Department of Computer Science & Engineering

Birla Institute of Technology, Mesra, Ranchi - 835215 (India)

M.Tech in Computer Science

Institute Vision

To become a Globally Recognized Academic Institution in consonance with the social, economic and ecological environment, striving continuously for excellence in education, research and technological service to the National needs.

Institute Mission

To educate students at Undergraduate, Postgraduate, Doctoral, and Post-Doctoral levels to perform challenging engineering and managerial jobs in industry.

- To provide excellent research and development facilities to take up Ph.D. programmes and research projects.
- To develop effective teaching and learning skills and state of art research potential of the faculty.
- To build national capabilities in technology, education and research in emerging areas.
- To provide excellent technological services to satisfy the requirements of the industry and overall academic needs of society.

Department Vision

The department strives to be recognized globally for outstanding education and research, leading to excellent professionals and innovators in the field of Computer Science and Engineering, who can positively contribute to the society.

Department Mission

To impart quality education and equip the students with strong foundation that could make them capable of handling challenges of the new century.

2. To maintain state of the art research facilities and facilitate interaction with world's leading universities, industries and research organization for constant improvement in the quality of education and research.

Programme Educational Objectives (PEOs) – M.Tech in Computer Science

PEO1: Students are trained in such a way that makes them capable of exploiting and enhancing theoretical and practical knowledge in various domains of Computer Science.

PEO2: Students are imparted with strong base of knowledge that makes them suitable for both industry teaching and research.

PEO3: Students are trained to develop practical and efficient solutions to the challenges in the growing field of software industry to gain leadership positions in their organization and/or teams.

PEO4: Students are inculcated with the sensitivity towards ethics, public policies and their responsibilities towards the society to gain trust and respect of others as ethical team members.

PROGRAM OUTCOMES (POs) for MTech (COMPUTER SCIENCE)

PO1: An ability to independently carry out research /investigation and development work to solve practical problems.

PO2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.

PO4: In depth understanding of fundamental principles and concepts of various domains of Computer Science.

PO5: Ability for analytical and critical thinking in order to analyse, design and improve existing tools and techniques.

PO6: Knowledge of contemporary issues in the field of Computer Science and ability to engage in lifelong learning.

COURSE INFORMATION SHEET

Course code: CS501

Course title: MATHEMATICAL FOUNDATIONS OF COMPUTER SCIENCE

Pre-requisite(s): Discrete Mathematics

Co- requisite(s):

Credits: 3 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: M. Tech

Semester / Level: I/5

Branch: Computer Science and Engineering

Name of Teacher:

Course Objectives

This course enables the students to:

1.	Present basic concepts and techniques of linear algebra, probability, statistics and graph theory
2.	Develop mathematical thinking and problem-solving skill
3.	Provide the foundations of probabilistic and statistical analysis
4.	Explain graphs to formulate computational problems

Course Outcomes

After the completion of this course, students will be able to:

CO1	Demonstrate skills in solving mathematical problems
CO2	Apply knowledge of computing and mathematics appropriate to the discipline

CO3	Analyze problems and identify the computing requirements appropriate to its solution
CO4	Explain basic concepts in probability theory and statistical analysis
CO5	Articulate the advanced courses in Computer science such as Coding Theory, Artificial Intelligence, Numerical Computation, etc.

SYLLABUS

Module I:
Linear Algebra

Introduction: Matrices and solving set of linear equations, Vector space, Subspace, Linear combination of vectors, Linear dependence and independence of vectors, Bases and dimensions.

(8L)

Module II:

Inner product spaces, Orthogonal vectors and dual vectors, Eigen values and Eigen vectors, Linear programming.

(8L)

Module III:

Probability and Statistics

Frequency distribution and measures of central tendency mean, median mode, quartiles, measures of dispersions and skewness, standard deviation, mean deviation, coefficient of variation, moments.

(8L)

Module IV:

Probability: definition, Distribution: discrete and continuous, Chi-square test, t-test.

(8L)

Module V:

Graph Theory

Introduction: Graphs and its types, Representation of graphs: Adjacency matrix, Incidence matrix,

Adjacency list, Planar graph, Kuratowski's Graphs, Clique and maximum Clique finding algorithms.

(8L)

Books recommended:

TEXT BOOK

1. K. Haffman, and R. Kunze, "Linear Algebra", 2nd Edition, Pearson, 2015. **(T1)**
2. G. Williams, "Linear Algebra with Applications", 4th Edition, John & Bartlett. **(T2)**
3. W. Navidi, "Statistics for Engineers and Scientists", 2nd Edition, TMH, 2008. **(T3)**
4. J.K. Goyal, and J. N. Sharma, "Mathematical Statistics", Krishna Prakashan, 2017. **(T4)**
5. NarasinghDeo, "Graph Theory with Applications to engineering and Computer Science", Prentice Hall of India, 2001. **(T5)**
6. Douglas B. West, "Introduction to Graph theory", Pearson Education, 2002. **(T6)**

Course Evaluation:

Individual assignment, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design: Teaching through research papers.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	1	1	1
CO2	3	3	1	1	1	1
CO3	2	3	2	1	1	1

CO4	3	2	1	1	1	1
CO5	3	1	1	1	1	1

If satisfying and < 34% = L, 34-66% = M, > 66% = H

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD6
CO2	CD1, CD6,CD7
CO3	CD1, CD2, CD3,CD6,CD7
CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD3,CD4,CD5,CD7

COURSE INFORMATION SHEET

Course code: CS502

Course title: ADVANCED DATA STRUCTURES

Pre-requisite(s): Data Structures, Algorithm Analysis

Co- requisite(s):

Credits: 3 L: 3 T:0 P:0

Class schedule per week: 03

Class: M. Tech

Semester / Level: I/5

Branch: Computer Science and Engineering

Name of Teacher:

Course Objectives

This course enables the students:

1.	The student should be able to choose appropriate data structures, understand the ADT/libraries, and use it to design algorithms for a specific problem.
2.	Students should be able to understand the necessary mathematical abstraction to solve problems.
3.	To familiarize students with advanced paradigms and data structure used to solve algorithmic problems.
4.	Student should be able to come up with analysis of efficiency and proofs of correctness.

Course Outcomes

After the completion of this course, students are expected to:

CO1	Understand the implementation of symbol table using hashing techniques.
CO2	Develop and analyze algorithms for red-black trees, B-trees and Splay trees.
CO3	Develop algorithms for text processing applications.
CO4	Interpret the basic working of advanced heaps.
CO5	Appraise the implementation of symbol table using hashing techniques.

SYLLABUS

Module I:

Dictionaries: Definition, Dictionary Abstract Data Type, Implementation of Dictionaries. Hashing: Review of Hashing, Hash Function, Collision Resolution Techniques in Hashing, Separate Chaining, Open Addressing, Linear Probing, Quadratic Probing, Double Hashing, Rehashing, Extendible Hashing.

(8L)

Module II:

Skip Lists: Need for Randomizing Data Structures and Algorithms, Search and Update Operations on Skip Lists, Probabilistic Analysis of Skip Lists, Deterministic Skip Lists

(8L)

Module III:

Trees: Binary Search Trees, AVL Trees, Red Black Trees, 2-3 Trees, B-Trees, Splay Trees

(8L)

Module IV:

Heaps: Balanced Search Trees as Heaps, Array-Based Heaps, Heap-Ordered Trees and Half-Ordered Trees, Leftist Heaps, Skew Heaps, Binomial Heaps, Changing Keys in Heaps, Fibonacci Heaps, Heaps of Optimal Complexity, Double-Ended Heap Structures and Multidimensional Heaps, Heap-Related Structures with Constant-Time Updates.

(8L)

Module V:

Text Processing: Sting Operations, Brute-Force Pattern Matching, The Boyer-Moore Algorithm, The Knuth-Morris-Pratt Algorithm, Standard Tries, Compressed Tries, Suffix Tries, The Huffman Coding Algorithm, The Longest Common Subsequence Problem (LCS), Applying Dynamic Programming to the LCS Problem.

(8L)

Books recommended:

TEXT BOOK

1. Mark Allen Weiss, "Data Structures and Algorithm Analysis in C++," 2nd Edition, Pearson, 2004.**(T1)**
2. Peter Brass, "Advanced Data Structures," Cambridge University Press, 1st Edition.**(T2)**
3. M T Goodrich, & Roberto Tamassia, "Algorithm Design," John Wiley, 2002.**(T3)**

Course Evaluation:

Individual assignment, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design: Teaching through research papers.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5

Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	1	1	1	1
CO2	2	3	3	1	1	1
CO3	2	3	3	2	1	1
CO4	3	1	1	1	1	1
CO5	3	1	1	1	1	1

If satisfying and < 34% = L, 34-66% = M, > 66% = H

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD6
CO2	CD1, CD6, CD7
CO3	CD1, CD2, CD3, CD6, CD7
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2, CD3, CD4,CD5,CD7

COURSE INFORMATION SHEET

Course code: CS504

Course title: DISTRIBUTED SYSTEMS

Pre-requisite(s): Data Structure, Operating system

Co- requisite(s):

Credits: 3 L:3 T:0 P:0

Class schedule per week: 03

Class: M. Tech

Semester / Level: I/5

Branch: Computer Science and Engineering

Name of Teacher:

Course Objectives

The course objectives are to enable the students to learn:

1.	Role of distributed systems in day-to-day life
2.	Distributed system models and communication methods
3.	Concepts of distributed file systems and distributed transactions
4.	Resource management techniques in distributed environment
5.	Analysing the approaches for designing and supporting distributed systems

Course Outcomes

After the completion of this course, students will be able to:

CO1	Identify trends and challenges in distributed systems
CO2	Understand various distributed system models and communication methods
CO3	Learn the concepts of distributed file systems and distributed transactions
CO4	Learn approaches for resource management in distributed environment
CO5	Understand the requirements for designing and supporting distributed systems

SYLLABUS

Module 1:

Introduction: Examples of Distributed Systems, Trends in Distributed Systems, Resource sharing, Challenges. Case study: World Wide Web.

Networking and Internetworking: Types of network, Network principles, Internet protocols

(8L)

Module 2:

Interprocess Communication: Client-server communication, Group communication, Network virtualization.

Remote Invocation: Request-reply protocols, Remote procedure call, Remote method invocation.

Indirect Communication: Publish subscribe system, Message queues, Shared memory approaches.

(8L)

Module 3:

Peer to Peer Systems: Introduction, Napster and its legacy, Middleware, Routing overlays.

Distributed File systems: Introduction, File service architecture, Case Study: NFS.

(8L)

Module 4:

Time and Global States: Clocks, events, and process states, Synchronizing physical clocks, Logical time and logical clocks, Global states, Distributed debugging

Coordination and Agreement – Distributed mutual exclusion, Elections, Coordination and agreement in group communication.

(8L)

Module 5:

Distributed Transactions: Flat and nested transactions, Atomic commit protocols, Concurrency Control, Distributed deadlocks, Transaction recovery.

Replication: Introduction, System model, Fault tolerant services, Transactions with replicated data.

(8L)

TEXT BOOK

1. G. Coulouris, J. Dollimore, T. Kindberg, Distributed Systems Concepts and Design, 5th Edition, Pearson Education, 2012**.(T1)**

REFERENCE BOOKS

1. A. S. Tanenbaum, M. Van Steen, Distributed Systems: Principles and Paradigms, Pearson Education, 2007. **.(R1)**
2. P. K. Sinha, Distributed Systems: Concepts and Design, Prentice Hall, 2007. **(R1)**

Course Evaluation:

Individual assignment, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment –

1. Student Feedback on Faculty

2. Student Feedback on Course Outcome

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design: Teaching through research papers.

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	2	1	2
CO2	3	3	3	1	3	1
CO3	2	3	3	3	2	1
CO4	3	3	3	3	1	1
CO5	2	2	3	2	1	1

If satisfying and < 34% = L, 34-66% = M, > 66% = H

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD6
CO2	CD1, CD6, CD7
CO3	CD1, CD2, CD3, CD6, CD7
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2, CD3, CD4,CD5,CD7

COURSE INFORMATION SHEET

Course code: CS503

Course title: ADVANCED DATA STRUCTURES LAB

Pre-requisite(s):

Co- requisite(s): Advanced Data Structures

Credits: 2 L: 0 T: 0 P: 4

Class schedule per week: 04

Class: M. Tech

Semester / Level: I/5

Branch: Computer Science and Engineering

Name of Teacher:

Course Objectives

This course enables the students to:

1.	The student should be able to choose appropriate data structures, understand the ADT/libraries, and use it to design algorithms for a specific problem.
2.	Students should be able to understand the necessary mathematical abstraction to solve problems.

3.	To familiarize students with advanced paradigms and data structure used to solve algorithmic problems.
4.	Student should be able to come up with analysis of efficiency and proofs of correctness.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Understand to implement the symbol table using hashing techniques.
CO2	Develop program for AVL, Red-Black trees, B-trees and Splay trees
CO3	Develop program for text processing applications
CO4	Learn the basic working of advanced heaps
CO5	Understand the implementation of symbol table using hashing techniques

SYLLABUS

List of Programs as Assignments:

1. **Lab Assignment No: 1**

   Write a program to implement a dictionary using the following ADTs. We assume all the entries in the dictionary to be distinct integers.

   a) Binary Search Tree (BST)
   b) Red Black Tree (RBT)

   Each ADT should support five operations, void Insert(val), boolean Delete(val), boolean Search(val), void ClearADT() and void DisplayADT(). Both search and delete operations should respond with a boolean value indicating whether the search/delete was successful or not. The objective of this assignment is to compare the performance of BST and RBT ADTs. You have to compute the time taken for completion of operations and study how the running times of ADT operations will vary across the two ADT implementations.

2. **Lab Assignment No: 2**

   Implement data structures to maintain a list of elements. In particular, implement the list as an array and as a linked list. Write a program to remove duplicates from the list. The code for remove duplicates functionality should remain the same across the two implementations of the list.

   Implement the following sequence of operations on the skip list:

a) remove() b) insert () c) Search() d) Update()
Assume the coin flips for the first insertion yield two heads followed by tails, and those for the second insertion yield three heads followed by tails.

3. **Lab Assignment No: 3**
   Implement different Hashing functions and Collision Resolution Techniques.

4. **Lab Assignment No: 4**
   Implement Kruskal's algorithm for finding the minimum spanning tree of a given (positively) weighted (undirected) graph G. You must use the Union-Find data structure that implements both "union by rank" and "path compression" heuristics.

5. **Lab Assignment No: 5 &6**

Implement the following priority queues:
a) Binary Heap b) Binomial Heap c) Fibonacci Heap

Your program should then create an appropriate priority queue object and perform makeHeap() method. After that, you should give the user menu options to insert(key), delete(key), extractMin(), findMin(), decrease(key), increase(key) updateKey(currentKey, newKey), and displayHeap(filename). You may assume that keys will be unique. For displayHeap(filename), you must output the tree structure of the priority queue (including linked list edges in Binomial Heap, etc) as a directed tree in the dot language format1 and store it in a file named filename (given as parameter).

6. **Lab Assignment No: 7&8**

Implement Text Processing using Huffman Coding.

Implement the compact representation of the suffix trie for the string "minimize minime".

Implement a standard trie for the following set of strings: {abab, baba, ccccc, bbaaaa, caa, bbaacc, cbcc, cbca }.

7. **Lab Assignment No: 9 &10**

One way to mask a message, *M*, using a version of *steganography*, is to insert random

characters into *M* at pseudo-random locations so as to expand *M* into a larger string, *C*.

For instance, the message,

ILOVEMOM,

could be expanded into

AMIJLONDPVGEMRPIOM.

It is an example of hiding the string, *M*, in plain sight, since the characters in *M* and *C* are not encrypted. As long as someone knows where the random

Books recommended:

TEXTBOOK

1. Mark Allen Weiss, "Data Structures and Algorithm Analysis in C++," 2nd Edition, Pearson, 2004. **(T1)**
2. Peter Brass, "Advanced Data Structures," Cambridge University Press, 1st Edition. **(T2)**
3. M T Goodrich, & Roberto Tamassia, "Algorithm Design," John Wiley, 2002. **(T3)**

Course Evaluation:

Day to day progressive evaluation, Lab Quizzes, Surprise Tests, Online Lab performance and Viva Voce

Gaps in the syllabus (to meet Industry/Profession requirements):

Implementing of real-world problems

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design: Teaching through research papers.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	60
Semester End Examination	40

Continuous Internal Assessment	% Distribution
Day to day performance & Lab files	30
Quiz (es)	10
Viva	20

Semester End Examination	% Distribution
Examination Experiment Performance	30
Quiz	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets

CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	1	1	1	1
CO2	3	2	2	1	1	1
CO3	2	3	3	2	1	1
CO4	3	1	1	1	1	1
CO5	3	1	1	1	1	1

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD6
CO2	CD1, CD6, CD7
CO3	CD1, CD2, CD3,
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2, CD7

COURSE INFORMATION SHEET

Course Code: CS509
Course title: ADVANCED COMPUTER ALGORITHM
Pre-requisite(s): Design and Analysis of Algorithms, Data Structures
Co- requisite(s): None
Credits: 3 L:3 T:0 P: 0
Class schedule per week: 03
Class: M. Tech
Semester / Level: II/5
Branch: Computer Science and Engineering

Course Objectives

After the completion of this course, students will be able to:

1.	Identify and relate different algorithm design techniques to real world problems.

2.	Able to describe a non-deterministic solution of different problem also they will be apply the concept of reducibility to convert one problem to another problem.
3.	Able to relate parallel, randomized and approximate solution of various problem.
4.	Able to analyze parallel, randomized and approximation algorithms.
5.	Able to design and criticize algorithms for different domains.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Identify and compare different approaches of computer algorithm for different practical application.
CO2	Understand the concept of NP-hard and NP-complete and reducibility.
CO3	Able to design and criticize of a wide range of advanced algorithms techniques namely, approximation, randomized and parallel algorithm
CO4	Can analyze the approximation algorithms using approximation ratio and can perform probabilistic analysis of randomized algorithms
CO5	Gain a good understanding on a wide range of advanced algorithmic problems, their relations and variants, and application to real-world problems

SYLLABUS

Module I:

Design Paradigms

Overview of Divide and Conquer, Greedy and Dynamic Programming strategies. Basic search and traversal techniques for graphs, Backtracking, Branch and Bound.

(8L)

Module II:

Theory of NP- Hard and NP-Complete Problems

P, NP and NP-Complete complexity classes; A few NP-Completeness proofs; Other complexity classes.

(8L)

Module III:

ApproximationAlgorithms

Introduction, Combinatorial Optimization, approximation factor, PTAS, FPTAS, Approximation algorithms for vertex cover, set cover, TSP, knapsack, bin packing, subset-sum problem etc. Analysis of the expected time complexity of the algorithms.

(8L)

Module IV:

Parallel Algorithms

Introduction, Models, speedup and efficiency, Some basic techniques, Examples from graph theory, sorting, Parallel sorting networks. Parallel algorithms and their parallel time and processors complexity.

(8L)

Module V:

Probabilistic Algorithms & Randomized Algorithms

Numerical probabilistic algorithms, Las Vegas and Monte Carlo algorithms, Game-theoretic techniques, Applications on graph problems

(8L)

Text Books:

1. T.H. Cormen, C.E.Leiserson, and R.L. Rivest, "Introduction to Algorithms".
2. G.Brassard, and P.Bratley, "Fundamentals of Algorithmics".
3. Vijay V.Vazirani, "Approximation Algorithms".

Reference Books:

1. D.Harel, "Algorithmics: The spirit of computing".
2. R. Motwani& P. Raghavan, "Randomized Algorithms," Cambridge University Press, 1995.

