University of Scholars
Department of Computer Science and Engineering

Course Title:	**Discrete Mathematics**
Course Code:	**CSE 1236-0611**
Credit/Hours:	**3hrs/Week**
Prerequisites:	N/A
Course Instructor:	**Ayesha Siddiqua**
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Course Objectives:	On completion of this course, students will be able to explain and apply the basic methods of discrete (noncontinuous) mathematics in Computer Science. They will be able to use these methods in subsequent courses in the design and analysis of algorithms, computability theory, software engineering, and computer systems. In particular, students will be able to: 1. Reason mathematically about basic data types and structures (such as numbers, sets, graphs, and trees) used in computer algorithms and systems; distinguish rigorous definitions and conclusions from merely plausible ones; synthesize elementary proofs, especially proofs by induction. 2. Model and analyze computational processes using analytic and combinatorial methods. 3. Apply principles of discrete probability to calculate probabilities and expectations of simple random processes. 4. Work in small teams to accomplish all the objectives above.
Course Outcome:	**Course Learning Outcomes (CLOs)**

	CLO1: Apply basic mathematical concepts such as sets, relations, and functions using logical terminology, number theory and counting principles. **CLO2:** Able to identify problems, investigate the scenario and define the solution such as cryptography and probabilities. **CLO3:** Able to solve various problems in non-linear data structures. **CLO4:** Able to solve and analyze programming challenges and software development.
Course Contents:	**Sets, Proof Templates, and Induction:** Basic Definitions, Operations on Sets, The Principle of Inclusion-Exclusion, Mathematical Induction. **Formal Logic:** Introduction to Propositional Logic, Truth and Logical Truth, Normal Forms, Predicates and Quantification. **Relations:** Binary Relations, Special Types of Relations, Equivalence Relations, Ordering Relations, Relational Databases. **Functions:** Basic Definitions, Operations on Functions, Sequences and Subsequences, The Pigeon-Hole Principle. **Number Theory and Cryptography:** Divisibility and Modular Arithmetic, Integer Representations and Algorithms, Primes and Greatest Common Divisors, Solving Congruences, Applications of Congruences, Cryptography. **Counting and Combinatorics:** Traveling Salesperson's Problem, Counting Principles, Set Decomposition Principle, Permutations and Combinations, Constructing the Kth Permutation, Counting with Repeated Objects, Combinatorial Identities. **Discrete Probability:** Ideas of Chance in Computer Science, Cross Product Sample Spaces, Independent Events and Conditional Probability, Discrete Random Variables, Variance, Standard Deviation and the Law of Average.

	Graph Theory: Introduction to Graph Theory, The Handshaking Problem, Paths and Cycles, Graph Isomorphism, Representation of Graphs, Connected Graphs, The K6nigsberg Bridge Problem **Trees:** Definition of Trees, Spanning Trees, Rooted Trees, Directed Graphs, Application, finding a Cycle in a Directed Graph, Priority in Scheduling, Connectivity in Directed Graphs, Eulerian Circuits in Directed Graphs. **Analysis of Algorithms:** Comparing Growth Rates of Functions, Complexity of Programs, Uncomputability. **Recurrence Relations:** The Tower of Hanoi Problem, Solving First-Order Recurrences Using Back Substitution, Fibonacci Recurrence Relation, Divide and Conquer Paradigm, Binary Search, Merge Sort, Multiplication of n-Bit Numbers, Divide-and-Conquer Recurrence Relations.
Grading policy:	

Assessment Strategy	Marks
Class attendance	10
Assignment/ Presentation	10
Class test/quiz	10
Midterm exam	30
Final exam	40
Total	**100**

Unit No.	Lecture	Topic Name	Mode of Teaching

1. Formal Logic	1	Introduction to Logic. Propositional Logic, Truth tables, Deduction, Resolution, Predicates and Quantifiers, Mathematical Proofs. Infinite sets, well-ordering.	ppt/video/notes
	2	Countable and Uncountable sets, Cantor's diagonalization. Mathematical Induction - weak and strong induction.	ppt/video/notes
	3	Direct proofs, Disproving by counterexample, Proof by contrapositive, Proof by contradiction	
2. Set Theory, Function and Relation	4	**i. Sets** Methods for describing a set, e.g., listing elements, set builder notation,Venn diagrams,Union, intersection, set difference, complement,Cartesian product,Power sets,Cardinality of finite sets	ppt/video/notes
	5	**ii. Relations** Reflexivity, symmetry, antisymmetry, transitivity, Equivalence relations, partial orders	ppt/video/notes
	6	**iii. Functions** Domain, target, and range/image of a function, Surjections, injections, bijections, Inverses, Composition	ppt/video/notes
3. Analysis of Algorithms	7	Introduction to Algorithms and Pseudo Code,The Division Algorithm,	ppt/video/notes
	8	Sorting Algorithm	
	9	Searching Algorithm	
Review Class	10	**Review Class**	ppt/video/notes
Class Test	11	**Class test - 1 and Assignment - 1**	
4. Number Theory and Cryptography	12	Introduction of Number Theory Number theory Divisibility and modular arithmetic.	ppt/video/notes
	13	Prime and GCD Cryptography	ppt/video/notes
5. Induction	14	Loop Invariants, Mathematical Induction	ppt/video/notes

