SEMESTER STUDY PLAN
DYNAMICAL SYSTEMS
(COMPULSORY 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
Dynamical Systems	MAT82141	https://sci.ilearn.unand.ac.id	3	2	15 May 2024

Person In Charge	Study Plan Creator	Head of Research Group	Head of Study Program
	Dr. Arrival Rince Putri Prof. Muhafzan	Dr. Ahmad Iqbal Baqi	Dr. Ferra Yanuar

Intended Learning Outcomes (ILO) and Performance Indicator (PI)	**Intended Learning Outcomes**	
	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: An ability to identify theories used in related mathematical problems. PI-2: An ability to apply theories for advancement in related fields (advanced theory). PI-3: An ability 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 PI-1: An ability to apply mathematical techniques in research problem-solving. PI-2: An ability to analyze research problems. PI-3: An ability to formulate theorems/models and prove their validity. PI-4: An ability to use various mathematical software to solve complex mathematical problems.
	ILO-5	An ability 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. PI-1: Capable of formally and correctly proving mathematical statements. PI-2: An ability to employ relevant techniques for conducting research. PI-3: Capable of communicating research findings in an academic manner.
	Course Learning Outcomes	

	1	An ability to analyze a qualitative behavior of linear and nonlinear dynamical systems, including local phase portraits, limit cycles, stability, and bifurcations (ILO-3:PI-2, PI-3).
	2	An ability to use Maple or Matlab applications to illustrate An qualitative behavior of linear and nonlinear dynamical systems (ILO-1:PI-4).
	3	An ability to explain physical aspects and interpret phase portraits of systems related to real-world problems (ILO-5: PI-3).
Brief Description	This course provides the qualitative and dynamic aspects of systems of ordinary differential equations. Topics discussed include classification of linear systems, existence and uniqueness of solutions to nonlinear initial value problems, continuous dependence on initial values, Hamiltonian systems, local stability, Liapunov functions, bifurcation, higher order systems and several applications.	
Course Materials	1. Linear and nonlinear dynamic systems: planar systems and their applications 2. Limit cycle 3. Stem Hamiltonian and Lyapunov stability 4. Bifurcation theory	
References	**Main:** 1. S. Lynch, Dynamical Systems with Application Using Mathematica, Birkhause, Boston, 2007. **Additional:** 2. D. W. Jordan and P. Smith, Nonlinear Ordinary Differential Equation, Oxford University Press, New York, 2007	
Learning Media	**Software:** ● LMS Unand (http://fmipa.ilearn.unand.ac.id/) ● Zoom meeting ● Whatsapp	**Hardware:** ● Computer/Laptop ● Smartphone
Team Teaching	1. Prof. Muhafzan 2. Dr. Susila Bahri 3. Dr. Arrival Rince Putri	
Assessment	-	

Required courses	-
Academic Norms	(https://akademik.unand.ac.id/images/2022-03-30%20Peraturan%20Rector%20Number%207%20Tahun%202022%20Penelenggaraan%20Special-education%20Chapter%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 analyze the qualitative behavior of linear and nonlinear dynamic systems, which includes local phase portraits, limit cycles, stability and bifurcations	• An ability to know the subject matter, learning methods, learning outcomes, references and assessments • An ability to understand the definition of linear systems and their relationship s with a regular diff	Non test: • Student engagement (2%) • Independent assignment	Teaching and Discussion : • Introduction to RPS • Discussion and question and answer course material [1 x 3x 50 minutes]		Students search for references [1 x 6 x 60 minutes]		• LMS (ilearn UNAND)	• Assessment Rules, RPS, Syllabus, Tuition Contract • Linear system	

		press								
2	An ability to analyze the qualitative behavior of linear and nonlinear dynamic systems, which includes local phase portraits, limit cycles, stability and bifurcations	• An ability to transform linear systems to Canonical Jordan form	Test: MID-TERM EXAM: 10% Non test: Independent assignment	Teaching and Discussion : • Concept explanation • Discussion and question and answer course material [1 x 3x 50 minutes]		Students search for references [1 x 6 x 60 minutes]		• LMS (ilearn UNAND)	• Jordan's canonical form.	
3	An ability to explain physical aspects and interpret phase portraits of systems related to real problems	• An ability to analyze the stAn ability of the equilibrium point of a linear system	Test: MID-TERM EXAM: 10% Non test: Independent assignment	Teaching and Discussion : • Concept explanation • Discussion and question and answer course material		Students search for references [1 x 6 x 60 minutes]		LMS (ilearn UNAND) •	Stability of the equilibrium point of a linear system.	

