Dr. Babasaheb Ambedkar Technological University

(Established as University of Technology in the State of Maharashtra

(Under Maharashtra Act No. XXIX of 2014)

P.O. Lonere, Dist. Raigad, Pin 402 103, Maharashtra

www.dbatu.ac.in

Undergraduate Programme

Bucket of Multi–Disciplinary Minor (MDM) Courses

In

Computer Engineering and Allied Branches

With effective from the academic year

2025 – 2026

(For Affiliated Institutes only)

Department of Computer Engineering

Dr. Babasaheb Ambedkar Technological University, Lonere

Course Structure for Multi-Disciplinary Minor (MDM) Bucket in Computer Engineering and Allied Branches (UG) w.e.f. 2025-26 as per NEP-2020 (For Affiliated Institutes Only)

Semester	Course Code	Course Name	Teaching Scheme		Evaluation Scheme			Credit
			T	P	CA	MTE	ESE	
III	25AF1245MD306A	Data Structures	3	-	20	20	60	3
	25AF1245MDL306A	Data Structures Laboratory	-	2	60	-	40	1
	25AF1245MD306B	Object-Oriented Programming	2	-	20	20	60	2
	25AF1245MDL306B	Object-Oriented Programming Laboratory	-	2	60	-	40	1
IV	25AF1245MD406A	Design and Analysis of Algorithms	3	-	20	20	60	3
	25AF1245MDL406A	Design and Analysis of Algorithms Laboratory	-	2	60	-	40	1
	25AF1245MDL406B	Python Programming	1	2	60	-	40	2
V	25AF1245MD506A	Operating Systems	3	-	20	20	60	3
	25AF1245MDL506A	Operating Systems Laboratory	-	2	60	-	40	1
	25AF1245MD506B	Database Management System	3	-	20	20	60	3
	25AF1245MDL506B	Database Management System Laboratory	-	2	60	-	40	1
	25AF1245MD506C	Machine Learning	3	-	20	20	60	3
	25AF1245MDL506C	Machine Learning Laboratory	-	2	60	-	40	1
VI	25AF1245MD606A	Software Engineering (DevOps)	3	-	20	20	60	3
	25AF1245MD606B	Data Communication & Computer Networks	3	-	20	20	60	3
VII	25AF1245MD705	AI Ethics	2	-	20	20	60	2

A student wishing to pursue a Minor program in B.Tech. (Artificial Intelligence and Machine Learning) needs to complete at least 14 credits from the list of courses.

Department of Computer Engineering

Second Year (Semester – III)
Data Structures

25AF1245MD306A	Data Structures	**MDM**	3L-0T-2P	4 Credit

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs.)

COURSE CONTENT

Unit I Introduction: Data, Data types, Data structure, Abstract Data Type (ADT), representation of Information, characteristics of an algorithm, program, analysing programs. Arrays and Hash Tables: Concept of sequential organisation, linear and non-linear data structures, storage representation, array processing, sparse matrices, transpose of sparse matrices, Hash Tables, Direct address tables, Hash tables, Hash functions, Open addressing, Perfect hashing.

Unit II Stacks and Queues: Introduction, stack and queue as ADT, representation and implementation of stack and queue using sequential and linked allocation, Circular queue and its implementation, Application of stack for expression evaluation and expression conversion, recursion, priority queue.

Unit-III Linked Lists: Concept of linked organization, singly and doubly linked list, and dynamic storage management, circular linked list, operations such as insertion, deletion, concatenation, traversal of linked list, dynamic memory management, garbage collection.

Unit-IV Trees and Graphs: Basic terminology, binary trees and their representation, insertion and deletion of nodes in binary trees, binary search tree and its traversal, threaded binary tree, Heap, Balanced Trees, Terminology and representation of graphs using adjacency matrix, Warshall's algorithm.

Unit-V Searching and Sorting: Sequential, binary searching, skip lists – dictionaries, linear list representation, skip list representation, operations – insertion, deletion, and searching. Insertion sort, selection sort, radix sort, and File handling.

Reference Books:

1. Horowitz and Sahani, Fundamentals of Data Structures, Universities Press, 2nd Edition, 2008.
2. Thomas Cormen, Introduction to Algorithms, PHI Publication, 2nd Edition, 2002.

