



## Module Description/Course Syllabi

Study Programme: Master of Mathematics  
Faculty of Mathematics and Natural Sciences  
Universitas Andalas

### 1. Course number and name

MAT82211 Combinatorial Group Theory

### 2. Credits and contact hours/Number of ECTS credits allocated

3 sks / 4,53 ECTS

### 3. Instructors and course coordinator

1. Dr. Yanita

### 4. Text book, title, author, and year

1. W. Magnus, A. Karrass, D. Solitar. 1976. *Combinatorial Group Theory*, 2<sup>nd</sup> 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.

### 5. Recommended reading and other learning resources/tools

4. D.L. Johnson. 1990. *Presentation of Groups*, LMS Students Text 15.
5. V. Guba & M. Sapir. 1997. *Diagram Groups*, Memoirs of the AMS No. 620.

### 6. Specific course information

#### A. Brief description of the content of the course (catalog 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.
<b><i>B. Prerequisites or co-requisites</i></b>
-
<b><i>C. Indicate whether a required or elective course in the program</i></b>
-
<b><i>D. Level of course unit (according to EQF: first cycle Bachelor, second cycle Master)</i></b>
Second Cycle Master
<b><i>E. Year of study when the course unit is delivered (if applicable)</i></b>
2 <sup>nd</sup> Year
<b><i>F. Semester when the course unit is delivered</i></b>
Even Semester
<b><i>G. Mode of delivery (face-to-face, distance learning)</i></b>
Face to face (a combination of Teacher-Centered Learning and Student-Centered Learning)

<b><i>7. Intended Learning Outcomes</i></b>
ILO 2: Mastering mathematical concepts and applications (real analysis, advanced linear algebra, and statistics) in solving complex mathematical problems

<p>PI-1 Able to explain mathematical concepts (Real Analysis, Advanced Linear Algebra, and Statistics).</p> <p>PI-2 Able to identify complex mathematical problems.</p> <p>PI-3 Able to solve complex mathematical problems.</p>
<p>ILO 3: Comprehensive mastery of one or several theories for development in the fields of analysis, algebra, applied mathematics, statistics and combinatorial mathematics.</p> <p>PI-1 Able to identify theories used in related mathematical problems.</p> <p>PI-2 Able to apply theories for advancement in related fields (advanced theory).</p> <p>PI-3 Able to use advanced theory to solve related mathematical problems.</p>
<p><b>8. Course Learning Outcomes</b></p>
<p>1. Able to understand the properties and solve problems in relation, partition, equivalence relation and class equivalence, residue classes modulo <math>n</math>. (<b>ILO-2</b>, PI-1, PI-2, PI-3)</p>
<p>2. Able to understand the properties and solve problems in algebraic systems, especially group theory. (<b>ILO-2</b>, PI-1, PI-2, PI-3)</p>
<p>3. Able to understand the properties and solve problems in word concepts and group presentation. (<b>ILO-2</b>, PI-1, PI-2, PI-3; <b>ILO-3</b>, PI-1, PI-2, PI-3)</p>
<p>4. Able to understand the properties and solve problems of the fundamental group from graphs. (<b>ILO-2</b>, PI-1, PI-2, PI-3; <b>ILO-3</b>, PI-1, PI-2, PI-3)</p>
<p>5. Able to understand the properties and solve problems of the fundamental group from 2-complexes. (<b>ILO-2</b>, PI-1, PI-2, PI-3; <b>ILO-3</b>, PI-1, PI-2, PI-3)</p>
<p>6. Able to understand the properties and solve problems of Tietze and <math>Q</math> transformations. (<b>ILO-2</b>, PI-1, PI-2, PI-3; <b>ILO-3</b>, PI-1, PI-2, PI-3)</p>
<p>7. Able to understand the properties and solve problems of the van Kampenn diagram. (<b>ILO-2</b>, PI-1, PI-2, PI-3; <b>ILO-3</b>, PI-1, PI-2, PI-3)</p>
<p>8. Able to understand the properties and solve problems of the second fundamental groups. (<b>ILO-2</b>, PI-1, PI-2, PI-3; <b>ILO-3</b>, PI-1, PI-2, PI-3)</p>
<p><b>9. Brief list of topics to be covered</b></p>
<p>1. Partitions and Equivalence Relations</p> <p>2. Algebraic System</p> <p>3. Group Theory</p> <p>4. Group of Cosets</p> <p>5. Word and Free Groups</p>

