M.Tech (CSE)

R19 COURSE STRUCTURE

I SEMESTER

S.NO.	Subject Code	SUBJECT	L	P	C
1	19011T01	Advanced Data Structures and Algorithm Analysis	3	-	3
2	19011T02	Software Engineering	3	-	3
3	19011T03	Computer Organization and Architecture	3	-	3
4	19011T04	Data Base Management Systems	3	-	3
5	19011T05	Operating Systems	3	-	3
6	19011L01	CSE Laboratory I	-	4	2
		TOTAL			**17**

II SEMESTER

S.NO.	Subject Code	SUBJECT	L	P	C
1	19012T06	Computer Networks	3	-	3
2	19012T07	Data Warehousing and Data Mining	3	-	3
3	 19012D01 19012D02 19012D03	**ELECTIVE 1** Machine Learning Compiler Design Human Computer Interaction	3	-	3
4	 19012D04 19012D05 19012D06	**ELECTIVE 2** Image Processing Mobile Computing Advanced Unix Programming	3	-	3
5	 19012D07 19012D08 19012D09	**ELECTIVE 3** Artificial Intelligence Cloud Computing Software Testing Methodologies	3	-	3
6	19012L02	CSE Laboratory2	-	4	2
		TOTAL			**17**

III SEMESTER

S.NO.	Subject Code	SUBJECT	L	P	C
1	19013T08	Cyber Security	3	-	3
2	19013T09	Big Data Analytics	3	-	3
3	19013P01	Comprehensive Viva	-	-	3
4	19013S01	Seminar-I	-	-	2
5	-----	Project Work Part - I	-	-	6
		TOTAL			**17**

IV SEMESTER

S.NO.	Subject Code	SUBJECT	L	P	C
1	19014S02	Seminar-II	-	-	2
2	19013P02	Project Work Part - II	-	-	15
		TOTAL			**17**

ADVANCED DATA STRUCTURES AND ALGORITHM ANALYSIS
M.Tech (Computer Science and Engineering)

Course Category	Professional Core	**Course Code**	
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites		**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	Comprehensive understanding of dictionaries, hashing mechanism which supports faster data retrieval.
2	Illustration of Balanced trees and their operations.
3	Comprehension of heaps, queues and their operations Priority Queues.
4	Detailed knowledge of nonlinear data structures and various algorithms using them Graph algorithms.

COURSE OUTCOMES		**BTL**
Upon successful completion of the course, the student will be able to:		
CO1	Compare linear and non linear data structures	L2
CO2	Implement searching, sorting and traversing methods	L3
CO3	Implement symbol table using hashing techniques.	L3
CO4	Analyze algorithms for Height balanced trees like AVL trees, B-trees.	L4
CO5	Analyze the performance of algorithms	L4

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	1	0	1	2	1
CO2	1	0	1	2	1
CO3	2	0	1	2	1
CO4	1	0	1	2	1
CO5	2	0	2	2	1

COURSE CONTENT	
UNIT I	**Introduction to Data Structures**: Singly Linked Lists, Doubly Linked Lists, Circular Lists-Algorithms. **Stacks and Queues**: Algorithm Implementation using Linked Lists.
UNIT II	**Searching**-Linear and Binary Search Methods. Sorting-Bubble Sort, Selection Sort, Insertion Sort, Quick sort, Merge Sort. Trees- Binary trees, Properties, Representation and Traversals (DFT, BFT), Expression Trees (Infix, prefix, postfix).Graphs-Basic Concepts, Storage Structures and Traversals.
UNIT III	**Dictionaries**, ADT, The List ADT, Stack ADT, Queue ADT, Hash Table Representation, Hash Functions, Collision Resolution-Separate Chaining, Open Addressing-Linear Probing, Double Hashing
UNIT IV	**Search Trees**- Binary Search Trees, Definition, ADT, Implementation, Operations-Searching, Insertion, Deletion. AVL Trees, Definition, Height of AVL Tree, Operations, Insertion, Deletion and Searching, B-Trees, Height of B-Tree, Insertion, Deletion and Searching, Comparison of Search Trees.
UNIT V	**Algorithm Analysis-** Space Complexity, Time Complexity, Asymptotic Notation, Performance Measurement. Basics of Probability Theory, Randomized algorithms: An Informal Description, Identifying the Repeated Element, Primality Testing, Advantages and Disadvantages.

TEXT BOOKS	
1.	Data Structures: A Pseudocode Approach, 2/e, Richard F.Gilberg, Behrouz A. Forouzon, Cengage.
2.	Data Structures, Algorithms and Applications in java, 2/e, Sartaj Sahni, University Press.
REFERENCE BOOKS	
1.	Data Structures And Algorithm Analysis, 2/e, Mark Allen Weiss, Pearson.
2.	Data Structures And Algorithms, 3/e, Adam Drozdek, Cengage.
WEB RESOURCES	
1.	http://lcm.csa.iisc.ernet.in/dsa/dsa.html
2.	http://utubersity.com/?page_id=878
3.	http://freevideolectures.com/Course/2519/C-Programming-and-Data-Structures

SOFTWARE ENGINEERING

M.Tech (Computer Science and Engineering)

Course Category	Professional Core	**Course Code**	
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites		**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	To develop skills that will enable them to construct software of high quality
2	Software that is Reliable, and that is reasonably easy to understand, modifies and maintain.

COURSE OUTCOMES		**BTL**
Upon successful completion of the course, the student will be able to:		
CO1	Analyze software development process models and their suitability to industrial applications.	L4
CO2	Develop SRS document for software design.	L3
CO3	Employ software architectural styles to design user interface.	L3
CO4	Compare software testing approaches and aspects.	L4
CO5	Inspect software reliability and quality.	L4

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	1	0	1	1	2
CO2	1	2	1	1	2
CO3	0	2	1	1	2
CO4	1	0	1	1	2
CO5	1	0	1	1	2

COURSE CONTENT	
UNIT I	**Software and Software Engineering**: The Nature of Software, The Unique Nature of Web Apps, Software Engineering, Software Process, Software Engineering Practice, Software Myths. **Process Models:** A Generic Process Model, Process Assessment and Improvement,

	Prescriptive Process Models, Specialized Process Models, The Unified Process, Personal and Team Process Models, Process Terminology, Product and Process
UNIT II	**Requirements Analysis and Specification**: Requirements Gathering and Analysis, Software Requirement Specification (SRS), Formal System Specification. **Software Design**: Overview of the Design Process, How to Characterize of a Design, Cohesion and Coupling, Layered Arrangement of Modules, Approaches to Software Design.
UNIT III	**Function-Oriented Software Design**: Overview of SA/SD Methodology, Structured Analysis, Developing the DFD Model of a System, Structured Design, Detailed Design, Design Review, over view of Object Oriented design. **User Interface Design**: Characteristics of Good User Interface, Basic Concepts, Types of User Interfaces, Fundamentals of Component-based GUI Development, A User Interface Design Methodology.
UNIT IV	**Coding and Testing**: Coding, Code Review, Software Documentation, Testing, Unit Testing, Black- Box Testing, White-Box Testing, Debugging, Program Analysis Tool, Integration Testing, Testing Object-Oriented Programs, System Testing, Some General Issues Associated with Testing.
UNIT V	**Software Reliability and Quality Management**: Software Reliability, Statistical Testing, Software Quality, Software Quality Management System, ISO 9000, SEI Capability Maturity Model. **Computer Aided Software Engineering**: Case and its Scope, Case Environment, Case Support in Software Life Cycle, Other Characteristics of Case Tools, Towards Second Generation CASE Tool, Architecture of a Case Environment.

