Module Description/Course Syllabi

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

1. *Course number and name*

MAT82245 Discrete Control Theory

2. *Credits and contact hours/Number of ECTS credits allocated*

3 sks / 4,53 ECTS

3. *Instructors and course coordinator*

1. Prof. Dr. Muhafzan

4. *Text book, title, author, and year*

1. G. Gu, Discrete Time Linear Systems, Springer, London, 2012
2. A. V. Oppenheim, R. W. Schaffer, J. R. Buck, Discrete Time Signal Processing, Prentice Hall, New Jersey, 1999

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

Z. M. Buchevats, L. T. Gruyitch, Linear Discrete-Time Systems, CRC Press, New York, 2018

6. *Specific course information*

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

The lecture begins by introducing the discrete linear control system problems in various real phenomena, followed by deepening aspects of the system of linear difference equations; such as the use of Z transformations, determination of discrete state transition matrices and solving systems of linear difference equations. The core

of this lecture is the analysis of control systems in discrete state space, such as controllability, observability, stability, canonical form, realization and pole placement. In addition, the use of Matlab software to detect controllability, observability and other aspects is also introduced. This course is equipped with self-learning activities through question exercises, discussion/review of material, and other forms of learning. Furthermore, to meet the demands of global developments in the mastery of technology for a master of mathematics, participants in this course are also equipped with the expertise to use Matlab software related to the discrete linear control systems
B. Prerequisites or co-requisites
-
C. Indicate whether a required or elective course in the program
Elective
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)
1st year
F. Semester when the course unit is delivered
Even Semester
G. Mode of delivery (face-to-face, distance learning)
Face to face

7. *Intended Learning Outcomes*

ILO-1: Possesses a good ethics and integrity
PI-1: Possess academic ethics
PI-2: Demonstrate academic integrity
ILO-3: Comprehensive mastery of one or several theories for development in the fields of analysis, algebra, applied mathematics, statistics and combinatorial mathematics
PI-2: Able to identify complex mathematical problems
PI-3: Able to solve complex mathematical problems
ILO-4: Mastering scientific techniques and developing them in solving research problems through multidisciplinary or interdisciplinary approaches
PI-1: Able to apply mathematical techniques in research problem-solving.
PI-2: Able to analyse research problems.
PI-4: Able to use various mathematical software to solve complex mathematical problems.
ILO-5: Able 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: Able to employ relevant techniques for conducting research.
PI-3: Capable of communicating research findings in an academic manner

8. *Course Learning Outcomes*

1. Ability to recognize the discrete linear control system problems in various real phenomena
2. Mastering the basic aspects of the discrete system of linear differential equations; such as the use of Z transformation, determination of the state transition matrix and solving the system of linear difference equations
3. Mastering the modeling of physical systems in the form of discrete state space models, transfer function models and block diagram models
4. Ability to analyze the discrete state space models; such as controllability, observability, canonical form, realizability and stability of discrete linear system

5. Ability to poles assignment for discrete linear system
6. Ablility to use Matlab software to solve problems in discrete linear control systems
9. *Brief list of topics to be covered*
Discrete linear control system problems in some real phenomena; some basic aspects of systems of linear difference equations, including the use of Z transform, determination of discrete state transition matrices and solving systems of linear difference equations; modeling of physical systems in the form of discrete state space models, transfer function models and block diagram models; controllability, observability, canonical form, realization and stability; pole placement for discrete linear systems; use of Matlab software to solve problems in discrete linear control systems
10. Learning and teaching methods
Directed Learning, Teacher Centered Learning
11. Language of instruction
Indonesia and English

12. Assessment methods and criteria
Summative Assessment : 1. Mid-term exam: 40% 2. Final exam: 40% 3. Assignment (home work): 20%

SEMESTER STUDY PLAN

DISCRETE CONTROL THEORY / MAT82245

(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
Discrete Control Theory	MAT82245	https://sci.ilearn.unand.ac.id	3	2	5 May 2024

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

Intended Learning Outcomes (ILO) and Performance Indicator (PI)	**Intended Learning Outcomes**	
	ILO-1	Possesses a good ethics and integrity PI-1: Possess academic ethics PI-2: Demonstrate academic integrity.
	ILO-3	Comprehensive mastery of one or several theories for development in the fields of analysis, algebra, applied mathematics, statistics and combinatorial mathematics PI-2: Able to identify complex mathematical problems PI-3: Able to solve complex mathematical problems
	ILO-4	Mastering scientific techniques and developing them in solving research problems through multidisciplinary or interdisciplinary approaches PI-1: Able to apply mathematical techniques in research problem-solving. PI-2: Able to analyse research problems. PI-4: Able to use various mathematical software to solve complex mathematical problems.
	ILO-5	Able 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: Able to employ relevant techniques for conducting research. PI-3: Capable of communicating research findings in an academic manner
	Course Learning Outcomes	
	1	Ability to recognize the discrete linear control system problems in various real phenomena (**ILO-1**: **ILO-3**: **ILO-4**)
	2	Mastering the basic aspects of the discrete system of linear differential equations; such as the use of Z transformation, determination of the state transition matrix and solving the system of linear difference equations (**ILO-3**: **ILO-4; ILO-5**)

