Master of Technology (Computer Science & Engineering)

Semester I

Sl. No	Subject Code	Subject	Teaching Scheme				Scheme of Examination (Marks			Duration of Exam. (Hours)	Minimum Passing Marks
			L	T	P	Total Credits	EE	CA	Total Marks		
1.	23PCS101T	Advanced Data Structures and Algorithms	3	1		4	60	40	100	3	50
2.	23PCS102T	Object Oriented Software Engineering	3	1		4	60	40	100	3	50
3.	23PCS103T	Advanced Computer Architecture	3	1		4	60	40	100	3	50
4.	23PCS104T	Program Elective-I	3			3	60	40	100	3	50
5.	23PCS105T	Program Elective-II	3			3	60	40	100	3	50
6.	23PCS101P	Laboratory I [Advanced Data Structures and Algorithms]			2	1	25	25	50	2	25
7	23PCS102P	Laboratory II [Object Oriented Software Engineering]			2	1	25	25	50	2	25
		Total Marks					350	250	**600**		
		Load of the semester				22	**Total credits in the semester**				**20**

Program Electives: PEI:

4. **[23PCS111T] Software Requirements& Estimation**
5. **[23PCS112T] Cryptographic Foundation**
6. **[23PCS113T] AI and Expert Sytems**

Program Electives: PEII:

4. **[23PCS121T] Embedded System**
5. **[23PCS122T] Modelling and Simulation**
6. **[23PCS123T] Data Science and Visualization**

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Master of Technology (Computer Science & Engineering)
Syllabus : Semester I

23PCS101T	Advanced Data Structures and Algorithms	L	T/P	C
		3	1	4

Course Objectives:

1. To introduce and practice advanced algorithms and programming techniques necessary for developing sophisticated computer application programs
2. To get accustomed with various programming constructs such as divide-and-conquer, backtracking, and dynamic programming.
3. To learn new techniques for solving specific problems more efficiently and for analyzing space and time requirements.

Course Outcome:

At the end of this course:

1. Students are familiar with algorithmic techniques such as brute force, greedy, and divide and conquer.
2. Student can apply advanced abstract data type (ADT) and data structures in solving real world problems.
3. Effectively combine fundamental data structures and algorithmic techniques in building a complete algorithmic solution to a given problem
4. Can practice advanced algorithms and programming techniques necessary for developing sophisticated computer application programs

UNIT I

Review of order rotation & growth of functions, recurrences, probability distributions, Average case analysis of algorithms, Basic data structures such as stacks, queues, linked lists, and applications.

UNIT II

Direct access tables and hash tables, hash functions and relates analysis, Binary Search trees and Operations, AVL Trees and balancing operations, R B Trees, properties, operations.

UNIT III

B – Trees – definition – properties, operations, Graph algorithms, MST single source all pair shortest paths, maximal independent sets, coloring vertex cover, introduction to perfect graphs.

UNIT IV

Quick sort randomized version, searching in linear time, Algorithmic paradigms Greedy Strategy, Dynamic programming, Backtracking, Branch-and-Bound, Randomized algorithms.

Text Books

H. S. Wilf, Algorithms and complexity, Prentice hall.
T. H. Cormen, C. E. Leiserson, R. L. Rivest, Introduction to Algorithms, Prentice hall.
K. Vishwanathan Iyer, Lecture notes for classroom use.

References:

1. Mark Allen Weiss (Second Edition) "Data Structures and Algorithm Analysis in C", Pearson
2. Robert L. Kruse Bruce P. Leung"Data Structures and Program Design in C(Second Edition)" ,

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Syllabus : Semester I

23PCS102T	Object Oriented Software Engineering	L	T/P	C
		3	1	4

Course Objectives:

This course will develop students' knowledge in/on:

1. Fundamentals of software engineering and Unified Modeling Language
2. Requirements elicitation and analysis
3. System design concepts and activities
4. Mapping model to code and test the system

Course Outcomes:

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

1. Illustrate the importance of software engineering
2. Develop the software requirements specification document
3. Design the workflow of the object oriented software system
4. Build the system using selected reusable design patterns

UNIT I

Introduction to Software Engineering: Software engineering failures, Software engineering concepts, Software engineering development activities, Managing software development Modeling with Unified Modeling Languages: Modeling concepts, A deeper view into UML Project Organization and Communication: A rocket example, Project organization concepts, Project communication concepts, Organizational activities

UNIT II

Requirements Elicitation: Usability examples, Requirements elicitation concepts, Requirements elicitation activities, Managing requirements elicitation Analysis: An optical illusion, Analysis concepts, Analysis activities - from use cases to objects, Managing analysis

UNIT III

System Design - Decomposing the System: A floor plan example, System design concepts, System design activities - from objects to subsystems System Design - Addressing design goals: A redundancy example, UML deployment diagrams, Managing system design

UNIT IV

Object Design - Reusing Pattern Solutions: Bloopers, Reuse concepts - Solution objects, Inheritance and design patterns; Reuse activities - Selecting design patterns and components, Managing reuse Object Design - Specifying Interfaces: A railroad example, Interface specification concepts, Interface specification activities, Managing object design Mapping Models to Code: A book example, Mapping concepts, Mapping activities, Managing implementation Testing: Testing the space shuttle, Testing concepts, Testing activities, Managing testing

Text Book:

1. Bernd Bruegge, Allen H.Dutoit, Object Oriented Software Engineering Using UML, Patterns and Java, 3rd ed., United States of America: Pearson Education, 2010.

Reference Books:

1. Timothy C.Lethbridge, Robert Laganiere, Object Oriented Software Engineering Practical Software Development using UML & Java, 1st. ed.,New York: TMH, 2004.
2. Grady Booch, James Rambaugh, Ivar Jacobson, The Unified Modeling Language user guide, 1st. ed., India: Pearson education, 2005.

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Syllabus : Semester I

23PCS103T	Advanced Computer Architecture	L	T/P	C
		3	1	4

Course Objectives:

1. The objective of this course is to analyze the parallelism, identify the conditions of parallelism, and study different parallel interconnection systems.
2. It also focuses on identifying the pipeline hazards, gain in-depth knowledge of architecture and learn parallel processing and its applications to solve workloads.

Course Outcomes:

1. Analyze the parallelism.
2. Identify the conditions of parallelism. and study different parallel interconnection systems.
3. Gain in-depth knowledge of architecture.
4. Understanding pipelined and non-pipelined processing

UNIT I

Flynn's classification: SISD, SIMD, MISD, MIMD, Parallel Processing: Definition, Theory of Parallelism. Parallel Computer Models, Parallelism in Uni-processor computers, Implicit Parallelism vs. explicit parallelism, Levels of parallelism. Soft ware Parallelism, Hardware Parallelism, Amdahl's law, Overview of RISC and CISC architecture, System Performance attributes of parallel Computers.

UNIT II

Pipelining: Linear pipe line processor, Asynchronous and Synchronous models, speed up, Efficiency, Throughput, Pipelining in MIPS architecture, Non linear pipe line processor, Instruction pipeline, Arithmetic pipeline. Conditions of Parallelism: Data and Resource Dependencies, Control Dependence, Resource dependence, Bernstein's condition, Hardware and software parallelism, pipeline hazards and their Resolution Mechanisms like data forwarding, Delayed Branch, Branch Prediction, Dynamic Branch Prediction(Two state machine, four state machine), loop unrolling, dynamic scheduling, Software pipelining.

UNIT III

Loosely coupled and tightly coupled system, Parallel Interconnection Systems: Static and Dynamic Networks, Linear Array, Ring, Star, Tree, Mesh, Systolic Array, Chordal ring, Completely connected network, Cube connected cycles, Torus, K-ary-n cube, Barrel shifter, single stage interconnection network, Multistage Interconnection Networks, Control Structure, Node degree, diameter, Bisection width, symmetric, functionality, Network Latency, Bandwidth, Scalability, Data routing functions:- Permutation, Perfect shuffle exchange, Hypercube Routing function.

UNIT IV

Memory hierarchy, Cache Design Issues, Memory Interleaving, Introduction to multicores, grid and cluster, Case studies on some commercial processors like Pentium, Power PC etc.

Text Books:

1. Advanced Computer Architecture, by Kai Hwang Mc Graw Hill.
2. Computer Architecture – A quantitative approach By J.L Hennessy and D.A.Patterson, Morgan Kaufmann

Reference Book:. Introduction to Parallel Computing, 2nd Edition, Pearson Education by Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar.

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Syllabus : Semester I

23PCS111T	Software Requirements& Estimation [PEI]	L	T/P	C
		3	1	4

Course Objectives:

1. Understand the good practices for requirements engineering.
2. Understand Requirements elicitation, elicitation techniques,
3. Understand analysis models, Software quality attributes.
4. Understand software estimation , size estimation ,
5. Understand Effort, Schedule and Cost Estimation.

