Module Description/Course Syllabi

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

1. *Course number and name*

MAT82213 Matrix Algebra

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. D. A. Harville, Matrix Algebra from a Statistician's Perspective, New York: Springer, 2008
2. J. R. Schott, Matrix Analysis for Statistics, 3rd ed., New Jersey: John Wiley and Sons, 2017.

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

3. R.A. Horn & C.R. Johnson. 2013. Matrix Analysis, 2nd eds., Cambridge University Press, New York.
4. Adi-Ben Israel & Thomas N.E. Greville , 2003, *Generalized Inverses : Theory and Application*, 2nd ed, Canadian Mathematical Society, Springer-Verlag, USA
5. Alexander Graham, 1981. *Kronecker Product and Matrix Calculus with application*, John Wiley and Sons, USA

6. *Specific course information*

A. Brief description of the content of the course (catalog description)

This course discusses several concepts about matrix; specific matrix, partition matrix and operations on matrix.
B. Prerequisites or co-requisites
-
C. Indicate whether a required or elective course in the program
-
D. Level of course unit (according to EQF: first cycle Bachelor, second cycle Master)
Second Cycle Master
E. Year of study when the course unit is delivered (if applicable)
2nd Year
F. Semester when the course unit is delivered
Odd Semester
G. Mode of delivery (face-to-face, distance learning)
Face to face (a combination of Teacher-Centered Learning and Student-Centered Learning)

7. *Intended Learning Outcomes*
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.

8. ***Course Learning Outcomes***

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)
2. Able to understand the properties and solve problems in algebraic systems, especially group theory. (**ILO**-2, PI-1, PI-2, PI-3)
3. Able 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. Able 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. Able 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. Able 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. Able 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. Able 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)

9. ***Brief list of topics to be covered***

1. Review some type of matrix
2. Properties of specific matrix (orthogonal, unitary, normal, idempotent Hermitian and skew-Hermitian matrix)
3. Partition matrix
4. Schur Complement

5. Determinan of the partition matrix 6. Inverse of the partition matrix 7. Kronecker product 8. Operators on matrix (Vec, vech, vecd, and vecp operator)
10. Learning and teaching methods
Directed Learning, Teacher Center Learning
11. Language of instruction
Bahasa Indonesia and English

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

SEMESTER STUDY PLAN
MATRIX ALGEBRA
(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

Course Name	Code	Course URL *i-Learn*	Credits	Semester	Compilation Date
Matrix Algebra	MAT82213	https://sci.ilearn.unand.ac.id	3	2	May 13th, 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 (ILO)	**Intended Learning Outcomes**	
	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.
	Course Learning Outcomes	
	1. Able to understand the properties and solve problems in specific matrix. (**ILO**-2, PI-1, PI-2, PI-3; **ILO**-3, PI-1, PI-2, PI-3)	
	2. Able to understand the properties and solve problems in partition matrix. (**ILO**-2, PI-1, PI-2, PI-3; **ILO**-3, PI-1, PI-2, PI-3)	

	3. Able to understand the properties and solve problems in Kronecker product. (**ILO**-2, PI-1, PI-2, PI-3; **ILO**-3, PI-1, PI-2, PI-3)
	4. Able to understand the properties and solve problems of the operators on matrix. (**ILO**-2, PI-1, PI-2, PI-3; **ILO**-3, PI-1, PI-2, PI-3)
	5. Able to understand the properties and solve problems of the matrix transformation (**ILO**-2, PI-1, PI-2, PI-3; **ILO**-3, PI-1, PI-2, PI-3)
Brief description	This course discusses several concepts about matrix; specific matrix, partition matrix and operations on matrix. The learning method in this course is face-to-face (a combination of Teacher-Centered Learning and Student-Centered Learning)
Study Materials	1. Review some type of matrix 2. Properties of specific matrix (orthogonal, unitary, normal, idempotent Hermitian and skew-Hermitian matrix) 3. Partition matrix 4. Schur Complement 5. Determinan of the partition matrix 6. Inverse of the partition matrix 7. Kronecker product 8. Operators on matrix (Vec, vech, vecd, and vecp operator) 9. Matrix transformation (commutation and duplication matrix)
References	**Main:** 1. D. A. Harville, Matrix Algebra from a Statistician's Perspective, New York: Springer, 2008 2. J. R. Schott, Matrix Analysis for Statistics, 3rd ed., New Jersey: John Wiley and Sons, 2017. **Additional** 1. R.A. Horn & C.R. Johnson. 2013. Matrix Analysis, 2nd eds., Cambridge University Press, New York. 2. Adi-Ben Israel & Thomas N.E. Greville , 2003, *Generalized Inverses : Theory and Application*, 2nd ed, Canadian Mathematical Society, Springer-Verlag, USA 3. Alexander Graham, 1981. *Kronecker Product and Matrix Calculus with application*, John Wiley and Sons, USA
	Software : | **Hardware :**