TEXT BOOKS	
1.	Software Engineering A practitioner's Approach, Roger S. Pressman, Seventh Edition McGraw Hill International Edition.
2.	Fundamentals of Software Engineering, Rajib Mall, Third Edition, PHI.
3.	Software Engineering, Ian Somerville, Ninth edition, Pearson education.
REFERENCE BOOKS	
1.	Software Engineering: A Primer, Waman S Jawadekar, Tata McGraw-Hill, 2008.
2.	Software Engineering, A Precise Approach, Pankaj Jalote, Wiley India,2010.
WEB RESOURCES	
1.	https://www.tutorialspoint.com/software_engineering/software_engineering_tutorial.pdf
2.	http://nptel.ac.in/downloads/106105087/

COMPUTER ORGANIZATION AND ARCHITECTURE

M.Tech(Computer Science and Engineering)

Course Category	Professional Core	**Course Code**	
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites		**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	To impart an understanding of the internal organization and operations of a computer functional units.
2	To familiarize with the single and multiprocessor design architectures.

COURSE OUTCOMES		**BTL**
Upon successful completion of the course, the student will be able to:		
CO1	Understand the architecture and data representation in modern computer.	L2
CO2	Examine Combinational and Sequential Circuits	L4
CO3	Compare Memory mapping techniques	L4
CO4	Implement Computer Arithmetic Operations	L3
CO5	Outline the I/O interfaces	L2

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)					
	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	1	0	1	1	2
CO2	1	0	1	1	2
CO3	1	0	1	1	2
CO4	1	0	1	1	2
CO5	1	0	1	1	2

COURSE CONTENT	
UNIT I	**Basic Structure of Computers**: Computer Types, Functional unit, Basic Operational concepts, Bus structures, **Data Representation and Number Systems**: Signed and Unsigned Numbers, Floating Point Representation, Logical Operation, Gray Code, BCD Code, Error Detecting Codes. Boolean Algebra, Simplification of Boolean Expressions- Maps.

UNIT II	**Combinational and Sequential Circuits**: Decoders, Encoders, Multiplexers, Half and Full Adders, Shift Registers, Flip-Flops, Binary Counters, Memory Unit.
UNIT III	**Memory Organization**: Memory Hierarchy, Main Memory, Auxiliary Memory, Associative Memory, Cache Memory, Virtual Memory Concept.
UNIT IV	**ALU**: Design, computer arithmetic, Addition and Subtraction, Multiplication and Division Algorithms, BCD Adders..
UNIT V	**Input –Output Organization**: Peripheral Devices, Input-Output Interface, Asynchronous data transfer, Modes of Transfer, Priority Interrupts, DMA, Input Output Processor, Serial Communication.

TEXT BOOKS	
1.	Computer System Architecture, 3/e, Moris Mano, Pearson/PHI.
2.	Micro Processor and Interfacing, 2/e, Douglas V.Hall, TMH.
REFERENCE BOOKS	
1.	Digital Logic and Computer Organisation, Rajaraman, Radha Krishnan, PHI.
2.	Computer Organisation and Architecture, 7/e, Stallings, Pearson.
WEB RESOURCES	
1.	https://www.reference.com/technology/computer-organization-36c3a064b20f9b33
2.	http://nptel.iitm.ac.in/video.php?subjectId=106106092
3.	https://www.tutorialspoint.com/videos/computer_organization/index.htm

DATABASE MANAGEMENT SYSTEMS

M.Tech (Computer Science and Engineering)

Course Category	Professional Core	**Course Code**	
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites		**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	Provide students with necessary skills for designing and development of databases for real world applications.
2	Make the students to Understand anomalies of Database and its resolution techniques.

COURSE OUTCOMES		**BTL**
Upon successful completion of the course, the student will be able to:		
CO1	Identify the role of Database Management System for maintenance of Databases	L2
CO2	Apply Relational Model to design and manipulate a Database.	L3
CO3	Convert Entity relationship model into Relational Model.	L3
CO4	Design a Database using Normalization techniques.	L3
CO5	Outline Database Concurrent transactions and Storage methods	L2

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)					
	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	1	0	1	2	1
CO2	0	1	1	2	1
CO3	0	1	1	2	1
CO4	2	0	1	2	1
CO5	2	0	1	2	1

COURSE CONTENT	
UNIT I	**INTRODUCTION**: Database system, Characteristics (Database Vs File System), Database Users (Actors on Scene, Workers behind the scene), Advantages of Data base systems, Database applications. Brief introduction of different Data Models; Concepts of Schema, Instance and data independence; Three tier schema architecture for data independence; Database system

	structure, environment.
UNIT II	**RELATIONALMODEL**: Introduction to relational model, concepts of domain, attribute, tuple, relation, importance of null values, constraints (Domain, Key constraints, integrity constraints) and their importance, Logical Data Base Design. **BASIC SQL**:Simple Database schema, data types, table definitions (create, alter), different DML operations (insert, delete, update), basic SQL querying (select and project) using where clause, arithmetic & logical operations, SQL functions(Date and Time, Numeric, String conversion).
UNIT III	**Entity Relationship Model**: Introduction to ER Model, Data Base Design, Representation of entities, attributes, entity set, relationship, relationship set, Additional Features of ER Model: constraints, sub classes, super class, Strong and Weak entities, inheritance, specialization, generalization, Aggregation. **SQL**:Creating tables with relationship, implementation of key and integrity constraints, nested queries, sub queries, grouping, aggregation, ordering, implementation of different types of joins, concepts of views, relational set operations.
UNIT IV	**SCHEMA REFINEMENT (NORMALIZATION)**: Purpose of Normalization or schema refinement, concept of functional dependency, normal forms based on functional dependency(1NF, 2NF and 3 NF), concept of surrogate key, Boyce-Codd normal form(BCNF), Lossless join and dependency preserving decomposition, Fourth normal form(4NF).
UNIT V	**TRANSACTION MANAGEMENT AND CONCURRENCY CONTROL**: Transaction, properties of transactions, transaction log, and transaction management with SQL using commit rollback and savepoint. Lock types, two phase locking for ensuring serializability, deadlocks, Concurrency control with time stamp ordering: Wait/Die and Wound/Wait Schemes. Basic PL/SQL procedures, functions and triggers. **STORAGE AND INDEXING**: Heap files and sorted files, hashing, single and multi-level indexes.

TEXT BOOKS	
1.	Database Management Systems, Raghu Ramakrishna, Johannes Gehrke, TMH, 3rd Edition, 2003.
2.	Database System Concepts, A.Silberschatz, H.F. Korth, S. Sudarshan, McGraw hill, VI edition, 2006.
3.	Fundamentals of Database Systems 5th edition. Ramez Elmasri, Shamkant B.Navathe, Pearson Education, 2008.
REFERENCE BOOKS	
1.	Database Management System Oracle SQL and PL/SQL,P.K.Das Gupta, PHI.
2.	Database System Concepts, Peter Rob & Carlos Coronel, Cengage Learning, 2008.
WEB RESOURCES	
1.	http://nptel.ac.in/courses/106106093 (Prof. D. Janakiram, IIT, Madras)

OPERATING SYSTEMS

M.Tech(Computer Science and Engineering)

Course Category	Professional Core	**Course Code**	
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites		**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	Understand the structure and functions of Operating Systems.
2	Learn process, disk and memory management.
3	Learn basics of Linux and Android Operating Systems.

COURSE OUTCOMES		**BTL**
Upon successful completion of the course, the student will be able to:		
CO1	Identify the operating system services	L2
CO2	Implement Scheduling algorithms for process management	L3
CO3	Implement process synchronization techniques to avoid deadlocks. .	L3
CO4	Compare memory management schemes	L4
CO5	Outline file structures used in protecting data	L2

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	1	0	1	1	2
CO2	2	0	1	1	2
CO3	2	0	1	1	2
CO4	1	0	1	1	2
CO5	1	0	1	1	2

COURSE CONTENT	
UNIT I	**Overview of Operating System**:Introduction, Computer System Organization, Computer System Architecture, Operating Systems Services, Systems Calls and Types, Evolution of Operating Systems.
UNIT II	**Process Management**: Process, Process States , Process Control Block ,Process Scheduling, Operations on Processes, Threads Concepts, Process Scheduling Concepts, CPU Scheduling Algorithms, Multiple Processor Scheduling.

