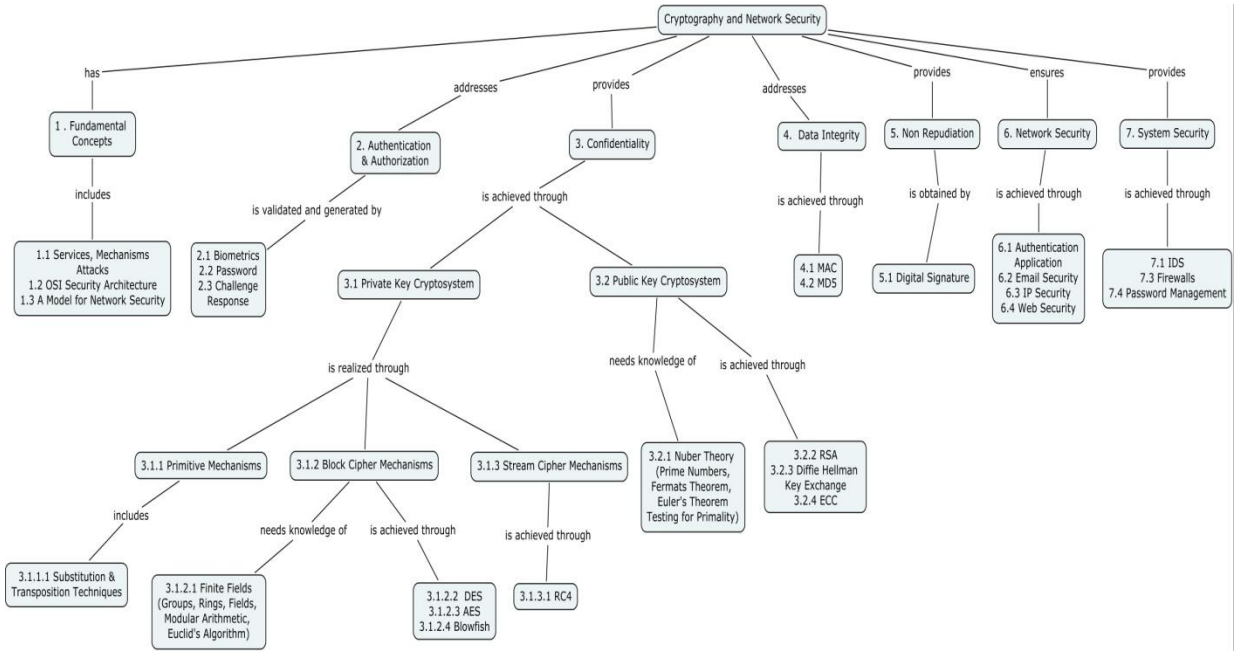
Course Outcome 4 (CO4):

1. Apply RSA algorithm to sign digitally the message PAYRANSOM.
2. Apply PGP authentication and confidentiality services to give message M = 73A56F49257…. K_S=47524635. Given KU_b=5, KR_a=317 n_b=437, KU_a=11, KR_a=35 and n_a=221.
3. Compare and contrast Hash and MAC authentication schemes

Course Outcome 5 (CO5):

1. List the uses of Firewalls.
2. Define any one scheme used in Electronic Mail security.
3. Describe the working of Kerberos 4 authentication protocol with a neat diagram.

Concept Map



Syllabus

Introduction: Services, Mechanisms and Attacks, The OSI Security Architecture, A Model for Network Security. **Authentication and Authorization:** Biometrics, Password, Challenge Response. **Confidentiality: Symmetric Ciphers:** Symmetric Cipher Model, Substitution and Transposition Techniques. **Block Cipher Mechanisms:** DES, Block cipher modes of operation. Introduction to Finite Fields: Groups, Rings and Fields, Modular Arithmetic, Euclid's Algorithm, Finite Fields, Advanced Encryption Standard, Blowfish. **Stream Cipher Mechanism:** RC4 Stream Cipher. **Public Key Encryption**: Introduction to Number Theory: Prime Numbers, Fermat's and Euler's Theorem, Testing for Primality, RSA, Diffie – Hellman Key Exchange, Elliptic Curve Cryptography. **Message Authentication and Integrity:** Message Authentication Codes, MD5 Message Digest Algorithm. **Non-Repudiation:** Digital Signature and Digital Signature Standard. **Network Security Practice: Authentication Application**- Kerberos**. Electronic Mail Security -** PGP. **IP Security -** IP Security Architecture**. Web Security**- Secure Socket Layer and Transport layer, Secure Electronic Transaction. **System Security:** Intruders- Intrusion Detection, Password Management. Malicious Software - Viruses and related Threats. Firewalls- Firewal Design Principles.

Reference Books

1. William Stallings, Cryptography and Network Security Principles and Practices, Fourth Edition, Pearson Education, 2008.
2. Behrouz A. Foruzan, Cryptography and Network Security, TataMcGraw Hill, 2007
3. William Stallings, Cryptography and Network Security Principles and Practices, Third Edition, Pearson Education, 2006.

