Data Structure and Algorithms

Course Title: Data Structure and Algorithms
Course No: BIT121
Nature of the Course: Theory + Lab
Semester: II

Full Marks: 60 + 20 + 20
Pass Marks: 24 + 8 + 8
Credit Hours: 3

Course Description

This course provides fundamental concepts and techniques for designing and analyzing data structures and algorithms. The course covers concepts of stack, queue, linked list, tree, graph, sorting, searching and hashing.

Course Objectives:

Upon the completion of the course, students will be able to:

- Understand the fundamental data structures and their applications
- Analyze the complexity of algorithms
- Use appropriate data structures for problem-solving
- Implement data structures like stack, queue, linked lists
- Apply recursion for problem solving
- Understand and implement sorting and searching problems
- Use hash tables
- Implement tree and graph data structures

Course Contents

Unit 1: Introduction to Data Structures and Algorithms **(3 Hrs.)**
Overview of Data Structures and Algorithms; Data Structure; Abstract Data Types (ADT); Algorithm Analysis and Complexity (Big-O, Big-Theta, Big-Omega); Best, Worst, and Average Case analysis; Array as an ADT

Unit 2: Stack and Queue **(7 Hrs.)**
Concepts of Stack; Operations on Stack; Applications of stacks: Expression Evaluation, Recursion

Concepts of Queue; Operations on Queue; Circular Queue; Priority Queues; Applications of Queue

Unit 3: Linked List **(8 Hrs.)**
Concepts of Linked List; Operations of Linked List; List Implementation of Stack; List Implementation of Queue; Circular Linked List; Doubly Linked List; Circular Doubly Linked List; Applications of Linked List

Unit 4: Recursion **(3 Hrs.)**
Concepts of Recursion; Recursive Algorithms; Applications of Recursion

Unit 5: Sorting **(5 Hrs.)**
Concepts of Sorting; Sorting Algorithms: Bubble Sort, Selection Sort, Insertion Sort, Quick Sort, Merge Sort; Complexity of Sorting Algorithms, Applications of Sorting

Unit 6: Searching and Hashing **(6 Hrs.)**

Concepts of Searching; Searching Algorithms: Linear Search; Binary Search; Complexity of Searching Algorithms; Concepts of Hashing; Hash Table; Collision Resolution in Hashing

Unit 7: Trees **(7 Hrs.)**

Concepts of Tree; Binary Tree; Operations on Binary Tree; Binary Search Tree; Operations on Binary Search Tree; Tree Traversal: Preorder, Inorder, Postorder; AVL Tree; Applications of Tree

Unit 8: Graphs **(6 Hrs.)**

Concepts of Graph; Graph Representation: Adjacency Matrix, Adjacency List; Graph Traversal: Breadth-First Search, Depth-First Search; Shortest Path Algorithms: Dijkstra's Algorithm, Floyd-Warshall Algorithm

Laboratory Works: The laboratory work includes implementation of the data structures and their operations as mentioned in above units.

Text/Reference Books:

1. Yedidyah Langsam, Moshe J. Augenstein, Aaron M. Tanenbaum, Data structure using C and C++, Pearson
2. E. Balagurusamy, Data Structures using C, MC Graw Hill,
3. Mark Allen Weiss, Data Structures and Algorithm Analysis in C++, Pearson
4. Seymour Lipschutz — Schaum's Outlines Data Structures with C, MC Graw Hill India

Object Oriented Programming

Course Title: Object Oriented Programming
Course No: BIT122
Nature of the Course: Theory + Lab
Semester: II

Full Marks: 60 + 20 + 20
Pass Marks: 24 + 8 + 8
Credit Hours: 3

Course Description: The course covers the concepts of object oriented programming using C++. The course includes concepts of objects, class, operator overloading, inheritance and polymorphism, file I/O, exception handling and templates

Course Objectives:
Upon the completion of this course, students will be able to:

- Understand object oriented programming
- Create class and objects
- Use the concepts of inheritance
- Perform operator overloading
- Implement the concepts of polymorphism
- Perform exception handling
- Do the file handling operations
- Use and implement templates

Course Contents:

Unit 1: Concepts of OOP and Basics of C++ **(7 Hrs.)**
Procedural vs. Object oriented programming, Characteristics of OOP: Objects, classes, Encapsulation, Data Abstraction, Inheritance, Polymorphism, Dynamic Binding, and Message Passing, Manipulators and input output statements in C++, Memory Management with New and Delete Operators, Reference variable, Pass by Value vs. Pass by Pointer vs. Pass by Reference, Default Arguments, Inline Functions and Macros, Method Overloading.

