SEMESTER STUDY PLAN INTRODUCTION TO 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 N	Name		Cours	e Code	URL I	-Learn	Credits	Semester	Compilation Date
INTRODUCTION TO	GRAPH	THEORY	MAT	61231	https://sci.ilea	<u>rn.unand.ac.id/</u>	3	3	12 May 2024
			S	tudy Plar	n Creator	Head of Resea	rch Group	Head of	Study Program
Person In Charge				Prof. Syaf	frizal Sy	Prof. Syafr	izal Sy	Dr. No	verina Alfiany
				Dr. Lyra Yulianti		-			
Intended Learning	Intende	d Learning							
Outcomes (ILO) and	Outcom	nes							
Performance	ILO-2	Possesses p	Possesses profound knowledge of the basic concept mathematics						
Indicator (PI)		PI-1: An al	PI-1: An ability to explain basic mathematical concepts						
		PI-2: An al	PI-2: An ability to provide examples that are relevant to basic mathematical concepts						
		PI-3: An al	PI-3: An ability to determine solutions to simple problems using basic mathematical concepts						
	ILO-3	An ability	to identif	y, explain	and generalize si	imple mathemation	cal		•
		PI-1: An ab	ility to id	entify sin	nple mathematica	l problems			
		PI-2: An ab	An ability to explain simple mathematical problems						
		PI-3: An ab	ility to ge	eneralize s	simple mathemat	ical problems			
	ILO-4	An ability	to use c	concept a	nd fundamental	technique of ma	thematics in	solving sin	nple mathematical
		problems		1		1		0	1
		PI-1: An a	bility to	choose a	appropriate basic	mathematical c	oncepts and	techniques	in solving simple
		math	ematical	problems	11 1		1	1	0 1
		PI-2: An a	bility to	illustrate	e simple mathem	natical problems	based on an	opropriate b	asic mathematical
		conce	pts and t	echniques	5	I	1		
		PI-3: An a	n ability to solve simple mathematical problems using appropriate basic mathematical concepts and					atical concepts and	
		techn	techniques						
		tecini	iques						

II O-5	An ability to formally and correctly proves a simple mathematical statement using facts and methods that
	have been studied
	DE 1. An abilita to identific (annul atmatumes and anales and famous in mathematics
	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 some basic concepts in graph theory
2	Understand some properties of trees and their specialties
3	Understand the concept of connectivity in graph, and able to determine the edge-connectivity and vertex-
	connectivity of a graph
4	Understand the concept of eulerian tour and hamiltonian cycle in a graph, and able to determine the
	eulerian tour or Hamiltonian cycle in a graph
5	Understand the concept of vertex coloring and edge coloring in graph, and able to determine the vertex-
_	chromatic number and edge-chromatic number of a graph
6	Understand the concept of matching, planarity, and its properties in graph, and able to determine maximal
_	and perfect matching in a graph.