Course Outcomes:

At the end of the course the student will be able to:

1. Gain knowledge about software requirements and analyze requirement elicitation techniques and prototyping.
2. Gain knowledge about requirement management, their principles and practices.
3. Estimating the software in terms of size, cost, effort and schedule.
4. Expose Industrial resources

UNIT I

Introduction to software life cycle, Management activities in a software project,
Requirements engineering: Requirements Elicitation, Requirement Elicitation techniques, Requirement Analysis, Requirement Analysis Models, Requirement Documentation, Requirement Management

UNIT II

Size Estimation: Function Point Analysis from DFD's, ER diagram, Function Point Analysis from Use Case Diagram & Class Diagram, Mask II FPA, LOC estimation, Conversion between size measures

UNIT III

Effort, schedule & cost estimation: Estimation factors, COCOMO-II, Estimation by Analogy, Validating Software Estimates
Tools: Software Estimation Tools

UNIT IV

Industry Resources; IFPUG, UQAM-SEMRL, COSMIC, IEEE, Two latest Research papers to be covered

Text Books:

1. Kishore, Swapna, “Software Requirements and Estimation”, Tata McGraw Hill, 2001

Reference Books:

1. Norman E. Fenton, “Software Metrics: A Rigorous and Practical Approach”, International Thomson Computer Press, 1996.
2. B. Henderson-Sellers, “Object-Oriented Metrics, Measures of Complexity”, Prentice Hall, 1996.

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Syllabus : Semester I

23PCS112T	Cryptographic Foundation [PEI]	L	T/P	C
		3	1	4

Course Objectives:

1. Build a solid mathematical basis to understand foundations of cryptography
2. Formally understand the notions related to security authentication and privacy.
3. Understand security concepts, Ethics in Cryptography.
4. Understand security threats, and the security services and mechanisms to counter them
5. Comprehend and apply relevant cryptographic techniques
6. Comprehend security services and mechanisms in the network protocol stack
7. Comprehend and apply authentication services and mechanisms

Course Outcomes:
Student should be able to:

1. Apply knowledge of computing and mathematics for developing efficient security algorithms.
2. Identify security threats and determine efforts to counter them
3. Write code for relevant cryptographic algorithms.
4. Determine firewall requirements, and configure a firewall.
5. Evaluate cryptographic primitives and their implementations for correctness,efficiency, and security.

UNIT I

Introduction to Security: Definition, Goal and Challengaes, OSI Security Architecture, Security Attacks, Security Services, Security Mechanisms, Techniques, Model for Network Security, Mathematics of Cryptography: Integer Arithmetic, Modular rithmatic, Matrices, Linear Congruence, Algebraic Structures: Group, Ring, Field, Galois Field, Classical Encryption Techniques: Symmetric Cipher Model, Substitution Techniques, Transposition Techniques, Stream and Block Cipher, Steganography.

UNIT II

Modern Symmetric Key Ciphers: Modern Block Ciphers, Modern Stream Ciphers, Data Encryption Standard (DES): DES Structure, DES Analysis, Multiple DES, Security of DES, Advanced Encryption Standard (AES), AES Transformation functions, Analysis of AES, Use of Modern Block Ciphers: ECB, CBC, CFB, OFB, CTR, Use of Stream Ciphers: RC4, Key Management, Key Generation.

UNIT III Number Theory: Prime Numbers, Fermat's and Euler's Theorems, Testing of Primality, Shinese Remainder Theorem, Exponentiation and Logarithm, RSA Algorithm, Elgamal Cryptosystem, Elliptic Curve Cryptography, Diffe-Hellman Key Exchange.

UNIT IV

Message Integrity and Message authentication: Application of Cryptographic Hash Functions, Two Simple Hash functions, Requirements and security, Secure Hash Algorithm (SHA), Message Authentication Requirements, Message authentication functions, Message Authentication Codes (MAC), Security of MAC, Digital Signature, Digital Signature Standards.

Text Books:

1. B. A. Forouzan, Cryptography & Network Security, McGraw Hill, Special Indian Edition, 2007.
2. W. Stallings, Cryptography and Network Security, Pearson Education, 3rd Ed, 2006.

References:

1. R. E. Smith, Internet Cryptography, AWL.
2. A. J. Menezes, Handbook of Applied Cryptography, CRC Press.
3. J. Hershey, Cryptography Demystified, McGraw Hill.
4. J. Knudsen, Java Cryptography, O'Reilly.

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Syllabus : Semester I

23PCS113T	Artificial Intelligence and Expert Systems [PEI]	L	T/P	C
		3	1	4

Course objectives:

1. To impart knowledge about Artificial Intelligence.
2. To give understanding of the main abstractions and reasoning for intelligent systems.
3. To enable the students to understand the basic principles of Artificial Intelligence in various applications.

Course outcomes:
Student should be able to:

1. Solve basic AI based problems.
2. Define the concept of Artificial Intelligence.
3. Apply AI techniques to real-world problems to develop intelligent systems.
4. Select appropriately from a range of techniques when implementing intelligent systems.

UNIT 1:

Introduction: Overview of AI problems, AI problems as NP, NP-Complete and NP Hard problems. Strong and weak, neat and scruffy, symbolic and sub-symbolic, knowledge-based and data-driven AI. Search Strategies: Problem spaces (states, goals and operators), problem solving by search, Heuristics and informed search, Minmax Search, Alpha-beta pruning. Constraint satisfaction (backtracking and local search methods).

UNIT II:

Knowledge representation and reasoning: propositional and predicate logic, Resolution and theorem proving, Temporal and spatial reasoning. Probabilistic reasoning, Bayes theorem. Totally-ordered and partially-ordered Planning. Goal stack planning, Nonlinear planning, Hierarchical planning. Learning: Learning from example, Learning by advice, Explanation based learning, Learning in problem solving, Classification, Inductive learning, Naive Bayesian Classifier, decision trees.

UNIT III:

Natural Language Processing: Language models, n-grams, Vector space models, Bag of words, Text classification. Information retrieval. Agents: Definition of agents, Agent architectures (e.g., reactive, layered, cognitive), Multi-agent systems- Collaborating agents, Competitive agents, Swarm systems and biologically inspired models.

UNIT IV:

Intelligent Systems: Representing and Using Domain Knowledge, Expert System Shells, Explanation, Knowledge Acquisition. Key Application Areas: Expert system, decision support systems, Speech and vision, Natural language processing, Information Retrieval, Semantic Web

Text books and References:

1. Artificial Intelligence by Elaine Rich, Kevin Knight and Shivashankar B Nair, Tata McGraw Hill. 2. Introduction to Artificial Intelligence and Expert Systems by Dan W. Patterson, Pearson Education. 3. Artificial Intelligence: A Modern Approach by S. Russell and P. Norvig, Prentice Hall.

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Syllabus : Semester I

23PCS121T	Embedded Systems [PEII]	L	T/P	C
		3	1	4

Course Objective:
An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, health and safety, manufacturability, and sustainability.

Course Outcomes:
1. Knowledge and understanding of fundamental embedded systems design paradigms, architectures, possibilities and challenges, both with respect to software and hardware
2. A wide competence from different areas of technology, especially from computer engineering, embedded intelligent systems and mechatronics.
3. Deep state-of-the-art theoretical knowledge in the areas of real time systems, embedded processors, sensor and measuring systems, and their interdisciplinary nature needed for integrated hardware/software co-design of embedded systems.
4. Understanding and experience of state-of-the-practice industrial embedded systems and intelligent embedded system development.

UNIT I
Introduction: Embedded system, Features of Embedded Systems, Design Metrics, Embeded System Design flow, Processor in the system, Other hardware units, Software embedded into a system, Exemplary embedded systems, Embedded System-on-chip (SOC) and in VLSI circuit. Devices and Device Drivers: Serial communication using the 'I2C', 'CAN' Parallel communication between the networked I/O multiple devices using the ISA, PCI, PCI-X Device drivers, Interrupt servicing (Handling) mechanism. Processor selection for an embedded system, Memory selection for an embedded system, Inter process communication.

UNIT II
Real Time Operating System: Types of Real-time tasks, Task Periodicity, Task Scheduling, Classification of Scheduling algorithms, Clock driven scheduling, Event driven scheduling, Features of RTOS, Commercial RTOS, Windows CE, LynxOS, VxWorks, Introduction to microc/OS-II Case Studies of Programming with RTOS: Case study of an embedded system for a smart card.

UNIT III
Hardware and Software Co-design: Embedded system project management, Embedded system design and co-design issues in system development process, Design cycle in the development phase for an embedded system

UNIT IV
Low power Embedded system Design: Sources of Power Dissipation, Dynamic power dissipation, Static power dissipation, Power reduction techniques, System level power management.

Text Books:

1. Embedded Systems-Architecture, Programming and Design – Raj Kamal, TMH
2. Embedded system design – Santanu Chattopadhyay, PHI

References:

1. Hardware Software Co-design of Embedded Systems – Ralf Niemann, KluwerAcademic.
2. Design Principles of Distributed Embedded Applications – Hermann Kopetz,kluwer Academic.
3. Embedded Real-Time Systems Programming – Sriram V. Iyer and Pankaj Gupta,TMH.

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Syllabus : Semester I

23PCS122T	Modelling and Simulation [PEII]	L	T/P	C
		3	1	4

Course Objectives:

1. Fundamentals of creating mathematical models of physical systems and implementation on computers to analyse the system.
2. The different mathematical approaches to modelling that are covered in the course can be characterized into differential and difference equation based models, probability based a model which includes stochastic differential equations, cellular automata and event based approaches, and matrix based models.

Course Outcomes:

1. To create a relevant model for a multitude of problems from science and engineering, by extracting the necessary and relevant information regarding the problem.
2. Be able to define the different modelling terms by analysing the system or the data that is present.
3. They would be able to implement the model on the computer and from the results check for the validity of the model and correctness of the assumptions present in the model.

