SEMESTER STUDY PLAN
INTRODUCTION TO MATRIX ALGEBRA
(ELECTIVE COURSE)

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

SEMESTER STUDY PLAN (SSP)
BACHELOR PROGRAM OF MATHEMATICS
FACULTY OF MATHEMATICS AND NATURAL SCIENCES
UNIVERSITAS ANDALAS

Course Name	Course Code	URL *I-Learn*	Credits	Semester	Compilation Date
Introduction to Matrix Algebra	MAT62211	https://sci.ilearn.unand.ac.id	**3**	**4**	**May 12th, 2024**

Person in Charge	Study Plan Creator	Head of Research Group	Head of Study Program
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	Intended Learning Outcomes	
Intended Learning Outcomes (ILO) and Performance Indicator (PI)	**ILO-2**	Possesses profound knowledge of the basic concept mathematics PI-1: An ability to explain basic mathematical concepts PI-2: An ability to provide examples that are relevant to basic mathematical concepts PI-3: An ability to determine solutions to simple problems using basic mathematical concepts
	ILO-3	An ability to identify, explain and generalize simple mathematical PI-1: An ability to identify simple mathematical problems PI-2: An ability to explain simple mathematical problems PI-3: An ability to generalize simple mathematical problems
	ILO-4	An ability to use concept and fundamental technique of mathematics in solving simple mathematical problems PI-1: An ability to choose appropriate basic mathematical concepts and techniques in solving simple mathematical problems PI-2: An ability to illustrate simple mathematical problems based on appropriate basic mathematical concepts and techniques

		PI-3: An ability to solve simple mathematical problems using appropriate basic mathematical concepts and techniques
	ILO-5	An ability formally and correctly proves a simple mathematical statement using facts and methods that have been studied PI-1: An ability to identify the formal structures and analogous forms in mathematics PI-2: An ability to use fact and apply methods to proves simple mathematical statements PI-3: An ability to present simple mathematical statement proof rigorously (sequentially and conscientious) PI-4: An ability to conclude or interpret result of the proving simple mathematical statement
	Course Learning Outcomes	
	1	An ability to prove the properties of the unit matrix, transvection matrix, dilation matrix, and permutation matrix (ILO 2: PI 1, 2, 3; ILO 3: PI 1, 2)
	2	An ability to understand and prove special formulas in matrices (Hendersen Searle formula, Banacheiwicz inver formula, and Schur complement) (ILO 3: PI 1, 2, 3; ILO 4, PI 1; ILO 5, PI 1, 2, 3)
	3	An ability to factor matrices with various types of factorizations (LU factorization, Hermite factorization, full rank factorization, and singular value decomposition) (ILO 4: PI 1, 2, 3; ILO 5: PI 1, 2, 3)
	4	An ability to determine the pseudo-inverse of a matrix (left inverse, right inverse, and Moore-Penrose inverse) (ILO 4: PI 1, 2, 3; ILO 5: PI 1, 2, 3)
Brief Description	This course will provide and discuss several fundamental concepts in matrix theory. This course also provides a vehicle for students to practice creative thinking in solving problems in matrix theory. This course is given with an emphasis on giving students a lot of time to carry out problem-solving ranging from simple problems to quite complex ones.	
Course Material	1. Unit Matrix 2. Transvection Matrix 3. Dilation Matrix 4. Permutasi Matrix 5. Schur's Complement 6. Banacheiwicz Inverse Formula 7. Henderson Searle Formula 8. *LU* Dekomposition (Factorization)	

<table>
<tr><td></td><td colspan="2">9. Permutation Matrix and LU Dekomposition
10. Singular Value Decomposition
11. Eselon Hermite Form
12. Full Rank Factorization
13. Left Inverse and Right Inverse
14. Moore-Penrose Inverse</td></tr>
<tr><td>References</td><td colspan="2">Main
1. R. Piziak & P. L. Odell. 2007. Matrix Theory: From Generalized Inverses to Jordan Form, Chapman & Hall CRC, USA. https://www.pdfdrive.com/matrix-theory-from-generalized-inverses-to-jordan-form-chapman-hall-crc-pure-and-applied-mathematics-d162087962.html
Additional
2. A. B. Israel & T.N.E. Greville. 2003. Generalized Inverses: Theory and Application, 2nd ed. Springer-Verlag, New York. https://www.pdfdrive.com/generalized-inverses-theory-and-applications-d158610187.html</td></tr>
<tr><td rowspan="2">Learning Media</td><td>Software:</td><td>Hardware:</td></tr>
<tr><td>● LMS Unand (http://fmipa.ilearn.unand.ac.id/)
● Zoom meeting
● Whatsapp</td><td>● Computer/Laptop
● Smartphone</td></tr>
<tr><td>Team Teaching</td><td colspan="2">Dr. Yanita</td></tr>
<tr><td>Assessment</td><td colspan="2">Task (Homework), Quizzes, Mid-Term exam, Final exam</td></tr>
<tr><td>Required Course</td><td colspan="2">Elementary Linear Algebra</td></tr>
<tr><td>Academic Norms</td><td colspan="2">https://akademik.unand.ac.id/images/2022-03-30%20Peraturan%20Rektor%20Nomor%207%20Tahun%202022%20Penyelenggaraan%20Pendidikan-khusus%20Bab%20II.pdf</td></tr>
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Weekly Study Plan

