Total Credits = 23								
SEMESTER 1st		**Contact Hrs.**				**Marks**		**Credits**
Subject Code	Subject Name	**L**	**T**	**P**	Internal	External	Total	
MCAPS1-101	Computer Networks	3	1	0	40	60	100	4
MCAPS1-102	Relational Database Management System	3	1	0	40	60	100	4
MCAPS1-103	Object Oriented Programming Using C++	3	1	0	40	60	100	4
MCAPS1-104	Computer Organization and Architecture	3	0	0	40	60	100	3
MCAPS1-105	Business Communications	2	0	0	40	60	100	2
MCAPS1-106	Relational Database Management Lab	0	0	4	60	40	100	2
MCAPS1-107	Object Oriented Programming using C++ Lab	0	0	4	60	40	100	2
MCAPS1-108	Business Communications and Soft Skills Lab	0	0	4	60	40	100	2
Total					380	420	800	23

Total Credits = 23										
SEMESTER 2nd			**Contact Hrs.**				**Marks**		**Credits**	
Subject Code		Subject Name	**L**	**T**	**P**	Internal	External	Total		
MCAPS1-201		Data Structures	3	1	0	40	60	100	4	
MCAPS1-202		Operating System	3	1	0	40	60	100	4	
MCAPS1-203		Discrete Mathematics	3	0	0	40	60	100	3	
MCAPS1-204		Data Structures Lab	0	0	4	60	40	100	2	
MCAPS1-205		Operating System Lab	0	0	4	60	40	100	2	
Departmental Elective – I (Select any one)										
DE11	**MCAPD1-211**	Data Warehousing and Data Mining	3	0	0	40	60	100	3	
DE12	**MCAPD1-212**	Business Intelligence & Digital	3	0	0	40	60	100	3	
DE13	**MCAPD1-213**	Software Testing and Quality Assurance	3	0	0	40	60	100	3	
Departmental Elective – II (*Select a combination (Theory & Lab)*)**										
DE21	**MCAPD1-221**	Programming in Java	3	0	0	40	60	100	3	5
	MCAPD1-222	Programming in JAVA Lab	0	0	4	60	40	100	2	
DE22	**MCAPD1-223**	Programming with Python	3	0	0	40	60	100	3	5
	MCAPD1-224	Programming with Python Lab	0	0	4	60	40	100	2	
Total						380	420	800	23	

Note:
***Students have to select a combination of subjects from **DE21/DE22** as Departmental Elective–II :*
**Note:*
After 2nd Semester minimum 04 weeks Training in Institute/Industry.

Total Credits = 23									
SEMESTER 3rd			**Contact Hrs.**			**Marks**			**Credits**
Subject Code		Subject Name	**L**	**T**	**P**	Internal	External	Total	
MCAPS1-301		Artificial Intelligence	3	1	0	40	60	100	4
MCAPS1-302		Design and Analysis of Algorithms	3	1	0	40	60	100	4
MCAPS1-303		Information and Network Security	3	0	0	40	60	100	3
MCAPS1-304		Design and Analysis of Algorithms Lab	0	0	4	60	40	100	2
MCAPS1-305		Institute /Industrial Training	--	--	--	60	40	100	2
Departmental Elective – III (*Select a combination (Theory & Lab)**)**									
DE31	**MCAPD1-311**	LAMP Technologies	3	0	0	40	60	100	3
	MCAPD1-312	LAMP Technologies Lab	0	0	4	60	40	100	2
DE32	**MCAPD1-313**	Database Administration	3	0	0	40	60	100	3
	MCAPD1-314	Database Administration Lab	0	0	4	60	40	100	2
DE33	**MCAPD1-315**	Cloud Computing	3	0	0	40	60	100	3
	MCAPD1-316	Cloud Computing Lab	0	0	4	60	40	100	2
OP31	**XXXX**	Open Elective	3	0	0	40	60	100	3
Total						380	420	800	23

****Note:*
*Students have to select a combination of subjects from **DE31/DE32 /DE33** as Departmental Elective–III*

Total Credits = 20										
SEMESTER 4th			**Contact Hrs.**			**Marks**			**Credits**	
Subject Code		Subject Name	**L**	**T**	**P**	Internal	External	Total		
MCAPS1-401		Theory of Computation	3	1	0	40	60	100	4	
MCAPS1-402		Current Trends and Technologies	3	0	0	40	60	100	3	
MCAPS1-403		Software Project	0	0	6	80	120	200	3	
MCAPS1-404		Seminar	--	--	2	100	0	100	1 (Satisfactory/ Unsatisfactory)	
Department Elective- IV (*Select a combination (Theory & Lab)***)**										
DE41	**MCAPD1-411**	Big Data	3	1	0	40	60	100	4	5
	MCAPD1-412	Big Data Lab	0	0	2	60	40	100	1	
DE42	**MCAPD1-413**	Dot Net Framework	3	1	0	40	60	100	4	5
	MCAPD1-414	Dot Net Framework Lab	0	0	2	60	40	100	1	
DE43	**MCAPD1-415**	Mobile Computing & Android	3	1	0	40	60	100	4	5
	MCAPD1-416	Mobile Computing & Android Lab	0	0	2	60	40	100	1	

DE44	**MCAPD1-417**	Soft Computing	3	1	0	40	60	100	4	5
	MCAPD1-418	Soft Computing Lab	0	0	2	60	40	100	1	
Departmental Elective – V (*Select a combination (Theory & Lab)****)**										
DE51	**MCAPD1-421**	Machine Learning	3	0	0	40	60	100	3	4
	MCAPD1-422	Machine Learning Lab	0	0	2	60	40	100	1	
DE52	**MCAPD1-423**	Computer Graphics	3	0	0	40	60	100	3	4
	MCAPD1-424	Computer Graphics Lab	0	0	2	60	40	100	1	
DE53	**MCAPD1-425**	Fog Computing and Internet of Things	3	0	0	40	60	100	3	4
	MCAPD1-426	Fog Computing and Internet of Things Lab	0	0	2	60	40	100	1	
Total						460	440	900	20	

*****Note:*
*Students have to select a combination of subjects from **DE41/DE42/DE43/DE44** as Departmental Elective–IV*

******Note:*
*Students have to select a combination of subjects from **DE51/DE52/DE53** as Departmental Elective–V*

Bridge Course Subjects for Non-IT Background Students: -								
Note: Students have to earn minimum 02 credit in each subject during the MCA Degree								
						Total Credits = 12		
Bridge courses		**Contact Hrs.**			**Marks**			**Credits**
Subject Code	Subject Name	**L**	**T**	**P**	Internal	External	Total	
MCAPS1-001	Software Engineering	3	1	0	40	60	100	4
MCAPS1-002	Digital Electronics	3	1	0	40	60	100	4
MCAPS1-003	Mathematical Foundations of Computer Science	3	1	0	40	60	100	4
Total		9	3	0	120	180	300	12

Overall

Semester	Marks	Credits
1st	800	23
2nd	800	23
3rd	800	23
4th	900	20
Total	**3300**	**89**

COMPUTER NETWORKS

Subject Code: MCAPS1-101 **LTPC** **Duration: 60 Hrs.**

3104

Course Objectives

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

1. Independently understand basic computer network technology, data communication system and its components.
2. Identify the different types of network topologies, protocols, layers of the OSI model and TCP/IP.
3. Identify the different types of network devices and their functions within a network.
4. Familiarity with the basic protocols of computer networks, and how they can be used to assist in network design and implementation.

