



MODULE HANDBOOK

FUNDAMENTALS OF CONTROL SYSTEMS AND LABORATORY



**BACHELOR DEGREE PROGRAM
DEPARTMENT OF BIOMEDICAL ENGINEERING
FACULTY OF INTELLIGENT ELECTRICAL AND INFORMATICS
TECHNOLOGY**

INSTITUT TEKNOLOGI SEPULUH NOPEMBER

ENDORSEMENT PAGE



MODULE HANDBOOK Fundamentals of Control Systems and Laboratory DEPARTMENT OF BIOMEDICAL ENGINEERING

INSTITUT TEKNOLOGI SEPULUH NOPEMBER
Number : B/21351/IT2.IX.5.1.2/PP.03.00.00/2020

Proses Process	Penanggung Jawab Person in Charge			Tanggal Date
	Nama Name	Jabatan Position	Tandatangan Signature	
Perumus Preparation	Ir. Ali Fatoni, M.T.	Dosen Lecturer		November 23, 2019
Pemeriksa dan Pengendalian Review and Control	Ir. Josaphat Pramudijanto, M.Eng.	Tim kurikulum Curriculum team		February 11, 2020
Persetujuan Approval	Ir. Josaphat Pramudijanto, M.Eng.	Koordinator RMK Course Cluster Coordinator		March 03, 2020
Penetapan Determination	Dr. Achmad Arifin, S.T., M.Eng.	Kepala Departemen Head of Department		March 10, 2020

MODULE HANDBOOK

FUNDAMENTALS OF CONTROL SYSTEMS AND LABORATORY

Module name	Fundamentals of Control Systems and Laboratory	
Module level	Undergraduate	
Code	EB184402	
Course (if applicable)	Fundamentals of Control Systems and Laboratory	
Semester	Second Semester (Genap)	
Person responsible for the module	Ir. Ali Fatoni, MT	
Lecturer		
Language	Bahasa Indonesia and English	
Relation to curriculum	Undergraduate degree program, mandatory , 4 th semester.	
Type of teaching, contact hours	Lectures, <60 students Tuesdays, 11.00-12.50 (GMT+7)	
Workload	1. Lectures : 4 x 50 = 200 minutes per week. 2. Exercises and Assignments : 4 x 60 = 240 minutes (4 hours) per week. 3. Private learning : 4 x 60 = 240 minutes (4 hours) per week.	
Credit points	4 credit points (sks)	
Requirements according to the examination regulations	A student must have attended at least 75% of the lectures to sit in the exams.	
Mandatory prerequisites	-	
Learning outcomes and their corresponding PLOs	Course Learning Outcome (CLO) after completing this module CLO 1: Students understand and able to design control system in a certain system CLO 2: Students able to model dynamic system CLO 3: Students able to determine and analyze response of system with 1 st and 2 nd order within several domain CLO 4: Students able to analyze stability of a system within several domain CLO 5: Students understand state space representation in a continuous-time and discrete-time system CLO 6: Students able to use MATLAB and Simulink	PLO – 1 PLO – 1 PLO – 2 PLO – 2 PLO – 3 PLO – 3

Content	This course studies about basic control system concepts and its application within biomedical discipline.
Study and examination requirements and forms of examination	• In-class exercises • Assignment 1, 2, 3, 4, 5, 6, 7 • Demo 1, 2, 3 • Mid-term examination • Final examination
Media employed	LCD, whiteboard, websites (myITS Classroom), zoom.
Reading list	Main: 1. Katsuhiko Ogata, "Modern Control Engineering", Prentice Hall Supporting: 1. Franklin, Powell, dan Emami-Naeini, "Feedback Control of Dynamic Systems", Prentice-Hall.