Course Contents and Lecture Schedule

Module No.	Topic	No of Lectures
1	**Fundamental Concepts (3)**	
1.1	Services, Mechanisms and Attacks	1

1.2	The OSI Security Architecture	1
1.3	A Model for Network Security.	1
2	**Authentication and Authorization (2)**	
2.1	Biometrics	1
2.2	Passwords	1
2.3	Challenge Response Schemes	
3	**Confidentiality (26)**	
3.1	Private Key Cryptosystem:	
3.1.1	**Primitive Mechanisms :** Symmetric Cipher Model	1
3.1.1.1	Substitution and Transposition Techniques.	1
3.1.1.2	Tutorial	2
3.1.2	**Block Cipher Mechanisms:**	
3.1.2.1	**Introduction to Finite Fields:** Groups, Rings Fields,Modular Arithmetic, Euclid's Algorithm, Finite Fields	2
3.1.2.2	Tutorial	1
3.1.2.3	DES	1
3.1.2.4	Tutorial	1
3.1.2.5	Advanced Encryption Standard	1
3.1.2.6	Tutorial	2
3.1.2.7	Blowfish	1
3.1.2.8	Tutorial	1
3.1.3	**Stream Cipher Mechanism:**	
3.1.3.1	RC4 Stream Cipher.	1
3.1.3.2	Tutorial	1
3.2	**Public Key Encryption**:	
3.2.1	Introduction to Number Theory: Prime Numbers, Fermat's and Euler's Theorem Testing for Primality	3
3.2.2	RSA	2
3.2.3	Tutorial	2
3.2.4	Diffie – Hellman Key Exchange	1
3.2.5	Elliptic Curve Cryptography	1
3.2.6	Tutorial	1
4	**Message Authentication and Integrity (4)**	
4.1	Message Authentication Codes	2
4.2	MD5 Message Digest Algorithm.	1
4.3	Tutorial	1
5	**Non-Repudiation (1)**	
5.1	Digital Signature and Digital Signature Standard.	1
6	**Network Security Practice** (8)	
6.1	**Authentication Application**- Kerberos**.**	1

6.2	**Electronic Mail Security-** PGP**.**	2
6.3	**IP Security-** IP Security Architecture**.**	2
6.4	**Web Security**- Secure Socket Layer and Transport layer, Secure Electronic Transaction	1
7	**System Security (6)**	
7.1	Intruders- Intrusion Detection,	1
7.2	Malicious Software- Viruses and related Threats.	2
7.3	Firewalls- Firewall Design Principles.	2
7.4	Password Management.	1
	Total	**48**

Course Designers:

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

14CGPJ0	DESIGN AND ANALYSIS OF PARALLEL ALGORITHMS	L	T	P	Credit
		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.

Prerequisite

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 and analyze parallel algorithms for 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.	M	M	M								
CO2.	M	M	M								
CO3,	M	M	M								
CO4.	L	L	L								
CO5.	L	L	L		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	30	30	30	30
Apply	50	40	40	40
Analyse	0	20	20	20
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (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.

