B.Tech. II (CSE) Semester – III
DISCRETE MATHEMATICS
MA221
(MATHEMATICS - III)

	L	T	P	Credit
Scheme	3	1	0	04

1. Course Outcomes (COs):

At the end of the course, the students will be able to

CO1	acquire knowledge of sets, group and functions, graphs.
CO2	apply group theory, relations and lattice.
CO3	analyse functions, counting and based on mathematical logic.
CO4	evaluate formal verification of computer programmes.
CO5	design solutions for various types of problems in different disciplines like information security, optimization, mathematical analysis.

2. Syllabus

- **INTRODUCTION** **(04 Hours)**

  Set Definition, Finite and Infinite Sets, Equality of Sets, Disjoint Sets, Family of Sets, Types of Sets, Operations on Sets, Algebra of Sets, Cardinality of a Set, Venn Diagrams, Multisets, Cartesian Product, Principle Inclusion and Exclusion, Functions as a Set, Domain and Co-domain, Image, Range, Types of Functions, Equal and Identity Functions, Invertible Functions, Composition of Functions, Application of Functions in Computer Science Areas.

- **GROUP THEORY** **(08 Hours)**

  Basic Properties of Group, Groupoid, Semigroup & Monoid, Abelian Group, Subgroup, Cosets, Normal Subgroup, Lagrange's Theorem, Cyclic Group, Permutation Group, Homomorphism & Isomorphism of Groups, Basic Properties, Error Correction & Detection Code.

- **RELATION & LATTICES** **(05 Hours)**

  Definition & Basic Properties, Graphs Of Relation, Matrices Of Relation, Equivalence Relation, Equivalence Classes, Partition, Partial Ordered Relation, Posets, Hasse Diagram, Upper Bounds, Lower Bound, GLB & LUB Of Sets, Definition & Properties Of Lattice, Sub Lattice, Distributive & Modular Lattices, Complemented & Bounded Lattices, Complete Lattices & Boolean Algebra.

- **MATHEMATICAL LOGIC AND PROGRAM VERIFICATION** **(05 Hours)**

  Induction, Propositions, Combination Of Propositions, Logical Operators & Propositional Algebra, Equivalence, Predicates & Quantifiers, Interaction of Quantifiers with Logical Operators, Logical

21/9/2026

Interference & Proof Techniques, Formal Verification of Computer Programs (Elements of Hoare Logic).

- **COUNTING AND RECURRENCE RELATION** **(05 Hours)**

  First Counting Principle, Second Counting Principle, Permutation, Circular Permutations, Combination, Pigeonhole Principle, Recurrence Relations, Linear Recurrence Relations, Inclusion And Exclusion, Generating Functions.

- **BASICS OF GRAPHS** **(05 Hours)**

  Graph Definition, Graph Representation, Basic Concepts Of Finite & Infinite Graph, Incidence & Degree, Isomorphism, Subgraph, Walk, Path & Circuits, Cliques, Cycles and Loops, Operations On Graphs, Connected Graph, Disconnected Graph & Components, Complete Graph, Regular Graph, Bipartite Graph, Planar Graphs, Weighted Graphs, Directed & Undirected Graphs, Connectivity Of Graphs.

- **GRAPHS ALGORITHMS** **(10 Hours)**

  Flows, Combinatorics, Euler's Graph, Hamiltonian Paths & Circuits, Activity Planning and Critical Path, Planar Graphs: Properties, Graph Coloring, Vertex Coloring, Chromatic Polynomials, Edge Coloring, Planar Graph Coloring, Matching and Factorizations: Maximum Matching In Bipartite Graphs, Maximum Matching In General Graphs, Hall's Marriage Theorem, Factorization; Networks: Max-Flow Min-Cut Theorem, Menger's Theorem, Graph and Matrices.

Tutorials will be based on the coverage of the above topics separately **(14 Hours)**

(Total Contact Time: 42 Hours + 14 Hours = 56 Hours)

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3. Tutorials:

1 Examples using different set operations
2 Examples of defining groups and studying properties
3 Examples on formal verification and applying different functions
4 Examples of mathematical logics and relations
5 Examples of recurrence and counting

4. Books Recommended:

1. Rosen K.H., Discrete Mathematics and Its Applications , 6/E, MGH, 2006.
2. Liu C.L., Elements of Discrete Mathematics , MGH, 2000.
3. Deo Narsingh., Graph theory with applications to Engineering & Computer Science , PHI, 2000.