and Recursion	15	Big-Oh Notation, Recursive Definitions	
	16	Tower of Hanoi	ppt/video/notes
	17	Recurrence Relations, Recursively defined functions,	
	18	Mathematical induction principles, The Euclidean Algorithm	
	19	Divide-and-Conquer Recurrence Relations.	
6. Counting Theory	20	Basic Counting Techniques, Elementary Probability, Inclusion-Exclusion and Binomial Methods, Counting and Partitions	ppt/video/notes
	21	Pigeon-Hole Principle	ppt/video/notes
Review Class	22	**Review Class**	ppt/video/notes
Mid Term Examination			
7. Combination Permutation	23	Permutations and combinations Basic definitions The binomial theorem	ppt/video/notes
	24	Constructing the Kth Permutation	ppt/video/notes
	25	Counting with Repeated Objects, Combinatorial Identities.	
8. Probability Theory	26	Finite probability space, events	ppt/video/notes
	27	Properties of events, Conditional probability	
	28	Bayes' theorem, Independence	
	29	Discrete Random Variables, Variance, Standard Deviation and the Law of Average	ppt/video/notes
Review Class	30	**Review Class**	ppt/video/notes
Class Test	31	**Class test - 1 and Assignment - 1 for Unit 1,2**	
9. Graph Theory	32	Introduction to Graph Theory	ppt/video/notes
	33	The Handshaking Problem	

	34	Paths and Cycles, Graph Isomorphism, Representation of Graphs	ppt/video/notes
	35	Hamiltonian cycle and Hamiltonian path	ppt/video/notes
	36	Euler circuits ,Euler paths	ppt/video/notes
10. Trees	37	Trees, binary tree, rooted tree	ppt/video/notes
	38	complete binary tree ,spanning tree	ppt/video/notes
	39	Breadth First Search (BFS)	ppt/video/notes
	40	Depth First Search (DFS)	ppt/video/notes
11. Modeling Computation	41	Turing Machine	ppt/video/notes
Review Class	42	**Review Class**	ppt/video/notes
Final Term Examination			

Mapping Course Learning outcomes (CLOs) with Teaching-Learning and Assessment Strategy:

Course Learning Outcomes (CLOs)	**Teaching- Learning Activities**	**Assessment Strategy**
Apply basic mathematical concepts such as sets, relations, and functions using logical terminology, number theory and counting principles.	Lecture slides, Text Book Lecture Videos and Web Materials.	Class Test, Quiz Test, Assignment and Presentation
Able to identify problems, investigate the scenario and define the solution such as cryptography and probabilities.	Lecture slides, Text Book Lecture Videos and Web Materials.	Class Test, Quiz Test, Assignment and Presentation

Able to solve various problems in non-linear data structures.	Lecture slides, Text Book Lecture Videos and Web Materials.	Quiz-Test, Exam, Assignment, Problem Solve and Presentation.
Able to solve and analyze programming challenges and software development.	Lecture slides, Text Book Lecture Videos, Lab Works and Web Materials.	Quiz-Test, Exam, Assignment, Problem Solve and Individual Presentation.

References

Learning Materials		
SL No.	**Text Books**	**Others Learning Materials**
1	Discrete Mathematics for Computer Science by Gary Haggard, John Schlipf and Sue Whitesides	Journals, Web Materials, etc.
2	Discrete Mathematics & Its Applications- Kenneth H Rosen	
3	Discrete Mathematics with Applications -Thomas Koshy	
4	Discrete Mathematics - Seymour Lipschutz, M. Lipson, Tata McGraw Hill	
5	Discrete Mathematical Structures - Kolman, Busby Ross, Prentice Hall International	
6	Combinatorics: Theory and Applications - V. Krishnamurthy, East-West Press.	