Instructional Media	• LMS Unand (http://fmipa.ilearn.unand.ac.id/) • Zoom meeting • Whatsapp	• Computer/Laptop • Smartphone
Team Teaching	Dr. Yanita	
Required courses	-	

Weekly Study Plan

Week/ Meet (1)	Course Outcomes (2)	Indicator (3)	Assessment (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 Able to understand the properties and solve problems in specific matrix. (**ILO**-2, PI-1, PI-2, PI-3; **ILO**-3, PI-1, PI-2, PI-3)	• Accuracy to understand some theory of matrix • Accuracy in proving the properties of orthogonal, unitary, normal, idempotent Hermitian and skew-Hermitian matrix	Non test : - Test Midterm: 6%	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 number of meetings)	• Students read and study learning materials • Students do assignments independently		• PPT • I learn (LMS Unand) (Specific condition: Zoom meeting, WA group, learning video)	• Tuition Contract • SLP **Study Materials** • Review some definitions and properties in matrix theory • Orthogonal matrix • Unitary matrix • Normal matrix • Idempotent matrix • Hermitian maytrix • skew-Hermitian matrix	**6%**

2/2	CLO-1 Able to understand the properties and solve problems in specific matrix. (**ILO**-2, PI-1, PI-2, PI-3; **ILO**-3, PI-1, PI-2, PI-3)	• Accuracy to understand definition of determinant • Accuracy in proving the properties of determinant	Non test : 1st Task : 8% Test : Midterm: 6%	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		• PPT • I learn (LMS Unand) (Specific condition: Zoom meeting, WA group, learning video)	• Determinant • Properties of determinant	14%
3/3	CLO-2 Able to understand the properties and solve problems in partition matrix. (**ILO**-2, PI-1, PI-2, PI-3; **ILO**-3, PI-1, PI-2, PI-3)	• Accuracy in determining partition on a matrix • Accuracy in using operation on partition matrices • Transpose of the partition matrix	Non-test : - Test : Mid-term: 6%	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	• Students read and study learning materials • Students do assignments independently		• PPT • I learn (LMS Unand) (Specific condition: Zoom meeting, WA group, learning video)	• Partition Matrix • operations on partition matrices • Transpose of the partition matrix	**6%**

					blended learning meetings is 50% of the total number of meetings)					
4/4	CLO-2 Able to understand the properties and solve problems in partition matrix. (**ILO**-2, PI-1, PI-2, PI-3; **ILO**-3, PI-1, PI-2, PI-3)	• Accuracy in determining inverse of the partition matrix • Accuracy in properties of the partition matrix	Non test : 2nd Task : 8 % Test : Mid-term: 6%	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		• PPT • I learn (LMS Unand) (Specific condition: Zoom meeting, WA group, learning video)	• Inverse of the partition matrix • Complement Schur • Properties of the partition matrix	**14%**
5/5	CLO-3 Able to understand the properties and solve problems in partition matrix. (**ILO**-2, PI-1, PI-2, PI-3; **ILO**-3, PI-1, PI-2, PI-3)	Accuracy in determining determinant of the partitioned	Non-Test : - Midterm: 4%	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		• PPT • I learn (LMS Unand) (Specific condition: Zoom meeting, WA group, learning video)	Determinant of the partition matrix	**4%**

				[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)					
6/6	CLO-3 Able to understand the properties and solve problems in partition matrix. (**ILO**-2, PI-1, PI-2, PI-3; **ILO**-3, PI-1, PI-2, PI-3)	Accuracy in determining inverse of the partition matrix	Non-Test : - Midterm : 4%	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		• PPT • I learn (LMS Unand) (Specific condition: Zoom meeting, WA group, learning video)	Inverse of partition matrix	**4%**
7/7	CLO-3 Able to understand the properties and solve problems	• Accuracy in determining Kronecker product of two matrix	• Non-Test : 3rd Task : 8% • Midterm: 4%	Teaching and discussion: - explanation of learning material	Teaching and discussion: - explanation of learning material	• Students read and study learning materials		• PPT • I learn (LMS Unand)	• Kronecker product • Basisc properties of	**12%**

	in Kronecker product. (**ILO**-2, PI-1, PI-2, PI-3; **ILO**-3, PI-1, PI-2, PI-3)	• Accuracy in proving basic properties of Kronecker product		- 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)	• Students do assignments independently		(Specific condition: Zoom meeting, WA group, learning video)	Kronecker product	
8	**MID-TERM EXAM**									
9	CLO-3 Able to understand the properties and solve problems in Kronecker product. (**ILO**-2, PI-1, PI-2, PI-3; **ILO**-3, PI-1, PI-2, PI-3)	Accuracy in pro ving advanced properties of Kronecker product	• Non-Test Task 6: 4% • Final exam: 6%	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%	• Students read and study learning materials • Students do assignments independently		• PPT • I learn (LMS Unand) (Specific condition: Zoom meeting, WA group, learning video)	Advanced properties of Kronecker product	**10%**