UNIT I

Introduction: System Concepts, System boundaries and environment, continuous and discrete systems, system modeling, Type of Models, Modeling Methodology, Model validation, Principles & Nature of Computer modeling and simulation, Steps in Simulation Study, Pitfalls in Simulation, When to use Simulation?, Physical and Interactive Simulation, RealTime Simulation, Simulation and Analytical Methods, Areas of Application.

UNIT II

Continuous & Discrete: Analog vs. Digital Simulation, Continuous simulation vs. Numerical Integration; Time Flow Mechanism, Concepts of simulation of continuous and discrete system with the help of live examples- Pure Pursuit Problem, Inventory Problem, Chemical Rector; Generation of random numbers, Monte Carlo Computation vs Stochastic Simulation, Generation of non-uniformly distributed random numbers, Discrete Probability Functions, Cumulative Distribution Function, Measures of Probability Function-Central Tendency & Dispersion, Generation of Poisson and Erlang variates.

UNIT III Simulators for the live systems: Simulation of a water reservoir system, Simulation of a hypothetical Computer. Simulation of queuing Systems: Basic concepts of queuing theory, Simulation of single-server, two server and general queuing systems, Simulation in Inventory Control systems : Elements of inventory theory, inventory models, simulators for complex Inventory systems.

UNIT IV

Design and Evaluation of Simulation Experiments: Length of simulation run, variance reduction techniques. Experiment layout and Validation. Simulation Languages: Continuous and discrete simulation languages, Block-Structured continuous simulation languages, Expression based languages, discrete system simulation languages: GPSS, SIMSCRIPT, SIMULA, Factors in selection of discrete system simulation languages.

Text Books:

1. Gordon G.: System Simulation" , Prentice-Hall of India Pvt. Ltd. New Delhi 1993.
2. Narsingh Deo: System Simulation with Digital Computer:, PHI New Delhi, 1993

Reference Books:

1. Neelamkavil Frances: "Computer Simulation and modelling, John Wiley & Sons,NewYork 1987,
2. Payne, James A.: " Introduction to Simulation: Programming Techniques and Methods of Analysis, McGraw-Hill International Editions, Computer Science Services, New York(1998).
3. Reitman Julian: "Computer Simulation Experiments", Wiley- Interscience, 1971.

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Syllabus : Semester I

23PCS123T	Data Science and Visualization [PEII]	L	T/P	C
		3	1	4

Course Objectives:
1. To know the fundamental concepts of data science and analytics
2. To learn various techniques for mining data streams
3. To learn event modeling for different applications.
4. To know about Hadoop and Map Reduce procedure

Course Outcomes: Upon the completion of the course the student should be able to:
1. Work with big data platform and its analysis techniques.
2. Design efficient algorithms for mining the data from large volumes.
3. Model a framework for Human Activity Recognition
4. Development with cloud databases

UNIT I
INTRODUCTION TO DATA SCIENCE – Applications - Data Science Process – Exploratory Data analysis – Collection of data – Graphical presentation of data – Classification of data – Storage and retrieval of data – Big data – Challenges of Conventional Systems - Web Data – Evolution Of Analytic Scalability - Analytic Processes and Tools - Analysis vs Reporting - Modern Data Analytic Tools - Statistical Concepts: Sampling Distributions - Re-Sampling - Statistical Inference - Prediction Error.

UNITII
DATA ANALYSIS: Correlation – Regression – Probability – Conditional Probability – Random Variables – Analysis using Mean, Median, Mode, Standard Deviation, Skewness, Kurtosis-Regression Modeling - Multivariate Analysis - Bayesian Modeling - Inference and Bayesian Networks - Support Vector and Kernel Methods - Analysis of Time Series: Linear Systems Analysis - Nonlinear Dynamics –

UNIT III
DATA MINING TECHNIQUES: Rule Induction - Neural Networks: Learning and Generalization - Competitive Learning - Principal Component Analysis and Neural Networks - Fuzzy Logic: Extracting Fuzzy Models from Data - Fuzzy Decision Trees - Stochastic Search Methods- Neuro-Fuzzy Modeling – Association rule mining – Clustering – Outlier Analysis – Sequential Pattern Mining – Temporal mining – Spatial mining – Web mining

UNIT IV
FRAMEWORKS AND VISUALIZATION: Map Reduce – Hadoop, Hive, MapR – Sharding – NoSQL Databases – Cloud databases - S3 - Hadoop Distributed File Systems – Visualizations - Visual Data Analysis Techniques - Interaction Techniques – Social Network Analysis – Collective Inferencing – Egonets - Systems and Applications.

Text/Reference Books:

1. Michael Berthold, David J. Hand, “Intelligent Data Analysis”, Springer, 2007.
2. Anand Rajaraman and Jeffrey David Ullman, “Mining of Massive Datasets”, Cambridge University Press, 2012.
3. Bill Franks, “Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics”, John Wiley & sons, 2012.
4. Jiawei Han, Micheline Kamber “Data Mining Concepts and Techniques”, Second Edition, Elsevier, Reprinted 2008.
5. Rachel Schutt, Cathy O'Neil, “Doing Data Science”, O'Reilly Publishers, 2013.
6. Foster Provost, Tom Fawcet, “Data Science for Business”, O'Reilly Publishers, 2013.
7. Bart Baesens, “Analytics in a Big Data World: The Essential Guide to Data Science and its Applications“, Wiley Publishers, 2014.
8. S. N. Sivanandam, S. N Deepa, “Introduction to Neural Networks Using Matlab 6.0”, Tata McGraw- Hill Education, 2006.

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Syllabus : Semester I

23PCS101P	Advanced Data Structures And Algorithms Lab	L	T/P	C
			2	1

Course Objectives:

1. The fundamental design, analysis, and implementation of basic data structures.
2. Basic concepts in the specification and analysis of programs.
3. Principles for good program design, especially the uses of data abstraction.
4. Sample Problems on Data structures:

Programs:

1. Write Java programs that use both recursive and non-recursive functions for implementing the following searching methods: a) Linear search b) Binary search
2. Write Java programs to implement the following using arrays and linked lists a) List ADT
3. Write Java programs to implement the following using an array. a) Stack ADT b) Queue ADT
4. Write a Java program that reads an infix expression and converts the expression to postfix form. (Use stack ADT).
5. Write a Java program to implement circular queue ADT using an array.
6. Write a Java program that uses both a stack and a queue to test whether the given string is a palindrome or not.
7. Write Java programs to implement the following using a singly linked list. a) Stack ADT b) Queue ADT
8. Write Java programs to implement the deque (double ended queue) ADT using a) Array b) Singly linked list c) Doubly linked list.
9. Write a Java program to implement priority queue ADT.
10. Write a Java program to perform the following operations: a) Construct a binary search tree of elements. b) Search for a key element in the above binary search tree. c) Delete an element from the above binary search tree.
11. Write a Java program to implement all the functions of a dictionary (ADT) using Hashing.
12. Write a Java program to implement Dijkstra's algorithm for Single source shortest path proble
13. Write Java programs that use recursive and non-recursive functions to traverse the given binary tree in a) Preorder b) Inorder c) Postorder
14. Write Java programs for the implementation of bfs and dfs for a given graph.
15. Write Java programs for implementing the following sorting methods: a) Bubble sort d) Merge sort g) Binary tree sort b) Insertion sort e) Heap sort c) Quick sort f) Radix sort
16. Write a Java program to perform the following operations: a) Insertion into a B-tree b) Searching in a B-tree
17. Write a Java program that implements Kruskal's algorithm to generate minimum cost spanning tree.

Reference Books:

1. Data Structures and Algorithms in java, 3rd edition, A.Drozdek, Cengage Learning.
2. Data Structures with Java, J.R.Hubbard, 2nd edition, Schaum's Outlines, TMH.
3. Data Structures and algorithms in Java, 2nd Edition, R.Lafore, Pearson Education.
4. Data Structures using Java, D.S.Malik and P.S. Nair, Cengage Learning.
5. Data structures, Algorithms and Applications in java, 2nd Edition, S.Sahani, Universities Press.
6. Design and Analysis of Algorithms, P. H. Dave and H.B.Dave, Pearson education.

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Syllabus : Semester I

23PCS102P	Object Oriented Software Engineering Lab	L	T/P	C
			2	1

Course Outcomes:

After completion of the course, the student will be able to:

1. Analyze software project using Microsoft project management tool
2. Design a software system using unified modeling approach
3. Apply Win-runner, QTP and selenium tools in software testing
4. Apply Test director and open source testing tools for test management

List of Experiments:

Experiment-I

1. Project scheduling using Microsoft project management tool
2. Project estimation using Microsoft project management tool

Experiment-II Construct Use case and class diagrams for the following

1. Online shopping
2. Banking system
3. Cab dispatching system

Experiment-III Construct Collaboration and Sequence diagrams for the following

1. Librarian issues books to student
2. Mobile phone

Experiment-IV Construct Activity and State chart diagrams for the following.

