

Maulana Abul Kalam Azad University of Technology, West Bengal

(Formerly known as West Bengal University of Technology)

Syllabus of *B.Sc. in Data Science*

Effective from academic session 2023-2024

Detailed Syllabus

SEMESTER - 1 (major) Year-1

Paper Code: BDS101

Paper Name: *Basic Mathematics and Statistics*

Credits: 5 (4Th+1Tu)

Module I: Basic Algebra

The Number System – Positive and Negative Integers, Fractions, Rational and Irrational Numbers, Real Numbers, Problems Involving the Concept of Real Numbers. *Basic Algebra* – Algebraic Identities and Functions (Linear, Non-linear, Logarithmic and Exponential), Basic Algebraic Operations on them, Simple Factorizations; Linear and Nonlinear Equations (in Single and Multiple Variables); System of Simultaneous Equations and their Solutions. Surds and Indices; Logarithms and their Properties (Including Change of Base), Problems Based on Logarithms.

Module II: Combinatorics

Set Theory - Introduction; Representation of Sets; Subsets and Supersets; Universal and Null Sets; Basic Operations on Sets; Laws of Set Algebra; Cardinal Number of a Set; Venn Diagrams; Application of Set Theory to the Solution of Problems. *Permutations and Combinations* – Fundamental Principles of Counting; Factorial Notation. Permutations: Permutation of N Different Things; Things not all Different; Restricted Permutations; Circular Permutations. Combinations: Different Formulas on Combinations; Complementary Combination; Restricted Combination; Division into Groups. Mixed Problems on Permutations and Combinations.

Module III: Linear Algebra

Determinants- Introduction to Determinants of order 2 and 3; Minors and Cofactors; Expansion of Determinants; Properties of Determinants; Cramer's rule for solving Systems of Linear Equations in two or three variables. *Matrices*- Introduction to Matrices; Different types of Matrices; *Matrix Algebra* – Addition, Subtraction and Multiplication of Matrices; Singular and Non-Singular matrices; Adjoint and Inverse of a Matrix; Elementary Row / Column Operations; Solution of a System of Linear Equations using matrix algebra. Concepts of Eigenvalues and Eigenvectors.

Module IV: Calculus

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Differential Calculus - Meaning & geometrical interpretation of differentiation; standard derivatives (excluding trigonometric functions); rules for calculating derivatives; Logarithmic Differentiation. Applications of Derivatives and Partial Derivatives.

Integral Calculus: Meaning, Standard formulas, Integration by Substitution, Integration by Parts (Excluding Trigonometric functions). Definite integral and their applications.

Module V: Introduction to Data

Data Collection, Editing and Presentation of Data - Primary data and Secondary data; Methods of collection; Scrutiny of data. Presentation of data: textual and tabular presentations; Construction of a table and the different components of a table. Diagrammatic representation of data: Line diagrams, Bar diagrams, Pie charts and Divided-Bar diagrams, etc.

Module VI: Frequency Distributions

Attribute and variable; Frequency distribution of an attribute; Discrete and continuous variables; Frequency distributions of discrete and continuous variables; Bivariate and Multivariate Frequency Distributions. Diagrammatic representation of a frequency distribution: case of an attribute; case of a discrete variable: column diagram, frequency polygon and step diagram; case of a continuous variable: histogram and ogive.

Module VII: Measures of Central Tendency

Definition and utility; Characteristics of a good average; Different measures of average; Arithmetic Mean; Median; Other positional measures – quartiles, deciles, percentiles; Mode; Relation between Mean, Median and Mode; Geometric and Harmonic Mean. Choice of a suitable measure of central tendency.

Module VIII: Measures of Dispersion

Meaning and objective of dispersion; Characteristics of a good measure of dispersion; Different measures of dispersion – Range, Quartile deviation, Mean deviation, Mean Absolute deviation, Standard deviation; Comparison of the different measures of dispersion. Measures of relative dispersion – Coefficient of Variation. Combined mean and standard deviation, Combined mean and standard deviation. Introduction to Skewness, Kurtosis, Moments.

