



Module Description/Course Syllabi

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

1. Course number and name
MAT82151 Combinatorics Theory
2. Credits and contact hours/Number of ECTS credits allocated
3/4,53 ECTS
3. Instructors and course coordinator
Dr. Des Welyyanti Dr. Lyra Yulianti
4. Text book, title, author, and year
J.M. Harris, J.L. Hirst, M.J. Mossinghoff, <i>Combinatorics and Graph Theory</i> , 2nd ed., Springer, 2008
5. Recommended reading and other learning resources/tools
1. R. Diestel, <i>Graph Theory (Graduate Text of Mathematics)</i> , 5th ed., Springer, 2017 2. K. H. Rosen, <i>Discrete Mathematics and Applications</i> , 7th ed., McGraw Hill, 2011
6. Specific course information
A. Brief description of the content of the course (catalog description)
This course is related to graph theory (graph theory, planarity, colorings, matchings, Ramsey theory) and combinatorics (some essential problems, binomial coefficients, multinomial coefficients, the pigeonhole principle, principle of inclusion and exclusion, generating function, theory of counting).
B. Prerequisites or corequisites
-
C. Indicate whether a required or elective course in the program
Required
D. Level of course unit (according to EQF: first cycle Bachelor, second cycle Master)
Second cycle degree
E. Year of study when the course unit is delivered (if applicable)
1st year
F. Semester when the course unit is delivered
Even semester
G. Mode of delivery (face-to-face, distance learning)
Face to face
7. Intended Learning Outcomes

<p>ILO-3: Able to master one or several mathematical problems in analysis, algebra, applied mathematics, statistics and combinatorics.</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>ILO-4: Mastering scientific techniques and developing them in solving research problems through multidisciplinary or interdisciplinary approaches.</p> <p>PI-1: Able to apply mathematical techniques in research problem-solving.</p> <p>PI-2: Able to analyse research problems.</p> <p>PI-3: Able to formulate theorems/models and prove their validity.</p> <p>PI-4: Able to use various mathematical software to solve complex mathematical problems.</p> <p>ILO-5: Able to work and conduct research in the field of mathematics and related fields of science by developing the latest issues independently or collaboratively and communicating them academically.</p> <p>PI-1: Capable of formally and correctly proving mathematical statements.</p> <p>PI-2: Able to employ relevant techniques for conducting research.</p> <p>PI-3: Capable of communicating research findings in an academic manner.</p>
<p>8. Course Learning Outcomes</p> <ol style="list-style-type: none"> 1. The student will understand the concept of planarity in graph 2. The student will understand the principles of chromatic number 3. The student will be able to determine classical Ramsey numbers and Ramsey numbers on graph 4. The student will be able to apply the pigeonhole principle, principle of inclusion and exclusion, generating function, theory of counting
<p>9. Brief list of topics to be covered</p> <p>Graph theory, planarity, colorings, matchings, Ramsey theory, some essential problems on combinatorics, binomial coefficients, multinomial coefficients, the pigeonhole principle, the principle of inclusion and exclusion, generating function, theory counting.</p>
<p>10. Learning and teaching methods</p> <ol style="list-style-type: none"> 1. Small group discussion 2. PjBL 3. Directed learning
<p>11. Language of instruction</p> <p>Bahasa Indonesia</p>
<p>12. Assessment methods and criteria</p> <p>Summative Assessment:</p> <ol style="list-style-type: none"> 1. Tasks: 15% 2. Quiz: 15% 3. Mid Semester: 30% 4. Final Semester: 30% 5. Attendance: 10%

Formative Assessment:

1. Thumb up and thumb down
2. Minutes paper

SEMESTER LEARNING PLAN

**COMBINATORIAL THEORY
(COMPULSORY 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 THEORY	MAT82151	https://sci.ilearn.unand.ac.id/course/view.php?id=1904	3	2	April 7 th , 2024
Person in Charge	Create by		Head of Research Group		Head of Master Program
	Dr. Lyra Yulianti		Prof. Dr. Syafrizal Sy		Prof. Dr. Ferra Yanuar
Intended Learning Outcomes (ILO) and Course Learning Outcomes (CLO)	Intended Learning Outcomes				
	ILO-3	Comprehensive mastery of one several theories for development in the fields of analysis, algebra, applied mathematics, statistics, and combinatorial mathematics: a) Able to identify theories used in related mathematical problems. b) Able to apply theories for advancement in related fields (advanced theory). c) Able to use advanced theory to solve related mathematical problems.			
	ILO-4	Mastering scientific techniques and developing them in solving research problems through multidisciplinary or interdisciplinary approaches: a) Able to apply mathematical techniques in research problem-solving. b) Able to analyze research problems. c) Able to formulate theorems/models and prove their validity. d) Able to use various mathematical software to solve complex mathematical problems.			
	ILO-5	Able to work and conduct research in the field of mathematics and related fields of science by developing the latest issues independently or collaboratively and communicating them academically: a) Capable of formally and correctly proving mathematical statements. b) Able to employ relevant techniques for conducting research. c) Capable of communicating research findings in an academic manner.			

