SEMESTER STUDY PLAN
APPLICATIONS OF GRAPH THEORY
(ELECTIVE COURSE)

DEPARTMENT OF MATHEMATICS AND DATA SCIENCE
FACULTY OF MATHEMATICS AND NATURAL SCIENCES
UNIVERSITAS ANDALAS
2024

SEMESTER STUDY PLAN (SSP)
BACHELOR PROGRAM OF MATHEMATICS
FACULTY OF MATHEMATICS AND NATURAL SCIENCES
UNIVERSITAS ANDALAS

Course Name	Course Code	URL *I-Learn*	Credits	Semester	Compilation Date
Applications of Graph Theory	MAT61232	https://sci.ilearn.unand.ac.id/	3	5	12 May 2024

Person In Charge	Study Plan Creator	Head of Research Group	Head of Study Program
	Narwen, M.Si	Prof. Syafrizal Sy	Dr. Noverina Alfiany

Intended Learning Outcomes (ILO) and Performance Indicator (PI)	Intended Learning Outcomes	
	ILO-2	Possesses profound knowledge of the basic concept mathematics PI-1: An ability to explain basic mathematical concepts PI-2: An ability to provide examples that are relevant to basic mathematical concepts PI-3: An ability to determine solutions to simple problems using basic mathematical concepts
	ILO-3	An ability to identify, explain and generalize simple mathematical PI-1: An ability to identify simple mathematical problems PI-2: An ability to explain simple mathematical problems PI-3: An ability to generalize simple mathematical problems
	ILO-4	An ability to use concept and fundamental technique of mathematics in solving simple mathematical problems PI-1: An ability to choose appropriate basic mathematical concepts and techniques in solving simple mathematical problems PI-2: An ability to illustrate simple mathematical problems based on appropriate basic mathematical concepts and techniques PI-3: An ability to solve simple mathematical problems using appropriate basic mathematical concepts and techniques

	ILO-5	An ability to formally and correctly proves a simple mathematical statement using facts and methods that have been studied. PI-1: An ability to identify formal structures and analogous forms in mathematics PI-2: An ability to use facts and apply methods to prove simple mathematical statements PI-3: An ability to present simple mathematical statement proof rigorously (sequentially and conscientious) PI-4: An ability to conclude or interpret result of the proving simple mathematical statement
	ILO-6	Have ability data literacy and technology and can apply them in solving simple mathematical problems or other relevant fields PI-1: An ability to identify the right data and technology to solve simple mathematical problems or other fields PI-2: An ability to use data and technology and apply them to solve simple mathematical statements or other areas PI-3: An ability to process data using available technology in simple mathematical problems or other fields PI-4: An ability to conclude and interpret data processing results for simple mathematical problems or other fields PI-5: An ability to design an algorithm to solve simple mathematical problems or other fields
	Course Learning Outcomes	
	1	Understand the shortest path problem and minimum spanning tree, and be able to determine the shortest path and minimum spanning tree in each given graph.
	2	Understand the Sperner Lemma and its proof
	3	Understand the Connector Problems and the optimal trees in graphs
	4	Understand the reliable network communication problem in graphs.
	5	Understand the Chinese Postman Problem and minimum weighted graphs
	6	Understand the Traveling Salesman Problem and Hamiltonicity in graphs
	7	Understand the Personnel Assignment Problem and the Optimal Assignment Problem, and be able to determine the perfect matching in a graph
	8	Understand the Timetabling Problem, and be able to determine some efficient time-schedule with edge coloring