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References:

1. H. S. Hall & S. R. Knight – Algebra for Beginners ; Arihant Prakashan, Meerut.
2. H. S. Hall & S. R. Knight – Higher Algebra; Arihant Prakashan, Meerut.
3. Joseph Edwards - Differential Calculus for Beginners, Arihant Prakashan, Meerut.
4. Joseph Edwards - Integral Calculus for Beginners, Arihant Prakashan, Meerut.
5. B S Grewal - Higher Engineering Mathematics, Khanna Publishers
6. Sancheti & Kapoor – Business Mathematics; Sultan Chand & Company.
7. N G Das, Statistical Methods (Combined edition volume 1 & 2), McGraw Hill Education.

SEMESTER - 1 (major) Year-1

Paper Code: BDS102 & BDS192

Paper Name: *Introduction to Computing and Programming with C & C Programming Lab*

Credits: 5 (3Th+2P)

Module I: Computer Fundamentals

Computing Systems: hardware & software, architecture & organization. *History:* evolution of computing systems & von Neumann Architecture: CPU, memory, processor, I/O modules; Data vs Information; bit, byte & nibble. *Number Systems:* binary, decimal, octal & hexadecimal; 1's & 2's complements; computer arithmetic. *Digital Logic:* AND, OR, NOT gates; Logic Circuits. *Basic Software:* BIOS & Boot Sequence, Application Software, System Software, Introduction of Operating systems, Programs & Processes; Introduction to Programming Languages.

Module II: General problem solving concepts

Algorithms and Flowcharts for problem solving with Sequential Logic Structure, Decisions and Loops, time & space complexity; Imperative languages: Introduction to imperative language; syntax and constructs of a specific language (ANSI C). Variable Names, Data Type and Sizes, Constants, Declarations, Arithmetic Operators, Relational Operators, Logical Operators, Type Conversion, Operators in C, Precedence and Order of Evaluation, proper variable naming.

Module III: Control Flow, Function of PS, Arrays & Pointers

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Statements and Blocks, *If-Else-If*, *Switch*, Loops – *while*, *do*, *for*, *break* and *continue*, *Goto* Labels, structured and un- structured programming. Basics of functions, parameter passing and returning type, C main return as integer, External, Auto, Local, Static, Register Variables, Scope Rules, Block structure, Initialisation, Recursion, Preprocessor, Standard Library Functions and return types. Arrays, Pointers and address, Pointers and Function Arguments, Pointers, Address Arithmetic, character Pointers and Functions, Pointer Arrays, Pointer to Pointer, Multi-dimensional array, Initialization of Pointer Arrays, Command line arguments, Pointer to functions.

Module IV: Structures Input & Output

Basic Structures, Structures and Functions, Array of structures, Pointer of structures, Self-referral Structures, Table look up, Typedef, Unions, Bit-fields. Standard I/O, Formatted Output – *printf*, Formatted Input – *scanf*, Variable length argument list, file access including FILE structure, *fopen*, *stdin*, *stdout* and *stderr*.

References:

1. B. S. Gottfried, “Programming in C”, Second Edition, Schaum Outline Series.
2. R.S. Salaria, “Problem Solving and Programming in C”, Khanna Publishing House
3. B. W. Kernighan and D. M. Ritchi, The ‘C Programming Language’, Second Edition, PHI.
4. Yashavant Kanetkar, “Let Us C”, BPB Publications.
5. Pradeep K Sinha and Preeti Sinha, “Computer Fundamentals”, BPB Publications.

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SEMESTER - 2 (major) Year-1

Paper Code: BDS201 & BDS291

Paper Name: *Database Management System & DBMS Lab*

Credits: 5 (3Th+2P)

Module I: Introduction

Concept & Overview of DBMS, Components of Database System, Basics of Database Management System, File-based System and Database Management System, Advantages of using Database over File based system, Data Models, Database Languages, Database Administrator, Database Users, Data Abstraction, Three Schema architecture of DBMS.

Module II: E-R Model

Basic Terminology related to ER Model, Relational Model – Introduction, Advantages and Disadvantages, Identifying Entities, and Relationships, Types of Relationships, Relationship Participation, Notations in ER Model, Strong and Weak entity sets, Managing Many-to-many, Relationship, Example of E-R Model, Types of Integrity Constraints, Subclass and Superclass, Generalization, Specialization, Aggregation.