Week / Meet (1)	Course Outcomes (2)	Indicator (3)	Assessment (4)	Activities/Forms of Learning [Time estimated]					Subject, references (10)	Weight (11)
				Synchronous*		Asynchronous**		Media (9)		
				Face to face Offline (5)	Face to face Online (6)	Individual (7)	Collaboration (7)			
1/1	Non-CLO (review matrix theory)	Accuracy in solving problems in basic matrix theory		Teaching and discussion: - explanation of learning material - explanation of the task - explanation of the assessment [1 × 3 × 50 minutes]	Teaching and discussion: - explanation of learning material - explanation of the task - explanation of the assessment [1 × 3 × 50 minutes] (Specific conditions: The total number of blended learning meetings is 40% of the total number of meetings)	Students read and study learning materials from the main and additional references [1 × 3 × 120 minutes]		• PPT • I learn (LMS Unand) (Specific condition: Zoom meeting, WA group, learning video)	• Tuition Contract • Semester Study Plan • Operations on matrix • Elementary row operations elementer • Gauss-Jordan Elimination • Determinant • Inverse matrix • Properties of inverse matrix	

2,3/2,3	CLO-1 Able to prove the properties of the unit matrix, transvection matrix, dilation matrix, and permutation matrix (ILO 2: PI 1, 2, 3; ILO 3: PI 1, 2)	• Accuracy in distinguishing between elementary matrices and non-elementary matrices. • Accuracy in determining the unit matrix Eij and proving the properties of the unit matrix. • Accuracy in determining the transvection matrix $Tij(c)$ proving the properties of the transvection matrix. • Accuracy in determining the dilation matrix $Di(c)$ proving the properties of the dilation matrix. • Accuracy in	Non test : 1st Task : 3% Test: Mid-term exam: 9%	Teaching and discussion: - explanation of learning material - explanation of the task - explanation of the assessment [$2 \times 3 \times 50$ minutes]	Teaching and discussion: - explanation of learning material - explanation of the task - explanation of the assessment [$2 \times 3 \times 50$ minutes] (Specific conditions: The total number of blended learning meetings is 40% of the total number of meetings)	● Students read and study learning materials from the main and additional references ● Students do assignments independently on: properties of unit matrix, transvection matrix, dilation matrix, permutation matrix [$2 \times 3 \times 120$ minutes]		● PPT ● I learn (LMS Unand) ● (Specific condition: Zoom meeting, WA group, learning video)	● Review Gauss Jordan elimination and Elementary Matrix ● Unit Matrix ● Transvection Matrix ● Dilation Matrix ● Permutation Matrix	12%