					of the total number of meetings)					
10	CLO-4 Able to understand the properties and solve problems of the operators on matrix. (**ILO**-2, PI-1, PI-2, PI-3; **ILO**-3, PI-1, PI-2, PI-3)	• Accuracy in determining operators on matrix (vec, vech, vecd, vecp) • Accuracy in proving properties of operators on matrix	• Non-Test : - • Test : Final exam: 4%	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		• PPT • I learn (LMS Unand) (Specific condition: Zoom meeting, WA group learning video)	• Vec perator • Vech operator • Vecd operator • Vecp operator	**4%**
11	CLO-4 Able to understand the properties and solve problems of the operators on matrix. (**ILO**-2, PI-1, PI-2, PI-3; **ILO**-3, PI-1, PI-2, PI-3)	• Accuracy in determining relation on vec and vech • Accuracy in determining relation on vec and vecd • Accuracy in determining relationon vec and vecp	• Non-Test : - • Test : Final exam: 4%	Teaching and discussion: - explanation of learning material - explanation of the task - explanation of the assessment [1 x 3 x 50 menit]	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)	• Relation on vec and vech • Relation on vec and vecd • Relation on vec and vecp	**4%**

					(Specific conditions: The total number of blended learning meetings is 50% of the total number of meetings)					
12	CLO-4 Able to understand the properties and solve problems of the operators on matrix. (**ILO**-2, PI-1, PI-2, PI-3; **ILO**-3, PI-1, PI-2, PI-3)	• Accuracy in determining relation on vec vech, and Kronecker product • Accuracy in determining relation vec, vecd and Kronecker product • Accuracy in determining relationon vec, vecp and Kronecker product	Non test : 4th Task : 8% Final exam: 4%%	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		• PPT • I learn (LMS Unand) (Specific condition: Zoom meeting, WA group, learning video)	• Relation on vec, vech and Kronecker product • Relation on vec, vecd and Kronecker product • Relation on vec, vecp and Kronecke r product	**12%**
13	CLO-5 Able to understand the properties and solve problems of the matrix	Accuracy in determining transformation matrix on vec and vech	• Non-Test : - • Test : Final exam: 4%	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	• Commuta tion matrix • Propertie s of commuta	**4%**

	transformation (**ILO**-2, PI-1, PI-2, PI-3; **ILO**-3, PI-1, PI-2, PI-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)			meeting, WA group, learning video)	tion matrix	
14	CLO-5 Able to understand the properties and solve problems of the matrix transformation (**ILO**-2, PI-1, PI-2, PI-3; **ILO**-3, PI-1, PI-2, PI-3)	Accuracy in determining transformation matrix on vec and vecd	• Non-Test : - • Test : Final exam: 4%	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		• PPT • I learn (LMS Unand) (Specific condition: Zoom meeting, WA group, learning video)	• Transformation matrix • Properties of transformation matrix	**4%**

15	CLO-5 Able to understand the properties and solve problems of the matrix transformation (**ILO**-2, PI-1, PI-2, PI-3; **ILO**-3, PI-1, PI-2, PI-3)	Accuracy in determining commutation matrix on vec and vecp	• Non-Test : 5th Task : 8% • Test : Final exam: 4%	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 menit] (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		• PPT • I learn (LMS Unand) (Specific condition: Zoom meeting, WA group, learning video)	• Transformation matrix • Properties of transformations matrix	**12%**
									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: 20%
   - CLO-2: 20%
   - CLO-3: 20%
   - CLO-4: 20%
   - CLO-5: 20%

Table Assesment Plan:

No.	Course Learning Outcomes	Weight (%)			
		Task (%)	Midterm (%)	Final Exam (%)	Total
1	Able to understand the properties and solve problems in specific matrix. (**ILO**-2, PI-1, PI-2, PI-3; **ILO**-3, PI-1, PI-2, PI-3)	Task 1 : 8	12		20
2	Able to understand the properties and solve problems in partition matrix. (**ILO**-2, PI-1, PI-2, PI-3; **ILO**-3, PI-1, PI-2, PI-3)	Task 2 : 8	12		20
3	Able to understand the properties and solve problems in Kronecker product. (**ILO**-2, PI-1, PI-2, PI-3; **ILO**-3, PI-1, PI-2, PI-3)	Task 3: 8	6	6	20
4	Able to understand the properties and solve problems of the operators on matrix. (ILO-2, ILO-3)	Task 4: 8		12	20
5	Able to understand the properties and solve problems of the matrix transformation (ILO-2, ILO-3)	Task 5 : 8		12	20
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			✓	✓	✓	✓	✓	✓										