SVKM's NMIMS Deemed-to-be University
Mukesh Patel School of Technology Management and Engineering

Program: B Tech Data Science and CSE(DS) MBA Tech Data Science				**Semester:** III	
Course: Optimization Methods				**Code:** 702BS0C032	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Internal Continuous Assessment (ICA) (Marks - 50)**	**Term End Examinations (TEE) (Marks- 100)**
3	2	0	4	Marks Scaled to 50	Marks Scaled to 50

Pre-requisite: Linear algebra (vectors, matrices, derivatives) and calculus

Course Objective

The aim of the course to provide basic understanding of optimization techniques and its applications. It focuses on Significance of optimization techniques in data science. It covers numerical techniques of optimization theory to solve concrete Engineering problems

Course Outcomes

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

1. Use optimization techniques in Data Analytics and related areas
2. Apply optimization techniques to business problems
3. Develop and implement basic optimization techniques.

Detailed Syllabus

Unit	Description	Duration
1.	**Linear Programming** Introduction, Maximization, Minimization, Graphical Method, Simplex Method, Duality, Big M Method, Two Phase Simplex Method, Primal vs Dual, Shadow Pricing, Sensitivity Analysis, Karmakar's Method, Software for Linear Programming Problem	6
2.	**Transportation Problem** Introduction, Mathematical Model, Balanced and Unbalanced Problem, North West Corner Rule, Stepping Stone Method, Vogel Approximation Method, MODI Method, Optimality Criteria, Software for Transportation Problem	5
3.	**Assignment Problem** Introduction, Mathematical Model, Cost Minimization Model, Profit Maximization Model, Hungarian Method, Flood's Method, Optimality Criteria, Traveling Salesman Problem, Software for Assignment Problem	5

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4.	**Decision Making Problem** Introduction, Conditions of Certainty, Uncertainty and Risk, MaxiMax, MaxiMin, Minimax, Hurwicz, Laplace Criteria, EMV, EOL and EVPI Calculations, Incremental and Marginal Analysis Methods, Software for Decision Making Problem	6
5.	**Game Theory** Introduction, Payoff Matrix, Decision Making under conditions of Conflict, Saddle Point, Value of Game, Principle of Dominance, Software for Game Theory Problem	5
6.	**Integer Linear Programming and Mix Integer Programming Problems** Introduction, Mathematical Formulation, Relaxation, Branch and Bound, Knapsack Problem, Warehouse Location, Graph Coloring, Cutting Planes, Gomory Cuts, Polyhedral Cuts, Node Packing, Cover Cuts, Branch and Cut, Seven Bridges, Traveling Salesman Problem, Software for Integer Linear Programming Problem	8
7.	**Goal Programming** Introduction, Mathematical Formulation, Solution to Goal Programming Problems, Software for Goal Programming Problem	**5**
8.	**Simulation Modeling** Introduction, Mathematical Formulation, Random Number Generation, Monte Carlo Method, Applications, Software for Simulation	**5**
	Total	45

Text Books

1. Bernard W. Taylor III, *Introduction to Management Science*, 13th Edition, Pearson, 2018
2. J.K. Sharma, *Operations Research: Theory and Applications*, 6th edition, MacMillan, 2017

Reference Books

1. Prem Kumar Gupta and D S Hira, *Operations Research*, Revised edition, Sultan Chand Publications, 2017
2. Hamdy D Taha, *Operations Research*, 8th edition, Prentice Hall, 2017
3. S S Rao, *Engineering Optimization*, 3rd edition, Prentice Hall, 2017

Laboratory/ Tutorial Work

8 to 10 programming exercises (and a practicum) based on the syllabus

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Mukesh Patel School of Technology Management & Engineering

Program: B Tech/ MBA Tech Data Science				**Semester :** III	
Course: Managing Uncertainty				**Code:** 702DB0C002	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Internal Continuous Assessment (ICA) (Marks -50)**	**Term End Examinations (TEE) (Marks - 100)**
3	**2**	**0**	**4**	**Scaled to 50 marks**	**Scaled to 50 Marks**

Pre-requisite: NIL

Course Objective

Students will be familiar with basic rules of probability and will be able to use them in modelling uncertainty in obtaining and recording data. They will be able to utilize graphical and numerical summaries of data in understanding data generating processes. To enable the students to analyse data more effectively using statistical software.