	3	Mastering the modeling of physical systems in the form of discrete state space models, transfer function models and block diagram models (**ILO-3**: **ILO-4; ILO-5**)
	4	Ability to analyze the discrete state space models; such as controllability, observability, canonical form, realizability and stability of discrete linear system (**ILO-3**: **ILO-4; ILO-5**)
	5	Ability to poles assignment for discrete linear system (**ILO-3**: **ILO-4; ILO-5**)
	6	Ablility to use Matlab software to solve problems in discrete linear control systems (**ILO-3**: **ILO-4; ILO-5**)
Brief Description	The lecture begins by introducing the discrete linear control system problems in various real phenomena, followed by deepening aspects of the system of linear difference equations; such as the use of Z transformations, determination of discrete state transition matrices and solving systems of linear difference equations. The core of this lecture is the analysis of control systems in discrete state space, such as controllability, observability, stability, canonical form, realization and pole placement. In addition, the use of Matlab software to detect controllability, observability and other aspects is also introduced. This course is equipped with self-learning activities through question exercises, discussion/review of material, and other forms of learning. Furthermore, to meet the demands of global developments in the mastery of technology for a master of mathematics, participants in this course are also equipped with the expertise to use Matlab software related to the discrete linear control systems	
Course Materials	1. Discrete linear control system problems in some real phenomena 2. Some basic aspects of systems of linear difference equations, including the use of Z transform, determination of discrete state transition matrices and solving systems of linear difference equations. 3. Modeling of physical systems in the form of discrete state space models, transfer function models and block diagram models 4. Controllability, observability, canonical form, realization and stability. 5. Pole placement for discrete linear systems 6. Use of Matlab software to solve problems in discrete linear control systems	
References	**Main:** [1]. G. Gu, Discrete Time Linear Systems, Springer, London, 2012. **Additional:** [2]. A. V. Oppenheim, R. W. Schaffer, J. R. Buck, Discrete Time Signal Processing, Prentice Hall, New Jersey, 1999.	
Learning Media	**Software:**	**Hardware:**
	• LMS Unand (http://fmipa.ilearn.unand.ac.id/) • Zoom meeting • Whatsapp	• Computer/Laptop • Smartphone

Team Teaching	1. Prof. Dr. Muhafzan
Assessment	Homework(assignment), Mid-Term exam, Final exam
Required courses	-

Weekly Study Plan

Week / Meet (1)	Course Outcomes (2)	Indicator (3)	Assessment (4)	Activities/Forms of Learning [Time estimated]					Subject, references (10)	Weight (11)
				Synchronus*		Asynchronus**		Media (9)		
				Face to face Offline (5)	Face to face Online (6)	Individual (7)	Collaboration (8)			
1	CLO-1 Able to identify the discrete linear control system problems and understand basic concepts, definitions, classification of the discretelinear control system problems	• Discipline in implementing the lecture contract • Accuracy in understanding related material • Accuracy in answering assignment questions • Neatness of assignment work • Originality of assignment results	Assignment : 3% Mid term: 7%	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]	• Students read and study learning materials • Students do assignments independently [1× 3 × 60 minutes]		• PPT • I learn (LMS Unand) (Specific condition: Zoom meeting, WA group, learning video)	• Assessment Rules, SSP, Course Contract • Basic concept • Examples of discrete linear control system problems [1, 2]	10%
2-3	CLO-2 Able to understand the basic aspects of	• Accuracy in understanding related material	Assignment : 1% Mid term: 15%	• Lecture: - explanation of concepts - discussion,	• Lecture: - explanation of concepts - discussion,	• Students read and study learning materials		• PPT • I learn (LMS Unand)	• Basic aspects of systems of linear difference	16%