UNIT III	**Synchronization**: Importance of Synchronization, The Critical-Section Problem, Semaphores, Classic Problems of Synchronization, Monitors, Synchronization Examples **Principles of Deadlock –** Deadlock System Model, Deadlock Characterization, Methods for Handling Deadlocks, Deadlock Prevention, Deadlock Detection and Avoidance, Recovery Form Deadlock.
UNIT IV	**Memory Management Strategies & Virtual Memory Management:**Concepts, Swapping, Contiguous Memory Allocation, Paging, Segmentation, Virtual Memory, Demand Paging, Page-Replacement Algorithms, Thrashing. **Secondary-Storage Structures & I/O Systems:**Overview of Mass-Storage Structure, Disk Structure, Disk Scheduling, Disk Management, RAID Structure, I/O Hardware, Application Interface, Kernel I/O Subsystem.
UNIT V	**File System Interface and Implementation:** The Concept of a File, Access Methods, Directory Structure, File System Structure, File System Implementation, File Sharing, Protection, Directory Implementation, Allocation Methods, Free-Space Management, Efficiency and Performance. **Protection and Security**: Principles of Protection, Security Problem, System and Network Threats, Denial Lock Service, Importance of Cryptography.

TEXT BOOKS	
1.	Operating System Principles,7/E,AbrahamSilberschatz, Peter Baer Galvin, Greg Gagne, WILEY INDIA publications.
2.	Operating Systems, 6/e, William Stallings, PHI/Pearson
REFERENCE BOOKS	
1.	Operating Systems, 2/e, Dhamdhre.
2.	Modern Operating Systems," Andrew S. Tanenbaum, Addison Wesley, Second Edition, 2001
3.	"Operating Systems: A Design-Oriented Approach,"Charles Crowley, Tata Mc Graw Hill Education", 1996.
WEB RESOURCES	
1.	http://nptel.ac.in/courses/106108101 (Prof. P.C.P. Bhatt, IISc Bangalore)

DATA WAREHOUSING AND DATA MINING

M.Tech(Computer Science and Engineering)

Course Category	Professional Core	**Course Code**	
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites		**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	Students will be enabled to understand and implement classical models and algorithms in data warehousing and data mining.
2	They will learn how to analyze the data, identify the problems, and choose the relevant models and algorithms to apply.
3	They will further be able to assess the strengths and weaknesses of various methods and algorithms and to analyze their behavior.

COURSE OUTCOMES		**BTL**
Upon successful completion of the course, the student will be able to:		
CO1	Implement data warehouse for heterogeneous data.	L3
CO2	Analyze real time datasets with basic summary statistics	L4
CO3	Construct a decision tree to resolve the problem of model overfitting	L3
CO4	Compare Apriori and FP-growth association rule mining algorithms for frequent itemset generation	L4
CO5	Apply suitable clustering algorithm for the given data set	L3

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	0	0	1	1	2
CO2	0	0	1	1	2
CO3	2	0	1	1	2
CO4	2	0	1	1	2
CO5	2	0	1	1	2

COURSE CONTENT	
UNIT I	**DATA WAREHOUSING**: Data warehousing Components –Building a Data warehouse –- Mapping the Data Warehouse to a Multiprocessor Architecture – DBMS Schemas for Decision Support – Data Extraction, Cleanup, and Transformation Tools –Metadata.
UNIT II	**BUSINESS ANALYSIS**: Reporting and Query tools and Applications – Tool Categories – The Need for Applications – Cognos Impromptu – Online Analytical Processing (OLAP) – Need – Multidimensional Data Model – OLAP Guidelines – Multidimensional versus Multi relational OLAP – Categories of Tools – OLAP Tools and the Internet.
UNIT III	**DATA MINING:** Introduction – Data – Types of Data – Data Mining Functionalities – Interestingness of Patterns – Classification of Data Mining Systems – Data Mining Task Primitives – Integration of a Data Mining System with a Data Warehouse – Issues –Data Preprocessing.
UNIT IV	**ASSOCIATION RULE MINING AND CLASSIFICATION**: Mining Frequent Patterns, Associations and Correlations – Mining Methods – Mining various Kinds of Association Rules – Correlation Analysis – Constraint Based Association Mining – Classification and Prediction – Basic Concepts – Decision Tree Induction – Bayesian Classification – Rule Based Classification – Classification by Back propagation – Support Vector Machines – Associative Classification – Lazy Learners – Other Classification Methods – Prediction.
UNIT V	**CLUSTERING AND TRENDS IN DATA MINING:** Cluster Analysis – Types of Data – Categorization of Major Clustering Methods – K-means– Partitioning Methods – Hierarchical Methods – Density-Based Methods –Grid Based Methods – Model-Based Clustering Methods – Clustering High Dimensional Data – Constraint – Based Cluster Analysis – Outlier Analysis – Data Mining Applications.

TEXT BOOKS	
1.	Alex Berson and Stephen J.Smith, “Data Warehousing, Data Mining and OLAP”, Tata McGraw – Hill Edition, Thirteenth Reprint 2008.
2.	2. Jiawei Han and Micheline Kamber, “Data Mining Concepts and Techniques”, Third Edition, Elsevier, 2012. AULibrary.com
REFERENCE BOOKS	
1.	Pang-Ning Tan, Michael Steinbach and Vipin Kumar, “Introduction to Data Mining”, Person Education, 2007.
2.	K.P. Soman, Shyam Diwakar and V. Aja, “Insight into Data Mining Theory and Practice”, Eastern Economy Edition, Prentice Hall of India, 2006
WEB RESOURCES	
1.	https://onlinecourses.nptel.ac.in/noc18_cs14/preview (PabitraMitra, IIT, Kharagpur)
2.	https://www-users.cs.umn.edu/~kumar001/dmbook/index.php
3.	http://hanj.cs.illinois.edu/bk3/bk3_slidesindex.htm

CSE LABORATORY 1

M.Tech (Computer Science and Engineering)

Course Category	Professional Core	**Course Code**	
Course Type	Laboratory	**L-T-P-C**	0-0-4-2
Prerequisites		**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	To understand the design aspects of operating system.
2	To study the process management concepts & Techniques, storage management concepts.
3	To familiarize students with the Linux environment

COURSE OUTCOMES		**BTL**
Upon successful completion of the course, the student will be able to:		
CO1	Implement linear and non linear data structures using C language.	L3
CO2	Develop C programs for searching and sorting techniques.	L3
CO3	Develop C programs for process scheduling, Memory Management, Deadlock Avoidance.	L3

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	0	0	1	2	1
CO2	0	0	1	2	1
CO3	1	0	1	2	1

COURSE CONTENT

Data Structures Programs:

1. To implement Stacks& Queues using Arrays & Linked Lists.
2. To implement Stack ADT, Queue ADT using arrays & Linked Lists.
3. To implement Dequeue using Double Linked List & Arrays.
4. To perform various Recursive & Non-recursive operations on Binary Search Tree.
5. To implement BFS & DFS for a graph.
6. To implement Merge & Heap sort of given elements.
7. To perform various operations on AVL trees.
8. To implement Krushkal's algorithm to generate a min-cost spanning tree.
9. To implement Prim's algorithm to generate min-cost spanning tree.
10. To implement functions of Dictionary using Hashing.

Operating system programs:

1. Program to implement FCFS(First Come First Serve)scheduling Algorithms.
2. Program to implement SJF(Shortest Job First)Scheduling Algorithm.
3. Program to implement Priority Scheduling algorithm.
4. Program to implement Round Robin Scheduling algorithm.
5. Program to implement FIFO(First In First Out) Page Replacement Algorithm.
6. Program to implement LRU(least Recently used)Page Replacement Algorithm.
7. Program to implement LFU(Least Frequently used)Page Replacement Algorithm.
8. Write a program to implement how Disk Scheduling is done in operating system.
9. Draw the appropriate C.P.U performance graphs for SJF Scheduling Algorithm.

CYBER SECURITY

M.Tech (Computer Science and Engineering)

Course Category	Professional Core	**Course Code**	
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites		**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	The Cyber Security Course will provide the students with foundational Cyber Security principles, Security architecture, risk management, attacks, incidents, and emerging IT and IS technologies.
2	Students will gain insight into the importance of Cyber Security and the integral role of Cyber Security professionals.

