Rajarshi Janak University
Faculty of Science, Technology and Engineering
Course of Study for B.Sc.CSIT
(Second Semester/First Year)

Course Title: Discrete Structures
Nature of Course: Theory and Practical
Credit Hrs: 3 Hrs

Course Code: CSIT 203
Full Marks: 60+20+20
Pass Marks: 20+8+8

Course Description:
This course introduces fundamental mathematical structures essential for computer science and information technology. It covers topics such as set theory, propositional logic, relations, functions, graph theory, number theory, combinatorics, and proof techniques. The course emphasizes both theoretical foundations and practical applications, including algorithms for graph traversal, shortest paths, minimum spanning trees, and combinatorial problem-solving. Laboratory work involves implementing these concepts using high-level programming languages (e.g., Python) to reinforce theoretical knowledge and develop problem-solving skills. The curriculum prepares students to apply discrete mathematical principles in areas like algorithm design, data structures, cryptography, and artificial intelligence.

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

1. Analyze sets, relations, and functions using principles like inclusion-exclusion, equivalence relations, and closure properties.
2. Apply propositional/predicate logic to evaluate truth values, construct proofs, and resolve quantified statements.
3. Model problems using graph theory, including shortest-path algorithms (Dijkstra), spanning trees (Kruskal), and Euler/Hamiltonian paths.
4. Solve number-theoretic problems (GCD, modular arithmetic) and combinatorial challenges (permutations, binomial coefficients).
5. Construct proofs using induction, contradiction, and contraposition, ensuring logical rigor.
6. Design solutions for optimization problems, such as network flows, graph isomorphism, and the Travelling Salesman Problem.
7. Integrate discrete mathematics with programming to simulate real-world scenarios in lab projects.

Course Contents

Unit 1
Set Theory and Propositional Logic **[8 hrs]**
Set Theory: Sets and Subsets, power set and its properties, set operations, Principle of Inclusion and Exclusion, computer Representation of sets, Fuzzy sets and Membership Function, Fuzzy Set Operations

Logic: Introduction, Propositional Equivalences, Predicates and Quantifiers, Negation of Quantified Statements, Nested Quantifiers, Rules of Inference and related Problems. Connectives well-formed formula (WFF), Quantification, examples and properties of WFF into causal form, Resolution and refutation, answer extraction and simple examples.

Unit-2

Relation and Function [**6 hrs]**

Relations: Relations and their Properties, N-ary Relations with Applications, Representing Relations, Closure of Relations, Equivalence Relations, Partial Ordering, Hasse diagram, Lattice

Functions: Basic Concepts, Injective and Bijective Functions, Inverse and Composite Functions, Graph of Functions, Functions for computer Science(Ceiling Function, Floor Function, Boolean Function, Exponential function, logarithmic Function)

Unit-3

Mathematical Induction and Proof Techniques [8 hrs]

Induction: Introduction to Mathematical Induction, Strong Induction, Well ordering, Recursive Definition and structural Induction, Recursively Defined Functions Recursive Algorithms, Proving Correctness of Recursive Algorithms

Proof Techniques: Basic Terminologies, Different Method: Direct Proof, Indirect Proof, Proof by Contradiction, Proof by contraposition, Proof of Equivalence, vacuous and Trivial Proof, Exhaustive Proof and Proof by cases, Mistakes in Proof

Unit-4

Number Theory and Counting [12 hrs]

Introduction to Integers and Number Theory : Integers and Division, Primes and Greatest Common Divisor, Euclidean and Extended Euclidean Algorithm, Integers and Algorithms, Applications of Number Theory (Linear Congruencies, Quadratic Congruencies, Chinese Remainder Theorem, Computer Arithmetic with Large Integers, one-one Matrices, Boolean Matrix Operations.

Counting: Elementary configuration: - Permutations, and Combinations, Generating functions, Counting Subsets of Set, Binomial Coefficients, Generalized Permutations and Combinations, Basics, Pigeonhole Principle, Generalized Pigeonhole Principle, Lexicographical and Fike's ordering of Permutations, Algorithms for Lexicographical, Reverse Lexicographical and Fike's ordering of Permutation.