1. ATM transaction
2. Ticket machine
3. Credit card processing

Experiment-V

Case study: Develop class diagram of Unified library application and model it in different views i.e. logic view, component view, deployment view, database design and perform forward & reverse Engineering List of Experiments on Testing

Experiment-VI

Manual testing: Take any system (e.g. ATM system) and study its system specifications and report the various bugs

Experiment-VII

Study of Win Runner testing tool and its implementation

1. Win Runner testing process and Win runner user interface
2. How Win Runner identifies GUI (Graphical User Interface) objects in an application and describes the two modes for organizing GUI map files
3. How to record a test script and explains the basics of Test Script Language (TSL)
4. How to synchronize a test when the application responds slowly
5. How to create a test that checks GUI objects and compare the behavior of GUI objects in different versions of the sample application
6. How to create and run a test that checks bitmaps in your application and run the test on different versions of the sample application and examine any differences, pixel by pixel
7. How to create Data-driven tests which supports to run a single test on several sets of data from a data table
8. How to read and check text found in GUI objects and bitmaps

9. How to create a batch test that automatically runs the tests
10. How to update the GUI object descriptions which in turn supports test scripts as the application changes

Experiment-VIII

Apply Selenium testing tool implementation on real time applications placement portal

Experiment-IX

Study of any bug tracking tool (e.g. Bugzilla, Bug Bit)

Experiment-X

Study of any test management tool (e.g. Test Director)

Experiment-XI

Study of any open source-testing tool (e.g. Test Link)

Experiment-XII

Take a mini project (e.g. University admission, Placement portal) and execute it. During the life cycle of the mini project create the various testing documents

Reference Books:

1. Meilir Page-Jones, Fundamentals of Object Oriented Design in UML, 1st ed. Noida: Pearson Education, 2000.
2. Dr. K.V.K.K. Prasad, Software Testing Tools: Covering WinRunner, Silk Test, Load Runner, JMeter and Test Director with case studies, 1st ed., New Delhi: Dreamtech Press, 2004.
3. Pascal Roques, Modeling Software Systems Using UML2, 1st ed., New Delhi: Wiley-India, 2009.
4. Mark Priestley, Practical Object-Oriented Design with UML, 2nd ed., New Delhi: TATA McGraw Hill , 2009.

Gandharba Swain, Object Oriented Analysis & Design Through Unified Modeling Language, 1st ed., New Delhi : Lakshmi Publications Pvt. Ltd, 20

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Semester II

Sl. No	Subject Code	Subject	Teaching Scheme				Scheme of Examination (Marks)			Duration of Exam.	Minimum Passing Marks
			L	T	P	Total Credits	EE	CA	Total Marks		
1.	23PCS201T	Advanced Database Systems	3			3	60	40	100	3	50
2.	23PCS202T	Advances in Operating System	3			3	60	40	100	3	50
3.	23PCS203T	High Performance Networks	3			3	60	40	100	3	50
4.	23PCS204T	Program Elective-III	3			3	60	40	100	3	50
5.	23PCS205T	Program Elective-IV	3			3	60	40	100	3	50
6.	23PCS206T	Foundation Course I Research Methodology and IPR	2			2	60	40	100	3	50
7	23PCS201P	Laboratory III [Advanced Database Systems]			2	1	25	25	50	2	25
8	23PCS202P	Laboratory IV[Advances in Operating System]			2	1	25	25	50	2	25
Total Marks							360	290	**650**		
Load of the semester						21	**Total credits in the semester**				**19**

Program Electives: PEIII:

4. **[23PCS231T] Natural Language Processing**
5. **[23PCS232T] Web Analytics and Intelligence**
6. **[23PCS233T] Cyber Crime Investigations and Cyber Forensics**

Program Electives: PEIV:

4. **[23PCS241T] Social Network Analysis**
5. **[23PCS242T] Computational Intelligence**
6. **[23PCS243T] Real Time Systems**

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Master of Technology (Computer Science & Engineering)
Syllabus : Semester II

23PCS201T	Advanced Database Systems	L	T/P	C
		3	1	4

Course Objectives:

1. To review the concepts of database architecture, schema and data models.
2. Revisiting the theory of normalization and various normal forms.
3. Develop proficiency in query processing and optimization.
4. To provide students with knowledge of database transaction processing, concurrency control and recovery from database failure.
5. To develop competence in students for designing and implementing a database for any real life application.

Course Outcome:

1. Compare and evaluate alternative database architectures and models in different application contexts.
2. Apply normalization steps in database design for minimizing redundancy and data anomalies.
3. Understanding of transaction management, concurrency control and how they affect database integrity and consistency.
4. Employ the conceptual and relational models to design large database systems.

UNIT I:

Review of Basic Database Concepts

Data Models, Schema and Instances, Three-Level Schema Architecture & Data Independence, E-R Modelling: Specialization, Generalization, Aggregation, Functional Dependencies, Decomposition, Concept of Normalization and Normal Forms

UNIT II:

Query Processing and Optimization

Basic Steps in processing an SQL Query, Catalog Information for Cost Estimation, Measures of Query Cost, Selection and Join Operations, Query Optimization: Overview, Transformation of Relational Expressions by Equivalence Rules.

UNIT III:

Transaction Management and Concurrency Control

Transaction concept, Transaction state, Implementation of Atomicity and durability, Concurrent executions, Serializability, Concurrency Control Schemes: Lock-based, Timestamp based, Validation based protocol, Multiple granularity, Multiversion schemes, Deadlock handling, Recovery System.

UNIT IV:

Advanced TopicsData Mining,

Data Warehousing, Parallel Databases, Distributed Databases, Mobile Databases, Multimedia Databases, Spatial database, Temporal databases.

Text Book:

1. Ramez Elmasri, Shamkant B. Navathe, Fundamentals of Database Systems, 6th Edition,Pearson Education India.

References Books:

1. Silberschatz, Korth, and Sudarshan, "Database system Concepts, 4/e", Tata-Mc-Graw Hill.
2. Bipin C. Desai: Introduction to Data Base Systems, Galgotia Publications.
3. C. J Date, "Introduction to database Systems, 7/e", Pearson Education India

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Syllabus : Semester II

23PCS202T	Advances in Operating System	L	T/P	C
		3	1	4

Course Objectives:

1. At the end of the course, the student will have become exposed to classic and current operating systems literature, gained the experience of conducting research in the area of operating systems, developed state-of-the-art research projects that lead to publishable results.
2. The course will be instrumental to familiarize and build the confidence in the students to develop the knowledge of design and develop mobile operating system based knowledge and application on it.

Course Outcomes

After completion of course, students would be conversant with:

1. Concepts of some of the advanced topics in operating system design, issues.
2. Knowledge involved in memory, concurrency, and file management techniques
3. Familiar with some advanced topics and emerging type of operating system design concepts.
4. Ability to design and analyze mobile OS based applications and to customize kernel tuning.

UNIT I:

Concurrent Execution: threads, event systems,async/sync I/O,Parallelism, Ordering, and Races, Dynamic Data Race Detector for Multi-Threaded Programs, Discussions of synchronization with an emphasis on monitors, On Optimistic Methods for Concurrency Control, Concurrency Control and Recovery, Communication using lightweight remote procedure call (RPC)

UNIT II:

Memory Management: virtual memory, NUMA machines, memory allocators – Hoard Scalable Memory Allocator, Memory Resource Management in VMware, Global Memory Management in Cluster machines Scalability: Multicore processing, locking, lock-free data structures, The Scalable Commutativity Rule: Designing Scalable Software for Multicore Processorsetc.

UNIT III:

OS Architecture:The structure and design of an operating system, OS Architecture and Extensibility: SPIN and the Exo-kernel, OS architecture for scalable multicore systems: Multi-kernelMobile OS Architecture: Android, iOS

UNIT IV:

Virtualization:Machine virtualization, binary instrumentation, VMware design etc. File Systems and Disk: file system interfaces, networked file systems, AFS, The Design and Implementation of a Log-Structured File System, File system extensibility, non-disk file systems,

Text Book:

1. Advanced Concepts in Operating Systems: Distributed, Database, and Multiprocessor Operating Systems by Mukesh Singhal, Niranjan Shivaratri, 2017, McGraw Hill
2. There is no specific textbook for this course. The course is based on a collection of journal and conference papers

Reference Books:

1. Modern Operating Systems, Tanenbaum
2. Operating Systems: A Modern Perspective, Gary Nutt,
3. Advanced Operating Systems, by Silberschatz, 1999
4. Advanced Programming in the Unix Environment by W. Richard Stevens, AddisonWesley, 1993
5. Unix Network Programming: Networking APIs: Sockets and XTI (Volume 1) by W. Richard Stevens.

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Syllabus : Semester II

23PCS203T	High Performance Networks	L	T/P	C
		3	1	4

Course Objectives:

1. To study high performance networks
2. To reinforce an understanding of LAN technologies which have lead to high speed LANs
3. To understand ATM technology
4. To introduce high speed switching concepts
5. To consider Quality of Service and congestion control issues
6. To look at related protocols such as multicast protocols

Course Outcomes:
After successful completion of the course, students should be able to:

1. Solve the challenges of High Speed Networks and its related performance.
2. Communicate effectively the principles used in High Performance computing.
3. Explain the basics of high speed networking technologies and to demonstrate the knowledge of network planning and optimization
4. Describe the key components and technologies involved in building the state of art network design applications, concepts to optimize performance of high-speed networks
5. Design and configure networks to support a specified set of applications

UNIT I:
The Motivation for Internetworking: Need for Speed and Quality of Service; History of Networking and Internet; Advanced TCP/IP and ATM; Internet Architecture; Interconnection through IP Routers; TCP Services; TCP format and connection management; UDP format and UDP Services; Encapsulation in IP; IP header format; IP Services; IP addressing; Classful and Classless addressing; Subnetting and Supernetting; CIDR; IPv6 overview

UNIT II:
Congestion Control and Quality of Service: Data traffic; Network performance; Effects of Congestion; Congestion Control; Congestion control in TCP and Frame Relay; Link-Level Flow and Error Control; TCP flow control. Quality of Service: Flow Characteristics, Flow Classes; Techniques to improve QoS; Traffic Engineering; Integrated Services; Differentiated Services; QoS in Frame Relay and ATM; Protocols for QoS Support: Resource Reservation-RSVP; Multiprotocol Label Switching; RealTime Transport Protocol;

UNIT III:
High Speed Networks: Packet Switching Networks; Frame Relay Networks; Asynchronous Transfer Mode (ATM); ATM protocol Architecture; ATM logical connections; ATM cells; ATM Service categories; ATM Adaptation Layer. Optical Networks: SONET networks;

SONET architecture; High-Speed LANs: The Emergence of High-Speed LANs; Bridged and Switched Ethernet; Fast Ethernet; Gigabit Ethernet.

