25UMAT401	GRAPH THEORY& STATISTICS	Category	L	T	P	R	Credit	Year of Introduction
		BSC	3	0	0	0	3	2025

Preamble:
This course introduces fundamental concepts in Graph Theory, including properties and characterization of graph/trees and graph theoretic algorithms, which are widely used in Mathematical modelling and has got applications across Computer Science and other branches in Engineering. This course also introduces students to the modern theory of statistics including hypothesis testing**.**

Prerequisite: 25UMAT301 Probability, Random processes and Numerical Techniques

Course Outcomes: After the completion of the course, the student will be able to:

CO	Course Outcomes	Knowledge Level
CO1	Explain the fundamental concepts of graph theory such as types of graphs, degree of a vertex, graph isomorphism, connectedness. operations on graphs, directed graphs.	K2 Understand
CO2	Explain the concepts of Euler graphs, Hamiltonian graphs, trees and types of trees	K2 Understand
CO3	Apply Prim's and Kruskal's algorithms for finding minimum cost spanning tree and Dijkstra's algorithm for finding shortest paths. Illustrate various representations of graphs using matrices and understand the concepts of connectivity.	K3 Apply
CO4	Explain the concepts estimation of population parameters, assess their certainty with confidence intervals, and test hypotheses about population means and proportions using z-tests and the one-sample t-test.	K3 Apply

Mapping of course outcomes with program outcomes and program specific outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	2	-	-	-	-	-	-	-	1
CO2	3	3	2	-	-	-	-	-	-	-	1
CO3	3	3	2	2	-	-	-	-	-	-	1
CO4	3	3	2	2	-	-	-	-	-	-	1
Avg	3	3	2	2	-	-	-	-	-	-	1

Mapping of course outcomes with Knowledge and Attitude Profile (WK)

	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1	*	*	*	*				*	
CO2	*	*	*	*				*	
CO3	*	*	*	*				*	
CO4	*	*	*	*				*	

WKs Mapped with the course

WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
*	*	*	*				*	

Mark Distribution:

Total Marks	CIE Marks	ESE Marks	ESE Duration
100	**40**	**60**	**2.5 hrs**

Continuous Internal Evaluation Pattern:

Attendance : 5 marks
Continuous Assessment Test : 20 marks
Continuous Assessment Assignment: 15 marks

SYLLABUS

Module 1 (10 hrs)

Introduction to Graphs - Basic definition, Application of graphs, finite and infinite graphs, Incidence and Degree, Isolated vertex, Pendant vertex and Null graph. Isomorphism, Sub graphs, Walks, Paths and circuits, Connected graphs, Disconnected graphs and components, Operations on Graphs, Directed graphs

[Text 1: Relevant topics from sections 1.1, 1.2, 1.3, 1.4, 1.5, 2.1, 2.2, 2.4, 2.5, 2.7, 9.1.Proof of Theorem 2.2 is excluded]

Module 2 (10hrs)

Euler graphs, Hamiltonian paths and circuits, Travelling Salesman Problem, Trees-properties, Pendant vertices, Distance and centres in a tree, Rooted and binary trees,

[Text 1: Relevant topics from sections 2.6, 2.9, 2.10, 3.1, 3.2, 3.3, 3.4, 3.5.Proofs of theorems 2.5, 2.7, 2.9, 3.5, 3.6 are excluded.]

Module 3 (11hrs)

Spanning trees, Prim's algorithm and Kruskal's algorithm, Dijkstra's shortest path algorithm, Cut Set, Connectivity, Edge connectivity, Vertex connectivity, Matrix representation of graphs- Adjacency matrix, Incidence Matrix, Circuit Matrix, Path Matrix,

[Text 1: Relevant topics from sections 3.7, 3.10, 4.1,7.1, 7.3, 7.8, 7.9, 11.5. Proofs of theorems 3.10, 3.16, 7.1, 7.5, 7.8 are excluded]

Module 4 (11hrs)

Confidence Intervals, Confidence Level, Confidence Intervals and One-side confidence intervals for a Population Mean for large and small samples (normal distribution and t-distribution), Hypotheses and Test Procedures, Type I and Type II error, z Tests for Hypotheses about a Population Mean (for large sample), t Test for Hypotheses about a Population Mean (for small sample), Tests concerning a population proportion for large and small samples.

[Text 2: Relevant topics from 7.1, 7.2, 7.3, 8.1, 8.2, 8.3, 8.4]

Textbooks

1. Deo, N. (1974). Graph theory with applications to engineering and computer science. Prentice Hall of India Learning Private Limited.
2. Devore, J. L. (2016). Probability and statistics for engineering and the sciences (9th ed.). Cengage Learning.

Reference Books

1. Wilson, R. J. (2010). Introduction to graph theory (5th ed.). Longman Group Ltd.
2. West, D. B. (2015). Introduction to graph theory (2nd ed.). Pearson Education India.
3. Veerarajan, T. (2008). Probability, statistics and random processes (3rd ed.). McGraw-Hill Education.

