SEMESTER STUDY PLAN
INTRODUCTION TO DYNAMICAL SYSTEMS
(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 Dynamical Systems	MAT62243	https://sci.ilearn.unand.ac.id	3	6	12 May 2024

Person In Charge	Study Plan Creator	Head of Research Group	Head of Study Program
	Dr. Arrival Rince Putri	Dr. Ahmad Iqbal Baqi	Dr. Noverina Alfiany

	Intended Learning Outcomes	
Intended Learning Outcomes (ILO) and Performance Indicator (PI)	**ILO-1**	Possesses a good ethics and integrity PI-1: An ability to explain academic ethics and integrity PI-2: An ability to act in accordance with academic ethics PI-3: An ability to act in accordance with academic integrity
	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-6	Have ability data literacy and technology and can apply them in solving simple mathematical problems or other relevant fields PI-1: An ability to identify the right data and technology to solve simple mathematical problems or other fields

		PI-2: An ability to use data and technology and apply them to solve simple mathematical statements or other areas PI-3: An ability to process data using availAn ability technology in simple mathematical problems or other fields PI-4: An ability to conclude and interpret data processing results for simple mathematical problems or other fields PI-5: An ability to design an algorithm to solve simple mathematical problems or other fields
	ILO-7	An ability to communicate effectively especially in the area of mathematics in with diverse communities PI-1: An ability to convey ideas or study results orally, especially in the field of mathematics PI-2: An ability to present ideas or study results in writing, especially in the field of mathematics PI-3: An ability to respond to feedback given
	ILO-8	An ability to work in team PI-1: An ability to actively participate in a team with full responsibility PI-2: An ability to respond well to any feedback within the team PI-3: An ability to complete tasks according to the set schedule PI-4: An ability to adapt in a team
	Course Learning Outcomes	
	1	An ability to use fundamental mathematical concepts for one-dimensional and two-dimensional linear systems, as well as nonlinear systems (ILO-1:PI-1, PI-2; ILO-4:PI-1).
	2	An ability to identify types of phase portraits for linear and nonlinear systems (ILO-1:PI-1, PI-2; ILO-4:PI-2).
	3	An ability to analyze the stAn ability of linear and nonlinear systems (ILO-1:PI-1, PI-2; ILO-4:PI-1, PI-2).
	4	An ability to explain the physical aspects and interpret phase portraits of systems related to real-world problems (ILO-1:PI-1, PI-2; ILO-6: PI-1; ILO-7:PI-1, PI-2; ILO-8).
Brief Description	This course is an elective course that covers one-dimensional linear equations and systems of equations, two-dimensional dynamic systems, phase portraits, nonlinear systems of equations, and equilibrium solutions along	

	with their stability/linearization. The course employs the Case-Based Method (CBM) of learning, where students understand and solve cases related to the learned material.
Course Materials	1. Review of Differential Equations 2. Differential Equations - One-Dimensional Linear Systems 3. Two-Dimensional Dynamical Systems 4. Phase Portraits 5. Differential Equations – Non-Linear Systems
References	**Main:** 1. M. W. Hirsch, Differential Equations, Dynamical Systems, and Introduction to Chaos, Elsevier, 2004. 2. W. E. Boyce dan R. C. DiPrima, Elementary Differential Equations and Boundary Value Problems, John Wiley & Sons, 2009. **Additional:** 3. Lynch, S. 2007. Dynamical System With Applications Using Mat ematica. Boston: Birkhauser.
Learning Media	**Software:** ● LMS Unand (http://fmipa.ilearn.unand.ac.id/) ● Zoom meeting ● Whatsapp **Hardware:** ● Computer/Laptop ● Smartphone
Team Teaching	1. Dr. Arrival Rince Putri 2. Dr. Noverina Alfiany
Assessment	-
Required courses	MAT61142 Ordinary Differential Equation
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	An ability to understand the RPS (Course Implementation Plan), Syllabus, Assessment Rules, and Course Contract.	• Discipline in adhering to the course contract.		Teaching and discussion: • Introduction to Course Outline (RPS). Explanation of Assignments and Group Assignment Distribution. Instructor Provides Several Examples [1 x 3 x 50 minutes]		• Students search for references and study the course material. • Students discuss in groups about the course material and the upcoming assignments [1 x 3 x 120 minutes]		• LMS (ilearn UNAND)	• Assessment Criteria, Syllabus, Course Outline, and Learning Contract	