3. Venkatesan & Rose, Data Structures, Wiley Publication, 1st Edition, 2015.
4. Goodrich & Tamassia, Data Structures & Algorithms in C++, Wiley Publication, 2nd Edition, 2011.
5. R. G. Dromey, How to Solve it by Computer, 2nd Impression, Pearson Education.
6. Kyle Loudon, Mastering Algorithms with C: Useful Techniques from Sorting to Encryption, O'Reilly Media, 1st Edition, 1999.

Text Books:

1. Mark Allen Weiss, Data structures and algorithms analysis in C++, Pearson Education, 4th Edition, 2013.
2. S. Lipschutz, Data Structures, McGraw-Hill Publication, Revised 1st Edition, 2014.
3. Y. Langsm, M. Augenstin, A. Tanenbaum, Data Structure using C and C++, Prentice Hall India Learning Private Limited, 2nd Edition, 1998.
4. Trembley and Sorenson, Introduction to Data Structures, PHI Publication, 2nd Revised Edition, 1983.
5. Vishal Goyal, Lalit Goyal, A Simplified Approach To Data Structure, SPD Publication, 1st Edition, 2014.

Second Year (Semester – III)
Object-Oriented Programming

25AF1245MD306B	Object-Oriented Programming	**MDM**	2L-0T-2P	3 Credit

Teaching Scheme	Examination Scheme
Lecture: 2 hrs./week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs.)

COURSE CONTENT

Unit-1 Introduction to Classes and Objects (Java): Introduction, Java Class Libraries, Typical Java Development Environment, Memory Concepts, Arithmetic. Classes, Objects, Methods and Instance Variables, Declaring a Class with a Method and Instantiating an Object of a Class, Declaring a Method, Instance variables, set Methods and get Methods, Primitive Types vs. Reference type double Types, Initializing Objects with Constructors, floating point numbers. Contro Statements and Array

Unit-2 Modularization in Java: Java Package, importing packages, Methods: static methods, static Fields, scope of declaration, method overloading, and Java API packages.

Unit-3 Inheritance and Polymorphism in Java
Inheritance: Super classes and Subclasses, protected members, relationship between super classes and subclasses, constructors in subclasses, object class.
Polymorphism: Abstract classes and methods, final methods and classes, polymorphism examples, and Interfaces.

Unit-4 Exception-handling: Exception-handling overview, handling Arithmetic Exceptions and Input Mismatch Exceptions, when to use exception handling, Java exception hierarchy, finally block. Java Iterator Methods Parametrized Classes in Java.

Text Books:

1. Paul Deitel and Harvey Deitel, Java: How to Program, Pearson's Publication, 9th Edition.

Reference Books:

1. Joel Murach and Michael Urban, Murach’s Beginning Java with Eclipse, Murach's Publication, 1st Edition, 2016.
2. Doug Lowe, Java All-in-One For Dummies, Wiley Publication, 4th Edition, 2014.
3. Herbert Schildt, Java: The Complete Reference, McGraw-Hill Publication, 9th Edition.
4. Patrick Niemeyer, Daniel Leuck, Learning Java, O'Reilly Media, 4th Edition, 2013.
5. JavaScript: The Good Parts‖, Douglas Crockford, O‘Reilly, ISBN: 9782744055973.

Second Year (Semester – IV)
Design and Analysis of Algorithms

25AF1245MD406A	Design and Analysis of Algorithms	**MDM**	3L-0T-2P	4 Credit

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs.)

COURSE CONTENT

Unit-1 Introduction to Algorithms: Definition, Properties of Algorithms, Expressing Algorithm, Flowchart, Algorithm Design Techniques, Performance Analysis of Algorithms, Types of Algorithms Analysis, Order of Growth, Asymptotic Notations, Recursion, Recurrences Relation, Substitution Method, Iterative Method, Recursion Tree, Master Theorem, Changing Variable, Heap Sort.

Unit-2 Divide and Conquer: Introduction, Binary Search, Merge Sort, Quick Sort, Strassen‘s Matrix Multiplication.