Course Evaluation:

Individual assignment, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design: Teaching through research papers.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10

Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

CD #	Course Delivery methods
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcome

Course Outcome	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	2	1	2
CO2	3	3	3	1	3	1
CO3	2	3	3	3	2	1
CO4	3	3	3	3	1	1
CO5	2	2	3	2	1	1

If satisfying and < 34% = L, 34-66% = M, > 66% = H

Mapping Between COs and Course Delivery (CD) methods			
CD	**Course Delivery methods**	**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1, CO2, CO3, CO4, CO5	CD1
CD2	Laboratory experiments/teaching aids		
CD3	Industrial/guest lectures		
CD4	Industrial visits/in-plant training		
CD5	Self- learning such as use of NPTEL materials and internets	CO5	CD5

COURSE INFORMATION SHEET

Course Code: CS511
Course title: ADVANCED DATABASE MANAGEMENT SYSTEM
Pre-requisite(s): UG level concepts of Database management systems
Co- requisite(s): None
Credits: 3 L:3 T:0 P: 0
Class schedule per week: 03
Class: M. Tech
Semester / Level: II/5
Branch: Computer Science and Engineering

Course Objectives
This course enables the students to:

1.	Understand transaction control and concurrency issues in databases.
2.	Have knowledge of locking mechanisms in a database management system
3.	Have idea of the backend activities involved in recovering data from databases
4.	Have knowledge of data warehousing and features of centralized and distributed database
5.	Obtain an insight into Open Issues in Data Warehouses, Mobile Databases Multimedia Databases Geographic Information Systems Genome Data Management

Course Outcomes

After the completion of this course, students will be able to:

CO1	To understand the fundamental and advanced concepts required for modeling and designing the database
CO2	To understand the advanced database technologies.
CO3	To effectively model and design the complex database systems
CO4	To effectively map the well-designed database to the level of implementation.
CO5	To understand the concepts of distributed database and various access and allocation methods.

SYLLABUS

Module I :
Review of basic concepts, Transaction and System Concepts, Desirable Properties of Transactions, Characterizing Schedules Based on Recoverability, Characterizing Schedules Based on Serializability, Transaction Support in SQL.

(8L)

Module II :
Concurrency Control Techniques, Two-Phase Locking Techniques for Concurrency Control, Concurrency Control Based on Timestamp Ordering, Multiversion Concurrency Control Techniques, Validation (Optimistic) Concurrency Control Techniques, Granularity of Data Items and Multiple Granularity Locking.

(8L)

Module III :
Recovery Concepts, Recovery Techniques Based on Deferred Update, Recovery Techniques Based on Immediate Update, Shadow Paging, The ARIES Recovery Algorithm, Recovery in Multidatabase Systems, Database Backup and Recovery from Catastrophic Failures.

(8L)

Module IV :
Distributed Databases and Client-Server Architectures, Distributed Database Concepts, Data Fragmentation, Replication and Allocation Techniques for Distributed Database Design, Types of Distributed Database Systems, Query Processing in Distributed Databases, Overview of Concurrency Control and Recovery in Distributed Databases, An Overview of 3-Tier Client-Server Architecture.

(8L)

Module V :
Data Modeling for Data Warehouses, Characteristics of Data Warehouses, Introduction, Definitions, and Terminology Building a Data Warehouse, Typical Functionality of a Data Warehouse, Data Warehouse Versus Views Problems and Open Issues in Data Warehouses, Mobile Databases, Multimedia Databases, Geographic Information Systems, Genome Data Management.

(8L)

Text Books:

1. Elmasri R., Navathe S.B., "Fundamentals of Database Systems", 5th Edition, Pearson Education/Addison Wesley, 2007**.(T1)**

Reference Books:

1. C.J. Date, "An introduction to Database Systems", 7th Edition.,Pearson Education, New Delhi, 2004. **(R1)**
2. H. Korth et al., "Database Management System Concepts", 3rd Edition, TMH, New Delhi, 2002. **(R2)**
3. B.Desai, "Database Management Systems", Galgotia Publications, New Delhi, 1998. **(R3)**

Course Evaluation:

Individual assignment, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design: Teaching through research papers.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

CD #	Course Delivery methods
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcome

Course Outcome	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	2	1	2
CO2	3	3	3	1	3	1
CO3	2	3	3	3	2	1
CO4	3	3	3	3	1	1
CO5	2	2	3	2	1	1

If satisfying and < 34% = L, 34-66% = M, > 66% = H

Mapping Between COs and Course Delivery (CD) methods			
CD	Course Delivery methods	Course Outcome	Course Delivery Method

CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1, CO2, CO3, CO4, CO5	CD1
CD2	Laboratory experiments/teaching aids		
CD3	Industrial/guest lectures		
CD4	Industrial visits/in-plant training		
CD5	Self- learning such as use of NPTEL materials and internets		

COURSE INFORMATION SHEET

Course Code: CS512
Course title: ARTIFICIAL INTELLIGENCE
Pre-requisite(s): Design and Analysis of Algorithms, Data Structures
Co- requisite(s): None
Credits: 3 L:3 T:0 P: 0
Class schedule per week: 03
Class: M. Tech
Semester / Level: II/5
Branch: Computer Science and Engineering

Course Objectives
After the completion of this course, students will be able to:

1.	An ability to apply knowledge of mathematics, science and engineering to both software and hardware design problems.
2.	An ability to design and conduct experiments and to analyze and interpret data related to software and hardware design solutions.
3.	An ability to design a system, component or process to meet desired needs within realistic constraints.

4.	An ability to function on multidisciplinary teams using current computer engineering tools and technologies.
5.	An ability to identify, formulate and solve engineering problems based on a fundamental understanding of concepts of computer engineering topics.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Recall the principles and approaches of artificial intelligence and understand different aspects of Intelligent agent.
CO2	Apply different search techniques for solving real world problems and select the most appropriate solution by comparative evaluation.
CO3	Understanding the various concepts of knowledge representations and demonstrate working. knowledge of reasoning in the presence of incomplete and/or uncertain information.
CO4	To develop a basic understanding of some of the more advanced topics of AI such as learning, natural language processing, Robotics etc.
CO5	Write various types of LISP and PROLOG programs and explore more sophisticated LISP and PROLOG code.

SYLLABUS

Module I:

Introduction: Overview of Artificial Intelligence- Problems of AI, AI Technique, Tic - Tac - Toe Problem.

Intelligent Agents: Agents & Environment, Nature of Environment, Structure of Agents, Goal Based Agents, Utility Based Agents, Learning Agents.

Problem Solving: Problems, Problem Space & Search: Defining The Problem as State Space Search, Production System, Problem Characteristics, Issues in The Design of Search Programs.

(8L)

Module II:

Search Techniques: Solving Problems by Searching, Problem Solving Agents, Searching for Solutions; Uniform Search Strategies: Breadth First Search, Depth First Search, Depth Limited Search, Bi-directional Search, Comparing Uniform Search Strategies.

Heuristic Search Strategies: Greedy Best-First Search, A* Search, Memory Bounded Heuristic Search: Local Search Algorithms & Optimization Problems: Hill Climbing Search, Simulated Annealing Search, Local Beam Search, Genetic Algorithms; Constraint Satisfaction Problems, Local Search for Constraint Satisfaction Problems.

Adversarial Search: Games, Optimal Decisions & Strategies in Games, The Minimax Search Procedure, Alpha-Beta Pruning, Additional Refinements, Iterative Deepening.

(8L)

Module III:

Knowledge & Reasoning: Knowledge Representation Issues, Representation & Mapping, Approaches to Knowledge Representation, Issues in Knowledge Representation.

Using Predicate Logic: Representing Simple Fact in Logic, Representing Instant & ISA Relationship, Computable Functions & Predicates, Resolution, Natural Deduction.

Representing Knowledge Using Rules: Procedural Versus Declarative Knowledge, Logic Programming, Forward Versus Backward Reasoning, Matching, Control Knowledge.

(8L)

Module IV:
Probabilistic Reasoning: Representing Knowledge in an Uncertain Domain, Bayesian Networks, Dempster -Shafer Theory.
Planning: Overview, Components of A Planning System, Goal Stack Planning, Hierarchical Planning.
Learning: Forms of Learning, Inductive Learning, Explanation Based Learning, Neural Net Learning & Genetic Learning.

(8L)

Module V:
Natural Language Processing: Brief introduction to Syntactic Processing, Semantic Analysis, Discourse & Pragmatic Processing.
Robotics: Introduction, Robot hardware, robotic perception, planning to move, planning uncertain movements, robotic software architecture, application domains.

(8L)

TEXT BOOKS:

1. S. Russel and P. Norvig, "Artificial Intelligence: A Modern Approach", 3rd Edition, Pearson Education. **(T1)**
2. E. Rich & K. Knight, "Artificial Intelligence", 2/e, TMH, New Delhi, 3rd Edition, TMH. **(T2)**

REFERENCE BOOKS:

1. Dan W. Patterson, "Introduction to Artificial Intelligence and Expert Systems", PHI, New Delhi, 2006. **(R1)**
2. D.W. Rolston, "Principles of AI & Expert System Development", TMH, New Delhi. **(R2)**

Course Evaluation:

Individual assignment, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design: Teaching through research papers.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

CD #	Course Delivery methods
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcome

Course Outcome	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	2
CO2	3	3	3	3	3	3
CO3	3	3	3	2	2	3

CO4	3	3	3	2	1	1
CO5	2	2	2	3	1	1

If satisfying and < 34% = L, 34-66% = M, > 66% = H

Mapping Between COs and Course Delivery (CD) methods			
CD	**Course Delivery methods**	**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1, CO2, CO3, CO4, CO5	CD1
CD2	Laboratory experiments/teaching aids		
CD3	Industrial/guest lectures		
CD4	Industrial visits/in-plant training		
CD5	Self- learning such as use of NPTEL materials and internets		

COURSE INFORMATION SHEET

Course Code: CS510
Course title: ADVANCED ALGORITHM LAB
Pre-requisite(s): Design and Analysis of Algorithms, Data Structures
Co- requisite(s): None
Credits: L:0 T:0 P: 2
Class schedule per week: 04
Class: M. Tech
Semester / Level: II/5
Branch: Computer Science and Engineering

Course Objectives
After the completion of this course, students will be able to:

1.	Able to match and implement various design strategies of algorithms.

2.	Able to interpret the efficiency of algorithm by changing the places of important steps.
3.	Able to compare approximate and exact solutions.
4.	Able to criticize effect randomness on correctness and efficiency of algorithms.
5.	Able to design approximate, random and parallel solution of different problems.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Should able to write and explain different algorithm design approaches. .
CO2	Solve real life problems by an appropriate and efficient algorithm. .
CO3	Analyse of an approximate or randomized solution to different practical problem.
CO4	Compare and justify appropriate number of processors required for parallel algorithms.
CO5	Construct algorithm for various graph problems.

SYLLABUS

List of Programs as Assignments:

1. **Lab Assignment No: 1**
   Divide and Conquer: Binary search, Quick sort, Merge Sort [CO1][CO2]

2. **Lab Assignment No: 2**
   Greedy Algorithm: Prims and Kruskal's algorithm [CO2][CO5]

3. **Lab Assignment No: 3**
   Dynamic Programming: Matrix Chain Multiplication, Longest Common Subsequence [CO1][CO2]

4. **Lab Assignment No: 4**
   Backtracking: N-Queen, Sum of Subset [CO1][CO2]

5. **Lab Assignment No: 5**
   Branch and Bound: Travelling Salesperson Problem, 0/1 Knapsack [CO1][CO2][CO5]

6. **Lab Assignment No: 6**
   Approximation Algorithm: Vertex cover, Travelling salesman problem, set cover [CO3]

7. **Lab Assignment No: 7**
   Polynomial Time Approximation Algorithm: sum of subset, 0/1 Knapsack [CO3]

8. **Lab Assignment No: 8**
   Randomized Algorithm: Las Vegas:- Randomized quicksort, 8-queen problem[CO3]

9. **Lab Assignment No: 9**
   Randomized Algorithm: Monte Carlo:- Randomized List Ranking, Min-Cut Problem[CO3]

10. **Lab Assignment No: 10**
    Parallel Algorithms: Prefix Computation, Merging of two sorted list[CO4]

11. **Lab Assignment No: 11**
    Parallel Graph Algorithms: All pair shortest path algorithm [CO4][CO5]

12. **Lab Assignment No: 12**
    Game Theoretic Techniques: Max-Min and And-Or game tree problems[CO5]

Books recommended:

Textbooks:

1. Thomas H Cormen, Charles E Lieserson, Ronald L Rivest and Clifford Stein, Introduction to Algorithms, Second Edition, MIT Press/McGraw-Hill, 2001. **(T1)**
2. Sanjoy Dasgupta, Christos H. Papadimitriou and Umesh V. Vazirani, Algorithms, Tata McGraw-Hill, 2008. **(T2)**
3. Jon Kleinberg and Éva Tardos, Algorithm Design, Pearson, 2005. **(T3)**

Course Evaluation:

Individual assignment, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design: Teaching through research papers.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	60
Semester End Examination	40

Continuous Internal Assessment	% Distribution

Day to day performance & Lab files	30
Quiz (es)	10
Viva	20

Semester End Examination	**% Distribution**
Examination Experiment Performance	30
Quiz	10

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

CD #	**Course Delivery methods**
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcome

Course Outcome	**Program Outcomes**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1	2		3	2

CO2	3	3		2	2	
CO3	2	3	3	2	3	1
CO4		2	3		2	3
CO5	1	2	3	3	2	3

If satisfying and < 34% = L, 34-66% = M, > 66% = H

Mapping Between COs and Course Delivery (CD) methods			
CD	**Course Delivery methods**	**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1, CO2, CO3, CO4, CO5	CD1
CD2	Laboratory experiments/teaching aids		
CD3	Industrial/guest lectures		
CD4	Industrial visits/in-plant training		
CD5	Self- learning such as use of NPTEL materials and internets		

COURSE INFORMATION SHEET

Course code: CS601
Course title: GRAPH THEORY
Pre-requisite(s): Discrete Mathematics
Co- requisite(s): None
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 03
Class: M. Tech
Semester / Level: III/6
Branch: Computer Science and Engineering

Course Objectives
This course enables the students to:

1.	Learn and become comfortable with graphs and its terminologies

2.	Understand applications of graph theory to practical problems and other branches of mathematics
3.	Understand various graphs algorithms along with its analysis.
4.	Practice creative problem solving and improve skills in this area

Course Outcomes

After the completion of this course, students will be able to:

CO1	Attain knowledge about different types of graphs and their applications in real world.
CO2	Perceive the role of cut-set, cut-vertex and fundamental circuits in network flows.
CO3	Create an awareness of planar and dual graph.
CO4	Understand how to represent graphs in computer system
CO5	Apply the concept of graph coloring and partitioning techniques in NP-problems

SYLLABUS

Module I:

Introduction: Graphs and its applications, Finite and infinite graphs, incidence and degree, isolated Vertex, pendant Vertex, and Null graph, paths and circuits, isomorphism, sub graphs, walks, paths, and circuits, connected graphs, disconnected graphs and components, Connectivity checking algorithm, Euler graphs, Operations on graphs, more on Euler graphs, Hamiltonian paths and circuits, Travelling Salesman problem.

(8L)

Module II:

Trees and Fundamental circuits: Trees and its properties, Distance and centers in a tree, Algorithm for checking if a graph is Tree, Partial k-trees, Dynamic Programming in partial k-trees, spanning trees, Spanning trees in a Weighted graph, Prim's and Kruskal's algorithms

Cut set and cut vertices: Properties of a cut set, Fundamental circuits and cut sets, connectivity and separability, Computing connected components, Menger's theorem, Network flows, 1-Isomorphism, 2-Isomorphism.

(8L)

Module III:

Planar and Dual Graphs: Planar graph, Kuratowski's Graphs, Representations of a planar graph, Detection of planarity, Planar Separator Theorem, Geometric Dual, Combinatorial, Duel, Thickness and crossings, Algorithms for finding Clique and maximum clique**.**

(8L)

Module IV:

Matrix Representation of Graphs: Incidence matrix, Adjacency matrix, Adjacency list, Circuits Matrix, Fundamental Circuit Matrix and Rank of B, Cut-set Matrix, Relationships among A *f,* B*f* and C*f*, path Matrix**.**

(8L)

Module V:

Coloring, Covering and partitioning: Chromatic number, Chromatic partitioning, Chromatics polynomial, Coverings, Four colour problem, Algorithm for graph colouring.
Directed Graphs: Digraphs and its types, Digraphs and binary Relations, Directed paths and connectedness, Euler Digraphs, Trees with Directed Edges, Fundamental Circuits in Di graphs, Matrices A, B and C of Digraphs, Adjacency Matrix of a Digraph, Paired Comparisons and Tournaments, Acyclic Di graphs and De-cyclization**.**

(8L)

Textbooks:

1. Narasingh Deo, "Graph Theory with Applications to engineering and Computer Science", Prentice Hall of India, 2001. **(T1)**

Reference Books:

1. Douglas B. West, "Introduction to Graph theory", Pearson Education, 2002. **(R1)**

Course Evaluation:

Individual assignment, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design: Teaching through research papers.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

CD #	Course Delivery methods
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	3	1	1
CO2	3	2	3	3	1	1
CO3	3	3	3	2	1	2
CO4	3	3	3	3	2	2
CO5	3	3	3	2	2	1

If satisfying and < 34% = L, 34-66% = M, > 66% = H

Mapping Between COs and Course Delivery (CD) methods			
CD	**Course Delivery methods**	**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1, CO2, CO3, CO4, CO5	CD1
CD2	Laboratory experiments/teaching aids		
CD3	Industrial/guest lectures		
CD4	Industrial visits/in-plant training		
CD5	Self- learning such as use of NPTEL materials and internets		

PROGRAM ELECTIVE I

COURSE INFORMATION SHEET

Course code: CS506

Course title: MACHINE LEARNING

Pre-requisite(s): Design of Algorithms, Mathematics II, Artificial Intelligence

Co- requisite(s):

Credits: 3 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: M. Tech

Semester / Level: I/5

Branch: Computer Science and Engineering

Course Objectives

This course enables the students:

1.	To formulate machine learning problems corresponding to different applications.
2.	To understand various supervised, semi-supervised and unsupervised machine learning algorithms.
3.	To familiarize various machine learning software libraries and data sets publicly available.
4.	To develop machine learning based system for various real-world problems.
5.	To assess how the choice of a machine-learning algorithm impacts the accuracy of a system.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Formulate machine learning problems corresponding to different applications: data, model selection, model complexity
CO2	Demonstrate understanding of a range of machine learning algorithms along with their strengths and weaknesses
CO3	Implement machine learning solutions to classification, regression, and clustering problems

CO4	Design and implement various machine learning algorithms in a range of real-world applications
CO5	Evaluate and analyse the performance of a machine-learning algorithm or a system based on machine learning algorithm.

SYLLABUS

Module I:
Introduction to Machine Learning
Machine Learning – what and why? Basics of Linear Algebra and Statistics, Overview of target function representations; Linear Regression.

(8L)

Module II:
Supervised Learning
Basics of Feature Selection and Evaluation, Decision Tree, Overfitting and Pruning, Logistic regression, Support Vector Machine and Kernel; Noise, bias-variance trade-off, under-fitting and over-fitting concepts.

(8L)

Module III:

Neural Networks

Perceptrons: representational limitation and gradient descent training. Multilayer networks and backpropagation. Hidden layers and constructing intermediate, distributed representations. Overfitting, learning network structure, recurrent networks.

(8L)

Module IV:
Unsupervised and Semi Supervised Learning
Learning from unclassified data. Clustering. Hierarchical Agglomerative Clustering. K-means partitional clustering. Expectation maximization (EM) for soft clustering. Semi-supervised learning with EM using labeled and unlabled data.

(8L)

Module V:
Ensemble
Committees of multiple hypotheses, bagging, boosting, active learning with ensembles.