	9	Understand the Schur Theorem and Ramsey Theorem for some simple graphs.
Brief Description	This course discusses about some applications of graph theory: The shortest path problem and minimum spanning tree, Sperner Lemma and Connector Problems, The reliable network communication problem, The Chinese Postman Problem, The Traveling Salesman Problem, The Personnel Assignment Problem, The Optimal Assignment Problem, The Timetabling Problem, Schur Theorem, and Ramsey Theorem.	
Course Materials	1. The shortest path problem and minimum spanning tree 2. Sperner Lemma 3. Connector Problems 4. The reliable network communication problem 5. The Chinese Postman Problem 6. The Traveling Salesman Problem 7. The Personnel Assignment Problem and the Optimal Assignment Problem 8. The Timetabling Problem 9. Schur Theorem and Ramsey Theorem	
References	**Main:** 1. J.A Bondy and U.S. R. Murty, *Graph Theory with Applications*, U.S.A, 1976 **Additional:** 1. N. Harsfield and G. Ringer, Pearls in Graph Theory, 2nd edition, Academic Press, New York, 2001	
Learning Media	**Software:**	**Hardware:**
	• LMS Unand (http://fmipa.ilearn.unand.ac.id/) • Zoom meeting/ Teams • Whatsapp	• Computer/Laptop • Smartphone • LCD Projector
Team Teaching	1. Narwen, M.Si	
Assessment	Homework, Quiz, Mid-Term exam, Final exam	
Required courses	MAT61231 Introduction to Graph Theory	

Weekly Study Plan

Week / Meet (1)	Course Outcomes (2)	Indicator (3)	Assessment (4)	Activities/Forms of Learning [Time estimated]					Subject, references (10)	Weight (11)
				Synchronous*		Asynchronous**		Media (9)		
				Face to face Offline (5)	Face to face Online (6)	Individual (7)	Collaboration (8)			

1/1	• Introduction to SSP, Material explanation, task explanation, discussion, and question-and-answer lecture material • **CLO-1** Understand the shortest path problem and minimum spanning tree, and be able to determine the shortest path and minimum spanning tree in each given graph	• Discipline in carrying out course contracts • Accurate understanding of related material	Activeness in lectures	Teaching and discussion: - Introduction to SSP - material explanation - task explanation - discussion and question-and-answer lecture material [1 x 3 x 50 minute]		Students read and study the learning materials individually [1 x 3 x 60 minute]	Students discuss in groups about lecture material [1 x 3 x 50 minutes]	• PPT • i-learn (LMS Unand) Specific condition: Zoom meeting, WA group, learning video	• Assessment Rules, SSP, Syllabus, Tuition Contract • The shortest path algorithm between two vertices in network • Dijkstra algorithm	
2/2	**CLO-2** Understand the Sperner Lemma and its proof	Accurate understanding of related material	Activeness in lectures	Teaching and discussion: - material explanation [1 x 3 x 50 minute]		Students read and study the learning materials individually [1 x 3 x 60 minute]	Students discuss in groups about lecture material [1 x 3 x 50 minutes]	• PPT • i-learn (LMS Unand) Specific condition: Zoom meeting, WA group, learning video	• The subdivision operation in graph • Sperner theorem and its proof	

3/3	**CLO-3** Understand the Connector Problems and the optimal trees in graphs	Accurate understanding of related material	Activeness in lectures	Teaching and discussion: material explanation [1 x 3 x 50 minute]		Students read and study the learning materials individually [1 x 3 x 60 minute]	Students discuss in groups about lecture material [1 x 3 x 60 minutes]	• PPT • i-learn (LMS Unand) Specific condition: Zoom meeting, WA group, learning video	• Network design determination to minimize total construction costs	
4/4	**CLO-3** Understand the Connector Problems and the optimal trees in graphs	Accurate understanding of related material	Activeness in lectures	Teaching and discussion: material explanation [1 x 3 x 50 minute]		Students read and study the learning materials individually [1 x 3 x 60 minute]	Students discuss in groups about lecture material [1 x 3 x 60 minutes]	• PPT • i-learn (LMS Unand) Specific condition: Zoom meeting, WA group, learning video)	• Optimal tree algorithm, • Kruskal algorithm	
5/5	**CLO-4** Understand the reliable network communication problem in graphs	Accurate understanding of related material	Activeness in lectures	Teaching and discussion: material explanation [1 x 3 x 50 minute]		Students read and study the learning materials individually [1 x 3 x 60 minutes]	Students discuss in groups about lecture material [1 x 3 x 60 minutes]	• PPT • i-learn (LMS Unand) Specific condition: Zoom meeting, WA group, learning video)	• The minimum weight of a spanning subgraph k-connected graph	
6/6	**CLO-5** Understand the Chinese Postman Problem and minimum	Accurate understanding of related material	Task 1	Teaching and discussion: material explanation [1 x 3 x 50 minute]		Students read and study the learning materials individually [1 x 3 x 60 minutes]	Students discuss in groups about lecture material [1 x 3 x 60 minutes]	• PPT • i-learn (LMS Unand) Specific condition:	Chinese Postman Problem Tour with minimum weight of a connected graph	10 %