	Course Learning Outcomes									
	<ol style="list-style-type: none"> 1. Able to understand the concept of binomial and multinomial coefficients and their simple applications. (ILO-3, ILO-4, ILO-5). 2. Able to understand and apply the pigeonhole principle, inclusion-exclusion principle, generating function and counting theory. (ILO-3, ILO-4, ILO-5). 3. Able to understand about graph theory, distance in graphs, trees, and connectivity in graphs. (ILO-3, ILO-4, ILO-5). 4. Able to understand the concept of vertex and edge colorings in graph, matching, Ramsey theory and some Ramsey numbers. (ILO-3, ILO-4, ILO-5). 									
Brief Description	<p>This course discusses several concepts in graph theory and combinatorics, i.e connectivity, planarity, some Ramsey numbers, binomial and multinomial theorems, pigeonhole and inclusion-exclusion principles, generating function, and counting theory. 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)</p>									
Course Materials	<ol style="list-style-type: none"> 1. Some Concept in Combinatorics 2. Binomial and Multinomial Coefficients 3. Pigeonhole Principle, Inclusion-Exclusion Principle 4. Generating Function and Counting Theory 5. Some Concept in Graph Theory, Trees, Trail, Circuits, Path, and Cycles 6. Planarity, Coloring and Matching 7. Ramsey Theory, Classical Ramsey Theory 8. Graph Ramsey Number and Size Ramsey Number. 									
References	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 20%;">Main:</td> <td></td> </tr> <tr> <td></td> <td>1. J.M. Harris, J.L. Hirst, M.J. Mossinghoff, <i>Combinatorics and Graph Theory</i>, 2nd edition, 2008, Springer</td> </tr> <tr> <td>Additional</td> <td></td> </tr> <tr> <td></td> <td>1. R. Diestel, 2017, <i>Graph Theory</i>, 5th edition, Springer</td> </tr> </table>		Main:			1. J.M. Harris, J.L. Hirst, M.J. Mossinghoff, <i>Combinatorics and Graph Theory</i> , 2 nd edition, 2008, Springer	Additional			1. R. Diestel, 2017, <i>Graph Theory</i> , 5 th edition, Springer
Main:										
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Additional										
	1. R. Diestel, 2017, <i>Graph Theory</i> , 5 th edition, Springer									
Learning Media	Software:	Hardware:								
	<ul style="list-style-type: none"> • LMS Unand (http://fmipa.ilearn.unand.ac.id/) • Zoom meeting • Whatsapp 	<ul style="list-style-type: none"> • Komputer/Laptop • Smartphone 								

Team Teaching	Dr. Lyra Yulianti, Dr. Des Welyyanti
Required courses	-

Weekly Plan Study

Week (1)	Course Outcomes (2)	Indicator (3)	Assessment (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)	Collaboration (8)			
1/1	<p>Able to understand Assessment Rules, RPS, Syllabus, and College Contract.</p> <p>CLO-1 Able to understand the concept of binomial and multinomial coefficients and their simple applications. (ILO-3, ILO-4, ILO-5).</p>	<p>Discipline in carrying out college contracts.</p> <p>Accuracy in explaining and understanding related material.</p>	<p>Activeness in lectures</p>	<p>Teaching and discussion:</p> <ul style="list-style-type: none"> • explanation of learning material [1 x 3 x 50 minutes] 		<ul style="list-style-type: none"> • Students read and study learning materials 		<ul style="list-style-type: none"> • PPT • I learn (LMS Unand) (Specific condition: Zoom meeting, WA group, learning video) 	<p>Assessment Rules, RPS, Syllabus, and College Contract. Some problems in combinatorics</p>	
2/2	<p>CLO-1 Able to understand the concept of binomial and multinomial coefficients and their simple applications. (ILO-3, ILO-4, ILO-5).</p>	<p>Accuracy in explaining and understanding related material.</p>	<p>Activeness in lectures</p>	<p>Teaching and discussion:</p> <ul style="list-style-type: none"> • explanation of learning material [1 x 3 x 50 minutes] 		<ul style="list-style-type: none"> • Students read and study learning materials 		<ul style="list-style-type: none"> • PPT • I learn (LMS Unand) (Specific condition: Zoom meeting, WA group, learning video) 	<p>Binomial coefficient and its applications</p>	
3/3	<p>CLO-1 Able to understand the concept of binomial and multinomial coefficients and their simple</p>	<p>Accuracy in explaining and understanding related material.</p>	<p>Activeness in lectures</p>	<p>Teaching and discussion:</p> <ul style="list-style-type: none"> • explanation of learning material [1 x 3 x 50 minutes] 		<ul style="list-style-type: none"> • Students read and study learning materials 		<ul style="list-style-type: none"> • PPT • I learn (LMS Unand)(Specific condition: Zoom meeting, WA group, 	<p>Multinomial coefficient and its applications</p>	

