SEMESTER LEARNING PLAN
COMBINATORIAL GROUP THEORY
(ELECTIVE COURSE)

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

SEMESTER STUDY PLAN (SSP) MASTER OF MATHEMATICS PROGRAM FACULTY OF MATHEMATICS AND NATURAL SCIENCE UNIVERSITAS ANDALAS

RENCANA PEMBELAJARAN SEMESTER					
Course Name	**Code**	**Course URL** *i-Learn*	**Credits**	**Semester**	**DATE**
Combinatorial Group Theory	**MAT82211**	https://sci.ilearn.unand.ac.id	3	2	February 24th , 2024

Person in Charge	**Create by**	**Head of Research Group**	**Head of Master Program**
	Dr. Yanita	Prof. Dr. Admi Nazra	Dr. Ferra Yanuar

Intended Learning Outcomes (ILO) and Course Learning Outcomes (CLO)	**Intended Learning Outcomes**	
	ILO-2	Mastering mathematical concepts and applications (real analysis, advanced linear algebra, and statistics) in solving complex mathematical problems PI-1 An ability to explain mathematical concepts (Real Analysis, Advanced Linear Algebra, and Statistics). PI-2 An ability to identify complex mathematical problems. PI-3 An ability to solve complex mathematical problems.
	ILO-3	Comprehensive mastery of one or several theories for development in the fields of analysis, algebra, applied mathematics, statistics and combinatorial mathematics. PI-1 An ability to identify theories used in related mathematical problems. PI-2 An ability to apply theories for advancement in related fields (advanced theory). PI-3 An ability to use advanced theory to solve related mathematical problems.

	Course Learning Outcomes
	1. An ability to understand the properties and solve problems in relation, partition, equivalence relation and class equivalence, residue classes modulo n. (**ILO**-2, PI-1, PI-2, PI-3)
	2. An ability to understand the properties and solve problems in algebraic systems, especially group theory. (**ILO**-2, PI-1, PI-2, PI-3)
	3. An ability to understand the properties and solve problems in word concepts and group presentation. (**ILO**-2, PI-1, PI-2, PI-3; **ILO**-3, PI-1, PI-2, PI-3)
	4. An ability to understand the properties and solve problems of the fundamental group from graphs. (**ILO**-2, PI-1, PI-2, PI-3; **ILO**-3, PI-1, PI-2, PI-3)
	5. An ability to understand the properties and solve problems of the fundamental group from 2-complexes. (**ILO**-2, PI-1, PI-2, PI-3; **ILO**-3, PI-1, PI-2, PI-3)
	6. An ability to understand the properties and solve problems of Tietze and Q transformations. (**ILO**-2, PI-1, PI-2, PI-3; **ILO**-3, PI-1, PI-2, PI-3)
	7. An ability to understand the properties and solve problems of the van Kampenn diagram. (**ILO**-2, PI-1, PI-2, PI-3; **ILO**-3, PI-1, PI-2, PI-3)
	8. An ability to understand the properties and solve problems of the second fundamental groups. (**ILO**-2, PI-1, PI-2, PI-3; **ILO**-3, PI-1, PI-2, PI-3)
Brief description	This course discusses several concepts about combinatorial groups. This course also provides a vehicle for students to think about the other side of group theory, namely studying groups geometrically. Concerning the targets above, this course is given with an emphasis on providing students with a relatively large amount of time to solve problems ranging from simple to quite complex ones. The learning method in this course is face-to-face (a combination of Teacher-Centered Learning and Student-Centered Learning)
Course Materials	1. Partitions and Equivalence Relations 2. Algebraic System

	3. Group Theory 4. Group of Cosets 5. Word and Free Groups 6. Group Presentations 7. Graph Theory and 2-Complexes 8. Fundamental Group from Graph 9. Fundamental Group from 2-Complexes 10. Tiezte Transformation 11. Rewriting Words 12. Van Kampenn Diagram 13. Pictures 14. Second Fundamental Groups (Second Homotopy Modules)
References	**Main:** 1. W. Magnus, A. Karrass, D. Solitar. 1976. *Combinatorial Group Theory, 2nd ed.*, Dover Publication, Inc. New York. 2. G. Baumslag. 1993. Topics in Combinatorial Group Theory, Lecture Notes in Maths, ETH, Zurich. 3. D.E. Cohen. 1989. Combinatorial Group Theory: a Topological Approach, LMS Students Text 14. **Additional** 1. D.L. Johnson. 1990. Presentation of Groups, LMS Students Text 15. 2. V. Guba & M. Sapir. 1997. Diagram Groups, Memoirs of the AMS No. 620.
Learning Media	**Software :** ● LMS Unand (http://fmipa.ilearn.unand.ac.id/) ● Zoom meeting ● Whatsapp **Hardware :** ● Komputer/Laptop ● Smartphone