Module III: Relational Model and Normalization

Concept of Relational Model, Keys, Entity integrity Rule, Closure set, Functional Dependency, Armstrong Axioms, Relational Set Operators, Relational Algebra and relational calculus, Different anomalies in designing a Database, Need for Normalization, Normalization using functional dependencies, Decomposition, Boyce-Codd Normal Form, 3NF, Normalization using multivalued dependencies, 4NF,5NF.

Module IV: SQL

Introduction, Features of SQL, Database Languages - Data definition and Data manipulation languages, Data Definition Commands, Data Manipulation Commands, (SELECT Statement and different Clauses, SQL Functions - Aggregate, Date and Time Functions, String Functions, Null Values, Domain Constraints, Referential Integrity Constraints, Different types of Join and Set Operators, Group by and having clauses, Sub-query, Views, Advances SQL Roll-up, Commit and Save point, Create user grant revoke, Stored procedures and triggers.

Module V: Transaction and Query Processing

Transaction Processing States, ACID Properties of Transaction, read and write operations in transaction, commit and rollback, concurrency problems and reasons for recovery, System log, Transaction in Sql, Steps of Query Processing, Query Optimization.

Module VI: Indexing and Introduction to NoSql

Introduction, Overview, Primary Secondary Multi level, Dense and Space Index, Introduction to NoSql, types of NoSql, Advantages of NoSql.

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References:

1. Korth, Silberschatz and Sudarshan – Database System Concepts; Tata Mc. Graw Hill
2. Ramez Elmasri and Shamkant B Navathe - Fundamentals of Database Systems; Pearson
3. Atul Kahate - Introduction to Database Management Systems , Pearson
4. Ivan Bayross - SQL, PL/SQL – The Programming Language of Oracle, BPB Publications
5. Brad Dayley - Sams Teach Yourself NoSQL with MongoDB in 24 Hours, Sams Publications, 2014

SEMESTER - 2 (major) Year -1

Paper Code: BDS202 & BDS292

Paper Name: *Data Structures and Algorithms & Data Structures in C Lab*

Credits: 5 (3Th+2P)

Module I: Fundamental Concepts

Concepts of Abstract Data Types, Structures, Unions, Enums, Pointer to Structures, Self-referential Structures, Pointer to Pointer, Dynamic Memory Allocation.

Module II: Data Structures using Array

Stacks, Queues, Circular Queues, Priority Queues, Dequeues, their operations and applications

Module III: Searching and Sorting

Searching: linear search, Binary search, their comparison, *Sorting*: insertion sort, Selection sort. Quick sort, Bubble sort, Merge Sort, Heap sort, Comparison of sorting methods, *Algorithms*: Introduction to Algorithms, Analysis of Algorithm, Space-Time Complexity, big 'O', small 'o' & 'Ω' notations.

Module IV: Linked Lists

Linear Link Lists, Doubly Linked Lists, Stack using Linked List, Queue using Linked List, Circular Linked List and their Operations and Applications.

Module V: Trees

Introduction to trees: Definition, Types of Trees, Binary trees, Binary Search Trees (Insertion, Deletion, Recursive and Iterative Traversals of Binary Search Trees). *Representations and Operations*: thread representations, sequential representations, B Tree, B+ Tree, AVL Tree (Various operations on AVL Trees).

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Module VI: Graphs and Hashing

Introduction to graphs: Definition, Terminology, Directed, Undirected & Weighted graphs, Representation of graphs, *Graph Traversal:* Depth First Search and Breadth First Search. Spanning Trees, Minimal Spanning Tree, Shortest Path Algorithms. *Hashing:* Definition, Hashing functions, Load factor and collision, open addressing (linear probing).

References:

1. Data Structures with C by S. Lipschutz.
2. Data Structure Using C , Tennenbaum, PHI
3. Data Structures in C, Ajay Agarwal, Cyber Tech
4. Data Structures Using C, Radhakrishnan & Srinivasan, ISTE/EXCEL BOOKS
5. C and Data Structures,Radhaganesan,Scitech
6. Data Structures by R.S. Salaria, Khanna Publishing House, 2017.