	applications. (ILO-3, ILO-4, ILO-5).							learning video)		
4/4	CLO-2 Able to understand and apply the pigeonhole principle, inclusion-exclusion principle, generating function and counting theory. (ILO-3, ILO-4, ILO-5).	Accuracy in explaining and understanding related material.	Activeness in lectures	Teaching and discussion: • explanation of learning material [1 x 3 x 50 minutes]		• Students read and study learning materials		• PPT • I learn (LMS Unand) (Specific condition: Zoom meeting, WA group, learning video)	Pigeonhole Principle, Inclusion-exclusion Principle, and their applications	
5/5	CLO-2 Able to understand and apply the pigeonhole principle, inclusion-exclusion principle, generating function and counting theory. (ILO-3, ILO-4, ILO-5).	Accuracy in explaining and understanding related material.	Activeness in lectures	Teaching and discussion: • explanation of learning material [1 x 3 x 50 minutes]		• Students read and study learning materials		• PPT • I learn (LMS Unand) (Specific condition: Zoom meeting, WA group, learning video)	Recurrence relation and generating function	
6/6	CLO-2 Able to understand and apply the pigeonhole principle, inclusion-exclusion principle, generating function and counting theory. (ILO-3, ILO-4, ILO-5).	Accuracy in explaining and understanding related material, accuracy in answering task questions, neatness in task work, and originality of task results.	Task 1	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		• PPT • I learn (LMS Unand) (Specific condition: Zoom meeting, WA group, learning video)	Fibonacci and Catalan Numbers, related to generating function and recurrence relation	
7/7	CLO-2 Able to understand and apply the pigeonhole principle, inclusion-exclusion principle, generating function and counting	Accuracy in explaining and understanding related material, accuracy in answering task questions, neatness in task work,	Quiz 1	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	Partition, Stirling Cycle dan Stirling Set Numbers	

	theory. (ILO-3, ILO-4, ILO-5).	and originality of task results.		<ul style="list-style-type: none"> • explanation of the assessment [1 x 3 x 50 minutes] 				group, learning video)		
8 s/d 9	MID-TERM EXAMINATION									30 %
10/8	CLO-3 Able to understand about graph theory, distance in graphs, trees, and connectivity in graphs. (ILO-3, ILO-4, ILO-5).	Accuracy in explaining and understanding related material.	Activeness in lectures		Teaching and discussion: <ul style="list-style-type: none"> • explanation of learning material [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"> • Students read and study learning materials 		<ul style="list-style-type: none"> • PPT • I learn (LMS Unand) (Specific condition: Zoom meeting, WA group, learning video) 	Distance in graphs, walk, trail, path, connected graph, disconnected graph and Matrices	
11/9	CLO-3 Able to understand about graph theory, distance in graphs, trees, and connectivity in graphs. (ILO-3, ILO-4, ILO-5).	Accuracy in explaining and understanding related material.	Activeness in lectures		Teaching and discussion: <ul style="list-style-type: none"> • explanation of learning material [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"> • Students read and study learning materials 		<ul style="list-style-type: none"> • PPT • I learn (LMS Unand) (Specific condition: Zoom meeting, WA group, learning video) 	Tress and their characterizations , spanning tress and the number of trees in graph	
12/10	CLO-3 Able to understand about graph theory, distance in graphs, trees, and connectivity in	Accuracy in explaining and understanding related material.	Activeness in lectures		Teaching and discussion: <ul style="list-style-type: none"> • explanation of learning material [1 x 3 x 50 minutes] (Specific 	<ul style="list-style-type: none"> • Students read and study learning materials 		<ul style="list-style-type: none"> • PPT • I learn (LMS Unand) (Specific condition: Zoom meeting, WA 	Eulerian Graf, Eulerian Trail and Circuit, Hamiltonian Paths dan Cycles	