Team Teaching	Dr. Yanita
Required courses	-
Academic Norms	https://akademik.unand.ac.id/images/2022-03-30%20Peraturan%20Rektor%20Nomor%207%20Tahun%202022%20Penyelenggaraan%20Pendidikan-khusus%20Bab%20II.pdf

Weekly Plan Study

Week (1)	Course Outcomes (2)	Indicator (3)	Assess-ment (4)	Activities/Forms of Learning [Estimated time]				Media (9)	Subject (10)	Weight (11)
				Synchronus*		Asynchronus**				
				Face-to-face Offline (5)	Face-to-face Online (6)	Individual (7)	Collaboration (8)			
1/1	CLO-1 An ability to understand the properties and solve problems in relation, partition, equivalence relation and class equivalence, residue classes modulo n. (ILO-2)	● Accuracy in proving the relation between sets A and B. ● Accuracy in determining partitions in a set ● Accuracy in proving a relation is an equivalence relation in a set ● The accuracy in determining whether two numbers in the set of integers are congruent modulo n	Non test : 1st Task : 5% Test : -	Teaching and discussion: - Explanation of Semester Learning Plan - explanation of learning material - explanation of the task - explanation of the assessment [1 x 3 x 50 minutes]	Teaching and discussion: - Explanation of Semester Learning Plan - explanation of learning material - explanation of the task - explanation of the assessment [1 x 3 x 50 minutes] (Specific conditions: The total number of blended learning meetings is 50% of the total	● Students read and study learning materials ● Students do assignments independently [1 x 3 x 120 minutes]		● PPT ● I learn (LMS Unand) (Specific condition: Zoom meeting, WA group, learning video)	● Tuition Contract ● SSP **Study Materials** ● Relation ● Partition ● Equiva-lence relation ● Residue class modulo	5%

						number of meetings)				
2/2	CO-2 An ability to understand the properties and solve problems in algebraic systems, especially group theory. (ILO-2)	● Accuracy in proving an operation in a set is a binary operation. ● Accuracy in determining a set is an algebraic system	Non test: Test : Midterm : 5%	Teaching and discussion: - explanation of learning material - explanation of the task - explanation of the assessment [1 x 3 x 50 minutes]	Teaching and discussion: - explanation of learning material - explanation of the task - explanation of the assessment [1 x 3 x 50 minutes] (Specific conditions: The total number of blended learning meetings is 50% of the total number of meetings)	●Students read and study learning materials ●Students do assignments independently [1 x 3 x 120 minutes]		● PPT ● I learn (LMS Unand) (Specific condition: Zoom meeting, WA group, learning video)	● Binary operation ● Algebraic system	5%
3/3	CO-2 An ability to understand the properties and solve problems in algebraic systems, especially	● Accuracy in proving a set is a group ● Accuracy in proving a set is a subgroup ● Accuracy in proving a set is	● Non Test : - ● Test : Mid-term: 5%	Teaching and discussion: - explanation of learning material - explanation of the task	Teaching and discussion: - explanation of learning material - explanation of the task	● Students read and study learning materials ● Students do assignments independently		● PPT ● I learn (LMS Unand) (Specific condition: Zoom meeting, WA group, learning video)	●Group theory ●Subgroup ●Group homomorphism	5%

	group theory. (ILO-2)	a direct product group • Accuracy in proving a function between two groups is homomorphism • Accuracy in determining the kernel and image of a homomorphism		- explanation of the assessment [1 x 3 x 50 minutes]	- explanation of the assessment [1 x 3 x 50 minutes] (Specific conditions: The total number of blended learning meetings is 50% of the total number of meetings)	[1 x 3 x 120 minutes]				
4/4	CO-2 An ability to understand the properties and solve problems in algebraic systems, especially group theory. (ILO-2)	• Accuracy in determining the left or right coset of a subgroup in the group • Accuracy in determining a subgroup is normal • Accuracy in determining the factor group	Non test : 2nd Task : 5% Test : Mid-term : 5%	Teaching and discussion: - explanation of learning material - explanation of the task - explanation of the assessment [1 x 3 x 50 minutes]	Teaching and discussion: - explanation of learning material - explanation of the task - explanation of the assessment [1 x 3 x 50 minutes] (Specific conditions: The total number of blended learning	• Students read and study learning materials • Students do assignments independently [1 x 3 x 120 minutes]		• PPT • I learn (LMS Unand) (Specific condition: Zoom meeting, WA group, learning video)	• Left and right cosets • Normal subgroup • Factor group	**10%**