UNIT IV:

Internet Routing: Interior and Exterior gateway Routing Protocols; Routers and core routers; RIP; OSPF; BGP; IDRP; Multicast Routing; MOSPF; Routing in Ad Hoc Networks. Error and Control Messages: ICMP; Error reporting vs Error Correction; ICMP message format and Delivery; Types of messages; IGMP; Address Resolution (ARP); BOOTP; DHCP; Application layer protocols: Remote Logging; File Transfer and Access; Comparison of SMTP and HTTP; Comparison of IMAP and POP.

Text Books:

1. William Stallings, "High-Speed Networks and Internets, Performance and Quality of Service", Pearson Education.
2. Douglas E. Comer, "Internetworking with TCP/IP Volume – I, Principles, Protocols, and Architectures", Fourth Edition, Pearson Education.
3. George Coulouris, Jean Dollimore, Tim Kindberg, "Distributed Systems-Concepts and Design", Pearson Education.

Reference Books:

1. B. Muthukumaran, "Introduction to High Performance Networks", Vijay Nicole Imprints.
2. Wayne Tomasi, "Introduction to Data Communications and Networking", Pearson Education.
3. James F. Kurose, Keith W. Ross, "Computer Networking, A Top-Down Approach Featuring the Internet", Pearson Education.
4. Andrew S. Tanenbaum, "Computer Networks", Pearson Education.
5. Behrouz A. Forouzan, "Data Communications and Networking", Fourth Edition, McGraw Hill.
6. Mahbub Hassan, Raj Jain, "High Performance TCP/IP Networking, Concepts, Issues, and Solutions", Pearson Education. 7. Andrew S. Tanenbaum, Marten Van Steen, "Distributed Systems-Principles & Paradigms", Pearson Education

Master of Technology (Computer Science & Engineering)
Syllabus : Semester II

23PCS231T	Natural Language Processing [PE III]	L	T/P	C
		3		3

Course Objectives:

1. Teach students the leading trends and systems in natural language processing.
2. Make them understand the concepts of morphology, syntax, semantics and pragmatics of the language and that they are able to give the appropriate examples that will illustrate the above mentioned concepts.
3. Teach them to recognize the significance of pragmatics for natural language understanding.
4. Enable students to be capable to describe the application based on natural language processing and to show the points of syntactic, semantic and pragmatic processing.

Course Outcomes:

After successful completion of the course, students should be able to:

1. Get the idea about origin and fundamentals of NLP with Morphology concepts.
2. Learn the need of machine translation and understand the process of it.
3. Understand about lexical analysis, Word net theory, speech recognition and their concepts.
4. Understand the use of NLP in Sentiment analysis and information retrieval.
5. Learn the Implementation of NLP using various tools and techniques and implementation of key algorithms using NLP.

UNIT I

Introduction: Origin of Natural Language Processing (NLP), Challenges of NLP, NLP Applications, Processing Indian Languages. Words and Word Forms Morphology fundamentals; Morphological Diversity of Indian Languages; Morphology Paradigms; Finite State Machine Based Morphology; Automatic Morphology Learning; Shallow Parsing; Named Entities; Maximum Entropy Models; Random Fields, Scope Ambiguity and Attachment Ambiguity resolution.

UNIT II

Machine Translation: Need of MT, Problems of Machine Translation, MT Approaches, Direct Machine Translations, Rule Based Machine Translation, Knowledge Based MT System, Statistical Machine Translation, UNL Based Machine Translation, Translation involving Indian Languages.

UNIT III

Meaning: Lexical Knowledge Networks, WorldNet Theory; Indian Language; Word Nets and Multilingual Dictionaries; Semantic Roles; Word Sense Disambiguation; WSD and Multi linguality; Metaphors. Speech Recognition: Signal processing and analysis method, Articulation and acoustics, Phonology and phonetic transcription, Word Boundary Detection; Argmax based computations; HMM and Speech Recognition.

UNIT IV

Other Applications: Sentiment Analysis; Text Entailment; Question Answering in Multilingual Setting; NLP in Information Retrieval, Cross Lingual IR. Laboratory Work: To implement Natural language concepts and Computational linguistics concepts using popular tools and technologies. To implement key algorithms used in Natural Language Processing.

Text Books:

Siddiqui and Tiwari U.S., Natural Language Processing and Information Retrieval, Oxford University Press

Allen J., Natural Language understanding, Benjamin/Cunnings, (1987).

Reference Books:

Jensen K., Heidorn G.E., Richardson S.D., Natural Language Processing: The PLNLP Approach, Springer (2013).

Roach P., Phonetics, Oxford University Press (2012)

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Syllabus : Semester II

23PCS232T	Web Analytics and Intelligence [PE III]	L	T/P	C
		3		3

Course Objective:
To Assess that how website visitors view and interact with a site's pages and features, and business intelligence, which would allow using data on customer purchasing patterns, demographics, and demanding trends to make effective strategic decisions.

Course Outcomes:
At the end of course student shall be able to:
1. Characterize the web data as visit or content type.
2. Understand to apply the conversion metrics offline as well as online web.
3. Collect the data of different kinds: web logs, web beacons and stream data.
4. Create packets and to perform the packet sniffing, identification of unique page.
5. Apply different metrics to count hits, views, bounce and to generate different kinds of reports

UNIT I
Introduction: Definition, Process, Key terms: Site references, Keywords and Key phrases; building block terms: Visit characterization terms, Content characterization terms, Conversion metrics; Categories: Offsite web, On site web; Web analytics platform, Web analytics evolution, Need for web analytics, Advantages, Limitations. Data Collection: Click stream Data: Web logs, Web Beacons, JavaScript tags, Packet Sniffing; Outcomes Data: E-commerce, Lead generation, Brand/Advocacy and Support; Research data: Mindset, Organizational structure, Timing; Competitive Data: Panel-Based measurement, ISPbased measurement, Search Engine data.

UNIT II
Qualitative Analysis: Heuristic evaluations: Conducting a heuristic evaluation, Benefits of heuristic evaluations; Site Visits: Conducting a site visit, Benefits of site visits; Surveys: Website surveys, Post-visit surveys, creating and running a survey, Benefits of surveys. Web Analytic fundamentals: Capturing data: Web logs or JavaScript's tags, Separate data serving and data capture, Type and size of data, Innovation, Integration, Selecting optimal web analytic tool, Understanding click stream data quality, Identifying unique page definition, Using cookies, Link coding issues.

UNIT III
Web Metrics: Common metrics: Hits, Page views, Visits, Unique visitors, Unique page views, Bounce, Bounce rate, Page/visit, Average time on site, New visits; Optimization (e-commerce, non e-commerce sites): Improving bounce rates, Optimizing adwords campaigns; Real time report, Audience report, Traffic source report, Custom campaigns, Content report, Google analytics, Introduction to KPI, characteristics, Need for KPI, Perspective of KPI, Uses of KPI. Relevant Technologies: Internet & TCP/IP, Client / Server Computing, HTTP (Hypertext Transfer Protocol), Server Log Files & Cookies, Web Bugs.

UNIT IV

Web Analytics 2.0:Web analytics 1.0, Limitations of web analytics 1.0, Introduction to analytic 2.0, Competitive intelligence analysis : CI data sources, Toolbar data, Panel data ,ISP data, Search engine data, Hybrid data, Website traffic analysis: Comparing long term traffic trends, Analyzing competitive site overlap and opportunities. Google Analytics: Brief introduction and working, Adwords, Benchmarking, Categories of traffic: Organic traffic, Paid traffic; Google website optimizer, Implementation technology, Limitations, Performance concerns, Privacy issues.

Text Books:

1. Clifton B., Advanced Web Metrics with Google Analytics, Wiley Publishing, Inc.2nd ed.
2. Kaushik A., Web Analytics 2.0, The Art of Online Accountability and Science of Customer Centricity, Wiley Publishing, Inc. 1st ed.

Reference Book:

Sterne J., Web Metrics: Proven methods for measuring web site success, John Wiley and Sons

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Syllabus : Semester II

23PCS233T	Cyber Crime Investigations and Cyber Forensics [PE III]	L	T/P	C
		3		3

Course Objectives:

1. To understand the basics of Cyber Crimes and Cyber Forensics
2. To understand how to examine digital evidences such as the data acquisition, identification analysis.
3. To explore techniques for conducting the forensic examination on different digital devices.