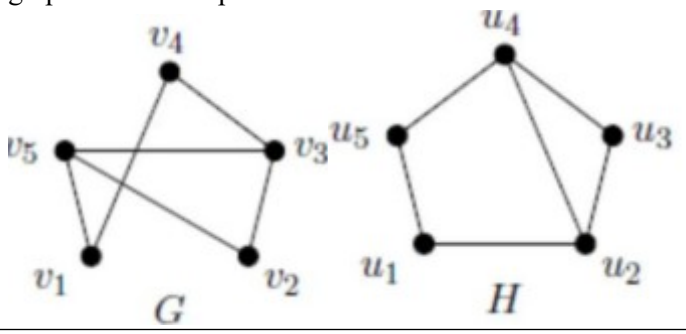
END SEMESTER EXAMINATION – MODEL QUESTION PAPER

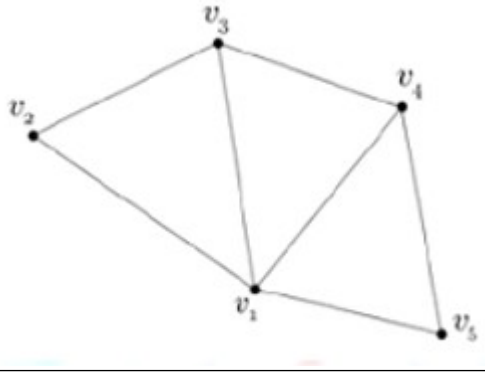
Course Code	**25UMAT401**
Course Name	**GRAPH THEORY& STATISTICS**
Max. Marks: 60	**Duration: 2.5 Hours**

Part A

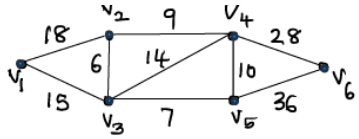
(Answer all questions. Each question carries 3 marks)

Qn No.	Question	Marks	CO	BL
1	Prove that the number of vertices of odd degree in a graph is always even.	3	1	L2
2	A simple graph G has 44 edges. It has 4 vertices of degree 5, 5 vertices of degree 4, and the remaining vertices have degree 2. Find the total number of vertices.	3	1	L2
3	Explain weakly connected graphs and strongly connected graphs. Give examples	3	2	L2
4	Define Euler graph with example	3	2	L2
5	Give an example of a graph with vertex connectivity, edge connectivity are equal	3	3	L2
6	Discuss spanning tree with example	3	3	L2
7	Explain the null hypothesis, Type-I error, and Type-II error	3	4	L2

8	A sample of size 64 has mean $\bar{x}$= 50, and a standard deviation σ = 8.Find the 95% confidence interval for the population mean.	3	4	L2
Part B (Answer any one full question from each Module. Each carry 9 marks)				
Module I				
Qn No.	**Question**	**Marks**	**CO**	**BL**
9a	Define isomorphism. Determine whether the following graphs are isomorphic or not? 	4	1	L2
9b	Prove that a simple graph with n vertices and k components can have atmost (n-k)(n-k+1)/2	5	1	L2
OR				
10a	State the Königsberg bridge problem and draw its graph.	4	1	L2
10b	Define directed graphs. Differentiate between symmetric digraphs and asymmetric digraphs with examples	5	1	L2
Module II				
Qn No.	**Question**	**Marks**	**CO**	**BL**
11a	Show that a tree with n vertices has exactly n-1 edges.	4	2	L2
11b	Prove that a connected graph G is an Euler graph if and only if all the vertices are of even degree.	5	2	L2
OR				
12a	Prove that there is one and only one path between every pair of vertices in a tree.	4	2	L2
12b	Prove that in a complete graph with n vertices there are n-1/2 edge disjoint Hamiltonian circuits, if n is an odd number ≥ 3.	5	2	L2
Module III				
Qn No.	**Question**	**Marks**	**CO**	**BL**
13. a	Prove that the maximum vertex connectivity of a	5	3	L2

	connected graph G with n vertices and e edges is $[\frac{2e}{n}$ ¿			
13. b	Construct an adjacency matrix(X) for the below graph 	4	3	L3

OR

14. a	Discuss matrix representation on graphs	5	3	L2
14. b	Use Dijkstra's algorithm to find the shortest path between v_1 and v_5. 	4	3	L3

Module IV

Qn No.	Question	Marks	CO	BL
15. a	A manufacturer claims that the mean lifetime of a bulb is 1000 hours. A sample of 64 bulbs gives $\bar{x}$= 960 hours. Population standard deviation is σ = 120 hours. Test at 5% level of significance whether the mean lifetime differs from 1000 hours.	5	4	L3
15. b	A sample of size 10 from a population gives $\bar{x}$= 17.5 and sample standard deviation s = 2.4. Test at 5% level of significance whether the population mean is 20.	4	4	L3
	OR			
16. a	A random sample of 150 recent donations at a certain blood bank reveals that 82 were type A. Does this suggest that the actual percentage of type A donations differs from 40%, the percentage of the population having type A blood? Test the appropriate hypotheses using a significance level of .01.	5	4	L3
16. b	A company claims that the mean battery life is 10 hours. A sample of 8 batteries gives $\bar{x}$= 11.2 hours, sample standard deviation s = 1.5 hours. Test at 1% level whether the mean battery life is greater than 10 hours.	4	4	L3