					meetings is 50% of the total number of meetings)					
5/5	CO-3 An ability to understand the properties and solve problems in word concepts and group presentation. (ILO-2, ILO-3)	● Accuracy in determining word on set X (alphabeth) ● Accuracy in using operations on words ● Accuracy in determining the equivalence of two words ●	● Non Test : - ● Test : Midterm : 5%	Teaching and discussion: - explanation of learning material - explanation of the task - explanation of the assessment [1 x 3 x 50 minutes	Teaching and discussion: - explanation of learning material - explanation of the task - explanation of the assessment [1 x 3 x 50 minutes] (Specific conditions: The total number of blended learning meetings is 50% of the total number of meetings)	● Students read and study learning materials ● Students do assignments independently [1 x 3 x 120 minutes]		● PPT ● I learn (LMS Unand) (Specific condition: Zoom meeting, WA group, learning video)	● Word ● Operationson word ● Free group ● Exponent sum	5%
6/6	CO-3 An ability to understand the properties and solve problems in word concepts and	● Accuracy in using operations on words in group presentations	● Non Test 3rd Task : 5% ● Test : Midterm : 5%	Teaching and discussion: - explanation of learning material	Teaching and discussion: - explanation of learning material	● Students read and study learning materials ● Students do assignments independently		● PPT ● I learn (LMS Unand) (Specific condition: Zoom	●Group presentation ●Words operation on group	10%

Week	CLO	Indicators	Assessment			Student Activities		Media	Material	Weight
	group presentation. (ILO-2, ILO-3)	● Accuracy in determining two words is equivalent			- explanation of the task - explanation of the assessment [1 x 3 x 50 minutes	- explanation of the task - explanation of the assessment [1 x 3 x 50 minutes] (Specific conditions: The total number of blended learning meetings is 50% of the total number of meetings)	[1 x 3 x 120 minutes]		meeting, WA group, learning video)	presentation ● Group presentation of cyclic groups ●Group presentation of free product group ●Group presentation of direct product group	
7/7	CLO-4 An ability to understand the properties and solve problems of the fundamental group from graphs. (ILO-2, ILO-3)	● Accuracy in determining a set of vertices and set of edge on a graph ● Accuracy in determining the path in a graph and length of a path ● Accuracy in determining the product from two paths and inverse of a path	●Non Test : - ●Test : Mid-term : 5%	Teaching and discussion: - explanation of learning material - explanation of the task - explanation of the assessment [1 x 3 x 50 minutes]	Teaching and discussion: - explanation of learning material - explanation of the task - explanation of the assessment [1 x 3 x 50 minutes] (Specific conditions: The	● Students read and study learning materials ●Students do assignments independently [1 x 3 x 120 minutes]		● PPT ● I learn (LMS Unand) (Specific condition: Zoom meeting, WA group, learning video)	●Graph ●Path and length of path ●Closed path ●Operations on path ●Maximal tree ●Star of vertex ●Matrix representa-tion of a graph	5%

		● Accuracy in determining reduced or irreducible or cyclically reduced of a path ● Accuracy in determining maximal tree of a path ● Accuracy in determining star of a vertex in a graph ● Accuracy in determining the matrix representation of a direct graph			total number of blended learning meetings is 50% of the total number of meetings)					
8	**MID-TERM EXAM**									
9	CO-4 An ability to understand the properties and solve problems of the fundamental group from graphs. (ILO-2, ILO-3)	● Accuracy in using operations on path in graph ● Accuracy in determining two paths is freely equivalent ● Accuracy in determining first	● Non test : 4th Task : 5% ● Test : -	Teaching and discussion: - explanation of learning material - explanation of the task - explanation of the assessment	Teaching and discussion: - explanation of learning material - explanation of the task - explanation of the assessment	● Students read and study learning materials ● Students do assignments independently [1 x 3 x 120 minutes]		● PPT ● I learn (LMS Unand) (Specific condition: Zoom meeting, WA group, learning video)	● Operations on path ● First fundamental group in a graph ● Free grenerator of the first fundament-tal groups	5%