I. Rencana Pembelajaran Semester / Semester Learning Plan

	INSTITUT TEKNOLOGI SEPULUH NOPEMBER (ITS) FACULTY OF INTELLIGENT ELECTRICAL AND INFORMATICS TECHNOLOGY DEPARTMENT OF BIOMEDICAL ENGINEERING					Kode Dokumen
SEMESTER LEARNING PLAN						
MATA KULIAH (MK) <i>COURSE</i>	KODE <i>CODE</i>	Rumpun MK <i>Course Cluster</i>	BOBOT (sks) <i>Credits</i>		SEMESTER	Tgl Penyusunan <i>Compilation Date</i>
Dasar Sistem Pengaturan dan Laboratorium Fundamentals of Control Systems and Laboratory	EB184402	Biocybernetics	T=4	P=0	IV	June 15, 2020
OTORISASI / PENGESAHAN <i>AUTHORIZATION / ENDORSEMENT</i>	Dosen Pengembang RPS <i>Developer Lecturer of Semester Learning Plan</i>		Koordinator RMK <i>Course Cluster Coordinator</i>		Ka DEPARTEMEN <i>Head of Department</i>	
	(Ir. Ali Fatoni, M.T.)		(Ir. Josaphat Pramudijanto, M.Eng.)		(Dr. Achmad Arifin, S.T., M.Eng.)	
Capaian Pembelajaran	CPL-PRODI yang dibebankan pada MK <i>PLO Program Charged to the Course</i>					
Learning Outcomes	CPL-01 <i>PLO-01</i>	Mampu menerapkan Ilmu Pengetahuan Alam dan Matematika pada bidang Teknik Biomedika <i>Able to apply Natural Sciences and Mathematics in the field of Biomedical Engineering</i>				
	CPL-02 <i>PLO-02</i>	Mampu menemukan, memahami, menjelaskan, merumuskan, dan menyelesaikan permasalahan umum pada bidang Teknik dan permasalahan khusus pada bidang Teknik Biomedika yang meliputi instrumentasi biomedika cerdas, teknik rehabilitasi medika, pencitraan dan pengolahan citra medika, serta informatika medika <i>Able to find, understand, explain, formulate, and solve general problems in the field of Engineering and special problems in the field of Biomedical Engineering which includes intelligent biomedical instrumentation, medical rehabilitation techniques, imaging and processing of medical images, and medical informatics</i>				
	CPL-03 <i>PLO-03</i>	Mampu merancang dan melaksanakan eksperimen laboratorium dan/atau lapangan, menganalisa dan menginterpretasi data, serta menggunakan penilaian yang obyektif untuk menarik kesimpulan				

		Able to design and implement laboratory experiment and / or field experiments, analyze and interpret data, and use objective assessments to draw conclusions											
	Capaian Pembelajaran Mata Kuliah (CPMK) – Bila CP MK sebagai kemampuan pada tiap tahap pembelajaran CP MK = Sub CP MK												
	CP MK 1 CLO 1	Mahasiswa memahami dan mampu merancang sistem pengaturan pada sebuah sistem Students understand and able to design control system in a certain system											
	CP MK 2 CLO 2	Mahasiswa mampu memodelkan sistem dinamik Students able to model dynamic system											
	CP MK 3 CLO 3	Mahasiswa mampu menentukan dan menganalisa respon terhadap sistem orde 1 dan 2 di beberapa domain Students able to determine and analyze response of system with 1st and 2nd order within several domain											
	CP MK 4 CLO 4	Mahasiswa mampu menganalisa kestabilan sebuah sistem di beberapa domain Students able to analyze stability of a system within several domain											
	CP MK 5 CLO 5	Mahasiswa memahami representasi state space dari sistem waktu kontinu dan diskrit Students understand state space representation in a continuous-time and discrete-time system											
	CP MK 6 CLO 6	Mahasiswa mampu menggunakan MATLAB dan Simulink Students able to use MATLAB and Simulink											
Peta CPL – CP MK													
Map of PLO - CLO		CPL-01	CPL-02	CPL-03	CPL-04	CPL-05	CPL-06	CPL-07	CPL-08	CPL-09	CPL-10	CPL-11	CPL-12
CPMK 1 / SUB CPMK 1 CLO 1 / LLO 1	√												
CPMK 2 / SUB CPMK 2 CLO 2 / LLO 2	√												
CPMK 3 / SUB CPMK 3 CLO 3 / LLO 3		√											
CPMK 4 / SUB CPMK 4 CLO 4 / LLO 4		√											
CPMK 5 / SUB CPMK 5 CLO 5 / LLO 5				√									
CPMK 6 / SUB CPMK 6 CLO 6 / LLO 6				√									