	the system of linear difference equations, including the use of Z transformations, determination of state transition matrices and solving the system of linear difference equations.	• Accuracy in answering assignment questions • Neatness of assignment work • Originality of assignment results		question and answer of lecture material [2 × 3 × 50 minutes]	question and answer of lecture material [2 × 3 × 50 minutes]	• Students do assignments independently [2× 3 × 60 minutes]		• (Specific condition: Zoom meeting, WA group, learning video)	equations; such as the use of Z transform, determination of state transition matrices and solving systems of linear difference equations. [1]	
4-5	CLO-3 Able to model physical systems in the form of discrete state space models, transfer function models and block diagram models.	• Accuracy in understanding related material • Accuracy in answering assignment questions • Neatness of assignment work • Originality of assignment results	Assignment : 5% Mid term: 14%	• Lecture: - explanation of concepts - discussion, question and answer of lecture material [2 × 3 × 50 minutes]	• Lecture: - explanation of concepts - discussion, question and answer of lecture material [2 × 3 × 50 minutes]	• Students read and study learning materials • Students do assignments independently [2× 3 × 60 minutes]		• PPT • I learn (LMS Unand) • (Specific condition: Zoom meeting, WA group, learning video)	Modeling of physical systems in the form of discrete state space models, transfer function models, and block diagram models [1]	19%
6-7	CLO-4 Able to understand the concept of controllability of discrete linear system, controllability test criteria CLO 6 Able to use Matlab software to solve	• Accuracy in understanding related material • Accuracy in answering assignment questions • Neatness of assignment work • Originality of assignment results	Assignment : 1% Mid term: 4%	• Lecture: - explanation of concepts - discussion, question and answer of lecture material [2 × 3 × 50 minutes]	• Lecture: - explanation of concepts - discussion, question and answer of lecture material [2 × 3 × 50 minutes]	• Students read and study learning materials • Students do assignments independently [2× 3 × 60 minutes]		• PPT • I learn (LMS Unand) (Specific condition: Zoom meeting, WA group, learning video)	Controllability of discrete linear system [1, 2]	5%

	controllability problems									
8-9	**MID-TERM EXAM**									
10-11	CLO-4 Able to understand the concept of observability of discrete linear systems, canonical form, realization and related test criteria. CLO 6 Able to use Matlab software to solve observability, canonical form, and realization problems.	• Accuracy in understanding related material • Accuracy in answering assignment questions • Neatness of assignment work • Originality of assignment results	Assignment : 5% Final term: 15%	• Lecture: - explanation of concepts - discussion, question and answer of lecture material [2 × 3 × 50 minutes]	• Lecture: - explanation of concepts - discussion, question and answer of lecture material [2 × 3 × 50 minutes]	• Students read and study learning materials • Students do assignments independently [2× 3 × 60 minutes] -		• PPT • I learn (LMS Unand) • (Specific condition: Zoom meeting, WA group, learning video)	Observability of discrete linear systems, canonical form, realization and related test criteria. [1, 2]	20%
12-13	CLO-4 Able to understand the stability concept of discrete linear system	• Accuracy in understanding related material • Accuracy in answering assignment questions • Neatness of assignment work • Originality of assignment results	Assignment : 5% Final term: 15%	• Lecture: - explanation of concepts - discussion, question and answer of lecture material [2 × 3 × 50 minutes]	• Lecture: - explanation of concepts - discussion, question and answer of lecture material [2 × 3 × 50 minutes]	• Students read and study learning materials • Students do assignments independently [2× 3 × 60 minutes] -		• PPT • I learn (LMS Unand) • (Specific condition: Zoom meeting, WA group, learning video)	Stability of discrete linear system. [1, 2]	20%
14-16	CLO-5 Able to poles assignment for discrete linear	• Accuracy in understanding related material	Assignment : 5% Final term: 15%	• Lecture: - explanation of concepts - discussion,	• Lecture: - explanation of concepts - discussion,	• Students read and study learning materials		• PPT • I learn (LMS Unand)	Pole placement for discrete linear systems	10%

	system	• Accuracy in answering assignment questions • Neatness of assignment work • Originality of assignment results		question and answer of lecture material [2 × 3 × 50 minutes]	question and answer of lecture material [2 × 3 × 50 minutes]	• Students do assignments independently [2× 3 × 60 minutes]		Specific condition: Zoom meeting, WA group, learning video)	[1, 2]	
									Total Weight	100%
17-18	**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	Mid-Term Exam	40
2	Final Exam	40
3	Assignment (Homework)	20
TOTAL		**100**

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

Assessment Plan Table:

No.	CLO	Assessment			Weigth (%)
		Homework (%)	Mid-Term Exam (%)	Final Exam (%)	
1	Ability to recognize the discrete linear control	2	4	4	10

	system problems in various real phenomena (**ILO-1**: **ILO-3**: **ILO-4**)				
2	Mastering the basic aspects of the discrete system of linear differential equations; such as the use of Z transformation, determination of the state transition matrix and solving the system of linear difference equations (**ILO-3**: **ILO-4; ILO-5**)	4	8	8	20
3	Mastering the modeling of physical systems in the form of discrete state space models, transfer function models and block diagram models (**ILO-3**: **ILO-4; ILO-5**)	4	8	8	20
4	Ability to analyze the discrete state space models; such as controllability, observability, canonical form, realizability and stability of discrete linear system (**ILO-3**: **ILO-4; ILO-5**)	4	8	8	20
5	Ability to poles assignment for discrete linear system (**ILO-3**: **ILO-4; ILO-5**)	4	8	8	20
6	Ablility to use Matlab software to solve problems in discrete linear control systems (**ILO-3**: **ILO-4; ILO-5**)	2	4	4	10
	Total	**20**	**40**	**40**	**100**