Advances in Counting: Recurrence Relations, Solving Recurrence Relations (Homogeneous and NonHomogeneous Equations), Introduction to Divide and Conquer Relations

Unit-5

Group Theory [3 hrs]

Group, subgroup, permutation group with simple examples, cosets, normal subgroup, burn sides theorem and its simple application, codes, prefix codes and group codes.

Unit 6 **[8 hrs]**

Graph Theory: Graph, Definitions and examples, Graphs diagraphs, walk, path cycle, sub graph, complements, and graph isomorphism, vertex degree, Representation of graphs, Euler Trails and circuits, connectivity in Graphs, Euler and Hamiltonian Paths and Circuits, Matching Theory, Shortest Path Algorithm (Dijkstra's Algorithm), Travelling Salesman Problem, Graph Coloring

Trees: Definition, properties and examples, Rooted trees, Tress and sorting, weighted trees, cycle connectedness tree, computer representation of relations, relation diagraph and graphs, transitive closer and Warshall's Algorithm, Spanning Trees, Minimum Spanning Trees (Kruskal's Algorithm)

Network Flows: Graph as Models of Flow of Commodities, Flows, Maximal Flows and Minimal Cuts, the Max Flow-Min Cut Theorem

Laboratory Work:

Laboratory works should consist of program development and testing of all the topics discussed in theory class software's like C, C++, MATLAB R202x., python 3.x with Numpy/Maplotlib or any other appropriate programming language platform. Separate lab report should be submitted for each lab applicable unit on individual basis.The list of lab experimens are:

1. Implement union, intersection, difference, power set, and Cartesian product.
2. Create and evaluate fuzzy set membership using triangular or trapezoidal functions.
3. Evaluate compound propositions and generate truth tables using user-defined input.
4. Check equivalence of two logical expressions using truth tables.
5. Analyze binary relations for reflexive, symmetric, and transitive properties.
6. Check if a given function is injective, surjective, or bijective.
7. Implement recursive functions (e.g., Fibonacci) and trace them to demonstrate induction.
8. Compute GCD and modular inverses.
9. Efficiently compute $a^b \bmod m$ using recursion or iterative methods.
10. Generate all permutations of a set and sort them lexicographically.
11. Compute C(n,k)C(n, k)C(n,k) using recursion and Pascal's triangle.
12. Find the shortest path from a source node to all others.
13. Generate MST from a weighted graph using Kruskal's algorithm.
14. Compute transitive closure of a directed graph.

Text Books/Reference Books:

1. K. H. Rosen, *Discrete Mathematics and Its Applications*, 7th ed. Chennai: McGraw Hill Education Pvt. Ltd.
2. J.-P. Tremblay and R. Manohar, *Discrete Mathematical Structures with Applications to Computer Science*. New York: McGraw Hill.
3. C. L. Liu, *Elements of Discrete Mathematics*, International ed.
4. N. S. Deo, *Graph Theory with Applications to Computer Science*. New Delhi: PHI.
5. B. Kolman, R. C. Busby, and S. Ross, *Discrete Mathematical Structures*. New Delhi: Pearson.

6. E. S. Page and L. B. Wilson, *An Introduction to Computational*. Cambridge: Cambridge University Press.
7. [7] R. P. Grimaldi, *Discrete and Combinatorial Mathematics*, 5th ed. New Delhi: Pearson Education.

Rajarshi Janak University
Faculty of Science, Technology, and Engineering
Course of Study for B.Sc. CSIT
(Second Semester/ First Year)

Course Title: Mathematics-II
Nature of Course: Theory and Practical
Credit Hrs: 3 Hrs

Course Code: CSMT 201
Full Marks: 60+20+20
Pass Marks: 24+8+8

Course Description
This course builds a strong foundation in Linear Algebra, combining theory with real-world applications. You will study key topics including matrices, determinants, vector spaces, linear transformations, orthogonality, and eigenvalues. Later units extend to abstract algebra concepts such as groups, rings, and fields.