6. Group Presentations 7. Graph Theory and 2-Complexes 8. Fundamental Group from Graph 9. Fundamental Group from 2-Complexes 10. Tietze Transformation 11. Rewriting Words 12. Van Kampenn Diagram 13. Pictures Second Fundamental Groups (Second Homotopy Modules)
<b><i>10. Learning and teaching methods</i></b>
Directed Learning, Teacher Center Learning
<b><i>11. Language of instruction</i></b>
Bahasa Indonesia and English

<b><i>12. Assessment methods and criteria</i></b>
<b>Summative Assessment :</b> 1. Task/homework : 40%  <b>Formative Assessment:</b> 2. Mid-term exam : 30% 3. Final exam: 30%

**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>i-Learn</i>	Credits	Semester	DATE
COMBINATORIAL GROUP THEORY	MAT82211	<a href="https://sci.ilearn.unand.ac.id">https://sci.ilearn.unand.ac.id</a>	3	2	February 24 <sup>th</sup> , 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)	<b>Intended Learning Outcomes</b>				
	ILO-2	Mastering mathematical concepts and applications (real analysis, advanced linear algebra, and statistics) in solving complex mathematical problems PI-1 Able to explain mathematical concepts (Real Analysis, Advanced Linear Algebra, and Statistics). PI-2 Able to identify complex mathematical problems. PI-3 Able 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 Able to identify theories used in related mathematical problems. PI-2 Able to apply theories for advancement in related fields (advanced theory). PI-3 Able to use advanced theory to solve related mathematical problems.			

	<p><b>Course Learning Outcomes</b></p> <ol style="list-style-type: none"> <li>1. Able to understand the properties and solve problems in relation, partition, equivalence relation and class equivalence, residue classes modulo <math>n</math>. (<b>ILO-2</b>, PI-1, PI-2, PI-3)</li> <li>2. Able to understand the properties and solve problems in algebraic systems, especially group theory. (<b>ILO-2</b>, PI-1, PI-2, PI-3)</li> <li>3. Able to understand the properties and solve problems in word concepts and group presentation. (<b>ILO-2</b>, PI-1, PI-2, PI-3; <b>ILO-3</b>, PI-1, PI-2, PI-3)</li> <li>4. Able to understand the properties and solve problems of the fundamental group from graphs. (<b>ILO-2</b>, PI-1, PI-2, PI-3; <b>ILO-3</b>, PI-1, PI-2, PI-3)</li> <li>5. Able to understand the properties and solve problems of the fundamental group from 2-complexes. (<b>ILO-2</b>, PI-1, PI-2, PI-3; <b>ILO-3</b>, PI-1, PI-2, PI-3)</li> <li>6. Able to understand the properties and solve problems of Tietze and <math>Q</math> transformations. (<b>ILO-2</b>, PI-1, PI-2, PI-3; <b>ILO-3</b>, PI-1, PI-2, PI-3)</li> <li>7. Able to understand the properties and solve problems of the van Kampenn diagram. (<b>ILO-2</b>, PI-1, PI-2, PI-3; <b>ILO-3</b>, PI-1, PI-2, PI-3)</li> <li>8. Able to understand the properties and solve problems of the second fundamental groups. (<b>ILO-2</b>, PI-1, PI-2, PI-3; <b>ILO-3</b>, PI-1, PI-2, PI-3)</li> </ol>
<b>Brief description</b>	<p>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.</p> <p>The learning method in this course is face-to-face (a combination of Teacher-Centered Learning and Student-Centered Learning)</p>
<b>Course Materials</b>	<ol style="list-style-type: none"> <li>1. Partitions and Equivalence Relations</li> <li>2. Algebraic System</li> </ol>