		determining the permutation matrix (σ) and proving the properties of the permutation matrix.								
4/4	CLO-2 Able to understand and prove special f ormulas in matrices (Hendersen Searle formula, Banacheiwicz inver formula, and Schur complement) (ILO 3: PI 1, 2, 3; ILO 4, PI 1; ILO 5, PI 1, 2, 3)	• Accuracy in calculating Schur's complement for matrix (example) $M = [1\ 2\ 6\ 5\ \ 5\ \ 3\ 4\ \ 9\ \ 4\ \ 8\ -3\ \ 13\ \ 5\ -7\ \ 2\ ]$ with different partitions • Accuracy in calculating the inverse of a matrix $M = [1\ 2\ 6\ 5\ \ 5\ \ 3\ 4\ \ 9\ \ 4\ \ 8\ -3\ \ 13\ \ 5\ -7\ \ 2\ ]$ using Banacheiwicz inverse formula	Non test : 2nd Task : 3% Test: Mid-term : 6%	Teaching and discussion: - explanation of learning material - explanation of the task - explanation of the assessment [1 × 3 × 50 minutes]	Teaching and discussion: - explanation of learning material - explanation of the task - explanation of the assessment [1 × 3 × 50 minutes] (Specific conditions: The total number of blended learning meetings is 40% of the total number of meetings)	• Students read and study learning materials from the main and additional references • Students do assign-ments indepen-dently on: calculating Schur's comple-ment and calculating the inverse using Banachei-wicz inverse formula [1 × 3 × 120 minutes]		• PPT • I learn (LMS Unand) • (Specific condition: Zoom meeting, WA group, learning video)	• Schur's Complement • Banacheiwicz Inverse Formula	9%
5/5	CLO-2 Able to understand and	• Accuracy in proving the Hendersen	Non test : 3rd Task : 4%	Teaching and discussion:	Teaching and discussion:	• Students read and study		• PPT	Henderson Searle Formula	9%

	prove special formulas in matrices (Hendersen Searle formula, Banacheiwicz inver formula, and Schur complement) (ILO 3: PI 1, 2, 3; ILO 4, PI 1; ILO 5, PI 1, 2, 3)	Searle formula • Accuracy in proving Hendersen Searle's Corollary formula	Test: Mid-term exam : 5%	- explanation of learning material - explanation of the task - explanation of the assessment [1 × 3 × 50 minutes]	- explanation of learning material - explanation of the task - explanation of the assessment [1 × 3 × 50 minutes] (Specific conditions: The total number of blended learning meetings is 40% of the total number of meetings)	learning materials from the main and additional references • Students do assign-ments independently on: Henderson Searle formula (Corollary Henderson Searle Formula) [1 × 3 × 120 minutes]		• I learn (LMS Unand) • (Specific condition: Zoom meeting, WA group, learning video)		
6/6	CLO-1 Able to prove the properties of the unit matrix, transvection matrix, dilation matrix, and permutation matrix (ILO 2: PI 1, 2, 3; ILO 3: PI 1, 2)	1st Quiz	1st Quiz : 10%	Quiz with materials: • Unit Matrix • Transvection Matrix • Dilation Matrix • Permutation Matrix [1 × 3 × 50 minutes]	Quiz with materials: • Unit Matrix • Transvection Matrix • Dilation Matrix • Permutation Matrix [1 × 3 × 50 minutes]	• Students read and study learning materials from the main and additional references • Students answer quiz questions [1 × 3 × 120 minutes]		• PPT • I learn (LMS Unand) • (Specific condition: Zoom meeting, WA group, learning video)	• Unit Matrix • Transvection Matrix • Dilation Matrix • Permutation Matrix	10%

					(Specific conditions: The total number of blended learning meetings is 40% of the total number of meetings)					
7/7	CLO-2 Able to understand and prove special fo rmulas in matrices (Hendersen Searle formula, Banacheiwicz inver formula, and Schur complement) (ILO 3: PI 1, 2, 3; ILO 4, PI 1; ILO 5, PI 1, 2, 3)	2nd Quiz	2nd Quiz : 10%	Quiz with materials: ● Hendersen Searle formula ● Schur's Complement ● Banachei-wicz Inverse Formula [1 × 3 × 50 minutes]	Quiz with materials: ● Hendersen Searle formula ● Schur's Complement ● Banachei-wicz Inverse Formula [1 × 3 × 50 minutes] [1 × 3 × 50 menit] (Specific conditions: The total number of blended learning meetings is 40% of the total	● Students read and study learning materials from the main and additional references ● Students answer quiz questions [1 × 3 × 120 minutes]		● PPT ● I learn (LMS Unand) ● (Specific condition : Zoom meeting, WA group, learning video)	● Hendersen Searle formula ● Schur's Complement ● Banacheiwicz inverse formula	10%