COURSE OUTCOMES		**BTL**
Upon successful completion of the course, the student will be able to:		
CO1	Summarize the security attacks and services	L2
CO2	Identify System and application security threats and vulnerabilities.	L2
CO3	Compare different classes of attacks.	L4
CO4	Apply Tools and techniques to identify Cybercrime.	L3
CO5	Analyze risk management processes and practices.	L3

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	1	0	1	1	2
CO2	1	0	1	1	2
CO3	1	0	1	1	2
CO4	2	0	1	1	2
CO5	1	0	1	1	2

COURSE CONTENT	
UNIT I	**Introduction to Cybercrime:** Introduction, Cybercrime: Definition and Origins of the Word, Cybercrime and Information Security, Who are Cybercriminals? , Classifications of Cybercrimes, Cybercrime: The Legal Perspectives, Cybercrimes: An Indian Perspective, Cybercrime and the Indian ITA 2000, A Global Perspective on Cybercrimes, Cybercrime Era: Survival Mantra for the Netizens.

UNIT II	**Cyber offenses**: How Criminals Plan Them –Introduction, How Criminals Plan the Attacks, Social Engineering, Cyber stalking, Cyber cafe and Cybercrimes, Botnets: The Fuel for Cybercrime, Attack Vector Cloud Computing..
UNIT III	**Cybercrime Mobile and Wireless Devices**: Introduction, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/CellPhones.
UNIT IV	**Tools and Methods Used in Cybercrime:** Introduction, Proxy Servers and Anonymizers, Phishing, Password Cracking, Key loggers and Spywares, Virus and Worms, Trojan Horses and Backdoors, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Overflow, Attacks on Wireless Networks, Phishing and Identity Theft: Introduction, Phishing, Identity Theft (ID Theft)
UNIT V	**Cybercrimes and Cyber security**: Why Do We Need Cyber laws: The Indian Context, The Indian IT Act, Challenges to Indian Law and Cybercrime Scenario in India, Consequences of Not Addressing the Weakness in Information Technology Act, Digital Signatures and the Indian IT Act.

TEXT BOOKS	
1.	"Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives," Nina Godbole, SunitBelapure, Wiley, 2011.
2.	"Principles of Information Security,"MichealE.Whitman and Herbert J.Mattord, CengageLearning, 2011.
REFERENCE BOOKS	
1.	"Information Security," Mark Rhodes, Ousley, MGH, 2013..
WEB RESOURCES	
1.	https://onlinecourses.nptel.ac.in/noc18_cs07 (Sourav Mukhopadhyay, National University of Singapore)

COMPUTER NETWORKS

M.Tech (Computer Science and Engineering)

Course Category	Professional Core	**Course Code**	
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites		**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	Understand the basic taxonomy, terminology and architectures of the computer networks.
2	Analyze the services, protocols and features of the various layers of computer networks.
3	Understand the requirements for a given organizational structure and select the most appropriate networking architecture and technologies.

COURSE OUTCOMES		**BTL**
Upon successful completion of the course, the student will be able to:		
CO1	Interpret data communication models using OSI/ISO and TCP/IP protocol architectures.	L2
CO2	Outline Physical Layer communication	L2
CO3	Analyze protocols implemented in data link layer for error and flow control.	L4
CO4	Analyze the features and operations of different MAC mechanisms.	L4
CO5	Build the skills of subnetting and routing mechanisms.	L3

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)					
	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	1	0	1	1	2
CO2	0	0	1	1	2
CO3	0	0	1	1	2
CO4	0	0	1	1	2
CO5	2	0	1	1	2

COURSE CONTENT	
UNIT I	**Introduction:** Network Topologies WAN, LAN, MAN. Reference models- The OSI Reference Model the TCP/IP Reference Model - A Comparison of the OSI and TCP/IP Reference Models.
UNIT II	**Physical Layer** – Fourier Analysis – Bandwidth Limited Signals – The Maximum Data Rate of a Channel - Guided Transmission Media, Digital Modulation and Multiplexing: Frequency Division Multiplexing, Time Division Multiplexing, Code Division Multiplexing
UNIT III	**The Data Link Layer** - Data Link Layer Design Issues ,Services Provided to the Network Layer – Framing – Error Control – Flow Control, Error Detection and Correction – Error-Correcting Codes – Error Detecting Codes, Elementary Data Link Protocols- A Utopian Simplex Protocol-A Simplex Stop and Wait Protocol for an Error free channel-A Simplex Stop and Wait Protocol for a Noisy Channel, Sliding Window Protocols-A One Bit Sliding Window Protocol-A Protocol Using Go-Back-N- A Protocol Using Selective Repeat.
UNIT IV	**The Medium Access Control Sub layer**-The Channel Allocation Problem-Static Channel Allocation- Assumptions for Dynamic Channel Allocation, Multiple Access Protocols-Aloha-Carrier Sense Multiple Multiple Access Protocols-Collision-Free Protocols-Limited Contention Protocols-Wireless LAN Protocols, Ethernet-Classic Ethernet Physical Layer-Classic Ethernet MAC Sub layer Protocol-Ethernet Performance-Fast Ethernet Gigabit Ethernet-10-Gigabit Ethernet-Retrospective on Ethernet, Wireless Lans-The 802.11 Architecture and Protocol Stack-The 802.11 Physical Layer-The802.11 MAC Sub layer Protocol-The 805.11 Frame Structure-Services.
UNIT V	**The Network Layer :**Design Issues **–** Store and Forward Packet Switching-Services Provided to the Transport layer- Implementation of Connectionless Service-Implementation of Connection Oriented Service-Comparison of Virtual Circuit and Datagram Networks, Routing Algorithms-The Optimality principle-Shortest path Algorithm, Congestion Control Algorithms- Approaches to Congestion Control-Traffic Aware Routing-Admission Control-Traffic Throttling-Load Shedding.

TEXT BOOKS	
1.	Computer Networks, Tanenbaum and David J Wetherall, 5th Edition, Pearson Edu, 2010.
2.	Computer Networks: A Top Down Approach, Behrouz A. Forouzan, FirouzMosharraf, McGraw Hill Education.
REFERENCE BOOKS	
1.	Larry L. Peterson and Bruce S. Davie, “Computer Networks - A Systems Approach” (5th ed), Morgan Kaufmann/Elsevier,2011..
WEB RESOURCES	
1.	http://nptel.ac.in/courses/106105081/1 (Prof. Sujoy Ghosh, IIT, Kharagpur)
2.	http://epgp.inflibnet.ac.in/view_f.php?category=1736
3.	http://media.pearsoncmg.com/ph/streaming/esm/tanenbaum5e_videonotes/tanenbaum_videoNotes.html

BIG DATA ANALYTICS

M.Tech (Computer Science and Engineering)

Course Category	Professional Core	**Course Code**	
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites		**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	Optimize business decisions and create competitive advantage with Big Data analytics
2	Derive business benefit from unstructured data
3	Imparting the architectural concepts of Hadoop and introducing map reduce paradigm
4	To introduce programming tools PIG & HIVE in Hadoop echo system.