	<ol style="list-style-type: none"> <li>3. Group Theory</li> <li>4. Group of Cosets</li> <li>5. Word and Free Groups</li> <li>6. Group Presentations</li> <li>7. Graph Theory and 2-Complexes</li> <li>8. Fundamental Group from Graph</li> <li>9. Fundamental Group from 2-Complexes</li> <li>10. Tietze Transformation</li> <li>11. Rewriting Words</li> <li>12. Van Kampenn Diagram</li> <li>13. Pictures</li> <li>14. Second Fundamental Groups (Second Homotopy Modules)</li> </ol>	
<b>References</b>	<b>Main:</b>	
	<ol style="list-style-type: none"> <li>1. W. Magnus, A. Karrass, D. Solitar. 1976. <i>Combinatorial Group Theory, 2<sup>nd</sup> ed.</i>, Dover Publication, Inc. New York.</li> <li>2. G. Baumslag. 1993. <i>Topics in Combinatorial Group Theory</i>, Lecture Notes in Maths, ETH, Zurich.</li> <li>3. D.E. Cohen. 1989. <i>Combinatorial Group Theory: a Topological Approach</i>, LMS Students Text 14.</li> </ol>	
	<b>Additional</b>	
	<ol style="list-style-type: none"> <li>1. D.L. Johnson. 1990. <i>Presentation of Groups</i>, LMS Students Text 15.</li> <li>2. V. Guba &amp; M. Sapir. 1997. <i>Diagram Groups</i>, Memoirs of the AMS No. 620.</li> </ol>	
<b>Learning Media</b>	<b>Software :</b>	<b>Hardware :</b>
	<ul style="list-style-type: none"> <li>• LMS Unand (<a href="http://fmipa.ilearn.unand.ac.id/">http://fmipa.ilearn.unand.ac.id/</a>)</li> <li>• Zoom meeting</li> </ul>	<ul style="list-style-type: none"> <li>• Komputer/Laptop</li> <li>• Smartphone</li> </ul>



	<ul style="list-style-type: none"><li>• Whatsapp</li></ul>	
<b>Team Teaching</b>	Dr. Yanita	
<b>Required courses</b>	-	

## Weekly Plan Study

Week (1)	Course Outcomes (2)	Indicator (3)	Assess- ment (4)	Activities/Forms of Learning [Estimated time]					Subject (10)	Weight (11)
				Synchronous*		Asynchronous**		Media (9)		
				Face-to-face Offline (5)	Face-to-face Online (6)	Individual (7)	Collaborat ion (8)			
1/1	CLO-1 Able to understand the properties and solve problems in relation, partition, equivalence relation and class equivalence, residue classes modulo $n$ . (ILO-2)	<ul style="list-style-type: none"> <li>• Accuracy in proving the relation between sets A and B.</li> <li>• Accuracy in determining partitions in a set</li> <li>• Accuracy in proving a relation is an equivalence relation in a set</li> <li>• The accuracy in determining whether two numbers in the set of integers are congruent modulo <math>n</math></li> </ul>	Non test : 1 <sup>st</sup> Task : 5%  Test : -	Teaching and discussion:  <ul style="list-style-type: none"> <li>- Explanation of Semester Learning Plan</li> <li>- explanation of learning material</li> <li>- explanation of the task</li> <li>- explanation of the assessment</li> </ul> [1 x 3 x 50 minutes]	Teaching and discussion:  <ul style="list-style-type: none"> <li>- Explanation of Semester Learning Plan</li> <li>- explanation of learning material</li> <li>- explanation of the task</li> <li>- explanation of the assessment</li> </ul> [1 x 3 x 50 minutes]  (Specific conditions: The total number of blended learning meetings is 50% of the total)	<ul style="list-style-type: none"> <li>• Students read and study learning materials</li> <li>• Students do assignments independently</li> </ul>		<ul style="list-style-type: none"> <li>• PPT</li> <li>• I learn (LMS Unand)</li> </ul> (Specific condition: Zoom meeting, WA group, learning video)	<ul style="list-style-type: none"> <li>• Tuition Contract</li> <li>• SSP Study Materials</li> <li>• Relation</li> <li>• Partition</li> <li>• Equivalence relation</li> <li>• Residue class modulo</li> </ul>	5%