	weighted graphs							Zoom meeting, WA group, learning video)		
7/7	**CLO-5** Understand the Chinese Postman Problem and minimum weighted graphs	Accurate understanding of related material	Quiz 1	Teaching and discussion: material explanation [1 x 3 x 50 minute]		Students read and study the learning materials individually [1 x 3 x 60 minute]	Students discuss in groups about lecture material [1 x 3 x 60 minutes]	• PPT • i-learn (LMS Unand) Specific condition: Zoom meeting, WA group, learning video)	Fleury algorithm	15 %
8 and 9	**MID-TERM EXAM**									**30 %**
10/10	**CLO-6** Understand the Traveling Salesman Problem and Hamiltonicity in graphs	Accurate understanding of related material	Activeness in lectures	Teaching and discussion: material explanation [1 x 3 x 50 minute]		Students read and study the learning materials individually [1 x 3 x 60 minutes]	Students discuss in groups about lecture material [1 x 3 x 60 minutes]	• PPT • i-learn (LMS Unand) • Specific condition: Zoom meeting, WA group, learning video)	• Traveling Salesman Problem • Hamiltonian cycle with minimum weight in graphs	
11/11	**CLO-7** Understand the Personnel Assignment Problem and the Optimal Assignment	Accurate understanding of related material	Activeness in lectures	Teaching and discussion: explanation of learning material [1 x 3 x 50 minutes]		Students read and study the learning materials individually [1 x 3 x 60 minutes]	Students discuss in groups about lecture material [1 x 3 x 60 minutes]	• PPT • i-learn (LMS Unand) • Specific condition: Zoom	• Perfect matching in graph, • Hungarian method	

	Problem, and be able to determine the perfect matching in a graph							meeting, WA group, learning video)		
12/12	**CLO-7** Understand the Personnel Assignment Problem and the Optimal Assignment Problem, and be able to determine the perfect matching in a graph	Accurate understanding of related material	Activeness in lectures	Teaching and discussion: explanation of learning material [1 x 3 x 50 minutes]		Students read and study the learning materials individually [1 x 3 x 60 minutes]	Students discuss in groups about lecture material [1 x 3 x 60 minutes]	• PPT • i-learn (LMS Unand) Specific condition: Zoom meeting, WA group, learning video)	• Maximal assignment to improve the effectiveness of an assignment • Kuhn-Munkres algorithm	
13/13	**CLO-8** Understand the Timetabling Problem, and be able to determine some efficient time-schedule with edge coloring	Accurate understanding of related material	Activeness in lectures	Teaching and discussion: explanation of learning material [1 x 3 x 50 minutes]		Students read and study the learning materials individually [1 x 3 x 60 minutes]	Students discuss in groups about lecture material [1 x 3 x 60 minutes]	• PPT • i-learn (LMS Unand) Specific condition: Zoom meeting, WA group, learning video)	Edge coloring in graph	
14/14	**CLO-8** Understand the Timetabling Problem, and be able to	Accurate understanding of related material	Activeness in lectures	Teaching and discussion: material explanation [1 x 3 x 50 minute]		Students read and study the learning materials individually [1 x 3 x 60 minutes]	Students discuss in groups about lecture material [1 x 3 x 60 minutes]	• PPT • i-learn (LMS Unand) Specific condition:	Finding the optimal solution of timetabling and scheduling	