Course Objectives:
The main objective of the course is:

- To develop in-depth knowledge of concepts and theories of Linear Algebra,
- To enable students to pursue applications of Linear Algebra to social, economic and engineering areas,
- To make students well practiced with problems manually and in scientific computing Software

Course Contents

Unit-1
Matrices and System of equations [5 hrs.]
Systems of linear equations; Row Echelon Form; Matrix Arithmetic; Matrix Algebra; Elementary Matrices; Partitioned Matrices.

Unit-2
Determinants [5 hrs.]
The Determinant of a matrix; Properties of Determinants; Additional topics and Applications.

Unit-3
Vector Spaces [6 hrs.]
Definition and Examples of Vector Space; Subspaces; Linear Independence; Basis and Dimension; Change of Basis; Row Space and Column Space.

Unit-4
Linear Transformations [6 hrs.]

Definition and Examples of Linear Transformation; Matrix Representations of Linear Transformations; Similarity.

Unit-5
Orthogonally [7 hrs.]
The Scalar Product in $\mathbb{R}n$; Orthogonal Subspaces; Least Square Problems; Inner Product Space; Orthonormal sets; The Gram-Schmidt Orthogonalization Process; Orthogonal Polynomials.

Unit-6
Eigenvalues [7 hrs.]
Eigen Values and Eigen Vectors; System of Differential Equations; Diagonalization; Hermitian Matrices; The Singular Value Decomposition; Quadratic Forms; Positive Definite Matrices; Non-negative Matrices.

Unit-7
Groups and Subgroups [5 hrs.]
Binary Operations, Groups, Subgroups, Cyclic Groups

Unit-8
Rings and Fields [4 hrs.]
Rings and Fields, Integral Domain

Laboratory Work:
The Laboratory work includes using any scientific computing software such as MATLAB/Octave, Python, Mathematica, etc. which convenient using practical problems to be covered in the Computerized Mathematics laboratory. The lists are:

1. Matrices in given scientific computing software.
2. Linear Systems
3. Matrix Operations
4. Homogeneous system, Echelon forms and Inverses
5. Linear Combinations
6. Inner Product Spaces
7. Orthogonal Sets
8. The Eigen Problem

Text Book/ Reference Books:

1. 1.S. J. Leon, *Linear Algebra with Applications*, 9th ed. Pearson, 2015.
2. D. C. Lay, *Linear Algebra and Its Applications*, 4th ed. Pearson Education, 2012.
3. G. Strang, *Linear Algebra and Its Applications*, 4th ed. Cengage Learning, 2006.

4. J. B. Fraleigh, *A First Course in Abstract Algebra*, 7th ed. Pearson, 2002.

Rajarshi Janak University
Institute of Science ,Technology and Engineering
Course of Study for B.Sc. CSIT
(Second Semester/First Year)

Course Title: Microprocessor and Microcontroller **Course Code:** CSIT 205 **Nature of Course:** Theory and Practical **Full Mark:** 60+20+20
Credit hrs. : 3 **Pass Mark:** 24+8+8

Course Description:
This course introduces the architecture, programming, and interfacing techniques of microprocessors and microcontrollers. It focuses on the 8085 and 8086 microprocessors and the 8051 microcontroller.
You will study internal architectures, instruction sets, machine cycles, and timing diagrams. You'll learn to write and analyze assembly programs, design memory and I/O interfacing circuits, and understand interrupt handling and serial/parallel communication.
The course includes practical sessions using hardware kits and simulation tools to develop hands-on skills in programming and interfacing.

Course Objectives:
- After completing the course, students will be able to:
- Study the Architecture of 8085 & 8086 microprocessor.
- Learn the design aspects of I/O and Memory Interfacing circuits.
- Study about communication and bus interfacing.
- Study about the advanced microprocessor

Course Contents
Unit-1
Introduction [4 hrs.]
Introduction and Evolution of microprocessor and its types, Microprocessor and Microcontrollers, Organization of Microprocessor Based System, Stored program Concept and Von Neumann Machine, Processing Cycle of a Stored Program Computer, Harvard Architecture.