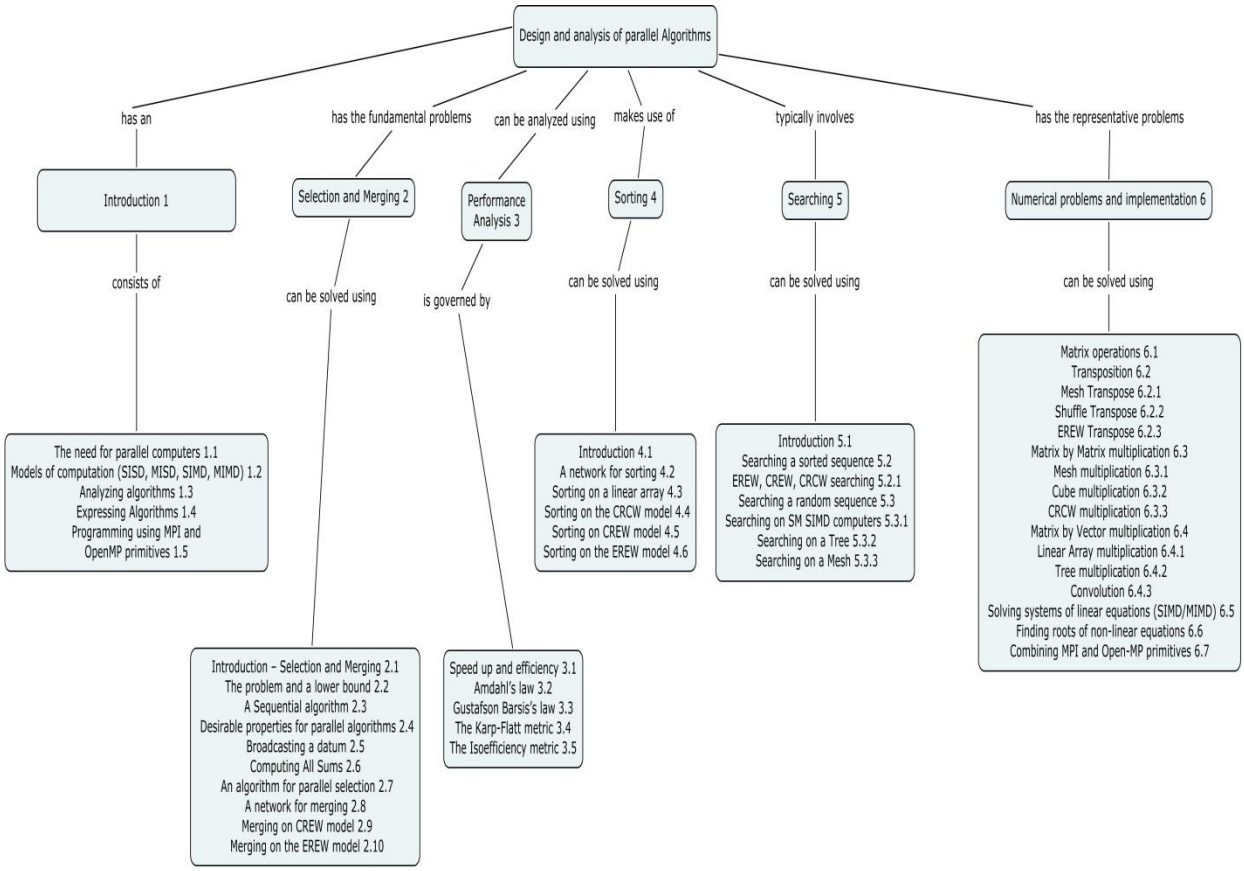
Course Outcome (CO4):

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, Programming using MPI and Open-MP primitives. **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. **Performance Analysis:** Speed up and efficiency, Amdahl's law, Gustafson Barsis's law, The Karp-Flatt metric, The

Isoefficiency metric. **Sorting:** Introduction, A network for sorting, Sorting on a linear array, Sorting on the CRCW model, Sorting on CREW model, Sorting on the EREW model. **Searching:** Introduction, Searching a sorted sequence, EREW, CREW, CRCW searching, Searching a random sequence, Searching on SM SIMD computers, Searching on a Tree, Searching on a Mesh. **Numerical problems and implementation**: Matrix operations, Transposition, Mesh Transpose, Shuffle Transpose, EREW Transpose, 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, Combining MPI and Open-MP primitives.

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

Module 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
1.5	Programming using MPI and Open-MP primitives	1
2	**Selection and Merging**	
2.1	Introduction – Selection and Merging	1
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	1
2.8	A network for merging	1
2.9	Merging on CREW model	1
2.10	Merging on the EREW model	1
3	**Performance Analysis**	
3.1	Speed up and efficiency	1
3.2	Amdahl's law	1
3.3	Gustafson Barsis's law	1
3.4	The Karp-Flatt metric	1
3.5	The Isoefficiency metric	1
4	**Sorting**	

Module No.	Topic	No. of Lectures
4.1	Introduction	1
4.2	A network for sorting	1
4.3	Sorting on a linear array	1
4.4	Sorting on the CRCW model	1
4.5	Sorting on CREW model	1
4.6	Sorting on the EREW model	1
5	**Searching**	
5.1	Introduction	1
5.2	Searching a sorted sequence	1
5.2.1	EREW, CREW, CRCW searching	1
5.3	Searching a random sequence	1
5.3.1	Searching on SM SIMD computers	1
5.3.2	Searching on a Tree	1
5.3.3	Searching on a Mesh	1
6	**Numerical problems and implementation**	
6.1	Matrix operations	1
6.2	Transposition	1
6.2.1	Mesh Transpose	1
6.2.2	Shuffle Transpose	1
6.2.3	EREW Transpose	1
6.3	Matrix by Matrix multiplication	1
6.3.1	Mesh multiplication	1
6.3.2	Cube multiplication	1
6.3.3	CRCW multiplication	
6.4	Matrix by Vector multiplication	1
6.4.1	Linear Array multiplication	1
6.4.2	Tree multiplication	1
6.4.3	Convolution	1
6.5	Solving systems of linear equations (SIMD/MIMD)	1
6.6	Finding roots of non-linear equations	2
6.7	Combining MPI and Open-MP primitives	
	Total	**48**

Course Designers:

1. Mr. S. Karthick skcse@tce.edu
2. Dr. S. Mercy Shalinie shalinie@tce.edu

14CGPK0 DISTRIBUTED AND GRID COMPUTING

L	T	P	Credit
4	0	0	4

Preamble

This course aims at facilitating students to understand the design issues and implementation details behind distributed computing and grid computing middlewares. The prerequisites for this course are operating systems and networks. A previous course on Distributed systems would be an added advantage.