Unit-3 Backtracking: Backtracking Concept, N–Queens Problem, Four–Queens Problem, Eight–Queen Problem, Hamiltonian Cycle, Sum of Subsets Problem, Graph Coloring Problem, Branch and Bound: Introduction, Traveling Salesperson Problem, 15-Puzzle Problem, Comparisons between Backtracking and Branch and Bound.

Unit-4 Greedy Algorithms: Introduction to Greedy Technique, Greedy Method, Optimal Merge Patterns, Huffman Coding, Knapsack Problem, Activity Selection Problem, Job Sequencing with Deadline, Minimum Spanning Tree, Single-Source Shortest Path Algorithm.

Unit-5 Dynamic Programming: Introduction, Characteristics of Dynamic Programming, Component of Dynamic Programming, Comparison of Divide-and-Conquer and Dynamic Programming Techniques, Longest Common Subsequence, matrix multiplication, shortest paths: Bellman-Ford, Floyd Warshall, Application of Dynamic Programming.
NP Completeness: Introduction, the Complexity Class P, the Complexity Class NP, Polynomial-Time Reduction, the Complexity Class NP-Complete.

Text Books:

1. T. Cormen, Introduction to Algorithms, PHI Publication, 4th Edition, 2022.

Reference Books:

1. Aho, Ullman, Data Structure and Algorithms, Addison-Wesley Publication, 1st Edition, 1983.
2. Michel Goodrich, Roberto Tamassia, Algorithm Design – Foundation, Analysis &

Internet Examples, Wiley Publication, 2nd Edition, 2006.
3. George T. Heineman, Gary Pollice, Stanley Selkow, Algorithms in a Nutshell, A Practical Guide, O'Reilly Media, 2nd Edition, 2016.
4. Sara Base, Computer algorithms: Introduction to Design and Analysis, Addison-Wesley Publication, 2nd Edition, 1988.

Second Year (Semester – IV)
Python Programming

25AF1245MD406B	Python Programming	**MDM**	1L-0T-2P	2 Credit

Teaching Scheme	Examination Scheme
Lecture: 1 hrs./week	Continuous Assessment: 60 Marks Mid Semester Exam: - End Semester Exam: 40 Marks

COURSE CONTENT

Unit-1: Informal introduction to programming, algorithms and data structures, downloading and installing Python, run a simple program on Python interpreter.

Unit-2: Variables, operations, control flow – assignments, conditionals, loops, functions: optional arguments, default values, passing functions as arguments, Statements, Expressions.
Strings: String processing. Exception handling, Basic input/output, handling files.

Unit-3: Class and Object, Data Structure: List, Tuple and Sequences, Set, Dictionaries.

Unit-4: Using Database and Structured Query Languages (SQL): SQLite manager, Spidering Twitter using a Database, Programming with multiple tables, JOIN to retrieve data.

Text/Reference Books:

1. Michael Urban and Joel Murach, Murach‘s Python Programming, Murach's Publication, 2016.
2. Charles Severance, Python for Informatics: Exploring Information, University of Michigan, Version 2.7.0, 2014.
3. Dr. R. Nageswara Rao, Core Python Programming, Dreamtech Press, 1st Edition, 2016.
4. Mark Lutz, Learning Python, O'Reilly Media, 5th Edition, 2013.
5. Mark Pilgrim, Dive into Python 3, A press Publication, 2nd Edition, 2009.
6. Allen B. Downey, Think Python, O'Reilly Media, 2nd Edition, 2012.
7. Jon Kleinberg and Eva Tardos, Algorithm Design, Pearson Education, 1st Edition, 2006.

Third Year (Semester – V)
Operating Systems

25AF1245MD506A	Operating Systems	**MDM**	3L-0T-2P	4 Credit

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks

COURSE CONTENT

Unit I: Introduction to Operating Systems

Definition and objectives of Operating Systems, Functions of an Operating System, Types of Operating Systems (Batch, Multiprogramming, Multitasking, Time-sharing, Distributed, Real-Time, Mobile), Basic Operating System Structure, System Components, System Services, System Calls (overview), User Interface (CLI and GUI), Virtual Machines (introduction).

Unit II: Processes and CPU Scheduling

Process Concept, Process States and Process Control Block (PCB), Process Scheduling, Types of Schedulers, Context Switching, Inter-process Communication (basic concepts), Threads and Multithreading (introduction), CPU Scheduling Concepts, Scheduling Criteria, Basic Scheduling Algorithms (FCFS, SJF, Priority, Round Robin).