Unit-2
Programming with 8085 Microprocessor [10 hrs.]
Internal architecture of 8085 microprocessor and its working, 8085 pin diagram and functions, Flag and flag registers, Instruction formats, Addressing Modes
Instructions Set: Data Transfer Instructions Set, Arithmetic Instructions Set, Logical Instructions Set, Branching Instructions Set, Miscellaneous Instructions Set, Stack and Sub Routines , Delay and Delay Routines, Types of Delay.

Unit-3

Machine cycle and Timing diagram [5 hrs.]

Definition: instruction cycle, machine cycle, fetch cycle and execution cycle, Machine cycle of 8085, Timing Diagram of :Op-code fetch , Memory read /write , I/O read/write , Timing diagram of 8085 instructions like LDA,MVI,ADD, CALL, etc.

Unit-4

Programming with 8086 Microprocessor [10 hrs.]

Internal Architecture and Features of 8086 Microprocessor: BIU and Components, EU and Components, EU and BIU Operations, Segment and Offset Address. Addressing Modes of 8086, Flags, Maximum mode configuration, minimum mode configuration, Assembly Language Syntax: Comments, Reserved words, Identifiers, Statements, Directives, Operators, and Instructions. EXE and COM programs, Assembling, Linking and Executing, One Pass and Two Pass Assemblers.

Unit-5

Basic I/O, Memory R/W and Interrupt operations [5 hrs.]

Memory devices and classification, Memory mapped I/O,I/O Mapped I/O ,Address decoding:- Unique and non-unique address decoding, Address decoding for I/O and memory , Memory Interfacing, DMA ,8237 DMA controller, Transfer Modes of 8237, Interrupt:-8085 Interrupts and its need Mask able and non-mask able interrupts, 8085 vectored interrupts, Restart and software instructions, 8259 Programmable Interrupt Controller, Priority modes of 8259

Unit-6

Input/output Interfaces [3 hrs.]

Parallel Communication : Introduction and Applications, Serial communication:- Introduction and Applications, 8255 Programmable peripherals interface, 8251 USART,RS-232 Introduction ,pin configuration and functions of each pin, Interconnection between DTE-DTE and DTE-DCE

Unit-7

Microcontroller [8 hrs.]

Introduction, Features of 8051, Microcontroller Hardware, Memory Organization, Input/output Pins and Circuits, Timers and Counters, Serial Port, Interrupt Structure, Clock and Oscillators, Addressing Modes, Data Transfer Instruction, Arithmetic Instruction, Logical Instruction, JUMP and CALL instruction, 8051 Timers, 8051 Serial Communication.

Laboratory Work:

The laboratory work includes implementing the concept of microprocessor and microcontroller using the hardware Kit and Simulator software. Also the instructor can use the different online and offline simulation to demonstrate the working of different programs.

1. Basic Arithmetic Operations in 8085: Addition, subtraction, increment, decrement using assembly.
2. Logical Operations in 8085: AND, OR, XOR, NOT, compare instructions.
3. Conditional Branching and Looping: Use of JZ, JNZ, JC, JNC in loops and decision-making.
4. Array Processing and Table Lookup: Search a value in an array; store max/min.
5. Decimal to Binary and BCD Conversion: Conversion routines using 8085 instructions.
8. Delay Program Using Register Pair: Create time delays with loop counters.
9. Basic Assembly Programming in 8086: Move, add, subtract, and store values.
10. String Handling in 8086: Reverse string, find length, copy string.
11. Loop and Counter Control: Use of LOOP, JCXZ, and conditional jumps.
11. Display ASCII and Decimal Characters : Convert and display characters in different formats.
12. Memory and I/O Interfacing Basics: Use of IN/OUT instructions with simulated I/O ports.
13. 8051 Programming: Arithmetic and Logical Operations: Addition, subtraction, AND, OR, rotate, etc.
14. Timer Programming in 8051: Create accurate delays using Timer 0 or Timer 1.
15. LED Blinking and Pattern Display: Interface LEDs and control patterns with ports.