	determine some efficient time-schedule with edge coloring							Zoom meeting, WA group, learning video)	problems using edge coloring	
15/15	**CLO-9** Understand the Schur Theorem and Ramsey Theorem for some simple graphs	Accurate understanding of related material	Task 2	Teaching and discussion: material explanation [1 x 3 x 50 minute]		Students read and study the learning materials individually [1 x 3 x 60 minutes]	Students discuss in groups about lecture material [1 x 3 x 60 minutes]	• PPT • i-learn (LMS Unand) Specific condition: Zoom meeting, WA group, learning video)	Schur theorem and Ramsey theorem	10 %
16/16	**CLO-9** Understand the Schur Theorem and Ramsey Theorem for some simple graphs	• Accurate understanding of related material • Accuracy in answering assignment questions • Neatness of task execution Originality of task	Quiz 2	Teaching and discussion: • explanation of learning material • explanation of the task • explanation of the assessment [1 x 3 x 50 minutes]		• Students read and study learning materials • Students do assignments independently	Students discuss in groups about lecture material and assignment [1 x 3 x 60 minutes]	• PPT • i-learn (LMS Unand) • Specific condition: Zoom meeting, WA group, learning video)	Some examples of Ramsey theorem for simple graphs	10 %
17 s/d 18	**FINAL EXAMINATION**									**30 %**

1 credit = 50 minutes face-to-face meeting, 60 minutes structured study, 60 minutes independent study
Each meeting duration is 2 credits = 2×50 minutes

Indicators, Criteria, and Assessment Weights

1. Assessment weight for each Assessment

NO	Assessment	Weight (%)
1	Mid-Term Exam	30
2	Final Exam	30
3	Homework	20
4	Quiz	20
TOTAL		**100**

2. Assessment weight for Intended Learning Outcome
   a) CLO-1: 10 %
   b) CLO-2. 10 %
   c) CLO-3: 10 %
   d) CLO-4: 10 %
   e) CLO-5: 10 %
   f) CLO-6: 10 %
   g) CLO-7: 10 %
   h) CLO-8: 20 %
   i) CLO-9: 10 %

Assessment Plan Table:

ASSESSMENT	Task		Quiz		Mid-term Exam	Final Exam	TOTAL
CLO	1	2	1	2			
CLO-1 Understand the shortest path problem and minimum spanning tree, and be able to determine the shortest path and minimum spanning tree in each given graph.	5 %				5 %		10 %
CLO-2 Understand the Sperner Lemma and its proof	5%				5 %		10 %
CLO-3 Understand the Connector Problems and the optimal trees in graphs			5 %		5 %		10%
CLO-4 Understand the reliable network communication problem in graphs.			5 %		5 %		10 %
CLO-5 Understand the Chinese Postman Problem and minimum weighted graphs					10 %		10 %
CLO-6 Understand the Traveling Salesman Problem and Hamiltonicity in graphs		5 %				5 %	10%
CLO-7 Understand the Personnel Assignment Problem and the Optimal Assignment Problem, and be able to determine the perfect matching in a graph		5 %				5 %	10 %

ASSESSMENT	Task		Quiz		Mid-term Exam	Final Exam	TOTAL
CLO-8 Understand the Timetabling Problem, and be able to determine some efficient time-schedule with edge coloring				5 %		15 %	20 %
CLO-9 Understand the Schur Theorem and Ramsey Theorem for some simple graphs.				5 %		5 %	10 %
TOTAL BOBOT	**20%**		**20%**		**30%**	**30%**	**100%**

Matrix of CLO and ILO

CLO	ILO																															
	1			2			3			4			5				6					7			8				9			
	PI			PI			PI			PI			PI				PI					PI			PI				PI			
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	4	1	2	3	4	5	1	2	3	1	2	3	4	1	2	3	4
1				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓											
2				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓											
3				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓											
4				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓											
5				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓											
6				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓											
7				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓											
8				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓											
9				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓											