University of Kerala

Discipline	Mathematics				
Course Code	UK4DSEMAT200				
Course Title	Elementary Graph Theory				
Type of Course	DSE				
Semester	IV				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours per week
	4	3	0	2	5
Pre-requisites	Fundamental concepts in set theory, Algebra and Geometry				
Course Summary	This course is intended to motivate the students to study Graph Theory as a branch of Discrete Mathematics and prepare them to learn more advanced concepts in Graph Theory				

Detailed Syllabus

Module	Unit	Contents	Hrs
I	**Basic concepts of Counting**		**9**
	1	Union of events (after explaining the definition of an event)	
	2	Arrangement problem	
	3	Selections	
	4	Binomial Theorem and its Applications	
	Chapter 5: Sections 5.2, 5.4, 5.5, 5.6 of Text [2]		
II	**Introduction to Graphs**		**9**
	5	What is a graph?	
	6	Application of graphs	
	7	Finite and Infinite graphs	
	8	Incidence and Degree	
	9	Isolated Vertex, Pendant Vertex, and Null Graph	

Module	Unit	Contents	Hrs
	Chapter 1: Sections 1.1, 1.2, 1.3, 1.4, 1.5 of Text [1]		
III	**Paths and Circuits**		**9**
	10	Isomorphism	
	11	Sub-graphs	
	12	Walks, Paths, and Circuits	
	13	Connected Graphs, Disconnected Graphs, and Components	
	Chapter 2: Sections 2.1, 2.2, 2.3, 2.4, 2.5 of Text [1]		
IV	**Euler Graphs and Hamiltonian Graphs**		**9**
	14	Euler Graphs	
	15	Operations On Graphs	
	16	More on Euler Graphs	
	17	Hamiltonian Paths and Circuits	
	Chapter 2: Sections 2.6, 2.7, 2.8, 2.9 of Text [1]		
V	**Topics suggested for the teacher designed module**		**9**
	18	Arrangement problem	
	19	Principle of inclusion and exclusion	
	20	The Traveling Salesman Problem	
	21	Tree related concepts	
	Chapter 5: Sections 5.3, 5.7 of Text [2], Chapter 2 : Section 2.10 of Text [1], Chapter 3 : Sections 3.1, 3.2, 3.3 of Text [1]		

Topics and problems for Practical sessions and practical examinations using SageMath software – 30 hours

1. Problems using binomial theorem.
2. Arrangement (with and without repetitions) related problems
3. Problems using principle of inclusion and exclusion
4. Drawing undirected graphs with edges defined as vertex pairs
5. Drawing a graph with a given number of verticies, containing isolated, and pendant vertices
6. Checking if two graphs are isomorphic
7. Drawing walks, paths, circuits
8. Drawing Euler graphs and Hamiltonian circuits
9. Graph operation problems
10. Drawing all trees with a given number of vertices

A record should be maintained with atleast 7 problems from the above. Each problem in the record must have a description of the problem, algorithm (step by step procedure),

commands used, input given and output obtained accordingly. For the ESE, the student should be able to answer two problems selected by the examiner from the 7 available in the record .

SageMath Problem resources

1. SageMath – documentation
   https://doc.sagemath.org/html/en/tutorial/introduction.html
2. Online SageMath server https://sagecell.sagemath.org/
3. Sage Quickstart for Graph Theory and Discrete Mathematics
   https://doc.sagemath.org/html/en/prep/Quickstarts/Graphs-and-Discrete.html
4. Graph theory - SageMath documentation
   https://doc.sagemath.org/html/en/reference/graphs/index.html
5. Discrete Math with SageMath - LibreTexts
   https://math.libretexts.org/Courses/City_Colleges_of_Chicago/Discrete_Math_with_SageMath
6. Enumeration and Combinatorics (Chapter 15, P. Zimmermann *et al*, Computational Mathematics with SageMath
   https://www.sagemath.org/sagebook/english.html)

Textbooks

1. Narsingh Deo, Graph Theory with Applications to Engineering and Computer Science, Dover Publications Inc. Mineola, New York, 2017.
2. W. D. Wallis, A Beginner's Guide to Discrete Mathematics, Second Edition, Birkhauser, Springer International Edition, 2012.

References

1. A. Bondy, U. S. R. Murthy, Graph Theory with Applications, Macmillan Press, London, 1976.
2. M. Joan and R. J. Wilson, Graphs and Applications: An Introductory Approach, Springer Indian Reprint, 2007.
3. Jonathan L. Gross, Jay Yellen, Mark Anderson, Graph Theory and Its Applications, CRC Press, 2018.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Students get motivated to study Graph Theory	PSO 1, 2	R,U	F,C	L	
CO 2	Students develop basic understanding of the concepts in Graph Theory	PSO 1, 2, 3	R,U	F,C	L, T	
CO 3	Students develop skill in solving various problems containing concepts in Graph Theory.	PSO 3, 4, 5	Ap, An, E	F,C, P, M	T	
CO 4	Students apply the knowledge and skills in new situations	PSO 3, 4, 5, 6	Ap, An, E	F,C, P, M	T	P

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	2	1	0	1	1	1	1	2	2	3	0	1
CO2	2	3	3	2	2	1	2	2	2	3	3	2	1	2
CO3	1	3	3	3	4	3	3	3	2	2	2	2	1	1
CO4	1	1	3	3	3	3	3	3	3	3	3	3	2	2

(0 - Nill, 1 - Slightly/Low, 2 - Moderate/Medium, 3 - Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		✓
CO2	✓	✓		✓
CO3	✓	✓	✓	✓
CO4	✓	✓	✓	✓