(8L)

Books recommended:

TEXT BOOK

1. Tom Mitchell, “Machine Learning”, Latest Edition, Mc-Graw Hill. **(T1)**

REFERENCE BOOK

1. Shai Shalev-Shwartz, and Shai Ben-David, “Understanding Machine Learning”, Cambridge University Press, 2017. **(R1)**
2. Christopher Bishop, “Pattern Recognition and Machine Learning”, Springer, 2006. **(R2)**

Course Evaluation:

Individual assignment, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design: Teaching through research papers.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	3	1	1

CO2	3	2	3	3	1	1
CO3	3	3	3	2	1	2
CO4	3	3	3	3	2	2
CO5	3	3	3	2	2	1

If satisfying and < 34% = L, 34-66% = M, > 66% = H

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD6
CO2	CD1, CD6, CD7
CO3	CD1, CD2, CD3, CD6, CD7
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2, CD3,CD4,CD5,CD7

COURSE INFORMATION SHEET

Course code: IT503

Course title: WIRELESS SENSOR NETWORKS

Pre-requisite(s): Basic Networking Fundamentals

Co-requisite(s):

Credits: 3 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: M. Tech

Semester / Level: I/5

Branch: Computer Science and Engineering

Name of Teacher:

Course Objectives

This course enables the students to:

1.	Familiarize with the principles of sensor nodes, network deployment and architectures.
2.	Know the data transmission and routing protocols. Know the differences among different networks.
3.	Analyze or compare the performance of different routing and MAC protocol
4.	Evaluate the performance of different MAC protocols and clustering algorithm
5.	Compute the throughput and channel utilization for different network scenarios.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Obtain a broad understanding about the network architecture of wireless sensor network.
CO2	Understand all basic characteristics of wireless sensor networks and sensor nodes.
CO3	Understand the principles of data transmission, clustering algorithm and routing protocols.
CO4	Analyze and evaluate different constraint of wireless sensor network, e.g., coverage, power management, security and data collisions.
CO5	Design and development of new sensor network architecture.

SYLLABUS

Module I:

Fundamentals of Sensor Networks

Introduction to wireless sensor networks, Wireless Sensor nodes- Sensing and sensors-challenges and constraints - node architecture-sensing subsystem, processor subsystem communication interfaces- prototypes, Application of Wireless sensors.

(8L)

Module II:

Communication Characteristics and Deployment Mechanisms

Wireless Transmission Technology and Systems-Radio Technology Primer-Available Wireless Technologies - Hardware- Telosb, Micaz motes- Time Synchronization Clock and the Synchronization Problem - Basics of time Synchronization-Time synchronization protocols - Localization- Ranging Techniques- Range based Localization-Range Free Localization- Event driven Localization.

(8L)

Module III:

Mac Layer

Overview-Wireless Mac Protocols-Characteristics of MAC protocols in Sensor networks – Contention free MAC Protocols- characteristics- Traffic Adaptive Medium Access-Y-MAC, Low energy Adaptive Clustering - Contention based MAC Protocols, Power Aware Multi-Access with signalling, Sensor MAC-Timeout MAC-Data gathering MAC.

(8L)

Module IV:

Routing in Wireless Sensor Networks

Design Issues in WSN routing- Data Dissemination and Gathering-Routing Challenges in WSN - Flooding-Flat Based Routing – SAR, Directed Diffusion, Hierarchical Routing- LEACH, PEGASIS - Query Based Routing- Negotiation Based Routing Geographical Based Routing- Transport layer- Transport Protocol Design issues, Performance of Transport Control Protocols.

(8L)

Module V:

Middleware and Security Issues

WSN middleware Principles-Middleware Architecture-Existing middleware - operating systems for wireless sensor networks-performance and traffic management - Fundamentals of network security-challenges and attacks - Protocols and mechanisms for security.

(8L)

Books recommended:

TEXT BOOK

1. WaltenegusDargie, Christian Poellabauer, "Fundamentals of Wireless Sensor Networks, Theory and Practice", Wiley Series on wireless Communication and Mobile Computing, 2011. **(T1)**
2. KazemSohraby, Daniel manoli, "Wireless Sensor networks- Technology, Protocols and Applications", Wiley Inter Science Publications 2010. **(T2)**

REFERENCE BOOK

1. BhaskarKrishnamachari, "Networking Wireless Sensors", Cambridge University Press, 2005. **(R1)**
2. C.S Raghavendra, Krishna M.Sivalingam, Taiebznati, "Wireless Sensor Networks", Springer Science 2004. **(R2)**

Course Evaluation:

Individual assignment, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design: Teaching through research papers.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6

CO1	3	2	1	1	1	1
CO2	3	2	1	1	1	1
CO3	3	3	1	1	1	1
CO4	2	3	2	1	1	1
CO5	2	3	3	2	1	1

If satisfying and < 34% = L, 34-66% = M, > 66% = H

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD6
CO2	CD1, CD6, CD7
CO3	CD1, CD2, CD3, CD6, CD7
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2, CD3,CD4,CD5,CD7

COURSE INFORMATION SHEET

Course code: CS507

Course title: COMPUTABILITY AND COMPLEXITY THEORY

Pre-requisite(s): Automata Theory and Computer algorithms

Co-requisite(s):

Credits: 3 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: M. Tech

Semester / Level: I/5

Branch: Computer Science and Engineering

Name of Teacher:

Course Objectives

This course enables the students to:

1.	Give introduction to the mathematical foundations of computation including automata
2.	Learn about the issues in finite representations for languages and machines, as well as gain a more formal understanding of algorithms and procedures.
3.	Motivate and expose to the fundamental understanding of computation under resource constraints.
4.	Set a research level exposure to deeper topics in complexity theory.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Relate formal languages and mathematical models of computation
CO2	Attain knowledge about different types of languages and the corresponding machines for computations
CO3	Understand the limitations on what computers can't do, and learn examples of unsolvable problems
CO4	Analyse P, NP, NP-C, NP-Hard, Tractable and Intractable problems
CO5	Explain reduction of problems for easy and hard problems

SYLLABUS

Module I:

Basic background on automata and languages, Types of automata and languages, Turing machines, Encoding and Enumeration of Turing Machines, k-tape Turing machines, non-deterministic Turing machines, Universal Turing machine, Resource bounded computation, Halting problem

(8L)

Module II:

Context Sensitive Language and Chomosky Hierarchy Recursive enumerable languages, Recursive languages, Decidable and recognizable language, Turing-decidable languages, Turing-recognizable languages, Kolmogorov Complexity

(8L)

Module III:

Primitive recursive function, partial recursive function, Recursive and recursive enumeration sets, Programming systems, Unsolvable problems, a non-recursive language and an unsolvable problem, Rice Theorem, More unsolvable problems, PCP

(8L)

Module IV:

Measuring complexity- Big Oh, small oh and other notations, Analysing algorithms, Time and space complexity of a Turing machine, Complexity analysis of multi-tape TM

(8L)

Module V:

Complexity classes: P, NP, NP-C, NP-Hard problem, PSPACE, NP-complete problems- clique, vertex cover, Hamiltonian cycle, graph colouring problem, graph isomorphism, Reduction from NP-C problem to another problem, Cook-Levin Theorem,Tractable and Intractable problems, Reducing one problem to another problem**,** Additional classes of problems- RP**,** ZPP

(8L)

Books recommended:

TEXT BOOK

1. Lewis H.R., Papadimitriou C.H., "Elements of the Theory of Computation", PHI Publ., 2nd edition, New Delhi. **(T1)**

REFERENCE BOOK

1. Hopcroft J.E., Motwani R. and Ullman J.D, "Introduction to Automata Theory, Languages and Computations", Second Edition, Pearson Education, 2008. **(R1)**
2. John Martin, "Introduction to Languages and the Theory of Computation", 3rd ed. McGraw Hill, New York, NY, 2003. **(R2)**
3. Dexter Kozen, "Theory of Computation", Springer publication. **(R3)**

Course Evaluation:

Individual assignment, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design: Teaching through research papers.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training

CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	1	1	1
CO2	3	2	1	1	1	1
CO3	3	3	1	1	1	1
CO4	2	3	2	1	1	1
CO5	2	3	3	2	1	1

If satisfying and < 34% = L, 34-66% = M, > 66% = H

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD6
CO2	CD1, CD6, CD7
CO3	CD1, CD2, CD3, CD6, CD7
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2, CD3, CD4,CD5,CD7

PE Lab 1

COURSE INFORMATION SHEET

Course code: IT509

Course title: MATLAB PROGRAMMING

Pre-requisite(s):

Co- requisite(s):

Credits: 2 L: 0 T: 0 P: 4

Class schedule per week: 04

Class: M. Tech

Semester / Level: I/5

Branch: Computer Science and Engineering

Name of Teacher:

Course Objectives

This course enables the students to:

1.	To familiarize the student in introducing and exploring MATLAB
2.	Develop mathematical thinking and problem-solving skill
3.	To enable the student on how to approach for solving Engineering problems using simulation tools.
4.	To provide a foundation in use of this software for real time app

Course Outcomes

After the completion of this course, students will be able to:

CO1	Express programming & simulation for engineering problems.
CO2	Find importance of this software for Lab Experimentation.
CO3	Analyze problems and write basic mathematical, electrical, electronic problems in Matlab
CO4	Implement programming files with GUI Simulink.
CO5	Simulate basic Engineering problems

SYLLABUS

List of Programs as Assignments:

1. **Lab Assignment No: 1**

   Objective: To Understand and Implement Matrix Algebra

   1. To create Sparse matrices using the function sparse.
   2. To convert a sparse matrix to full matrix.

2. **Lab Assignment No: 2**

   Objective: To Understand and Implement Data Analysis

   1. To measure the daily high temperatures in three cities with different color.
   2. To solve a different cities temperature do the filter.

3. **Lab Assignment No: 3**

   Objective: To Understand and Implement Data Interpolation

   1. To Draw 2-D random data.
   2. To Draw Threshold of Human Hearing.

4. **Lab Assignment No: 4**

   Objective: To Understand and Implement Cubic Splines

   1. To design Spline differentiation and Integration.
   2. To design interpolated Spiral Y=f(X).

5. **Lab Assignment No: 5**

   Objective: To Understand and Implement Fourier Analysis

   1.To solve the use of the FFT, consider the problem of estimating the continuous Fourier transform of the signal

   $f(t)=2e^{-3t}$ $t \geq 0$, where f(t) is gven by

   $F(\omega)=2/(3+j\ \omega)$

   2. To design sawtooth Waveform at arbitrary points.

6. **Lab Assignment No: 6**

   Objective: To Understand and Implement Optimization

   1. To solve 1-D minimization and maximization.
   2. To design Rosenbrock's banana function.

7. **Lab Assignment No: 7**

   Objective: To Understand and Implement Differential Equations

   1. Design a van der Pol Solution.
   2. To solve Jacobian matrix.

8. **Lab Assignment No: 8**

   Objective: To Understand and Implement Two-Dimensional Graphics

   1. To add new plots to an existing plot by using the hold command.
   2. To create new Figure windows, use the figure command in the Command window or the **New Figure** selection from the **File** menu in the Command or Figure window.

9. **Lab Assignment No: 9**

   Objective: To Understand and Implement Three- Dimensional Graphics

   1. Plot = 2 with 0 5in polar coordinates.

2. Design a Surface plot using the surf function.

10. Lab Assignment No: 10

Objective: To Understand and Implement Images, Movies, and Sound

1. To display 8-bit intensity and RGB images.
2. To convert between indexed images and movie frames.

11. Lab Assignment No: 11

Objective: To Understand and Implement Graphical User Interfaces

1. Using uigetfile to find the startup.m file on the author's computer.

2. Write a program using the function **guidata,** which stores and retrieves data in the GUI figure **'ApplicationData'** property.
3. How to put walls by clicking a mouse button to make an arbitrary maze.
4. Design a GUI System.

Books recommended:

TEXTBOOK

1. Duane Hanselman, bruce Littlefield, Mastering MATLAB 7, Reason edu., 2nd edition, 2008. **(T1)**
2. Sandeep Nagar, Introduction to MATLAB for Engineers and Scientists: Solutions for Numerical Computation and Modeling, APress, 2017. **(T2)**

REFERENCE BOOK

1. MATLAB Primer by MATHWORKS. **(R1)**

Course Evaluation:

Day to day progressive evaluation, Lab Quizzes, Surprise Tests, Online Lab performance and Viva Voce

Gaps in the syllabus (to meet Industry/Profession requirements):

Implementing of real-world problems

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design: Teaching through research papers.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	60
Semester End Examination	40

Continuous Internal Assessment	% Distribution
Day to day performance & Lab files	30
Quiz (es)	10
Viva	20

Semester End Examination	% Distribution
Examination Experiment Performance	30
Quiz	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	1	1
CO2	3	3	2	2	1	1
CO3	2	3	2	1	2	1
CO4	3	3	2	2	1	1
CO5	3	2	1	1	1	1

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD6
CO2	CD1, CD6, CD7
CO3	CD1, CD2, CD3,
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2, CD7

COURSE INFORMATION SHEET

Course code: IT510

Course title: JAVA PROGRAMMING

Pre-requisite(s):

Co- requisite(s): None

Credits: 2 L: 0 T: 0 P: 4

Class schedule per week: 04

Class: M. Tech

Semester / Level: I/5

Branch: Computer Science and Engineering

Name of Teacher:

Course Objectives

This course enables the students to:

1.	To familiarize the student in introducing and exploring JAVA.
2.	Knowledge of the structure and model of the Java programming language.
3.	Use the Java programming language for various programming technologies.
4.	To provide a foundation for Java programming language to solve the given problems.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Write, compile, and execute Java programs that may include basic data types and control flow constructs using J2SE or other Integrated Development Environments (IDEs)
CO2	Write, compile, and execute Java programs manipulating Strings and text documents.
CO3	Write, compile, execute Java programs that include GUIs and event driven programming
CO4	Create Applets and GUI

CO5	Executing Client server and socket programming

SYLLABUS

List of Programs as Assignments:

1. **Lab Assignment No: 1**
   Objective: To Understand and Implement COLLECTION FRAMEWORK
   1. To create sparse matrices using the function sparse.
   2. To convert a sparse matrix to full matrix.
2. **Lab Assignment No: 2**
   Objective: To Understand and Implement Generic Programming
   1. Write the tasks performed by type erasure?
   2. Write a generic method to exchange the positions of two different elements in an array?
3. **Lab Assignment No: 3**
   Objective: To Understand and Implement REFLECTION
   1. Write a program that finds and displays inheritance hierarchy of a specified class?
   2. Write a program that shows all public fields of a specified class?
4. **Lab Assignment No: 4**
   Objective: GUI Development with Swing
   1. Working with Text Fields
   2. Working with Buttons
   3. Working with Lists
   4. Working with Scroll Panes
5. **Lab Assignment No: 5**
   Objective: Implementing Robust Geometric Primitives
   1. Java Program to Apply Above-Below-on Test to Find the Position of a Point with respect to a Line
   2. Java Program to Compute the Area of a Triangle Using Determinants
   3. Java Program to Compute the Volume of a Tetrahedron Using Determinants
   4. Java Program to Find the Area of any Polygon Using Triangulation
6. **Lab Assignment No: 6**
   Objective: To Understand and Implement examples on "Convex Hull"
   1. Java Program to Implement Graham Scan Algorithm to Find the Convex Hull
   2. Java Program to Implement Gift Wrapping Algorithm in Two Dimensions
   3. Java Program to Implement Jarvis March to Find the Convex Hull
7. **Lab Assignment No: 7**

   Objective: To Understand and Implement examples on "Nearest Neighbor Search"
   1. Java Program to Find the Nearest Neighbour Using K-D Tree Search
   2. Java Program to Find Nearest Neighbour Using Voronoi Diagram
8. **Lab Assignment No: 8**

   Objective: To Understand and Implement Network Programming

1. Working with URLs
2. Socket Server Programming
3. Client Server Programming

9. Lab Assignment No: 9

Objective: To Understand and Implement SOCKET PROGRAMMING
1.Write a java socket program to get the resource http://www.google.com/index.html using HTTP protocol?
2. Write a program how do you get the IP address of a machine from its hostname?

10. Lab Assignment No: 10

Objective: To Understand and Implement Java Web Applications
1. Simple Servlet
2. Java Web Applications - Get Request
3. Java Web Applications - Post Request

11. Lab Assignment No: 11

Objective: To Understand and Implement Advanced Java Input/output (NIO)
1. File Copying With NIO
2. Working with Buffers
3. Working with File Data

Books recommended:

TEXTBOOKS

1. Uttam K Roy, Advanced JAVA Programming, Oxford University Press, 1st Edition, 2015 **(T1)**
2. HeerbertSchildt, Java: A Beginner's Guide, SeventhEdition,Oracle Press, 2014 **(T2)**

Course Evaluation:

Day to day progressive evaluation, Lab Quizzes, Surprise Tests, Online Lab performance and Viva Voce

Gaps in the syllabus (to meet Industry/Profession requirements):

Implementing of real-world problems

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design: Teaching through research papers.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	60
Semester End Examination	40

Continuous Internal Assessment	% Distribution
Day to day performance & Lab files	30
Quiz (es)	10
Viva	20

Semester End Examination	% Distribution
Examination Experiment Performance	30
Quiz	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	1	1
CO2	3	3	2	2	1	1
CO3	3	2	2	2	2	1
CO4	3	2	3	2	1	1
CO5	3	2	1	1	1	1

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD6
CO2	CD1, CD6, CD7
CO3	CD1, CD2, CD3,
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2, CD7

COURSE INFORMATION SHEET

Course code: IT511

Course title: R PROGRAMMING

Pre-requisite(s):

Co- requisite(s): None

Credits: 2 L: 0 T: 0 P: 4

Class schedule per week: 04

Class: M. Tech

Semester / Level: I/5

Branch: Computer Science and Engineering

Name of Teacher:

Course Objectives

This course enables the students to:

1.	To familiarize the student in introducing and exploring R
2.	Develop basic thinking for data analysis.
3.	To enable the student on how to approach for statistical Analysis
4.	To provide a foundation in use of this software

Course Outcomes

After the completion of this course, students will be able to:

CO1	Manipulate data within R
CO2	Perform basic data analysis procedures

CO3	Create plots
CO4	Implement programming features like accessing R packages, writing R functions
CO5	Simulation & Profiling with R

SYLLABUS

List of Programs as Assignments:

1. **Lab Assignment No: 1**

   Objective: To Understand and Implement Data Types
   1. Data Types - R Objects and Attributes
   2. Data Types - Vectors and Lists
   3. Data Types - Matrices
   4. Data Types - Factors
   5. Data Types - Missing Values
   6. Data Types - Data Frames
   7. Data Types - Names Attribute
   8. Data Types - Summary

2. **Lab Assignment No: 2**

   Objective: To Understand and Implement Data Analysis
   1. Reading Tabular Data
   2. Reading Large Tables
   3. Textual Data Formats
   4. Connections: Interfaces to the Outside World
   5. Subsetting - Basics
   6. Subsetting - Lists
   7. Subsetting - Matrices
   8. Subsetting - Partial Matching
   9. Subsetting - Removing Missing Values
   10. Vectorized Operations
   11.