UNIT-I (17 Hrs.)

Introduction to Computer Networks - Data Communication System and its components, Data Flow, Computer network and its goals, Types of computer networks: LAN, MAN, WAN, Wireless and wired networks, broadcast and point to point networks, Network topologies, Network software: concept of layers, protocols, interfaces and services, ISO-OSI reference model, TCP/IP reference model.

Physical Layer - Concept of Analog & Digital Signal, Bandwidth, Transmission Impairments: Attenuation, Distortion, Noise, Data rate limits: Nyquist formula, Shannon Formula, Multiplexing: Frequency Division, Time Division, Wavelength Division, Introduction to Transmission Media: Twisted pair, Coaxial cable, Fiber optics, Wireless transmission (radio, microwave, infrared), Switching: Circuit Switching, Message Switching, Packet Switching & their comparisons.

UNIT-II (15 Hrs.)

Data Link Layer - Design issues, Framing, Error detection and correction codes: checksum, CRC, hamming code, Data link protocols for noisy and noiseless channels, Sliding Window Protocols: Stop & Wait ARQ, Go-back-N ARQ, Selective repeat ARQ, Data link protocols: HDLC and PPP.

Medium Access Sub-Layer - Static and dynamic channel allocation, Random Access: ALOHA, CSMA protocols, Controlled Access: Polling, Token Passing, IEEE 802.3 frame format, Ethernet cabling, Manchester encoding, collision detection in 802.3, Binary exponential back off algorithm.

UNIT-III (14 Hrs.)

Network Layer - Design issues, IPv4 classful and classless addressing, subnetting, Routing algorithms: distance vector and link state routing, Congestion control: Principles of Congestion Control, Congestion prevention policies, Leaky bucket and token bucket algorithms

UNIT-IV (14 Hrs.)

Transport Layer - Elements of transport protocols: addressing, connection establishment and release, flow control and buffering, multiplexing and de-multiplexing, crash recovery, introduction to TCP/UDP protocols and their comparison.

Application Layer - World Wide Web (WWW), Domain Name System (DNS), E-mail, File Transfer Protocol (FTP), Introduction to Network security.

Recommended Books

1. Andrew S. Tanenbaum, 'Computer Networks', 5th Edn., Pearson Education, **2010.**
2. Behrouz A. Forouzan, 'Data Communications & Networking', 5th Edn., Tata McGrawHill, **2012.**
3. James F. Kurose and Keith W. Ross, 'Computer Networking', 6th Edn., Pearson Education,**2013.**
4. Douglas E. Comer, 'Internetworking with TCP/IP, Volume-I', 6th Edn., Prentice HallIndia, **2013.**

RELATIONAL DATABASE MANAGEMENT SYSTEM

Subject Code: MCAPS1-102 **L T P C** **Duration: 60 Hrs.**

3104

Course Objectives

1. The course aims at providing the students through insight on few DBMS principles and practices.
2. Students will learn and implement the operations for making and using databases with help of SQL and PL/SQL.

UNIT- I (17 Hrs.)

Introduction to DBMS - Overview of DBMS, Basic DBMS terminology, Data independence. Architecture of a DBMS, Introduction to data models: Entity relationship model, Hierarchical model, Network model, Relational model.

Relational Design - Relation scheme, Codd's Rule for RDBMS, Anomalies in a database, Functional Dependency: Dependencies and Logical implications, Closure set, Testing if FD is in closure, Covers, Non redundant and Minimum cover, Canonical cover, Functional dependencies and Keys.

Normal Forms - INF, 2NF, 3NF, BCNF, Multi valued dependencies and Joined dependencies, 4NF, 5NF.

UNIT-II (15 Hrs.)

Structured Query Language - Introduction to SQL, Oracle server and Oracle database, Oracle data types, Starting SQL*Plus, querying database tables, Conditional retrieval of rows, working with null values, matching a pattern from a table, Ordering the result of a query, Aggregate Functions, Grouping the result of a query.

Querying multiple Tables - Equi Joins, Cartesian Joins, Outer Joins, Self Joins; SET Operators - Union, Intersect, Minus.

Functions - Arithmetic functions, Character functions, Date functions, and Group functions.

UNIT-III (14 Hrs.)

Data Manipulation and Control - Data Definition Language (DDL), Creating Tables, creating a Table with data from another table, Inserting Values into a Table, Updating Column(s) of a Table, Deleting Row(s) from a Table, dropping a Column; VIEW - Manipulating the Base table, Rules of DML Statements on Join Views, Dropping a VIEW, Inline Views.

Database security and privileges - GRANT command, REVOKE command, COMMIT and ROLLBACK.

UNIT- IV (14 Hrs.)

PL/SQL - Introduction to PL/SQL, The Advantage of PL/SQL, PL/SQL Architecture, Fundamentals of PL/SQL, PL/SQL Data types, variables and constants, Assignments and expressions, Operator precedence, referencing Non-PL/SQL variables, built in functions, conditional and iterative control, SQL within PL/SQL, writing PL/SQL code. Cursor management in PL/SQL, Cursor manipulation, Triggers, Stored procedures, Exception handling in PL/SQL, Predefined exceptions, User defined exceptions, Triggers, Stored procedures.

Recommended Books

1. Bipin C. Desai, 'An Introduction to Database System', 3rd Edn., Galgotia PublicationsPrivate Ltd, **2012**.
2. Ivan Bayross, 'SQL, PL/SQL The Programming Language of ORACLE', 2nd Edn., BPBPublication, **2003**.
3. Henry F. Korth, 'Database Systems Concepts', 5th Edn., McGraw Hill Inc, **2005**.
4. Ramez Elmasri and Shamkant B. Navathe, 'Fundamentals of Database Systems', 4th Edn., Pearson, **2003**.