Unit III: Memory Management

Memory Management Concepts, Logical and Physical Address Space, Memory Allocation Techniques (Contiguous Allocation, Fixed and Variable Partitioning), Internal and External Fragmentation, Compaction, Paging (basic concept), Segmentation (overview), Virtual Memory (introduction), Demand Paging, Page Replacement Concepts (FIFO and LRU only).

Unit IV: File and Secondary Storage Management

File Concept, File Attributes and Operations, File Access Methods, Directory Structure, File Allocation Methods (Contiguous, Linked, Indexed), Free Space Management (overview), Disk Structure, Disk Scheduling Concepts (FCFS, SSTF, SCAN), Disk Management, Swap Space (introduction).

Unit V: Process Synchronization, Deadlocks and Case Studies

Need for Process Synchronization, Critical Section Problem (concept only), Semaphores (basic concept), Deadlocks (introduction, causes, necessary conditions, prevention concepts), Practical Features of Modern Operating Systems, Overview of Windows, Linux and Android Operating Systems, Case Studies and Applications of Operating Systems.

Text/Reference Books:

1. Michael Urban and Joel Murach, Murach‘s Python Programming, Murach's Publication, 2016.
2. Charles Severance, Python for Informatics: Exploring Information, University of Michigan, Version 2.7.0, 2014.
3. Dr. R. Nageswara Rao, Core Python Programming, Dreamtech Press, 1st Edition, 2016.
4. Mark Lutz, Learning Python, O'Reilly Media, 5th Edition, 2013.
5. Mark Pilgrim, Dive into Python 3, A press Publication, 2nd Edition, 2009.
6. Allen B. Downey, Think Python, O'Reilly Media, 2nd Edition, 2012.
7. Jon Kleinberg and Eva Tardos, Algorithm Design, Pearson Education, 1st Edition, 2006.

List of Lab Assignment Names:

1. Introduction to Operating System Environment
2. Linux File and Directory Management
3. Linux Process Management
4. CPU Scheduling Algorithms Simulation
5. Memory Management Techniques
6. Virtual Memory and Page Replacement
7. File Management and File Permissions in Linux
8. Basic Shell Scripting
9. Disk Management and Storage Organization
10. Comparative Study of Modern Operating Systems

Third Year (Semester – V)
Database Management Systems

25AF1245MD506B	Database Management Systems	**MDM**	3L-0T-2P	4 Credit

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks

COURSE CONTENT

Unit I: Introduction to Database Management Systems

Introduction, Applications of DBMS, Purpose and Advantages of Database Systems, Database Users, View of Data, Database Languages (DDL, DML, DCL), Database Architecture (Three-Schema Architecture – overview), Relational Database Concepts, Database Design Process, Introduction to Data Storage and Transaction Management.

Unit II: Data Modeling and Relational Model

Entity-Relationship (ER) Model, ER Model Concepts, Entities, Attributes, Relationships, Constraints, Keys (Super Key, Candidate Key, Primary Key), Weak Entity Sets, ER Diagrams, Mapping Cardinality, Extended ER Model (Generalization and Aggregation – overview), Mapping ER Diagrams to Relational Tables, Relational Data Model, Database Schema.

Unit III: Relational Algebra and SQL

Relational Algebra: Selection, Projection, Union, Set Difference, Cartesian Product, Join (basic concept).

Introduction to SQL, SQL Data Definition (CREATE, ALTER, DROP), SQL Data Manipulation (INSERT, UPDATE, DELETE), Basic SQL Queries (SELECT, WHERE, ORDER BY), Aggregate Functions, GROUP BY, HAVING, Set Operations, Nested Queries, Join Operations, Views (overview).

Unit IV: Database Design and Normalization

Need for Database Design, Features of Good Relational Design, Functional Dependency (basic concept), Normalization, First Normal Form (1NF), Second Normal Form (2NF), Third Normal Form (3NF), Boyce-Codd Normal Form (BCNF), Database Design Process.

Unit V: Transactions, Security, Advanced Databases

Introduction to Transactions, ACID Properties (overview), Database Security Concepts, Integrity Constraints, Authorization (basic concepts), Introduction to NoSQL Databases, Cloud Databases.