Prerequisite

Course Outcomes

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

Understand the hardware and software building blocks of a distributed system. (CO1)	Understand
Understand the design issues involved in designing a distributed system in terms of networking/OS/middleware. (CO2)	Understand
Understand the limitations of a distributed system like absence of a global state, clock drift and so on. (CO3)	Understand
Apply Service Oriented Architecture (SOA) principles to design a compute or data grid. (CO4)	Apply
Understand the design trade-offs involved in selecting a grid computing toolkit and select a toolkit to be used for a specific application. (CO5)	Apply
Construct pseudo-code for running parallel algorithms using application programming interfaces offered by distributed kernels. (CO6)	Apply
Demonstrate an understanding of distributed static and dynamic scheduling algorithms and their impacts on the performance of a distributed system. (CO7)	Apply
Construct distributed systems and protocols with an understanding of the security issues involved. (CO8)	Apply
Construct distributed systems which uses distributed file systems (DFS) and programming models for DFS like Map-Reduce and Dryad. (CO9)	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1.	L										
CO2.	L										
CO3.	L										
CO4.	M	L	L								
CO5.	M	L	L		M						
CO6.	M	L	L		M						
CO7.	M	L	L								
CO8.	M	L	L								
CO9.	M	L	L		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	30	30	30	30
Apply	50	60	60	60
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome (CO1):

1. Summarize any five Collection of Processes (COP) based approaches to distributed programming.
2. Describe the various distributed system architectures like Client-Server, Thin-Client and P2P

Course Outcome (CO2):

1. a. Illustrate ways to synchronize the clocks in two computers that are linked by a local network without reference to an external time source.
   b. Summarize the factors that limit the accuracy of the procedure you have described.
   c. Describe ways in which the clocks in a large number of computers connected by the Internet be synchronized.
2. State the differences between centralized and hierarchical meta-scheduling schemes.
3. Illustrate any six types of transparency to be supported by a good distributed system as identified by the ISO's reference model for open distributed processing.

Course Outcome (CO3):

1. Discuss some of the design requirements while building a distributed system. In specific discuss regarding the following requirements: Throughput, Performance issues, Load balancing, Caching and Replication

2. Discuss the different types of failures and recovery options in distributed systems. Discuss in specific about Byzantine failures, timing failures, Masking failures and Omission failures.

Course Outcome (CO4):

1. Identify the SOAP features which have to be implemented for the following grid service endpoint:
The endpoint accepts a secure purchase order as a request and responds with a status indicating whether the order got placed successfully; Once it returns this response, the endpoint periodically sends a status update to the client indicating the current status of the order (Under process, Shipped, Delivered).

a. Illustrate the two different mechanisms provided by SOAP, to implement these SOAP features and demonstrate the pros and cons of both these implementation schemes.

b. Construct a new MEP to cater to the use case mentioned.
c. Construct a SOAP Header (as per the WS-Security standard) which can be used to check the integrity of the messages transferred to the server which processes the secure purchase order.

Course Outcome (CO5):

1. Different server machines are currently being used to host an array of applications of an IT services company. The management would like to cut down the costs incurred by the company in procuring high-end servers and would like to reuse its infrastructure as much as possible across these applications. When the management wants to launch a new product/application, there is a need for procuring a server machine, provisioning the

machine in its data centre and deploying the application. This severely increases the time-to-market a product for the IT services firm. Identify a suitable technology enabler behind grid computing to solve this problem and illustrate the features of the identified technology which can be leveraged in solving this problem.

2. a. Construct a relationship diagram depicting various legion objects for the following grid application which is deployed on top of the Legion middleware: Given a XLS, TXT, DOC, PPT or a PS document, the grid application converts the document to a PDF format and stores it for later reference. The grid application also takes into account the geographical proximity of the user to the database in which the PDF will be stored to leverage 'data locality optimization'.

b. Illustrate the functionalities provided by the different layers of the legion application architecture (with a neat sketch) on top of which the application has been deployed.

Course Outcome (CO6):

1. Assume that there is a distributed system formed to collect and query the data archives accumulated as a result of the experiments conducted using the Large Hadron Collider at the Centre for Nuclear research (CERN). Researchers and administrators of this distributed system, would like to periodically monitor the resource's availability to schedule tasks on a resource. Demonstrate the way to apply parsets for such resource monitoring.

2. Illustrate how SPMD parallelism can be applied to solve the below mentioned problem using parsets. (Compose your solution as a C code snippet)

"There is an array containing 109 integers. The array must be sorted in the ascending order and de-duplicated."