3. **Lab Assignment No: 3**

   Objective: To Understand and Implement Swirl
   1. Workspace and Files
   2. Sequences of Numbers
   3. Vectors

4. **Lab Assignment No: 4**

   Objective: To Understand and Implement Cubic Splines

1. To design Spline differentiation and Integration.
2. To design interpolated Spiral Y=f(X).

5. **Lab Assignment No: 5**

Objective: To Understand and Implement Control Structures

1. If-else
2. Control Structures - For loops
3. Control Structures - While loops
4. Control Structures - Repeat, Next, Break

6. **Lab Assignment No: 6**

Objective: To Understand and Implement Functions

1. Functions (part 2)
2. Scoping Rules - Symbol Binding
3. Scoping Rules - R Scoping Rules
4. Scoping Rules - Optimization Example (OPTIONAL)

7. **Lab Assignment No: 7 &8**

Objective: To Understand and Implement Loop Functions and Debugging

1. Loop Functions - lapply
2. Loop Functions - apply
3. Loop Functions - mapply
4. Loop Functions - tapply
5. Loop Functions – split

8. **Lab Assignment No: 9 & 10**

Objective: To Understand and Implement Two-Dimensional Graphics

1. Generating Random Numbers
2. Simulation - Simulating a Linear Model
3. Simulation - Random Sampling

Books recommended:

TEXT BOOKS

1. Norman Matloff, The Art of R Programming, A Tour of Statistical Software Design 1st Edition, **(T1)**
2. Hadley Wickham, Garrett Grolemund, R for Data Science: Import, Tidy, Transform, Visualize, and Model Data, Orielly, 1st Edition. **(T2)**

Course Evaluation:

Day to day progressive evaluation, Lab Quizzes, Surprise Tests, Online Lab performance and Viva Voce

Gaps in the syllabus (to meet Industry/Profession requirements):

Implementing of real-world problems

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design: Teaching through research papers.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	60
Semester End Examination	40

Continuous Internal Assessment	% Distribution
Day to day performance & Lab files	30
Quiz (es)	10
Viva	20

Semester End Examination	% Distribution
Examination Experiment Performance	30
Quiz	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	1	1
CO2	3	3	2	2	1	1
CO3	2	2	2	1	1	1

CO4	3	1	1	1	1	1
CO5	3	2	1	1	1	1

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD6
CO2	CD1, CD6, CD7
CO3	CD1, CD2, CD3,
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2, CD7

Program Electives III

COURSE INFORMATION SHEET

Course code: CS605

Course title: HIGH PERFORMANCE COMPUTER ARCHITECTURE

Pre-requisite(s): Computer Architecture/Organization, Operating System, Parallel Computing

Co- requisite(s):

Credits:3 L:3 T:0 P:0

Class schedule per week: 03
Class: M. Tech

Semester / Level: III/6

Branch: Computer Science &Engineering

Course Objectives

This course enables the students to:

	To Explain different terminologies in High Performance Computer Architecture.
2	To introduce basic concepts of High-Performance Computer Architecture
3	Hands on the different parallel architectures in terms of various parameters.
4	Evaluate performance metrics and scalability and selection criteria for parallelism and different parallel systems and able to modify it.
5	Provide the students with practice on running complex problem in high performance computing machines.

Course Outcomes

After the completion of this course, students will be:

CO1	Describe different terminologies in High Performance Computer Architecture.
CO2	Demonstrate and Implement the concepts of High-Performance Computer Architecture
C03	Compare and differentiate the different parallel architectures in terms of various parameters.
CO4	Evaluate performance metrics and scalability and selection criteria for parallelism and different parallel systems and able to modify it.
CO5	Design effective high-performance systems as per users' criteria with proper justification by self or in a group.

SYLLABUS

Module I

Parallel Computer Models: The State of Computing, Multiprocessors and Multicomputers, Multivector and SIMD Computers, PRAM and VLSI Models, Architectural Development Tracks.

(8L)

Program and Network Properties: Conditions for Parallelism, Program Partitioning and Scheduling, Program Flow Mechanism, System Interconnect Architectures.

Module II

Program and Network Properties: Conditions for Parallelism, Program Partitioning and Scheduling, Program Flow Mechanism, System Interconnect Architectures.

Principles of Scalable Performance: Performance Metrics and Measures, Parallel Processing Applications, Speedup Performance Laws, Scalability Analysis and Approaches.

(8L)

Module III

Processors and Memory Hierarchy: Advanced Processor Technology, Super Scaler and Vector Processors, Memory Hierarchy Technology, Virtual Memory Technology.

Bus, Cache, and Shared Memory: Bus Systems, Cache Memory Organizations, Shared-Memory Organizations, Sequential and Weak Consistency Models, Weak Consistency Models.

(8L)

Module IV

Pipelining and Superscalar Techniques: Linear Pipeline Processors, Non-Linear Pipeline Processor, Instruction Pipeline Design, Arithmetic Pipeline Design, Superscalar Pipeline Design

Multiprocessors and Multicomputers: Multiprocessor System Interconnects, Cache Coherence Synchronization Mechanism, Three Generations of Multicomputers, Message-Passing Mechanisms.

(8L)

Module V

Multivector and SIMD Computers: Vector Processing Principles, Multivector Multiprocessor, Compound Vector Processing, SIMD Computer Organizations, The Connection Machine CM-5

Scalable, Multithreaded and Data Flow Architecture: Latency-Hiding Techniques, Principle of Multithreading, Fine-Grain Multicomputers, Scalable and Multithreaded Architectures, Data Flow and Hybrid Architectures.

(8L)

Textbook:

1.Hwang K., Jotwani N., Advanced Computer Architecture, 2nd Edition, Tata Mc-Graw Hill, India, 2010. **(T1)**

Reference Book:

1.Stone, H. S., High Performance Computer Architecture, 3rd Edition, Addison Wesley Publishing Company, USA. **(R1)**

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

Course Evaluation:

Individual assignment, Theory (Quiz and End semester) examinations

POs met through Topics beyond syllabus/Advanced topics/Design: Teaching through research papers.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #						
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3			1	2	1
CO2	3	3		1	1	1
C03	3	3	3			1
CO4	2	3			2	1
CO5	2	3	2			1

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD6
CO2	CD1, CD6, CD7
CO3	CD1, CD2, CD3,
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2, CD5, CD7

Program Elective II

COURSE INFORMATION SHEET

Course code: CS515
Course title: ADVANCED OPERATING SYSTEM
Pre-requisite(s): C/C++/Java Programming, Data Structure, Operating system
Co- requisite(s): None
Credits: 3 L: 3 T: 0 P:0
Class schedule per week: 03
Class: M. Tech
Semester / Level: II/5
Branch: Computer Science and Engg.
Name of Teacher:

Course Objectives
This course enables the students to:

1.	Introducing the advance concepts of modern operating systems
2.	Illustrating various design issues in different environments
3.	Evaluating design choices with performance analysis
4.	Identifying thrust areas in research in operating systems

Course Outcomes

After the completion of this course, students will be able to:

CO1	Understand and implement basic services and functionalities of the operating system using system calls. .
CO2	Use modern operating system calls and synchronization libraries in software/ hardware interfaces.
CO3	Understand the benefits of thread over process and implement synchronized programs using multithreading concepts.
CO4	Analyze and simulate CPU Scheduling Algorithms like FCFS, Round Robin, SJF, and Priority.
CO5	Implement memory management schemes and page replacement schemes.

SYLLABUS

Module I:

Introduction: History, Hardware Review, Types of Operating Systems, Operating System Concepts, System Calls, Operating System Structure, Research on Operating systems

(8L)

Module II:

Virtualization and Clouds: Requirements, Hypervisors, Techniques, Memory Virtualization, I/O Virtualization, Multicore CPUs, Clouds.

(8L)

Module III:

Multiple Processor Systems: Multiprocessors, Multicomputers, Distributed Systems, Research on Multiple Processor Systems

(8L)

Module IV:

Security: Security Problems, /controlling Access to Resources, Formal Models, Cryptography, Authentication, Exploiting Software, Attacks, Malwares, Defenses

(8L)

Module V:

Operating system Design: Design Problem, Interface Design, Implementation, Performance, Trends

(8L)

TEXT BOOKS:

1. Andrew S. Tanenbaum, Modern Operating Systems, 4th Edition, Pearson Education, 2014. **(T2)**

REFERENCE BOOKS:

2. William Stalling, Operating System: Internal and Design Principles, 8th Edition, Pearson International, 2014. **(R1)**
3. Silberschatz, Galvin, Gagne, Operating System Concepts, 10th Edition, Wiley, 2017. **(R2)**
4. D. M. Dhamdhare, Operating Systems, Tata McGraw Hill India, 2012. **(R3)**

Course Evaluation:

Individual assignment, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design: Teaching through research papers.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment –

1. Student Feedback on Faculty

2. Student Feedback on Course Outcome

CD #	Course Delivery methods
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcome

Course Outcome	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	2
CO2	3	3	3	3	3	3
CO3	3	3	3	2	2	3
CO4	3	3	3	2	1	1
CO5	2	2	2	3	1	1

If satisfying and < 34% = L, 34-66% = M, > 66% = H

Mapping Between COs and Course Delivery (CD) methods			
CD	**Course Delivery methods**	**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1, CO2, CO3, CO4, CO5	CD1
CD2	Laboratory experiments/teaching aids		
CD3	Industrial/guest lectures		
CD4	Industrial visits/in-plant training		

CD5	Self- learning such as use of NPTEL materials and internets		

COURSE INFORMATION SHEET

Course code:IT516

Course title: DATA MINING AND DATA ANALYSIS

Pre-requisite(s):

Co- requisite(s): None

Credits: 3 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: M. Tech

Semester / Level: II/5

Branch: Computer Science & Engg.

Name of Teacher:

Course Objectives

This course enables the students to:

1.	Explain about the necessity of preprocessing and its procedure.
2.	Generate and evaluate Association patterns
3.	Solve problems using various Classifiers
4.	Learn the principles of Data mining techniques and various mining algorithms.
5.	Learn about traditional and modern data driven approach and problem

	solving techniques for various datasets

Course Outcomes

After the completion of this course, students will be able to:

CO1	Understand Data Warehousing and Data Mining and its applications and challenges and Create mini data warehouse.
CO2	Apply the association rules for mining applications .
CO3	Identify appropriate Classification techniques for various problems with high dimensional data.
CO4	Implement appropriate Clustering techniques for various problems with high dimensional data sets.
CO5	Implement various mining techniques on complex data objects.

SYLLABUS

Module I:

Data Analysis foundation, Numeric and Categorical attributes, Dimensionality reduction.

(8L)

Module II:

Data Warehouse: Introduction, A Multidimensional Data Model, Data Warehouse Architecture, Data Warehouse Implementation, Data Cube Technology, From Data Warehousing to Data Mining. Data Cube Computation and Data Generalization.

(8L)

Module III:

Frequent Pattern Mining, Summarizing Item sets, Itemset Mining, Sequence Mining.

(8L)

Module IV:

Classification: Naïve Bayes, KNN, Decision Tree, Classification Performance measures, Classifier evaluation.

(8L)

Module V:

Clustering: K-Means, Agglomerative, Hierarchical, DBSCAN, Spectral and Graph Clustering. Anomaly detection, Statistical, distance and density-based approaches.

(8L)

Text Books:

1. Mohammed J. Zaki, and Wagner Meira Jr., "Data Mining and Analysis: Fundamental Concepts and Algorithms", Cambridge University Press, 2016. **(T1)**
2. Pang-Ning Tan, Michael Steinbach, and Vipin Kumar, "Introduction to Data Mining", Pearson, 2014. **(T2)**
3. Jiawei Han, and Micheline Kamber, "Data Mining Concepts & Techniques", 3rd Edition, Publisher Elsevier India Private Limited, 2015. **(T3)**

Course Evaluation:

Individual assignment, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design: Teaching through research papers.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓

Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

CD #	Course Delivery methods
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcome

Course Outcome	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	2		3	2
CO2	3	3		2	2	
CO3	2	3	3	2	3	1
CO4		2	3		2	3
CO5	1	2	3	3	2	3

If satisfying and < 34% = L, 34-66% = M, > 66% = H

Mapping Between COs and Course Delivery (CD) methods			
CD	**Course Delivery methods**	**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1, CO2, CO3, CO4, CO5	CD1

CD2	Laboratory experiments/teaching aids		
CD3	Industrial/guest lectures		
CD4	Industrial visits/in-plant training		
CD5	Self- learning such as use of NPTEL materials and internets		

COURSE INFORMATION SHEET

Course code:CS517

Course title: DESIGN AND ANALYSIS OF PARALLEL ALGORITHMS

Pre-requisite(s): Data Structure, Operating system

Co- requisite(s): None

Credits:3 L:3 T:0 P:0

Class schedule per week: 03

Class: M.Tech

Semester / Level:II/5

Branch: Computer Science & Engg.

Course Objectives

1.	An implementation-oriented introduction to programming paradigms for parallel computers.
2.	Modelling, analysis and measurement of program performance.
3.	Description, implementation and use of parallel programming.
4.	Understanding parallel communication operations and use of library routines and applications.

Course Outcomes

After the completion of this course, students will:

CO1	Understand principles of parallel algorithms and describe the developments in the field of parallel computing.
CO2	Develop ability to compare the performance of different methods
C03	Demonstrate advanced knowledge of the elements of parallel programming
CO4	Analyse performance of parallel algorithms
CO5	Design and implement parallel algorithms

SYLLABUS

ModuleI:

Introduction to Parallel Computing: Scope of Parallel Computing, Implicit Parallelism: Trends in Microprocessor Architectures, Limitations of Memory System Performance, Dichotomy of Parallel Computing Platforms, Physical Organization of Parallel Platforms, Communication Costs in Parallel Machines, Routing Mechanisms for Interconnection Networks, Impact of Process-Processor Mapping and Mapping Techniques.

(8L)

Module II:

Principles of Parallel Algorithm Design: Preliminaries, Decomposition Techniques, Characteristics of Tasks and Interactions, Mapping Techniques for Load Balancing, Methods for Containing Interaction Overheads, Parallel Algorithm Models.

(8L)

Module III :

Basic Communication Operations: One-to-All Broadcast and All-to-One Reduction, All-to-All Broadcast and Reduction, All-Reduce and Prefix-Sum Operations, Scatter and Gather, All-toAll Personalized Communication, Circular Shift, Improving the Speed of Some Communication Operations.

(8L)

Module IV :

Analytical Modelling of Parallel Programs: Sources of Overhead in Parallel Programs, Performance Metrics for Parallel Systems, The Effect of Granularity on Performance, Scalability of Parallel Systems, Minimum Execution Time and Minimum Cost-Optimal Execution Time, Asymptotic Analysis of Parallel Programs, Other Scalability Metrics.

(8L)

Module V:

Programming Using the Message-Passing Paradigm: Principles of Message-Passing Programming, The Building Blocks: Send and Receive Operations, MPI: the Message Passing Interface, Topologies and Embedding, Overlapping Communication with Computation, Collective Communication and Computation Operations, Groups and Communicators.

(8L)

Textbooks:

1. Ananth Grama, Anshul Gupta, Gorge Karypis, Vipin Kumar, Introduction to Parallel Computing, 2nd Edition, Pearson Education,2004. **(T1)**

Reference Book:

1. Michael J. Quinn, Parallel Computing: Theory and Practice, 2nd Edition, McGraw Higher Education, 2002. **(R1)**
2. Zbinieu J Czech, Introduction to Parallel Computing, 1st Edition, Cambridge University Press, 2017. **(R2)**
3. An Introduction to Parallel Programming, Peter Pacheco, 1st Edition, Morgan Kaufmann, 2011. **(R3)**

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

Course Evaluation:

Individual assignment, Theory (Quiz and End semester) examinations

POs met through Topics beyond syllabus/Advanced topics/Design: Teaching through research papers.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	3	3	3	2	1
2	3	3	3	2	1	1
3	3	2	2	3	1	1
4	3	3	2	1	3	1
5	2	1	3	2	1	1

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD6
CO2	CD1, CD6, CD7
CO3	CD1, CD2, CD3,
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2, CD5, CD7

PE LAB-2

COURSE INFORMATION SHEET

Course code:IT517

Course title: DATA MINING AND DATA ANALYSIS LAB

Pre-requisite(s):

Co- requisite(s): None

Credits: 2 L: 0 T: 0 P: 4

Class schedule per week: 04

Class: M. Tech

Semester / Level: II/5

Branch: Computer Science & Engg.

Name of Teacher:

Course Objectives

This course enables the students to:

1.	Explain about the necessity of preprocessing and its procedure.
2.	Generate and evaluate Association patterns
3.	Solve problems using various Classifiers
4.	Learn the principles of Data mining techniques and various mining algorithms.
5.	Learn about traditional and modern data driven approach and problem-solving techniques for various datasets

Course Outcomes

After the completion of this course, students will be able to:

CO1	Understand Data Warehousing and Data Mining and its applications and challenges and Create mini data warehouse.
CO2	Apply the association rules for mining applications .
CO3	Identify appropriate Classification techniques for various problems with high dimensional data.
CO4	Implement appropriate Clustering techniques for various problems with high dimensional data sets.
CO5	Implement various mining techniques on complex data objects.

SYLLABUS

List of Programs as Assignments:

1. **Lab Assignment No: 1**

. Build a Data Warehouseand Explore WEKA tool.

2. **Lab Assignment No: 2**

   . Demonstration of preprocessingon variousdatasets.

3. **Lab Assignment No: 3**

   Q3. Demonstration of Association rule process on dataset using apriori algorithm.

4. **Lab Assignment No: 4**

   Q4. Demonstrate performance of classification on various data sets.

5. **Lab Assignment No: 5**

   Q5. Demonstrate performance ofclustering on various data sets.

6. **Lab Assignment No: 6**

   Q6. Demonstrate performance ofRegression on various data sets

7. **Lab Assignment No: 7**

   Q7. Implement following algorithms for various datasets

   A. Apriori Algorithm.
   B. FP-Growth Algorithm.
   C. K-means clustering.

8. Q8. **Lab Assignment No: 8**

   Implement Bayesian Classification for various datasets

9. **Lab Assignment No: 9**

   Q9 Implement Decision Tree for various datasets.

10. **Lab Assignment No: 10**

    Q10. Implement Support Vector Machines.

11. **Lab Assignment No: 11**

    Q11Applications of classification for web mining.

12. **Lab Assignment No: 12**

Q12. Case Study on Text Mining or any commercial application

Books recommended:

TEXTBOOKS:

1. Jiawei Han &MichelineKamber - Data Mining Concepts & Techniques Publisher Harcout India. Private Limited. **(T1)**

REFERENCE BOOKS:

1. G.K. Gupta – Introduction to Data Mining with case Studies, PHI, New Delhi – 2006. **(R1)**
2. A. Berson& S.J. Smith – Data Warehousing Data Mining, COLAP, TMH, New Delhi – 2004. **(R2)**
3. H.M. Dunham & S. Sridhar – Data Mining, Pearson Education, New Delhi, 2006. **(R3)**

Course Evaluation:

Day to day progressive evaluation, Lab Quizzes, Surprise Tests, Online Lab performance and Viva Voce

Gaps in the syllabus (to meet Industry/Profession requirements):

Implementing of real-world problems

POs met through Gaps in the Syllabus: PO5&6

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design: Teaching through research papers.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	60
Semester End Examination	40

Continuous Internal Assessment	% Distribution
Day to day performance & Lab files	30
Quiz (es)	10
Viva	20

Semester End Examination	% Distribution
Examination Experiment Performance	30
Quiz	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors

CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	2	2		1
CO2	3	3	2		1	
CO3	2	3	2	1	1	1
CO4	3				1	1
CO5	3	2	1			1

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD6
CO2	CD1, CD6, CD7
CO3	CD1, CD2, CD3,
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2, CD7

COURSE INFORMATION SHEET

Course code:CS518

Course title: PARALLEL COMPUTING LAB.

Pre-requisite(s):

Co- requisite(s): None

Credits: 2 L: 0 T: 0 P: 4

Class schedule per week: 04

Class: B. Tech

Semester / Level: II/5

Branch: Computer Science &Engineering

Name of Teacher:

Course Objectives

This course enables the students to:

1.	To describe benefits and applications of parallel computing.
2.	Explain architectures of multicore CPU, GPUs and HPC clusters, including the key concepts in parallel computer architectures, e.g. shared memory system, distributed system, NUMA and cache coherence, interconnection
3.	Understand principles for parallel and concurrent program design, e.g. decomposition of works, task and data parallelism, processor mapping, mutual exclusion, locks.
4.	write programs that effectively use parallel collections to achieve performance.
5.	To use large scale parallel machines to solve problems as well as discuss the issues related to their construction and use.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Reason about task and data parallel programs.

CO2	Express common algorithms in a functional style and solve them in parallel.
CO3	To analyse a problem, and identify, formulate and use the appropriate computing and engineering requirements for obtaining its solution.
CO4	Write parallel program using OpenMP, CUDA, MPI programming models.
CO5	Perform analysis and optimization of parallel program.