Course Outcomes:

At the end of course student shall be able to:

1. Understand the fundamentals of Cyber Crime and analyze the nature and effect of cybercrimes in society.
2. Understand Cyber Crime Investigation Process.
3. Apply the Investigation processes to various operating systems and its applications
4. Demonstrate and explore various Cyber forensic Tools and apply it to digtal devices.

UNIT I

Introduction :Introduction to Cyber World, Types of cyber-attacks, Cyber Crime and Digital Fraud, Cyber-attacks and cyber security , Information warfare and cyber terrorism, Overview of Types of computer forensics i.e. Media Forensics, Network forensics (internet forensics), Machine forensic, Email forensic (e-mail tracing and investigations)

UNIT II

Under Standing Computer Investigations : Preparing a Computer Investigations, Taking a systematic approach, Understanding Data recovery workstations and software, Conducting an Investigation, Completing the case., Processing Crime and Incident Response: Identifying Digital evidences, Collecting evidence, Preparing for a search, Seizing and Storing Digital evidences, Digital Hashing.

UNIT III

Windows and DOS systems based Investigations: File Systems, Examining File systems, Disk Encryption, Windows registry, startup tasks, Linux Boot processes and File systems, Digital signature and time stamping, cryptography, cell phone and mobile device forensics, Email investigations, Network Forensics, SQL Injections, Steganography.

UNIT IV

Computer Forensics Tools and Software: Helix, DTsearch, S-tools, Camouflage, Recovery of Deleted files in windows and Unix , Hardware forensic tools like Port scanning and vulnerability assessment tools like Nmap , Netscanetc . Password recovery e.g. Passware, Mobile forensic tools , DOS file systems and Forensic tools, Password encryption analyzer

Text Books:

1. Computer Forensics and Investigations, 2nd edition, Nelson, Phillips, Enfinger,Steuart, Cenage Learning 2008
2. Incident Response & Computer Forensics.Mandia, k., Prosise, c., Pepe, m. 2 nd edition. Tata-McGraw Hill, 2003.

Reference Books:

1. Digital Evidence and Computer Crime, 2nd Edition , Eoghan Casey , academic Press File System Forensic Analysis by Brian Carrier , addition Wesley
2. Windows Forensic Analysis DVD Toolkit (Book with DVD-ROM), Harlan Carvey, syngress Publication
3. EnCE: The Official EnCase Certified Examiner Study Guide, 2nd Edition , Steve Bunting , sybex Publication

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Syllabus : Semester II

23PCS241T	Social Network Analysis [PE IV]	L	T/P	C
		3	1	4

Course Objective:
The objective of this course is to provide students with an understanding of basic concepts in Social Network Analysis and explain its importance. The basic object of social network analysis is to study and analyse the different network structure when the actors are interacting each other in a real world.

Course Outcomes:
At the end of course student shall be able to:
1. Understand the concepts Social Network and its analysis.
2. Understand the community structure and cohesiveness of different sub groups.
3. Understand the cascading properties of different networks.
4. Do analysis of decentralize online social networks and understand different link analysis for web mining.

UNIT I
Limitations of current Web - Development of Semantic Web-Emergence of the Social Web-Social Network analysis: Development of Social Network Analysis -Key concepts and measures in Network analysis - Electronic sources for network analysis: Electronic discussion networks, Blogs and online communities - Web-based networks - Applications of Social Network Analysis. Types of networks, Tools for visualizing network data, review of graph theory basics.

UNIT II
Structural properties of networks: Notions of centrality, cohesiveness of subgroups: clique, n-cliques, n-clans, n-clubs, k-flexes and k-cores. Roles and positions, structural equivalence, regular equivalence, automorphic equivalence, equitable partitions, stochastic block models and community structure in networks.

UNIT III
Cascading properties of networks: Information/influence diffusion on networks, maximizing influence spread, power law and heavy tail distributions, preferential attachment models, small world phenomenon

UNIT IV
Mining Graphs: Community and cluster detection: Extracting evolution of Web Community from a Series of Web archive- Detecting communities in social networks- Definition of community- Evaluating communities- Methods for community detection and mining,
Applications of community mining algorithms -Tools for detecting communities social network infrastructures and communities Decentralized online social networks- Multi Relational characterization of dynamic social network communities, random walks, spectral methods, link analysis for web mining: page rank, weighted page rank and hyper-link induced topic search(HITS) algorithms.

Text Books:

1. Stanley Wasserman, Katherine Faust. Social network analysis: methods and applications. Cambridge University Press, 1994.
2. Peter Mika, “Social Networks and the Semantic Web”, First Edition, Springer 2007.

Reference Books:

1. Peter R. Monge, Noshir S. Contractor, Theories of communication networks. Oxford University Press, 2003.
2. Duncan Watts. Six degrees: the science of a connected age. Norton, 2004.

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Syllabus : Semester II

23PCS242T	Computational Intelligence [PE IV]	L	T/P	C
		3	1	4

Course Objectives:

1. To understand, analyze and apply the concepts of neural network, neuro-modelling, several neural network paradigms.
2. To understand, analyze and apply the concepts of fuzzy logic, knowledge representation using fuzzy logic, approximation reasoning, fuzzy inference system, fuzzy logic control and other machine intelligent application of fuzzy logic.
3. To understand, analyze and apply the concept of evolutionary computing paradigm known as genetic algorithm to engineering optimization problems.
4. To understand, analyze and apply the concept of hybrid algorithms in different engineering application.

Course Outcomes:

At the end of course student shall be able to:

1. Know about the basic concept of computational intelligence and also their use in some real life situation.
2. Solve the problems using neural network techniques.
3. Find the solution using different fuzzy logic techniques.
4. Use genetic algorithms for different modeling.

UNIT I

Artificial Neuron and its model, activation functions, Neural network architecture: single layer and multilayer feed forward networks, recurrent networks, perception model, feed forward neural network, Back propagation, Adaline, Widrow-Hoff's Adaline model, Madaline, Unsupervised learning neural network: Hopfield neural network, Competitive learning, self-organizing feature map, Reinforcement learning: Q-learning, Temporal difference learning.

UNIT II

Basic concepts of fuzzy logic, Fuzzy sets and Crisp sets, membership functions, Fuzzy set theory
and operations, Extension principle of fuzzy set, fuzzy inference, Fuzzy implications, fuzzy relation, fuzzy reasoning , fuzzy c-means clustering , fuzzy inference Engine on VLSI architecture, Defuzzification techniques

UNIT III

Fundamentals of genetic algorithms: Encoding, Fitness functions, Reproduction Genetic Modeling : Cross cover, Inversion and deletion, Mutation operator, Bit-wise operators, Bitwise operators used in GA. Convergence of Genetic algorithm. GA as an alternative to back propagation, Applications of GA in navigational planning of robots , Particle swarm optimisation,ant-colony optimisation,Bee colony optimisation.

UNIT IV

Hybrid Systems: Neuro-fuzzy synergism, weakly coupled Neuro-fuzzy system, Tightly coupled Neuro-Fuzzy System, fuzzy-GA synergism, Neuro-GA, Adaptation of neural learning algorithm using GA

Text Books:

1. Computational Intelligence Principles, Techniques and Applications, Amit Konar, Springer publication.
2. Neural Networks, Fuzzy Logic, and Genetic Algorithm (synthesis and Application) S.Rajasekaran, G.A. Vijayalakshmi Pai, PHI
3. Principles of Soft Computing S.N.Sivanandam & S.N.Deepa,Wiley-India Edition

Reference Books:

1. Neuro Fuzzy and Soft Computing, J. S. R. JANG,C.T. Sun, E. Mitzutani, PHI
2. 2. Soft-computing, D.K.Pratihar,Alpha Science

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Syllabus : Semester II

23PCS243T	Real Time Systems [PE IV]	L	T/P	C
		3	1	4

Course Objectives:
1. To study issues related to the design and analysis of systems with real-time constraints.
2. To learn the features of Real time OS.
3. To learn about computer control and hardware requirements for Real time systems.
4. To study the methods of developing Real time applications.
5. To study the difference between different Real time system development methodologies.

Course Outcomes:
At the end of course student shall be able to:
1. Understand classifications of Real time systems.
2. Comprehend Real-time programming environments
3. Schedule jobs in Real time systems
4. Develop real time systems.

UNIT I
Introduction to real–time computing
Elements of Control System – Structure of a real–time system – Classification of Real-time Systems, Time Constraints, Classification of Programs, Concepts of Computer Control: Introduction, Sequence Control, Loop Control, Supervisory Control, Centralized Computer Control, Hierarchical Systems. Hardware Requirements for Real-Time Applications Introduction – General Purpose Computer – Single Chip Microcomputers and Microcontrollers – Specialized Processors – Process-Related Interfaces – Data Transfer Techniques – Communications – Standard Interface.

UNIT II
Languages for Real-Time Applications Introduction – Syntax Layout and Readability – Declaration and Initialization of Variables and Constants – Modularity and Variables – Compilation of Modular Programs – Data types – Control Structures – Exception Handling – Low-level facilities – Co–routines – Interrupts and Device Handling – Concurrency –Real-Time
Support – Overview of Real-Time Languages.

UNIT III
Real Time Operating Systems
Introduction – Real-Time Multi-Tasking OS – Scheduling Strategies – Priority Structures – Task Management – Scheduler and Real-Time Clock Interrupt Handler – Memory Management – Code Sharing – Resource Control Task Co-Operation and Communication – Mutual Exclusion.