3. a. A gray-scale image can be expressed as a 2-D array consisting of pixel intensities. An image transformation function operates on a single line in the image. The array must be transformed into a simple parset which can exploit the SPMD parallelism inherently present in the problem statement. Illustrate the use of grain control mechanism in solving the problem mentioned above.

b. Assume that the problem statement requires a programmer to perform scaling, shearing and rotation functions in parallel on the gray scale image. Identify the type of parallelism that can be exploited in the redefined problem statement and Illustrate the use of polymorphic functions and untyped parsets in exploiting the parallelism identified.

c. Identify the limitations of your solution to [3 b] and Illustrate with the help of a pseudo code snippet the use of function parsets in overcoming these limitations.

Course Outcome (CO7):

1. Assume that there are six machines on a grid M = {m1, m2, m3, m4, m5, m6}. The predicted execution times (in sec) of three tasks T = {t1, t2, t3} on the machines in set M is given by the following table:

tasks/machines	m_1	m_2	m_3	m_4	m_5	m_6
t_1	2	1	6	7	1	1
t_2	6	2	1	2	1	2
t_3	3	10	2	1	2	5

Assume the following:

Job queue of all the machines is empty to begin with.
The grid scheduler has a prior knowledge about the set of tasks to be mapped.

t1 ~ {insertion sort on 100 numbers} with best case complexity O(n)
t2 ~ {quick sort on 512 numbers} with best case complexity O(nlog2 n)
t3 ~ {searching on a binary tree having 1024 leaf nodes} with best case complexity O(log2 n)
m1, m3 ,m5 ~ have a processing speed of 1.5 GHz
m2, m4, m6 ~ have a processing speed of 2 GHz
Simplification assumption: each instruction requires four machine cycles to complete.

Construct the task-machine mapping using the A* heuristic.

2. Construct a scheduler hierarchy for catering to about 1000 resources. The overall scheduling latency of your design should be less than 4 seconds from the root scheduler to any leaf-level scheduler. Assume the following: If a scheduler has to make a scheduling decision among 100 resources/schedulers, it takes a latency of about 10 seconds. Assume that scheduling latency is proportional to the number of resources/schedulers among which a scheduler must schedule a job.

Course Outcome (CO8):

1. Construct a SOAP module to satisfy the below mentioned security requirements:
A banking firm has exposed a grid service, which users can contact to download and view account statements (contains credits/debits which took place in the account within a specific time period). Before downloading the account statement the end points have to mutually authenticate each other through Kerberos V5 ticket. The integrity of the messages transferred should be checked at both the client and the server.

2. Illustrate the trust establishment process with respect to the following grid application:
A user from the domain tce.edu wants to collaborate and work with a user from the domain stanford.edu and hence assume that a grid has been established across both the domains. Both of these domain controllers trust the VeriSign certificate authority.

Course Outcome (CO9):

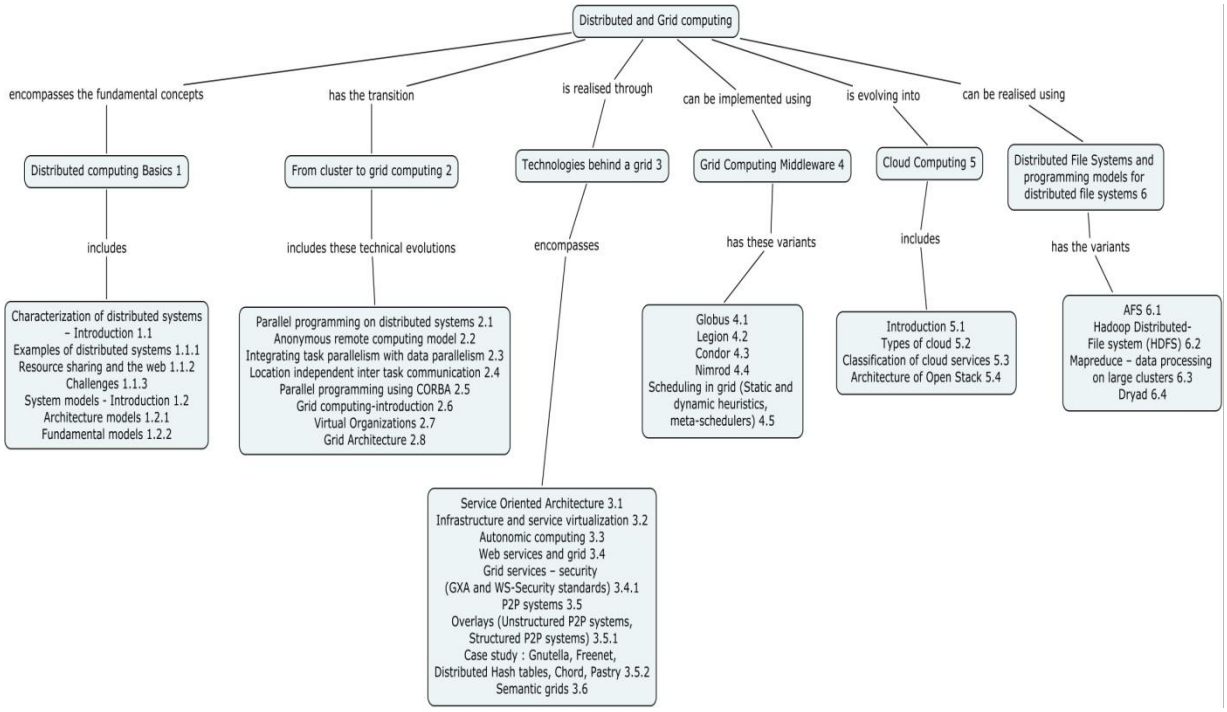
1. a. Assume that a DFS has been formed using HDFS which spans two data centers D1 and D2. D1 contains 3 racks each containing 20 nodes numbered n1 to n20. D2 contains 4 racks each containing 15 nodes numbered n1 to n15. A file chunk has been replicated on the following data nodes by HDFS: d1/r1/n3, d1/r3/n18, d2/r2/n3, and d2/r4/n15. A client HDFS daemon running on d2/r2/n2, issues a read request for this file chunk. Illustrate the calculation of the distance metric which is used in sorting the data node locations by the name node before the name node returns the list of data node locations to the DFS daemon running in the client.