					number of meetings)					
2/2	CO-2 Able to understand the properties and solve problems in algebraic systems, especially group theory. (ILO-2)	<ul style="list-style-type: none"> <li>• Accuracy in proving an operation in a set is a binary operation.</li> <li>• Accuracy in determining a set is an algebraic system</li> </ul>	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)	<ul style="list-style-type: none"> <li>• Students read and study learning materials</li> <li>• Students do assignments independently</li> </ul>		<ul style="list-style-type: none"> <li>• PPT</li> <li>• I learn (LMS Unand)</li> </ul> (Specific condition: Zoom meeting, WA group, learning video)	<ul style="list-style-type: none"> <li>• Binary operation</li> <li>• Algebraic system</li> </ul>	5%
3/3	CO-2 Able to understand the properties and solve problems in algebraic systems, especially	<ul style="list-style-type: none"> <li>• Accuracy in proving a set is a group</li> <li>• Accuracy in proving a set is a subgroup</li> </ul>	<ul style="list-style-type: none"> <li>• Non Test : -</li> <li>• Test : Mid-term: 5%</li> </ul>	Teaching and discussion:  - explanation of learning material - explanation of the task	Teaching and discussion:  - explanation of learning material - explanation of the task	<ul style="list-style-type: none"> <li>• Students read and study learning materials</li> <li>• Students do assignments independently</li> </ul>		<ul style="list-style-type: none"> <li>• PPT</li> <li>• I learn (LMS Unand)</li> </ul> (Specific condition: Zoom meeting,	<ul style="list-style-type: none"> <li>• Group theory</li> <li>• Subgroup</li> <li>• Group homomorphism</li> </ul>	5%

	group theory. (ILO-2)	<ul style="list-style-type: none"> <li>• Accuracy in proving a set is a direct product group</li> <li>• Accuracy in proving a function between two groups is homomorphism</li> <li>• Accuracy in determining the kernel and image of a homomorphism</li> </ul>		- 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)			WA group, learning video)		
4/4	CO-2 Able to understand the properties and solve problems in algebraic systems, especially group theory. (ILO-2)	<ul style="list-style-type: none"> <li>• Accuracy in determining the left or right coset of a subgroup in the group</li> <li>• Accuracy in determining a subgroup is normal</li> <li>• Accuracy in determining the factor group</li> </ul>	Non test : 2 <sup>nd</sup> 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	<ul style="list-style-type: none"> <li>• Students read and study learning materials</li> <li>• Students do assignments independently</li> </ul>		<ul style="list-style-type: none"> <li>• PPT</li> <li>• I learn (LMS Unand)</li> </ul> (Specific condition: Zoom meeting, WA group, learning video)	<ul style="list-style-type: none"> <li>• Left and right cosets</li> <li>• Normal subgroup</li> <li>• Factor group</li> </ul>	10%

					total number of blended learning meetings is 50% of the total number of meetings)					
5/5	CO-3 Able to understand the properties and solve problems in word concepts and group presentation. (ILO-2, ILO-3)	<ul style="list-style-type: none"> <li>• Accuracy in determining word on set <math>X</math> (alphabeth)</li> <li>• Accuracy in using operations on words</li> <li>• Accuracy in determining the equivalence of two words</li> <li>•</li> </ul>	<ul style="list-style-type: none"> <li>• Non Test : -</li> <li>• Test : Midterm : 5%</li> </ul>	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)	<ul style="list-style-type: none"> <li>• Students read and study learning materials</li> <li>• Students do assignments independently</li> </ul>		<ul style="list-style-type: none"> <li>• PPT</li> <li>• I learn (LMS Unand)</li> </ul> (Specific condition: Zoom meeting, WA group, learning video)	<ul style="list-style-type: none"> <li>• Word</li> <li>• Operation word</li> <li>• Free group</li> <li>• Exponent sum</li> </ul>	5%
6/6	CO-3 Able to understand the properties and solve problems	<ul style="list-style-type: none"> <li>• Accuracy in using operations on words in</li> </ul>	<ul style="list-style-type: none"> <li>• Non Test 3<sup>rd</sup> Task : 5%</li> </ul>	Teaching and discussion:	Teaching and discussion:	<ul style="list-style-type: none"> <li>• Students read and study learning materials</li> </ul>		<ul style="list-style-type: none"> <li>• PPT</li> <li>• I learn (LMS Unand)</li> </ul>	<ul style="list-style-type: none"> <li>• Group presentation</li> </ul>	10%