SYLLABUS

List of Programs as Assignments:

1. **Lab Assignment No: 1**
   Objective: To understand and Implement basic MPI program.
   Q1. Write a program that uses MPI and has each MPI process print
   'Hello world from process i of n' using the rank in MPI_COMM_WORLD for i and the size of MPI_COMM_WORLD for n.
   Q2. Write a parallel program to print any input message supplied by user.
2. **Lab Assignment No: 2**
   Objective: To Understand and Implement MPI program.
   Q1. Write a parallel program to add two one dimensional arrays of size 'n'.
   Q2. Write a parallel program to add two matrices of order n * n.
3. **Lab Assignment No: 3**
   Objective: To Understand and Implement MPI program.
   Q1. Write a parallel program to multiply two matrices.
   Q2. Write a parallel program to multiply a matrix of order n x n by a vector of size n.
4. **Lab Assignment No: 4**
   Objective: To Understand and Implement MPI program.
   Q1. Write a parallel Program to count the no. of vowels in a text.
   Q2. Write a parallel program to find the largest element of n elements.
5. **Lab Assignment No: 5**
   Objective: To Understand and Implement MPI program.
   Q1. Write a parallel program to count no. of characters, words and lines in a file.
   Q2. Write a parallel program to find factorial value of an integer.
6. **Lab Assignment No: 6**
   Objective: To Understand and Implement MPI program.
   Q1. Write a parallel program to find the transpose of a given Matrix.

Q2. Write a parallel program to implement ring topology.

7. **Lab Assignment No: 7**

   Objective: To Understand and Implement MPI program.

   Q1. Write a parallel program to find the largest and the second largest from a list of elements considering minimum no. of comparisons.

   Q2. Write a parallel program to sort n elements, using any sorting technique.

8. **Lab Assignment No: 8**

   Objective: To Understand and Implement MPI program.

   Q1. Write a parallel program to solve a set of linear equations using gauss elimination method.

   Q2. Write a parallel program to find the inverse of a given matrix of n*n order.

9. **Lab Assignment No: 9**

   Objective: To Understand and Implement MPI program.

   Q1. Write a parallel program to find minimal path (minimal cost) in an undirected graph.

   Q2. Write a parallel program to find roots of an equation using N-R method.

Books recommended:

TEXTBOOKS

1. Ananth Grama, Anshul Gupta, George Karypis, and Vipin Kumar, Introduction to Parallel Computing (2nd Edition). **(T1)**
2. Edition), PDF, Amazon, cover theory, MPI and OpenMP introduction Recommended: John Cheng, Max Grossman, and Ty McKercher, Professional CUDA C Programming, 1st Edition 2014. **(T2)**

REFERENCE BOOKS

1. Barbara Chapman, Gabriele Jost, and Ruud van der Pas, Using OpenMP: Portable Shared Memory Parallel Programming, 2007. **(R1)**

Course Evaluation:

Day to day progressive evaluation, Lab Quizzes, Surprise Tests, Online Lab performance and Viva Voce

Gaps in the syllabus (to meet Industry/Profession requirements):

Implementing of real-world problems

POs met through Gaps in the Syllabus: PO5&6

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design: Teaching through research papers.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	60
Semester End Examination	40

Continuous Internal Assessment	% Distribution
Day to day performance & Lab files	30
Quiz (es)	10
Viva	20

Semester End Examination	% Distribution
Examination Experiment Performance	30
Quiz	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment –

1. Student Feedback on Faculty

2. Student Feedback on Course Outcome

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	**Program Outcomes**									
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	2	2	1	1	3					
CO2	2	1	1	1	3			3		
CO3	1	2	3	3	3					
CO4		1	1	3	2					1
CO5	1	1	2	2				2		3

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD6
CO2	CD1, CD6, CD7
CO3	CD1, CD2, CD3,
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2, CD7

COURSE INFORMATION SHEET

Course code: CS516
Course title: ADVANCED OPERATING SYSTEM LAB
Pre-requisite(s):
Co- requisite(s): None
Credits: 2 L: 0 T: 0 P: 4
Class schedule per week: 04
Class: M. Tech
Semester / Level: II/5
Branch: Computer Science &Engineering

Name of Teacher:

Course Objectives
This course enables the students to:

1.	Gain practical experience with designing and implementing concepts of operating systems such as system calls.
2.	Implement and develop CPU scheduling.
3.	Implement and understand process management, memory management.
4.	To provide a foundation in use of file systems and deadlock handling using C language in Linux environment.

Course Outcomes
After the completion of this course, students will be able to:

CO1	Understand and implement basic services and functionalities of the operating system using system calls. .
CO2	Use modern operating system calls and synchronization libraries in software/ hardware interfaces.
CO3	Understand the benefits of thread over process and implement synchronized programs using multithreading concepts.
CO4	Analyze and simulate CPU Scheduling Algorithms like FCFS, Round Robin, SJF, and Priority.

CO5	Implement memory management schemes and page replacement schemes.

SYLLABUS

List of Programs as Assignments:

1. **Lab Assignment No: 1**
   Objective: To Understand and Implement Directory Structure
   Q1. WAP to create a File directory system.
2. **Lab Assignment No: 2**
   Objective: To Understand and Implement Scheduling processes
   Q1. WAP to schedule various processes
3. **Lab Assignment No: 3**
   Objective: To Understand and Implement FCFS
   Q1. WAP to implement FCFS CPU Scheduling
4. **Lab Assignment No: 4**
   Objective: To Understand and Implement SJF
   Q1. WAP to implement SJF CPU scheduling.
5. **Lab Assignment No: 5**
   Objective: To Understand and Implement SRTF
   Q1.WAP to implement SRTF CPU scheduling.
6. **Lab Assignment No: 6**
   Objective: To Understand and Implement Scheduling algorithms
   Q1. WAP to implement Round Robin Scheduling
7. **Lab Assignment No: 7**
   Objective: To Understand and Implement Scheduling algorithms
   Q1 WAP to implement SRTF scheduling.
8. **Lab Assignment No: 8**
   Objective: To Understand and Implement context switching
   Q1. WAP to implement Round Robin Scheduling with context switching.
9. **Lab Assignment No: 9**
   Objective: To Understand and Implement context switching.
   Q1.WAP to implement SRTF with context switching.
10. **Lab Assignment No: 10**
    Objective: To Understand and Implement Page Replacement Techniques
    Q1. WAP to implement FCFS page replacement algorithm.
    Q2. WAP to implement Optimal page replacement algorithm.

Books recommended:

Textbooks:

1. Operating System Concepts (2012): Abraham Silberschatz Yale University PETER BAER GALVIN Pluribus Networks GREG GAGNE Westminster College. **(T1)**
2. Operating Systems (2003) by Deitel, Deitel, and Choffnes. (**T2**)

Course Evaluation:

Day to day progressive evaluation, Lab Quizzes, Surprise Tests, Online Lab performance and Viva Voce

Gaps in the syllabus (to meet Industry/Profession requirements):

Implementing of real-world problems

POs met through Gaps in the Syllabus: PO5&6

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design: Teaching through research papers.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	60
Semester End Examination	40

Continuous Internal Assessment	% Distribution
Day to day performance & Lab files	30
Quiz (es)	10
Viva	20

Semester End Examination	% Distribution
Examination Experiment Performance	30
Quiz	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	2	2	2
CO2	2	3	3	3	3	2
CO3	3	2	2	1	1	1

CO4	3	3	3	2	3	1
CO5	2	2	2	2	1	3

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD4
CO2	CD1, CD2, CD5
CO3	CD1, CD2
CO4	CD1, CD3, CD5
CO5	CD1, CD2

PE – 3

COURSE INFORMATION SHEET

Course code: CS605

Course title: HIGH PERFORMANCE COMPUTER ARCHITECTURE

Pre-requisite(s): Computer Architecture/Organization, Operating System, Parallel Computing

Co- requisite(s):

Credits:3 L:3 T:0 P:0

Class: M. Tech

Semester / Level: II/6

Branch: Computer Science &Engineering

Course Objectives

This course enables the students to:

1.	To Explain different terminologies in High Performance Computer Architecture.
2.	To introduce basic concepts of High Performance Computer Architecture
3.	Hands on the different parallel architectures in terms of various parameters.
4.	Evaluate performance metrics and scalability and selection criteria for parallelism and different parallel systems and able to modify it.
5.	Provide the students with practice on running complex problem in high performance computing machines.

Course Outcomes

After the completion of this course, students will be:

CO1	Describe different terminologies in High Performance Computer Architecture.
CO2	Demonstrate and Implement the concepts of High Performance Computer Architecture
C03	Compare and differentiate the different parallel architectures in terms of various parameters.
CO4	Evaluate performance metrics and scalability and selection criteria for parallelism and different parallel systems and able to modify it.
CO5	Design effective high-performance systems as per users' criteria with proper justification by self or in a group.

SYLLABUS

Module I:

Parallel Computer Models : The State of Computing, Multiprocessors and Multicomputers, Multivector and SIMD Computers, PRAM and VLSI Models, Architectural Development Tracks.

Program and Network Properties : Conditions for Parallelism, Program Partitioning and Scheduling, Program Flow Mechanism, System Interconnect Architectures.

(8L)

Module II:

Program and Network Properties : Conditions for Parallelism, Program Partitioning and Scheduling, Program Flow Mechanism, System Interconnect Architectures.

Principles of Scalable Performance: Performance Metrics and Measures, Parallel Processing Applications, Speedup Performance Laws, Scalability Analysis and Approaches.

(8L)

Module III:

Processors and Memory Hierarchy: Advanced Processor Technology, Super Scaler and Vector Processors, Memory Hierarchy Technology, Virtual Memory Technology.

Bus, Cache, and Shared Memory: Bus Systems, Cache Memory Organizations, Shared-Memory Organizations, Sequential and Weak Consistency Models, Weak Consistency Models.

(8L)

Module IV:

Pipelining and Superscalar Techniques: Linear Pipeline Processors, Non Linear Pipeline Processor, Instruction Pipeline Design, Arithmetic Pipeline Design, Superscalar Pipeline Design

Multiprocessors and Multicomputers: Multiprocessor System Interconnects, Cache Coherence Synchronization Mechanism, Three Generations of Multicomputers, Message-Passing Mechanisms.

(8L)

Module V:

Multivector and SIMD Computers: Vector Processing Principles, Multivector Multiprocessor, Compound Vector Processing, SIMD Computer Organizations, The Connection Machine CM-5

Scalable, Multithreaded and Data Flow Architecture: Latency-Hiding Techniques, Principle of Multithreading, Fine-Grain Multicomputers, Scalable and Multithreaded Architectures,Data Flow and Hybrid Architectures.

(8L)

TEXT BOOK:

1. Hwang K., Jotwani N., Advanced Computer Architecture, 2nd Edition, Tata Mc-Graw Hill, India, 2010. **(T1)**

REFERENCE BOOK:

1. Stone, H. S., High Performance Computer Architecture, 3rd Edition, Addison Wesley Publishing Company, USA. **(R1)**

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

Course Evaluation:

Individual assignment, Theory (Quiz and End semester) examinations

POs met through Topics beyond syllabus/Advanced topics/Design: Teaching through research papers.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #						
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3			1	2	1
CO2	3	3		1	1	1
C03	3	3	3			1
CO4	2	3			2	1
CO5	2	3	2			1

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD6
CO2	CD1, CD6, CD7
CO3	CD1, CD2, CD3,

CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2, CD5, CD7

COURSE INFORMATION SHEET

Course Code: IT508
Course title: CLOUD COMPUTING
Pre-requisite(s):
Co- requisite(s): None
Credits: 3 L:3 T:0 P: 0
Class schedule per week: 03
Class: M. Tech
Semester / Level: II/5
Branch: Information Technology

Course Objectives:

This course enables the students:

A.	Understand the elements of distributed computing and core aspects of cloud computing.
B.	Understand the concepts and aspects of virtualization and application of virtualization technologies in cloud computing environment.
C.	Understand the architecture and concept of different cloud models: IaaS, PaaS, SaaS and gain comprehensive knowledge of different types of clouds.
D.	Be familiar with application development and deployment using services of different cloud computing technologies provider: Google app Engine, Amazon Web Services (AWS) and Microsoft Azure.
E	Understanding the key security, compliance, and confidentiality challenges in cloud computing.
F	Understand the commonly used cloud programming platforms, tools, and simulator.

Course Outcomes:

After the completion of this course, students will be able to:

1.	Recall the various aspects of cloud computing and distributed computing
2.	Understand the specifics of virtualization and cloud computing architectures.
3.	Develop and deploy cloud application using services of different cloud computing technologies provider: Google app Engine, Amazon Web Services (AWS) and Microsoft Azure.
4.	Evaluate the security and operational aspects in cloud system design, identify and deploy appropriate design choices when solving real-world cloud computing problems.

5.	Provide recommendations on cloud computing solutions for an enterprise.

Syllabus:

Module-I
Introduction:
Cloud computing at a glance: vision of cloud computing, defining a cloud, cloud computing reference model, characteristics and benefits, challenges ahead, Historical Developments: DS, virtualization, web 2.0, SOC, UOC, Building cloud computing environments: application, infrastructure and system development, Computing Platforms and Technologies.

(8L)

Module-II
Principles of Parallel and Distributed Computing:
Parallel vs. Distributed computing, Elements of parallel computing: parallel processing, H/W architecture of parallel processing, parallel programming, levels of parallelism, Elements of distributed computing: Defination, components architectural style and models for inter-prosses communication, Technologies for distributed computing: RPC, distributed object framework.

(8L)

Module-III
Virtualization:
Introduction, Characteristics of virtualized environments, Taxonomy of virtualization techniques, Virtualization and cloud computing, Pros and cons of virtualization, Technology examples: XEN, VMware, Microsoft hyper-V. (8L)

Module-IV
Cloud computing architecture and Cloud Security:
Introduction, Cloud reference model (IAAS, PAAS and SAAS), Types of clouds, Economics of the cloud, Cloud compliance, Data confidentiality and interoperability challenges, Salability and Fault tolerance, Security, trust and privacy issues in cloud computing.

(8L)

Module-V
Cloud platforms in industry and Cloud applications:
Amazon web services: EC2, S3, communication services, Google app engine: Architecture, core concept and application, Microsoft azure: core concept, SQL azure and windows azure platform appliance, Cloud application: Scientific applications, Business, and Consumer applications.

(8L)

Text Books:

1. Rajkumar Buyya, C. Vecchiola, S. Thamarai Selvi, Mastering Cloud Computing, McGraw Hill
2. Nick Antonopoulos and Lee Gillam, Cloud Computing: Principles, Systems and Applications, Editors, springer publication

Reference Books:

1. Borko Furht Armando Escalante, Hand book of Cloud Computing, Editors, springer Publication.
2. Judith Hurwitz, Robin Bloor, Marcia Kaufman, Fern Halper, Cloud Computing for Dummies, Wiley Publication.
3. John W. Rittinghouse, JamesF. Ran some, Cloud Computing: Implementation, management and security, CRC Press, Taylor and Francis Publication.

Course Evaluation: Individual assignment, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements): POs met through Gaps in the Syllabus.

Topics beyond syllabus/Advanced topics/Design: POs met through Topics beyond syllabus/Advanced topics/Design: Teaching through research papers.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcome

Course Outcome	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	1	1	1	1
CO2	3	3	3	2	1	1
CO3	3	2	2	1	1	1
CO4	3	2	1	1	1	1
CO5	1	2	3	1	1	1

If satisfying and < 34% = L, 34-66% = M, > 66% = H

Mapping Between COs and Course Delivery (CD) methods			
CD	**Course Delivery methods**	**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1, CO2, CO3, CO4, CO5	CD1
CD2	Laboratory experiments/teaching aids		
CD3	Industrial/guest lectures		
CD4	Industrial visits/in-plant training		
CD5	Self- learning such as use of NPTEL materials and internets	CO5	CD5

COURSE INFORMATION SHEET

Course code: IT518

Course title: INTERNET OF THINGS

Pre-requisite(s):

Co-requisite(s):

Credits:3 L:3 T:0 P:0

Class schedule per week: 03

Class: M. Tech

Semester / Level: III/05

Branch: Computer Science &Engineering

Course Objectives

This course enables the students:

1.	Understand the basic concept and the IOT Paradigm

2.	Know the state of art architecture for IoT applications
3.	Learn the available protocols used for IoT
4.	Design basic IoT Applications.
5.	Evaluate optimal IoT applications.

Course Outcomes

After the completion of this course, students will be:

CO1	Identify the IoT Components and its capabilities
CO2	Explain the architectural view of IoT under real world constraints
C03	Analyse the different Network and link layer protocols
CO4	Evaluate and choose among the transport layer protocols
CO5	Design an IoT application

SYLLABUS

Module I:

IoT-An Architectural Overview

An Architectural Overview Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations. M2M and IoT Technology Fundamentals- Devices and gateways, Local and wide area networking, Data management, Business processes in IoT, Everything as a Service (XaaS), M2M and IoT Analytics, Knowledge Management.

(8L)

ModuleII:

IoT Architecture-State of the Art

State of the art, Reference Model and architecture, IoT Reference Architecture; Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views.

(8L)

ModuleIII:

Sensor Technology, RFID Technology, WPAN Technologies for IoT/M2M, Cellular and Mobile Network Technologies for IoT/M2M CoAP, REST, Zigbee, Bluetooth

(8L)

ModuleIV:

Transport & Session Layer Protocols

Mobile IPv6 technology for IoT, 6LoWPAN, Transport Layer TCP, MPTCP, UDP, DCCP,

Session Layer-HTTP, CoAP, XMPP, AMQP, MQTT

(8L)

ModuleV:

Layer Protocols & Security

Introduction, Technical Design constraints. Implementation Examples. Security and Interoperability.

(8L)

Books recommended:

TEXTBOOK

1. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, StamatisKarnouskos, David Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", 1st Edition, Academic Press, 2014. **(T1)**
2. Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6". **(T2)**

REFERENCE BOOK

1. Bernd Scholz-Reiter, Florian Michahelles, "Architecting the Internet of Things", ISBN 978-3-642-19156-5 e-ISBN 978-3-642-19157-2, Springer. **(R1)**
2. Peter Waher, "Learning Internet of Things", PACKT publishing, BIRMINGHAM – MUMBAI. **(R2)**

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

Course Evaluation:

Individual assignment, Theory (Quiz and End semester) examinations

POs met through Topics beyond syllabus/Advanced topics/Design: Teaching through research papers.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50

Semester End Examination	50

Continuous Internal Assessment	**% Distribution**
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
D4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	**Program Outcomes**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**

CO1	3	3	3	3	2	1
CO2	3	3	3	2	1	1
C03	3	2	2	3	1	1
CO4	3	3	2	1	3	1
CO5	2	1	2	2	1	1

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD6
CO2	CD1, CD6, CD7
CO3	CD1, CD2, CD3,
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2, CD5, CD7

PE LAB-3

COURSE INFORMATION SHEET

Course code: IT519

Course title: INTERNET OF THINGS LAB

Pre-requisite(s):

Co-requisite(s):

Credits: 2 L: 0 T: 0 P: 4
Class schedule per week: 04

Class: M. Tech

Semester / Level: I/05

Branch:Computer Science & Engg.

Course Objectives

This course enables the students:

1.	Understand the basic concept and the IoT Paradigm
2.	Know the state of art architecture for IoT applications
3.	Learn the available protocols used for IoT
4.	Design basic IoT Applications.
5.	Evaluate optimal IoT applications.

Course Outcomes

After the completion of this course, students will be:

CO1	Identify the IoT Components and its capabilities
CO2	Explain the architectural view of IoT under real world constraints
C03	Analyse the different Network and link layer protocols

CO4	Evaluate and choose among the transport layer protocols
CO5	Design an IoT application

SYLLABUS

List of Programs as Assignments:

1. **Lab Assignment No: 1**
   Glowing LEDs.
   Toggling LED's.
2. **Lab Assignment No: 2**
   Transmitting a string through UART
   Controlling LEDs blinking pattern through UART.
3. **Lab Assignment No: 3**
   Echo each character typed on HyperTerminal

Digital IO configuration.
Timer based LED Toggle.