Unit 2: Class and Objects **(7 Hrs.)**
Class and objects, accessing class members, defining methods inside the class and outside the class. Object as function arguments, Constructors and its types, Passing Arguments to Constructors, Destructors, Overloading Constructors, Static Members and functions, this pointer, Friend function and friend Classes,

Unit 3: Inheritance **(7 Hrs.)**
Introduction and Importance of Inheritance, Access Specifies: Private, Public and Protected. Types of Inheritance: Single inheritance, Multiple, Multilevel, Hybrid Inheritance, Method overriding, Ambiguity in multiple inheritance, Resolving ambiguity, Ambiguity in multipath inheritance and Virtual Base Class. Public, Private, and Protected Derivations. Constructors and Destructors in Base and Derived Classes.

Unit 4: Operator Overloading **(5 Hrs.)**
Operator Overloading rules, Overloading Unary Operators, Overloading Binary Operators, Overloading using Friend Function, Conversion between data types: Basic to Basic, Basic to User defined, User defined to Basic, User defined to User defined.

Unit 5: Polymorphism **(4 Hrs.)**
Static and dynamic polymorphism, Virtual Functions, Abstract Base Classes and Pure Virtual Functions, Achieving Dynamic Polymorphism using Pure Virtual Function and Method overriding.

Unit 6: Exception Handling **(4 Hrs.)**
Concept of Exception, Exception handling concept, throwing an Exception, handling an Exception, Multiple Exceptions, Extracting Data from the Exception Class, Re-throwing an Exception.

Unit 7: File Handling and Namespace in C++ **(6 Hrs.)**
Stream Classes, Unformatted I/O Operations, Formatted console I/O Operations, Opening and Closing Files, Reading and Writing Text Files, Detecting End of File, Reading and Writing Binary Files, Reading and Writing Objects, Random Access in File

Unit 8: Templates **(5 Hrs.)**
Function Template, Templates with Multiple Type, overloading with Function Templates, Class Templates, Defining Objects of the Class Template, Class Templates and Inheritance. Standard Template Library (STL)

Laboratory Works: The laboratory work includes implementation of object oriented concepts using C++ programming as mentioned in above units.

Text/ Reference Books:

1. Schildt, H., *C++*: The complete reference, Tata McGraw-Hill.
2. Balagurusamy, E., Object-oriented programming with C++, Tata McGraw-Hill.
3. Shah, M., & Thakker, K., Programming in C++, ISTE/Excel Books.
4. Johnston, J., C++ Programming Today, Prentice-Hall of India.
5. Venugopal, K. R., Mastering C++, Tata McGraw-Hill.
6. Stroustrup, B., The C++ programming language, Addison-Wesley.
7. Sahay, S., Object-oriented programming with C++, Oxford University Press.

Discrete Structure

Title: Discrete Structure
Course No: BIT123
Nature of the Course: Theory + Lab
Semester: II

Full Marks: 60+20+20
Pass Marks: 24 + 8 + 8
Credit Hours: 3

Course Description:
This course introduces the mathematical foundations required in information technology. The topics include logic, set theory, relations, functions, combinatorics, graph theory, and discrete probability, with an emphasis on applications in information technology.

Course Objectives:
The main objective of the course is to:

- Introduce basic concepts of discrete mathematics
- Use set and relations
- Implement functions
- Understand induction and recursion
- Get familiar with combinations and permutations
- Acquaint with graph and tree
- Understand number theory and modular arithmetic
- Explore applications of discrete mathematics in information technology.