OBJECT ORIENTED PROGRAMMING USING C++

Subject Code: MCAPS1-103 **LTPC 3104** **Duration: 60 Hrs.**

Course Objectives

After completion of this course, the students would be:

1. Able to learn basics and programming skills of high level language C++.
2. Able to learn how to manage the memory by using dynamic memory management.
3. Able to learn how to use reusability concept by using inheritance and templates.
4. Able to learn the skills of handing modular approach and exceptions.

UNIT-I (17 Hrs.)

Object-Oriented Programming Concepts - Need of Object-Oriented Programming - Comparison of procedural programming and Object Oriented Programming - Characteristics of Object-Oriented Languages - C++ Programming Basics: Basic Program Construction - Data Types, Variables, Constants - Type Conversion, Operators, Library Functions - Loops and Decisions, Structures - Functions : Simple Functions, Passing arguments, Returning values, Reference Arguments. - Recursion, Inline Functions, Default Arguments - Storage Classes - Arrays , Strings

UNIT-II (15 Hrs.)

Features of Object Oriented Programming- Introduction to Classes and Objects Constructors and its types, Destructors - Passing Objects as Function arguments and Returning Objects from Functions - Operator Overloading Inheritance - Overloading Member Functions Pointers - Virtual Functions – Friend Functions, Static Functions.

UNIT-III (14 Hrs.)

Streams and Files- Streams: Classes and Errors, Disk File I/O with Streams - - Files: File Pointers - Error handling in File I/O - File I/O with member Functions - Overloading the extraction and Insertion Operators - Multi File Programs

UNIT-IV (14 Hrs.)

Templates and Exception-Templates: Function templates, Class templates - Exceptions: Need of Exceptions, keywords, Simple and Multiple Exceptions - Re-throwing Exception and Exception Specifications, Custom Exception, Introduction to Standard Template Library (STL)

Recommended Books

1. Robert Lafore, 'Object Oriented Programming in C++', 4th Edn., Waite Group, **2001**.
2. E. Balagurusamy, 'Object Oriented Programming with C++', 6th Edn., Tata McGraw Hill, **2013**.
3. R.S. Salaria, 'Object-Oriented Programming using C++', 4th Edn., Khanna BookPublishing, **2009**.
4. Bjarne Stroustrup, 'The C++ Programming Language', 3rd Edn., Addison Wesley, **1997**.
5. Herbert Schildt, 'C++: The Complete Reference', 4th Edn., McGraw Hill, **2009**.

COMPUTER ORGANIZATION & ARCHITECTURE

Subject Code: MCAPS1-104 **L T P C** **Duration: 45 Hrs.**

3003

Course Objectives

1. To provide students with a solid foundation in computer design.
2. To examine the operation of the major building blocks of a computer system.
3. To introduce students to the design and organization of modern digital computers & basic assembly language.

UNIT-I (12 Hrs.)

Basic Computer Organization and Design - Common Bus System, Registers, Instruction codes, computer Instructions, Timing and Control, Instruction Cycle, Arithmetic, Logic & Shift micro operations instructions, Memory Reference Instructions, Design of Basic Computer and its working**.**

Programming & Controlling Basic Computer - Machine & Assembly Language, Programming Arithmetic and Logic Operations, Hardwired & Micro programmed control, Address Sequencing, Design of a control unit.

UNIT-II (10 Hrs.)

CPU Architecture - General register & stack organization, Instruction formats, Addressing Modes, Data Transfer and Manipulation, Program Control, ALU & Control Unit Architecture.

I/O Organization - Peripheral Devices, input-output interface, Asynchronous Data Transfer, Modes of data transfer-programmed & interrupt initiated I/O, Priority Interrupt, DMA, I/O Processors.

UNIT-III (12 Hrs.)

Memory Organization - Main Memory-Memory Address Map, Memory connection to CPU, Associative Memory-Hardware organization, Cache Memory-Levels of Cache, Associative Mapping, Direct Mapping, Set-Associative Mapping.

Parallel & Multiprocessing Environment - Introduction to parallel processing, Pipelining, RISC Architecture, Vector & array processing, multiprocessing concepts, memory & resource Sharing, Inter processor communication & Synchronization.

UNIT- IV (11 Hrs.)

Overview of Assembly Language Programming - Architecture of a typical 8-bit processor(8085 microprocessor) - Registers, Instruction Set-Data Transfer Instructions, Arithmetic Instructions, Logical Instructions, Program Control Instructions, Machine Control Instructions.

Use of an Assembly Language for Specific Programs - Simple numeric manipulations, sorting of a list and use of I/O instructions.

Recommended Books

1. M. Morris Mano, 'Computer System Architecture', Prentice Hall, **1976**.
2. William Stallings, 'Computer Organization and Architecture', 9th Edn., Pearson, **2016**.
3. P.V.S. Rao, 'Computer System Architecture', 2nd Edn., PHI, **2009**.
4. John P. Hayes, 'Computer Architecture & Organization, 3rd Edn., McGraw Hill, **2012**.
5. Stone, 'Introduction to Computer Architecture', 2nd Edn., Galgotia, **1996**.

BUSINESS COMMUNICATIONS

Subject Code: MCAPS1-105 **L T P C** **Duration - 30 Hrs.**

2002

Course Objectives

1. This course is designed to give students a comprehensive view of communication, its scope and importance in business, the role of communication in establishing a favorable image of the organization.
2. The aim is to develop students' ability to communicate correctly and effectively on matters having relevance to day-to-day business operations.

3. This course will make student conversant with fundamentals of communication, help them honing oral, written and non-verbal communication skills and to transform their communication abilities.

UNIT- I (7 Hrs.)

Introduction to Communication - Meaning, Process, Importance of Communication in Business, Types of Information, Formal and Informal Communication, Internal and External Communication. Approaches to Effective Communication, Essentials of Effective Business Communication (7Cs model).

Written Communication - Advantages and Disadvantages, Covering letter, Need, Functions and Kinds, Layout of Letter Writing, Types of Letter Writing: Persuasive Letters, Request Letters, Sales Letters, Complaints and Adjustments.

UNIT –II (7 Hrs.)

Developing Reading Skills - Identify the Purpose of Reading, Factors Effecting Reading, Course How to Think and Read, Developing Effective Reading Habits, Reading Tactics and Strategies: Training Eye and Training Mind (SQ3R)

Developing Listening Skills - Importance, Purpose of Listening, Art of Listening, Factors Affecting Listening, Components of Effective Listening, Process of Listening, Principles and Barriers to Listening, Activities to Improve Listening

UNIT- III (8 Hrs.)