2	CLO-1, CLO-4 An ability to use fundamental mathematical concepts for one-dimensional and two-dimensional linear systems, as well as nonlinear systems CLO-1, CLO-6, CLO-7, CLO-8 An ability to explain the physical aspects and interpret phase portraits of systems related to real-world problems	• Accuracy in understanding the relevant material	Group report (10%)	• Group presentation • Discussion and question and answer on course material and group assignments [1 x 3 x 50 minutes]		• Students search for references and study the course material. • Students discuss within groups about the course material and upcoming assignments. [1 x 3 x 120 minutes]		• LMS (ilearn UNAND)	• Basic concepts of ODE and dynamic systems • Examples • Application problems [1, 2]	10%
3	CLO-1, CLO-4 An ability to use fundamental mathematical concepts for	• Accuracy in understanding the relevant material	Test: Mid-term exam: 5%	Lecture: • The lecturer provides several case examples related to the		• Students search for references and study the course material.		• LMS (ilearn UNAND)	• General form of a one-dimensional linear	5%

	one-dimensional and two-dimensional linear systems, as well as nonlinear systems			topic of one-dimensional linear dynamic systems and logistic growth models. • The lecturer poses several challenging questions to encourage students to think about how to solve the given cases. • The student groups are asked to find their own relevant cases related to logistic growth models and solve the problems to discuss within their respective groups.		• Students discuss within groups about the course material and upcoming assignments [1 x 3 x 120 minutes]			dynamic system • Logistic growth model [1, 2]	

				• Discussion and Q&A session on course material and assignments. [$1 \times 3 \times 50$ minutes]						
4	CLO-1, CLO-4 An ability to apply basic mathematical concepts to one-dimensional and two-dimensional linear systems, as well as nonlinear systems CLO-1, CLO-6, CLO-7, CLO-8 An ability to explain the physical aspects and interpret phase portraits of systems related to real-	• Accuracy in understanding the relevant material	Non test: Group report: 10%	• Group presentation • Discussion and Q&A on course materials and group assignments [1 x 3 x 50 minutes]		• Students search for references and study learning materials. • Students engage in group discussions about course materials and upcoming assignments [1 x 3 x 120 minutes]		• LMS (ilearn UNAND)	Continuation of one-dimensional linear dynamical systems. [1,2]	10%

	world problems									
5	CLO-1, CLO-2, CLO-4 An ability to apply basic mathematical concepts to one-dimensional and two-dimensional linear systems, as well as nonlinear systems	• Accuracy in understanding the relevant material	Test: Mid-term exam: 5%	Lecture: • The lecturer provides several case examples related to the topic of planar systems. • The lecturer poses challenging questions to encourage students to think about how to solve the given cases. • Student groups are asked to find their own relevant cases related to planar systems and discuss them within their respective groups.		• Students search for references and study learning materials. • Students engage in group discussions about course materials and upcoming assignments [1 x 3 x 120 minutes]		• LMS (ilearn UNAND)	• Second-order differential equation • Dynamical systems in two dimensions • Planar systems • Characteristic equations [1,3]	5%

				• Discussion and question-answer session on the lecture material and assignments. [*1* × *3* × *50* minutes]						
6	CLO-1, CLO-4 An ability to identify types of phase portraits for linear and nonlinear systems CLO-1, CLO-6, CLO-7, CLO-8 An ability to explain the physical aspects and interpret phase portraits of systems related to real-world problems	• Accuracy in understanding the relevant material	Non test: Group report: 10%	• Group presentation • Discussion and Q&A on course materials and group assignments [1 x 3 x 50 minutes]		• Students search for references and study learning materials. • Students engage in group discussions about course materials and upcoming assignments [1 x 3 x 120 minutes]		• LMS (ilearn UNAND)	• Phase portraits for distinct real eigenvalues [1,3]	10%

7	CLO-1, CLO-4 An ability to identify different types of phase portraits for linear and nonlinear systems	• Accuracy in understanding the relevant material	Test: Mid-term exam: 10%	Lecture: • The lecturer provides several case examples related to the phase portrait topic. • The lecturer poses challenging questions to encourage students to think about how to solve the given cases. • Student groups are asked to find their own relevant cases related to phase portraits and discuss them within their respective groups. • Discussion and Q&A on lecture		• Students search for references and study learning materials. • Students engage in group discussions about course materials and upcoming assignments [1 x 3 x 120 minutes]		• LMS (ilearn UNAND)	• Phase portrait for complex eigenvalues • Phase portrait for real repeated eigenvalues [1,3]	10%

				material and assignments [1 x 3 x 50 minutes]						
8	**MID-TERM EXAM**									
9	CLO-1, CLO-4 An ability to identify the types of phase portraits for linear and nonlinear systems CLO-1, CLO-6, CLO-7, CLO-8 An ability to explain the physical aspects and interpret the phase portraits of systems related to real-world problems	• Accuracy in understanding the relevant material	Non test: Group report: 10%	• Group presentation • Discussion and Q&A on course materials and group assignments [1 x 3 x 50 minutes]		• Students search for references and study learning materials. • Students engage in group discussions about course materials and upcoming assignments [1 x 3 x 120 minutes]		• LMS (ilearn UNAND)	• Reviewing phase portraits • Trace-determinant plane [1,3]	10%
10	CLO-1, CLO-4 An ability to identify the types of phase portraits for linear and	• Accuracy in understanding the relevant material	Test: Final exam: 5%	Lecture: • The lecturer provides several case examples related to the		• Students search for references and study learning materials.		• LMS (ilearn UNAND)	• Coordinate transformation for systems with	5%

	nonlinear systems			course topic of coordinate transformation ● The lecturer poses challenging questions to encourage students to think about how to solve the given cases. ● The student groups are asked to find their own relevant cases related to coordinate transformations and solve the problems for discussion within their respective groups. ● Discussion and Q&A on lecture material and assignments		● Students engage in group discussions about course materials and upcoming assignments [1 x 3 x 120 minutes]			distinct real eigenvalues [1, 3]	