b. Assume that the same HDFS daemon also issues a write request to append a file chunk at the end of the file mentioned in question [1 a]. Illustrate the anatomy of the read and write operations issued by the HDFS client daemon with neat sketches of the HDFS component pipelines.

2. Design a data grid to solve the following problem using a Map-Reduce algorithm which is to be run on top of the Hadoop framework:
Weather sensors all over the world collect the temperature, humidity, air pressure, wind direction at periodic intervals throughout the year and log the readings in a file present in HDFS in the following format <Weather station Id, Timestamp at which the reading is taken, temperature, humidity, air pressure, wind direction>. The size of the file is huge (~100 PB). The task is to analyze this data and output the minimum temperature recorded for each year in the past decade.

Compose snippets of code for the mapper, reducer functions and also the Hadoop job which invokes the MR code snippets. [You can use any programming language of your choice which is supported by the Hadoop framework]

Concept Map



Syllabus

Introduction – Distributed computing: Characterization of distributed systems – Introduction, Examples of distributed systems, Resource sharing and the web, Challenges, System models – Introduction, Architecture models, Fundamental models. **From cluster to grid computing:** Parallel programming on distributed systems, Anonymous remote computing model, Integrating task parallelism with data parallelism, Location independent inter task communication, Parallel programming using CORBA, Grid computing-introduction, Virtual Organizations, Grid Architecture. **Technologies behind a grid**: Service Oriented Architecture, Infrastructure and service virtualization, Autonomic computing, Web services and grid, Grid services – security (GXA and WS-Security standards), P2P systems – Overlays (Unstructured P2P systems, Structured P2P systems), Case study : (Gnutella, Freenet, Distributed Hash tables, Chord, Pastry), Semantic grids. **Grid Computing Middleware**: Globus, Legion, Condor, Nimrod, Scheduling in grid (Static and Dynamic heuristics, meta-schedulers). **Cloud Computing:** Introduction, Types of cloud, Classification of cloud services, Architecture of Open Stack. **Distributed File Systems and programming models for distributed file systems:** AFS, Hadoop Distributed File system (HDFS), Mapreduce – data processing on large clusters, Dryad.

Reference Books

1.George Coulouris, Jean Dollimore, Tim Kindberg: “Distributed Systems – concepts and design”, Third edition, Pearson Education, 2001.

2.Joshy Joseph, Craig Fellenstein: “Grid Computing”, First Edition, Pearson Education, 2004.
3.Ian Foster and Carl Kesselman: “The Grid2 - Blueprint for a new computing infrastructure”, Second Edition, Morgan Kaufmann, 2006.
4.Andrew S. Tanenbaum: “Distributed Operating Systems”, First Edition, Pearson Education, 2008.
5.Mukesh Singhal, Niranjan G. Shivaratri: “Advanced concepts in Operating Systems”, First Edition, Tata McGraw-Hill, 2006.
6.Andrew S. Tanenbaum, Maarten Van Steen: “Distributed Systems – Principles and Paradigms”, Second Edition, Pearson Education, 2008.
7.Maozhen Li, Mark Baker: “The Grid Core Technologies”, First Edition, John Wiley & Sons, 2005.
8.D. Janakiram: “Grid Computing”, Tata Mc-Graw Hill, First edition, 2005.
9.Tom White: “Hadoop: The definitive guide Map reduce for the cloud”, O’Reilly media, First edition, 2009.
10.Frederic Magoules, Thi-Mai-Huong Nguyen, Lei Yu: “Grid Resource Management: Toward Virtual and Services Compliant Grid Computing”, First Edition, CRC Press, 2008.
11.http://openstack.org/

