SEMESTER STUDY PLAN
INTRODUCTION TO FUNCTIONAL ANALYSIS
(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 Functional Analysis	MAT62224	https://sci.ilearn.unand.ac.id	3	6	14 May 2024

Person In Charge	Study Plan Creator	Head of Research Group	Head of Study Program
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Intended Learning Outcomes (ILO) and Performance Indicator (PI)	Intended Learning Outcomes	
	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 to formally and correctly proves a simple mathematical statements using facts and methods that have been studied. PI-1: An ability to identify formal structures and analogous forms in mathematics PI-2: An ability to use facts and apply methods to prove 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
	ILO-9	An ability to apply knowledge of mathematics in career and involve in life long learning PI-1: An ability to carry out learning independently to deepen and expand the knowledge that has been obtained
	Course Learning Outcomes	
	1	Ability to master the basic concepts of inner product spaces, Hilbert spaces, normed spaces, Banach spaces, metric spaces, functionals and operators, as well as their related properties. (**ILO-2**: PI-1, PI-2, PI-3)
	2	Ability to apply the basic properties learned in solving problems related to this course material. (**ILO-4**: PI-1, PI-2, PI-3)
	3	Ability to generalizing problems related to the subject matter of this course. (**ILO-3**: PI-1, PI-2, PI-3)
	4	Ability to identifying the formal structure of statements related to the course material and their analogous forms. (**ILO-5**: PI-1-4)
	5	Ability to mastery of fundamental techniques necessary for problem-solving within the scope of this course material. (**ILO-4**: PI-1, PI-2, PI-3)
	6	Ability to independently solve problems related to functional Analysis. (**ILO-9**: PI-1)
Brief Description	In this course, basic theory about vector spaces, inner product spaces, Hilbert spaces, normed spaces, Banach spaces, metric spaces, as well as some related theories, functionals, and operators are explained. The study of introductory functional analysis is limited to definitions, examples, and properties contained within inner product spaces, normed spaces, and metric spaces. Therefore, the prerequisite material required is what has been obtained in the Real Analysis 1 course. The initial discussion in this course covers sets and vector spaces, inner product spaces, norms (convergence and completeness), metric spaces (definitions and examples of metrics), open and closed sets, continuous mappings, and several applications in the form of theorems, examples, and related properties. To enhance student understanding, this course also includes quizzes and assignments, both group and individual work.	

Course Materials	Set theory, vector space, inner product space, Hilbert space, normed space, Banach space, metric space, functionals and operators, and related properties.	
References	**Main:** 1. E. Kreyszig. (1978). *Introductory Functional Analysis with Application.* John & Wiley, New York **Additional:** 2. N. Young. (1988). *An Introduction to Hilbert Space*. Cambridge University Press	
Learning Media	**Software:**	**Hardware:**
	• LMS Unand (http://fmipa.ilearn.unand.ac.id/) • Zoom meeting • Whatsapp	• Computer/Laptop • Smartphone
Team Teaching	1. Dr. Shelvi Ekariani 2. Dr. Haripamyu	
Assessment	Homework, Quizzes, Mid-Term exam, Final exam	
Required courses	Introduction to Mathematics, Calculus 3	
Academic Norms	https://akademik.unand.ac.id/images/2022-03-30%20Peraturan%20Rektor%20Nomor%207%20Tahun%202022%20Penyelenggaraan%20Pendidikan-khusus%20Bab%20II.pdf	

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 (8)			
1	CLO-1 Ability to master the basic concepts of inner product spaces, Hilbert spaces, normed spaces, Banach spaces, metric spaces, functionals and operators, as well as their related properties. (**ILO-2**: PI-	• Discipline in carrying out the course contract. • Accuracy in understandin g related material.	Non test Test Mid-Term exam: 3%	Teaching and discussion: - Explanation of Semester Learning Plan - explanation of learning material - explanation of the task - explanation of the assessment [1 × 3 × 50 minutes]	Teaching and discussion: - Explanation of Semester Learning Plan - 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 related to real number systems and their properties [1 × 3 × 120 minutes]		• PPT • I learn (LMS Unand) • (Specific condition: Zoom meeting, WA group, learning video)	• Course Introduction • Definition, properties, and examples of sets and vector spaces References: Main Reference 1.	3%

	1, PI-2, PI-3)									
2	CLO-1 Ability to master the basic concepts of inner product spaces, Hilbert spaces, normed spaces, Banach spaces, metric spaces, functionals and operators, as well as their related properties.	• Accuracy in understanding related material • Accuracy in answering assignment questions • Neatness in completing assignments • Originality of assignment results	Non test: Test Mid-Term exam: 7%	Lectures and discussions [1 × 3 × 50 minutes]		Students read and study materials from the main reference and others. [1×3×120 minutes]		• PPT • I learn (LMS Unand) • (Specific condition: Zoom meeting, WA group, learning video)	• Definition of normed space • Examples of normed spaces • Properties of normed spaces • Definition of Banach space Reference: Main Reference 1.	7%