21/9/2020

4. J A Bondy and USR Murty, Graph Theory , Springer, 2008.
5. V. K. Balakrishnan, Theory and Problems of Graph Theory , Tata McGraw-Hill, 2007.

ADDITIONAL REFERENCE BOOKS

1. Kolman B., Busby R.C. & Ross S., Discrete Mathematical Structure , 5/E, PHI, 2003.
2. Tremblay J. P. & Manohar R., Discrete Mathematical structure with applications to computer science , MGH, 1999.
3. Liu C.L., Elements of Discrete Mathematics , MGH, 2000.
4. D B West, Introduction to Graph Theory , 2nd Edition, PHI 2002.
5. G Chatrand and O.R. Ollermann, Applied and Algorithmic Graph Theory ,McGraw Hill, 1993.

B.Tech. II (CSE) Semester – III
DATA STRUCTURES (CORE-1)
CS210

	L	T	P	Credit
Scheme	3	1	2	05

1. Course Outcomes (COs): At the end of the course, the students will be able to	
CO1	recognize the need of different data structures and describe its characteristics.
CO2	apply different data structures for given problems.
CO3	design and analyse different data structures, sorting and searching techniques.
CO4	evaluate data structure operations theoretically and experimentally.
CO5	design solutions for complex engineering problems.

2. **Syllabus**

- **INTRODUCTION TO DATA STRUCTURES** **(02 Hours)**

  Review of Concepts: Information and Meaning, Abstract Data Types, Internal Representation of Primitive Data Structures, Arrays, Strings, Structures, Pointers.

- **LINEAR LISTS** **(06 Hours)**

  Sequential and Linked Representations of Linear Lists, Comparison of Insertion, Deletion and Search Operations for Sequential and Linked Lists, Doubly Linked Lists, Circular Lists, Lists in Standard Template Library (STL), Applications Of Lists.

- **STACKS** **(06 Hours)**

  Sequential and Linked Implementations, Representative Applications such as Recursion, Expression Evaluation Viz., Infix, Prefix and Postfix, Parenthesis Matching, Towers of Hanoi, Wire Routing in a Circuit, Finding Path in a Maze.

- **QUEUES** **(06 Hours)**

  Operations of Queues, Circular Queue, Priority Queue, Dequeue, Applications of Queues, Simulation of Time Sharing Operating Systems, Continuous Network Monitoring System Etc.

- **SORTING AND SEARCHING** **(04 Hours)**

Sorting Methods, Bubble Sort, Selection Sort, Quick Sort, Radix Sort, Bucket Sort, Dictionaries, Hashing, Analysis of Collision Resolution Techniques, Searching Methods, Linear Search, Binary Search, Character Strings and Different String Operations.

- **TREES** **(08 Hours)**

  Binary Trees and Their Properties, Terminology, Sequential and Linked Implementations, Tree Traversal Methods and Algorithms, Complete Binary Trees, General Trees, AVL Trees, Threaded Trees, Arithmetic Expression Evaluation, Infix-Prefix-Postfix Notation Conversion, Heaps as Priority Queues, Heap Implementation, Insertion and Deletion Operations, Heapsort, Heaps in Huffman Coding, Tournament Trees, Bin Packing.

- **MULTIWAY TREES** **(04 Hours)**

  Issues in Large Dictionaries, M-Way Search Trees, B Trees, Search, Insert and Delete Operations, Height of B-Tree, 2-3 Trees, Sets and Multisets in STL.

- **GRAPHS** **(06 Hours)**

  Definition, Terminology, Directed and Undirected Graphs, Properties, Connectivity in Graphs, Applications, Adjacency Matrix and Linked Adjacency Chains, Graph Traversal, Breadth First and Depth First Traversal, Spanning Trees, Shortest Path and Transitive Closure, Activity Networks, Topological Sort and Critical Paths.