Course Contents:
Unit 1: Mathematical Logic and Proof Methods **(8 Hrs.)**
Introduction: Mathematical logic, Statements and Notations, Connectives, Well-formed Formulas, Truth Tables

Propositional Logic: Propositional Logic, Propositional Equivalences, Rule of Inferences, Well-formed Formula, Valid Arguments

Predicate Logics: Predicates and Quantifiers, Negation of Quantified Statements, Proof of quantified statements, Nested Quantifiers, Rules of Inference: Propositional Logic and Quantified Statements, and Translating English Sentence to predicate logic expressions

Proof Methods: Basic Terminologies, Proof Methods: Direct Proof, Indirect Proof, Proof by Contradiction, Proof by Contraposition, Exhaustive Proofs and Proof by Cases, Common Errors in Proofs

Unit 2: Sets, Relations and Functions **(9 Hrs.)**
Set Theory: Sets and Subsets, Power Sets, Set Operations: Union, Intersection, Difference, Complement), Venn Diagrams, Inclusion-Exclusion Principle, Cartesian Product, Representation of Sets in Computer.

Relations: Relations and their Properties, N-ary Relations with Applications, Representing Relations, Closure of Relations, Equivalence Relations, Partial Orderings

Functions: Introduction, Injective and Bijective Functions, Inverse and Composite Functions, Graph of Functions, Functions for Information Technology: Ceiling Function, Floor Function, Boolean Function, and Exponential Function

Unit 3: Induction and Recursion **(8 Hrs.)**
Mathematical Induction, Strong Induction, Structural Induction, Recurrence Relation, Recursive Algorithms, Growth of Functions, Solving Homogeneous and Non-homogeneous Recurrences

Unit 4: Elementary Combinatorics **(7 Hrs.)**
Basis of Counting: Product Rule and Sum Rule, Combinations & Permutations, with repetitions, Constrained Repetitions, Binomial Coefficients, Binomial Multinomial Theorems, Principle of Inclusion – Exclusion. Pigeonhole Principle and Its Application

Unit 5: Graphs and Trees **(9 Hrs.)**
Graphs: Definitions and Terminology, Types of Graphs: Simple, Directed, Undirected, Weighted, Handshaking Theorem, Graph Representations: Adjacency List, Adjacency Matrix, Graph Traversal Algorithms: DFS, BFS, Isomorphism, Euler and Hamiltonian Path and Circuits, Planar Graphs and Graph Coloring

Tree: Introduction, Tree Traversals, Spanning Trees, and Minimum Spanning Trees: Kruskal's Algorithm, Prim's Algorithm

Unit 6: Number Theory, Modular Arithmetic, and Discrete Probability **(4 Hrs.)**
Modular Arithmetic, Primes, Greatest Common Divisor and Least Common Multiples, Euclidean Algorithm, Congruences, Chinese Remainder Theorem, Fermat's Little Theorem, Discrete Probability, Probability Theory

Laboratory Works: The lab work involves applying the algorithms and concepts covered in above units. Students are expected to solve problems using the following concepts:

- Set operations, relations, and functions
- Number theory algorithms
- Counting techniques and recursive algorithms
- Predicate logic
- Algorithms for trees and graphs

Text/Reference Books:

1. Rosen, Kenneth H., Discrete Mathematics & Applications, McGraw-Hill
2. Graham, Ronald, Donald Knuth, and Oren Patashnik, Concrete Mathematics: A Foundation for Computer Science, Addison-Wesley Publishing Company
3. Graham, Knuth, and Patashnik, Concrete Mathematics: A Foundation for Computer Science
4. Kolman, Bernard, Robert C. Busby, and Sharon Ross., Discrete Mathematical Structures, Prentice-Hall, Inc., 2014
5. E.G. Goodaire & M M Parmenter, Discrete Mathematics with Graph Theory, 2nd Ed, Pearson

Probability and Statistics

Title: Probability and Statistics
Course Code: BIT124
Nature of the Course: Theory + Lab
Semester: II

Full Marks: 60 + 20 + 20
Pass Marks: 24 + 08 + 08
Credit Hours: 3

Course Description:
This course is designed to provide the students with basic concept of statistics. The course covers the basic tools used to describe data for the purposes of transforming data into information. In addition, the course presents the fundamentals of statistical inference.