	(**ILO-2**: PI-1, PI-2, PI-3) CLO-2 Ability to apply the basic properties learned to solve problems related to the course material. (**ILO-4**: PI-1, PI-2, PI-3)									
3-4	CLO-2 Ability to apply the basic properties learned to solve problems related to the course material. (**ILO-4**: PI-1, PI-2, PI-3)	• Accuracy in understanding related material • Accuracy in answering assignment questions • Neatness in completing assignments	Non test: Test Mid-Term exam: 3%	Lectures and discussions [1 × 3 × 50 minutes]		Students read and study materials from the main reference and others. [1 × 3 × 120 minutes]		• PPT • I learn (LMS Unand) • (Specific condition: Zoom meeting, WA group, learning video)	• Definition of linear operator • Examples of linear operators • Continuity and boundedness properties of	3%

		• Originality of assignment results							linear operators Reference: Main Reference 1.	
5	CLO-2 Ability to apply the basic properties learned to solve problems related to the course material. (**ILO-4**: PI-1, PI-2, PI-3) CLO-4 Ability to identifying the formal structure of statements related to the course	• Accuracy in understanding related material • Accuracy in answering assignment questions • Neatness in completing assignments • Originality of assignment results	Non test: Test: Mid-Term exam: 5%	Lectures and discussions [1 × 3 × 50 minutes]		Students read and study materials from the main reference and others [1 × 3 × 120 minutes]		• PPT • I learn (LMS Unand) • (Specific condition: Zoom meeting, WA group, learning video	• Definition of linear functional • Examples of linear functionals • Properties of linear functionals Reference: Main Reference 1.	5%

	material and their analogous forms. (**ILO-5**: PI-1-4)									
6	CLO-3 Ability to generalizing problems related to the subject matter of this course. (**ILO-3**: PI-1, PI-2, PI-3)	● Accuracy in understanding related material ● Accuracy in answering assignment questions ● Neatness in completing assignments ● Originality of assignment results	Non test: Test Mid-Term exam: 5%	Lectures and discussions [1 × 3 × 50 minutes]		Students read and study materials from the main reference and others [1 × 3 × 120 minutes]		● PPT ● I learn (LMS Unand) ● (Specific condition: Zoom meeting, WA group, learning video)	● Linear operators on finite-dimensional spaces Reference: Main Reference 1.	5%
7	CLO-3 Ability to generalizing problems related to the subject matter of this course.	● Accuracy in understanding related material ● Accuracy in answering assignment questions	Non test: Test Mid-Term exam: 7%	Lectures and discussions [1 × 3 × 50 minutes]		Students read and study materials from the main reference and others [1 × 3 × 120 minutes]		● PPT ● I learn (LMS Unand) ● (Specific condition: Zoom meeting, WA group,	● Norm space of operators ● Dual space ● Related properties	7%

	(**ILO-3**: PI-1, PI-2, PI-3) CLO-4 Ability to identifying the formal structure of statements related to the course material and their analogous forms. (**ILO-5**: PI-1-4)	• Neatness in completing assignments • Originality of assignment results						learning video)		
8	**MID-TERM EXAM**									
9	CLO-2 Ability to apply the basic properties learned to solve problems related to the course material.	• Accuracy in understanding related material • Accuracy in answering assignment questions • Neatness in completing assignments	Non test : Test Final exam: 7% Quizzes: 3%	Lectures and discussions [1 × 3 × 50 minutes]		Students read and study materials from the main reference and others [1 × 3 × 120 minutes]		• PPT • I learn (LMS Unand) • (Specific condition: Zoom meeting, WA group, learning video)	• Definition of inner product space • Examples of inner product spaces • Related properties	**10%**

	(**ILO-4**: PI-1, PI-2, PI-3) CLO-4 Ability to identifying the formal structure of statements related to the course material and their analogous forms. (**ILO-5**: PI-1-4)	● Originality of assignment results							● Definition of Hilbert space Reference: Main Reference 1.	
10	CLO-2 Ability to apply the basic properties learned to solve problems related to the course material.	● Accuracy in understanding related material ● Accuracy in answering assignment questions	Non test: Test Final exam: 2%	Lectures and discussions [1 × 3 × 50 minutes]		Students read and study materials from the main reference and others [1 × 3 × 120 minutes]		● PPT ● I learn (LMS Unand) ● (Specific condition: Zoom meeting, WA group, learning video)	● Definition of orthogonal complement ● Definition of direct sum ● Examples and related properties	**2%**