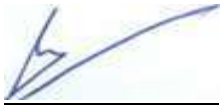
Course Outcomes

After completion of the course, students will able to -

1. Define marginal and conditional probabilities and the covariance of two random variable
2. Outline most common discrete and continuous probability distributions and their real life applications
3. Apply dispersion, correlation and distribution to solve problems

Detailed Syllabus

Unit	Description	Duration
1	**Classification and tabulation of Data** Meaning and objective of classification, Types of classification, formation of discrete and continuous distribution.	2
2	**Descriptive Statistics** • Measures of central tendency. Average, median and mode • Measures of statistical dispersion. Sample variance, quartiles, and interquartile range • Distribution visualization. Histogram, Frequency distribution, Quantitative Data Graphs (Histograms , Frequency Polygons, Ogives, Dot Plots, Stem-and-Leaf Plots) ; Qualitative Data Graphs (Pie Charts ,Bar Graphs, Pareto Charts) ; Graphical Depiction of Two-Variable Numerical Data: Scatter Plots • Descriptive statistics of sample vs population • Descriptive statistics • Basic visualizations of statistical data • Converting columns in data-frames • Data summarization and descriptive statistics. Highlights	8



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3	**Measures of Variability** Dispersion, Range, Standard deviation, Chebyshev's theorem; Population v/s sample variance and standard deviation, Skewness; Kurtosis. **Correlations and visualizations** • Sample covariance and Pearson's correlation • Correlation vs causation • Rank correlations for non-linearly dependent data and ordered categorical data. • Finding correlations • Correlations and visualizations	6
4	**Conditional probability and Independence** • Conditional probability. Motivation and Example • Conditional probability. Definition • Independent events. Example • Independent events. Definition • Mosaic Plot. Visualization of conditional probabilities and Independence • Using independence to find probabilities. Examples • Pairwise and mutual independence • Bernoulli Scheme • Law of total probability • Bayes's rule • Python for conditional probabilities • Conditional probability. Highlights	4
5	**Random variables** • Examples of random variables • Mathematical definition of random variable • Probability distribution and probability mass function (PMF) • Binomial distribution • Expected value of random variable. Motivation and definition • Expected value example and calculation: • Expected value as best prediction: • Variance of random variable. Motivation and definition • Discrete random variables with infinite number of values • Saint Petersburg Paradox. Example of infinite expected value • Generating discrete random variables for generation and visualization of common distributions	4

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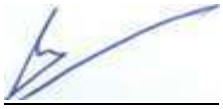
6	**Properties of Expectation and variance, covariance and correlation Random Variable** • Linear transformations of random variables • Linearity of expected value • Symmetric distributions and their expected values • Functions of random variables • Properties of variance • Sum of random variables. Expected value and variance. • Joint probability distribution • Marginal distribution • Independent random variables • Another example of non-independent random variables • Expected value of product of independent random variables. • Variance of sum of random variables. Covariance • Properties of covariance • Correlation of two random variables	6
7	**Continuous random variables** • Continuous random variables. Motivation and Example • Probability density function (PDF) • Cumulative distribution function (CDF) • Properties of CDF • Linking PDF and CDF • Examples of probability density functions • Histogram as approximation to a graph of PDF • Expected value of continuous random variable. • Variance of continuous random variable. Properties of expected value and variance • Transformations of continuous random variables and their PDFs • Joint CDF and PDF. Level charts. Marginal PDF • Independence, covariance, and correlation of continuous random variables • Mixed random variables. Example • Generating and visualizing continuous random variables • Generating correlated random variables	6