brief Description	This course discusses about some basic concepts in graph theory, some properties of trees and their specialties				
	connectivity in graph, Eulerian tour	and Hamiltonian cycle in a graph, matching, vertex coloring, chromatic			
	number of a graph, planarity, Kurato	wski Theorem, and some simple applications.			
<b>Course Materials</b>	1. Graph and subgraph				
	2. Trees and their properties				
	3. Connectivity				
	4. Eulerian tour and Hamiltonian c	ycle			
	5. Matching				
	6. Coloring in Graphs: Vertex, edge, and map colorings				
	7. Vertex-chromatic and edge-chro	matic numbers of graph			
	8. Planar graphs				
References					
	1. J.A Bondy and U.S. R. Murty, Graph Theory with Applications, U.S.A, 1976				
	Additional:				
	1. N. Harsfield and G. Ringer, Pear	ls in Graph Theory, 2 <sup>nd</sup> edition, Academic Press, New York, 2001			
Learning Media	Software:	Hardware:			
	• LMS Unand	Computer/Laptop			
	<ul> <li>LMS Unand (<u>http://fmipa.ilearn.unand.ac.id/</u>)</li> </ul>	<ul><li>Computer/Laptop</li><li>Smartphone</li></ul>			
	<ul> <li>LMS Unand (<u>http://fmipa.ilearn.unand.ac.id/</u>)</li> <li>Zoom meeting/ Teams</li> </ul>	<ul> <li>Computer/Laptop</li> <li>Smartphone</li> <li>LCD Projector</li> </ul>			
	<ul> <li>LMS Unand (<u>http://fmipa.ilearn.unand.ac.id/</u>)</li> <li>Zoom meeting/ Teams</li> <li>Whatsapp</li> </ul>	<ul> <li>Computer/Laptop</li> <li>Smartphone</li> <li>LCD Projector</li> </ul>			
Team Teaching	<ul> <li>LMS Unand (<u>http://fmipa.ilearn.unand.ac.id/</u>)</li> <li>Zoom meeting/ Teams</li> <li>Whatsapp</li> <li>1. Prof. Dr. Syafrizal Sy</li> </ul>	<ul> <li>Computer/Laptop</li> <li>Smartphone</li> <li>LCD Projector</li> </ul>			
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Team Teaching Assessment	<ul> <li>LMS Unand (http://fmipa.ilearn.unand.ac.id/)</li> <li>Zoom meeting/ Teams</li> <li>Whatsapp</li> <li>1. Prof. Dr. Syafrizal Sy</li> <li>2. Dr. Lyra Yulianti</li> <li>Homework, Quiz, Mid-Term exam,</li> </ul>	<ul> <li>Computer/Laptop</li> <li>Smartphone</li> <li>LCD Projector</li> </ul> Final exam			
Team Teaching Assessment Required courses	<ul> <li>LMS Unand (http://fmipa.ilearn.unand.ac.id/)</li> <li>Zoom meeting/ Teams</li> <li>Whatsapp</li> <li>1. Prof. Dr. Syafrizal Sy</li> <li>2. Dr. Lyra Yulianti</li> <li>Homework, Quiz, Mid-Term exam,</li> <li>-</li> </ul>	<ul> <li>Computer/Laptop</li> <li>Smartphone</li> <li>LCD Projector</li> </ul> Final exam			
Team Teaching Assessment Required courses Academic Norms	<ul> <li>LMS Unand (http://fmipa.ilearn.unand.ac.id/)</li> <li>Zoom meeting/ Teams</li> <li>Whatsapp <ol> <li>Prof. Dr. Syafrizal Sy</li> <li>Dr. Lyra Yulianti</li> </ol> </li> <li>Homework, Quiz, Mid-Term exam, <ul> <li>https://akademik.unand.ac.id/images</li> </ul> </li> </ul>	<ul> <li>Computer/Laptop</li> <li>Smartphone</li> <li>LCD Projector</li> </ul> Final exam /2022-03-			
Team Teaching Assessment Required courses Academic Norms	<ul> <li>LMS Unand (http://fmipa.ilearn.unand.ac.id/)</li> <li>Zoom meeting/ Teams</li> <li>Whatsapp <ol> <li>Prof. Dr. Syafrizal Sy</li> <li>Dr. Lyra Yulianti</li> </ol> </li> <li>Homework, Quiz, Mid-Term exam, <ul> <li>https://akademik.unand.ac.id/images</li> <li>30%20Peraturan%20Rektor%20Nomor</li> </ul> </li> </ul>	<ul> <li>Computer/Laptop</li> <li>Smartphone</li> <li>LCD Projector</li> </ul> Final exam /2022-03- %207% 20Tahun% 202022% 20Penyelenggaraan% 20Pendidikan-			

# Weekly Study Plan

Week	Course	Indicator	Assessment	Synchron	ous*	Asynchro	nous**		Subject,	Weight
(1)	Outcomes (2)	(3)	(4)	Face to face Offline (5)	Face to face Online (6)	Individual (7)	Collaboration (8)	Media (9)	references (10)	(11)
1/1	<ul> <li>Introduction to SSP, Material explanation, task explanation, discussion, and question- and-answer lecture material</li> <li>CLO-1 Understand some basic concepts in graph theory</li> </ul>	<ul> <li>Discipline in carrying out course contracts</li> <li>Accurate understanding of related material</li> </ul>	Activeness in lectures	<ul> <li>Teaching and discussion:</li> <li>Introduction to SSP</li> <li>material explanation</li> <li>task explanation</li> <li>discussion and question-and- answer lecture material [1 x 3 x 50 minutes]</li> </ul>		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]	<ul> <li>PPT</li> <li>i-learn (LMS Unand) Specific condition: Zoom meeting, WA group, learning video</li> </ul>	<ul> <li>Assessment         <ul> <li>Rules, SSP,</li> <li>Syllabus,</li> <li>Tuition</li> <li>Contract</li> </ul> </li> <li>Definition of         graph,         <ul> <li>subgraphs, and</li> <li>some</li> <li>terminologies in             graph theory:</li> <li>Simple graph,                 isomorphism in             graph,                 adjacency, and                 incidence</li> </ul> </li> </ul>	

