CBCS Syllabus as per NEP 2020 for S.Y.B.Sc.(Comp.Sci.) Mathematics
(2023 Pattern)

Name of the Programme	**:** B.Sc. (Comp.Sci.) Mathematics
Program Code	**:** COS-241-MN(B)
Class	**:** S.Y.B.Sc. (Comp.Sci.)
Semester	**:** III
Course Type	**:** Minor
Course Name	**:** Graph Theory
No. of Teaching Hours	**:** 30
No. of Credits	**:** 2

Course Objective:

1. Define and explain concepts like degree, isolated vertex, pendent vertex, and null graph.
2. Understand graph isomorphism and its significance.
3. Understand the impact of these operations on the properties of graphs.
4. Apply matrices to represent graph structures.
5. Understand applications of chromatic numbers in graph colouring.
6. Explore the significance and solutions to this problem.
7. Explore real-world scenarios where directed graphs are applicable.

Course Outcomes:

CO1: Student will be able to define and recognize the components of a graph.
CO2: Student will grasp the definitions of degree, isolated vertex, pendent vertex, and null graph, and apply them to analyse graph structures.
CO3: Students will be able to identify isomorphic graphs and sub graphs within a given graph.
CO4: Student will be able to identify and analyse connected graphs, recognizing their importance in real-world applications.
CO5: Student will understand and apply incidence and adjacency matrices to represent graph structures.
CO6: Student will analyse paths and connectedness in directed graphs, applying these concepts to practical situations.
CO7: Student will Understand and apply Euler digraphs and trees with directed edges in various scenarios.

Topics and Learning Points

Teaching Hours

Unit 01: Introduction to Graph **7**

1.1 Graph
1.2 Finite and Infinite Graphs.
1.3 Definitions (Degree, Isolated Vertex, Pendent Vertex and Null Graph)
1.4 Isomorphism
1.5 Subgraphs
1.6 Walks, Paths and Circuits

Unit 02: Connected Graphs and Trees **8**

2.1 Connected Graph
2.2 Euler Graph
2.3 Operation on Graphs
2.4 Hamiltonian Paths
2.5 Trees
2.6 Rooted and Binary Trees
2.7 Spanning Trees

Unit 03: Matrix Representation and Colouring of Graph **8**

3.1 Incidence Matrix
3.2 Adjacency Matrix
3.3 Chromatic Number
3.4 Matching and Covering
3.5 The Four Colour Problem

Unit 04: Directed Graph **7**

4.1 Directed Graph
4.2 Binary relations
4.3 Path and Connectedness
4.4 Euler Digraphs
4.5 Trees with directed edges

Text Book : Narsingh Deo, Graph Theory with Application to Engineering and Computer Science, Dover Publications, INC. New York.

Reference Books:

1. Douglas B. West, Introduction to Graph Theory, Pearson education Pte. Ltd.
2. John Clark and Derek Allan Holton, A First Look at Graph Theory, Allied Publishers.
3. Reinhard Diestel, Graph Theory , Springer Publication.
4. Richard J.Trudeau, Introduction to Graph Theory, Dover Publication.

Mapping of Program Outcomes with Course Outcomes

Class: S.Y.B.Sc. (Comp.Sci.) (Sem III) **Subject**: Mathematics

Course Name: Graph Theory **Course Code**: COS-241-MN(B)

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

Programme Outcomes	Course Programme Outcomes (COs)						
	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6	CO 7
PO 1	2	2	2	2	2	2	2
PO 2	2	2	2	2	2	2	2
PO 3	1	1	1	1	1	1	1
PO 4	2	2	2	2	2	2	2
PO 5	2	2	2	2	2	2	2
PO 6	2	2	2	2	2	2	2
PO 7	2	2	2	2	2	2	2
PO8	2	2	2	2	2	2	2
PO9	2	2	2	2	2	2	2
PO10	1	1	1	1	1	1	1
PO11	1	1	1	1	1	1	1
PO12	1	1	1	1	1	1	1
PO13	1	1	1	1	1	1	1

Justification for the mapping

PO1 (Comprehensive Knowledge and Understanding):
Moderate or partial relation (2) for all COs as they contribute to a comprehensive understanding of graph theory.

PO2 (Practical, Professional, and Procedural Knowledge):
Moderate or partial relation (2) for all COs as they involve practical knowledge and skills in graph theory.

PO3 (Entrepreneurial Mindset and Knowledge):
Weak or low relation (1) for all COs as they do not directly relate to entrepreneurial mindset or knowledge.

PO4 (Specialized Skills and Competencies):
Moderate or partial relation (2) for all COs as they contribute to specialized skills in graph theory.

PO5 (Capacity for Application, Problem-Solving, and Analytical Reasoning):
Moderate or partial relation (2) for all COs as they involve application, problem-solving, and analytical reasoning in graph theory.

PO6 (Communication Skills and Collaboration):
Moderate or partial relation (2) for all COs as they involve communication and collaboration in graph theory.

PO7 (Research-related Skills):
Moderate or partial relation (2) for all COs as they contribute to research skills in graph theory.

PO8 (Learning How to Learn Skills):
Moderate or partial relation (2) for all COs as they involve learning skills in graph theory.

PO9 (Digital and Technological Skills):
Moderate or partial relation (2) for all COs as they involve digital and technological skills in graph theory.
PO10 (Multicultural Competence, Inclusive Spirit, and Empathy):
Weak or low relation (1) for all COs as they do not directly relate to multicultural competence, inclusive spirit, or empathy.
PO11 (Value Inculcation and Environmental Awareness):
Weak or low relation (1) for all COs as they do not directly relate to value inculcation or environmental awareness.
PO12 (Autonomy, Responsibility, and Accountability):
Weak or low relation (1) for all COs as they do not directly relate to autonomy, responsibility, or accountability.
PO13 (Community Engagement and Service):
Weak or low relation (1) for all COs as they do not directly relate to community engagement or service.