COURSE OUTCOMES		**BTL**
Upon successful completion of the course, the student will be able to:		
CO1	Implement data structures required for developing map reduce programs.	L3
CO2	Interpret Hadoop's architecture and core components of Hadoop Distributed File System.	L2
CO3	Apply data modelling techniques to large data sets using map reduce paradigm.	L3
CO4	Analyze interfaces for Hadoop I/O.	L4
CO5	Analyze data using pig and Hive tools.	L4

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	0	0	1	2	2
CO2	0	0	1	2	2
CO3	1	0	1	2	2
CO4	2	0	0	2	2
CO5	2	0	1	2	2

COURSE CONTENT

UNIT I	**Data structures in Java:** Linked List, Stacks, Queues, Sets, Maps; Generics: Generic classes and Type parameters, Implementing Generic Types, Generic Methods, Wrapper Classes, Concept of Serialization.
UNIT II	**Working with Big Data:** Google File System, Hadoop Distributed File System (HDFS) – Building blocks of Hadoop (Namenode, Datanode, Secondary Namenode, Job Tracker, Task Tracker), Introducing and Configuring Hadoop cluster (Local, Pseudo-distributed mode, Fully Distributed mode), Configuring XML files.
UNIT III	**Writing MapReduce Programs**: A Weather Dataset, Understanding Hadoop API for MapReduce Framework (Old and New), Basic programs of Hadoop MapReduce: Driver code, Mapper code, Reducer code, Record Reader, Combiner, Partitioner.
UNIT IV	**Hadoop I/O:** The Writable Interface, Writable Comparable and comparators, Writable Classes: Writable wrappers for Java primitives, Text, Bytes Writable, Null Writable, Object Writable and Generic Writable, Writable collections, Implementing a Custom Writable: Implementing a Raw Comparator for speed, Custom comparators.
UNIT V	**Pig:** Hadoop Programming Made Easier Admiring the Pig Architecture, Going with the Pig Latin Application Flow, Working through the ABCs of Pig Latin, Evaluating Local and Distributed Modes of Running Pig Scripts, Checking out the Pig Script Interfaces, Scripting with Pig Latin Applying Structure to Hadoop Data with Hive: Saying Hello to Hive, Seeing How the Hive is Put Together, Getting Started with Apache Hive, Examining the Hive Clients, Working with Hive Data Types, Creating and Managing Databases and Tables, Seeing How the Hive Data Manipulation Language Works, Querying and Analyzing Data.

TEXT BOOKS	
1.	Big Java 4th Edition, Cay Horstmann, Wiley John Wiley & Sons, INC
2.	Hadoop: The Definitive Guide by Tom White, 3rd Edition, O'reilly
3.	Hadoop in Action by Chuck Lam, MANNING Publ.
4.	Hadoop for Dummies by Dirk deRoos, Paul C.Zikopoulos, Roman B.Melnyk,Bruce Brown, Rafael Coss.
REFERENCE BOOKS	
1.	.Hadoop in Practice by Alex Holmes
2.	Hadoop MapReduce Cookbook
WEB RESOURCES	
1.	Hadoop: http://hadoop.apache.org/
2.	Hive: https://cwiki.apache.org/confluence/display/Hive/Home
3.	Piglatin: http://pig.apache.org/docs/r0.7.0/tutorial.html

MACHINE LEARNING

M.Tech (Computer Science and Engineering)

Course Category	Professional Elective	**Course Code**	
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites		**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	The main objective of this course is for the students to achieve basic knowledge of artificial intelligence.
2	a deepened technical understanding of machine learning research and theories, as well as practical experience of the use
3	Design of machine learning and data mining algorithms for applications and experiments.

COURSE OUTCOMES		**BTL**
Upon successful completion of the course, the student will be able to:		
CO1	Analyze the need for learning.	L4
CO2	Apply linear regression and logistic regression techniques for finding best-fit parameters.	L3
CO3	Apply artificial neural networks for face recognition.	L3
CO4	Analyze the hypothesis in Evaluation	L4
CO5	Apply Support vector machines, PCA for Dimensionality reduction, Instance-based learning methods.	L3

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	1	0	2	1	2
CO2	2	0	2	1	2
CO3	2	0	2	1	2
CO4	2	0	2	1	2
CO5	2	0	2	1	2

COURSE CONTENT	
UNIT I	**Introduction:** Well-posed learning problems, Designing a learning system, Perspectives and issues in machine learning. Concept learning and the general to specific ordering – Introduction, A concept learning task, Concept learning as search, Find- S: finding a maximally specific hypothesis, Version spaces and the candidate elimination algorithm, Inductive bias.
UNIT II	**Linear Regression & Logistic Regression:** Predicting numeric values: regression - Finding the best fit lines with linear regression, Locally weighted linear regression, Shrinking Coefficients, The bias / Variance trade-off. Logistic Regression: Classification with logistic regression and the sigmoid function, Using optimization to find the best regression coefficients.
UNIT III	**Artificial Neural Networks**: Introduction, Neural network representation, Appropriate problems for neural network learning, Perceptions, Multilayer networks and the back propagation algorithm, An illustrative example face recognition.
UNIT IV	**Evaluation Hypothesis**: Motivation, Estimation hypothesis accuracy, Basics of sampling theory, A general approach for deriving confidence intervals, Difference in error of two hypothesis, Comparing learning algorithms.
UNIT V	**Support Vector Machines & Dimensionality Reduction techniques**: Separating data with the maximum margin, finding the maximum margin, efficient optimization with SMO algorithm, Dimensionality Reduction techniques: Principal Component analysis **Instance-Based Learning-** Introduction, k-Nearest Neighbour Learning, Locally Weighted Regression.

TEXT BOOKS	
1.	.Machine Learning, Tom M. Mitchell, MGH.
2.	Machine Learning in Action,‖ Peter Harington, Cengage, 2012
REFERENCE BOOKS	
1.	Understanding Machine Learning: From Theory to Algorithms, Shai Shalev-Shwartz, Shai Ben-David, Cambridge.
2.	Machine Learning in Action, Peter Harington, 2012, Cengage.
3.	EthemAlpaydin, Introduction to Machine Learning, Second Edition, PHI, 2010
WEB RESOURCES	
1.	http://www2.ift.ulaval.ca/~chaib/IFT-4102-7025/public_html/Fichiers/Machine_Learning_in_Action.pdf
2.	http://cs.du.edu/~mitchell/mario_books/Introduction_to_Machine_Learning_-_2e_-_Ethem_Alpaydin.pdf
3.	http://onlinecourses.nptel.ac.in/noc18_cs26/preview (Prof. Balaraman Ravindran, IIT Madras)

COMPILER DESIGN

M.Tech (Computer Science and Engineering)

Course Category	Professional Elective	**Course Code**	
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites		**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	Understand the basic concepts of compiler design, and its different phases
2	The Students can Learn how to construct tools like LEX, YACC.

COURSE OUTCOMES		**BTL**
Upon successful completion of the course, the student will be able to:		
CO1	Outline lexical analyzer.	L2
CO2	Construct top down parsers.	L3
CO3	Construct SLR, CLR, and LALR bottom up parsers.	L3
CO4	Develop intermediate code by analyzing semantic analysis phase.	L3
CO5	Generate code by using machine independent code optimization techniques.	L3

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	1	0	1	1	2
CO2	1	0	1	1	2
CO3	1	0	1	1	2
CO4	2	0	1	1	2
CO5	2	0	1	1	2

COURSE CONTENT	
UNIT I	**Introduction** Language Processing, Structure of a compiler the evaluation of Programming language, The Science of building a Compiler application of Compiler Technology. Programming Language Basics. **Lexical Analysis**-: The role of lexical analysis buffing, specification of tokens. Recognitions of tokens the lexical analyzer generator lexical.
UNIT II	**Syntax Analysis** -: The Role of a parser, Context free Grammars Writing A grammar, top down passing bottom up parsing Introduction to LR Parser.

UNIT III	**Bottom up parsing**: Shift Reduce Parsing, Introduction to LR Parser, Model of an LR Parsers, SLR parsing, More Powerful LR parsers: CLR, LALR parsers, Error Recovery in LR parsing, YACC tool.
UNIT IV	**Semantic Analysis**: Syntax Directed Definition. Intermediated Code Generation: Variants of Syntax trees 3 Address code, Types and Deceleration, Translation of Expressions, Type Checking. Canted Flow Back patching.
UNIT V	**Code generation**: Issues in design of code generation, The target Language, Basic blocks and Flow graphs. **Machine Independent Code Optimization**: The principle sources of Optimization, Global common sub expression elimination, Copy propagation, Dead code elimination, Constant folding, Strength reduction, Loop optimization, Instruction Scheduling.