UNIT IV
RTS Development Methodologies Introduction – Yourdon Methodology – Ward and Mellor Method – Hately and Pirbhai Method.

Text Books:

Stuart Bennet, “Real–Time Computer Control”, 2nd Edn., Pearson Education, 2008.

Reference Books:

Rajib Mall, "Real–Time Systems: Theory and Practice", 1st edition, Pearson Education, 2012

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Syllabus : Semester II

23PCS206T	Foundation Course I: Research Methodology	L	T/P	C
		3		3

Course Objectives:

1. Identify and discuss the role and importance of research in the social sciences.
2. identify and discuss the issues and concepts salient to the research process.
3. identify and discuss the complex issues inherent in selecting a research problem, selecting an appropriate research design, and implementing a research project.
4. identify and discuss the concepts and procedures of sampling, data collection, analysis and reporting.

Course Outcomes:

At the end of course student shall be able to:

1. Explain key research concepts and issues
2. Read, comprehend, and explain research articles in their academic discipline.
3. Demonstrate the ability to choose methods appropriate to research aims and objectives
4. Understand the limitations of particular research methods

UNIT I

Introduction to Research Methodology

Meaning of research, objectives of research, meaning of research, motivation in research, types of research, scope of educational research, characteristics and prerequisites of educational research, types of educational research, research approaches, significance of research, research methods versus methodology, research and scientific method, importance of knowing how research is done, research process, criteria of good research, necessity of defining the problem.

UNIT II

Techniques for Research Methodology

Defining research problems, hypothesis formulation, developing a research plan, research design, features of a good design, different research designs, and important concepts related to research design, methods for data collection.

UNIT III

Data Analysis and Statistical Techniques

Data and their analyses, quantitative methods and techniques, Measure of central tendency, measures of variation, frequency distribution, analysis of variance methods, identifying the distribution with data, parameter estimation, Goodness-of-Fit tests-Chi-Square test, K-S Goodness-of-Fit test, Correlation analysis, Regression analysis, time series and forecasting, Introduction to discriminate analysis, factor analysis, cluster analysis, conjoint analysis. Sampling methods, test of hypothesis

UNIT IV

Algorithmic Research and Simulation

Algorithmic research problems, types of algorithmic research, types of solution procedure, steps of development of algorithm, steps of algorithmic research, design of experiments, steps of modeling, operations research models, application of models. Need for simulation,

types of simulation, simulation language, fitting the problem to simulation study, simulation models, output analysis.

Text Books and Reference Books:

1. Research Methodologies, R. Panneerselvam, Prentice Hall, 2007.
2. Research in Education, Best John V. and James V Kahn, Wiley eastern, 2005.
3. Elements of Educational Research, Sukhia, S.P., P.V. Mehrotra, and R.N. Mehrotra, PHI publication, 2003.
4. Methodology of Research Education, K. Setia, EEE publication, 2004.
5. Research methodology, Methods and Techniques, Kothari, C.R., 2000.

Master of Technology (Computer Science & Engineering)
Syllabus : Semester II

23PCS201P	Advanced Database Systems Lab	L	T/P	C
			2	1

Course Objective:
This lab work will enhance database handling, data manipulation and data processing skills through SQL & PL/SQL, which will help them in developing data centric computer applications.

Course Outcomes:
At the end of course student shall be able to:
1. Understand the fundamentals of relational database systems including: data models, database architectures and ER features.
2. Evaluate and adopt the different normalization techniques.
3. Assess the basic issues of transaction processing and concurrency control.
4. Understand the roles that databases play in organizations and familiarize with basic database storage, file organization, database accessing techniques.

Experiments on the following topics are expected to be covered:

5. Familiarization of the MySQL database – creation and manipulation of tables.
6. Analyze a given situation, develop an ER model and convert the ER model to Relational model.
7. Implement the database using MySQL and manipulate the tables using SQL commands.
8. Lab Course Project : Course project topic selection, developing an ER model and converting ER model to a Scheme diagram
9. Developing a data flow diagram for the problem specification.
10. Implementation of front end pages.
11. Implementation of server side pages and verifying the normalization
12. Testing the constraints and project
13. Submission and evaluation of project

Text Books/Reference Books :

1. Elmasr, Navathe, 'Fundamentals of Database Systems', 4 th ed., Pearson Education
2. Reghu Ramakrishnan, Databse Management Systems, McGrawHill

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Syllabus : Semester II

23PCS202P	Advances in Operating Systems Lab	L	T/P	C
			2	1

Course Objectives:

1. To study the characteristics of OS for Multiprocessor and Multicomputer.
2. To learn the issues related to designing OS.
3. To learn the latest trends in building Mobile OS.

Course Outcomes:
At the end of course student shall be able to:

1. Knowledge about advanced concepts in OS
2. Ability to develop OS for distributed systems
3. Ability to develop modules for mobile devices

Followings are some of the areas where experiments need to be conducted under the Advances in Operating Systems lab:

1. Synchronization, communication and scheduling in parallel systems
2. Distributed systems and their communication mechanisms
3. Failures and recovery management
4. System support for Internet-scale computing
5. Research position in Multi-OS environment(Linux OS, Mac OS, Symbian and other mobile applications)
6. The research group might be funded by Intel, Nutanix, semiconductor research consortium
7. Research positions may include Operating System Developer (Kernel / Algorithm / Memory)

Text Book:

M Singhal and NG Shivaratri , Advanced Concepts in Operating Systems, Tata McGraw Hill Inc, 2001

Reference Books:

1. A S Tanenbaum, Distributed Operating Systems, Pearson Education Asia, 2001
2. Source Wikipedia, Mobile Operating Systems, General Books LLC, 2010

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Semester III

Sl. No	Subject Code	Subject	Teaching Scheme				Scheme of Examination (Marks)			Duration of Exam. (Hours)	Minimum Passing Marks
			L	T	P	Total Credits	EE	CA	Total Marks		
1.	23PCS301T	Elective V [Open]	3			3	60	40	100	3	50
2.	23PCS302T	Foundation Course II Project planning and Management	2			2	60	40	100	3	50
3.	23PCS303P	Project and Seminar			16	8		200	200	-	100
Total Marks							120	280	400		
Load of the semester						**21**	**Total credits in the semester**				**13**

Open Elective V [OPEN]:

1. **[23PCS351T] Fundamentals of Cyber Security**
2. **[23PCS352T] Multimedia**
3. **[23PCS353T] ERP**

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Syllabus : Semester III

23PCS351T	Fundamentals of Cyber Security [OE]	L	T/P	C
		3		3

Course Objectives:

1. Understand various block cipher and stream cipher models
2. Describe the principles of public key cryptosystems, hash functions and digital signature
3. To get a firm knowledge on Cyber Security Essentials

Course Outcomes:

At the end of course student shall be able to:

1. Implement basic security algorithms required by any computing system
2. Analyze the vulnerabilities in any computing system and hence be able to design a security solution
3. Analyze the possible security attacks in complex real time systems and their effective countermeasures
4. Enumerate various governing bodies of cyber laws
5. Impart various privacy policies for an organization

UNIT I

PUBLIC KEY CRYPTOGRAPHY AND HASH ALGORITHMS:

Principles of public key cryptosystems. The RSA algorithm-Key management, Diffie-Hellman Key exchange- Hash functions-Hash Algorithms (MD5, Secure Hash Algorithm)

UNIT II

FUNDAMENTALS OF CYBER SECURITY:

How Hackers Cover Their Tracks- Fraud Techniques- Threat Infrastructure- Techniques to Gain a Foothold (Shellcode, SQL Injection, Malicious PDF Files)- Misdirection, Reconnaissance, and Disruption Methods

UNIT III

PLANNING FOR CYBER SECURITY:

Privacy Concepts -Privacy Principles and Policies -Authentication and Privacy - Data Mining - Privacy on the Web - Email Security - Privacy Impacts of Emerging Technologies

UNIT IV

CYBER SECURITY MANAGEMENT:

Security Planning - Business Continuity Planning - Handling Incidents - Risk Analysis - Dealing with Disaster – Legal Issues – Protecting programs and Data – Information and the law – Rights of Employees and Employers - Emerging Technologies - The Internet of Things - Cyber Warfare

Text Books and References:

1. William Stallings, “Cryptography and Network Security”, Pearson Education, 6th Edition, 2013.
2. Charles P. Pfleeger Shari Lawrence Pfleeger Jonathan Margulies, Security in Computing, 5th Edition , Pearson Education , 2015.
3. Graham, J. Howard, R., Olson, R., Cyber Security Essentials, CRC Press, 2011.
4. George K.Kostopoulous, Cyber Space and Cyber Security, CRC Press, 2013.

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Syllabus : Semester III

23PCS352T	Multimedia [OE]	L	T/P	C
		3		3

Course Objectives:

1. To introduce various aspects of multimedia components like Images, audio, sound and computer graphics.
2. Students will gain knowledge and express their creativity which will also arouse students' interest in the course and further motivate them towards developing their career in the area of multimedia and internet applications

Course Outcomes:
At the end of course student shall be able to:

1. To Critically and analyze the key components of multimedia technologies including text, graphics, voice, video and animation and the broad principles associated with multimedia concepts used in computer graphics.
2. Create vector and typographic designs and apply masking effect to images and Create an animation using the tools panel.
3. Design an image using image editing tools and apply effectively. Create animated sequence with titles applying the principles of animation.
4. Apply acquired knowledge in the field of multimedia for the good cause like advertisement in practice and independently continue to expand knowledge in this field.