Text/Reference Books:

1. Henry Korth, Abraham Silberschatz & S. Sudarshan, Database System Concepts, McGraw-Hill Publication, 6th Edition, 2011.
2. Raghu Ramakrishnan, Johannes Gehrke, Database Management Systems, McGraw-Hill Publication, 3rd Edition, 2003.
3. Joel Murach, Murach's Oracle SQL and PL/SQL for Developers, Mike Murach & Associates, 2nd Edition, 2014.
4. Wiederhold, Database Design, McGraw-Hill Publication, 2nd Edition, 1983.
5. Navathe, Fundamentals of Database System, Addison-Wesley Publication, 6th Edition, 2012.
6. Mark L. Gillenson, Fundamentals of Database Management System, Wiley Publication, 2nd Edition, 2011.
7. Serge Abiteboul, Richard Hull, Victor Vianu, Foundations of Databases, Reprint by Addison-Wesley.

List of Lab Assignment Names:

1. Introduction to DBMS and Database Tools
2. Database Creation and Table Design using SQL
3. SQL Data Manipulation Operations
4. SQL Queries and Aggregate Functions
5. SQL Joins and Nested Queries
6. Entity-Relationship Diagram Design
7. Relational Algebra Operations
8. Database Normalization
9. Transactions and Database Security
10. Mini Project: Database Design and Implementation

Third Year (Semester – V)
Machine Learning

25AF1245MD506C	Machine Learning	**MDM**	3L-0T-2P	4 Credit

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks

COURSE CONTENT

Unit I: Introduction to Machine Learning
Introduction, Applications of Machine Learning, Types of Learning (Supervised, Unsupervised, Reinforcement), Machine Learning Workflow, Training and Testing Data, Hypothesis Space and Inductive Bias (basic concepts), Model Evaluation, Training, Validation and Testing, Cross-Validation (overview), Introduction to Feature Selection and Feature Reduction.

Unit II: Supervised Learning
Linear Regression, Logistic Regression, Decision Trees, Instance-Based Learning (K-Nearest Neighbors), Support Vector Machine (basic concept), Overfitting and Underfitting, Model Performance Evaluation (Accuracy, Precision, Recall, F1-Score), Introduction to Recommendation Systems, Collaborative Filtering (overview).

Unit III: Neural Networks and Deep Learning
Introduction, Perceptron Model, Multilayer Neural Networks, Backpropagation (basic concept), Introduction to Deep Learning, Applications of Deep Neural Networks in Image Recognition, Speech Processing, Healthcare, and Smart Systems.

Unit IV: Unsupervised Learning
Introduction, Clustering Concepts, K-Means Clustering, Hierarchical Clustering (overview), Gaussian Mixture Model (basic concept), Applications of Clustering in Business, Healthcare, Marketing, and Customer Segmentation.

Unit V: Machine Learning Applications and Ethics
Machine Learning Applications in Healthcare, Finance, Agriculture, Manufacturing, Education, and Smart Cities, Introduction to Predictive Analytics, Model Selection (overview), Ethical Issues in Machine Learning, Bias and Fairness, Privacy, Challenges.

Text/Reference Books:

1. Tom Mitchell, Machine Learning, First Edition, McGraw Hill, 1997.
2. Ethem Alpaydin, Introduction to Machine Learning, Prentice Hall India Learning Private Limited; 2nd edition, 2010.

List of Lab Assignment Names:

1. Introduction to Python and Machine Learning Tools
2. Data Preprocessing and Visualization
3. Linear Regression
4. Classification using Logistic Regression
5. Decision Tree Classification
6. K-Nearest Neighbors (KNN) Classification
7. Support Vector Machine (SVM)
8. Artificial Neural Network
9. K-Means Clustering
10. Mini Project: Machine Learning Application

Third Year (Semester – VI)
Software Engineering

25AF1245MD606A	Software Engineering	**MDM**	3L-0T-0P	3 Credit

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks

COURSE CONTENT

Unit I: Introduction to Software Engineering
Nature and Characteristics of Software, Software Applications and Importance, Software Crisis, Software Engineering Principles, Software Process Models: Waterfall, Incremental, Prototype, Spiral, Agile (overview), Software Development Life Cycle (SDLC).