Diskripsi Singkat MK <i>Short Description of Course</i>		Mata kuliah ini mempelajari tentang konsep dasar sistem pengaturan dan aplikasi nya dalam disiplin ilmu biomedik. <i>This course studies about basic control system concepts and its application within biomedical discipline.</i>					
Bahan Kajian: Materi pembelajaran <i>Course Materials:</i>		1. Konsep sistem pengaturan / <i>Concept of control system</i> 2. Representasi Sistem Dinamika / <i>Dynamic System Representation</i> 3. Analisa Respon Waktu Sistem Orde 1 dan 2 / <i>Time Response Analysis of 1st and 2nd order systems</i> 4. Kriteria Stabilitas Sistem di beberapa domain / <i>System Stability Criterias within several domain</i> 5. Analisa Respon Frekuensi / <i>Frequency Response Analysis</i> 6. Representasi State Space dari sistem waktu kontinu dan diskrit / <i>State Space representation with continuous-and-discrete-time system</i> 7. Sampled Data Control System / <i>Sampled Data Control System</i>					
Pustaka <i>References</i>		Utama / Main: 1. Katsuhiko Ogata, "Modern Control Engineering", Prentice Hall Pendukung / Supporting: 1. Franklin, Powell, dan Emami-Naeini, "Feedback Control of Dynamic Systems", Prentice-Hall.					
Dosen Pengampu <i>Lecturer</i>							
Matakuliah syarat <i>Prerequisite</i>		-					
Mg ke/ Week	Kemampuan akhir tiap tahapan belajar (Sub-CPMK) / <i>Final ability of each learning stage (LLO)</i>	Penilaian / <i>Assessment</i>		Bantuk Pembelajaran; Metode Pembelajaran; Penugasan Mahasiswa; [<i>Estimasi Waktu</i>] / <i>Form of Learning; Learning Method; Student Assignment; [Estimated Time]</i>		Materi Pembelajaran [<i>Pustaka</i>] / <i>Learning Material [Reference]</i>	Bobot Penilaian / <i>Assessment Load (%)</i>
		Indikator / <i>Indicator</i>	Kriteria & Teknik / <i>Criteria & Techniques</i>				
(1)	(2)	(3)	(4)	Tatap Muka / <i>In-class</i> (5)	Daring / <i>Online</i> (6)	(7)	(8)

1-2	Mahasiswa memahami dan mampu merancang sistem pengaturan pada sebuah sistem <i>Students understand and able to design control system in a certain system</i>	• Mampu memodelkan sebuah sistem pengaturan • Mampu menggunakan Simulink untuk memodelkan sebuah sistem dalam bentuk diagram blok • <i>Able to model a control system</i> • <i>Able to use Simulink to model sistem in a block diagram</i>	• Tugas Tertulis 1 Melakukan identifikasi komponen sistem pengaturan Mendesain kontroler untuk sistem pengaturan • Tugas Pemrograman 1 Merepresentasi kan model sistem pengaturan sebuah sistem dengan menggunakan Simulink • <i>Written Task 1 Identify control system components, design controller for control system</i> • <i>Programming Task 1 Represent control system model of a</i>	• Kuliah dan brainstorming, tanya jawab. [TM : 2 x 4 x 50"] [BM : 2 x 4 x 60"] [PT : 2 x 4 x 50"] • <i>Presentation and brainstorming, ask and answer.</i> [FF : 2 x 4 x 50"] [SA : 2 x 4 x 60"] [SS : 2 x 4 x 50"]	• Chatting dan diskusi dalam forum platform ITS. • <i>Chat and discussion in ITS platform forum.</i>	• Konsep Sistem Pengaturan • Komponen Sistem Pengaturan • Pemodelan Sistem Pengaturan • <i>Control System Concept</i> • <i>Control System Components</i> • <i>Control System Modelling</i>	10
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			<i>certain system using SIMULINK</i>				
3	Mahasiswa mampu memodelkan sistem dinamik <i>Students able to model dynamic system</i>	• Mampu memodelkan sistem linear dan non linear • <i>Able to model linear and non-linear system</i>	• Tugas Tertulis 2 Melakukan pemodelan sistem linear dan non linear • <i>Written Task 2 Model linear and non-linear system</i>	• Kuliah dan brainstorming, tanya jawab. [TM : 4 x 50"] [BM : 4 x 60"] [PT : 4 x 50"] • <i>Presentation and brainstorming, ask and answer.</i> [FF : 4 x 50"] [SA : 4 x 60"] [SS : 4 x 50"]	• Chatting dan diskusi dalam forum platform ITS. • <i>Chat and discussion in ITS platform forum.</i>	• Pemodelan Sistem Linear • Pemodelan Sistem Non-Linear • <i>Linear System Modeling</i> • <i>Non-Linear System Modeling</i>	2.5
4-5	Mahasiswa mampu menentukan dan menganalisa respon terhadap sistem orde 1 dan 2 pada domain waktu <i>Students able to determine and analyze response of system with 1st and 2nd order within several domain</i>	• Mampu menentukan respon sebuah sistem berdasarkan orde nya • Mampu menentukan respon transien dan steady state dari sebuah sistem LTI • Mampu menganalisa dan menjelaskan efek penambahan kontroler pada sistem • <i>Able to determine response of a system according to its order</i>	• Tugas Tertulis 3 Menghitung respon sistem orde 1 dan 2 Menentukan respon transien dan steady state sistem LTI Menghitung konstanta error dan steady state error pada respon waktu sistem LTI	• Kuliah dan brainstorming, tanya jawab. [TM : 2 x 4 x 50"] [BM : 2 x 4 x 60"] [PT : 2 x 4 x 50"] • <i>Presentation and brainstorming, ask and answer.</i>	• Chatting dan diskusi dalam forum platform ITS. • <i>Chat and discussion in ITS platform forum.</i>	• Respon Waktu Orde 1 • Respon Waktu Orde 2 • Analisa Respon Transien Sistem LTI • Analisa Respon Steady State Sistem LTI • Steady State Error • Error Constant • Persamaan Karakteristik Feedback Control System	10