UNIT I

INTRODUCTION: Multimedia- Definitions, Use of Multimedia, Introduction To Making Multimedia: The Stages of a Multimedia Project, Need, Creativity, Organization, Communication. Text-About Fonts and Faces, Cases, Serif Versus Sans Serif, Using Text in Multimedia, Computers and Text, Font editing and design tools, Hypermedia and Hypertext. Designing for the World Wide Web-Developing for the Web, Text for the Web, Images for the Web, Sound for the Web, Animation for the Web.

UNIT II

IMAGES: Images: Making Still Images, Bitmaps, Vector Drawing, 3-D Drawing and Rendering, Color, Understanding Natural Light and Color, Computerized Color, Color Palettes, Image File Formats.

UNIT III

IMAGE EDITING: Image Editing software: selection tools, working with layers, masks and channels, correcting and enhancing photographs, typographic design and vector drawing, working with 3D images, producing files for the web.

UNIT IV

ANIMATION: Animation-Principles of Animation, Animation by Computer, Animation Techniques, Animation File Formats, Making Animations that Work, a Rolling Ball, a Bouncing Ball, Creating an Animated Scene; Installing and using animation software (Flash or Blender), adding animation, tweening, morphing; Interactive navigation-working with sound and video.

Textbook:

Tay Vaughan,Multimedia: Making it Work (Seventh Edition) (2010). McGraw Hill Professional.

References/Books:

1. Student friendly video lecturers pertaining to this course are available at http://spoken-tutorial.org
2. .Juan Manuel Ferreyra , GIMP 2.6 cookbook,2011 .
3. Roland Hess ,Blender Foundation

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Syllabus : Semester III

23PCS353T	Enterprise Resource Planning [OE]	L	T/P	C
		3		3

Course Objectives:

1. Communicate the relevance and evolution of modern Enterprise applications.
2. Convey an understanding of the basic concepts of Process Mapping and Business Process Reengineering in an ERP context.
3. Explain the ERP Lifecycle challenges and success factors.
4. Inform the latest trends in Enterprise Applications.
5. Guide the configuration of the business processes in open source ERP and SAP.

Course Outcomes:

At the end of course student shall be able to:

1. Identify the relevance and evolution of modern Enterprise applications.
2. Examine the basic concepts of Process Mapping and Business Process Reengineering in an ERP context.
3. Identify the ERP Lifecycle challenges and success factors.
4. Build and configure business process in open source ERP.

UNIT I

ERP Introduction, Technology & Functional Modules

Introduction, Evolution from MRP to ERP, Need for an ERP, Essentials, Advantages and Risks: ERP Architecture, System Landscape, RDBMS, Configuration, Customisation: Functional Modules of ERP; Manufacturing/SCM, Sales & Distribution, HR, Finance; CRM, SRM.

UNIT II

Business Process Redesign and Mapping

Business Function & Processes, Cross Functional Processes, Functional departments in a Business, Business Process Reengineering, Process mapping.

UNIT III

ERP Life Cycle: Selection an Implementation

Pre-implementation tasks/Readiness for ERP, Requirements definition/analysis, Cost Benefit Analysis/ERP Costs, ERP Life Cycle: Package Selection, ERP Transition Strategies, ERP Implementation Strategies, methodologies and challenges, ERP implementation lifecycle, Vendors and Consultants, Training & Education, Data Migration, Post Implementation activities, Success & Failure factors of ERP implementation, Testing and Users, Operation & Maintenance of an ERP system, Measurement of the performance of ERP system.

UNIT IV

ERP Market and Trends

ERP Market Share Analysis, Popular ERP Package Vendors, Cloud based ERP, Mobility, Business Intelligence and Analytics, Geographic Information systems (GIS), OLAP, Security Systems for ERP, Enterprise Application Integration, ERP and e-Business, Open Source ERP, Introduction to ERP packages such as SAP, Odoo, ERP Sim.

Text Books:

1. Bradford, Marianne. Modern Erp: Select, Implement and Use Today's Advanced Business Systems. Morrisville, NC: Lulu, 2015. Print.
2. Leon, Alexis. Enterprise Resource Planning. (Fourth Edition) New Delhi: McGraw-Hill Education (India) Pte Ltd, 2019. Print.

References:

1. Monk, Ellen & Wagner, Bret. Concepts in Enterprise Resource Planning (3rd Edition), 2011.
2. Leon, Alexis. ERP Demystified. , 2014. Print.
3. Ray, Rajesh. Enterprise Resource Planning-Text & Cases. McGraw-Hill Education (India) Pte Ltd, 2011. Print.
4. K. Ganesh & Sanjay Mohapatra & S. P. Anbuudayasankar & P. Sivakumar, "Enterprise Resource Planning," Management for Professionals, Springer, edition 127, number 978-3-319-05927-3, August. 2014.

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Syllabus : Semester III

23PCS302T	Foundation Course II: Project Planning and Management	L	T/P	C
		3		3

Course Objectives:

This course is aimed at introducing the primary important concepts of project management related to managing software development projects. They will also get familiar with the different activities involved in Software Project Management. Further, they will also come to know how to successfully plan and implement a software project management activity, and to complete a specific project in time with the available budget.

Course Outcomes:

At the end of course student shall be able to:

1. Identify the different project contexts and suggest an appropriate management strategy.
2. Practice the role of professional ethics in successful software development.
3. Identify and describe the key phases of project management.
4. Determine an appropriate project management approach through an evaluation of the business context and scope of the project.

UNIT I

SOFTWARE MANAGEMENT & ECONOMICS: The Waterfall Model, Conventional software Management Performance; Evolution of Software Economics - Software economics, Pragmatic software cost estimation, Reducing software product size, Improving software processes.

UNIT II

THE OLD AND THE NEW WAY OF PROJECT MANAGEMENT: Improving team effectiveness, Improving automation through software environment, Achieving required quality; Peer inspections – A pragmatic view, The principles of conventional software engineering, Principles of modern software management, Transitioning to an iterative process.

UNIT III

SOFTWARE MANAGEMENT PROCESS FRAMEWORK: Life cycle phases, The artifact sets, Management artifacts, Engineering artifacts, Pragmatic artifacts; Model Based Software Architectures - A management perspective and A technical perspective.

UNIT IV

PROJECT ORGANIZATION AND PLANNING: Work breakdown structures, Planning guidelines, The cost and schedule estimating process, The iteration planning process, Pragmatic planning, Line-of-Business organizations, Project organizations, Evolution of organizations; Process automation - Automation building blocks, The project environment.

Text Book:

Walker Royce, “Software Project Management”, 1st Edition, Pearson Education, 2006.

References Books:

1. Bob Hughes and Mike Cotterell, “Software Project Management”, 3rd Edition, Tata McGraw Hill Edition, 2005.
2. Joel Henry, “Software Project Management”, 1st Edition, Pearson Education, 2006.
3. Pankaj Jalote, “Software Project Management in practice”, 1st Edition, Pearson Education, 2005.

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Syllabus : Semester III

23PCS303P	Project and Seminar	L	T/P	C
			16	8

For Project with Seminar, a student under the supervision of a faculty member, shall collect the literature on a topic and critically review the literature and submit it to the department in a report form and shall make an oral presentation before the Project Review Committee consisting of Head of the Department, supervisor/mentor and two other senior faculty members of the department. For Project with code and Seminar, there will be internal evaluation as well as external evaluation of 100 marks each. A candidate has to secure a minimum of 50% of marks to be declared successful.

Master of Technology (Computer Science & Engineering)

Syllabus: Semester IV

Sl. No	Subject Code	Subject	Teaching Scheme				Scheme of Examination (Marks)			Duration of Exam. (Hours)	Minimum Passing Marks
			L	T	P	Total Credits	EE	CA	Total Marks		
1.	23PCS401P	Industrial Project			32	16	200	200	400	-	200
Total Marks							200	200	400		
Load of the semester			**32**				**Total credits in the**				**16**

The Dissertation/Project internal evaluation will be done by the Committee on the basis of seminar, viva-voce and the dissertation report submitted by the candidate out of 200 marks. Committee will comprising of the following members:
HOD
M.Tech Coordinator
Dissertation Supervisor (and Co-Supervisor).
Two faculty members as expert preferably from the same specialization.

External evaluation will be done by the appointed External Examiner for 200 marks and shall be evaluated through presentation cum viva-voce examination by a committee comprising of the following members:

- HOD
- M.Tech Coordinator
- Dissertation Supervisor (and/or Co-Supervisor)
- One external expert appointed by the Board of Studies

The evaluation will be as per the following criterion:

a) Final Evaluation Components (Maximum 110 marks)
1) Content of Report (Maximum 60 marks)
2) Presentation (Maximum30 marks)
3) Answer 10 Examiner's queries (Maximum20 marks)

b) Marks for paper presented in reputed Conferences and journals of professional societies or Outstanding work done during internship duly certified by industrial supervisor.
[Total: 30 Marks]

c) Marks for paper in non-paid paper in peer reviewed Journals in Scopus SCI, SCIE, ESCI or IEEE Transaction (30 marks per paper) or Patent Published (30 marks per patent) or M,Tech Best Project Award given by recognized agency (30 marks) (Maximum 60 marks for entire c component)

Final Evaluation:
The final grade of the fourth semester will be evaluated based on grand total of marks **(a+b+c)** as per the institute norms.