				[1 x 3 x 50 minutes]						
11	CLO-1, CLO-4 An ability to identify the types of phase portraits for linear and nonlinear systems CLO-1, CLO-6, CLO-7, CLO-8 An ability to explain the physical aspects and interpret the phase portraits of systems related to real-world problems	• Accuracy in understanding the relevant material	Non test: Group report: 10%	• Group presentation • Discussion and Q&A on course materials and group assignments [1 x 3 x 50 minutes]		• Students search for references and study learning materials. • Students engage in group discussions about course materials and upcoming assignments • [1 x 3 x 120 minutes]		• LMS (ilearn UNAND)	• Coordinate transformation for systems with complex eigenvalues and repeated real eigenvalues [1,3]	10%
12	CLO-1, CLO-4 An ability to analyze the stability of linear and nonlinear systems	• Accuracy in understanding the relevant material	Test: Final exam: 5%	Lecture: • The lecturer provides several case examples related to the lecture topic of canonical		• Students search for references and study learning materials. • Students engage in		• LMS (ilearn UNAND)	• Canonical Form • Manifold [1,3]	5%

				forms and manifolds. ● The lecturer poses challenging questions to encourage students to think about how to solve the given cases. ● The student groups are asked to find their own relevant cases related to canonical forms and manifolds and discuss them within their respective groups.Discussion and Q&A on lecture material and assignments [1 x 3 x 50 minutes]		group discussions about course materials and upcoming assignments - [1 x 3 x 120 minutes]				

13	CLO-1, CLO-4 An ability to analyze the stability of linear and nonlinear systems CLO-1, CLO-6, CLO-7, CLO-8 An ability to explain physical aspects and interpret phase portraits of systems related to real-world problems	• Accuracy in understanding the relevant material	Non test: Group report: 10%	• Group presentation • Discussion and Q&A on course materials and group assignments [1 x 3 x 50 minutes]		• Students search for references and study learning materials. • Students engage in group discussions about course materials and upcoming assignments [1 x 3 x 120 minutes]		• LMS (ilearn UNAND)	• Stable and Unstable Manifolds [1,3]	10%
14	CLO-1, CLO-4 An ability to analyze the stability of linear and nonlinear systems	• Accuracy in understanding the relevant material	Test: Final exam: 10%	Lecture: • The lecturer provides several case examples related to the lecture topic of nonlinear systems. • The lecturer poses challenging		• Students search for references and study learning materials. • Students engage in group discussions about course materials and		• LMS (ilearn UNAND)	• Linearization • Stability of Nonlinear Systems [1,3]	10%

				questions to encourage students to think about how to solve the given cases. ● The student groups are asked to find their own relevant cases related to canonical forms and manifolds and discuss them within their respective groups.Discussion and Q&A on lecture material and assignments [1 x 3 x 50 minutes]		upcoming assignments [1 x 3 x 120 minutes]				
15	CLO-1, CLO-6, CLO-7, CLO-8 An ability to explain the physical aspects and interpret the	● Accuracy in understanding the relevant material	Non test: Group report	● Group presentation ● Discussion and Q&A on course materials		● Students search for references and study learning materials.		● LMS (ilearn UNAND)	● Review of material	

	phase portraits of systems related to real-world problems			and group assignments [1 x 3 x 50 minutes]		• Students engage in group discussions about course materials and upcoming assignments [1 x 3 x 120 minutes]				
									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	20
2	Final Exam	20
3	Group Report	60
TOTAL		**100**

2. Assessment weight for Intended Learning Outcome
   - CLO-1: 20 %
   - CLO-2: 20 %
   - CLO-3: 20 %
   - CLO-4: 40 %

Assessment Plan Table:

No.	CLO	Assessment			Weight (%)
		Mid-Term Exam (%)	Final Exam (%)	Group Report (%)	
1	Students can use basic mathematical concepts for one-dimensional and two-dimensional linear systems, as well as nonlinear systems. (ILO-1:PI-1,PI-2; ILO-4:PI-1)	10%		10%	20%
2	Students can identify various types of phase portraits of linear and nonlinear systems.(ILO-1:PI-1, PI-2; ILO-4:PI-2)	10%		10%	20%
3	Students can analyze the stability of linear and nonlinear systems. (ILO-1:PI-1, PI-2; ILO-4:PI-1, PI-2)		10%	10%	20%
4	Students can explain physical aspects and interpret phase portraits of systems related to real-world problems. (ILO-1:PI-1, PI-2; ILO-6:PI-1; ILO-7:PI-1; ILO-7:PI-1, PI-2; ILO-8)		10%	30%	40%
Total		**20**	**20**	**60**	**100**

Information:

TK: Group ask