1. **Name of the course:** Discrete Mathematics

2. **Objective of the course:** The primary objective of the course is that students should learn a particular
set of mathematical facts and how to apply them. In particular it teaches students how to think logically and mathematically through five important themes: mathematical reasoning, combinatorial analysis, discrete structures, algorithmic thinking, and applications and modeling. A successful discrete mathematics course should carefully blend and balance all five themes.

3. Learning Outcome:
Learning outcomes from the five themes are listed as follows:

(i) Mathematical Reasoning: Students will be able to understand mathematical reasoning in order to read, comprehend, and construct mathematical arguments which serves as the foundation for the subsequent discussions of methods of proof.

(ii) Combinatorial Analysis: The learners will possess the ability to count or enumerate objects which begins with the basic techniques of counting. They will be able to perform combinatorial analysis to solve counting problems and analyze algorithms, not on applying formulae.

(iii) Discrete Structures: Students can work with discrete structures, which are the abstract mathematical structures used to represent discrete objects and relationships between these objects. These discrete structures include sets, permutations, relations, graphs, trees.

(iv) Algorithmic Thinking: Certain classes of problems are solved by the specification of an algorithm. After an algorithm has been described, a computer program can be constructed implementing it. The learner will be able to perform the mathematical portions of this activity, which include the specification of the algorithm, the verification that it works properly, and the analysis of the computer memory and time required to perform it.

(v) Applications and Modeling: Discrete mathematics has applications to almost every conceivable area of study. There are many applications to computer science and data networking in this text, as well as applications to such diverse areas as chemistry, biology, linguistics, geography, business, and the Internet. Students of this course will learn to solve such applications by modeling them with discrete mathematics.

4. Detailed Syllabus

(a) The foundations - Logic and Proofs: Propositional logic, Predicates and Quantifiers, Rules of Inference, Proof methods and strategies.

(b) Combinatorics:
(i) Basic Structures - Sets, Functions, Relations, Equivalence relation, Partitions, PO Set, Lattice
(ii) Counting - Basics of counting, Pigeonhole principle, Permutation, Combination, Binomial and Multinomial Theorem, Generating permutation and combination, Inclusion-Exclusion and its application

(iii) Advanced Counting technique - Recurrence relation, Solving linear recurrence relation, Generating functions
(iv) Discrete Probability - Introduction, Conditional probability, Bayes theorem, Random variable, Expectation, Variance, Bernoulli distribution, Binomial distribution, Poisson distribution, Geometric distribution
(v) Basic Number theory - Divisibility, Congruence, GCD, Euclidean Algorithm, Extended Euclidean Algorithm, Chinese Remainder theorem, RSA

(c) Graph Theory:
(i) Graphs and di-graphs, Basic terminologies (clique, independent set, vertex cover, degree, regular, complement), Graph models, Isomorphism, Representation of graphs (incidence and adjacency matrix),
(ii) Connectivity - Cut-vertex and cut-edge, k-connectivity, Eulerian paths and circuits, Hamiltonian paths and circuits, De-bruijn Graphs, Knight's Tour, Tournaments
(iii) Graph traversal - BFS, DFS, Topological Sorting, Shortest path algorithm (Dijkstra)
(iv) Tree - Definition, Counting trees (Prufer Code), Minimal Spanning Trees, Kruskal Algorithm, Prim's algorithm,
(v) Planar graph - Definition, Euler's Formula, Kuratowski's Theorem, Five-color Theorem
(vi) Matching - Bi-partite Matching, Halls Theorem, Stable Matching, Matching in any graph, Tutte's Theorem
(vii) Coloring of graphs - Vertex Coloring, Chromatic Number, Brooks Theorem, Edge Coloring, Vizing's Theorem, Art Gallery Problem.
==========