	graphs. (ILO-3, ILO-4, ILO-5).				conditions: The total number of blended learning meetings is 50% of the total number of meetings)			group, learning video)		
13/11	CLO-4 Able to understand the concept of vertex and edge colorings in graph, matching, Ramsey theory and some Ramsey numbers. (ILO-3, ILO-4, ILO-5).	Accuracy in explaining and understanding related material.	Activeness in lectures		Teaching and discussion: <ul style="list-style-type: none"> explanation of learning material [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"> Students read and study learning materials 		<ul style="list-style-type: none"> PPT I learn (LMS Unand) (Specific condition: Zoom meeting, WA group, learning video) 	Coloring in graph, chromatic number, Four Color Theorem and chromatic polynomial	
14/12	CLO-4 Able to understand the concept of vertex and edge colorings in graph, matching, Ramsey theory and some Ramsey numbers. (ILO-3, ILO-4, ILO-5).	Accuracy in explaining and understanding related material.	Activeness in lectures	Teaching and discussion: <ul style="list-style-type: none"> explanation of learning material [1 x 3 x 50 minutes] 	Teaching and discussion: <ul style="list-style-type: none"> explanation of learning material [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"> Students read and study learning materials 		<ul style="list-style-type: none"> PPT I learn (LMS Unand) (Specific condition: Zoom meeting, WA group, learning video) 	Matching in graph, Ramsey theory	

15/13	CLO-4 Able to understand the concept of vertex and edge colorings in graph, matching, Ramsey theory and some Ramsey numbers. (ILO-3, ILO-4, ILO-5).	Accuracy in explaining and understanding related material, accuracy in answering task questions, neatness in task work, and originality of task results.	Task 2		Teaching and discussion: <ul style="list-style-type: none"> • 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"> • Students read and study learning materials • Students do assignments independently 		<ul style="list-style-type: none"> • PPT • I learn (LMS Unand) (Specific condition: Zoom meeting, WA group, learning video) 	Classical Ramsey number, Graph Ramsey number	
16/14	CLO-4 Able to understand the concept of vertex and edge colorings in graph, matching, Ramsey theory and some Ramsey numbers. (ILO-3, ILO-4, ILO-5).	Accuracy in explaining and understanding related material, accuracy in answering task questions, neatness in task work, and originality of task results.	Quiz 2		Teaching and discussion: <ul style="list-style-type: none"> • 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"> • Students read and study learning materials • Students do assignments independently 		<ul style="list-style-type: none"> • PPT • I learn (LMS Unand) (Specific condition: Zoom meeting, WA group, learning video) 	Size Ramsey number and Ramsey minimal graphs	
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 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	Quiz	20
4	Task (Homework)	20
TOTAL		100

2. Assessment weight for Intended Learning Outcome

- a) CLO-1: 25 %
- b) CLO-2: 25 %
- c) CLO-3: 25 %
- d) CLO-4: 25 %

Table Assessment Plan:

No.	Course Learning Outcomes	Weight (%)						
		Mid-term Exam (%)	Final Exam (%)	Quiz (%)		Task (%)		Total
				1	2	1	2	
1	Able to understand the concept of binomial and multinomial coefficients and their simple applications. (ILO-3, ILO-4, ILO-5).	15		5		5		5
2	Able to understand and apply the pigeonhole principle, inclusion-exclusion principle, generating function and counting theory. (ILO-3, ILO-4, ILO-5).	15		5		5		10
3	Able to understand about graph theory, distance in graphs, trees, and connectivity in graphs. (ILO-3, ILO-4, ILO-5).		15		5		5	

4	Able to understand the concept of vertex and edge colorings in graph, matching, Ramsey theory and some Ramsey numbers. (ILO-3, ILO-4, ILO-5).		15		5		5	
Total		30 %	30 %	20 %	20 %	100		

Matrix of CLO and ILO

CLO	ILO			
	1	2	3	4
1	✓	✓	✓	✓
2	✓	✓	✓	✓
3	✓	✓	✓	✓
4	✓	✓	✓	✓