								matrices	
2/2	CLO-1 Understand some basic concepts in graph theory	Accurate understanding of related material	Activeness in lectures Task 1	Teaching and discussion: - material explanation [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]	<ul> <li>PPT</li> <li>i-learn (LMS Unand) Specific condition: Zoom meeting, WA group, learning video</li> </ul>	<ul> <li>Degree of a vertex, path and connectivity</li> <li>Cycle graph</li> <li>Shortest path problems</li> </ul>	5%
3/3	<b>CLO-2</b> Understand some properties of trees and their specialties	Accurate understanding of related material	Activeness in lectures Task 1	Teaching and discussion: material explanation [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]	<ul> <li>PPT</li> <li>i-learn (LMS Unand) Specific condition: Zoom meeting, WA group, learning video</li> </ul>	<ul> <li>Trees</li> <li>Cut-edges, bonds</li> <li>Cut-vertex</li> </ul>	5%
4/4	CLO-3 Understand the concept of connectivity in graph, and able to determine the edge- connectivity and vertex- connectivity of a graph	Accurate understanding of related material	Activeness in lectures	Teaching and discussion: material explanation [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]	<ul> <li>PPT</li> <li>i-learn (LMS Unand) Specific condition: Zoom meeting, WA group, learning video)</li> </ul>	• Cayley Formula and Connector problem	
5/5	CLO-3 Understand the	Accurate understanding	Activeness in lectures	Teaching and discussion:	Students read and study the	Students discuss in	• PPT	• Connectivity in graph	

	conceptofconnectivityingraph, and abletodeterminetheedge-connectivityandvertex-connectivityofa graph	of related material		material explanation [1 x 3 x 50 minutes]	learning materials individually [1 x 3 x 60 minutes]	groups about lecture material [1 x 3 x 60 minutes]	• i-learn (LMS Unand) Specific condition: Zoom meeting, WA group, learning video)	<ul> <li>Edge- connectivity</li> <li>Vertex- connectivity</li> <li>Blocks</li> </ul>	
6/6	CLO-3 Understand the concept of connectivity in graph, and able to determine the edge- connectivity and vertex- connectivity of a graph	Accurate understanding of related material	Activeness in lectures	Teaching and discussion: material explanation [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]	<ul> <li>PPT</li> <li>i-learn (LMS Unand) Specific condition: Zoom meeting, WA group, learning video)</li> </ul>	• The Traveling Salesman Problem dan the Chinese Postman Problem.	
7/7	CLO-4 Understand the concept of eulerian tour and hamiltonian cycle in a graph, and able to determine the eulerian tour or Hamiltonian cycle in a graph	Accurate understanding of related material	Quiz 1	Teaching and discussion: material explanation [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]	<ul> <li>PPT</li> <li>i-learn (LMS Unand) Specific condition: Zoom meeting, WA group, learning video)</li> </ul>	• Eulerian Tour • Hamiltonian cycle	15 %
8 and 9	MID-TERM EXA	M							30 %

10/10	CLO-5 Understand the concept of vertex coloring and edge coloring in graph, and able to determine the vertex- chromatic number and edge-chromatic number of a graph	Accurate understanding of related material	Activeness in lectures	Teaching and discussion: material explanation [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]	<ul> <li>PPT</li> <li>i-learn (LMS Unand)</li> <li>Specific condition: Zoom meeting, WA group, learning video)</li> </ul>	<ul> <li>Vertex coloring</li> <li>Vertex- chromatic number</li> <li>Vizing theorem</li> <li>Timetabling Theorem</li> </ul>	
11/11	CLO-5 Understand the concept of vertex coloring and edge coloring in graph, and able to determine the vertex- chromatic number and edge-chromatic number of 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]	<ul> <li>PPT</li> <li>i-learn (LMS Unand)</li> <li>Specific condition: Zoom meeting, WA group, learning video)</li> </ul>	<ul> <li>Edge coloring</li> <li>Edge- chromatic number</li> </ul>	
12/12	CLO-6 Understand the concept of matching, planarity, and its properties in graph, and able to determine	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	<ul> <li>Matching</li> <li>Covering in bipartite graph</li> <li>Perfect matching,</li> </ul>	