		• <i>Able to determine transient response and steady state in a LTI System</i> • <i>Able to analyze and explain effects of adding controller to a system</i> • Mampu menggunakan MATLAB/Simulink untuk menentukan dan membuat grafik respon waktu sistem LTI	Menentukan respon waktu sistem yang menggunakan kontroler • Tugas Pemrograman 2 Membuat program untuk menghitung dan memplot respon sistem LTI dengan menggunakan MATLAB • <i>Written Task 3 Calculate 1st and 2nd order system, determining transient and steady state response, calculate error constant and steady state error in time response of LTI system,</i>	<i>[FF : 2 x 4 x 50"]</i> <i>[SA : 2 x 4 x 60"]</i> <i>[SS : 2 x 4 x 50"]</i>		• Efek Kontroler pada Respon Sistem • <i>1st order time response</i> • <i>2nd order time response</i> • <i>Transient response analysis of LTI System</i> • <i>Steady State response analysis of LTI System</i> • <i>Steady state error</i> • <i>Error Constant</i> • <i>Feedback Control System Characteristic Equation</i> • <i>Controller effect on system response</i>	
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			<i>determining system's time response using controller</i> • <i>Programming Task 3</i> <i>Create program to calculate and plot LTI System response with MATLAB</i>				
6-7	Mahasiswa mampu menganalisa kestabilan sebuah sistem di domain waktu dan S <i>Students able to analyze stability of a system in time and S domain</i>	• Mampu menganalisa kestabilan sebuah sistem di domain waktu dan domain S • <i>Able to analyze stability of a system in time and S domain</i>	• Tugas Tertulis 4 Menentukan kestabilan sebuah sistem dengan Kriteria Routh Hurwitz Menentukan kestabilan sebuah sistem dengan menggunakan Root Locus • <i>Written Task 4</i> <i>Determine stability of a system with Routh Hurwitz</i>	• Kuliah dan brainstorming, tanya jawab. [TM : 2 x 4 x 50"] [BM : 2 x 4 x 60"] [PT : 2 x 4 x 60"] • <i>Presentation and brainstorming, ask and answer.</i> <i>[FF : 2 x 4 x 50"]</i> <i>[SA : 2 x 4 x 60"]</i>	• Chatting dan diskusi dalam forum platform ITS. • <i>Chat and discussion in ITS platform forum.</i>	• Konsep Stabilitas • Kriteria Stabilitas Routh-Hurwitz • Limitasi Routh-Hurwitz • Teknik Root Locus • <i>Stability Concept</i> • <i>Routh-Hurwitz Stability Criterias</i> • <i>Routh-Hurwitz Limitation</i> • <i>Root Locus Technique</i>	2.5