4. **Lab Assignment No: 4**
   Scanning the available SSID's in the range of Wi-FI Mote.
   Connect to the SSID of choice
5. **Lab Assignment No: 5**
   Demonstration of a peer to peer network topology.
   check the connectivity to any device in the same network**.**
6. **Lab Assignment No: 6**
   Send hello world to TCP server existing in the same network
   Reading of atmospheric pressure value from pressure sensor.
7. **Lab Assignment No: 7**
   I2C protocol study
   Reading Temperature and Relative Humidity value from the sensor.
   Reading Light intensity value from light sensor.
8. **Lab Assignment No: 8**
   Proximity detection with IR LED.
   Generation of alarm through Buzzer.
9. **Lab Assignment No: 9**
   Timestamp with RTC
   IO Expander.
   Relay control.
10. **Lab Assignment No: 10**
    I2C based 12-channel ADC
    EEPROM read and write
11. **Lab Assignment No: 11**
    Transmitting the measured physical value from the UbiSense Over the Air.

Textbooks:

1. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, StamatisKarnouskos, David Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", 1 st Edition, Academic Press, 2014. **(T1)**

2. Peter Waher, "Learning Internet of Things", PACKT publishing, BIRMINGHAM – MUMBAI. **(T2)**

Reference books:

1. Bernd Scholz-Reiter, Florian Michahelles, "Architecting the Internet of Things", ISBN 978-3-642-19156-5 e-ISBN 978-3-642-19157-2, Springer. **(R1)**

Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6:" **(R2)**

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

Course Evaluation:

Individual assignment, Theory (Quiz and End semester) examinations

POs met through Topics beyond syllabus/Advanced topics/Design: Teaching through research papers.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	60
Semester End Examination	40

Continuous Internal Assessment	% Distribution
Day to day performance & Lab files	30
Quiz (es)	10
Viva	20

Semester End Examination	% Distribution
Examination Experiment Performance	30
Quiz	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
D4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6

CO1	3	3	3	3	2	1
CO2	3	3	3	2	1	1
C03	3	2	2	3	1	1
CO4	3	3	2	1	3	1
CO5	2	1	2	2	1	1

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD6
CO2	CD1, CD6, CD7
CO3	CD1, CD2, CD3,
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2, CD5, CD7

COURSE INFORMATION SHEET

Course code:IT603

Course title: PYTHON PROGRAMMING LAB

Pre-requisite(s):

Co- requisite(s): None

Credits: 2 L: 0 T: 0 P: 4
Class schedule per week: 04

Class:

Semester / Level: III/6

Branch: Computer Science and Engg.

Name of Teacher:

Course Objectives

This course enables the students to:

1.	To introduce with fundamentals and grammar of Python programming.
2.	To understand and be able to use basic programming principles such as data types, variable, conditionals, loops, recursion and function calls.
3.	To learn how to use basic data structures such as List, Dictionary and be able to manipulate text files and images.
4.	To understand the process and skills necessary to effectively attempt a programming problem and implement it with a specific programming language -- Python.
5.	To understand a python program written by someone else and be able to debug and test the same.

Course Outcomes

After the completion of this course, students will be able to:

CO1	To use their problem-solving abilities to implement programs in Python.
CO2	To apply Python in software development, testing and systems administration environments.
CO3	To develop Python applications for a variety of uses
CO4	To understand the fact that there is more than one right solution to a problem.
CO5	Work in industry environment with good enough knowledge about Python programming.

SYLLABUS

List of Programs as Assignments:

1. **Lab Assignment No: 1**

   Objective: To Implement basic Python programming.

   Q1. Create a new program called hello world.py. Use this file to write your very First "Hello, world!" program.

   Q2. Write a Python program containing exactly one print statement that produces the following output:

   A
   B
   C
   D
   E
   F

2. **Lab Assignment No: 2**

   Objective: To Understand and Implement the concept of if-else-if statements.

   Q1. Write a Python program that requests five integer values from the user. It then prints one of two things: if any of the values entered are duplicates, it prints "DUPLICATES"; otherwise, it prints "ALL UNIQUE".

   Q2. Write a Python program that allows the user to enter a four-digit binary number and displays its value in base 10. Each binary digit should be entered one per line, starting with the leftmost digit, as shown below.

   Enter leftmost digit: 1
   Enter the next digit: 0
   Enter the next digit: 0
   Enter the next digit: 1
   The value is 9

   Q3. Develop and test a program that prompts the user for their age and determines approximately how many breaths and how many heartbeats the person has had in their life. The average respiration (breath) rate of people changes during different stages of development. Use the breath rates given below for use in your program:

	Breaths per Minute
Infant	30–60
1 –4 years	20–30
5 –14 years	15–25
adult	12–20

   For heart rate, use an average of 67.5 beats per second.

3. **Lab Assignment No: 3**

Objective: To Understand and Implement the flow control statements.
Q1. Using a for loop, write a program that prints out the decimal equivalents of 1/2, 1/3, 1/4... 1/10.
Q2. Write a program using a for loop that calculates exponentials. Your program should ask the user for a base ‘b’ and an exponent ‘exp’, and calculate b^exp.
Q3. Write a program using a while loop that asks the user for a number, and prints a countdown from that number to zero. What should your program do if the user input? a negative number? As a programmer, you should always consider “edge conditions” like these when you program! (Another way to put it- always assume the users of your program will be trying to find a way to break it! If you don’t include a condition that catches negative numbers, what will your program do?)

4. **Lab Assignment No: 4**

Objective: To practice drawing patterns
Q1. Write the program to print the following pattern: ex if the user enters 7, the program will print

```
    *
   **
  ***
 ****
*****
******
*******
******
*****
****
***
**
*
```

Q2. Write a program in python to print the following pattern:

```
          1
         1 1
         121
 1331
        12641
 15101051
1615201561
```

5. **Lab Assignment No: 5**

   Objective: To Understand and Implement methods in Python.

   Q1. Write a method fact that takes a number from the user and prints its factorial.

   Q2. Write a Python function named compare3 that is passed three integers and returns true if the three integers are in order from smallest to largest, otherwise it returns false.

   Q3. Write a python function named modCount that is given a positive integer and a second positive integer, m<=n, and returns how many numbers between 1 and n are evenly divisible by m.

6. **Lab Assignment No: 6**

   Objective: To Understand and Implement the concept of Recursion

   Q1. Write a program to read an integer number. Print the reverse of this number using recursion.

   Q2. Write a program that calculates the GCD using recursive functions.

7. **Lab Assignment No: 7**

   Objective: To Understand and Implement Sorting techniques

   Q1. Write a program to sort the list of elements using Insertion sort.

   Q2. Write a program to sort the list of elements using Merge sort.

   Q3. Write a program to multiply the two matrices.

8. **Lab Assignment No: 8**

   Objective: To Understand and Implement the concept of Strings in Python

   Q1. Write a program to check whether string is a palindrome or not.

   Q2. Write a program to implement format method available with string object.

9. **Lab Assignment No: 9**

   Objective: To Understand and Implement Dictionary

   Q1. Program to demonstrate the built-in functions within the dictionary.

   Q2. Program to implement dictionary as an associative array

10. **Lab Assignment No: 10**

    Objective: To Understand and Implement File Handling.

    Q1. Program to open the file in the read mode and use of for loop to print each line present in the file.

    Q2. Write a Python program to illustrate Append vs write mode.

    Q3. Write a Program to read and write data from a file.

Books recommended:

TEXTBOOKS

1. Krishna P. R., Object Oriented Programming through JAVA, 1st Edition, Universities Press, 2008. **(T1)**

2. Patrick Naghton& H. Schildt – The Complete Reference Java 2, Tata McGraw Hill Publication, New Delhi. **(T2)**
3. Dietel,Dietel - Java How to program , 7th edition; Pearson Education , New Delhi. **(T3)**

REFERENCE BOOKS

1. C. Horstmann,G. Cornell - Core Java 2 Vol I & Vol II ; Pearson Education , New Delhi. **(R1)**
2. Balagurusamy -Programming in Java, 2nd Edition; Tata McGraw Hill Publication; New Delhi. **(R2)**

Course Evaluation:

Day to day progressive evaluation, Lab Quizzes, Surprise Tests, Online Lab performance and Viva Voce

Gaps in the syllabus (to meet Industry/Profession requirements):

Implementing of real-world problems

POs met through Gaps in the Syllabus: PO5&6

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design: Teaching through research papers.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	60
Semester End Examination	40

Continuous Internal Assessment	% Distribution
Day to day performance & Lab files	30
Quiz (es)	10
Viva	20

Semester End Examination	% Distribution
Examination Experiment Performance	30
Quiz	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	2	1	1	3	
CO2	2	1	1	1	3	
CO3	1	2	3	3	3	
CO4		1	1	3	2	
CO5	1	1	2	2		

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD6
CO2	CD1, CD6, CD7
CO3	CD1, CD2, CD3,
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2, CD7

COURSE INFORMATION SHEET

Course code:IT604

Course title: WEB APP DEVELOPMENT LAB

Pre-requisite(s):

Co- requisite(s): None

Credits: 2 L: 0 T: 0 P: 4

Class schedule per week: 04

Class:

Semester / Level: III/6

Branch: Computer Science & Engg.

Name of Teacher:

Course Objectives

This course enables the students to:

1.	To get familiar with basics of the Internet Programming.
2.	To acquire knowledge and skills for creation of web site considering both client and server-side programming
3.	To gain ability to develop responsive web applications
4.	To explore different web extensions and web services standards

Course Outcomes

After the completion of this course, students will be able to:

CO1	Analyze a web page and identify its elements and attributes.
CO2	Implement interactive web page(s) using HTML, CSS and JavaScript.
CO3	Demonstrate Rich Internet Application.
CO4	Build Dynamic web sites using server-side Programming and Database connectivity.

SYLLABUS

List of Programs as Assignments:

1. **Lab Assignment No: 1**

   Objective: To Understand and Implement HTML

   Q1. To create a simple html file to demonstrate the use of different tags.

   Q2. To create an html file to link to different html page which contains images, tables, and also link within a page.

   Q3. To create an html page with different types of frames such as floating frame, navigation frame & mixed frame.

   Q4. To create a registration form as mentioned below.

   Create an html page named as "registration.html"

   a) set background colors

   b) use table for alignment

   c) provide font colors & size

2. **Lab Assignment No: 2**

   Objective: To Understand and Implement CSS

   Q1. To create an html file by applying the different styles using inline, external & internal style sheets.

   1. Create an external style sheet named as "external_css.css" and provide some styles for h2, hr, p & a tags.

   2. Create an html file named as "Style_sheet.html"

   a) Include the external style sheet with necessary tag.

   b) Include the internal style sheet for body tags & also use class name, so that the style can be applied for all tags.

   c) Include a tag with inline style sheet.

3. **Lab Assignment No: 3**

   Objective: To Understand and Implement JavaScript

   Q1. To write a Javascript program to define a user defined function for sorting the values in an array.

   Q2. Create an html page named as "exception.html" and do the following.

   1. within the script tag write code to handle exception

   a) define a method RunTest() to get any string values(str) from the user and cll the method Areletters(str).

   b) In Areletters(str) method check whether str contain only alphabets (a-z, AZ), if not throw exception.

   c) Define an exception method Input Exception(str) to handle the exception thrown bythe above method.

2. Within the body tag define a script tag to call Runtest() method defined.

Q3. To display the calendar using javascript code by getting the year from the user.

Q4. To create a html page to display a new image & text when the mouse comes over the existing content in the page.

4. **Lab Assignment No: 4**

Objective: To Understand and Implement ASP

Q1. To create an ASP file to find the no of hits on the page and to have rotating banner content.

Q2. To create a table of content using ASP program & navigate within the pages.

Q3. Create an ASP file named as request.asp

a) Create a simple form to get the first name & last name and a button submit. When the button is clicked the values in the text box are printed by response object by Request.QueryString

b) Create a hyperlink with some values defined in the tag & display the same using request & response object.

Q4. To display all the content in the database using ASP program.

Lab Assignment No: 5

Objective: To Understand and Implement Java Servlets

Q1. To create a simple servlet program to display the date (using Tomcat server).

Q2. To create a servlet program to retrieve the values entered in the html file (Using NetBeans IDE).

Q3. To display the cookie values that are entered in the html page using servlet program. (using NetBean IDE).

Lab Assignment No: 6

Objective: To Understand and Implement XML

Q1. To create a simple catalog using XML file

Q2. To create external style sheet and using the style sheet in xml file.

Lab Assignment No: 7

Objective: To Understand and Implement PHP

Q1. To create a php program to demonstrate the different file handling methods.

Q2. To create a php program to demonstrate the different predefined function in array, Math, Data & Regular Expression.

Books recommended:

TEXTBOOKS

1. Web Technologies: A Computer Science Perspective, Jeffrey C Jackson, Pearson Education , India. **(T1)**
2. Stephen Wynkoop, Running a perfect website, QUE, 1999. **(T2)**

REFERENCE BOOKS

1. Eric Ladd, Jim O' Donnel, Using HTML 4, XML and Java, Prentice Hall of India-QUE, 1999 **(R1)**

2. Chris Bates, Web Programming - Building Intranet applications, Wiley Publications, 2004 **(R2)**

3. Deitel, Deitel & Nieto, Internet and World Wide Web - How to Program, Pearson Education Asia, 2000. **(R3)**

Course Evaluation:

Day to day progressive evaluation, Lab Quizzes, Surprise Tests, Online Lab performance and Viva Voce

Gaps in the syllabus (to meet Industry/Profession requirements):

Implementing of real-world problems

POs met through Gaps in the Syllabus: PO5&6

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design: Teaching through research papers.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	60
Semester End Examination	40

Continuous Internal Assessment	% Distribution
Day to day performance & Lab files	30
Quiz (es)	10
Viva	20

Semester End Examination	% Distribution
Examination Experiment Performance	30
Quiz	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets

CD7	Simulation

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1		3			2	
CO2	1	3	3		1	2
CO3	2		1	2	2	1
CO4	1	3	3		1	

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD2, CD3, CD6
CO3	CD1, CD2, CD3, CD6
CO4	CD3, CD6, CD7

OPEN ELECTIVES I

COURSE INFORMATION SHEET

Course code: CS514

Course title: SOFTWARE METRICS

Pre-requisite(s): Software Engineering, Software Testing

Co- requisite(s):

Credits: 3 L:3 T:0 P: 0

Class schedule per week: 03

Class: M. Tech

Semester / Level: I/5

Branch: Computer Science and Engineering

Name of Teacher:

Course Objectives

After the completion of this course, students will be:

1.	Provide a basic understanding and knowledge of the software metrics.
2.	Understand the importance of Metrics data collection.
3.	Analysis and Metrics for object-oriented systems.
4.	Understand external product attributes, Dynamic Metrics and Resource measurement.

Course Outcomes

After the completion of this course, students will be:

CO1	Able to understand the importance of the software development process.
CO2	Analyze the importance of modelling and modelling language.
C03	Design and develop correct and robust software products.
CO4	Explain the business requirements pertaining to software development.
CO5	Design Metrics for object-oriented systems.

SYLLABUS

ModuleI:

Basics of measurement: Measurement in software engineering Scope of software metrics Representational theory of measurement Measurement and models Measurement scales Meaningfulness in measurement Goal-based framework for software measurement Classifying software measures Determining what to measure Software measurement validation Empirical investigation Types of investigation Planning and conducting investigations.

(8L)

ModuleII:

Measuring size, Aspects of software size Length, functionality and complexity Measuring structure Types of structural measures Control-flow structure Modularity and information flow attributes Data structures.

(8L)

ModuleIII:

Modeling software quality Measuring aspects of software quality Software reliability Basics of software reliability Software reliability problem Parametric reliability growth models Predictive accuracy Recalibration of software-reliability growth predictions Importance of operational environment Wider aspects of software reliability.

(8L)

ModuleIV:

The intent of object-oriented metrics Distinguishing characteristics of object-oriented metrics Various object-oriented metric suites LK suite CK suite and MOOD metrics

Runtime Software Metrics Extent of Class Usage Dynamic Coupling Dynamic Cohesion and Data Structure Metrics.

(8L)

ModuleV:

The intent of component-based metrics, Distinguishing characteristics of comp.

Measuring productivity, teams, tools, and methods.

(8L)

Books recommended:

Textbook

1. "Software Metrics: A rigorous and Practical Approach" by Norman E. Fenton and Shari Lawrence Pfleeger, International Thomson Computer Press, 2nd Edition, 1997. **(T1)**
2. "Applied Software Measurement" by Capers Jones, McGraw Hill, 2008. **(T2)**

Reference Book

1. "Object-Oriented Software Metrics" by Mark Lorenz, Jeff Kidd, Prentice Hall, 1994. **(R1)**
2. "Practical Software Metrics for Project Management And Process Improvement" by Robert B Grady, Hewlett Packard Professional Books, 1st Edition, 2004. **(R2)**

Course Evaluation:

Individual assignment, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design: Teaching through research papers.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	1	1

CO2	2	2	3	1	1	1
CO3	1	3	3	2	2	2
CO4	3	3	3	2	1	1
CO5	2	1	3	3	3	1

If satisfying and < 34% = L, 34-66% = M, > 66% = H

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD6
CO2	CD1, CD6, CD7
CO3	CD1, CD2, CD3, CD6, CD7
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2,CD3,CD4,CD5,CD7

COURSE INFORMATION SHEET

Course code: CS522

Course title: PATTERN RECOGNITION AND APPLICATION

Pre-requisite(s): Linear Algebra, Vector Calculus, Data Structure& Programming

Co- requisite(s):

Credits: 3 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: M.Tech

Semester / Level:I/5

Branch: Computer Science and Engineering

Name of Teacher:

Course Objectives

This course enables the students to:

1.	Be familiar with both the theoretical and practical aspects Pattern Recognition.
2.	Have described the foundation of pattern formation, measurement, and analysis.
3.	Understand the mathematical and computer aspects of while extracting features of an object.
4.	Learn the techniques of clustering and classification for various applications.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Apply their knowledge on Real World Problems while converting these problems to computer compatible problems for Pattern Recognition.
CO2	Solve Decision-making model using Statistical and Mathematical Decision Theory.
CO3	Design clusters for various Pattern using classical and Modern clustering techniques.
CO4	Analyzing various Techniques for Pattern Classification and Clustering.
CO5	Develop Model for Pattern classification through Probabilistic or fuzzy.

SYLLABUS

Module I:

Introduction: Feature Vectors, Classifiers, Supervised, Unsupervised, MATLAB Tools. Classifiers Based on Bayesian Theory, Linear Classifiers, Nonlinear Classifiers.

(8L)

ModuleII:

Feature Selection, Feature Generation I: Data Transformation and Dimensionality Reduction, Feature Generation II.

(8L)

Module III:

Template Matching, Context Dependent Classification, Super vised Learning.

(8L)

Module IV:

Clustering Basic Concepts, sequential Algorithms.

(8L)

ModuleV:

Hierarchical algorithms, Fuzzy clustering, probabilistic clustering, Hard Clustering, Optimization.

(8L)

Books recommended:

TEXT BOOK

1. "Pattern Recognition" by S Theodoridis, K Koutroumbas, Elsevier, 5th Edition, 2015. **(T1)**
2. "Pattern Recognition" by N NarshimaMurty, Springer, University press, 2nd Edition, 2015. **(T2)**

REFERENCE BOOK

1. R.O. Duda et.al,"Pattern Classification", 2nd Edition, John Wiley, New York, 2002. **(R1)**

Course Evaluation:

Individual assignment, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design: Teaching through research papers.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	2	1
CO2	3	3	3	2	1	1
CO3	3	2	2	3	1	1
CO4	3	3	2	1	3	1
CO5	2	1	2	2	1	1

If satisfying and < 34% = L, 34-66% = M, > 66% = H

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD6
CO2	CD1, CD6, CD7
CO3	CD1, CD2, CD3, CD6, CD7
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2, CD3, CD4,CD5,CD7

COURSE INFORMATION SHEET

Course code: IT518

Course title: INTERNET OF THINGS

Pre-requisite(s):

Co-requisite(s):

Credits: 3 L:3 T:0 P:0

Class schedule per week: 03

Class: M. Tech

Semester / Level: I/5

Branch: Computer Science and Engineering

Name of Teacher:

Course Objectives

This course enables the students to:

1.	Understand the basic concept and the IoT Paradigm
2.	Know the state of art architecture for IoT applications
3.	Learn the available protocols used for IoT
4.	Design basic IoT Applications.
5.	Evaluate optimal IoT applications.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Identify the IoT Components and its capabilities
CO2	Explain the architectural view of IoT under real world constraints
CO3	Analyse the different Network and link layer protocols
CO4	Evaluate and choose among the transport layer protocols
CO5	Design an IoT application

SYLLABUS

Module I:

IoT-An Architectural Overview

An Architectural Overview Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations. M2M and IoT Technology Fundamentals- Devices and gateways, Local and wide area networking, Data management, Business processes in IoT, Everything as a Service (XaaS), M2M and IoT Analytics, Knowledge Management.