No	CO	Indicators	Assessment	Teaching (offline)	Teaching (online)	Student Activity		Media	Materials	Weight
		fundamental group with base poin specific vertex in a connected graph ● Accuracy in determining free generator set of a first fundamental group		[1 x 3 x 50 minutes]	[1 x 3 x 50 minutes] (Specific conditions: The total number of blended learning meetings is 50% of the total number of meetings)					
10	CO-5 An ability to understand the properties and solve problems of the fundamental group from 2-complexes. (ILO-2, ILO-3)	● Accuracy in using operations on path in a 2-complexes ● Accuracy in determining two paths is equivalent ● Accuracy in determining first fundamental group with base poin specific vertex in a connected 2-complexes	● Non-Test 5th Task : 5% ● Test : Final exam: 5%	Teaching and discussion: - explanation of learning material - explanation of the task - explanation of the assessment [1 x 3 x 50 minutes]	Teaching and discussion: - explanation of learning material - explanation of the task - explanation of the assessment [1 x 3 x 50 minutes] (Specific conditions: The total number of blended learning meetings is 50% of the total	● Students read and study learning materials ● Students do assignments independently [1 x 3 x 120 minutes]		● PPT ● I learn (LMS Unand) (Specific condition: Zoom meeting, WA group learning video)	● Operations for path in 2-complexes ● First fundamental group in a 2-complexes ●	**10%**

	number of meetings)									
11	CLO-6 An ability to understand the properties and solve problems of Tietze and Q transformation. (ILO-2, ILO-3)	● Accuracy in using Tietze and Q transformation on group presentation ● Accuracy in using Q transformation on group presentation	● Non Test : - ● Test : Final exam : 5%	Teaching and discussion: - explanation of learning material - explanation of the task - explanation of the assessment [1 x 3 x 50 minutes]	Teaching and discussion: - explanation of learning material - explanation of the task - explanation of the assessment [1 x 3 x 50 minutes] (Specific conditions: The total number of blended learning meetings is 50% of the total number of meetings)	● Students read and study learning materials ● Students do assignments independently [1 x 3 x 120 minutes]		● PPT ● I learn (LMS Unand) (Specific condition: Zoom meeting, WA group, learning video)	● Tietze transformation ● Q transformation ● Van Kampenn Lemma	5%
12	CLO-6 An ability to understand the properties and solve problems of the van Kampenn	● Accuracy in determining (van Kampenn) diagram over group presentations ● Accuracy in using	● Non test : 6th Task : 5% ● Test : Final exam : 5%	Teaching and discussion: - explanation of learning material - explanation of the task	Teaching and discussion: - explanation of learning material - explanation of the task	● Students read and study learning materials ● Students do assignments independently		● PPT ● I learn (LMS Unand) (Specific condition: Zoom meeting, WA group,	● Van Kampenn diagram ● Operations on diagrams over group	10%

	diagram. (ILO-2, ILO-3)	operations for diagram over group presentation		- explanation of the assessment [1 x 3 x 50 minutes]	- explanation of the assessment [1 x 3 x 50 minutes] (Specific conditions: The total number of blended learning meetings is 50% of the total number of meetings)	[1 x 3 x 120 minutes]		learning video)	presentations	
13	CLO-7 An ability to understand the properties and solve problems of the van Kampenn diagram. (ILO-2, ILO-3)	● Accuracy in using van Kampenn Theorem on group presentations	● Non Test : 7th Task : 5% ● Test Final exam : 5%	Teaching and discussion: - explanation of learning material - explanation of the task - explanation of the assessment [1 x 3 x 50 minutes]	Teaching and discussion: - explanation of learning material - explanation of the task - explanation of the assessment [1 x 3 x 50 minutes] (Specific conditions: The total number of blended learning	● Students read and study learning materials ● Students do assignments independently [1 x 3 x 120 minutes]		● PPT ● I learn (LMS Unand) (Specific condition: Zoom meeting, WA group, learning video)	● Van Kampenn diagram for diagram	**10%**