Tutorials will be based on the coverage of the above topics separately **(14 Hours)**

Practicals will be based on the coverage of the above topics separately **(28 Hours)**

(Total Contact Time: 42 Hours + 14 Hours + 28 Hours = 84 Hours)

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3. Tutorials:

1 Problems on Array
2 Problems on Stack and Queue
3 Problems on Linked List
4 Problems on Trees
5 Problems on Graph

4. Practicals:

1 Implementation of Array and its applications
2 Implementation of Stack and its applications

3 Implementation of Queue and its applications

4 Implementation of Link List and its applications

5 Implementation of Trees and its applications

6 Implementation of Graph and its applications

7 Implementation of Hashing functions and collision resolution techniques

8 Mini Project (Implementation using above Data Structure)

5. Books Recommended:

1. Trembley and Sorenson, An Introduction to Data Structures with Applications, 2nd Edition, TMH, 1991.
2. Tanenbaum and Augenstein, Data Structures using C and C++, 2nd Edition, Pearson, 2007.
3. Horowitz and Sahani, Fundamentals of Data Structures in C, 2nd Edition, Silicon Press, 2007.
4. T. H. Cormen, C. E. Leiserson and R. L. Rivest, Introduction to Algorithms, 3rd Edition, MIT Press, 2009.
5. Robert L. Kruse, C. L. Tondo and Brence Leung, Data Structures and Program Design in C, 2nd Edition, Pearson Education, 2001.

B.Tech. II (CSE) Semester – III
COMPUTER ORGANIZATION (CORE-2)
CS201

	L	T	P	Credit
Scheme	**3**	**1**	**2**	**05**

1. Course Outcomes (COs): **At the end of the course, the students will be able to**	
CO1	acquire knowledge of basics of computer architecture, its components with peripheral devices, instruction set architecture, instruction execution using data path and control unit interface.
CO2	apply knowledge of combinational and sequential logic circuits to mimic simple computer architecture to solve the given problem.
CO3	analyze performance of various instruction set architecture, control unit, memories, various processor architectures.
CO4	evaluate programming solutions to implement fast methods of ALU, FP unit implementations, processor architectures and instruction set architectures.
CO5	implement fast methods of ALU, FP unit implementations and to design and develop hardware solution for given instruction coding scheme of an Instruction Set Architecture or vice versa using available technology tools.

2. Syllabus

- **PROCESSOR BASICS** **(05 Hours)**

  Basics CPU Organization - Functional Units, Data Paths, Registers, Stored Program Concept, Data Representation - Basic Formats, Fixed and Floating Point Representation, Instruction Sets, Instruction Types, Instruction Formats, Addressing Modes, Designing of an Instruction Set, Data path Design, Concepts of Machine Level Programming, Assembly Level Programming and High Level Programming.

- **ARITHMETIC AND LOGIC UNIT** **(08 Hours)**

  Arithmetic and Logical Operation and Hardware Implementation, Implementation of some Complex Operation: Fixed-Point Arithmetic Multiplication Algorithms-Hardware Algorithm, Booth Multiplication Algorithm, Division Algorithm, Divide Overflow Algorithm, Combinational ALU and Sequential ALU, Floating Point Arithmetic Operations.

- **CONTROL UNIT** **(07 Hours)**

  Basic Concepts, Instruction Interpretation and Execution, Hardwired Control, Microprogrammed Control, CPU Control Unit Design, Performance.

- **SUBROUTINE MANAGEMENT** **(03 Hours)**

  Concepts of Subroutine, Subroutine Call and Return.

- **MEMORY ORGANIZATION** **(06 Hours)**

  Concepts of Semiconductor Memory, Cpu-Memory Interaction, Organization of Memory Modules, Cache Memory and Related Mapping and Replacement Policies, Virtual Memory.

- **SYSTEM ORGANIZATION** **(05 Hours)**

  Introduction to Input And Output Processing, Working with Video Display Unit and Keyboard and Routine to Control them, Programmed Controlled I/O Transfer, Interrupt Controlled I/O Transfer, DMA Controller, Secondary Storage and Type Of Storage Devices, Introduction to Buses and Connecting I/O Devices to CPU and Memory.

- **PIPELINE CONTROL AND PARALLEL PROCESSING** **(08 Hours)**

  Instruction Pipelines, Pipeline Hazards, Pipeline Performance, Superscalar Processing, Introduction to Parallel Processing, Processor-Level Parallelism, Multiprocessor.