	in word concepts and group presentation. (ILO-2, ILO-3)	group presentations <ul style="list-style-type: none"> <li>• Accuracy in determining two words is equivalent</li> </ul>	<ul style="list-style-type: none"> <li>• Test : Midterm : 5%</li> </ul>	<ul style="list-style-type: none"> <li>- explanation of learning material</li> <li>- explanation of the task</li> <li>- explanation of the assessment</li> </ul> <p>[1 x 3 x 50 minutes]</p>	<ul style="list-style-type: none"> <li>- explanation of learning material</li> <li>- explanation of the task</li> <li>- explanation of the assessment</li> </ul> <p>[1 x 3 x 50 minutes]</p> <p>(Specific conditions: The total number of blended learning meetings is 50% of the total number of meetings)</p>	<ul style="list-style-type: none"> <li>• Students do assignments independently</li> </ul>		(Specific condition: Zoom meeting, WA group, learning video)	<ul style="list-style-type: none"> <li>• Words operation on group presentation</li> <li>• Group presentation of cyclic groups</li> <li>• Group presentation of free product group</li> <li>• Group presentation of direct product group</li> </ul>	
7/7	CLO-4 Able to understand the properties and solve problems of the fundamental group from graphs. (ILO-2, ILO-3)	<ul style="list-style-type: none"> <li>• Accuracy in determining a set of vertices and set of edge on a graph</li> <li>• Accuracy in determining the path in a graph and length of a path</li> </ul>	<ul style="list-style-type: none"> <li>• Non Test :-</li> <li>• Test : Mid-term : 5%</li> </ul>	Teaching and discussion: <ul style="list-style-type: none"> <li>- explanation of learning material</li> <li>- explanation of the task</li> <li>- explanation of the assessment</li> </ul>	Teaching and discussion: <ul style="list-style-type: none"> <li>- explanation of learning material</li> <li>- explanation of the task</li> <li>- explanation of the assessment</li> </ul>	<ul style="list-style-type: none"> <li>• Students read and study learning materials</li> <li>• Students do assignments independently</li> </ul>		<ul style="list-style-type: none"> <li>• PPT</li> <li>• I learn (LMS Unand)</li> </ul> <p>(Specific condition: Zoom meeting, WA group, learning video)</p>	<ul style="list-style-type: none"> <li>• Graph</li> <li>• Path and length of path</li> <li>• Closed path</li> <li>• Operations on path</li> <li>• Maximal tree</li> </ul>	5%

		<ul style="list-style-type: none"> <li>• Accuracy in determining the product from two paths and inverse of a path</li> <li>• Accuracy in determining reduced or irreducible or cyclically reduced of a path</li> <li>• Accuracy in determining maximal tree of a path</li> <li>• Accuracy in determining star of a vertex in a graph</li> <li>• Accuracy in determining the matrix representation of a directed graph</li> </ul>		[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)				<ul style="list-style-type: none"> <li>• Star of vertex</li> <li>• Matrix representation of a graph</li> </ul>	
8	<b>MID-TERM EXAM</b>									
9	CO-4 Able to understand the properties and	<ul style="list-style-type: none"> <li>• Accuracy in using</li> </ul>	<ul style="list-style-type: none"> <li>• Non test : 4<sup>th</sup> Task : 5%</li> </ul>	Teaching and discussion:	Teaching and discussion:	<ul style="list-style-type: none"> <li>• Students read and study</li> </ul>		<ul style="list-style-type: none"> <li>• PPT</li> <li>• I learn (LMS Unand)</li> </ul>	<ul style="list-style-type: none"> <li>• Operations on path</li> </ul>	5%