TEXT BOOKS	
1.	Compilers, Principles Techniques and Tools. Alfred V Aho, Monical S. Lam, Ravi Sethi Jeffery D. Ullman,2nd edition,pearson,2007.
2.	Compiler Design K.Muneeswaran, OXFORD.
3.	Principles of compiler design, 2nd edition, Nandhini Prasad, Elsebier.
REFERENCE BOOKS	
1.	Compiler Construction, Principles and practice, Kenneth C Louden, CENGAGE
2.	Implementations of Compiler, A New approach to Compilers including the algebraic methods,Yunlinsu,SPRINGER.
WEB RESOURCES	
1.	http://nptel.ac.in.courses/106108052/1 (Prof. Y.N. Srikanth, IISc Bangalore)

HUMAN COMPUTER INTERACTION

M.Tech (Computer Science and Engineering)

Course Category	Professional Elective	**Course Code**	
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites		**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	The main objective of this course is for the students to achieve basic knowledge of graphical user interface Importance of human characteristics
2	The students can Learn the screen designing, windows and components.

COURSE OUTCOMES		**BTL**
Upon successful completion of the course, the student will be able to:		
CO1	Illustrate importance and characteristics of graphical user interface.	L2
CO2	Analyze human characteristics, human interaction speeds.	L4
CO3	Apply better screen design techniques.	L3
CO4	Analyze windows and components.	L4
CO5	Analyze Interaction Devices	L4

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	1	1	1	0	1
CO2	0	0	1	0	1
CO3	1	1	1	0	1
CO4	1	0	1	0	1
CO5	2	0	1	0	1

COURSE CONTENT	
UNIT I	**Introduction:** Importance of user Interface, definition, importance of good design. Benefits of good design. A brief history of Screen design. **The graphical user interface:** Popularity of graphics, the concept of direct manipulation, graphical system, Characteristics, Web user – interface popularity, characteristics- Principles of user interface.

UNIT II	**Design process:** Human interaction with computers, importance of human characteristics human consideration, Human interaction speeds, understanding business junctions.
UNIT III	**Screen Designing:** Design goals, Screen planning and purpose, organizing screen elements, ordering of screen data and content, screen navigation and flow, Visually pleasing composition, amount of information, focus and emphasis, presentation information simply and meaningfully, information retrieval on web, statistical graphics, Technological consideration in interface design.
UNIT IV	**Windows**: Windows new and Navigation schemes selection of window, selection of devices based and screen based controls. **Components:** Components text and messages, Icons and increases, Multimedia, colors, uses problems, choosing colors.
UNIT V	**Software tools**: Specification methods, interface, Building Tools. Interaction Devices: Keyboard and function keys, pointing devices, speech recognition digitization and generation, image and video displays, drivers.

TEXT BOOKS	
1.	Human Computer Interaction. 3/e, Alan Dix, Janet Finlay, Goryd, Abowd, Russell Beal, PEA, 2004.
2.	The Essential guide to user interface design,2/e, Wilbert O Galitz, Wiley DreamaTech.
REFERENCE BOOKS	
1.	Designing the user interface. 4/e, Ben Shneidermann , PEA.
2.	User Interface Design, Soren Lauesen , PEA.
WEB RESOURCES	
1.	https://www.interaction-design.org/literature/topics/human-computer-interaction
2.	https://www.youtube.com/watch?v=m1zk4r6NWBc

IMAGE PROCESSING

M.Tech(Computer Science and Engineering)

Course Category	Professional Elective	**Course Code**	
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites		**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	The main objective of this course is for the students to achieve basic knowledge of Computer Graphics and Image Processing.
2	The students can learn how to interpret image representation and description techniques

COURSE OUTCOMES		**BTL**
Upon successful completion of the course, the student will be able to:		
CO1	Summarize elementary stages in digital Image Processing.	L2
CO2	Develop Morphological Image Applications	L3
CO3	Identify suitable Image segmentation algorithm	L2
CO4	Apply Image Processing operations to color images	L3
CO5	Interpret image representation and description techniques	L2

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	1	0	0	1	2
CO2	3	0	2	1	2
CO3	3	0	2	1	2
CO4	3	0	1	1	2
CO5	3	0	2	1	2

COURSE CONTENT	
UNIT I	**INTRODUCTION:** Introduction to image processing, fundamental steps in digital image processing, components of an image processing system, image sensing and acquisition, image

	sampling and quantization, some basic relationships between pixels, an introduction to the mathematical tools used in digital image processing.
UNIT II	**Morphological Image Processing:** ***Binary***-Dilation and Erosion, Opening and closing, Hit-or-Miss Transformation, Boundary Extraction, Hole Filling, Skeletons, Thinning, Pruning, Thickening, Gray Scale dilation and erosion, Gray Scale Opening and closing.
UNIT III	**SEGMENTATION:** Point, Line and Edge Detection,Thresholding-Basic Global Thresholding, Optimum Global Thresholding Using Otsu's Method, Multiple Thresholds, Variable Thresholding , Multivariable Thresholding, Region based segmentation-Region Growing, Region Splitting and Merging, Segmentation using morphological watersheds.
UNIT IV	**COLOR IMAGE PROCESSING:** color fundamentals, color models, pseudo color image processing, basics of full color image processing, color transformations, smoothing and sharpening. Image segmentation based on color, noise in color images, color image compression.
UNIT V	**Representation and Description:** Representation- Boundary (Border) Following, Chain Code, Polygonal Approximations Using Minimum-Perimeter Polygons, Other Polygonal Approximation Approaches, Signatures, Boundary Segments, Boundary Descriptors-Simple Descriptors, Shape Numbers, Regional Descriptors- Simple Descriptors, Topological Descriptors.

TEXT BOOKS	
1.	Digital Image Processing, Rafael C. Gonzalez, Richard E. Woods, Pearson Education,3rd Edition.
2.	Image Processing, Analysis and Machine Vision, Millan Sonka, VaclovHalvoc, Roger Boyle, Cengage Learning, 3ed
REFERENCE BOOKS	
1.	Computer & Machine Vision, Theory , Algorithms , Practicles, E R Davies, Elsevier, 4ed.
2.	Digital Image Processing with MATLAB and LABVIEW, Vipul Singh, Elsevier.
WEB RESOURCES	
1.	https://www.youtube.com/watch?v=QMLbTEQJCaI
2.	https://www.youtube.com/watch?v=CVV0TvNK6pk
3.	https://www.youtube.com/watch?v=-f0WEitGmiw

MOBILE COMPUTING

M.Tech(Computer Science and Engineering)

Course Category	Professional Elective	**Course Code**	
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites		**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	To understand the typical mobile networking infrastructure through a popular GSM protocol.
2	To understand the issues and solutions of various layers of mobile networks, namely MAC layer, Network Layer & Transport Layer.
3	To understand the ad hoc networks and related concepts.
4	To understand future generation platforms and protocols used in mobile environment.

COURSE OUTCOMES		**BTL**
Upon successful completion of the course, the student will be able to:		
CO1	Illustrate GSM Architecture in wireless networks.	L2
CO2	Select efficient Medium access control mechanism.	L4
CO3	Outline the functionality of a mobile agent in network layer.	L2
CO4	Explain transport layer protocols of mobile node and its database issues.	L2
CO5	Survey of Mobile adhoc network protocols for distinguishing them from infrastructure-based networks.	L4

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	1	0	1	0	2
CO2	2	0	1	0	2
CO3	2	0	1	0	2
CO4	2	0	1	0	2
CO5	3	0	1	0	2

COURSE CONTENT	
UNIT I	**Introduction:** Mobile Communications, Mobile Computing – Paradigm, Promises/Novel Applications and Impediments and Architecture; Mobile and Handheld Devices, Limitations of Mobile and Handheld Devices. GSM – Services, System Architecture, Radio Interfaces, Protocols, Localization, Calling, Handover, Security, New Data Services, GPRS.
UNIT II	**(Wireless) Medium Access Control (MAC):** Motivation for a specialized MAC (Hidden and exposed terminals, Near and far terminals), SDMA, FDMA, TDMA, CDMA, Wireless LAN/(IEEE 802.11)
UNIT III	**Mobile Network Layer:** IP and Mobile IP Network Layers, Packet Delivery and Handover Management, Location Management, Registration, Tunneling and Encapsulation, Route Optimization, HCP.
UNIT IV	**Mobile Transport Layer:** Conventional TCP/IP Protocols, Indirect TCP, Snooping TCP, Mobile TCP, Other Transport Layer Protocols for Mobile Networks. **Database Issues:** Database Hoarding & Caching Techniques, Client-Server Computing & Adaptation, Transactional Models, Query processing, Data Recovery Process & QOS Issues.
UNIT V	**Data Dissemination:** Communications Asymmetry, Classification of Data Delivery Mechanisms, Data Dissemination, Broadcast Models, Selective Tuning and Indexing Methods. **Mobile Ad hoc Networks (MANETs) :** Introduction, Applications & Challenges of a MANET, Routing, Classification of Routing Algorithms, Algorithms such as DSR, AODV, DSDV.