			<i>criteria, determining system's stability using Root Locus</i>	<i>[SS : 2 x 4 x 60"]</i>			
8	EVALUASI TENGAH SEMESTER MID-SEMESTER EXAM						15
9	Mahasiswa mampu menentukan dan menganalisa respon terhadap sistem pada domain frekuensi <i>Students able to determine and analyze response of sytem within frequency domain</i>	• Mampu menganalisis respon frekuensi sebuah sistem dengan berbagai metode yang telah diajarkan • <i>Able to analyze frequency response of a system with methods that have been taught</i>	• Tugas Tertulis 5 Menentukan respon frekuensi sebuah sistem; Membuat plot bode, polar, dan nyquist sebuah sistem; Menggunakan Nichol's Chart untuk analisis sistem pengaturan; Menghitung kompensasi di domain waktu dan frekuensi • <i>Written Task 5 Determining frequency response of a</i>	• Kuliah dan brainstorming, tanya jawab. [TM : 4 x 50"] [BM : 4 x 60"] [PT : 4 x 60"] • <i>Presentation and brainstorming, ask and answer.</i> [FF : 4 x 50"] [SA : 4 x 60"] [SS : 4 x 60"]	• Chatting dan diskusi dalam forum platform ITS. • <i>Chat and discussion in ITS platform forum.</i>	• Respon Frekuensi • Plot Bode, Polar Nyquist • Lingkaran M dan N konstan • Nichol's Chart • Kompensasi Lead, Lag, dan Lead Lag • <i>Frequency response</i> • <i>Bode, polar, nyquist plot</i> • <i>M and N constant circles</i> • <i>Nichol's chart</i> • <i>Lead, Lag, and Lead Lag Compensation</i>	2.5

			<i>system; Creating bode polar, and nyquist plot of a system; Using Nichol's chart to analyze control system; Calculating compensation in time and frequency domain</i>				
10	Mahasiswa mampu menganalisa kestabilan sebuah sistem di domain frekuensi <i>Students able to analyze stability of a system within frequency domain</i>	- Mampu menganalisis kestabilan sebuah sistem dengan berbagai metode yang telah diajarkan pada domain frekuensi <i>Able to analyze stability in a system using previously taught methods within frequency domain</i>	- Tugas Tertulis 6 Menentukan kestabilan sebuah sistem pada domain frekuensi <i>Written Task 6 Determining stability of a system in frequency domain</i>	- Kuliah dan brainstorming, tanya jawab. [TM : 4 x 50"] [BM : 4 x 60"] [PT : 4 x 60"] <i>Presentation and brainstorming, ask and answer. [FF : 4 x 50"] [SA : 4 x 60"] [SS : 4 x 60"]</i>	- Chatting dan diskusi dalam forum platform ITS. <i>Chat and discussion in ITS platform forum.</i>	- Kriteria stabilitas Nyquist - Asesmen stabilitas relatif: gain margin dan phase margin <i>Nyquist stability criterias</i> <i>Relative stability assessment: gain margin and phase margin</i>	2.5
11	Mahasiswa mampu menggunakan MATLAB dan	Mampu menggunakan MATLAB untuk	Tugas Praktikum 1 Menganalisa	Kuliah dan brainstorming, tanya jawab.	Chatting dan diskusi dalam	Motor DC Position Control	25