Oral Communication - Advantages and Disadvantages, Conversation as Communication, Art of Public Speaking, Group Communication Through Committees, Preparing and Holding
Meetings, Overcoming Stage Fright, Ambiguity Avoidance.

Departmental Communication - Meaning, Need and Types: Interview Letters, Promotion Letters, Resignation Letters, Newsletters, Circulars, Agenda, Notice, Office Memorandums, Office Orders, Press Release

Report Writing - Structure, Types, Formats, Drafting of Various Types of Report. Nonverbal – Features, Understanding of Body Language, Posture, Gestures. Influences on Communication: Social Influences, Culture and Communication, Few Guidelines for Better Multicultural Communication, Business Etiquettes and Communication.

UNIT- IV (8 Hrs.)

Group Discussion - Nature, Uses and Importance, Guidelines for GD Presentations: How to Make Effective Presentations, Four P‟ S of Presentation, Structuring, Rehearsing and Delivery Methods.

Resume Writing - Planning, Organizing Contents, Layout, Guidelines for Good Resume. Interviews: Preparation Techniques, Frequently Asked Questions about How to Face an Interview Board, Proper Body Posture, projecting a Positive Image, steps to Succeed in
Interviews, Practice Mock Interview in Classrooms.

The Case Method of Course - Dimensions of a Case, Case Discussion, Usefulness of The Case Method, Training of Managers, Use The Case Method. Report Writing: Structure, Types, Formats, Preparations and Presentation.

Recommended Books

1. Lesikar, Petit & Flately, 'Lesikar's Basic Business Communication', Tata McGraw Hill.
2. Raman Meenakshi, 'Prakash Singh, Business Communication', Oxford University Press.
3. Rizvi Ashraf, 'Effective Technical Communication', Tata McGraw Hill.
4. Krizan, Buddy, 'Merrier, Effective Business Communication', Cengage Course.
5. Diwan & Aggarwal, 'Business Communication', Excel.
6. Baugh, Frayer & Thomas, 'How to write first class Business Correspondence', Viva Book
7. Taylor, 'English Conversion Practice', Tata McGraw Hill.
8. Devaraj, 'Executive Communication', Tata McGraw Hill.
9. Ober, 'Effective Bossiness Communication', Cengage Course.

SOFTWARE LAB. – I
(RELATIONAL DATABASE MANAGEMENT SYSTEM)

Subject Code: MCAPS1-106 **L T P C**
0042

This laboratory course will comprise as exercises to supplement what is learnt under paper MCAPS1-102. Students are required to do at least 8 assignments based on the paper.

SOFTWARE LAB – II
(OBJECT ORIENTED PROGRAMMING USING C++)

Subject Code: MCAPS1-107 **L T P C**
0042

This laboratory course will comprise as exercises to supplement what is learnt under paper MCAPS1-103.

BUSINESS COMMUNICATIONS AND SOFT SKILLS LAB.

Subject Code: MCAPS1-108 **L T P C**
0042

The students will have to perform the practicals in lab related to the syllabus of the subject "Business Communications" (MCAPS1-105).

MRSPTU

DATA STRUCTURES

Subject Code: MCAPS1-201 **L T P C** **Duration: 60 Hrs.**
3 1 0 4

Course Objectives

1. A study of advanced programming topics focused on logical structures of data, their physical representation, design and analysis of algorithms operating on the structures, and techniques for program development and debugging.
2. Emphasis is placed on the appropriate use and choice of standard data structures.

UNIT-I (17 Hrs.)

Introduction to Data Structure - Concept of data, Problem analysis, Data structures andData structure operations, Notations, Mathematical notation and Functions, Algorithmic Complexity, Big-O Notation and time space trade off.

Arrays - Overview of Arrays, Recursion, Pointers, Pointer Arithmetic, Array of pointers,Arrays in terms of pointers, Static and Dynamic Memory Management, Garbage Collection, Understanding and Implementation of Various Data Structures with Applications.

Stack - Operations like Push, Pop and Various Applications like Conversion from Infix topostfix and prefix expressions, Evaluation of postfix expression using stacks.

Queues - Operations like Enqueue, Dequeue on Simple, Circular and Priority Queues.

Linked Lists - Operations like Creations, Insertion, Deletion, Retrieval and Traversal onSingle, Circular and doubly linked list.

UNIT-II (15 Hrs.)

Trees - Definitions and Concepts: Root Node, Leaf Node, Level, Degree, Height and Treerepresentation using linked List and array.

Tree Operations - Creation, Insertion, Deletion and Traversals (Preorder, In-order, Postordered) and searching on various types of trees. Types of Trees: Binary trees, Binary search tree, Height balanced (AVL) tree, B trees, B+ Tree.

Heap - Definition, Structure, Algorithms and applications.

UNIT-III (14 Hrs.)

Graphs - Graph definitions and Concepts: Edge, Vertices, and Graph representation using

Adjacency matrix, Adjacency lists. Types of graphs: Weighted, Unweighted, Directed, Undirected Graphs. Graph Operations: Creation, Insertion, Deletion, Traversals and Searching (Depth first, Breadth-first) of various types of graphs and Dijkstra's algorithm for shortest distance calculation.

UNIT- IV (14 Hrs.)

Sorting - Concepts, Order, Stability and Efficiency of various algorithms (Selection Sort,Bubble Sort, Insertion Sort, Merge Sort, Quick Sort, Heap Sort and Radix Sort).

Searching - Concept and Efficiency of linear and binary search algorithms.

Hashing - Definition, Implementation and Applications.

Recommended Books

1. Seymour Lipschutz, 'Data Structures', 1st Edn., McGraw Hill Education, **2014.**
2. E. Horowitz, and S. Sahni, 'Fundamentals of Data Structures in C++', 2nd Edn., GalgotiaPublications Pvt. Ltd., **1999**.
3. A.V. Aho, Hopcroft, J.D. Ullman, 'Data Structures and Algorithms', 1st Edn., Pearson, **1983**.
4. Tanenbaum, 'Data Structures using C', 2nd Edn., Prentice Hall International, **2015**.

OPERATING SYSTEM

Subject Code: MCAPS1-202 **LTPC 3104** **Duration: 60 Hrs.**

Course Objectives

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

1. Understand functions, Role, different structures and views of Operating system.
2. Understand Process management in operating system.
3. Understand Memory Management in operating system.
4. Understand Device Management in operating system.