TEXT BOOKS	
1.	Jochen Schiller, “Mobile Communications”, Addison-Wesley, Second Edition, 2009.
2.	Raj Kamal, “Mobile Computing”, Oxford University Press, 2007, ISBN: 0195686772.
REFERENCE BOOKS	
1.	ASOKE K TALUKDER, HASAN AHMED, ROOPA R YAVAGAL, “Mobile Computing, Technology Applications and Service Creation” Second Edition, Mc Graw Hill.
2.	UWE Hansmann, LotherMerk, Martin S. Nocklous, Thomas Stober, “Principles of Mobile Computing,” Second Edition, Springer.
WEB RESOURCES	
1.	https://onlinecourses.nptel.ac.in/noc16_cs13 (Prof. Pushpendra Singh, IIIT-Delhi)
2.	https://disco.ethz.ch/courses/ss02/mobicomp/

ADVANCED UNIX PROGRAMMING

M.Tech (Computer Science and Engineering)

Course Category	Professional Elective	**Course Code**	
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites		**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	Introduction to UNIX Operating System and its File System
2	To gain an understanding of important aspects related to the SHELL and the process utilities and service utilities.

COURSE OUTCOMES		**BTL**
Upon successful completion of the course, the student will be able to:		
CO1	Make use of basic Unix commands.	L2
CO2	Analyze file system architecture to organize the file system	L4
CO3	Analyze shell command line structure	L4
CO4	Illustrate the usage of filters in AWK language.	L2
CO5	Implement commands using Shell Programming.	L3

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	1	0	1	2	1
CO2	1	0	1	2	1
CO3	1	0	1	2	1
CO4	1	0	1	2	1
CO5	2	0	1	2	1

COURSE CONTENT	
UNIT I	**Introduction to unix**-Brief History-What is Unix-Unix Components-Using Unix-Commands in Unix- Some Basic Commands-Command Substitution-Giving Multiple Commands.
UNIT II	**The File system** –The Basics of Files-What's in a File-Directories and File Names-Permissions-I Nodes- The Directory Hierarchy, File Attributes and Permissions-The File Command knowing the File Type- The Chmod Command Changing File Permissions-The

	Chown Command Changing the Owner of a File-The Chgrp Command Changing the Group of a File.
UNIT III	**Using the Shell**-Command Line Structure-Met characters-Creating New Commands-Command Arguments and Parameters-Program Output as Arguments-Shell Variables- -More on I/O Redirection- Looping in Shell Programs.
UNIT IV	**Filters**-The Grep Family-Other Filters-The Stream Editor Sed-The AWK Pattern Scanning and processing Language-Good Files and Good Filters.
UNIT V	**Shell Programming**-Shell Variables-The Export Command, The read Command-Positional parameters-The $? Variable knowing the exit Status-the Set Command-The Exit Command-Branching Control Structures-Loop Control Structures-The Continue and Break Statement. The Expr Command: Performing Integer Arithmetic-Real Arithmetic in Shell Programs-The Sleep Command- Debugging Scripts-The Script Command-The Eval Command-The Exec Command.

TEXT BOOKS	
1.	The Unix programming Environment by Brain W. Kernighan & Rob Pike, Pearson..
2.	Introduction to Unix Shell Programming by M.G. Venkateshmurthy, Pearson.
REFERENCE BOOKS	
1.	Unix and shell programming by B.M. Harwani, OXFORD university press.
WEB RESOURCES	
1.	https://www.tutorialspoint.com/unix/index.htm
2.	http://www.theunixschool.com/p/awk-sed.html
3.	https://nptel.ac.in/courses/106108101/pdf/PPTs/Mod_13.pdf

ARTIFICIAL INTELLIGENCE

M.Tech(Computer Science and Engineering)

Course Category	Professional Elective	**Course Code**	
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites		**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	Learn about basic AI fundamentals and AI problems
2	Students will gain an understanding about searching
3	Study about AI game playing concepts
4	Understand about AI knowledge
5	Students will know about AI order logic

COURSE OUTCOMES		**BTl**
Upon successful completion of the course, the student will be able to:		
CO1	Apply Artificial Intelligence in Game Playing.	L3
CO2	Identify problem solving and reduction strategies in AI.	L2
CO3	Outline logic concepts in AI.	L2
CO4	Analyze the current knowledge representation techniques in AI.	L4
CO5	Develop an expert system in AI.	L3

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	1	0	1	1	2
CO2	2	0	1	1	2
CO3	2	0	1	1	2
CO4	2	1	1	1	2
CO5	2	0	2	1	2

COURSE CONTENT	
UNIT I	**Introduction to artificial intelligence:** Introduction ,history, intelligent systems, foundations of AI, applications, tic-tac-tie game playing, development of AI languages, current trends in AI.
UNIT II	**Problem solving: state-space search and control strategies:** Introduction, general problem solving, characteristics of problem, exhaustive searches, heuristic search techniques, iterative-deepening a*, constraint satisfaction. **Problem reduction and game playing:** Introduction, problem reduction, game playing, alpha-beta pruning, two-player perfect information games.
UNIT III	**Logic concepts:** Introduction, propositional calculus, proportional logic, natural deduction system, axiomatic system, semantic tableau system in proportional logic, resolution refutation in proportional logic, predicate logic..
UNIT IV	**Knowledge representation:** Introduction, approaches to knowledge representation, knowledge representation using semantic network, extended semantic networks for KR **Advanced knowledge representation techniques:** Introduction, conceptual dependency theory, script structure.
UNIT V	**Expert system and applications:** Introduction phases in building expert systems, expert system versus traditional systems, rule-based expert systems blackboard systems truth maintenance systems, application of expert systems, list of shells and tools.

TEXT BOOKS	
1.	Artificial Intelligence- Saroj Kaushik, CENGAGE Learning.
2.	Artificial intelligence, A modern Approach, 2nd ed, Stuart Russel, Peter Norvig, PEA.
3.	Artificial Intelligence- Rich, Kevin Knight, Shiv Shankar B Nair, 3rd ed, TMH.
REFERENCE BOOKS	
1.	Artificial intelligence, structures and Strategies for Complex problem solving, -George F Lugar, 5th ed, PEA.
2.	Introduction to Artificial Intelligence, Ertel, Wolf Gang, Springer.
WEB RESOURCES	
1.	http://www.cs.jhu.edu/~phi/ai/slides/lecture-inference-in-first-order-logic.pdf
2.	https://en.wikipedia.org/wiki/History_of_artificial_intelligence
3.	http://www.imada.sdu.dk/~marco/DM828/Slides/dm828-lec18.pdf

CLOUD COMPUTING

M.Tech(Computer Science and Engineering)

Course Category	Professional Elective	**Course Code**	
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites		**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	The student will learn about the cloud environment, building software systems and components that scale to millions of users in modern Cloud Environments.
2	The student will be able to create a cloud account and develop and deploy small application on one of the public cloud offerings.

COURSE OUTCOMES		**BTL**
Upon successful completion of the course, the student will be able to:		
CO1	Differentiate among various cloud offerings, cloud environments, distributed technologies	L4
CO2	Analyze various cloud platforms and cloud applications.	L4
CO3	Survey the policies and mechanisms for resource management, performance, scheduling	L4
CO4	Choose among different storage technologies for cloud like DFS, GFS, HDFS, S#, Big Table.	L2
CO5	Develop a small application on cloud platform like Amazon Aws, Azure..	L3

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	1	0	1	1	2
CO2	2	0	1	1	2
CO3	2	0	1	1	2
CO4	2	0	1	1	2
CO5	2	0	2	1	2

COURSE CONTENT	
UNIT I	**Introduction:** Network centric computing, Network centric content, peer-to –peer systems, cloud computing delivery models and services, Ethical issues, Vulnerabilities, Major challenges for cloud computing.