(8L)

ModuleII:

IoT Architecture-State of the Art

State of the art, Reference Model and architecture, IoT Reference Architecture; Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views.

(8L)

ModuleIII:

Sensor Technology, RFID Technology, WPAN Technologies for IoT/M2M, Cellular and Mobile Network Technologies for IoT/M2M CoAP, REST, Zigbee, Bluetooth

(8L)

ModuleIV:

Transport & Session Layer Protocols

Mobile IPv6 technology for IoT, 6LoWPAN, Transport Layer TCP, MPTCP, UDP, DCCP,

Session Layer-HTTP, CoAP, XMPP, AMQP, MQTT

(8L)

ModuleV:

Layer Protocols & Security

Introduction, Technical Design constraints. Implementation Examples. Security and Interoperability.

(8L)

Books recommended:

TEXTBOOK

3. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, StamatisKarnouskos, David Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", 1st Edition, Academic Press, 2014. **(T1)**
4. Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6". **(T2)**

REFERENCE BOOK

3. Bernd Scholz-Reiter, Florian Michahelles, "Architecting the Internet of Things", ISBN 978-3-642-19156-5 e-ISBN 978-3-642-19157-2, Springer. **(R1)**
4. Peter Waher, "Learning Internet of Things", PACKT publishing, BIRMINGHAM – MUMBAI. **(R2)**

Course Evaluation:

Individual assignment, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design: Teaching through research papers.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training

CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	2	1
CO2	3	3	3	2	1	1
CO3	3	2	2	3	1	1
CO4	3	3	2	1	3	1
CO5	2	1	2	2	1	1

If satisfying and < 34% = L, 34-66% = M, > 66% = H

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD6
CO2	CD1, CD6, CD7
CO3	CD1, CD2, CD3, CD6, CD7
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2,CD3,CD4,CD5,CD7

COURSE INFORMATION SHEET

Course code: IT570

Course title: **Basics of Python programming**

Pre-requisite(s):

Co- requisite(s):

Credits: L: 0 T:1 P:2

Class schedule per week: 1

Class: M. Tech

Semester / Level:

Branch:

Course Objectives

This course enables the students:

1.	To facilitate skills required to Install and run the Python interpreter
2.	To facilitate skills required to Create and execute Python programs
3.	To introduce the Understanding the concepts offile I/O
4.	To provide skills to read data from a text file using Python
5.	To discover the interesting patterns using appropriate Python visualization libraries

Course Outcomes

After the completion of this course, students will be able to do the following:

1.	Understand how to convert the problems into algorithms
2.	Analyse and develop the algorithms to Python programs.
3.	Design programs with Interactive Input and Output, utilizing arithmetic expression repetitions, decision making, arrays.

4.	Develop modular Python programs using functions
5.	Design programs using file Input and Output.

Syllabus

Module I

Problem Analysis-Formal Definition of a Problem, Algorithms, Flowcharts, Examples for Algorithms and Flowcharts

Introduction to Python- Variables, Operators, Expressions, Evaluation of Expressions, String Operations, Input and Output functions

Module II

Control Statements- Decision making statements, Iterative Statements, Loop Control Statements

Strings and Lists- String Operations, Tuples and Dictionaries-Operations and Examples

Module III

Functions- Function Definition and Call, Mathematical functions, User defined Functions, Parameters and Arguments, Type Conversion and Coercion

Module IV

Files – Different File Operations, File Object Attributes, Directories

Exceptions- Except clause, Exception with arguments, Raising an Exception, User Defined Exceptions

Module V

Introduction to Classes and Objects- Object Oriented Features, Attributes, Instances, Garbage Collection

SYLLABUS

List of Programs as Assignments:

12. Lab Assignment No: 1

Objective: ToImplement basic Python programming.

Q1. Create a new program called hello world.py. Use this file to write your very First "Hello, world!" program.

Q2. Write a Python program containing exactly one print statement that produces the following output:

A
B
C
D
E
F

13. Lab Assignment No: 2

Objective: To Understand and Implement the concept of if-else-if statements.

Q1.Write a Python program that requests five integer values from the user. It then prints one of two things: if any of the values entered are duplicates, it prints "DUPLICATES"; otherwise, it prints "ALL UNIQUE".

Q2. Write a Python program that allows the user to enter a four-digit binary number and displays its value in base 10. Each binary digit should be entered one per line, starting with the leftmost digit, as shown below.

Enter leftmost digit: 1
Enter the next digit: 0
Enter the next digit: 0
Enter the next digit: 1
The value is 9

Q3.Develop and test a program that prompts the user for their age and determines approximately how many breaths and how many heartbeats the person has had in their life. The average respiration (breath) rate of people changes during different stages of development. Use the breath rates given below for use in your program:

	Breaths per Minute
Infant	30–60
1 –4 years	20–30
5 –14 years	15–25
adult	12–20

For heart rate, use an average of 67.5 beats per second.

14. Lab Assignment No: 3

Objective: To Understand and Implement the flow control statements.

Q1. Using a for loop, write a program that prints out the decimal equivalents of 1/2, 1/3, 1/4... 1/10.

Q2. Write a program using a for loop that calculates exponentials. Your program should ask the user for a base ‘b’ and an exponent ‘exp’, and calculate b^exp.
Q3. Write a program using a while loop that asks the user for a number, and prints a countdown from that number to zero. What should your program do if the user input a negative number? As a programmer, you should always consider “edge conditions” like these when you program! (Another way to put it- always assume the users of your program will be trying to find a way to break it! If you don’t include a condition that catches negative numbers, what will your program do?)

15. Lab Assignment No: 4

Objective: To practice drawing patterns
Q1.Write the program to print the following pattern: ex if the user enters 7, the program would print

```
    *
   **
  ***
 ****
*****
******
*******
******
*****
****
***
**
*
```

Q2.Write a program in python to print the following pattern:

```
             1
            1 1
            121
 1331
          12641
 15101051
1615201561
```

16. Lab Assignment No: 5

Objective: To Understand and Implement methods in Python.

Q1.Write a method fact that takes a number from the user and prints its factorial.

Q2. Write a Python function named compare3 that is passed three integers and returns true if the three integers are in order from smallest to largest, otherwise it returns false.

Q3. Write a python function named modCount that is given a positive integer and a second positive integer, m<=n, and returns how many numbers between 1 and n are evenly divisible by m.

17. **Lab Assignment No: 6**

    Objective: To Understand and Implement the concept of Recursion

    Q1. Write a program to read an integer number. Print the reverse of this number using recursion.

    Q2. Write a program that calculates the GCD using recursive functions.

18. **Lab Assignment No: 7**

    Objective: To Understand and Implement Sorting techniques

    Q1. Write a program to sort the list of elements using Insertion sort.

    Q2. Write a program to sort the list of elements using Merge sort.

    Q3.Write a program to multiply the two matrices.

19. **Lab Assignment No: 8**

    Objective: To Understand and Implement the concept of Strings in Python

    Q1. Write a program to check whether string is a palindrome or not.

    Q2. Write a program to implement format method available with string object.

20. **Lab Assignment No: 9**

    Objective: To Understand and Implement Dictionary

    Q1. Program to demonstrate the built in functions within the dictionary.

    Q2. Program to implement dictionary as an associative array

21. **Lab Assignment No: 10**

    Objective: To Understand and Implement File Handling.

    Q1. Program to open the file in the read mode and use of for loop to print each line present in the file.

    Q2. Write a Python program to illustrate Append vs write mode.

    Q3. Write a Program to read and write data from a file.

Text book:

1. Downey A.,How to think like a computer scientist: Learning with Python.

Reference books:

1.JoseJeeva, Taming Python by Programming, Khanna Publishing House.

2. Jose J. Introduction to Computing and Problem Solving with Python, (ISBN: 978-93-82609-810).

Course Evaluation:

Day to day progressive evaluation, Lab Quizzes, Surprise Tests, Online Lab performance and Viva Voce

Gaps in the syllabus (to meet Industry/Profession requirements):

Implementing of real world problems

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design: Teaching through research papers.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	60
Semester End Examination	40

Continuous Internal Assessment	% Distribution
Day to day performance & Lab files	30
Quiz (es)	10
Viva	20

Semester End Examination	% Distribution
Examination Experiment Performance	30
Quiz	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	1	3
CO2	3	3	2	2	1	3

CO3	2	2	2	1	2	1
CO4	3	1	1	3	2	2
CO5	3	2	1	3	1	3

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD6
CO2	CD1, CD6,CD7
CO3	CD1, CD2, CD3,
CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD7

COURSE INFORMATION SHEET

Course code: IT522

Course title: CYBER SECURITY AND DIGITAL FORENSICS

Pre-requisite(s): Computer Basics, Programming and Problem solving

Co-requisite(s):

Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 03
Class: M. Tech.
Semester / Level: I/5
Branch: Computer Science and Engineering
Name of Teacher:

Course Objectives

This course enables the students:

1.	Know about computer-based crime.
2.	Understand Technical and legal aspects of computer crime investigations
3.	Know the limitations of law and its enforcement agencies.
4.	Learn the procedures of recovering computer evidence and seize process.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Exposure on computer-based crime.
CO2	Technical and legal aspects of computer crime investigations
C03	Know the limitations of law and its enforcement agencies.
CO4	Learn the procedures of recovering computer evidence and seize process.
CO5	Apply techniques for finding, preserving, presenting, and extracting information from the digital devices.

SYLLABUS

Module I:

Introduction: Cyberspace and Criminal Behavior, Traditional problems associated with computer-based crime, e cash problems, Computer Technology and History: Computer Language, Hardware, software, operating system, Internet, Network language.

(8L)

ModuleII:

Early Hackers and Theft Components: Phreakers, Hacking, Commodities, Intellectual property.

Contempory computer crime: web based criminal activity, money laundering,

(8L)

Module III:

Identity theft and identity fraud: Typologies of internet theft, virtual identity, credit identity. Prevalence and victimology, physical methods, of identity theft, phishing, spyware, trojans, insurance and loan fraud, immigration fraud. Terrorism and organized crime:Terror online, criminal activities, organized crime as cyber gangs., technology used in organized crime. Data piracy.

(8L)

Module IV:

Avenues for Prosecution and Government efforts: Act, Law enforcement agencies, International efforts, Cyber law and its amendments of current state, other legal considerations.

(8L)

ModuleV:

Forensic Terminologies and Developing forensic capabilities, Searching and seizing computer related evidence, Processing of evidence and report preparation.

(8L)

Books recommended:

TEXT BOOK

1. "Computer Forensics and Cyber Crime" by M.T.Britz, Pearson Education, First Impression, 2012.**(T1)**
2. "Computer Crime and investigation" by E Casey, Springer, 1st Edition, 2001. **(T2)**

REFERENCE BOOK

1. "Computer Crime Investigations and Law" by C Easttom& D.J.Taylor, Carenage Learning. **(R1)**

Course Evaluation:

Individual assignment, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design: Teaching through research papers.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training

CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	1	1	2	1
CO2	3	3	3	1	1	1
CO3	3	3	3	2	1	1
CO4	2	3	2	2	2	1
CO5	2	3	2	2	2	1

If satisfying and < 34% = L, 34-66% = M, > 66% = H

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD6
CO2	CD1, CD6, CD7
CO3	CD1, CD2, CD3, CD6, CD7
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2, CD3, CD4, CD5,CD7

OPEN ELECTIVE-II

COURSE INFORMATION SHEET

Course code: IT523

Course title: BIOMETRIC SECURITY

Pre-requisite(s):

Co- requisite(s):

Credits:3 L:3 T:0 P:0

Class schedule per week: 03

Class: M. Tech

Semester / Level: II/5

Branch: Computer Science & Engg.

Course Objectives

This course enables the students to:

1.	To understand the brief functioning of biometric system.
2.	To know the different types of biometric and their accuracy.
3.	To increase the likelihood that biometric technologies, when deployed, will be as protective of personal and informational privacy as possible.
4.	To raise awareness of privacy issues for end users and for students.
5.	To increase security of the system as well as data.

Course Outcomes

After the completion of this course, students will be able to:

1.	Demonstrate knowledge of the basic physical and biological science and engineering principles underlying biometric systems.
2.	Identify the sociological and acceptance issues associated with the design and implementation of biometric systems.

3.	Developing new advanced authentication algorithms.
4.	Analyze the accurate discrimination between individuals.
5.	Illustrate the two-factor authentication system.

SYLLABUS

Module I:

Biometrics- Introduction- benefits of biometrics over traditional authentication systems -benefits of biometrics in identification systems-selecting a biometric for a system –Applications - Key biometric terms and processes - biometric matching methods -Accuracy in biometric systems.

(8L)

Module II:

Physiological Biometric Technologies: Fingerprints - Technical description –characteristics - Competing technologies - strengths – weaknesses – deployment - Facial scan - Technical description - characteristics - weaknesses-deployment - Iris scan - Technical description – characteristics - strengths – weaknesses – deployment - Retina vascular pattern.

(8L)

Module III :

Technical description – characteristics - strengths – weaknesses – deployment - Hand scan - Technical description-characteristics - strengths – weaknesses deployment – DNA biometrics. Behavioral Biometric Technologies: Handprint Biometrics - DNA Biometrics.

(8L)

Module IV:

signature and handwriting technology - Technical description – classification – keyboard / keystroke dynamics- Voice – data acquisition - feature extraction - characteristics - strengths – weaknesses-deployment.

(8L)

Module V:

Multi biometrics and multi factor biometrics - two-factor authentication with passwords - tickets and tokens – executive decision - implementation plan.

(8L)

TEXT BOOKS :

1. Samir Nanavathi, Michel Thieme, and Raj Nanavathi: "Biometrics -Identity verification in a network", 1st Edition, Wiley Eastern, 2002. **(T1)**
2. John Chirillo and Scott Blaul : "Implementing Biometric Security", 1st Edition, Wiley Eastern Publication, 2005. **(T2)**

REFERENCE BOOKS :

1. John Berger: "Biometrics for Network Security", 1st Edition, Prentice Hall, 2004. **(R1)**

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

Course Evaluation:

Individual assignment, Theory (Quiz and End semester) examinations

POs met through Topics beyond syllabus/Advanced topics/Design: Teaching through research papers.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	3	3	3	2	1
2	3	3	3	2	1	1
3	3	2	2	3	1	1
4	3	3	2	1	3	1
5	2	1	3	2	1	1

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD6
CO2	CD1, CD6, CD7
CO3	CD1, CD2, CD3,
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2,CD5,CD7

COURSE INFORMATION SHEET

Course code: IT504

Course title: APPLIED CRYPTOGRAPHY

Pre-requisite(s):

Co- requisite(s):

Credits:3 L:3 T:0 P:0

Class schedule per week: 03

Class: M. Tech

Semester / Level: II/5

Branch: Computer Science &Engineering

Course Objectives

This course enables the students:

1.	To understand the foundations of cryptographic attacks.
2.	To gain knowledge of encrypting data, and to choose between different algorithms.
3.	Prepare students for research in the area of cryptography and enhance student's communication and problem-solving skills
4.	To differentiate between the encryption techniques and know their suitability to an application.
5.	To effectively apply their knowledge to the construction of secure cryptosystems.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Understand the various types of cryptographic protocols and the mathematics behind cryptography.
CO2	Describe the various types of ciphers and hash functions.
CO3	Apply the different cryptographic techniques to solve real life problems.
CO4	Evaluate different techniques as to their suitability to various applications.
CO5	Develop a cryptosystem keeping in view social issues and societal impacts.

SYLLABUS

Module I:

Foundations – Protocol Building Blocks - Basic Protocols - Intermediate Protocols - Advanced Protocols - Zero-Knowledge Proofs - Zero-Knowledge Proofs of Identity -Blind Signatures - Identity-Based Public-Key Cryptography.

(8L)

Module II:

Key Length - Key Management – Public Key Cryptography versus Symmetric Cryptography - Encrypting Communications Channels - Encrypting Data for Storage - Hardware Encryption versus Software Encryption - Compression, Encoding, and Encryption - Detecting Encryption – Hiding and Destroying Information.

(8L)

Module III:

Information Theory - Complexity Theory - Number Theory - Factoring - Prime Number Generation - Discrete Logarithms in a Finite Field - Data Encryption Standard (DES) – Lucifer - Madryga - NewDES - GOST – 3 Way – Crab – RC5 - Double Encryption - Triple Encryption - CDMF Key Shortening - Whitening.

(8L)

Module IV:

Pseudo-Random-Sequence Generators and Stream Ciphers – RC4 - SEAL - Feedback with Carry Shift Registers - Stream Ciphers Using FCSRs - Nonlinear-Feedback Shift Registers - System-Theoretic Approach to Stream-Cipher Design - Complexity-Theoretic Approach to Stream-Cipher Design - N- Hash - MD4 - MD5 - MD2 - Secure Hash Algorithm (SHA) - OneWay Hash Functions Using Symmetric Block Algorithms - Using Public-Key Algorithms - Message Authentication Codes

(8L)

Module V:

RSA - Pohlig-Hellman - McEliece - Elliptic Curve Cryptosystems -Digital Signature Algorithm (DSA) - Gost Digital Signature Algorithm - Discrete Logarithm Signature Schemes - Ongchnorr-Shamir -Cellular Automata - Feige-Fiat-Shamir -Guillou-Quisquater - Diffie-Hellman - Station-to-Station Protocol -Shamir's Three-Pass Protocol - IBM Secret-Key Management Protocol - MITRENET - Kerberos - IBM Common Cryptographic Architecture.

(8L)

TEXT BOOKS:

1. Bruce Schneier, "Applied Cryptography: Protocols, Algorithms, and Source Code in C" John Wiley & Sons, Inc, 2nd Edition, 1996. **(T1)**

2. 2. Wenbo Mao, “Modern Cryptography Theory and Practice”, Pearson Education, 2004. **(T2)**
3. Atul Kahate, “Cryptography and Network Security”, Tata McGrew Hill, 2003. **(T3)**

REFERENCE BOOKS:

1. William Stallings- Cryptography & Network Security Principles and Practice, Pearson Education. **(R1)**

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

Course Evaluation:

Individual assignment, Theory (Quiz and End semester) examinations

POs met through Topics beyond syllabus/Advanced topics/Design: Teaching through research papers.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		3	1	2	
CO2	3	3	3		2	

C03		3	2		1	
CO4			3	2		2
CO5		3		1		1

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD6
CO2	CD1, CD6, CD7
CO3	CD1, CD2, CD3,
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2, CD5,CD7

COURSE INFORMATION SHEET

Course code: IT524

Course title: IMAGE PROCESSING TECHNIQUES

Pre-requisite(s):

Co- requisite(s):

Credits:3 L:3 T:0 P:0

Class schedule per week: 3

Class: M. Tech

Semester / Level: II/5

Branch: Computer Science &Engineering

Course Objectives

This course enables the students:

1.	Understand the basic concept of Digital Image Processing
2.	To Learn the Fourier, Transform & its application
3.	Understand the basic components of filters
4.	Understand the basic concept of Image Compression Fundamentals
5.	Understand the basic concept of Image Segmentation.

Course Outcomes

After the completion of this course, students will be:

1.	Understand the concept of image formation, digitization, and role human visual system plays in perception of image data and spatial filtering techniques for enhancing the appearance of an image.
2.	Acquire an appreciation for various frequency-based filtering techniques for enhancing the appearance of an image, duly applying them in different applications.
3.	Discern the difference between noise models, gain an insight into assessing the degradation function and realize different spatial and frequency-based filtering techniques for reduction and removal of noise.
4.	Synthesize a solution to image compression using the concept of information theory and lossless and lossy compression techniques.
5.	Design and create practical solutions using morphological and image segmentation operators for common image processing problems and assess the results.