Course Objectives:
Upon the completion of this course, students will be able to:

- Explain how statistics is used in IT
- Explain the principles of data presentation
- Develop tables and charts for Numerical data
- Organize the numerical data
- Understand basic probability concepts.
- Define the term random variable and probability distribution
- Understand the concepts of estimation
- Perform hypothesis testing
- Compute correlation coefficient and interpret its values
- Perform regression analysis

Course Contents:

Unit 1: Introduction and Data Management **(6 Hrs.)**
Basic Concept of Statistics; Application of Statistics in including Information Technology (IT) Field; Scales of Measurement; Types of Data and Data source; Basic Vocabulary of Statistics

Organizing Numerical Data: Ordered array; Stem-and-Leaf display; Frequency Distribution

Visualizing Categorical Data: Bar Diagrams; Pareto Charts; Pie Chart

Visualizing Numerical Data: Histogram; Frequency polygon; Cumulative Frequency Curve or Ogive

Unit 2: Descriptive Statistics **(7 Hrs.)**
Measures of Central Tendency: Mean, Median, and Mode

Measures of Dispersion: Range, Semi-inter Quartile Range; Standard Deviation and Coefficient of Variation

Measures of Shape: Skewness (Using Karl Pearson's Method) and Kurtosis (Using Percentile Method)

Exploratory Data Analysis: Five Number Summary and Box and Whisker Plot

Unit 3: Basic Probability **(6 Hrs.)**
Basic probability concepts

Basic Terminology Used in Probability: Random Experiment or Trial, Outcomes or Events, Sample Space, Mutually Exclusive Events, Equally Likely Events, Favorable Events, Exhaustive Events Independent and Dependent Events

Definition of Probability: Classical, Statistical, Subjective and Axiomatic Definitions, Basic Principles of Counting, Permutation and Combinations

Laws of Probability: Additive, and Multiplicative

Conditional Probability: Marginal and Joint probability and Statistical independence

Unit4: Random variable and Probability Distribution **(7 Hrs.)**
Random Variables: Concept of a Random Variable; Types of Random Variables; Probability Distribution of a Random Variable; Mathematical Expectation of a Random Variable.

Discrete Probability Distribution; Binomial; Poisson; and Geometric Distribution their Characteristic Features, Mean, and Variance.

Continuous Probability Distribution; Normal; Standard Normal; Exponential, and Pareto Distribution their Characteristic Features, Mean, and Variance.

Unit 5: Estimation **(6 Hrs.)**
Definitions of Population; Sample; Parameter; Statistic and Standard Error.

Concept of Point and Interval Estimation

Characteristics of Good Estimator

Confidence Interval Estimation for Mean

Concept of Method of Maximum Likelihood Estimation (MLE): MLE for Parameters of Binomial; Poisson; Geometric Normal; Exponential; and Pareto Distribution

Unit 6: Hypothesis Testing: **(7 Hrs.)**
Hypothesis Testing Methodology: The Null and Alternative Hypothesis; Risks of Decision-Making using Hypothesis Testing; Level of Significance; Tails of a Test; Regions of Rejection and Non-rejection; Steps for Testing of Hypothesis

Test of Significance for Large Samples-Z test of Hypothesis for One Mean (σ known or unknown); Z test for the Difference between Two Means

Test of Significance for Small Samples: Assumptions and Application of t-distribution; Degree of Freedom; t-test of Hypothesis for One Mean; t-test for the Difference between Two Means and Paired t-test

Unit 7: Simple Linear Correlation and Regression Analysis **(6 Hrs.)**

Types of Correlations

Methods of Studying Simple Correlation: Scatter Diagram and Karl Pearson's Coefficient of Correlation.

Test of Significance of Simple Co-relation Coefficient.

Simple Linear Regression: Determining the Simple Linear Regression Equation using Least Squares Method.