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8	**Probability and Bayes' Theorem** • Classical and frequentist probability • Bayesian probability and coherence • Conditional probability • Bayes' theorem • Bernoulli and binomial distributions • Uniform distribution • Exponential and normal distributions	5
9	Introduction to Hypothesis Testing and statistical Inference	4
Total		45

Text Book

1. Richard Levin,David S Rubin, Sanjay Rastogi and Massod Husain, *Statistics For Management*, 8th edition, Pearson, 2017

Reference Book

1. Damodar Gujarati, *Basic Econometrics*, 5th edition, McGraw Hill Education, 2017

Laboratory/ Tutorial Work

8 to 10 programming exercises (and a practicum) based on the syllabus

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Mukesh Patel School of Technology Management & Engineering

Program: B Tech/ MBA Tech Data Science, B Tech AI and DS and B Tech CSE (DS)				**Semester :** III	
Course: Data Wrangling				**Code :** 702DB0C012	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Internal Continuous Assessment (ICA) (Marks -50)**	**Term End Examinations (TEE) (Marks - 100)**
1	4	0	3	Marks Scaled to 50	Marks Scaled to 50

Pre-requisite: Nil

Course Objective

To understand and analyse the amount of data needed today for business decision, which is increasing rapidly that is Big Data, most of the time (about 70%) is spent on data gathering, data cleaning and making these data process worthy for business decision. Hence, it is important for students to understand and have hands-on training for data cleaning and know the theory of ETL (Extract, Transform, and Load) process. To give information about fundamental concepts in Data Warehousing like slowly changing dimensions (SCD), data granularity, data velocity, metadata etc. To learn, clean and operationalize data and datasets using statistical decision-making tools and basic analytical tools.

Course Outcomes

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

1. Find data from a variety of sources into the tool environment. Explain the principles of tidy data, data wrangling and sharing
2. Make use of statistical and basic data analysis tool and fundamental functions for data cleaning and manipulation. Construct data-sets and further modify and analyse it
3. Tell the basic terms in data warehousing like metadata, SCD, ETL etc.

Detailed Syllabus

Unit	Description	Duration
1	Introduction to Data Science	01
2	A Data Scientist's Toolbox; Types of data questions Lifecycle of a DS problem:- Discovery, Data Preparation, Model Planning, Model Planning, Model Building, Operationalize, Communicate Result	01
3	Overview of data processing steps which increases the value of data, Basics of data analytical tool, Basics of Statistical Analytical tool:- Getting data into environment, existing local data and other format, Data wrangling and Analysis:-object's structure, drawing basic statistical	04

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	summary from data using base commands and packages, Primary Data Analysis:- its summary and structure slices or subsets of your data, creating and working with vectors, matrices, lists, arrays, data frames, Getting and Cleaning Data – best practices: Data collection, Data formats Making data tidy, Detection and localisation of errors, missing values, special values, Imputation for fields where data is missing, join data, functioning with dates, characters, functions, Distributing data, Scripting for data cleaning	04
4	Online transaction processing vs. Online analytical processing, Introduction to Data Warehousing, Advantages, characteristics, Architecture, Front room & back room; Metadata, its classification:- operational, extraction and Transformational, end user; its role in ETL environment, security mechanism in DW environment	03
5	Data quality tool functions, Data Cleaning, its steps , reasons for dirty data, Sources of data pollution, Data velocity, cyclicity of data, Data Quality Framework-roles and responsibility, levels of testing a DW:- unit, integration, system and acceptance, performance, Data Granularity	02
6	The ETL Process; Major steps, Data Extraction, Transformation, Loading; SCD, operational data store (ODS), basic ODBC topology in ETL	04
Total		**15**

Text Books

1. Mark van der Loo and Edwin de Jonge, *Statistical Data Cleaning with Applications in R*, 1st Edition, Wiley, 2018
2. Reema Thareja, *Data Warehousing*, 10th edition, Oxford university Press, 2017

Reference Book

1. Joy Mundy, Warren Thornthwaite and Ralph Kimball, *The Microsoft Data Warehouse Toolkit*, 2nd edition, Wiley, 2011

Laboratory/ Tutorial Work

8 to 10 programming exercises (and a practicum) based on the syllabus

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SVKM's NMIMS
Mukesh Patel School of Technology Management & Engineering

Program: B Tech/ MBA Tech Data Science				**Semester:** III	
Course: Information Security and Privacy				**Code :** 702DB0C004	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Internal Continuous Assessment (ICA) (Marks -50)**	**Term End Examinations (TEE) (Marks - 100)**
1	2	0	2	Marks Scaled to 50	Marks Scaled to 50

Pre-requisite: Nil

Course Objective

To give an introduction in the field of information and computer network security. Understanding the working of Encryption standards and learn basic key exchange algorithm. Describe the need and importance of data privacy for organizations

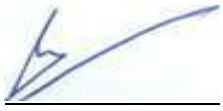
Course Outcomes

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

1. Define concepts of firewall, cookies and elements of data privacy
2. Explain the working of Encryption standards and basic key exchange algorithm
3. Interpret requirements of good documentation practice, payment card industry data compliance guide

Detailed Syllabus

Unit	Description	Duration
1	Principles of security; confidentiality; authentication; integrity; non-repudiation, A model for network security	01
2	Symmetric cipher model; ingredients to symmetric encryption scheme, simple substitution cipher, a few ciphers:-playfair cipher, otp vernam cipher, hill cipher	02
3	Data encryption standard; general description of encoding algorithm, Advanced encryption standard, Public key cryptosystem; Diffie-Hellman key exchange; RSA Algorithm, symmetric vs. asymmetric cryptography	02
4	Fundamentals of OSI model; brief functions/description for every layers; basic protocols used in it	04
5	Basic of:- Intrusion detection system; its classification, firewall; its configuration, cookies, how to verify a digital certificate	02
6	Data privacy and its need and importance; elements of data privacy; data privacy vs. data security; what is more important to your organization, Consequences of non-compliance	02



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7	Requirements of good documentation practice, general payment card industry data security compliance guide	02
Total		**15**

Text Books

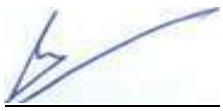
1. William Stallings, *Cryptography and network security; principles and practices*, 7th edition, Pearson, 2017
2. M. Whiteman, H. Mattford, *Principle of Information Security, Cengage Learning*, 6th edition, Cengage Learning, 2018
3. Jim Seaman, *PCI DSS: An Integrated Data Security Standard Guide*, Apress, 2020

Reference Book

1. Atul Kahate, *Cryptography and Network Security*, 1st edition, McGraw Hill, 2017

Laboratory/ Tutorial Work

8 to 10 programming exercises (and a practicum) based on the syllabus



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Program: B Tech/MBA Tech. (Artificial Intelligence, Data Science, Computer Engineering, Information Technology, CSE (Cyber), AI and ML, AI and DS, CSBS, Computer Science) MBA Tech All Programs	**Semester :** III/IV
Course: Database Management Systems	**Code:** 702AI0C001

Teaching Scheme				Evaluation Scheme	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Internal Continuous Assessment (ICA) (Marks - 50)**	**Term End Examinations (TEE) (Marks - 100)**
2	2	0	3	Marks Scaled to 50	Marks Scaled to 50

Pre-requisite: Nil

Course Objective

The objective of the course is to provide a comprehensive introduction to the fundamental concepts for design and development of database systems, with an emphasis on how to organize, maintain and retrieve - efficiently, and effectively - information from a database management system.

