Course Title : Graph Theory
Course No. : Math Ed. 478
Level : B Ed (ICTE)
Semester : 6th

Nature of the Course: Theoretical
Credit Hours: 3
Teaching Hours: 48
F.M.: 100

1. Course Description

The content of graph theory is exclusively based on concept of set theory and matrices. For the development of its concepts, other many areas of mathematics such as algebraic concepts, topological concepts, and group theories are also used. Actually, the graph theory is a modern branch of mathematics which deals mathematical problems with the help of diagrams. It describes real world situations by means of diagram consisting of a set of points together with lines which join them in certain pairs. In recent years, graph theory has established itself as an important mathematical tool in a wide range of subjects such as physics, chemistry, biology, engineering, computer, operational research, linguistics, geography, sociology etc. Further, it provides much popular techniques to solve games and puzzles along with management of networking business, air-routes and traffic flow system to name few of them.

2. The General Objectives

The general objectives of this course are as follows:

- To familiarize students with concepts, principles, techniques, and application of graph theory.
- To make students capable in applying the phenomena of graph theory to solve the problems of mathematics and other branches of sciences (physics, chemistry, biology, engineering, computer etc.).
- To make students efficient in applying the graph theory to solve the problems of daily life circle such as shortest path problem, air-routes, electrical circuits, traffic flow system etc.
- To enhance the skills of students in using different tools and techniques for the application of graph theory in real life situation.
- To make students competent in applying graph theory to study other branches of mathematics.
- To make students efficient to settle the problems related with games, puzzles, coloring, matching, tournaments, communication network etc.

3. Specific Objectives and Contents

On completion of this course students should be able to:

Specific Objectives	Content
➢ To define and represent the graphs ➢ To identify the degrees of different vertices ➢ To draw and study paths and cycles. ➢ To differentiate trees and forests ➢ To categorize the graphs ➢ To state and compare the properties of different types of graph ➢ To apply the concepts of graph theory to solve the problems related with shortest paths	**Unit I: Fundamental Concepts of Graph Theory (6)** 1.1 Introduction of graph 1.2 Representation of graphs 1.3 Different types of graph 1.4 Walk, paths and cycles 1.5 The degrees of a vertex 1.6 Matrix representation of graph ***Applications*** 1.7 The shortest path problem
➢ To define isomorphism ➢ To identify and draw the connectivity of graphs ➢ To define and illustrate the subgraphs ➢ To apply different operations on graphs ➢ To apply graphical concepts to establish reliable network of communication	**Unit II: Isomorphism and Operations (6)** 2.1 Connectivity 2.2 Blocks 2.3 Isomorphism 2.4 Some special graphs 2.5 Subgraphs 2.6 Operations on graphs ***Applications*** 2.7 The reliable communication networks
➢ To state and illustrate Eulerian graphs ➢ To identify and draw Hamilton cycles ➢ To locate the degrees of sequences ➢ To draw and exemplify the trees ➢ To state the properties of spanning trees ➢ To apply graphical concepts to solve the problem of Chinese postman ➢ To solve the problem of travelling salesman	**Unit III: Eulerian Tours and Hamiltonian Cycles (10)** 3.1 Eulerian graphs 3.2 Hamiltonian graphs 3.3 Trees and forest 3.4 Spanning trees ***Applications***

	3.5 The Chinese postman problem 3.6 The travelling salesman problem
➢ To state and illustrate planar graphs ➢ To identify dual graphs ➢ To color vertices and edges ➢ To color graphs and maps ➢ To apply the concepts of planar graphs and coloring to planarity algorithm ➢ To solve a storage problem	**Unit IV: Planar Graphs and Coloring (10)** 4.1 Plane and planar graphs 4.2 Dual graphs 4.3 Coloring vertices 4.4 Coloring edges 4.5 Coloring maps
➢ To state and draw diagraphs ➢ To define the relations ➢ To represent diagraphs in matrices ➢ To illustrate connectivity ➢ To locate and identify traversability ➢ To apply the concepts to systematize and regularize traffic flow arrangement ➢ To manage and standardize the tournaments' tie sheets	**Unit V: Diagraphs and Traversability (10)** 5.1 Diagraph 5.2 Relation 5.3 Matrix representation 5.4 Connectivity of digraphs 5.5 Traversability of digraphs ***Applications*** 5.6 Tournaments management 5.7 Traffic flow system
➢ To state and use matching system ➢ To identify the relation between matching and bipartite graphs ➢ To locate the perfect matching ➢ To apply the concept of matching to solve the problem of personal assignment ➢ To use the concepts of matching to settle marriage problems	**Unit VI: Matching (6)** 6.1 Matching 6.2 Perfect matching 6.3 Maximal matching 6.4 Maximum matching 6.5 Covering 6.6 Matching in bipartite graphs 6.7 M-alternating path ***Applications*** 6.8 Personal assignment problem

	6.9 The marriage problem

4. Instructional Techniques

4.1 General Instructional Techniques

As per the demonstrative and practical nature of the content of graph theory, the conventional way of teaching and learning system does not work in it. Even the theoretical parts of graph theory demand the real sense and meaning making interaction, understanding and explanation. The real aspiration of this course is to use and reuse the concepts and then put their meanings back into the course. Listening to students lead naturally to make instruction more effective. So, students should be engaged in group works to find the reason why things work the way they do, what they mean, and when they are to be used. In this way, discussion, illustration, practice, group work, project work, mini-lecture, demonstration, problem solving, poster presentation, and approach of mathematical induction will be general instructional techniques to deliver this course.

4.2 Specific Instructional Techniques

Unit	Activity and Instructional Techniques	Teaching Hours (48)
I	Group discussion over the basic concepts of graph theory based on set theory and matrices	6
II	Work in groups and their dissemination followed by guided discussion	6
III	Demonstration of project works on some theorems and practices	10
IV	Mini-lecture followed by group discussion with sharing of experience	10
V	Elaborate the ideas by mathematical induction method and then discuss in groups	10

VI	Poster presentation, brain storming, problem solving and sharing	6

5. Evaluation

5.1 Internal Evaluation 40%

Students' internal evaluation will be conducted by the subject teacher based on the following aspects:

1)	Attendance	5 points
2)	Participation in learning activities	5 points
3)	First assignment/Mid-term exam	10 points
4)	Second assignments (1 or 2)	20 points
	Total	**40 points**

5.2 External Evaluation (Final Examination) 60%

Examination Division under Dean's office will conduct final examination at the end of the semester and the types of questions and scores allocated for each category of questions are as given below:

1)	Objective Type Questions (Multiple Choice 10 × 1)	10 points
2)	Short Answer Questions (6 Questions × 5 points)	30 points
3)	Long Answer Questions (2 Questions × 10 points)	20 points
	Total	**60 points**

6. Recommended Books and References

Recommended Books

Kshetree, M. P. (2018). *Graph Theory*. Kathmandu: Bhundipuran Publication.

Maharjan, H. B. and Sharma, L. N. (2008). *An introduction to graph theory*. Kathmandu: Paluwa Prakashan

Maskey, S. M. (2002). *First Course in Graph Theory*. Kathmandu: Ratna Pustak Bhandar.

Reference Books

Bondy, J. A. & Murty, U. S. R. (1982). *Graph Theory with Applications*. New York: Elsevier Science Publishing Co. Inc.

Dooren, P. V. (2009). *Graph Theory and Applications*. Belgium: Catholique University.

Verma, A. K. (2011). *Graph Theory.* Kerala: University of Calicut.