	maximal and perfect matching in a graph						group, learning video)	<ul> <li>Maximal matching</li> <li>The assignment problem</li> </ul>	
13/13	CLO-6 Understand the concept of matching, planarity, and its properties in graph, and able to determine maximal and 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]	<ul> <li>PPT</li> <li>i-learn (LMS Unand) Specific condition: Zoom meeting, WA group, learning video)</li> </ul>	Scheduling problems	
14/14	CLO-6 Understand the concept of matching, planarity, and its properties in graph, and able to determine maximal and perfect matching in a graph	Accurate understanding of related material	Activeness in lectures	Teaching and discussion: material explanation [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]	<ul> <li>PPT</li> <li>i-learn (LMS Unand) Specific condition: Zoom meeting, WA group, learning video)</li> </ul>	<ul> <li>Planar and plane graphs</li> <li>Dual graph</li> </ul>	
15/15	<b>CLO-6</b> Understand the concept of matching, planarity, and its properties in	Accurate understanding of related material	Activeness in lectures	Teaching and discussion: material explanation [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:	Kuratowski Theorem	

	graph, and able to determine maximal and perfect matching in a graph							Zoom meeting, WA group, learning video)		
16/16	Review	<ul> <li>Accurate understanding of related material</li> <li>Accuracy in answering assignment questions</li> <li>Neatness of task execution Originality of task</li> </ul>	Quiz 2	<ul> <li>Teaching and discussion:</li> <li>explanation of learning material</li> <li>explanation of the task</li> <li>explanation of the assessment <ul> <li>[1 x 3 x 50 minutes]</li> </ul> </li> </ul>		<ul> <li>Students read and study learning materials</li> <li>Students do assignments independently</li> <li>[1 x 3 x 60 minutes]</li> </ul>	Students discuss in groups about lecture material and assignment [1 x 3 x 60 minutes]	<ul> <li>PPT</li> <li>i-learn (LMS Unand)</li> <li>Specific condition: Zoom meeting, WA group, learning video)</li> </ul>	Review materia 1 topics	15 %
17 s/d 18	FINAL EXAMIN	NATION								30 %
	1 credit =	50 minutes face-to	-face meet	ing 60 minutes struc	tured study 6	n minutes indene	ndent study			

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	10
4	Quiz	30

TOTAL	100

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

Assessment	Plan	Table:
1 100 COoline III	I IMII	I UDIC.

ASSESSMENT	Task	Qui	z	Mid-term Exam	Final Exam	TOTAL
CLO	1	1	2			
CLO-1	5 %	5%		10%		20 %
Understand some basic concepts in graph theory						
CLO-2	5 %	5%		10%		20 %
Understand some properties of trees and their						
specialties						
CLO-3		5 %		10%	5 %	20%
Understand the concept of connectivity in graph,						
and able to determine the edge-connectivity and						
vertex-connectivity of a graph						
CLO-4			10 %		10 %	20 %
Understand the concept of eulerian tour and						
hamiltonian cycle in a graph, and able to determine						

the eulerian tour or Hamiltonian cycle in a graph						
CLO-5			5 %		5 %	10 %
Understand the concept of vertex coloring in graph,						
and able to determine the chromatic number of a						
graph						
CLO-6					10%	10%
Understand the concept of edge coloring, matching,						
planarity, and its properties in graph, and able to						
determine maximal and perfect matching in a graph.						
TOTAL BOBOT	10%	30%	0	30%	30%	100%

### Matrix of CLO and ILO

	ILO																															
CLO		1		2 3					4		5				6				7			8			9							
CLU	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				$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	>																								
2				$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$																								
3				$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$																								
4				$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$																								
5				<	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	<	$\checkmark$	<b>\</b>	$\checkmark$	<	$\checkmark$	<b>\</b>	<ul> <li></li> </ul>	<	$\checkmark$	$\checkmark$	$\checkmark$											
6				$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$																								