Course Outcomes

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

1. Describe core concepts of database and model a database management system through ER modelling
2. Apply knowledge of relational algebra and structured query language to retrieve and manage data from relational database
3. Demonstrate the use of normalization for database design
4. Demonstrate the concept of transactions and use modern database techniques such as NoSQL

Detailed Syllabus

Unit	Description	Duration
1	**Introduction** Database System Applications, Purpose of Database Systems, View of Data, Database Languages, Data Models, Database Users and Administrator	03
2	**Database Design and the E-R Model** Overview of the Design Process, The Entity-Relationship Model, Constraints, Entity Relationship Diagrams, Reduction to Relational Schemas, Schema Diagrams , Entity-Relationship Design Issues, Extended ER features	05
3	**Introduction to the Relational Model**	03

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	Structure of Relational Databases, Database Schema, Keys, Relational Algebra, Basic operators of Relational Algebra,	
4	**Structured Query Language** Overview of the SQL Query Language, SQL Data Definition, SQL Constraints, Basic Structure of SQL Queries, Additional Basic Operations, DML operations, Set operations, Aggregate Functions, Nested Sub-queries, Joins, views	06
5	**Relational Database Design** Features of Good Relational Designs, Problems with bad design, Decomposition using concept of functional dependencies, Armstrong's axioms, Closure of functional dependency, Closure of attribute, Introduction to process of Normalization and de-normalization, Normal Forms- 1NF, 2NF, 3NF, BCNF	05
6	**Transactions** What is Transactions? Properties of transaction, Transaction states, Issues with concurrent executions, Schedules, Serializability- Conflict and View	04
7	**Introduction to NoSQL** Overview of NoSQL, characteristics of NoSQL, Storage types of NoSQL, Implementing NoSQL in MongoDB - Managing Databases and Collections from the MongoDB shell, Finding Documents in MongoDB collection from the MongoDB shell.	04
	Total	**30**

Text Books

1. Hennery Korth and Abraham Silberschatz, *Database System Concepts*, 7th Edition, McGraw Hill, 2019
2. Gaurav Vaish, *Getting Started with NoSQL*, 1st edition, Packt Publication, March 2013
3. Brad Daylel, *NoSQL with MongoDB in 24 Hours*, 1st edition, Sams Teach Yourself, January 2015

Reference Books

1. Elmarsi and Navathe, *Fundamentals of Database Design*, 7th Edition, Addison Wesley, 2019
2. Bob Bryla, Kevin Loney *Oracle Database 12C The Complete Reference*, 1st edition, Tata McGraw Hill, 2017

Laboratory Work

8 to 10 experiments (and a practicum where applicable) based on the syllabus

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Mukesh Patel School of Technology Management & Engineering

Program: B Tech CSBS B Tech and MBA Tech (All programs except Civil and Mechanical) B Tech Computer Science and Engineering (Data Science) B Tech Integrated Computer	**Semester:** II III III VII
Course: Data Structures and Algorithms	**Code:** 702CO1C001

Teaching Scheme				Evaluation Scheme	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Internal Continuous Assessment (ICA) (Marks - 50)**	**Term End Examinations (TEE) (Marks- 100)**
3	2	0	4	Marks Scaled to 50	Marks Scaled to 50

Prerequisite: Programming for Problem Solving

Course Objective

This course imparts knowledge of data structures and algorithms so as to identify and implement appropriate data structure and determine the computational complexity of the given application.

Course Outcomes

After completion of the course, students will be able to -

1. Understand the concept of data structures and computational complexity
2. Identify and implement appropriate linear data structure for the given problem.
3. Identify and implement appropriate non-linear data structure for the given problem.
4. Differentiate various searching and sorting algorithms.

Detailed Syllabus

Unit	Description	Duration
1	**Introduction** Introduction to data structure and its importance, Classification of data structures, Basic operations., Abstract data type, Performance analysis- time and space complexity, Asymptotic Notations.	04
2	**Linear Data Structure I** Representation of arrays in memory, Operations on arrays -Traversal, Insertion, Deletion. Introduction to Stacks, Operations on Stacks, Applications of stacks - Expression conversion and evaluation (Polish notation), Balanced parenthesis checker, Recursion, Introduction to Queue, Operation on Queues, Linear queue Circular queue, Priority queue, Application of Queues.	10
3	**Linear Data Structure II** Introduction to linked list, Representation of linked list in memory, Singly linked list and its operations, Introduction to Doubly Linked list Linked list	07