UNIT-I (17 Hrs.)

Introduction - Introduction to Operating system, Role of Operating System as resourcemanager, function of kernel and shell, operating system structures, views of an operating system.

UNIT-II (14 Hrs.)

Process management - CPU scheduling, Scheduling Algorithms, PCB, Pricessynchronization, Deadlocks, Prevention, Detection and Recovery

UNIT-III (14 Hrs.)

Memory Management - Overlays, Memory management policies, Fragmentation and itstypes, Portioned memory managements, Paging, Segmentation, Ned of Virtual memories, Page replacement Algorithms, Concept of Thrashing

UNIT-IV (15 Hrs.)

Device Management - I/O system and secondary storage structure, Device managementpolicies, Role of I/O traffic controller, scheduler, File Management: File System Architecture, Layered Architecture, Physical and Logical File Systems, Protection and Security, Brief study to multiprocessor and distributed operating systems. Case Studies: LINUX / UNIX Operating System and Windows based operating systems. Recent trends in operating system.

Recommended Books

1. A. Silberschatz and Peter B. Galvin, 'Operating System Concepts', 2nd Edn., Wiley, **2013**.
2. Dhananjay M. Dhamdhere, 'Operating Systems', 1st Edn., McGraw Hill, **2008**.
3. Gary Nutt, 'Operating Systems Concepts', 2nd Edn., McGraw Hill, **2001**.
4. Stuart E. Madnick and John J. Donovan, 'Operating Systems', 1st Edn., McGraw Hill, **1974**.
5. William Stallings, 'Operating Systems: Internals and Design Principles', 6th Edn., PrenticeHall, **2008**.

DISCRETE MATHEMATICS

Subject Code: MCAPS1-203 **L T P C 3 0 0 3** **Duration: 45 Hrs.**

Course Objectives

1. To learn the ability to distinguish between the tractability and intractability of a given computational problem.
2. To be able to devise fast and practical algorithms for real-life problems using the algorithm design techniques and principles learned in this course.

UNIT-I (11 Hrs.)

Sets, Relations and Functions: Introduction, Combination of Sets, ordered pairs, proofs of general identities of sets, relations, operations on relations, properties of relations and functions, Hashing Functions, equivalence relations, compatibility relations, partial order relations.

Basic Logic: Propositional logic, Logical connectives, Truth tables, Normal forms (conjunctive and disjunctive), Validity of well-formed formula, Propositional inference rules (concepts of modus ponens and modus tollens), Predicate logic, Universal and existential quantification, Limitations of propositional and predicate logic.

UNIT-II (10 Hrs.)

Combinatorial Mathematics: Basic counting principles Permutations and combinations Inclusion and Exclusion Principle Recurrence relations, Generating Function, Application.

UNIT-III (12 Hrs.)

Probability Distributions: Probability, Bayes theorem, Discrete & Continuous probability distributions, Moment generating function, Probability generating function, Properties and applications of Binomial, Poisson and normal distributions.

Graph Theory: Graph- Directed and undirected, Eulerian chains and cycles, Hamiltonian chains and cycles Trees, Chromatic number Connectivity, Graph coloring, Plane and connected graphs, Isomorphism and Homomorphism. Applications.

UNIT-IV (12 Hrs.)

Monoids and Groups: Groups Semigroups and monoids Cyclic semigraphs and submonoids, Subgroups and Cosets. Congruence relations on semigroups. Morphisms. Normal subgroups. Dihedral groups.

Rings and Boolean Algebra: Rings, Subrings, morphism of rings ideals and quotient rings. Euclidean domains Integral domains and fields Boolean Algebra direct product morphisms Boolean sub-algebra Boolean Rings Application of Boolean algebra (Logic Implications, Logic Gates, Karnaugh map)

Recommended Books:

1. Lipschutz, 'Discrete Mathematics (Schaum Series)', 3rd Edn., McGraw Hill, **2009.**
2. Alan Doerr and Kenneth Levarseur, 'Applied Discrete Structures for Computer Science', Galgotia Publications, **2009.**
3. N. Ch SN Iyengar, V.M. Chandrasekaran, 'Discrete Mathematics', 1st Edn., Vikas Publication House, **2003.**
4. S. Santha, 'Discrete Mathematics and Graph Theory', 1st Edn., Cengage COURSE.
5. Kenneth H. Rosen, 'Discrete Mathematics and its Applications', 7th Edn., McGraw Hill, **2008.**
6. C.L. Liu, 'Elements of Discrete Mathematics', 4th Edn., McGraw Hill, **2012**.
7. Satinder Bal Gupta, 'Discrete Mathematics and Structures', 4th Edn., Laxmi Publications, **2008.**

SOFTWARE LAB. – III (DATA STRUCTURES)

Subject Code: MCAPS1-204 **L T P C**
0 0 4 2

This laboratory course will comprise as exercises to supplement what is learnt under paper MCAPS1-201.

SOFTWARE LAB. – IV (OPERATING SYSTEM)

Subject Code: MCAPS1-205 **L T P C**
0 0 4 2

This laboratory course will comprise as exercises to supplement what is learnt under paper MCAPS1-202. Students are required to do at least 8 assignments based on the paper.

DATA WAREHOUSING AND DATA MINING

Subject Code: MCAPD1-211 **L T P C** **Duration: 45 Hrs.**
3 0 0 3

Course Objectives

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

1. Understand operational database, data ware housing, need of database to meet industrial needs.

2. Identify the components in typical data warehouse Architecture and understand the multidimensional schemas for data warehouse.
3. Understand the knowledge about data mining, decision tree, generic algorithms and Fuzzy set approach.

UNIT – I (10 Hrs.)

Review of Data Warehouse- Need for strategic information, Decision support system,Knowledge discovery & decision making, need for data warehouse, Data warehousing and data mining, common characteristics of Data warehouse, Data Marts, Metadata, Operational versus analytical databases, trends and planning of Data warehousing.

UNIT - II (11 Hrs.)

Schemas and Architecture of Data warehouse- Multidimensional data model, Data cubes,Schemas for Multidimensional Database: stars, snowflakes and fact constellations. Data warehouse process & architecture, OLTP vs. OLAP, ROLAP vs. MOLAP, types of OLAP servers, 3-Tier data warehouse architecture, distributed and virtual data warehouses, data warehouse manager.

UNIT – III (12 Hrs.)

Introduction to Data Mining- Data mining definition & task, KDD versus Data mining,Techniques, Tools and Applications of Data mining. Data mining query languages, data specification, specifying knowledge, hierarchy specification, pattern presentation & visualization specification.