Standard Error of the Estimate

The Coefficient of Determination

Testing the Significance of Regression Coefficient in Simple Linear Regression Model

Laboratory Works:

The laboratory work includes solving the statistical problems mentioned in above units using appropriate tools like Excel or any other statistical tool.

Text/ Reference Books:

1. Levine, Stephan, Krehbiel and Berenson (2008), Statistics for Managers using Microsoft excel, 5th Edition, New Delhi: Prentice Hall of India.
2. Douglas A Lind, William G Marchal, Samuel A Wathen (2008), Statistical Techniques in Business and Economics, 13th edition, Tata McGraw-Hill India.
3. Douglas C. Montgomery & George C. Ranger (2003). Applied Statistics and Probability for Engineers. 3rd Ed., John Willey and Sons, Inc.
4. Richard A. Johnson (2001). Probability and Statistics for Engineers. 6th Ed., Pearson Education, India

Technical Writing & Communication Skill

Course Title: Technical Writing & Communication Skill	**Full Marks: 60 + 40**
Course No: BIT. 125	**Pass Marks: 24 + 16**
Nature of the Course: Theory	**Credit Hours: 3**
Semester: II	

Course Description:
The course covers the fundamental concepts of technical writing and communication. This course includes the description of writing process, audience analysis, organizing document, professional communication, preparing proposal, report writing and ethical issues.

Course Objectives:
By the end of the course, students will be able to:

- Understand the core principles and formats of technical writing in IT.
- Write various types of technical documents (manuals, reports, proposals, etc.).
- Structure and design documents using visual and verbal clarity.
- Apply ethics and audience awareness in all communication.
- Practice and improve professional communication skills
- Acquaint with technical writing skills

Course Contents:

Unit 1: Introduction to Technical Writing (3 Hrs.)
Introduction to technical writing; Differences from creative/academic writing; Role in IT industry

Unit 2: The Writing Process (3 Hrs.)
Prewriting, drafting, revising, editing; Writing cycle and collaboration; Writer's block and productivity

Unit 3: Audience and Purpose Analysis (3 Hrs.)
Identifying technical vs non-technical readers; Adapting tone, vocabulary, and detail; Communication goals

Unit 4: Principles of Effective Technical Writing (6 Hrs.)
Clarity, conciseness, consistency; Active vs passive voice; Parallelism, grammar, punctuation

Unit 5: Organization and Document Structure (5 Hrs.)
Sections: Title, TOC, Introduction, Body, Conclusion; Paragraph coherence; Flow and transitions

Unit 6: Professional Communication Formats (7 Hrs.)
Emails, memos, notices, meeting minutes; Writing etiquette, format, subject lines

Unit 7: Writing Technical Proposals (7 Hrs.)
Purpose of proposals; Components: intro, background, method, budget; Feasibility and persuasion

Unit 8: Report Writing (8 Hrs.)

Types: progress, status, feasibility reports; Report structure and formatting; Executive summary, findings

Unit 9: Ethics, Plagiarism, and Legal Issues **(3 Hrs.)**
Intellectual Property; Citation Standards; Data Confidentiality, Inclusive language

Text/Reference Books:

1. Markel, M., & Selber, S. A. (2021). Technical Communication (12th Ed.). Bedford/St. Martin's.
2. Alred, G. J., Brusaw, C. T., & Oliu, W. E. The Handbook of Technical Writing.
3. Markel, M., & Selber, S. A. (2021). Technical Communication (12th Edition). Boston: Bedford/St. Martin's, Macmillan Learning.
4. Alred, G. J., Brusaw, C. T., & Oliu, W. E. (Latest edition). The Handbook of Technical Writing. Boston: Bedford/St. Martin's.
5. Meenakshi Raman & Sangeeta Sharma, Technical Communication: Principles and Practice
6. K.R. Lakshminarayanan, English for Technical Communication
7. Sanjay Kumar & Pushp Lata , Communication Skills
8. William Strunk Jr. and E.B. White, The Elements of Style
9. Mike Markel, Technical Communication
10. Gary Blake and Robert W. Bly, The Elements of Technical Writing