	(**ILO-4**: PI-1, PI-2, PI-3)	• Neatness in completing assignments • Originality of assignment results								
11	CLO-2 Ability to apply the basic properties learned to solve problems related to the course material. (**ILO-4**: PI-1, PI-2, PI-3)	• Accuracy in understanding related material • Accuracy in answering assignment questions • Neatness in completing assignments • Originality of assignment results	Non test: Test Final exam: 1%	Lectures and discussions [1 × 3 × 50 minutes]		Students read and study materials from the main reference and others [1 × 3 × 120 minutes]		• PPT • I learn (LMS Unand) • (Specific condition: Zoom meeting, WA group, learning video)	• Definition of orthonormal set • Examples and related properties	**1%**
12	CLO-1 Ability to master the basic concepts of inner product	• Accuracy in understanding related material • Accuracy in answering assignment questions	Non test: Test Final exam: 5%	Lectures and discussions [1 × 3 × 50 minutes]		Students read and study materials from the main reference and others [1 × 3 × 120 minutes]		• PPT • I learn (LMS Unand) • (Specific condition: Zoom meeting,	Definition of a contractive mapping and definition of a fixed point	**5%**

	spaces, Hilbert spaces, normed spaces, Banach spaces, metric spaces, functionals and operators, as well as their related properties. (**ILO-2**: PI-1, PI-2, PI-3)	• Neatness in completing assignments • Originality of assignment results						WA group, learning video)		
13	CLO-4 Ability to identifying the formal structure of statements related to the course material	• Accuracy in understanding related material • Accuracy in answering assignment questions	Non test: Test Final exam: 5% Quizzes: 2%	Lectures and discussions [1 × 3 × 50 minutes]		Students read and study materials from the main reference and others [1 × 3 × 120 minutes]		• PPT • I learn (LMS Unand) • (Specific condition: Zoom meeting, WA group,	Banach Fixed Point Theorem	**7%**

	and their analogous forms. (**ILO-5**: PI-1-4)	• Neatness in completing assignments • Originality of assignment results						learning video)		
14	CLO-5 Ability to mastery of fundamental techniques necessary for problem-solving within the scope of this course material. (**ILO-4**: PI-1, PI-2, PI-3) CLO-6 Ability to independen	• Accuracy in understanding related material • Accuracy in answering assignment questions • Neatness in completing assignments • Originality of assignment results	Non test: Homework: 15% Test Final exam: 5% Quizzes: 5%	Lectures and discussions [1 × 3 × 50 minutes]		Students read and study materials from the main reference and others [1 × 3 × 120 minutes]		• PPT • I learn (LMS Unand) • (Specific condition: Zoom meeting, WA group, learning video)	• Examples of mappings with fixed points • Application of the Banach fixed-point theorem	**25%**

	tly solve problems related to functional Analysis. (**ILO-9**: PI-1)									
15	CLO-5 Ability to mastery of fundamental techniques necessary for problem-solving within the scope of this course material. (**ILO-4**: PI-1, PI-2, PI-3) CLO-6 Ability to independently solve	• Accuracy in understanding related material • Accuracy in answering assignment questions • Neatness in completing assignments • Originality of assignment results	Non test: Homework: 10% Test Final exam: 5% Quizzes: 5%	Lectures and discussions [1 × 3 × 50 minutes]		Students read and study materials from the main reference and others [1 × 3 × 120 minutes]		• PPT • I learn (LMS Unand) • (Specific condition: Zoom meeting, WA group, learning video)	• Examples of mappings with fixed points • Application of the Banach fixed-point theorem	**20%**

	problems related to functional Analysis. (**ILO-9**: PI-1)									
									Total Weight	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	Homework	25

4	Quizzes	15
TOTAL		**100**

2. Assessment weight for Intended Learning Outcome
   - CLO-1: 10 %
   - CLO-2: 15 %
   - CLO-3: 10 %
   - CLO-4: 20 %
   - CLO-5: 20 %
   - CLO-6: 25%

Assessment Plan Table:

No.	CLO	Assessment				Weight (%)
		Homework (%)	Quizzes (%)	Mid-Term Exam (%)	Final Exam (%)	
1	Ability to master the basic concepts of inner product spaces, Hilbert spaces, normed spaces, Banach spaces, metric spaces, functionals and operators, as			5	5	10

	well as their related properties. (**ILO-2**: PI-1, PI-2, PI-3)					
2	Ability to apply the basic properties learned to solve problems related to the course material. (**ILO-4**: PI-1, PI-2, PI-3)			10	5	15
3	Ability to generalizing problems related to the subject matter of this course. (**ILO-3**: PI-1, PI-2, PI-3)			10		10
4	Ability to identifying the formal structure of statements related to the course material and their analogous forms. (**ILO-5**: PI-1-4)		Quizzes: 5	5	10	20
5	Ability to mastery of fundamental techniques necessary for problem-solving within the scope of this course material. (**ILO-4**: PI-1, PI-2, PI-3)		Quizzes: 10		10	20
6	Ability to independently solve problems related to functional Analysis. (**ILO-9**: PI-1)	Homework: 25				25
	Total	**25**	**15**	**30**	**30**	**100**

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													□	□	□	□																
5										□	□	□																				
6																													□			