Syllabus

Module I:

Introduction to Digital Image Processing, Elements of Visual Perception, Image Sensing & Acquisition, Sampling and Quantization, Basic Relationships between Pixels, Intensity Transformations, Histogram Processing, Spatial Convolution & Correlation, Smoothing Spatial Filters, Sharpening Spatial Filters.

(8L)

Module II:

Introduction to the Fourier Transform, Discrete Fourier Transform, Properties of the Two-Dimensional Fourier Transform, Image Smoothing using Frequency Domain filters, Image

Sharpening using Frequency Domain filters, Selective Filtering, Basics of Fast Fourier Transform, Basics of: Walsh- Hadamard Transform; K-L Transform; Discrete Cosine Transform.

(8L)

Module III:

Model of Image Degradation/Restoration Process, Noise Probability Density Functions, Restoration in presence of Noise only, Periodic Noise Reduction using Frequency Domain filtering, Circulant Matrices, Block Circulant Matrices, Unconstrained Restoration, Constrained Restoration, Basics of Inverse Filtering

(8L)

Module IV:

Image Compression Fundamentals – Coding Redundancy, Interpixel Redundancy, Psychovisual Redundancy, Fidelity Criteria, Image Compression Models– Source Encoder and Decoder, Channel Encoder and Decoder, Elements of Information Theory, Error-Free Compression – Variable-Length Coding, Bit-Plane Coding, Lossless Predictive Coding. Lossy Compression – Lossy Predictive Coding, Transform Coding.Color Fundamentals, Color Models, Basics of Full Color Image Processing.

(8L)

Module V:

Morphological Image Processing- Preliminaries, Dilation and Erosion, Opening and Closing, Hit-or-Miss Transformation, Boundary Extraction, Hole Filling, Connected Components, Convex Hull, Thinning, Thickening, Skeletons, Pruning

Image Segmentation- Fundamentals, Point, Line and Edge Detection, Thresholding, Region Based Segmentation, Segmentation based on color.

(8L)

Text books:

1. Rafael. C. Gonzalez & Richard E. Woods- Digital Image Processing, 3/e Pearson Education, New Delhi – 2009. **(T1)**

Reference books:

1. W.K.Pratt-Digital Image Processing, 4/e, John Wiley & sons, Inc. 2006. **(R1)**
2. M. Sonka et al. Image Processing, Analysis and Machine Vision, 2/e, Thomson, Learning, India Edition, 2007. **(R2)**
3. Jayaraman, Digital Image Processing, Tata McGraw-Hill Education, 2011. **(R3)**

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

Course Evaluation:

Individual assignment, Theory (Quiz and End semester) examinations

POs met through Topics beyond syllabus/Advanced topics/Design: Teaching through research papers.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors

CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3			1	2	1
CO2	3	3		1	1	1
C03	3	3	3			1
CO4	2	3			2	1
CO5	2	3	2			1

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD6
CO2	CD1, CD6, CD7
CO3	CD1, CD2, CD3,
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2, CD5, CD7

COURSE INFORMATION SHEET

Course code: CS524

Course title: SOFT COMPUTING

Pre-requisite(s):

Co- requisite(s):

Credits:3 L:3 T:0 P:0

Class schedule per week: 3

Class: M. Tech

Semester / Level: II/5

Branch: Computer Science &Engineering

Course Objectives

After the completion of this course, students will be:

1.	To understand the concepts of soft computing
2.	To introduce the ideas of fuzzy sets, fuzzy logic and use of heuristics based on human experience.
3.	To become familiar with neural networks that can learn from available examples and generalize to form appropriate rules for inference systems.
4.	To provide the mathematical background for carrying out the optimization and familiarizing genetic algorithm for seeking global optimum in self-learning situation.
5.	To develop neural network models.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Solve numericals on Fuzzy sets and Fuzzy Reasoning.
CO2	Develop Fuzzy Inference System (FIS).
C03	Solve problems on Genetic Algorithms
CO4	Explain concepts of neural networks
CO5	Develop neural networks models for various applications.

SYLLABUS

Module I:

Introduction: Soft Computing vs. hard computing, soft computing paradigms, Basic mathematics of soft computing, learning and statistical approaches to classification and regression.

Fuzzy Logic: Introduction, Fuzzy set theory and operations, Fuzzy set versus crisp set, Crisp relation & fuzzy relations, Membership functions, fuzzification and defuzzification.

(8L)

Module II:

Fuzzy Rule Base System: Fuzzy propositions, formation, decomposition & aggregation of fuzzy rules, fuzzy reasoning, fuzzy inference systems, fuzzy decision making. **Applications**: Fuzzy logic in modeling and control, image processing

(8L)

Module III:

Neural Networks: Introduction, Biological neural network, learning paradigms. Artificial Neural Network (ANN): Evolution of Basic neuron modeling, Difference between ANN and human brain, McCulloch-Pitts neuron models, Learning paradigms, activation function, Single layer Perceptron, Perceptron learning, Windrow-Hoff/ Delta learning rule, Multilayer Perceptron, Adaline, Madaline, different activation functions, Back propagation network, momentum, limitation, FBFN, Convolution Networks, Kohonen SOM, Hopfield Networks, HebbNet.

(8L)

Module IV:

Genetic Algorithms: Introduction, working principle, Basic operators and Terminologies like individual, gene, encoding, fitness function and reproduction, Genetic modeling: Significance of Genetic operators, Inheritance operator, cross over, inversion & deletion, mutation operator, Bitwise operator, GA optimization problems such as TSP (Travelling salesman problem),

Applications:Genetic Algorithm based Back propagation Networks.

(8L)

Module V:

Particle Swarm Optimization: Background, Operations of Particle Swarm Optimization, Basic Flow of Particle Swarm Optimization, Comparison between GA and PSO, Applications of PSO.

Ant Colony Optimization: Ant Colony Optimization Algorithm, Ant System, Ant Colony System, Basic Flow of Ant colony Optimization, Applications of ACO.

(8L)

TEXT BOOKS:

1. S.N. Sivanandam,Principle of Soft Computing, Wiley India. **(T1)**

2. Simon Haykins," Neural Networks: A Comprehensive Foundation, Pearson Education,2002. **(T2)**
3. Timothy J. Ross, "Fuzzy Logic with Engineering Applications." TMH, New York, 1997. **(T3)**

REFERENCE BOOKS

1. K.S.Ray ,"Soft Computing and Its application", Vol 1, Apple Academic Press.2015. **(R1)**
2. K.H.Lee ,"First Course on Fuzzy Theory and App.", Adv in Soft Computing Spinger.2005. **(R2)**
3. H.Z.Zimmermann ,"Fuzzy Set Theory and its App " , 4thEd.Spinger Science,2001. **(R3)**

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

Course Evaluation:

Individual assignment, Theory (Quiz and End semester) examinations

POs met through Topics beyond syllabus/Advanced topics/Design: Teaching through research papers.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	3	1	1
CO2	3	2	3	3	1	1
C03	3	3	3	2	1	3
CO4	2	2	3	3	1	2
CO5	2	3	3	2	1	1

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD6
CO2	CD1, CD6
CO3	CD1, CD2,
CO4	CD1, CD7
CO5	CD1, CD2,

COURSE INFORMATION SHEET

Course code:IT571

Course title**: Introduction to R Programming**

Pre-requisite(s):

Co- requisite(s):

Credits: L: 0 T:1 P:2

Class schedule per week: 1

Class: M. Tech

Semester / Level:

Branch:

Course Objectives

This course enables the students:

1.	To develop problem solving skills
2.	To learn programming and to solve problems using computers
3.	To learn Data Manipulation, Analysis and Visualization using Computers
4.	To introduce students to the key concepts and ideas of a statistical computing environment
5.	To introduce students to fundamental concepts in (scientific) programming in general.

Course Outcomes

After the completion of this course, students will be to do the following:

1.	Design programs with Interactive Input and Output, utilizing arithmetic expression, repetitions and decision making
2.	Design programs using the fundamental data structures in R
3.	Develop programs in R interfacing files and URLs
4.	Solve Mathematical problems using R
5.	Design graphs and simulations in R

Syllabus

Module I

Introduction- R reserved words, Variables and Constants, Operators, Operator Precedence

Getting Data in and out of R –Accessing the Keyboard and Monitor, Reading in Larger Datasets

Module II

Control Statements- if ..else, for loop, while loop, repeat loop, break and next

Data Structures- Vectors, Arrays, Matrices, Lists, Data Frames, Factors, Operations on Dates and Times

Module III

Strings: Overview of String Manipulation Functions

Functions: Function Syntax, Environment and Scope, Recursive Function

Interfaces to the Outside World: File Connections, Reading Lines of a Text File Reading From a URL Connection

Module IV

Maths in R- Math Functions, Functions for Statistical Distributions, Sorting, Linear Algebra Operations, Set Operations.

Simulation -Generating Random Numbers, Simulating a Linear Model, Random Sampling

Module V

Graphics-Creating Graphs, Customising Graphs

Introduction to Object Oriented Features- Concept of Class and Object

SYLLABUS

List of Programs as Assignments:

9. Lab Assignment No: 1

Objective: To Understand and Implement Data Types

9. Data Types - R Objects and Attributes
10. Data Types - Vectors and Lists
11. Data Types - Matrices
12. Data Types - Factors
13. Data Types - Missing Values
14. Data Types - Data Frames
15. Data Types - Names Attribute
16. Data Types - Summary

10. Lab Assignment No: 2

Objective: To Understand and Implement Data Analysis

12. Reading Tabular Data
13. Reading Large Tables
14. Textual Data Formats
15. Connections: Interfaces to the Outside World
16. Subsetting - Basics
17. Subsetting - Lists
18. Subsetting - Matrices
19. Subsetting - Partial Matching
20. Subsetting - Removing Missing Values
21. Vectorized Operations

11. Lab Assignment No: 3

Objective: To Understand and Implement Swirl

4. Workspace and Files
5. Sequences of Numbers
6. Vectors

12. Lab Assignment No: 4

Objective: To Understand and Implement Cubic Splines

1. To design Spline differentiation and Integration.
2. To design interpolated Spiral Y=f(X).

13. Lab Assignment No: 5

Objective: To Understand and Implement Control Structures

5. If-else
6. Control Structures - For loops

7. Control Structures - While loops
8. Control Structures - Repeat, Next, Break

14. <u>Lab Assignment No: 6</u>

Objective: To Understand and Implement Functions

5. Functions (part 2)
6. Scoping Rules - Symbol Binding
7. Scoping Rules - R Scoping Rules
8. Scoping Rules - Optimization Example (OPTIONAL)

15. <u>Lab Assignment No: 7 &8</u>

Objective: To Understand and Implement Loop Functions and Debugging

6. Loop Functions - lapply
7. Loop Functions - apply
8. Loop Functions - mapply
9. Loop Functions - tapply
10. Loop Functions – split

16. <u>Lab Assignment No: 9 & 10</u>

Objective: To Understand and Implement Two-Dimensional Graphics

4. Generating Random Numbers
5. Simulation - Simulating a Linear Model
6. Simulation - Random Sampling

Text books:

2. Matloff Norman, The Art of R Programming– A Tour of Statistical Software Design.(T1)

3. Hadley Wickham, Garrett Grolemund, R for Data Science: Import, Tidy, Transform, Visualize, and Model Data, Orielly, 1st Edition. (T2)

Reference books:

1. Grolemund Garret,Hands-On Programming with R.(R1)

2. Gardener Mark,Beginning R: The Statistical Programming Language.(R2)

Course Evaluation:

Day to day progressive evaluation, Lab Quizzes, Surprise Tests, Online Lab performance and Viva Voce

<u>Gaps in the syllabus (to meet Industry/Profession requirements):</u>

Implementing of real world problems

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design: Teaching through research papers.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	60
Semester End Examination	40

Continuous Internal Assessment	% Distribution
Day to day performance & Lab files	30
Quiz (es)	10
Viva	20

Semester End Examination	% Distribution
Examination Experiment Performance	30
Quiz	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	1	3
CO2	3	3	2	2	1	2
CO3	2	2	2	3	1	3
CO4	3	1	2	3	1	1
CO5	3	2	1	3	2	2

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD6

CO2	CD1, CD6,CD7
CO3	CD1, CD2, CD3,
CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD7

COURSE INFORMATION SHEET

Course Code: CS512

Course title: ARTIFICIAL INTELLIGENCE

Pre-requisite(s): Design and Analysis of Algorithms, Data Structures

Co- requisite(s): None

Credits:3 L:3 T:0 P: 0

Class schedule per week: 03

Class: M. Tech

Semester / Level: II/5

Branch: Computer Science and Engineering

Course Objectives

After the completion of this course, students will be able to:

1.	An ability to apply knowledge of mathematics, science and engineering to both software and hardware design problems.
2.	An ability to design and conduct experiments and to analyze and interpret data related to software and hardware design solutions.
3.	An ability to design a system, component or process to meet desired needs within realistic constraints.
4.	An ability to function on multidisciplinary teams using current computer engineering tools and technologies.
5.	An ability to identify, formulate and solve engineering problems based on a fundamental understanding of concepts of computer engineering topics.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Recall the principles and approaches of artificial intelligence and understand different aspects of Intelligent agent.
CO2	Apply different search techniques for solving real world problems and select the most appropriate solution by comparative evaluation.
CO3	Understanding the various concepts of knowledge representations and demonstrate working. knowledge of reasoning in the presence of incomplete and/or uncertain information.
CO4	To develop a basic understanding of some of the more advanced topics of AI such as learning, natural language processing, Robotics etc.
CO5	Write various types of LISP and PROLOG programs and explore more sophisticated LISP and PROLOG code.

SYLLABUS

Module I:

Introduction: Overview of Artificial Intelligence- Problems of AI, AI Technique, Tic - Tac - Toe Problem.

Intelligent Agents: Agents & Environment, Nature of Environment, Structure of Agents, Goal Based Agents, Utility Based Agents, Learning Agents.

Problem Solving: Problems, Problem Space & Search: Defining the Problem as State Space Search, Production System, Problem Characteristics, Issues in The Design of Search Programs.

(8L)

Module II:

Search Techniques: Solving Problems by Searching, Problem Solving Agents, Searching for Solutions; Uniform Search Strategies: Breadth First Search, Depth First Search, Depth Limited Search, Bi-directional Search, Comparing Uniform Search Strategies.

Heuristic Search Strategies: Greedy Best-First Search, A* Search, Memory Bounded Heuristic Search: Local Search Algorithms & Optimization Problems: Hill Climbing Search, Simulated Annealing Search, Local Beam Search, Genetic Algorithms; Constraint Satisfaction Problems, Local Search for Constraint Satisfaction Problems.

Adversarial Search: Games, Optimal Decisions & Strategies in Games, The Minimax Search Procedure, Alpha-Beta Pruning, Additional Refinements, Iterative Deepening.

(8L)

Module III:

Knowledge & Reasoning: Knowledge Representation Issues, Representation & Mapping, Approaches to Knowledge Representation, Issues in Knowledge Representation.

Using Predicate Logic: Representing Simple Fact in Logic, Representing Instant & ISA Relationship, Computable Functions & Predicates, Resolution, Natural Deduction. **Representing Knowledge Using Rules:** Procedural Versus Declarative Knowledge, Logic Programming, Forward Versus Backward Reasoning, Matching, Control Knowledge.

(8L)

Module IV:

Probabilistic Reasoning: Representing Knowledge in an Uncertain Domain, Bayesian Networks, Dempster -Shafer Theory.

Planning: Overview, Components of A Planning System, Goal Stack Planning, Hierarchical Planning.

Learning: Forms of Learning, Inductive Learning, Explanation Based Learning, Neural Net Learning & Genetic Learning.

(8L)

Module V:

Natural Language Processing: Brief introduction to Syntactic Processing, Semantic Analysis, Discourse & Pragmatic Processing.

Robotics: Introduction, Robot hardware, robotic perception, planning to move, planning uncertain movements, robotic software architecture, application domains.

(8L)

TEXTBOOKS:

1. S. Russel and P. Norvig, "Artificial Intelligence: A Modern Approach", 3rd Edition, Pearson Education. **(T1)**
2. E. Rich & K. Knight, "Artificial Intelligence", 2/e, TMH, New Delhi, 3rd Edition, TMH. **(T2)**

REFERENCE BOOKS:

1. Dan W. Patterson, "Introduction to Artificial Intelligence and Expert Systems", PHI, New Delhi, 2006. **(R1)**
2. D.W. Rolston, "Principles of AI & Expert System Development", TMH, New Delhi. **(R2)**

Course Evaluation:

Individual assignment, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design: Teaching through research papers.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

CD #	Course Delivery methods
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids

CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcome

Course Outcome	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	2
CO2	3	3	3	3	3	3
CO3	3	3	3	2	2	3
CO4	3	3	3	2	1	1
CO5	2	2	2	3	1	1

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD6

CO2	CD1,
CO3	CD1, CD2, CD3,
CO4	CD1, CD3
CO5	CD1, CD2, CD7

COURSE INFORMATION SHEET

Course code:IT516

Course title: DATA MINING AND DATA ANALYSIS

Pre-requisite(s):

Co- requisite(s): None

Credits: 3 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: M. Tech

Semester / Level: II/5

Branch: Computer Science & Engg.

Name of Teacher:

Course Objectives

This course enables the students to:

1.	Explain about the necessity of preprocessing and its procedure.
2.	Generate and evaluate Association patterns
3.	Solve problems using various Classifiers

4.	Learn the principles of Data mining techniques and various mining algorithms.
5.	Learn about traditional and modern data driven approach and problem-solving techniques for various datasets

Course Outcomes

After the completion of this course, students will be able to:

CO1	Understand Data Warehousing and Data Mining and its applications and challenges and Create mini data warehouse.
CO2	Apply the association rules for mining applications .
CO3	Identify appropriate Classification techniques for various problems with high dimensional data.
CO4	Implement appropriate Clustering techniques for various problems with high dimensional data sets.
CO5	Implement various mining techniques on complex data objects.

SYLLABUS

Module I:

Data Analysis foundation, Numeric and Categorical attributes, Dimensionality reduction.

(8L)

Module II:

Data Warehouse: Introduction, A Multidimensional Data Model, Data Warehouse Architecture, Data Warehouse Implementation, Data Cube Technology, From Data Warehousing to Data Mining. Data Cube Computation and Data Generalization.

(8L)

Module III:

Frequent Pattern Mining, Summarizing Itemsets, Itemset Mining, Sequence Mining.

(8L)

Module IV:

Classification: Naïve Bayes, KNN, Decision Tree, Classification Performance measures, Classifier evaluation.

(8L)

Module V:
Clustering: K-Means, Agglomerative, Hierarchical, DBSCAN, Spectral and Graph Clustering. Anomaly detection, Statistical, distance and density-based approaches.

(8L)

Textbooks:

1. Mohammed J. Zaki, and Wagner Meira Jr., "Data Mining and Analysis: Fundamental Concepts and Algorithms", Cambridge University Press, 2016. **(T1)**
2. Pang-Ning Tan, Michael Steinbach, and Vipin Kumar, "Introduction to Data Mining", Pearson, 2014. **(T2)**
3. Jiawei Han, and Micheline Kamber, "Data Mining Concepts & Techniques", 3rd Edition, Publisher Elsevier India Private Limited, 2015. **(T3)**

Course Evaluation:

Individual assignment, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design: Teaching through research papers.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

CD #	Course Delivery methods
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcome

Course Outcome	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	2		3	2
CO2	3	3		2	2	
CO3	2	3	3	2	3	1
CO4		2	3		2	3
CO5	1	2	3	3	2	3

If satisfying and < 34% = L, 34-66% = M, > 66% = H

Mapping Between COs and Course Delivery (CD) methods			
CD	Course Delivery methods	Course Outcome	Course Delivery Method
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1, CO2, CO3, CO4, CO5	CD1

CD2	Laboratory experiments/teaching aids		
CD3	Industrial/guest lectures		
CD4	Industrial visits/in-plant training		
CD5	Self- learning such as use of NPTEL materials and internets		