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1	**Distributed computing Basics**	
1.1	Characterization of distributed systems – Introduction	1
1.1.1	Examples of distributed systems	1
1.1.2	Resource sharing and the web	1
1.1.3	Challenges	1
1.2	System models – Introduction	1
1.2.1	Architecture models	1
1.2.2	Fundamental models	1
2	**From cluster to grid computing**	
2.1	Parallel programming on distributed systems	2
2.2	Anonymous remote computing model	2
2.3	Integrating task parallelism with data parallelism	2
2.4	Location independent inter task communication	2
2.5	Parallel programming using CORBA	2
2.6	Grid computing-introduction	2
2.7	Virtual Organizations	1
2.8	Grid Architecture	2
3	**Technologies behind a grid**	
3.1	Service Oriented Architecture	2
3.2	Infrastructure and service virtualization	1
3.3	Autonomic computing	1
3.4	Web services and grid	1
3.4.1	Grid services – security (GXA and WS-Security	1

Module No.	Topic	No. of Lectures
	standards)	
3.5	P2P systems	1
3.5.1	Overlays (Unstructured P2P systems, Structured P2P systems)	1
3.5.2	Case study : Gnutella, Freenet, Distributed Hash tables, Chord, Pastry	2
3.6	Semantic grids	
4	**Grid Computing Middleware**	
4.1	Globus	1
4.2	Legion	1
4.3	Condor	1
4.4	Nimrod	
4.5	Scheduling in grid (Static and dynamic heuristics, meta-scheduling schemes)	3
5	**Cloud Computing**	
5.1	Introduction	1
5.2	Types of cloud	
5.3	Classification of cloud services	1
5.4	Architecture of Open Stack	
6	**Distributed File Systems and programming models for distributed file systems**	
6.1	AFS	2
6.2	Hadoop Distributed File system (HDFS)	2
6.3	Mapreduce – data processing on large clusters	2
6.4	Dryad	2

Course Designers:

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

		L	T	P	Credit
14CGPL0	**CLOUD COMPUTING**	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, building cloud networks, virtualization, distributed storage and security.

Prerequisite

Course Outcomes

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

Explain the basics of cloud computing. (CO1)	Understand
Identify the real time cloud providers and their service levels. (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.	M	L	L	L	L	L	M	L	L	M	M
CO2.	M	L	L	M	L	M	M	L	M	L	L
CO3.	S	M	M	M	M	S	M	M	M	M	M
CO4.	L	L	L	L	L	M	M	L	L	L	L
CO5.	M	L	L	M	S	S	S	M	M	M	M

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	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Discuss on Infrastructure as a Service offering. (Understand)
2. Discuss on the Layers and types of cloud (Understand)
3. Explain the benefits of using a cloud model (Understand)

4. Explain the limitations of using a cloud model. (Understand)

Course Outcome 2 (CO2):

1. Illustrate the various services offered by Microsoft service provider. (Apply)
2. Illustrate the various Amazon web services. (Apply)
3. Illustrate the features of Google Cloud platform. (Apply)

Course Outcome 3 (CO3):

1. Demonstrate the steps to construct the virtual machine using a virtualization tool. (Apply)
2. Illustrate Application Virtualization using any one of the tools of your choice. (Apply)
3. Discuss on server virtualization. (Apply)

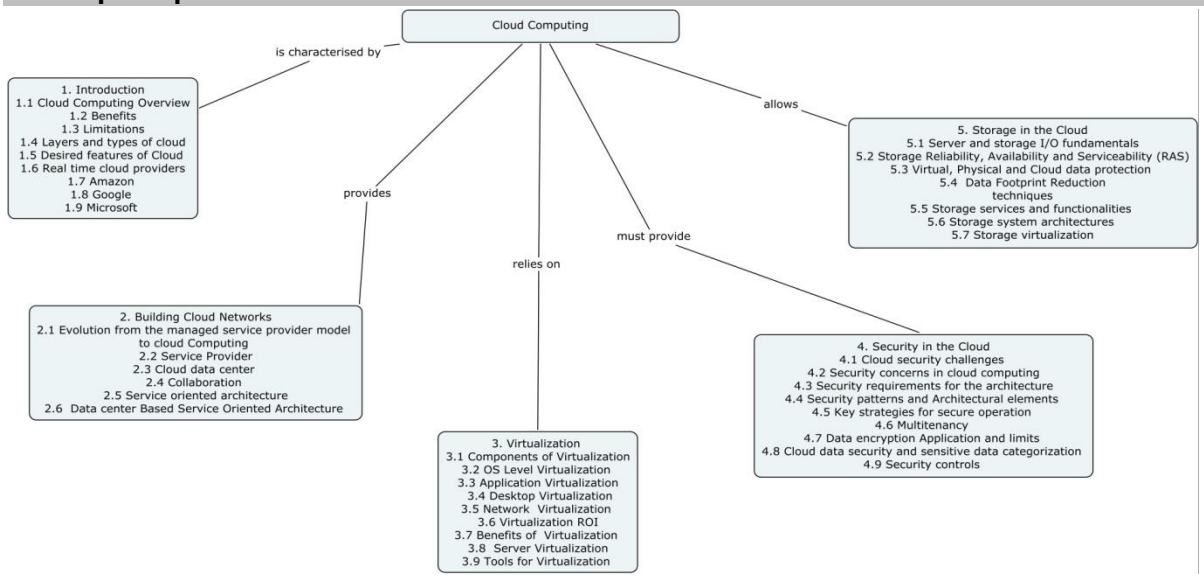
Course Outcome 4 (CO4):