Data Mining Techniques- Association rules, Clustering techniques, Decision treeknowledge discovery through neural.

UNIT – IV (12 Hrs.)

Data Mining Classification- Networks & Genetic Algorithms, Rough Sets, Support VectorMachines and Fuzzy techniques. Mining Complex data objects, Spatial databases, Multimedia databases, Time series and Sequence data, mining Text Data bases and mining Word Wide Web.

Recommended Books:

1. Jiawei Han, Micheline Kamber, Jian Pei, 'Data Mining: Concepts and Techniques', 3rdEdn., Morgan Kaufmann, **2011**.
2. George M. Marakas, 'Modern Data Warehousing, Mining, and Visualization', 1stEdn., Prentice Hall, **2001**.
3. Elzbieta Malinowski and Esteban Zimanyi, 'Advanced Data Warehouse Design: From Conventional to Spatial and Temporal Applications (Data-Centric Systems and Applications)', 1stEdn., Springer, **2008.**
4. Matteo Golfarelliand Stefano Rizzi, 'Data Warehouse Design: Modern Principles and Methodologies', 1stEdn., McGra Hill Education, **2009.**
5. Alex Berson and Stephen J. Smith, 'Data Warehousing, Data Mining, & OLAP', 1stEdn., Tata McGraw Hill, **1997.**

BUSINESS INTELLIGENCE AND DIGITAL MARKETING

Subject Code: MCAPD1-212 **L T P C** **3 0 0 3** **Duration: 45 Hrs.**

Course Objectives

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

1. Understand the role of business intelligence and digital marketing within an organization.
2. Use decision-making tools/Operations Research techniques and manage business processes using analytical and management tools.
3. Analyse and solve problems from different industries such as manufacturing, service, retail, software, banking and finance, sports, pharmaceutical, aerospace etc.

UNIT – I (12 Hrs.)

Introducing the Technical Architecture- The value of architecture, Technical Architectureoverview, Back room Architecture, Presentation Server Architecture, Front room Architecture, Infrastructure, Metadata, and Security.

Introducing Dimensional Modeling- Making the Case for Dimensional Modeling,Dimensional Modeling primer, Enterprise Data Warehouse Bus Architecture, More on Dimensions & Facts.

UNIT – II (10 Hrs.)

Designing the Dimensional Modeling- Modeling Process overview, Getting Organized,Four Step Modeling Process, Design the Dimensional Model.

UNIT – III (11 Hrs.)

Introducing Extract, Transformation & Load- Round up the requirements, the 34subsystems of ETL, Extracting Data, Cleaning & Conforming data.

Introducing Business Intelligence Applications- Importance of B.I., Applications,Analytical cycle for B.I., Types of B.I. Applications, Navigating Applications via the B.I. portal.

UNIT – IV (12 Hrs.)

Designing & Developing B.I. Applications- B.I. Application resource planning, B.I.Application Specification, B.I. Application Development, B.I. Application maintenance.

Recommended Books

1. Sam Anahory and Dennis Murray, 'Data Warehousing in the Real World: A Practical Guide for Building Decision Support Systems', 1st Edn., Addison Wesley Longman Ltd., **1997**.
2. Ralph Kimball and Margy Ross, 'The Data Warehouse Toolkit: The Definitive Guide to Dimensional Modelling', 3rd Edn., Wiley, **2013**.
3. Micheline Kamber, Jian Pei, 'Data Mining: Concepts and Techniques', 3rd Edn., Morgan Kaufmann, **2011**.
4. R.N. Prasad and Seema Acharya, 'Fundamentals of Business Analytics', 1st Edn., Wiley, **2011**.

SOFTWARE TESTING AND QUALITY ASSURANCE

Subject Code: MCAPD1-213 **L T P C** **3 0 0 3** **Duration: 45 Hrs.**

Course Objectives

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

1. Analyse different approaches to software testing and quality assurance, and select optimal solutions for different situations and projects;
2. Conduct independent research in software testing and quality assurance and apply that knowledge in their future research and practice;
3. Evaluate the work of peers constructively by following proven methods of peer-review, and by using the principles of research ethics.

UNIT-I (10 Hrs.)

Testing Principles- Need of testing, Basic concepts–errors, faults, defects, failures, test bed, unit testing, integration testing system, system testing, regression testing, alpha, beta and acceptance testing, functional testing, performance testing, white box testing, black box testing, verification and validation.

UNIT-II (12 Hrs.)

Test Management- Testing Life Cycle–Roles and activities, Test Planning, Develop test plan review, Test Cases design strategies. Black box approach: random testing, equivalence class partitioning and boundary value analysis. White box approach: test adequacy criteria, coverage and control flow graphs, paths, loop testing, mutation testing.

UNIT-III (12 Hrs.)

Software Metrics- Scope of software metrics, Classifying software measures, Measurement basics – representational theory, scales, meaningfulness, What to measure–GOM technique, Control flow structure, product quality metrics – MTTF, defect density,
customer problems, customer satisfaction, function point.

Quality Assurance- Quality concepts–quality, quality control, quality assurance, cost ofquality Software quality assurance – SQA activities, software reviews, inspections, audits, Software reviews, inspections,

audits, Software reliability Quality Attributes: correctness, reliability, usability, integrity, portability, maintainability, interoperability. Ishikawa's Seven Basic Tools.

UNIT-IV (11 Hrs.)

Quality Standards- Basic concept of–ISO 9000 & 9001, CMM, six sigmas.

Development of CMM- CMM–Following KPAs: requirements management (RM),software project tracking and oversight (SPTO), software configuration management (SCM), organization process definition (OPD), software product engineering (SPE), peer reviews (PR), quantitative process management (QPM), process change management.

Recommended Books:

1. Kshirasagar Naik and PriyadarshiTripathy, 'Software Testing and Quality Assurance:Theory and Practice', 1st Edn., Wiley, **2008**.
2. Jeff Tian, 'Software Quality Engineering: Testing, Quality Assurance, and Quantifiable, Improvement', 1st Edn., Wiley, **2005**.
3. William E. Perry, 'Effective Methods for Software Testing: Includes Complete Guidelines, and Checklists', 3rd Edn., Wiley, **2006**.
4. Glenford J. Myers, 'The Art Of Software Testing', 3rd Edn., Wiley, **2015**.

PROGRAMMING IN JAVA

Subject Code: MCAPD1-221 **LTPC 3003** **Duration: 45 Hrs.**

Course Objectives

At the end of the course, the students should be able to:

1. Use the Java programming language in the development of small application programs that demonstrate professionally acceptable coding and performance standards.
2. Understanding of the basic principles of the object oriented development process and apply this understanding to the analysis and design of solutions for small scale problems.
3. Work with the JDBC technology and learn Java Generics and the development of Projects.