Unit II: Requirements Engineering
Requirements Engineering Process, Functional and Non-Functional Requirements, Requirements Elicitation Techniques, Use Cases and User Stories, Software Requirements Specification (SRS), Introduction to UML Diagrams: Use Case and Activity Diagram.

Unit III: Software Design
Software Design Concepts, Modularity and Abstraction, Architectural Design, Interface Design, Data Design, Introduction to UML: Class Diagram and Sequence Diagram.

Unit IV: Software Project Management and Quality
Project Planning, Effort and Schedule Estimation (basic concepts), Risk Management, Software Quality Concepts, Quality Assurance and Reviews, Configuration Management (overview).

Unit V: Software Testing and Maintenance
Need for Software Testing, Testing Levels: Unit, Integration, System, Acceptance, Black-Box Testing, White-Box Testing (basic idea), Debugging Concepts, Software Maintenance and Evolution, Case Study of a Real-World Software Project.

Text/Reference Books:

1. Roger S. Pressman, “Software Engineering”, Tata McGraw-Hill, 6th Edition, 2006.
2. G. Booch, J. Rambaugh, and I. Jacobson, “The Unified Modeling Language User Guide”, Addison Wesley, 2nd Edition, 2005.
3. Srinivasan Desikan, Gopalaswamy Ramesh, “Software Testing: Principles and Practices”, Pearson publication, 2nd Edition, 2006.
4. Pankaj Jalote, “An Integrated Approach to Software Engineering”, Springer New York, 2nd Edition, 2013.

Third Year (Semester – VI)
Data Communication & Computer Networks

25AF1245MD606B	Data Communication & Computer Networks	**MDM**	3L-0T-0P	3 Credit

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks

COURSE CONTENT

Unit I: Introduction to Computer Networks and Data Communication
Introduction, Applications of Computer Networks, Types of Networks (LAN, MAN, WAN), Network Topologies, Network Devices (Hub, Switch, Router, Gateway, Modem, Access Point), Data and Signals (Analog and Digital), Analog and Digital Transmission, Transmission Media (Guided and Unguided), Bandwidth, Bit Rate, Transmission Impairments, Network Performance (Throughput, Latency, Bandwidth, Jitter).

Unit II: Data Link Layer and Local Area Networks
Functions of the Data Link Layer, Framing, Error Detection and Error Correction (basic concepts), Flow Control (overview), Ethernet (IEEE 802.3), Wireless LAN (Wi-Fi – IEEE 802.11), Bluetooth, RFID, Introduction to Mobile and Broadband Wireless Communication.

Unit III: Network Layer and Transport Layer
Introduction, IPv4 and IPv6 Addressing (basic concepts), Routing Concepts, Role of Routers, Introduction to Transport Layer, TCP and UDP, Basic Socket Concept, Introduction to Congestion Control, Quality of Service (QoS) (overview).

Unit IV: Application Layer Protocols
Introduction, Domain Name System (DNS), Hypertext Transfer Protocol (HTTP/HTTPS), File Transfer Protocol (FTP), Simple Mail Transfer Protocol (SMTP), Post Office Protocol (POP3), Web Browsing, Email Services, Cloud-Based Network Applications.

Unit V: Network Security
Introduction, Authentication, Encryption (Public Key and Private Key Concepts), Digital Signatures, Digital Certificates, Firewalls, Secure Communication, Introduction to Cloud Networking, Internet of Things (IoT), 5G Networks.

Text/Reference Books:

1. A. Tanenbaum, Computer Networks, PHI Publication, 5th Edition, 2011.
2. B. Forouzan, Data Communications and Networking, McGraw Hill Publication, 5th Edition, 2013.

3. Larry Peterson and Bruce Davie, Computer Networks: A Systems Approach, Morgan Kufman Publication, 5th Edition, 2012.
4. D. Comer, Computer Networks and Internet, Pearson Education, 6th Edition, 2014.
5. M. Gallo, W. Hancock, Computer Communications and Networking Technologies, Brooks/Cole Publisher, 2001.
6. Natalia Olifer, Victor Olifer, Computer Networks: Principles, Technologies and Protocols for Network Design, Wiley Publication, 2005.