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	representation of Stack and Queues, Applications of linked list – Polynomial Addition	
4	**Non-Linear Data Structures - I** Introduction, Binary tree terminologies, Representation of Binary trees in memory, Binary Tree traversal algorithms, Construction of Binary Tree from traversals, Binary Search Tree: Insertion, Deletion, Applications of tree data structure: Expression trees, Huffman trees.	10
5	**Non- Linear Data Structures - II** Introduction, Graph theory terminology, Representation of graph: Adjacency Matrix, Adjacency List, Graph Traversal: Breadth first search, Depth first search, Applications of Graphs (Problem Solving): Shortest path (Dijkstra's algorithm), Minimum Spanning Tree.	06
6	**Searching and Sorting** Linear Search, Binary Search, Selection Sort, Insertion sort, Merge sort, Introduction to Hashing	08
	Total	**45**

Text Books

1. Seymour Lipschutz, "*Data structures with C*", Schaum's Outlines, 1st Edition, 2017.
2. Reema Thareja, "*Data Structures using C*", Oxford University Press, 2nd Edition, 2014.
3. Y. Langsam, M.J. Augenstein, A.M. Tenenbaum, "*Data Structures using C and C++*", PHI 2nd Edition, 2015.

Reference Books

1. Richard F. Gillberg, Behrouz A. Forouzen, "*Data Structures – A Pseudo Approach with C*", Cengage Publication, 2nd Edition 2004. (Classic)
2. Mark Allen Weiss, "*Data Structures and Algorithm analysis in C++*", PHI, 4th Edition, 2013.
3. Thomas, H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, "*Introduction to Algorithms*", MIT Press, 3rd Edition 2009.

Laboratory Work

8 to 10 experiments (and a practicum where applicable) based on the syllabus.

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Mukesh Patel School of Technology Management and Engineering

Program: B Tech All Program [except CSBS and CSE(DS) 311 (VT)], MBA Tech All Program, B Tech Integrated Mechanical, Computer				**Semester:** III / VII	
Course: Technical Communication				**Code:** 702BS0C062	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Internal Continuous Assessment (ICA) (Marks - 50)**	**Term End Examinations (TEE)**
0	**0**	**1**	**1**	**Marks scaled to 50**	**-**

Pre-requisite: Fundamentals of English Communication

Course Objective

The objective of the course is to develop students' proficiency in written technical communication so that they are able to produce documents of the kind required in the workplace, such as reports and letters, that are sound, effective, coherent and error-free

Course Outcomes

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

1. Apply the fundamentals of written communication to create written documents that are coherent, error-free and well organized
2. Develop the ability to create effective and persuasive business correspondence, such as letters and emails, that follow etiquette and are able to achieve the desired outcomes
3. Create basic reports such as memo, letter and survey-based report, using their understanding of report writing

Detailed Syllabus

Unit	Description	Duration
1.	**Principles of Effective Writing** Salient features of sentence construction, Paragraph writing, 7 Cs of communication, Making outlines, Writing for the Web	**02**
2.	**Writing Skills** Note taking, Summarizing Fiction / Non-fiction	**04**
3.	**Business Correspondence** Business letter writing – principles and types, Business email writing – subject line, recipient design, language, structuring content, framing, etiquette, cultural sensitivity	**04**

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4.	**Report Writing** Introduction – what is a report, types, and characteristics of reports, pre-writing, principles and of report writing, Ethics in Writing - plagiarism. Survey-based reports Memo Report Letter Report Academic Report (with References and Citations)	**05**
	Total	**15**

Text Books

1. Meenakshi Raman and Sangeeta Sharma, *Technical Communication: Principles and Practice*, 3rd ed. Oxford University Press, 2015

Reference Books

1. Shirley Mathew, *Communication Skills*, Technical Publications, 2013
2. Sheryl Lindsell-Roberts, *Technical Writing for Dummies*, Hungry Minds Inc., 2001
3. Mike Markel, *Technical Communication*, Palgrave Macmillan, 2012

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