Text book/ Reference Book:

1. R. S. Gaonkar, *Microprocessor Architecture, Programming, and Applications with 8085*. Englewood Cliffs, NJ: Prentice Hall.
2. D. V. Hall, *Microprocessors and Interfacing: Programming and Hardware*. New York: McGraw Hill.
3. K. J. Ayala, *The 8051 Microcontroller: Architecture, Programming and Applications*, 3rd ed. Boston, MA: Cengage Learning.
4. W. A. Triebel and A. Singh, *The 8088 and 8086 Microprocessors: Programming, Interfacing, Software, Hardware and Applications*, 4th ed., 2003. Upper Saddle River, NJ: Prentice Hall.
5. M. A. Mazidi and J. G. Mazidi, *The 8051 Microcontroller and Embedded Systems*. New Delhi: Pearson Education.
6. B. B. Brey, *The Intel Microprocessors*, 8th ed. New Delhi: Pearson.

Rajarshi Janak University
Faculty of Science, Technology and Engineering
Course of Study for B.Sc.CSIT
(Second Semester/First Year)

Course Title: Object-Oriented programming in C++ **Course Code:** CSIT 202
Nature of Course: Theory and Practical **Full Mark:** 60+20+20
Credit hrs. : 3 **Hrs** **Pass Mark:** 24+8+8

Course Description:
This course introduces students to the principles of object-oriented programming (OOP) using C++. It covers OOP concepts such as classes, objects, inheritance, polymorphism, encapsulation, and abstraction, along with advanced features like operator overloading, file handling, templates, and exception handling.

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

- Understand the fundamentals of object-oriented programming.
- Use C++ syntax and semantics to write efficient object-oriented programs.
- Implement key OOP concepts like classes, inheritance, polymorphism, and abstraction.
- Apply exception handling and file operations in real-world problems.
- Develop reusable and maintainable software systems.

Course Contents:

Unit 1
Introduction to C++ and OOP **[3 hrs.]**
Evolution of C++ from C, Key differences between C and C++, Structure of a C++ program, Basic I/O operations (Cin, Cout), Introduction to OOP concepts: Class, Object, Abstraction, Encapsulation, Inheritance, Polymorphism

Unit 2
Classes and Objects **[7 hrs.]**
Defining classes and creating objects, Access specifiers: public, private, protected, Namespace, scope resolution operator, member functions (inside and outside class), inline function, storage classes: (automatic, external, static, register)., Static data members and functions, this pointer Constructors and destructors, types of constructor (default, parameterized), Dynamic constructor, copy constructor, constructor overloading, manipulating private data members.

Unit 3
Operator Overloading and Type Conversion **[7 hrs.]**

Introduction to operator overloading**,** overloading unary and binary operators**,** Friend functions**,** friend class, Type conversion: Basic-to-class, Class-to-basic, Class-to-class.

Unit 4

Inheritance [7 hrs]

Base class and Derived class, Concept and types of inheritance**,** Constructors and destructors in inheritance**,** Ambiguity and virtual base classes**,** Object slicing.

Unit 5

Polymorphism and Virtual Functions [7 hrs.]

Function overloading, Function overriding, Pointers to objects, Virtual functions and late binding, Pure virtual functions and abstract classes.

Unit 6

Templates and Exception Handling [7 hrs]

Function templates and class templates,use of templates, Exception handling basics**:** Try, throw, catch blocks**,** Multiple catch blocks and nested try, purpose of exceptional handling.

Unit 7

File Handling in C++ [7 hrs.]

File streams (ifstream, ofstream, fstream)**,** Reading from and writing to files/console**,** File modes**,** Binary and text file operations, command line arguments, file pointer and their manipulator: specifying the position, specifying the objects,tellg(),seekg(),tellp(),seekp().

Laboratory Work:

Students must complete a set of practical exercises that cover:

1. Creating classes and objects
2. Implementing inheritance and polymorphism
3. Using file I/O operations
4. Building small projects such as a student record system, inventory management, or banking application

Text Books/Reference Books:

1. E. Balagurusamy, *Object-Oriented Programming with C++*, Tata McGraw-Hill publication.
2. Herbert Schildt, *C++: The Complete Reference* , Tata McGraw Hill publication.
3. Robert Lafore ,*Programming in C++* , SAMS Publication.
4. Joyce Farrell,*Object-Oriented Programming in C++* by ,Cengage Learning.

