GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject Code: 3171611

GRAPH THEORY AND COMBINATORICS

B.E. 7th Semester

Type of course: Elective

Prerequisite: Calculus, Linear Algebra, and comfort with mathematics

Rationale: This course will introduce students to graph theory through foundational concepts and fundamental existential and algorithmic problems related to trees, matchings, connectivity and planarity, using proof techniques based on induction, extremal choices, and algorithms.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	0	3	70	30	0	0	100

Syllabus:

Sr. No.	Content	Total Hrs
1	Introduction to Graph Theory: Definitions and Examples, Subgraphs, Complements, and Graph Isomorphism, Vertex Degree, Euler Trails and Circuits, de Bruijn sequences, Planar Graphs, Hamilton Paths and Cycles, Graph Colouring, and Chromatic Polynomials	11
2	Trees: Definitions, Properties, and Examples, Routed Trees, Trees and Sorting, Weighted Trees and Prefix Codes, Planar duality, Spanning trees in planar graphs	05
3	Optimization and Matching: Transport Networks – Max-flow, Min-cut Theorem, Matching's, Hall's marriage theorem, Optimal matching's, The stable matching problem,	06
4	Fundamental Principles of Counting : The Rules of Sum and Product, Permutations, Combinations – The Binomial Theorem, Combinations with Repetition, The Catalon Numbers	05
5	The Principle of Inclusion and Exclusion, Generalizations of the Principle, Derangements – Nothing is in its Right Place, Rook Polynomials	05
6	Generating Functions: Introductory Examples, Definition and Examples – Calculational Techniques, Partitions of Integers, the Exponential Generating Function, the Summation Operator	05
7	Recurrence Relations: First Order Linear Recurrence Relation, The Second Order Linear Homogeneous Recurrence Relation with Constant Coefficients, The Non-homogeneous Recurrence Relation, The Method of Generating Functions	05

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
15	25	20	20	15	5

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1) J. A. Bondy and U. S. R. Murty, Graph Theory with Applications
2) Ralph P. Grimaldi: Discrete and Combinatorial Mathematics, 5th Edition, Pearson Education, 2004
3) B Bollobás, Graph theory, An Introductory Course.
4) B Bollobás, Modern Graph Theory, Springer - 1998
5) D Jungnickel, Graphs, Networks and Algorithms

Course Outcome:

After learning the course, the students should be able to:

Sr. No.	CO Statement	Marks % Weightage
1	Understand and apply the basic concepts of graph theory, including Eulerian trails, Hamiltonian cycles, bipartite graphs, planar graphs, and Euler characteristics.	20%
2	Use permutations and combinations to solve counting problems with sets and multisets	15%
3	Apply the inclusion/exclusion principle	15%
4	Compute a generating function and apply them to solve a variety combinatorial problems	20%
5	formulate problems in terms of graphs and apply the theorems and algorithms taught in the course to solve them	15%
6	Set up and solve a linear recurrence relation	15%