	Simulink untuk aplikasi sistem pengaturan <i>Students able to use MATLAB and Simulink for control system application</i>	menganalisis respon sebuah sistem • Mampu menggunakan PLC untuk memprogram sistem pengaturan sederhana • <i>Able to use MATLAB to analyze system response</i> • <i>Able to use PLC to program simple control system</i>	respon terhadap sistem pengaturan posisi motor DC • Tugas Praktikum 2 Menganalisa respon terhadap sistem pengaturan level ketinggian air • Tugas Praktikum 3 Membuat program sederhana dengan menggunakan PLC • Tugas Praktikum 4 Menganalisa penggunaan sensor pada sistem pengaturan • <i>Lab Task 1 Analyze response of DC</i>	[TM : 4 x 50"] [BM : 4 x 60"] [PT : 4 x 60"] • <i>Presentation and brainstorming, ask and answer. [FF : 4 x 50"] [SA : 4 x 60"] [SS : 4 x 60"]</i>	forum platform ITS. • <i>Chat and discussion in ITS platform forum.</i>	• Process Control Water Level • PLC • Introduction to Sensor	
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			<i>motor control system</i> • <i>Lab Task 2</i> <i>Analyze response of water height control system</i> • <i>Lab Task 3</i> Create a simple program to use PLC • <i>Lab Task 4</i> <i>Analyze uses of sensor in control system</i>				
12-14	Mahasiswa memahami representasi state space dari sistem waktu kontinu dan diskrit <i>Students understand state space representation in a continuous-time and discrete-time system</i>	• Mampu merepresentasikan sebuah sistem dalam state space • Mampu melakukan proses sampling untuk analisa sistem pengaturan digital • <i>Able to represent system in a state space</i> • <i>Able to do sampling process for analyzing digital control system</i>	• Tugas Tertulis 7 Menentukan representasi state space dari sebuah sistem • Tugas Pemrograman 3 Melakukan proses sampling Membuat program untuk menganalisa sistem pengaturan digital	• Kuliah dan brainstorming, tanya jawab. [TM : 3 x 4 x 50"] [BM : 3 x 4 x 60"] [PT : 3 x 4 x 60"] • <i>Presentation and brainstorming, ask and answer.</i> [FF : 3 x 4 x 50"] [SA : 3 x 4 x 60"] [SS : 3 x 4 x 60"]	• Chatting dan diskusi dalam forum platform ITS. • <i>Chat and discussion in ITS platform forum.</i>	• Representasi State Space pada sistem waktu kontinu • Representasi State Space pada sistem waktu diskrit • Digital Control System • <i>State Space Representation in continuous-time system</i> • <i>State space representation in discrete-time system</i>	10

			• <i>Written Task 7</i> <i>Determining state space representation in a system</i> • <i>Programming Task 3</i> <i>Do sampling process and create program to analyze digital control system</i>			• <i>Digital Control System</i>	
15-16	EVALUASI AKHIR SEMESTER FINAL-SEMESTER EXAM						20

TM=Tatap Muka, **PT**=Penugasan Terstruktur, **BM**=Belajar Mandiri.
FF = Face to Face, **SA** = Structured Assignment, **SS** = Self Study.

II. Rencana Asesmen & Evaluasi (RAE)/ *Assessment & Evaluation Plan*

	ASSESSMENT & EVALUATION PLAN BACHELOR DEGREE PROGRAM OF BIOMEDICAL ENGINEERING - FTEIC ITS Course : Fundamentals of Control Systems and Laboratory		RA&E
			Write Doc Code
Kode/code: EB184402	Bobot sks/credits (T/P): 4/0	Rumpun MK: Biocybernetics Course Cluster: Biocybernetics	Smt: IV
OTORISASI AUTHORIZATION	Penyusun RA & E Compiler A&EP Ir. Ali Fatoni, MT	Koordinator RMK Course Cluster Coordinator Ir. Josaphat Pramudijanto, M.Eng.	Ka DEP Head of DEP Dr. Achmad Arifin, S.T., M.Eng.

Mg ke/ Week (1)	Sub CP-MK / Lesson Learning Outcomes (LLO) (2)	Bentuk Asesmen (Penilaian) Form of Assessment (3)	Bobot / Load (%) (4)
1-2	Sub CP-MK 1: Mahasiswa memahami dan mampu merancang sistem pengaturan pada sebuah sistem LLO 1: <i>Students understand and able to design control system in a certain system</i>	- Tugas Tertulis 1 Melakukan identifikasi komponen sistem pengaturan Mendesain kontroler untuk sistem pengaturan - Tugas Pemrograman 1 Merepresentasikan model sistem pengaturan sebuah sistem dengan menggunakan Simulink <i>Written Task 1</i> <i>Identify control system components, design controller for control system</i> <i>Programming Task 1</i> <i>Represent control system model of a certain system using SIMULINK</i> <i>2 soal pada ETS (2 Questions in Midterm Exam) [6.3%]</i>	10
3	Sub CP-MK 2: Mahasiswa mampu memodelkan sistem dinamik LLO 2: <i>Students able to model dynamic system</i>	- Tugas Tertulis 2 Melakukan pemodelan sistem linear dan non linear <i>Written Task 2</i> <i>Model linear and non-linear system</i> <i>2 soal pada ETS (2 Questions in Midterm Exam)</i> <i>1 soal pada EAS (1 Question in Final Exam)</i>	2.5

