B.E (OPEN TO ALL PROGRAMMES OF ENGINERRING

Choice Based Credit System (CBCS) and Outcome-Based Education (OBE)

(Effective from the academic year 2022-2023)

SEMESTER – VII

GRAPH THEORY AND COMBINATORICS

Course Code	21MAT756	CIE Marks	50
Teaching Hours/Week (L: T:P)	2:2:0	SEE Marks	50
Total Number of Contact Hours	40	Total Marks	100
Credits	03	Exam Hours	3

Course Learning Objectives: This course Graph Theory & Combinatorics 21MAT756 will enable students to:

1. Appreciate the definition and basics of graphs along with types and their examples. Understand the notion of planarity and coloring of a graph.
2. Understand the definition of a tree and learn its applications to fundamental circuits. Know the applications of graph theory to network flows.
3. To give the learner a broad exposure of combinatorial Mathematics through applications especially the Computer Science application.

Pedagogy (General Instructions):

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. In addition to the traditional lecture method, different types of innovative teaching methods may be adopted so that the delivered lessons shall develop students' theoretical and applied mathematical skills.
2. State the need for Mathematics with Engineering Studies and Provide real-life examples.
3. Support and guide the students for self–study.
4. You will also be responsible for assigning homework, grading assignments and quizzes, and documenting students' progress.
5. Encourage the students for group learning to improve their creative and analytical skills.
6. Show short related video lectures in the following ways:
   - As an introduction to new topics (pre-lecture activity).
   - As a revision of topics (post-lecture activity).
   - As additional examples (post-lecture activity).
   - As an additional material of challenging topics (pre-and post-lecture activity).
   - As a model solution for some exercises (post-lecture activity).

Module – 1

Introduction to Graph Theory: Definition and properties of a graph, subgraph, and Examples, Complements, and Graph Isomorphism, Vertex Degree, Euler Trails and Circuits, Planar Graphs, Hamilton Paths and Cycles, Graph Colouring, and Chromatic Polynomials. Directed graphs and their properties. **(8 Hours)**

(RBT Levels: L1, L2 and L3)

Pedagogy	Chalk and Board, Problem based learning

Module – 2	
Trees: Definitions, Properties, and Examples, Routed Trees, Trees and Sorting, Weighted Trees and Prefix Codes. **Optimization and Matching:** Dijkstra‟s Shortest Path Algorithm, Minimal Spanning Trees – The algorithms of Kruskal and Prim, Transport Networks – Max-flow, Min-cut Theorem. Matching Theory. **(8 Hours)** **(RBT Levels: L1, L2 and L3)**	
Pedagogy	Chalk and Board, Problem based learning

Module – 3	
Fundamental Principles of Counting: The Rules of Sum and Product, Permutations, Combinations – The Binomial Theorem, Combinations with Repetition, The Catalon Numbers **The Principle of Inclusion and Exclusion:** The Principle of Inclusion and Exclusion, Generalizations of the Principle, **(8 Hours)** **(RBT Levels: L1, L2 and L3)**	
Pedagogy	Chalk and Board, Problem based learning

Module – 4	
Generating Functions: Introductory Examples, Definition and Examples – Calculational Techniques, Partitions of Integers, the Exponential Generating Function. The Summation Operator. **(8 Hours)** **(RBT Levels: L1, L2 and L3)**	
Pedagogy	Chalk and Board, Problem based learning

Module – 5	
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. **(8 Hours)** **(RBT Levels: L1, L2 and L3)**	
Pedagogy	Chalk and Board, Problem based learning

Course Outcomes

Course Outcomes: At the end of the courses, the students will be able to:

1. Know the history and development of graph theory and apply the fundamental results of graph theory.
2. Apply various proof techniques in proving theorems in graph theory.
3. Write algorithms to solve problems in graph theory.
4. The learner able to apply combinatorial Mathematics to the applications in the Computer Science field.

ASSESSMENT PATTERN (BOTH CIE AND SIE)

Assessment Details (both CIE and SEE): The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The student must obtain a minimum of 40% marks individually both in CIE and SEE to pass.

Theory Semester End Exam (SEE) is conducted for 100 marks (3 hours duration). Based on this grading will be awarded.

Continuous Internal Evaluation:

1. Methods recommended: Three Tests (60%), a Written Quiz (20%) and module assignments (20%).
2. The class teacher shall decide the topic for the closed book test and Written Quiz. In the beginning, the teacher must announce the methods of CIE for the subject.

Semester End Examination: Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject.

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), should have a mix of topics under that module.
3. The students shall answer 5 full questions, selecting one full question from each module.

Marks scored out of 100 shall be reduced proportionally to 50 marks

Textbooks:

1. Ralph P. Grimaldi: Discrete and Combinatorial Mathematics, 5 th Edition, Pearson Education, 2004.
2. Narasingh Deo: Graph Theory with Applications to Engineering and Computer Science. 2016.

References:

1. Kenneth H Rosen: Discrete Mathematics & its Applications with Combinatorics and Graph Theory. 6th Edition, 2009.
2. D.S. Chandrasekharaiah: Graph Theory and Combinatorics, Prism, 2005.
3. Chartrand Zhang: Introduction to Graph Theory, TMH, 2006.
4. Richard A. Brualdi: Introductory Combinatorics, 4th Edition, Pearson Education, 2004.
5. Geir Agnarsson & Raymond Geenlaw: Graph Theory, Pearson Education, 2007.

Web links and Video Lectures (e-Resources):

http://www.class-central.com/subject/math(MOOCs)

http://academicearth.org/

http://www.bookstreet.in.

VTU EDUSAT PROGRAMME – 20

VTU e-Shikshana Program

Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning

- Quizzes
- Assignments
- Seminars