					number of meetings)					
8/8	**MID-TERM EXAM**									
9,10/9,10	CLO-3 Able to factor matrices with various types of factoriza-tions (LU factorization, Hermite factorization, f ull rank factorization, and singular value decomposi-tion) (ILO 4: PI 1, 2, 3; ILO 5: PI 1, 2, 3)	• Accuracy in factoring matrix $A = [\ 2\ \ 6\ 2\ -3\ -8\ 0\ \ 4\ \ 9\ 2\ ]$ become the LU matrix • Accuracy in determining solution of system of linear equation: $[-3\ 12\ -6\ 1\ -2\ 2\ 0\ 1\ 1\ ][x\ y\ z\ ] = [-33\ 7\ -1\ ]$ and $[5\ 5\ 10\ -8\ -7\ -9\ 0\ 4\ 26\ ][x\ y\ z\ ] = [0\ 1\ 4\ ]$ using LU decomposition methods • Accuracy in factoring matrix $A = [1\ 4\ 6\ 3\ 1\ 18\ 2\ 0\ 1$ using full rank factorization	Non test : 4th Task : 4% Test Final exam : 6%	Teaching and discussion: - explanation of learning material - explanation of the task - explanation of the assessment [2 × 3 × 50 minutes]	Teaching and discussion: - explanation of learning material - explanation of the task - explanation of the assessment [2 × 3 × 50 minutes] (Specific conditions: The total number of blended learning meetings is 40% of the total number of meetings)	• Students read and study learning materials from the main and additional references • Students do assign-ments independently on: – LU decomposition – Full rank factorization [2 × 3 × 120 minutes]		• PPT • I learn (LMS Unand) • (Specific condition : Zoom meeting, WA group, learning video)	• LU decomposition (Factorization) • Permutation Matrix and LU decomposition • Echelon Hermite form • Full Rank factorization	10

11/11	CLO-3 Able to factor matrices with various types of factoriza-tions (LU factorization, Hermite factorization, fu ll rank factorization, and singular value decomposi-tion) (ILO 4: PI 1, 2, 3; ILO 5: PI 1, 2, 3)	• Accuracy in diagonalizing matrices orthogonally • Accuracy in determining the singular value decomposition of the matrix	Non test : 5th Task : 3% Test Final Exam: 4%	Teaching and discussion: - explanation of learning material - explanation of the task - explanation of the assessment [1 × 3 × 50 minutes]	Teaching and discussion: - explanation of learning material - explanation of the task - explanation of the assessment [1 × 3 × 50 minutes] (Specific conditions: The total number of blended learning meetings is 40% of the total number of meetings)	• Students read and study learning materials from the main and additional references • Students do assignment independently on: singular value decomposition [1 × 3 × 120 minutes]		• PPT • I learn (LMS Unand) • (Specific condition : Zoom meeting, WA group, learning video)	• Eigen value factorization (orthogonal diagonalizatio n) • Singular value decomposition	7%
12,13/ 12,13	CLO-4 Able to determine the pseudo-inverse of a matrix (left inverse, right inverse, and Moore-Penrose inverse) (ILO 4: PI 1, 2, 3; ILO 5: PI 1, 2, 3)	• Accuracy in determining of left inverse of matrix $A = [1\ 0\ 1\ 0\ 1\ 1\ 0\ 0\ 1$ and right inverse of matrix $A = [1\ 0\ 1\ \ 0\ 1\ 0\ \ 0\ 1$ • Accuracy in determining of	Non test : 6th Task: 3% Test Final exam : 10%	Teaching and discussion: - explanation of learning material - explanation of the task - explanation of the assessment [2 × 3 × 50 minutes]	Teaching and discussion: - explanation of learning material - explanation of the task - explanation of the assessment	• Students read and study learning materials from the main and additional references • Students do assignment independently on: calculating		• PPT • I learn (LMS Unand) • (Specific condition : Zoom meeting, WA group,	• Left inverse • Right inverse • Moore-Penrose inverse • Properties of Moore-Penrose inverse	**13%**

		Moore-Penrose of matrix $A = [1\ 4\ 6\ 3\ 1\ 18\ 2\ 0$			[2 × 3 × 50 minutes] (Specific conditions: The total number of blended learning meetings is 40% of the total number of meetings)	pseudo-inverse (left and right inverse, Moore-Penrose inverse and its properties [2 × 3 × 120 minutes]		learning video)		
14/14	CLO-3 Able to factor matrices with various types of factorizations (LU factorization, Hermite factorization, full rank factorization, and singular value decomposition) (ILO 4: PI 1, 2, 3; ILO 5: PI 1, 2, 3)	3rd Quiz	3rd Quiz : 10%	Quiz with materials: ● LU decomposition (Factorization) ● Permutation Matrix and LU decomposition ● Echelon Hermite form ● Full Rank factorization ● Eigen value factorization (orthogonal diagonalization) ● Singular value	Quiz with materials: ● LU decomposition (Factorization) ● Permutation Matrix and LU decomposition ● Echelon Hermite form ● Full Rank factorization ● Eigen value factorization (orthogonal	● Students read and study learning materials from the main and additional references ● Students answer quiz questions [1 × 3 × 120 minutes]		● PPT ● I learn (LMS Unand) ● (Specific condition : Zoom meeting, WA group, learning video)	● LU decomposition (Factorization) ● Permutation Matrix and LU decomposition ● Echelon Hermite form ● Full Rank factorization ● Eigen value factorization (orthogonal diagonalization) ● Singular value decomposition	**10%**