	<p>solve problems of the fundamental group from graphs. (ILO-2, ILO-3)</p>	<p>operations on path in graph</p> <ul style="list-style-type: none"> <li>• Accuracy in determining two paths is freely equivalent</li> <li>• Accuracy in determining first fundamental group with base point specific vertex in a connected graph</li> <li>• Accuracy in determining free generator set of a first fundamental group</li> </ul>	<ul style="list-style-type: none"> <li>• Test : -</li> </ul>	<ul style="list-style-type: none"> <li>- explanation of learning material</li> <li>- explanation of the task</li> <li>- explanation of the assessment</li> </ul> <p>[1 x 3 x 50 minutes]</p>	<ul style="list-style-type: none"> <li>- explanation of learning material</li> <li>- explanation of the task</li> <li>- explanation of the assessment</li> </ul> <p>[1 x 3 x 50 minutes]</p> <p>(Specific conditions: The total number of blended learning meetings is 50% of the total number of meetings)</p>	<p>learning materials</p> <ul style="list-style-type: none"> <li>• Students do assignments independently</li> </ul>		<p>(Specific condition: Zoom meeting, WA group, learning video)</p>	<ul style="list-style-type: none"> <li>• First fundamental group in a graph</li> <li>• Free generator of the first fundamental groups</li> </ul>	
10	<p>CO-5 Able to understand the properties and solve problems of the fundamental group from 2-</p>	<ul style="list-style-type: none"> <li>• Accuracy in using operations on path in a 2-complexes</li> <li>• Accuracy in determining two paths is equivalent</li> </ul>	<ul style="list-style-type: none"> <li>• Non-Test 5<sup>th</sup> Task : 5%</li> <li>• Test : Final exam: 5%</li> </ul>	<p>Teaching and discussion:</p> <ul style="list-style-type: none"> <li>- explanation of learning material</li> <li>- explanation of the task</li> <li>- explanation of the assessment</li> </ul>	<p>Teaching and discussion:</p> <ul style="list-style-type: none"> <li>- explanation of learning material</li> <li>- explanation of the task</li> <li>- explanation of the assessment</li> </ul>	<ul style="list-style-type: none"> <li>• Students read and study learning materials</li> <li>• Students do assignments independently</li> </ul>		<ul style="list-style-type: none"> <li>• PPT</li> <li>• I learn (LMS Unand)</li> </ul> <p>(Specific condition: Zoom meeting, WA group learning video)</p>	<ul style="list-style-type: none"> <li>• Operations for path in 2-complexes</li> <li>• First fundamental group in a 2-complexes</li> </ul>	10%



	complexes. (ILO-2, ILO-3)	<ul style="list-style-type: none"> <li>• Accuracy in determining first fundamental group with base point specific vertex in a connected 2-complexes</li> </ul>		[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)					
11	CLO-6 Able to understand the properties and solve problems of Tietze and $Q$ transformation. (ILO-2, ILO-3)	<ul style="list-style-type: none"> <li>• Accuracy in using Tietze and <math>Q</math> transformation on group presentation</li> <li>• Accuracy in using <math>Q</math> transformation on group presentation</li> </ul>	<ul style="list-style-type: none"> <li>• Non Test : -</li> <li>• Test : Final exam : 5%</li> </ul>	Teaching and discussion:  <ul style="list-style-type: none"> <li>- explanation of learning material</li> <li>- explanation of the task</li> <li>- explanation of the assessment</li> </ul> [1 x 3 x 50 minutes]	Teaching and discussion:  <ul style="list-style-type: none"> <li>- explanation of learning material</li> <li>- explanation of the task</li> <li>- explanation of the assessment</li> </ul> [1 x 3 x 50 minutes]  (Specific conditions: The total number of blended learning meetings is 50% of the total	<ul style="list-style-type: none"> <li>• Students read and study learning materials</li> <li>• Students do assignments independently</li> </ul>		<ul style="list-style-type: none"> <li>• PPT</li> <li>• I learn (LMS Unand)</li> </ul> (Specific condition: Zoom meeting, WA group, learning video)	<ul style="list-style-type: none"> <li>• Tietze transformation</li> <li>• <math>Q</math> transformation</li> <li>• Van Kampenn Lemma</li> </ul>	5%