Mg ke/ Week (1)	Sub CP-MK / Lesson Learning Outcomes (LLO) (2)	Bentuk Asesmen (Penilaian) Form of Assessment (3)	Bobot / Load (%) (4)
4-5	Sub CP-MK 3: Mahasiswa mampu menentukan dan menganalisa respon terhadap sistem orde 1 dan 2 pada domain waktu LLO 3: <i>Students able to determine and analyze response of system with 1st and 2nd order within several domain</i>	- Tugas Tertulis 3 Menghitung respon sistem orde 1 dan 2 Menentukan respon transien dan steady state sistem LTI Menghitung konstanta eror dan steady state error pada respon waktu sistem LTI Menentukan respon waktu sistem yang menggunakan kontroler - Tugas Pemrograman 2 Membuat program untuk menghitung dan memplot respon sistem LTI dengan menggunakan MATLAB - Written Task 3 <i>Calculate 1st and 2nd order system, determining transient and steady state response, calculate error constant and steady state error in time response of LTI system, determining system's time response using controller</i> - Programming Task 3 <i>Create program to calculate and plot LTI System response with MATLAB</i> 2 soal pada ETS (2 Questions in Midterm Exam) 1 soal pada EAS (1 Question in Final Exam)	10
6-7	Sub CP-MK 4: Mahasiswa mampu menganalisa kestabilan sebuah sistem di domain waktu dan S LLO 4: <i>Students able to analyze stability of a system in time and S domain</i>	- Tugas Tertulis 4 Menentukan kestabilan sebuah sistem dengan Kriteria Routh Hurwitz Menentukan kestabilan sebuah sistem dengan menggunakan Root Locus - Written Task 4 <i>Determine stability of a system with Routh Hurwitz criterias, determining system's stability using Root Locus</i> 1 soal pada ETS (1 Question in Midterm Exam) 1 soal pada EAS (1 Question in Final Exam)	2.5
8	Evaluasi Tengah Semester Midterm Exam	Tes: Ujian Tulis/Ujian Daring Test: • Writing Exams / Online Exams	15
9	Sub CP-MK 5: Mahasiswa mampu menentukan dan menganalisa respon	Tugas Tertulis 5 Menentukan respon frekuensi sebuah sistem; Membuat plot bode, polar, dan nyquist sebuah sistem; Menggunakan Nichol's Chart untuk analisis sistem	2.5

Mg ke/ Week (1)	Sub CP-MK / Lesson Learning Outcomes (LLO) (2)	Bentuk Asesmen (Penilaian) Form of Assessment (3)	Bobot / Load (%) (4)
	terhadap sistem pada domain frekuensi LLO 5: <i>Students able to determine and analyze response of sytem within frequency domain</i>	pengaturan; Menghitung kompensasi di domain waktu dan frekuensi • <i>Written Task 5</i> <i>Determining frequency response of a system; Creating bode polar, and nyquist plot of a system; Using Nichol's chart to analyze control system; Calculating compensation in time and frequency domain</i> • <i>1 soal pada EAS (1 Question in Final Exam)</i>	
10	Sub CP-MK 6: Mahasiswa mampu menganalisa kestabilan sebuah sistem di domain frekuensi LLO 6: <i>Students able to analyze stability of a system within frequency domain</i>	• Tugas Tertulis 6 Menentukan kestabilan sebuah sistem pada domain frekuensi • <i>Written Task 6</i> <i>Determining stability of a system in frequency domain</i> • <i>1 soal pada EAS (1 Question in Final Exam)</i>	2.5
11	Sub CP-MK 7: Mahasiswa mampu menggunakan MATLAB dan Simulink untuk aplikasi sistem pengaturan LLO 7: <i>Students able to use MATLAB and Simulink for control system application</i>	• Tugas Praktikum 1 Menganalisa respon terhadap sistem pengaturan posisi motor DC • Tugas Praktikum 2 Menganalisa respon terhadap sistem pengaturan level ketinggian air • Tugas Praktikum 3 Membuat program sederhana dengan menggunakan PLC • Tugas Praktikum 4 Menganalisa penggunaan sensor pada sistem pengaturan • <i>Lab Task 1</i> <i>Analyze response of DC motor control system</i> • <i>Lab Task 2</i> <i>Analyze response of water height control system</i> • <i>Lab Task 3</i> Create a simple program to use PLC • <i>Lab Task 4</i> <i>Analyze uses of sensor in control system</i>	25