				decomposi-tion [1 × 3 × 50 minutes]	diagonaliza-tion) ● Singular value decomposi-tion [1 × 3 × 50 minutes] (Specific conditions: The total number of blended learning meetings is 40% of the total number of meetings)					
15/15	CLO-4 Able to determine the pseudo-inverse of a matrix (left inverse, right inverse, and Moore-Penrose inverse) (ILO 4: PI 1, 2, 3; ILO 5: PI 1, 2, 3)	4th Quiz	4th Quiz: 10%	Quiz with material: ● Left and right inverse ● Moore-Penrose inverse ● Properties of Moore-Penrose inverse [1 × 3 × 50 minutes]	Quiz with material: ● Left and right inverse ● Moore-Penrose inverse ● Properties of Moore-Penrose inverse	● Students read and study learning materials from the main and additional references ● Students answer quiz questions [1 × 3 × 120 minutes]		● PPT ● I learn (LMS Unand) ● (Specific condition : Zoom meeting, WA group, learning video)	● Left and right inverse ● Moore-Penrose nverse ● Properties of Moore-Penrose inverse	**10%**

					[1 × 3 × 50 minutes] (Specific conditions: The total number of blended learning meetings is 40% of the total number of meetings)					
									Total Weight	100%
16/16	**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)	20
4	Quizzes	20
TOTAL		**100**

2. Assessment weight for Intended Learning Outcome
   - CLO-1: 23 %
   - CLO-2: 27 %
   - CLO-3: 27 %
   - CLO-4: 23 %

Assessment Plan Table:

No.	Course Learning Outcomes	Assessment				Weight (%)
		Task (%)	Quiz (%)	Mid-term Exam (%)	Final Exam (%)	
1	An ability to prove the properties of the unit matrix, transvection matrix, dilation matrix, and permutation matrix (ILO 2: PI 1, 2, 3; ILO 3: PI 1, 2)	1st Task : 3	1st Quiz : 5	15		23
2	An ability to understand and prove special formulas in matrices (Hendersen Searle formula, Banacheiwicz inver formula, and Schur complement) (ILO 3: PI 1, 2, 3; ILO 4, PI 1; ILO 5, PI 1, 2, 3)	2nd Task : 3 3rd Task : 4	2st Quiz : 5	15		27
3	An ability to factor matrices with various types of factorizations (LU factorization, Hermite factorization, full rank factorization, and singular value decomposition) (ILO 4: PI 1, 2, 3; ILO 5: PI 1, 2, 3)	4th Task : 4 5th Task : 3	3rd Quiz : 5		15	27
4	An ability to determine the pseudo-inverse of a matrix (left inverse, right inverse, and Moore-Penrose inverse) (ILO 4: PI 1, 2, 3; ILO 5: PI 1, 2, 3)	6th Task : 3	4th Quiz : 5		15	23
	Total	**20**	**20**	**30**	**30**	**100**

Task / Homework	About
1	Student do assignment individually about properties of unit matrix, transvection matrix, dilation matrix, and permutation matrix
2	Student do assignment individually about calculating Schur's complement, and determining inverse matrix using Banacheiwicz inverse methods
3	Student do assignment individually about proving Corollary of Henderson Searle formula
4	Student do assignment individually about: – LU decomposition – full rank factorization
5	Student do assignment individually about: singular value decomposition
6	Student do assignment individually about determining pseudo-inverse (left and right inverse, Moore-Penrose inverse, and properties of Moore-Penrose inverse

Matrix of CLO and ILO

CLO	ILO																															
	1			2			3			4			5				6					7			8				9			
	PI			PI			PI			PI			PI				PI					PI			PI				PI			
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	4	1	2	3	4	5	1	2	3	1	2	3	4	1	2	3	4

1				□	□	□	□	□																							
2							□	□	□	□			□	□	□																
3										□	□	□		□	□																
4										□	□	□	□	□	□																