1. Discuss the security concerns in Cloud Computing. (Understand)
2. Discuss the patterns and elements that contribute to cloud security. (Understand)
3. Illustrate the security services offered by any one of the Cloud Information security vendors. (Apply)

Course Outcome 4 (CO4):

1. Illustrate the disaster recovery techniques offered by storage services. (Apply)
2. Discuss on storage reliability, availability and serviceability. (Understand)
3. Explain the various DFR techniques available to address storage capacity optimization. (Understand)

Concept Map



Syllabus

Introduction – Cloud Computing Overview – benefits – limitations – Layers and types of cloud – Desired features of Cloud – Real time cloud providers – Amazon – Google – Microsoft

- **Building Cloud Networks -** Evolution from the managed service provider model to cloud Computing - Service Provider - Cloud data center – Collaboration - Service oriented architecture - Data center Based Service Oriented Architecture **Virtualization -** Components of Virtualization - OS Level Virtualization - Application Virtualization - Desktop Virtualization - Network Virtualization - Virtualization ROI-Benefits of Virtualization - Server Virtualization – Tools for Virtualization - **Security in the Cloud -** Cloud security challenges - Security concerns in cloud computing - Security requirements for the architecture - Security patterns and Architectural elements - Key strategies for secure operation – Multitenancy – Data encryption Application and limits – Cloud data security and sensitive data categorization – Security controls – **Storage in the Cloud –** Server and storage I/O fundamentals – Storage Reliability, Availability and Serviceability (RAS) - Virtual, Physical and Cloud data protection - Data Footprint Reduction techniques – Storage services and functionalities – Storage system architectures – Storage virtualization

Reference Books

1. Rajkumar Buyya, James Brogerg, Andrzej Goscinski, “Cloud Computing Principles and Paradigms”, John Wiley & Sons, Inc. Publications, 2011.
2. Anthony T.Velte, Toby J.Velte, Robert Elsenpeter,“Cloud Computing:A Practical Approach”, McGraw Hill Publication, 2010.
3. John Rittinghouse, James F. Ransome, “Cloud Computing: Implementation, Management and Security”, CRC Press 2010.
4. Vic (J.R.) Winkler, “Securing the Cloud: Cloud Computer Security Techniques and Tactics, Elsevier, 2011
5. Greg Schulz, “Cloud and Virtual Data Storage Networking”, CRC Press, 2012.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1	**INTRODUCTION (12)**	
1.1	Cloud Computing Overview	1
1.2	Benefits	1
1.3	Limitations	1
1.4	Layers and types of cloud	1
1.5	Desired features of Cloud	1
1.6	Real time cloud providers	1
1.7	Amazon	2
1.8	Google	2
1.9	Microsoft	2
2	**BUILDING CLOUD NETWORKS (10)**	
2.1	Evolution from the managed service provider model to cloud Computing	1
2.2	Service Provider	1
2.3	Cloud data center	1
2.4	Collaboration	2
2.5	Service oriented architecture	2
2.6	Data center Based Service Oriented Architecture	1

3	**VIRTUALIZATION (10)**	
3.1	Components 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	Virtualization ROI	1
3.7	Benefits of Virtualization	1
3.8	Server Virtualization	1
3.9	Tools for Virtualization	2
4	**SECURITY IN THE CLOUD (10)**	
4.1	Cloud security challenges	1
4.2	Security concerns in cloud computing	1
4.3	Security requirements for the architecture	1
4.4	Security patterns and Architectural elements	1
4.5	Key strategies for secure operation	1
4.6	Multitenancy	1
4.7	Data encryption Application and limits	1
4.8	Cloud data security and sensitive data categorization	2
4.9	Security controls	1
5	**STORAGE IN THE CLOUD(8)**	
5.1	Server and storage I/O fundamentals	1
5.2	Storage Reliability, Availability and Serviceability (RAS)	1
5.3	Virtual, Physical and Cloud data protection	1
5.4	Data Footprint Reduction techniques	2
5.5	Storage services and functionalities	1
5.6	Storage system architectures	1
5.7	Storage virtualization	1
	Total	**48**

Course Designers:

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