					number of meetings)					
12	CLO-6 Able to understand the properties and solve problems of the van Kampenn diagram. (ILO-2, ILO-3)	<ul style="list-style-type: none"> <li>• Accuracy in determining (van Kampenn) diagram over group presentations</li> <li>• Accuracy in using operations for diagram over group presentation</li> </ul>	<ul style="list-style-type: none"> <li>• Non test : 6<sup>th</sup> Task : 5%</li> <li>• Test : Final exam : 5%</li> </ul>	<p>Teaching and discussion:</p> <ul style="list-style-type: none"> <li>- explanation of learning material</li> <li>- explanation of the task</li> <li>- explanation of the assessment</li> </ul> <p>[1 x 3 x 50 minutes]</p>	<p>Teaching and discussion:</p> <ul style="list-style-type: none"> <li>- explanation of learning material</li> <li>- explanation of the task</li> <li>- explanation of the assessment</li> </ul> <p>[1 x 3 x 50 minutes]</p> <p>(Specific conditions: The total number of blended learning meetings is 50% of the total number of meetings)</p>	<ul style="list-style-type: none"> <li>• Students read and study learning materials</li> <li>• Students do assignments independently</li> </ul>		<ul style="list-style-type: none"> <li>• PPT</li> <li>• I learn (LMS Unand)</li> </ul> <p>(Specific condition: Zoom meeting, WA group, learning video)</p>	<ul style="list-style-type: none"> <li>• Van Kampenn diagram</li> <li>• Operations on diagrams over group presentations</li> </ul>	10%
13	CLO-7 Able to understand the properties and solve problems of the van Kampenn	<ul style="list-style-type: none"> <li>• Accuracy in using van Kampenn Theorem on group presentations</li> </ul>	<ul style="list-style-type: none"> <li>• Non Test : 7<sup>th</sup> Task : 5%</li> <li>• Test Final exam : 5%</li> </ul>	<p>Teaching and discussion:</p> <ul style="list-style-type: none"> <li>- explanation of learning material</li> <li>- explanation of the task</li> </ul>	<p>Teaching and discussion:</p> <ul style="list-style-type: none"> <li>- explanation of learning material</li> <li>- explanation of the task</li> </ul>	<ul style="list-style-type: none"> <li>• Students read and study learning materials</li> <li>• Students do assignments independently</li> </ul>		<ul style="list-style-type: none"> <li>• PPT</li> <li>• I learn (LMS Unand)</li> </ul> <p>(Specific condition: Zoom meeting, WA</p>	<ul style="list-style-type: none"> <li>• Van Kampenn diagram for diagram</li> </ul>	10%

	diagram. (ILO-2, ILO-3)			- 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)			group, learning video)		
14	CO-8 Able to understand the properties and solve problems of the second fundamental groups (ILO-2, ILO-3)	<ul style="list-style-type: none"> <li>• Accuracy in drawing pictures in a group presentation</li> <li>• Accuracy in determining kind of pictures</li> <li>• Accuracy in using operations on pictures</li> <li>• Accuracy in using van Kampenn Lemma on pictures</li> </ul>	<ul style="list-style-type: none"> <li>• Non Test : -</li> <li>• Test : Final exam : 5%</li> </ul>	<p>Teaching and discussion:</p> <ul style="list-style-type: none"> <li>- explanation of learning material</li> <li>- explanation of the task</li> <li>- explanation of the assessment</li> </ul> <p>[1 x 3 x 50 minutes]</p>	<p>Teaching and discussion:</p> <ul style="list-style-type: none"> <li>- explanation of learning material</li> <li>- explanation of the task</li> <li>- explanation of the assessment</li> </ul> <p>[1 x 3 x 50 minutes]</p> <p>(Specific conditions: The total number of blended learning</p>	<ul style="list-style-type: none"> <li>• Students read and study learning materials</li> <li>• Students do assignments independently</li> </ul>		<ul style="list-style-type: none"> <li>• PPT</li> <li>• I learn (LMS Unand)</li> </ul> <p>(Specific condition: Zoom meeting, WA group, learning video)</p>	<ul style="list-style-type: none"> <li>• Pictures</li> <li>• Operations on pictures</li> <li>• Van Kampenn Lemma on pictures</li> </ul>	5%