CBCS Syllabus as per NEP 2020 for S.Y.B.Sc.(Comp.Sci.) Mathematics

(2023 Pattern)

Name of the Programme	**:** B.Sc. (Comp.Sci.) Mathematics
Program Code	**:** COS-242-MN(B)
Class	**:** S.Y.B.Sc. (Comp.Sci.)
Semester	**:** III
Course Type	**:** Minor
Course Name	**:** Mathematics Practical Based on Graph Theory
No. of Teaching Hours	**:** 30
No. of Credits	**:** 2

A) Course Objectives:

1) Understand and apply algorithms to determine connectivity in graphs.
2) Implement and utilize algorithms for finding shortest paths in connected graphs.
3) Apply tree structures to problem-solving in different contexts
4) Apply matrix representations to solve graph-related problems.
5) Develop C functions for matrix operations relevant to graph representations
6) Apply graph coloring algorithms to different types of graphs.
7) Implement algorithms to find cycles and determine the shortest path in directed graphs.

B) Course Outcome:

CO1: Student will be able to implement algorithms to find shortest paths in connected graphs.

CO2: Student will be able to understand and describe tree structures in the context of graph theory.

CO3: Student will be able to analyze and interpret properties of adjacency matrix and incidence matrix.

CO4: Write C programs for basic graph representation using an adjacency matrix.

CO5: Student will be able to develop C programs for implementing DFS and BFS algorithms for tree traversal.

CO6: Student will be able to implement C functions for matrix operations applicable to graph representations.

CO7: Student will be able to develop C functions to perform operations on directed graphs, including cycle detection and shortest path determination.

List of Practical's:

1) **Introduction to Graphs**: Understanding basic graph terminology.
2) **Exploring Connected Graphs**: Identifying connected components determining connectivity and finding shortest paths in connected graphs.
3) **Trees in Graph Theory**: Studying tree structures, properties of trees and applications of trees.
4) **Matrix Representation of Graphs**: Converting graphs into matrix form, exploring properties of adjacency matrix and Incidence matrix.
5) **Coloring of Graphs**: Investing vertex coloring, edge coloring, chromatic number and applications of graph colorings in scheduling and map coloring problems.
6) **Directed Graphs**: Understanding directed graphs and analyzing properties of directed graphs and exploring applications in network and flow problems.

Practical's using C-Programming

7) **Graph representation in C**: Implementing the basic representation of graphs using adjacency matrix in C
8) **Connected Components**: Writing a C- Programs to find display connected components in a graph.
9) **Tree traversal Algorithm**: Implementing Depth First Search (DFS) and Breadth First Search (BFS) algorithms for tree traversal in C.
10) **Matrix Operation for Graphs**: Developing C functions for matrix operations such as addition, multiplication and transposition to manipulate graph representations.
11) **Graph Coloring Algorithm**: Implementing a graph coloring algorithms (i.e. greedy coloring) in C and applying it to various graphs.
12) **Directed Graph Operations**: Creating function in C to perform operations on directed graphs such as finding cycles and determining the shortest path.

Mapping of Program Outcomes with Course Outcomes

Class: S.Y.B.Sc.(Computer Science)(Sem III) **Subject:** Mathematics

Course: Mathematics Practical Based on Graph Theory **Course Code:** COS-242-MN(B)
Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

Programme Outcomes	Course Programme Outcomes (COs)						
	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6	CO 7
PO 1	2	2	2	2	2	2	2
PO 2	3	2	2	3	3	3	3
PO 3	2	2	2	2	2	2	2
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PO11	2	2	2	2	2	2	2
PO12	2	2	2	2	2	2	2
PO13	2	2	2	2	2	2	2

Justification for the mapping

PO1 (Comprehensive Knowledge and Understanding):
Moderate or partial relation (2) for all COs as they contribute to the understanding of graph theory and algorithms.

PO2 (Practical, Professional, and Procedural Knowledge):
Strong or direct relation (3) for all COs as they involve practical programming skills and knowledge.

PO3 (Entrepreneurial Mindset and Knowledge):
Moderate or partial relation (2) for all COs as they contribute to problem-solving skills.

PO4 (Specialized Skills and Competencies):
Strong or direct relation (3) for all COs as they involve specialized skills in graph theory and programming.

PO5 (Capacity for Application, Problem-Solving, and Analytical Reasoning):
Strong or direct relation (3) for all COs as they require application, problem-solving, and analytical skills.

PO6 (Communication Skills and Collaboration):
Moderate or partial relation (2) for all COs as they involve communicating and collaborating in programming tasks.

PO7 (Research-related Skills):
Moderate or partial relation (2) for all COs as they involve analyzing and interpreting graph-related data.

PO8 (Learning How to Learn Skills):
Moderate or partial relation (2) for all COs as they contribute to learning new programming concepts and algorithms.
PO9 (Digital and Technological Skills):
Moderate or partial relation (2) for all COs as they involve programming and using digital tools**.**
PO10 (Multicultural Competence, Inclusive Spirit, and Empathy):
Weak or low relation (1) for all COs as they do not directly relate to multicultural competence or inclusive spirit.
PO11 (Value Inculcation and Environmental Awareness):
Weak or low relation (1) for all COs as they do not directly relate to value inculcation or environmental awareness**.**
PO12 (Autonomy, Responsibility, and Accountability):
Moderate or partial relation (2) for all COs as they involve taking responsibility for programming tasks.
PO13 (Community Engagement and Service):
Weak or low relation (1) for all COs as they do not directly relate to community engagement or service.