UNIT–I (11 Hrs.)

Introduction- Object Oriented Concept, Features and Applications of Java, Differencesbetween Java and C++, Structure of Java Program, Literals, Tokens, Keywords, Constants, Variables & Data types, Scope of variables, Operators, Expressions, Flow control statements. Arrays, Vectors, Type Conversion, Command Line Arguments, Access specifiers, Constructors, Inheritance, Static Classes, Abstract Classes, Final Classes, Wrapper Classes, Garbage Collection & Finalize method, Handling String and String Buffer classes, Method Overloading and Overriding.

UNIT–II (11 Hrs.)

Interfaces & Packages- Introduction, implementing multiple inheritance through Interfaces,Packages, Multithreaded Programming.

Exception Handling- Introduction, Handling System defined Exceptions, Creating andhandling user defined exceptions.

Managing I/O- Introduction to streams, Handling and using various Stream Classes.

UNIT–III (11 Hrs.)

Applets- Introduction to Applets, Types of Applets, Using Applet Applications, PassingParameters to Applets.

Introduction to Graphic Programming- Applying 2-D transformations on Objects, EventHandling, Layouts, Frames, Panels, JDBC.

UNIT–IV (12 Hrs.)

Advanced Programming- Servlet Programming (Servlet Life Cycle, Generic Servlet,HttpServlet, HttpServletRequest, HttpServletResponse, Service method, doGET method, doPOST method, Servlet Exception).

Recommended Books

1. Y. Daniel Liang, 'Introduction to Java Programming', 9th Edn., Pearson, **2011.**

2. HerbetSchildt, 'Java 2: The Complete Reference', 5th Edn., McGraw Hill, **2002.**
3. Gary Cornell and Cay S. Horstmann, 'Core Java, Volume 2- Advanced Features', 8th Edn., Pearson, **2008.**
4. Ed Roman, Rima Patel and Gerald Brose, 'Mastering Enterprise Java Beans', 3rd Edn., JohnWiley& Sons Inc., **2004.**

PROGRAMMING WITH PYTHON

Subject Code: MCAPD1-223 **LTPC 3003** **Duration: 45 Hrs.**

Course Objectives

At the end of the course, the students should be able to:

1. Master the fundamentals of writing Python scripts and Learn core Python scripting elements such as variables and flow control structures.
2. Discover how to work with lists and sequence data
3. Write Python functions to facilitate code reuse
4. Use Python to read and write files and Work with the Python standard library

UNIT-I (11 Hrs.)

Introduction to Python: Installing Python, Simple program using Python, Expressions and Values, Variables and Computer Memory, error detection, Multiple line statements, Designing and using functions, functions provided by Python, Tracing function calls in memory model, omitting return statement. Working with Text: Creating Strings of Characters, Using Special Characters in Strings, Creating a Multiline String, Printing Information, Getting Information from the Keyboard.

UNIT- II (11Hrs.)

A Boolean Type: A Boolean Type, Choosing Statements to Execute, Nested If Statements, Remembering the Results of a Boolean Expression Evaluation, A Modular Approach to Program Organization, Importing Modules, Defining Your Own Modules, Testing Code Semi automatically Grouping Functions Using Methods: Modules, Classes, and Methods, Calling Methods the Object-Oriented Way, Exploring String Methods, Underscores.

UNIT- III (12Hrs.)

Storing Collections of Data Using Lists: Storing and Accessing Data in Lists, modifying Lists, Operations on Lists, Slicing Lists, Aliasing, List Methods, Working with a List of Lists. Repeating Code Using Loops: Processing Items in a List, Processing Characters in Strings, Looping Over a Range of Numbers, Processing Lists Using Indices, Nesting Loops in Loops, Looping Until a Condition Is Reached, Repetition Based on User Input, Controlling Loops UsingBreak and Continue Reading and Writing.

UNIT- IV (11Hrs.)

File Operation: Reading config files in python Writing log files in python Understanding read functions, read (), read line () and read lines () Understanding write functions, write () and writelines () Manipulating file pointer using seek Programming using file operations.

Recommended Books:

1. Downey, Allen B. Think Python: How to Think Like a Computer Scientist (Version 1.6.6 Ed.),**2012**.
2. Hamilton, Naomi. "The A-Z of Programming Languages: Python",**2008**.
3. Lutz, Mark Learning Python (5th ed.). O'Reilly Media,**2013**.
4. Pilgrim, Mark Dive into Python 3. Apress,**2009**.

SOFTWARE LAB. – V
(PROGRAMMING IN JAVA)

Subject Code: MCAPD1-222 **LTPC**
0042

This laboratory course will comprise as exercises to supplement what is learnt under paper MCAPD1-221.

SOFTWARE LAB. – VI
(PROGRAMMING WITH PYTHON)

Subject Code: MCAPD1-224 **LTPC**
0042

This laboratory course will comprise as exercises to supplement what is learnt under paper MCAPD1-223.

MRSPTU

SOFTWARE ENGINEERING

Subject Code: MCAPS1-001 **L T P C** **Duration: 60 Hrs.**
3 1 0 4

Course Objectives

1. To apply principles of software development and evolution.
2. To specify, abstract, verify, validate, plan, develop and manage large software and learn emerging trends in software engineering.

UNIT-I (17 Hrs.)

Introduction to Software- Definition, Software characteristics, Software components, Software Applications.
Introduction to Software Engineering- Definition, Software Engineering Paradigms, Waterfall Model, Prototyping Model, Interactive Enhancement Model, the Spiral Model.

UNIT- II (15Hrs.)

Software Metrics- Role of Metrics and Measurement, Metrics for software productivity and quality, Measurement software, size–oriented metrics, function oriented metrics, Metrics for software quality.
Software Requirement Specification (SRS)- Problem analysis, structuring information, Data flow diagram and data dictionary, structured analysis, Characteristics and component of (SRS).

UNIT- III (14Hrs.)

Planning a Software Project- Cost estimation, uncertainties in cost estimation, Single variable model, COCOMO model, Project scheduling and milestones, Software & Personal Planning, Verification & Validation (V & V), inspection & review.
System Design- Design Objectives, Design Principles, problem, Partitioning, Abstraction, Top Down and Bottom–up techniques, Structure Design, Structure Charts, Design Methodology.

UNIT- IV (14Hrs.)