Mg ke/ Week (1)	Sub CP-MK / Lesson Learning Outcomes (LLO) (2)	Bentuk Asesmen (Penilaian) Form of Assessment (3)	Bobot / Load (%) (4)
12-14	Sub CP-MK 8: Mahasiswa memahami representasi state space dari sistem waktu kontinu dan diskrit LLO 8: <i>Students understand state space representation in a continuous-time and discrete-time system</i>	- Tugas Tertulis 7 Menentukan representasi state space dari sebuah sistem - Tugas Pemrograman 3 Melakukan proses sampling Membuat program untuk menganalisa sistem pengaturan digital <i>Written Task 7 Determining state space representation in a system</i> <i>Programming Task 3 Do sampling process and create program to analyze digital control system</i> <i>1 soal pada EAS (1 Question in Final Exam)</i>	10
16	Evaluasi Akhir Final Exam	Tes: Ujian Tulis/Ujian Daring Test: <i>Writing Exams / Online Exams</i>	20
Total bobot penilaian Total assessment load			100%

- **Indikator Pencapaian CPL Pada MK / *Indicator of PLO achievement charged to the course***

CPL yang dibebankan pada MK / <i>PLO charged to the course</i>	CPMK / <i>Course Learning Outcome (CLO)</i>	Minggu ke / <i>Week</i>	Bentuk Asesmen / <i>Form of Assessment</i>	Bobot / <i>Load (%)</i>
CPL-01 / PLO-01	CPMK 1 / CLO 1	Week-1	Task 1 + Demo 1	10
		Week-8	Mid Exam Question 1 and 2	
	CPMK 2 / CLO 2	Week-3	Task 2	2.5
		Week-8	Mid Exam Question 3 and 4	
		Week-16	Final Exam Question 1	
CPL-02 / PLO-02	CPMK 5 / CLO 5	Week-9	Task 5	2.5
		Week-16	Final Exam Question 2	
	CPMK 6 / CLO 6	Week-10	Task 6	2.5
		Week-16	Final Exam Question 3	
CPL-03 / PLO-03	CPMK 3 / CLO 3	Week-4,5	Task 3 + Demo 2	10
		Week-8	Mid Exam Question 3 and 4	
		Week-16	Final Exam Question 4	
	CPMK 4 / CLO 4	Week-6,7	Task 4	2.5
		Week-8	Mid Exam Question 5	
		Week-16	Final Exam Question 5	
	CPMK 7 / CLO 7	Week-11	Lab Task 1-4	25
	CPMK 8 / CLO 8	Week-12,13,14	Task 7 + Demo 3	10
		Week-16	Final Exam Question 6	
				$\Sigma = 100\%$

No	Form of Assessment	PLO-01	PLO-02	PLO-03	PLO-04	PLO-05	PLO-06	PLO-07	PLO-08	PLO-09	PLO-10	PLO-11	PLO-12	Total
1	Task 1 + Demo 1	0.1												0.1
2	Task 2	0.025												0.025

3	<i>Task 3 + Demo 2</i>			0.1										0.1
4	<i>Task 4</i>			0.025										0.025
5	<i>Task 5</i>		0.025											0.025
6	<i>Task 6</i>		0.025											0.025
7	<i>Task 7 + Demo 3</i>			0.1										0.1
8	<i>Laboratory Task</i>			0.25										0.25
9	<i>Mid Exam</i>	0.15												0.15
10	<i>Final Exam</i>	0.2												0.2
	<i>Total</i>	0.475	0.05	0.475										1