				[1 x 3x 50 minutes]						
4	An ability to explain physical aspects and interpret phase portraits of systems related to real problems	• An ability to check whether a linear system has a solution or not and its uniqueness		Teaching and Discussion : • Concept explanation • Discussion and question and answer course material [1 x 3x 50 minutes]		Students search for references [1 x 6 x 60 minutes]		LMS (ilearn UNAND)	The concept of dynamic system flow and the existence and singularity of solutions.	
5	An ability to analyze the qualitative behavior of linear and nonlinear dynamic systems, which includes local phase portraits, limit cycles, stability and bifurcations	• An ability to understand evidence of continuous solution dependence on initial values and express this through examples		Teaching and Discussion : • Concept explanation • Discussion and question and answer course material [1 x 3x 50 minutes]		Students search for references [1 x 6 x 60 minutes]		LMS (ilearn UNAND)	Continuous dependence of the solution on the initial value.	
6	An ability to analyze the qualitative behavior of linear and nonlinear	• An ability to expand solutions and analyze their stAn ability	Independent assignment	Teaching and Discussion : • Concept explanation • Discussion and question		Students search for references [1 x 6 x 60 minutes]		LMS (ilearn UNAND)	Problems of solution expansion and local stability	

	dynamic systems, which includes local phase portraits, limit cycles, stability and bifurcations			and answer course material						
7	An ability to analyze the qualitative behavior of linear and nonlinear dynamic systems, which includes local phase portraits, limit cycles, stability and bifurcations	• An ability to solve several dynamic system cases	Test: Mid-term: 10% Non test: • Student engagement (2%) • Independent assignment	Teaching and Discussion : • Concept explanation • Discussion and question and answer course material		Students search for references [1 x 6 x 60 minutes]		LMS (ilearn UNAND)	Jordan's canonical form	
8	**MID-TERM EXAM**									
9	An ability to analyze the qualitative behavior of linear and nonlinear dynamic systems, which includes local phase portraits, limit	• An ability to check the stability of the system through the eigenvalues of the linear approximation of the system	Test Final exam: 10% Non test: • Student engagement: 2% • Group assignment	Teaching and Discussion : • Concept explanation • Discussion and question and answer course material		Students search for references - [1 x 6 x 60 minutes]		• LMS (ilearn UNAND)	Stability and Liapunov Functions	

	cycles, stability and bifurcations									
10	An ability to analyze the qualitative behavior of linear and nonlinear dynamic systems, which includes local phase portraits, limit cycles, stability and bifurcations	• An ability to construct Lyapunov Functions to analyze the stability of the system	Non test: ● Group assignment	Teaching and Discussion : ● Concept explanation ● Discussion and question and answer course material		Students search for references [1 x 6 x 60 minutes]		● LMS (ilearn UNAND)	● Lyapunov function Gradient System	
11	An ability to analyze the qualitative behavior of linear and nonlinear dynamic systems, which includes local phase portraits, limit cycles, stability and bifurcations	• An ability to understand the meaning of bifurcation • An ability to identify saddle and transcritical points	Test Final exam: 10% Non test: ● Student engagement: 2% ● Group assignment	Teaching and Discussion : ● Concept explanation ● Discussion and question and answer course material		Students search for references [1 x 6 x 60 minutes]		● LMS (ilearn UNAND)	● Bifurcation Saddle point, transcritical	
12	An ability to analyze the qualitative behavior of	• An ability to properly understand the meaning	Group assignment	Teaching and Discussion : ● Concept explanation		Students search for references		● LMS (ilearn UNAND)	● Hopf Bifurcation	

	linear and nonlinear dynamic systems, which includes local phase portraits, limit cycles, stability and bifurcations	of bifurcation and recognize bifurcation hoptf		● Discussion and question and answer course material		[1 x 6 x 60 minutes]				
13	An ability to explain physical aspects and interpret phase portraits of systems related to real problems	• An ability to understand the behavior of high-order dynamic systems	Test Final exam: 10% Non test: ● Student engagement: 2% ● Group assignment	Teaching and Discussion : ● Concept explanation ● Discussion and question and answer course material		Students search for references [1 x 6 x 60 minutes]		● LMS (ilearn UNAND)	● Higher Order Systems	
14	An ability to analyze the qualitative behavior of linear and nonlinear dynamic systems, which includes local phase portraits, limit cycles,	• An ability to understand manifold theory	Non test Independent assignment	Teaching and Discussion : ● Concept explanation ● Discussion and question and answer course material		Students search for references [1 x 6 x 60 minutes]		● LMS (ilearn UNAND)	• Manifold Theory	

	stability and bifurcations									
15	An ability to use Maple or Matlab applications to describe the qualitative behavior of linear and nonlinear dynamic systems	• An ability to understand examples/cases of application of dynamic systems to biological problems.		Teaching and Discussion : • Concept explanation • Discussion and question and answer course material		Students search for references [1 x 6 x 60 minutes]		• LMS (ilearn UNAND)	• Multiple Applications	
									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 2 credits = 2×50 minutes

Indicators, Criteria, and Assessment Weights

1. Assessment weight for each Assessment

NO	Assessment	Weight (%)
1	Homework	20
2	Student engagement	10
3	Quizzes	10
4	Mid-Term Exam	30
5	Final Exam	30
TOTAL		**100**

2. Assessment weight for Intended Learning Outcome
   - CLO-1: 50 %
   - CLO-2: 20 %

- CLO-3: 30 %

Assessment Plan Table:

No.	CLO	Assessment					Weight (%)
		Homework (%)	Quizzes (%)	Quizzes (%)	Mid-Term Exam (%)	Final Exam (%)	
1	Students can analyze the qualitative behavior of linear and nonlinear dynamic systems, which includes local phase portraits, limit cycles, stability and bifurcations	15	20	5	5	5	50
2	Students can use Maple or Matlab applications to describe the qualitative behavior of linear and nonlinear dynamic systems	10	5	5			20
3	Students can explain physical aspects and interpret phase portraits	5	5	10	5	5	30

	of systems related to real problems						
Total		20	30	30	20	10	100

Information:
TK: Group ask