Coding- Coding by Top–down and Bottom–up, Structured Programming, Information Hiding, Programming style, Internal Documentation.

Testing- Level of testing, Test cases and test criteria, Functional Testing, Structural Testing.

Recommended Books

1. Roger S. Pressman, 'Software Engineering – A Practitioner's Approach ', 6th Edn., McGraw Hill,**2010**.
2. R.E. Fairley, 'Software Engineering Concepts', Paperback Edn., McGraw Hill,**2004**.
3. Jalota P., 'An Integrated Approach to Software Engineering', 3rd Edn., Narosa Publishing House,**2016**.

DIGITAL ELECTRONICS

Subject Code: MCAPS1-002 **LTPC** **Duration: 60 Hrs.**
3104

Course Objectives

1. Digital circuits which are the basic building blocks of a computer are introduced in this module to let the students know what activities it does behind the computing environment.
2. This course portrays excellent ideas of the logic gates available and data processing to make students understand the concept better with the analog and digital signals while computing.

UNIT-I (17 Hrs.)

Number System - Decimal Number System, Binary Number System, Octal Number System, Hexadecimal Number System, Signed and Unsigned number, Conversion from One Number System to another. Arithmetic Operation without Changing the Base, Floating Point Representation.
Binary Codes - Weighted Binary Codes, Non Weighted Codes, Reflective Codes, Sequential Codes, Alphanumeric Codes, BCD Code, Code Conversions, BCD Arithmetic.
Logic Gates - Introduction to Logic gates, Universal Gates, Logic Gates Applications.

UNIT-II (15 Hrs.)

Boolean Algebra - Introduction, Boolean Laws-Commutative Law, Associative Law, Distributive Law, AND Laws, OR Laws, Inversion Laws, Principle of Duality, Duality Theorem, De-Morgan's Theorem. Simplification of Boolean Expression using Boolean algebra, Sum of Products (SOP) & Product of Sums (POS) Forms, Realization of Boolean Expression using Gates, K-Maps, Simplification of Boolean Expression using K-Maps.
Combinational Logic Circuits - Half Adder & Half Subtractor, Full Adder &Full Subtractor, Parallel Binary Adder, Binary Adder/Subtractor, BCD Adder, BCD Subtractor. Multiplexers & Demultiplexers, Implementation of Boolean equations using Multiplexer and Demultiplexer, Encoders & Decoder.

UNIT-III (14 Hrs.)

Sequential Logic Circuits - Latch, Flip Flops- R-S Flip-Flop, J-K Flip-Flop, Master-Slave J-K Flip-Flop, Race Condition, Removing Race Condition, D Flip-Flop, T Flip-Flop, Applications of Flip-Flops, Registers.

Counters - Design of Asynchronous Counters, Design of Synchronous Counters.

Logic Families - RTL, DCTL, DTL, TTL, ECL and its various Types, Comparison of LogicFamilies.

UNIT-IV (14 Hrs.)

Memory Devices - Classification of memories, RAM organization, Write operation, Readoperation, Memory cycle. Static RAM Cell-Bipolar, RAM cell, MOSFET RAM cell, Dynamic RAM cell. ROM Organization, PROM, EPROM, EEPROM, Field Programmable Gate Arrays (FPGA).

Signal Conversions - Analog & Digital signals, A/D and D/A conversion.

VLSI Design - Introduction, Process & Applications.

Recommended Books

1. Thomas C. Bartee, 'Digital Computer Fundamentals', 6th Edn., McGraw Hill, **1984**.
2. R.P. Jain, 'Modern Digital Electronics', 4th Edn., Tata McGraw Hill, **2009**.
3. M. Morris Mano, 'Digital Logic and Computer Design', 1st Edn., Pearson, **2004**.
4. William H. Gothmann, 'Digital Electronics: An Introduction to Theory and Practice', 2nd Edn., Prentice Hall, **1982**.
5. Albert Malvino, 'Digital Principles and Applications', 5th Edn., Tata McGraw Hill, **1994**.

MATHEMATICAL FOUNDATIONS OF COMPUTER SCIENCE

Subject Code: MCAPS1-003 **L T P C** **3 1 0 4** **Duration: 60 Hrs.**

Course Objectives

1. To introduce the students to the topics and techniques of discrete methods and combinatorial reasoning.
2. To introduce a wide variety of applications. The algorithmic approach to the solution of problems is fundamental in discrete mathematics, and this approach reinforces the close ties between this discipline and the area of computer science.

UNIT-I (14 Hrs.)

Mathematical Logic - Statements, logical operations, tautologies, contradictions, logical implications and equivalence, normal forms, theory and Inference for statement calculus, predicate calculus, Inference theory for predicate calculus.

UNIT- II (14 Hrs.)

Relations and Functions - Binary relations, computer representation of relations and diagraph, Equivalence relations, applications of congruence, Composition of relations, Transitive Closure, partially ordered sets, Hasse diagrams, lexicographic ordering, topological sorting, Lattices and special types of lattices, Types of functions, functions for computer sciences, growth of function and binary operations.

UNIT-III (17 Hrs.)

Permutations and Combinations - Basic concepts; Rules of counting, combinatorial distribution of distinct and non-distinct objects, generating functions for permutation and combinatorial enumeration.

Recursion and Recurrence Relation - Primitive recursive function, Polynomials and their recursion, Iteration, Sequence and discrete functions, Recurrence relations, Generating function.

UNIT-IV (15 Hrs.)

Trees and Graphs - Lattice and Algebraic System, Basic Properties of Algebraic Systems, Special Types of Lattices, Distributed, Complemented Lattices, Boolean Algebra, Boolean Expressions, Normal Form of Boolean Expressions, Boolean Function, Basic Circuits and Theorems, Logical Gates and Relations of Boolean Function, Introduction to Graphs, Graph Terminology, Graph Isomorphism, Directed and Undirected Graphs and Their Representations; Paths, Reachability and Connectedness; Basic Concepts of Trees And Spanning Tree.

Recommended Books

1. J.P. Tremblay, 'Discrete Mathematical Structures', Tata McGraw Hill, **1987**.
2. Kenneth H. Rosen, 'Discrete Mathematics and its applications', 7th Edn., Tata McGrawHill, **2012**.
3. Ralph P. Grimaldi, 'Discrete and Combinatorial Mathematics', Pearson Education, **2002**.
4. Alan Doerr, 'Applied Discrete Structures for Computer Science', Galgotia Publications, **1991**.
5. C.L. Liu, 'Elements of Discrete Mathematics', 2nd Edn., Tata McGraw Hill, **1985**.