Tutorials will be based on the coverage of the above topics separately. **(14 Hours)**

Practicals will be based on the coverage of the above topics separately. **(28 Hours)**

(Total Contact Time: 42 Hours + 14 Hours + 28 Hours = 84 Hours)

3. Tutorials:

1 Problems on data conversion in various formats and floating-point representation

2 Solving computations involving complex arithmetic operations and hardware implementation of the same

3 Interpretation of basic instruction execution and various addressing modes possible

4 Learning instruction set architecture level instructions for the high level language programming

5 Problems on memory management, mapping and replacement policies

4. Practicals:

1 Implementation of arithmetic operations on various number systems

2 Implementation of basic combinatorial logic circuits in Logisim

3 Implementation of complex combinatorial logic circuits in Logisim

4 Design storage components as per the given specifications

5 Design of arithmetic logic unit and its associated control unit

6 Design of control unit of set of instructions

7 Implementation of control unit and memory modules

8 Implementation of basic components of computers and integration of them in Logisim

5. Books Recommended:

1. John L. Hannessy and David A. Patterson, Computer Organization and Design, 3rd Edition, Morgan Kaufmaan, 2003.
2. Andrew S. Tanenbaum, Structured Computer Organization, 6th Edition, PHI, 1995.
3. William Stallings, Computer Organization and Architecture: Designing For Performance, 6th Edition, PHI, 2002.
4. Carl Hamacher, Zvonko Vranesic and Safwat Zaky, Computer Organization, 5th Edition, McGraw-Hill, 2002.
5. Morris Mano, Computer Systems Architecture, 3rd Edition, PHI, reprint 1997.

B.Tech. II (CSE) Semester – III
DIGITAL ELECTRONICS & LOGIC DESIGN (CORE-3)
(Interdisciplinary Subject)
EC207

	L	T	P	Credit
Scheme	**3**	**1**	**2**	**05**

1. Course Outcomes (COs): **At the end of the course, the students will be able to**	
CO1	acquire knowledge about different types of diodes and circuits.
CO2	apply the knowledge of gates, Boolean algebra and operational amplifier in designing logical and integrated circuits.
CO3	analyse the logical, integrated, and operational amplifier based circuits.
CO4	evaluate the different circuits and compare their performance.
CO5	design ALU and control unit.

2. Syllabus

- **PN DIODE AND TRANSITOR** **(04 Hours)**

  PN Diode Theory, PN Characteristic and Breakdown Region, PN Diode Application as Rectifier, Zener Diode Theory, Zener Voltage Regulator, Diode as Clamper and Clipper, Photodiode Theory, LED Theory, 7 Segment LED Circuit Diagram and Multi Colour LED, LASER Diode Theory and Applications, Bipolar Junction Transistor Theory, Transistor Symbols And Terminals, Common Collector, Emitter and Base Configurations, Different Biasing Techniques, Concept of Transistor Amplifier, Introduction to FET Transistor And Its Feature.

- **WAVESHAPING CIRCUITS AND OPERATIONAL AMPLIFIER** **(06 Hours)**

  Linear Wave Shaping Circuits, RC High Pass and Low Pass Circuits, RC Integrator and Differentiator Circuits, Nonlinear Wave Shaping Circuits, Two Level Diode Clipper Circuits, Clamping Circuits, Operational Amplifier OP-AMP with Block Diagram, Schematic Symbol of OP-AMP, The 741 Package Style and Pinouts, Specifications of Op-Amp, Inverting and Non-Inverting Amplifier, Voltage Follower Circuit, Multistage OP-AMP Circuit, OP-AMP Averaging Amplifier, OP-AMP Subtractor.

- **BOOLEAN ALGEBRA AND SWITCHING FUNCTIONS** **(04 Hours)**

  Basic Logic Operation and Logic Gates, Truth Table, Basic Postulates and Fundamental Theorems of Boolean Algebra, Standard Representations of Logic Functions- SOP and POS Forms, Simplification of Switching Functions-K-Map and Quine-Mccluskey Tabular Methods, Synthesis of Combinational Logic Circuits.

- **COMBINATIONAL LOGIC CIRCUIT USING MSI INTEGRATED CIRCUITS** **(07 Hours)**

Binary Parallel Adder; BCD Adder; Encoder, Priority Encoder, Decoder; Multiplexer and Demultiplexer Circuits; Implementation of Boolean Functions Using Decoder and Multiplexer; Arithmetic and Logic Unit; BCD to 7-Segment Decoder; Common Anode and Common Cathode 7-Segment Displays; Random Access Memory, Read Only Memory And Erasable Programmable ROMS; Programmable Logic Array (PLA) and Programmable Array Logic (PAL).

