Course Title: Discrete Structures **Credit: 3**
Course No: CSIT.212 **Number of period per week: 3+3**
Nature of the Course: Theory + Tutorial **Total hours: 45+45**
Year: Second, Semester: Third
Level: B. Sc. CSIT

1. Course Introduction

After completing this course, the target student will gain knowledge in discrete mathematics. It helps the target student in gaining fundamental and conceptual clarity in the area of set theory, logic, reasoning, counting, probability, and graph theory.

2. Objectives

At the end of this course the students should be able to:

- Describe basic discrete structures such as sets, functions and relations
- Express and proof verbal arguments using propositional and predicate logic
- Select the best proof strategy for the given problem
- Demonstrate counting principles and apply them to solve problems
- Model problems using graph theory and identify their solutions

3. Specific Objectives and Contents

Specific Objectives	Contents
• Explain with examples the basic terminology of functions, relations, and sets. • Perform the operations associated with sets, functions, and relations. • Relate practical examples to the appropriate set, function, or relation model.	**Unit I: Functions Sets and Relations (4)** 1.1. Sets: Venn Diagrams, Complements, Cartesian Products, Power Sets, Cardinality and Countability, Computer Representation of Sets 1.2. Functions: Surjections, Injections, Bijections, Inverses, Composition, Growth of Functions 1.3. Relations: Reflexivity, Symmetry, Transitivity, Asymmetry, Equivalence Relations, Representing Relations using Matrices and Diagraphs, Equivalence Classes, Partitions, Partial and Total Ordering
• Apply formal methods of symbolic propositional and predicate logic. • Describe how formal tools of symbolic logic are used to model real-life situations. • Describe the importance and limitations of predicate logic.	**Unit II: Basics of Logic (10)** 2.1. Propositional logic, Logical connectives, Truth tables, Normal forms (conjunctive and disjunctive), Validity 2.2. Conditional statements, inverse, converse, and contrapositive, Translating English sentences, logical equivalences, inference rules, proof of equivalence 2.3. Predicate logic, Universal and existential quantification, Nested quantifiers, Logical equivalences, Translating english sentences, proof of logical equivalences, Limitations of predicate logic

• Outline the basic structure of and give examples of each proof technique. • Relate the ideas of mathematical induction to recursion. • Identify the difference between mathematical and strong induction.	**Unit III: Proof Techniques (6)** 3.1. Proof Strategies: Direct Proofs, Proof By Counterexample, Proof By Contradiction 3.2. Mathematical Induction, Strong Induction And Well Ordering 3.3. Recursive Mathematical Definitions, Structural Induction, Recursive Algorithms 3.4. Program Correctness
• Compute permutations and combinations of a set. • Solve a variety of basic recurrence equations. • Analyze a problem to create relevant recurrence equations or to identify important counting questions.	**Unit IV: Basics Of Counting (8)** 4.1. Sum And Product Rule, Inclusion-Exclusion Principle, Pigeon-hole Principle, and Applications of Pigeon-hole Principle. 4.2. Permutations and Combinations, Binomial Coefficients, Pascal's Identity and Triangle, Generalized Permutation and Combinations, Generating Permutation and Combinations. 4.3. Recurrence Relations, Modeling with Recurrence Relations, Solving Linear Recurrence Relations (Proof of theorems is not Required)
• Calculate probabilities of events and expectations of random. • Differentiate between dependent and independent events. • Apply the binomial theorem to independent events and Bayes' theorem to dependent events.	**Unit V: Discrete Probability (6)** 5.1. Finite probability space, probability measure, events, overview of non-discrete probability theory 5.2. Conditional probability, independence, Bayes' theorem, Applications of Bays Theorem 5.3. Integer random variables, expectation, variance, and Chebyshev bounds, Law of large numbers
• Illustrate by example the basic terminology of graph theory, and some of the properties and special cases of each. • Demonstrate different traversal methods for trees and graphs. • Model problems in computer science using graphs and trees.	**Unit VI: Graphs and Trees (6)** 6.1. Types of Graphs, Basic Terminologies, Special Types of Graphs and their Applications, Graph Representation, Graph Isomorphism. 6.2. Connectivity, Paths, Connectedness, Euler and Hamiltonian Paths and circuits, Travelling Salesman Problem, Planner Graphs, Shortest path problems, Graph Coloring and Applications 6.3. Trees, Properties and Applications of Trees, Decision Trees, infix/prefix/postfix Notations, Tree Traversal, Spanning Trees, Minimum Spanning Trees.
• Use network flows in optimization problems.	**Unit VII: Network Flows (5)** 7.1. Concept of network flows, proof of Maxflow and Mincut theorem, verification of the algorithms by examples.

Evaluation System

Undergraduate Programs							
External Evaluation	**Marks**	**Internal Evaluation**	**Weightage**	**Marks**	**Viva-voce**	**Weightage**	**Mark**
End semester examination	60	Assignments	20%	20	Report on any topic	50%	20
(Details are given in the separate table at the end)		Quizzes	10%		Presentation	25%	
		Attendance	20%		Viva	25%	
		Internal Exams	50%				
Total External	60	Total Internal	100%	20		100%	20
Full Marks 60+20+20 = 100							

External evaluation:

1. **End semester examination:**
   It is a written examination at the end of the semester. The questions will be asked covering all the units of the course. The question model, full marks, time and others will be as per the following grid.

2. **External Evaluation (Viva):**
   After completing the end semester theoretical examination, viva examination will be held. External examiner will evaluate report/presentation, take viva exam and will do above mentioned evaluation. Students should make a small report by relating any of the studied topics in the subject to some application areas/examples. Reports can be made in groups. There will be an internal examiner to assist the external examiner. In this examination Students must demonstrate the knowledge of the subject matter.

Full Marks: 100, Pass Marks: 45, Time: 3 Hrs

Nature of question	Total questions to be asked	Total questions to be answered	Total marks	Weightage
Group A: multiple choice*	20	20	20×1 = 20	60%
Group B: Short answer type questions	8	6	6×8 = 48	60%
Group C: Long answer type question/long menu driven programs	3	2	2×16 =32	60%
			100	100%

Each student must secure at least 50% marks in internal evaluation in order to appear in the end semester examination. Failed student will not be eligible to appear in the end semester examinations.

Internal evaluation

Assignment: Each student must submit the assignment individually. The stipulated time for submission of the assignment will be seriously taken.

Quizzes: Unannounced and announced quizzes/tests will be taken by the respective subject teachers. Such quizzes/tests will be conducted twice per semester. The students will be evaluated accordingly.

Attendance in class: Students should regularly attend and participate in class discussion. Eighty percent class attendance is mandatory for the students to enable them to appear in the end semester examination. Below 80% attendance in the class will signify NOT QUALIFIED (NQ) to attend the end semester examination.

Presentation: Students will be divided into groups and each group will be provided with a topic for presentation. It will be evaluated individually as well as group-wise. Individual students have to make presentations on the given topics.

Mid-term examination: It is a written examination and the questions will be asked covering all the topics in the session of the course.

Discussion and participation: Students will be evaluated on the basis of their active participation in the classroom discussions.

Instructional Techniques: All topics are discussed with emphasis on real-world application. List of instructional techniques is as follows:

- Lecture and Discussion
- Group work and Individual work
- Assignments
- Presentation by Students
- Quizzes
- Guest Lecture

Students are advised to attend all the classes and complete all the assignments within the specified time period. If a student does not attend the class(es), it is his/her sole responsibility to cover the topic(s) taught during that period. If a student fails to attend a formal exam/quiz/test, there won't be any provision for re-exam.

Prescribed Text

- *Kenneth H. Rosen,* Discrete Mathematics & it's Applications to Computer Science, WCB/McGraw Hill.
- *Joe L. Mott, Abrahan Kandel and Theodore P. Baker,* Discrete Mathematics for Computer Scientists and Mathematicians, Prentice-Hall of India.

Reference

- *G. Chartand, B.R. Oller Mann,* Applied and Algorithmic Graph Theory, McGraw Hill.
- *G. Birkhoff, T.C. Bartee,* Modern Applied Algebra, CBS Publishers.