					meetings is 50% of the total number of meetings)					
15	CO-8 Able to understand the properties and solve problems of the second fundamental groups. (ILO-2, ILO-3)	<ul style="list-style-type: none"> <li>• Accuracy in drawing spherical pictures in a group presentation</li> <li>• Accuracy in using operations on spherical pictures</li> <li>• Accuracy in determining second fundamental group over group presentations</li> <li>• Accuracy in determining generator in second fundamental group</li> </ul>	<ul style="list-style-type: none"> <li>• Non Test 8<sup>th</sup> Task : 5%</li> <li>• Test : Final exam : 5%</li> </ul>	Teaching and discussion: <ul style="list-style-type: none"> <li>- explanation of learning material</li> <li>- explanation of the task</li> <li>- explanation of the assessment</li> </ul> [1 x 3 x 50 minutes]	Teaching and discussion: <ul style="list-style-type: none"> <li>- explanation of learning material</li> <li>- explanation of the task</li> <li>- explanation of the assessment</li> </ul> [1 x 3 x 50 minutes] (Specific conditions: The total number of blended learning meetings is 50% of the total number of meetings)	<ul style="list-style-type: none"> <li>• Students read and study learning materials</li> <li>• Students do assignments independently</li> </ul>		<ul style="list-style-type: none"> <li>• PPT</li> <li>• I learn (LMS Unand)</li> </ul> (Specific condition: Zoom meeting, WA group, learning video)	<ul style="list-style-type: none"> <li>• Spherical pictures</li> <li>• Operations on spherical pictures</li> <li>• Second fundamental group</li> <li>• Generator of second fundamental group</li> </ul>	10%
<b>Total</b>										<b>100%</b>
<b>16</b>	<b>FINAL EXAM</b>									

1 credit = 50 minutes face-to-face meeting, 60 minutes structured study, 60 minutes independent study  
Each meeting duration is 3 credits = 3 x 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
<b>TOTAL</b>		<b>100</b>

#### 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	Able 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))	1 <sup>st</sup> Task : 5			5

2	Able to understand the properties and solve problems in algebraic systems, especially group theory. ( <b>ILO-2</b> , PI-1, PI-2, PI-3)	2 <sup>nd</sup> Task : 5	5		10
3	Able to understand the properties and solve problems in word concepts and group presentation. ( <b>ILO-2</b> , PI-1, PI-2, PI-3; <b>ILO-3</b> , PI-1, PI-2, PI-3)	3 <sup>rd</sup> Task : 5	10		15
4	Able to understand the properties and solve problems of the fundamental group from graphs. ( <b>ILO-2</b> , PI-1, PI-2, PI-3; <b>ILO-3</b> , PI-1, PI-2, PI-3)		15		15
		4 <sup>th</sup> Task : 5			5
5	Able to understand the properties and solve problems of the fundamental group from 2-complexes. ( <b>ILO-2</b> , PI-1, PI-2, PI-3; <b>ILO-3</b> , PI-1, PI-2, PI-3)	5 <sup>th</sup> Task : 5		7	12
6	Able to understand the properties and solve problems of Tietze and $Q$ transformations. ( <b>ILO-2</b> , PI-1, PI-2, PI-3; <b>ILO-3</b> , PI-1, PI-2, PI-3)	6 <sup>th</sup> Task : 5		8	13
7	Able to understand the properties and solve problems of the van Kampenn diagram ( <b>ILO-2</b> , PI-1, PI-2, PI-3; <b>ILO-3</b> , PI-1, PI-2, PI-3)	7 <sup>th</sup> Task : 5		7	12
8	Able to understand the properties and solve problems of the second fundamental groups. ( <b>ILO-2</b> , PI-1, PI-2, PI-3; <b>ILO-3</b> , PI-1, PI-2, PI-3)	8 <sup>th</sup> Task : 5		8	13
<b>Total</b>		<b>40</b>	<b>30</b>	<b>30</b>	<b>100</b>

### Matrix of CLO and ILO

CLO	ILO
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