					meetings is 50% of the total number of meetings)					
14	CO-8 An ability to understand the properties and solve problems of the second fundamental groups (ILO-2, ILO-3)	● Accuracy in drawing pictures in a group presentation ● Accuracy in determining kind of pictures ● Accuracy in using operations on pictures ● Accuracy ini using van Kampenn Lemma on pictures	● Non Test : - ● Test : Final exam : 5%	Teaching and discussion: - explanation of learning material - explanation of the task - explanation of the assessment [1 x 3 x 50 minutes]	Teaching and discussion: - explanation of learning material - explanation of the task - explanation of the assessment [1 x 3 x 50 minutes] (Specific conditions: The total number of blended learning meetings is 50% of the total number of meetings)	● Students read and study learning materials ● Students do assignments independently [1 x 3 x 120 minutes]		● PPT ● I learn (LMS Unand) (Specific condition: Zoom meeting, WA group, learning video)	● Pictures ● Operati-ons on pictures ● Van Kampenn Lemma on pictures	**5%**
15	CO-8 An ability to understand the properties and solve problems of the second	● Accuracy in drawing spherical pictures in a group presentation	● Non Test 8th Task : 5% ● Test : Final exam : 5%	Teaching and discussion: - explanation of learning material	Teaching and discussion: - explanation of learning material	● Students read and study learning materials ● Students do assignments independently		● PPT ● I learn (LMS Unand) (Specific condition: Zoom	● Spherical pictures ● Operations on spherical pictures	**10%**

	fundamental groups. (ILO-2, ILO-3)	● Accuracy in using operations on spherical pictures ● Accuracy in determining second fundamental group over group presentations ● Accuracy in determining generator in second fundamental group		- explanation of the task - explanation of the assessment [1 x 3 x 50 minutes]	- explanation of the task - explanation of the assessment [1 x 3 x 50 minutes] (Specific conditions: The total number of blended learning meetings is 50% of the total number of meetings)	[1 x 3 x 120 minutes]		meeting, WA group, learning video)	● Second fundamental group ● Generator of second fundamental group	
							Total			**100%**
16	**FINAL EXAM**									

1 credit = 50 minutes face-to-face meeting, 60 minutes structured study, 60 minutes independent study

Each meeting duration is 3 credits = 3×50 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	Task (Homework)	40
	TOTAL	**100**

2. Assessment weight for Intended Learning Outcome
   - CLO-1: 5%
   - CLO-2: 10%
   - CLO-3: 15%
   - CLO-4: 20%
   - CLO-5: 12%
   - CLO-6: 13%
   - CLO-7: 12%
   - CLO 8: 13%

Table Assesment Plan:

No.	Course Learning Outcomes	Weight (%)			
		Task (%)	Mid-term exam (%)	Final Exam (%)	Total
1	An ability to understand the properties and solve problems in relation, partition, equivalence relation and class equivalence, residue classes modulo n. (**ILO**-2, PI-1, PI-2, PI-3))	1st Task : 5			5

No.	CLO	Assignment	Mid Exam	Final Exam	Total
2	An ability to understand the properties and solve problems in algebraic systems, especially group theory. (**ILO**-2, PI-1, PI-2, PI-3)	2nd Task : 5	5		10
3	An ability to understand the properties and solve problems in word concepts and group presentation. (**ILO**-2, PI-1, PI-2, PI-3; **ILO**-3, PI-1, PI-2, PI-3)	3rd Task : 5	10		15
4	An ability to understand the properties and solve problems of the fundamental group from graphs. (**ILO**-2, PI-1, PI-2, PI-3; **ILO**-3, PI-1, PI-2, PI-3)		15		15
		4th Task : 5			5
5	An ability to understand the properties and solve problems of the fundamental group from 2-complexes. (**ILO**-2, PI-1, PI-2, PI-3; **ILO**-3, PI-1, PI-2, PI-3)	5th Task : 5		7	12
6	An ability to understand the properties and solve problems of Tietze and Q transformations. (**ILO**-2, PI-1, PI-2, PI-3; **ILO**-3, PI-1, PI-2, PI-3)	6th Task : 5		8	13
7	An ability to understand the properties and solve problems of the van Kampenn diagram (**ILO**-2, PI-1, PI-2, PI-3; **ILO**-3, PI-1, PI-2, PI-3)	7th Task : 5		7	12
8	An ability to understand the properties and solve problems of the second fundamental groups. (**ILO**-2, PI-1, PI-2, PI-3; **ILO**-3, PI-1, PI-2, PI-3)	8th Task : 5		8	13
	Total	**40**	**30**	**30**	**100**

Matrix of CLO and ILO

CLO	ILO																	
	1		2			3			4				5			6		
	PI-1	PI-2	PI-1	PI-2	PI-3	PI-1	PI-2	PI-3	PI-1	PI-2	PI-3	PI-4	PI-1	PI-2	PI-3	PI-1	PI-2	PI-3
1																		
2																		
3																		
4																		
5																		
6																		
7																		
8																		