- **INTRODUCTION TO SEQUENTIAL LOGIC CIRCUITS** **(04 Hours)**

Basic Concepts of Sequential Circuits; Cross Coupled SR Flip-Flop Using NAND or NOR Gates; JK Flip-Flop Rise Condition; Clocked Flip-Flop; D-Type and Toggle Flip-Flops; Truth Tables and Excitation Tables for Flip-Flops; Master Slave Configuration; Edge Triggered and Level Triggered Flip-Flops; Elimination of Switch Bounce using Flip-Flops; Flip-Flops with Preset and Clear.

- **SEQUENTIAL LOGIC CIRCUIT DESIGN** **(06 Hours)**

Basic Concepts of Counters and Registers; Binary Counters; BCD Counters; Up Down Counter; Johnson Counter, Module-N Counter; Design of Counter Using State Diagrams and Table; Sequence Generators; Shift Left and Right Register; Registers With Parallel Load; Serial-In-Parallel-Out (SIPO) And Parallel-In-Serial-Out(PISO); Register using Different Type of Flip-Flop.

- **REGISTER TRANSFER LOGIC** **(04 Hours)**

Arithmetic, Logic and Shift Micro-Operation; Conditional Control Statements; Fixed-Point and Floating-Point Data; Arithmetic Shifts; Instruction Code and Design Of Simple Computer.

- **PROCESSOR LOGIC DESIGN** **(03 Hours)**

Processor Organization; Design of Arithmetic Logic Unit; Design of Accumulator.

- **CONTROL LOGIC DESIGN** **(04 Hours)**

Control Organization; Hard-Wired Control; Micro Program Control; Control Of Processor Unit; PLA Control.

(Total Contact Time: 42 Hours + 14 Hours + 28 Hours = 84 Hours)

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3. Tutorials:

1 Problems on different diode based circuits and wave shaping circuit design

2 Problems on logic gates and application of operational amplifiers

3 Problems on boolean algebra and logical circuit design

4 Problems on designing sequential circuits using digital logic gates and integrated circuits

5 Problems on designing ALU and CPU

4. Practicals:

1. Study of BJT Characteristics
2. Study of CE Amplifier
3. Study of RC Coupled / Tuned Amplifier
4. Study of FET Characteristics
5. Study of Diode Clipper Circuits
6. Study of Diode Clamper Circuits
7. Study and Implement RC Low Pass and High Pass Filter Circuits
8. Study and Implement RC Integrator Circuits
9. Study and Implement RC Differentiator Circuits
10. Full and Half-Adder/ Half-subtarctor Circuits using a serial Input
11. 4-Bit Gray to Binary/ Binary to Gray Code convertor using Select input
12. Logic expression with the Help of MUX IC 74153
13. Flip-flops using NAND/ NOR Gate
14. Modulo-7 Ripple Counter
15. 4-Bit Shift Left/Right Register
16. Sequence Generator

5. Books Recommended:

1. Donald L. Schilling and E. Belove, Electronics Circuits- Discrete and Integrated, 3rd Edition, McGraw-Hill, 1989, Reprint 2008.
2. Millman Jacob, Halkias Christos and C. Parikh, Integrated Electronics, 2nd Edition, McGraw-Hill, 2009.
3. H. Taub, Mothibi Suryaprakash and Millman J., Pulse, Digital and Switching Waveforms, 2nd Edition, McGraw-Hill, 2007.
4. Mano Morris, Digital Logic and Computer Design, 5th Edition, Pearson Education, 2005.
5. Lee **Samual**, Digital Circuits and Logic Design, 1st Edition, PHI, 1998.

ADDITIONAL REFERENCE BOOKS

1. Malvin Albert and David J. Bates, Electronic Principles, 7th Edition, Tata McGraw Hill, 2007.
2. De Debashis, Basic of Electronics, 1st Edition, Pearson Education, 2008.
3. Floyd and Jain, Digital Fundamentals, Pearson Education, 2006.