Rajarshi Janak University

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Course of Study for BSc CSIT

(Second Semester/ First Year)

Course Title: Statisics I **Course Code:** CSST 204

Nature of Course: Theory an Pratical **Full Marks:** 60+20+20

Credit Hrs.: 3 **Pass Mark:** 24+8+8

Course Description

This course introduces students to the fundamental principles of statistics with a focus on descriptive analysis and probability theory. It emphasizes understanding data, summarizing information, and preparing students for advanced data analysis in computing and information technology.

Course Learning Objectives:

After completing this course, students will be able to:

- Understand basic statistical concepts, data types, and measurement levels.
- Summarize and describe data using tables, graphs, and statistical measures.
- Apply probability theory and work with different probability distributions.
- Use statistical software to analyze and visualize data for IT applications.

Course Content

Unit 1

Introduction to Statistics [4 hrs.]

Meaning, significance, and scope of statistics in computer science and IT, Types of data: qualitative vs. quantitative, Levels of measurement: nominal, ordinal, interval, and ratio scales, Descriptive vs. inferential statistics

Unit 2

Data Collection and Presentation [4 hrs.]

Sources and methods of data collection, Frequency distributions, Data tabulation, graphical representation (bar diagram, histogram, pie chart, box plot).

Unit 3

Descriptive Statistics [12 hrs.]

Measures of Central Tendency: Mean, Median and Mode, Partition Values: Quartiles, Deciles and Percentiles, Measures of Dispersion: Range, Q.D, Standard Deviation, Variance, C.V, Skewness: Karl Pearson's and Bowley's method, Kurtosis: Percentile method, Moments, Steam and leaf display, Five Number Summary and Box Plot

Unit 4

Correlation and Regression Analysis [6 hrs.]

Scatter Plots, Karl Pearson and Spearman Correlation, Simple Linear Regression, Coefficient of determination and Standard error

Unit 5

Fundamentals of Probability [6 hrs.]

Concept of probability, Basic rules and definitions., Conditional probability, Bayes' Theorem and its applications.

Unit 6

Random Variable and Mathematical Expectation [6 hrs.]

Concept of random variable, Types of random variable, Probability mass function and probability density function, mathematical expectation, Addition and multiplication theorems of expectation, Variance and covariance of random variable

Unit 7

Probability Distributions [10 hrs.]

Concept of probability distribution , Bernoulli trial, Binomial distribution; mean and variance, properties, fitting of binomial distribution, Poisson distribution as a limiting case of binomial distribution, mean and variance, properties, fitting of poisson distribution, Normal distribution and Standard normal distribution, Normal distribution as an approximation of binomial and Poisson distribution, Mean and variance, properties and importance, fitting of normal distribution, Exponential Distribution; mean and variance, properties, uses, Gamma Distribution; mean and variance, properties, uses

Laboratory Works:

Laboratory sessions will focus on applying statistical concepts using appropriate software tools such as Microsoft Excel, SPSS, STATA, or any other accessible statistical package. Students will work on practical problem sets in the Computerized Statistics Laboratory to develop practical experience in data analysis and interpretation.

1. Draw simple, multiple, subdivided and percentage subdivided bar diagram and pie-chart
2. Draw histogram and ogives
3. Compute mean, median and mode
4. Calculate range, Q.D. and S.D.
5. Generate five number summary and Box and whisker plot
6. Create scatter plots to visualize relationships.
7. Compute Karl Pearson's correlation coefficients.
8. Run simple linear regression and interpret slope.
9. Conditional probability and Bayes theorem
10. Binomial, Poisson and Normal distributions

Text Books/ Reference Texts:

1. Gupta, S.C. (2007). Fundamentals of Statistics. 6th Edition, Sultan Chand & Sons, New Delhi.
2. Richard A. Johnson (2001). Probability and Statistics for Engineers. 6th Ed., Pearson Education, India
3. Douglas C. Montgomery & George C. Ranger (2003). Applied Statistics and Probability for Engineers. 3rd Ed., John Willey and Sons, Inc.

4. Michael Baron (2013). Probability and Statistics for Computer Scientists. 2nd Ed., CRC Press, Taylor & Francis Group, A Chapman & Hall Book.