	Parallel and Distributed Systems: introduction, architecture, distributed systems, communication protocols, logical clocks, message delivery rules, concurrency.
UNIT II	**Cloud Infrastructure:** At Amazon, The Google Perspective, Microsoft Windows Azure, Open Source Software Platforms, Cloud storage diversity, Inter cloud. **Cloud Computing:** Applications and Paradigms: Challenges for cloud, existing cloud applications and new opportunities, architectural styles, workflows, The Zookeeper, The Map Reduce Program model, HPC on cloud, biological research.
UNIT III	**Cloud Resource virtualization:** Virtualization, layering and virtualization, virtual machine monitors, virtual machines, virtualization- full and para, performance and security isolation. **Cloud Resource Management and Scheduling**: Policies and Mechanisms, Applications of control theory to task scheduling, Stability of a two-level resource allocation architecture, feedback control based on dynamic thresholds, coordination, resource bundling, cloud scheduling subject to deadlines, Resource management and dynamic application scaling.
UNIT IV	**Storage Systems:** Evolution of storage technology, storage models, file systems and database, distributed file systems, general parallel file systems. Google file system., Apache Hadoop, Big Table, Megastore (text book 1), Amazon Simple Storage Service(S3)
UNIT V	**Cloud Application Development:** Amazon Web Services : EC2 – instances, connecting clients, security rules, launching, usage of S3 in Java, Installing Simple Notification Service on Ubuntu 10.04, Installing Hadoop on Eclipse, Cloud based simulation of a Distributed trust algorithm, Cloud service for adaptive data streaming (Text Book 1) **Google:** Google App Engine, Google Web Toolkit (Text Book 2) **Micro Soft:** Azure Services Platform, Windows live, Exchange Online, Share Point Services, Microsoft Dynamics CRM.

TEXT BOOKS	
1.	Cloud Computing, Theory and Practice, Dan C Marinescu, MK Elsevier.
2.	Cloud Computing, A Practical Approach, Anthony T Velte, Toby J Velte, Robert Elsenpeter,
REFERENCE BOOKS	
1.	Mastering Cloud Computing, Foundations and Application Programming, Raj Kumar Buyya, Christen vecctiola, S Tammaraiselvi, TMH.
WEB RESOURCES	
1.	https://onlinecourses.nptel.ac.in/noc16_cs13 (Prof. Pushpendra Singh, IIIT-Delhi)
2.	https://disco.ethz.ch/courses/ss02/mobicomp/

SOFTWARE TESTING METHODOLOGIES

M.Tech (Computer Science and Engineering)

Course Category	Professional Elective	**Course Code**	
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites		**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	Apply software testing knowledge and engineering methods.
2	Design and conduct a software test process for a software testing project.
3	Solve software testing problems by designing and selecting software test models, criteria, strategies, and methods.
4	Identify the needs of software test automation.

COURSE OUTCOMES		**BTL**
Upon successful completion of the course, the student will be able to:		
CO1	Outline the necessity of testing, debugging using program control flow.	L2
CO2	Apply transaction flow, data flow testing to unit and integration testing.	L3
CO3	Analyze white box testing methods and metrics.	L4
CO4	Compare state graph, transaction testing, and graph matrices for optimizing code.	L4
CO5	Examine testing strategies of system testing.	L4

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	1	0	1	2	1
CO2	2	1	1	2	1
CO3	2	1	1	2	1
CO4	2	0	1	2	1
CO5	1	1	1	2	1

COURSE CONTENT	
UNIT I	**Introduction:** Purpose of Testing, Dichotomies, Model for Testing, Consequences of Bugs, Taxonomy of Bugs. Flow graphs and Path testing: Basics Concepts of Path Testing, Predicates, Path Predicates and achievable Paths, Application of Path Testing, Need of Black box and White box testing.
UNIT II	**Transaction Flow Testing**: Transaction Flows, Transaction Flow Testing Techniques. **Dataflow Testing:** Basics of Dataflow Testing, Strategies in Dataflow Testing, Application of Data flow Testing. Validation activities: Unit testing, Integration Testing.
UNIT III	**Domain Testing:** Domains and Paths, Nice & Ugly Domains, Domain testing, Domains and Interfaces Testing, Domain and Interface Testing, Domains and Testability. **Paths, Path products and Regular Expressions:** Path Products & Path Expression, Reduction Procedure, Applications, Regular Expressions & Flow Anomaly Detection.
UNIT IV	**State, State Graphs and Transition Testing:** State Graphs, Good & Bad State Graphs, State Testing, and Testability Tips. **Graph Matrices and Application:** Motivational overview, matrix of graph, relations, power of a matrix, node reduction algorithm.
UNIT V	**Validation Activities**: Function testing, system testing, acceptance testing **Regression Testing:** Progressives Vs regressive testing, Regression testability, Objectives of regression testing, when regression testing done? Regression testing types, Regression testing techniques.

TEXT BOOKS	
1.	Software testing techniques," Boris Beizer, Dreamtech, second edition, 2003.
2.	Software Testing," Yogesh Singh, Cambridge University Press, 2011.
3.	Introduction to Software Testing,"P.Ammann&J.Offutt, Cambridge University Press, 2nd edition, 2017.
REFERENCE BOOKS	
1.	The Craft of software testing," Brian Marick, Pearson Education, 1995.
2.	Software Testing," N.Chauhan, Oxford University Press, 2010.
WEB RESOURCES	
1.	https://onlinecourses.nptel.ac.in/noc17_cs32/preview (Meenakshi D Souza, IIIT-Bangalore)
2.	https://www.youtube.com/watch?v=6rNgPXz9A9s
3.	https://www.youtube.com/watch?v=_U6y5xhPdSQ

CSE LABORATORY2

M.Tech(Computer Science and Engineering)

Course Category	Professional Core	**Course Code**	
Course Type	Laboratory	**L-T-P-C**	0-0-4-2
Prerequisites		**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	To write, execute and debug c programs which use Socket API.
2	To understand the use of client/server architecture in application development
3	To understand how to use TCP and UDP based sockets and their differences.
4	To get acquainted with Unix system internals like Socket files, IPC structures.
5	To Design reliable servers using both TCP and UDP sockets

COURSE OUTCOMES		**BTL**
Upon successful completion of the course, the student will be able to:		
CO1	Implement connection oriented and connectionless protocols.	L3
CO2	Implement the SMTP, FTP & HTTP	L3

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	2	0	1	2	1
CO2	2	0	1	2	1

COURSE CONTENT

1. a) Study of Unix/Linux general purpose utility command list man,who,cat, cd, cp, ps, ls, mv, rm, mkdir, rmdir, echo, more, date, time, kill, history, chmod, chown, finger, pwd, cal, logout, shutdown.
b) Study of vi editor.
c) Study of Bash shell, Bourne shell and C shell in Unix/Linux operating system.
d) Study of Unix/Linux file system (tree structure).
e) Study of. bashrc, /etc/bashrc and Environment variables.
2. Write a C program that makes a copy of a file using standard I/O, and system calls
3. Write a C program to emulate the UNIX ls –l command.

4. Write a C program that illustrates how to execute two commands concurrently with a command pipe.
Ex: - ls –l | sort
5. Write a C program that illustrates two processes communicating using shared memory.
6. Write a C program to simulate producer and consumer problem using semaphores.
7. Write C program to create a thread using pthreads library and let it run its function.
8. Write a C program to illustrate concurrent execution of threads using pthreads library. Understanding and using of commands like ifconfig, netstat, ping, arp, telnet, ftp, finger, traceroute, whoisetc. Usage of elementary socket system calls (socket (), bind(), listen(), recvfrom())
9. Implementation of Connection oriented concurrent service (TCP).
10. Implementation of Connectionless Iterative time service (UDP).
11. Implementation of Select system call.
12. Implementation of gesockopt (), setsockopt () system calls.
13. Implementation of getpeername () system call.
14. Implementation of remote command execution using socket system calls.