B.Tech. II (CSE) Semester – III
DIGITAL COMMUNICATION (CORE-4)
(Interdisciplinary Subject)
EC209

	L	T	P	Credit
Scheme	**3**	**0**	**2**	**04**

1. Course Outcomes (COs): **At the end of the course, the students will be able to**	
CO1	acquire knowledge about the basics of communication theory.
CO2	apply different modulations schemes for designing the communication network.
CO3	analyse different modulations schemes to design better schemes for different types of channels.
CO4	evaluate and compare different communication topology, modulations schemes and their performance over various types of channels.
CO5	design robust communication network based of advanced modulations scheme.

2. Syllabus

- **INTRODUCTION** **(05 Hours)**

  History, Concept of Transmitter, Receiver, Channel, Noise, Modulation, Types of Modulation, Different communication systems based on Input and Output. Classification Of Signals, Unit Impulse Signals, Correlation Of Signals, Orthogonal Signal Set, Exponential Fourier Series, Types of Noises, Internal: Shot, Thermal, Agitation, Transit Time Noise and External: Atmospheric, Extra-Terrestrial, Industrial Noise, White Noise and Filtered Noise, AWGN Properties, Signal To Noise Ratio.

- **AMPLITUDE MODULATION (AM)** **(06 Hours)**

  AM, AM Index, Frequency spectrum, Average Power for Sinusoidal AM, Effective Voltage and Current, Non sinusoidal Modulation, DSBFC & DSBSC Modulation, Amplitude modulator and Demodulator Circuits, AM Transmitters.

- **SINGLE-SIDEBAND (SSB) MODULATION** **(06 Hours)**

  SSB Principles, Balanced Modulators, SSB Generation and Reception.

- **ANGLE MODULATION** **(06 Hours)**

21/12/20

Frequency Modulation (FM), Frequency spectra, Average power, Deviation Ratio, Measurement of Modulation Index, Phase Modulations (PM), Sinusoidal PM, Digital PM, Angle Modulator Circuits, FM Transmitters, Angle Modulations Detectors.

- **PULSE MODULATION** **(07 Hours)**

  Pulse Amplitude Modulation, Pulse Code Modulation, Delta Modulation, Pulse Frequency Modulation, Pulse Time Modulation, Pulse Position modulation and Pulse Width Modulation.

- **DIGITAL CARRIER SYSTEM** **(06 Hours)**

  Introduction and representation of Digital Modulated Signal, ASK, PSK, FSK, QAM with Mathematics and Constellation Diagram, Spectral Characteristics of Digitally Modulated Signals. M-Ary Digital Carrier Modulation.

- **FIBER-OPTIC COMMUNICATIONS** **(06 Hours)**

  Principles of Light Transmission in Fiber Losses in Fibers, Dispersion, Light Sources and Detectors for Fiber Optics.

(Total Contact Time: 42 Hours + 28 Hours = 70 Hours)

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3. Practicals:

1. Study of The Spectrum Analyzer.
2. Study of Various Signals and its Spectrum Using MATLAB.
3. DSB-SC and DSB-C AM Transmitter and Receiver with Tone and Voice Input.
4. FM Transmission and Reception Techniques.
5. Frequency Division Multiplexing Techniques.
6. AM and FM Simulation On MATLAB with AWGN Channel and Concept of SNR.
7. Study of Sampling Theorem Pulse Code Modulation and Demodulation.
8. Study of PAM/PWM/PPM Modulation.
9. Study of Delta Modulation and Demodulation.
10. ASK, FSK, PSK, QAM With Performance Analysis Under Channel Effects And BER

4. Books Recommended:

1. Dennis Roddy and John Coolen, Electronic Communications, PHI, 4th Edition, 1995.

2. George Kennedy, Electronic Communication Systems, 3rd Edition, McGraw Hill Book Co., 1993.
3. Simon Haykin, Communication Systems, 2nd Edition, Wiley Eastern Ltd, 1994.
4. Taub and Schilling, Principles of Communication Systems, 3rd Edition, Mc Graw Hill Publication, 1992.
5. B. P. Lathi, Modern Digital and Analog Communication Systems, 4th Edition, Holt Sounders Publication, 1998.

ADDITIONAL REFERENCE BOOKS

1. Lathi B. P. and Ding Zhi, Modern Digital and Analog Communication Systems, Oxford University Press, 4th Edition, 2010.
2. Proakis J. and Salehi M., Fundamental Of Communication Systems, PHI/Pearson Education-LPE, 2nd Edition, 2006.