



MODULE HANDBOOK

FUNDAMENTALS OF SIGNAL PROCESSING



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

INSTITUT TEKNOLOGI SEPULUH NOPEMBER

ENDORSEMENT PAGE



MODULE HANDBOOK Fundamentals of Signal Processing DEPARTMENT OF BIOMEDICAL ENGINEERING INSTITUT TEKNOLOGI SEPULUH NOPEMBER Number : B/21350/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	Nada Fitriyatul Hikmah, S.T., M.T.	Dosen Lecturer		November 23, 2019
Pemeriksa dan Pengendalian Review and Control	Eko Agus Suprayitno, S.Si., M.T.	Tim kurikulum Curriculum team		February 11, 2020
Persetujuan Approval	Dr. Rachmad Setiawan, S.T., M.T.	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 SIGNAL PROCESSING

Module name	Fundamentals of Signal Processing	
Module level	Undergraduate	
Code	EB184401	
Course (if applicable)	Fundamentals of Signal Processing	
Semester	Second Semester (Genap)	
Person responsible for the module	Nada Fitriyatul Hikmah, S.T., M.T.	
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 fundamental signal and system analysis CLO 2: Students understand and are able to analyze Linear Time Invariant Systems in several domains CLO 3: Students understand and are able to analyze continuous-time signal such as: singularity function, exponential and geometrical complex, Fourier transform and representation CLO 4: Students understand and are able to analyze discrete-time signal such as: singularity function,	

	exponential and geometrical complex, Fourier transform and representation, sampling and signal reconstruction CLO 5: Students are able to design simple digital filters	
Content	This course consists of fundamentals of signal and system analysis, with focus upon representation of continuous and discrete time signals (singularity function, exponential and geometrical complex, Fourier representation, Laplace and Z transformation, signal sampling and reconstruction) and Linear Time Invariant system representation (differential equation, block diagram, system function, pole and zero, convolution, step and impulse response, frequency response), and basic digital filter design.	
Study and examination requirements and forms of examination	• In-class exercises • Assignment 1, 2, 3, 4, 5, 6 • Quiz 1, 2 • Mid-term examination • Final examination	
Media employed	LCD, whiteboard, websites (myITS Classroom), zoom.	
Reading list	Main: 1. Alan V. Oppenheim and Alan Wilsky, "Signals and Systems," 2nd Ed., Prentice Hall. 2. L. C. Ludeman, "Fundamentals of Digital Signal Processing", Harper and Row, 1986. 3. John G. Proakis, Dimitris G. Manolakis, "Digital Signal Processing: Principles, Algorithms, Applications," Prentice Hall, 1996. Supporting: 1. Paulo S.R. Diniz, Eduardo A.B. da Silva, dan Sergio L. Netto, "Digital Signal Processing: System Analysis and Design," Cambridge University Press, 2002. 2. Monson H. Hayes, "Digital Signal Processing," Schaum's Outlines Series, McGraw Hill, 1999. 3. Andre Quinquins, "Digital Signal Processing with MATLAB," John Wiley, 2007.	

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 Pengolahan Sinyal Fundamentals of Signal Processing	EB184401	Biomedical Instrumentation and Signal Processing	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>	
	(Nada Fitrieyatul Hikmah, S.T., M.T.)		(Dr. Rachmad Setiawan, S.T., M.T.)		(Dr. Achmad Arifin, S.T., M.Eng.)	
Capaian Pembelajaran <i>Learning Outcomes</i>	CPL-PRODI yang dibebankan pada MK <i>PLO Program Charged to the Course</i>					
	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-06 <i>PLO-06</i>	Mampu menerapkan ilmu pengetahuan, keterampilan, dan metode terkini dalam menyelesaikan permasalahan di bidang Teknik Biomedika				

		Able to apply the latest knowledge, skills and methods in solving problems in the field of Biomedical Engineering												
	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 dasar analisis sinyal dan sistem Students understand fundamental signal and system analysis												
	CP MK 2 CLO 2	Mahasiswa memahami dan mampu melakukan analisis terhadap sistem linear dan tidak berubah terhadap waktu (LTI) di beberapa domain Students understand and able to analyze Linear Time Invariant System in several domain												
	CP MK 3 CLO 3	Mahasiswa memahami dan mampu melakukan analisis sinyal waktu kontinu seperti fungsi singular, eksponensial dan geometri kompleks, representasi dan transformasi Fourier Students understand and are able to analyze continuous-time signal such as: singularity function, exponential and geometrical complex, Fourier transform and representation												
	CP MK 4 CLO 4	Mahasiswa memahami dan mampu melakukan analisa sinyal waktu diskrit: Fungsi singular, Eksponensial dan geometri kompleks, representasi dan transformasi Fourier, sampling dan rekonstruksi sinyal Students understand and are able to analyze discrete-time signal such as: singularity function, exponential and geometrical complex, Fourier transform and representation, sampling and signal reconstruction												
	CP MK 5 CLO 5	Mahasiswa mampu merancang filter digital sederhana Students are able to design simple digital filters												
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	√						√					

Diskripsi Singkat MK Short Description of Course	Mata kuliah ini mempelajari tentang dasar analisa sinyal dan system, dengan fokus terhadap representasi sinyal waktu kontinyu dan diskrit (fungsi singularitas, kompleks eksponensial dan geometri, representasi Fourier, transformasi Laplace and Z, sampling dan rekonstruksi sinyal) dan representasi sistem LTI (persamaan diferensial, blok diagram, fungsi sistem, pole dan zero, konvolusi, respon step dan impuls, respon frekuensi), dan dasar perancangan filter digital. <i>This course consists of fundamentals of signal and system analysis, with focus upon representation of continuous and discrete time signals (singularity function, exponential and geometrical complex, Fourier representation, Laplace and Z transformation, signal sampling and reconstruction) and Linear Time Invariant system representation (differential equation, block diagram, system function, pole and zero, convolution, step and impulse response, frequency response), and basic digital filter design.</i>
Bahan Kajian: Materi pembelajaran Course Materials:	1. Pengenalan sinyal dan sistem / <i>Signal and System Introduction</i> 2. Sistem Linear Time Invariant (LTI) / <i>Linear Time Invariant System</i> 3. Representasi Fourier waktu kontinyu dari sinyal periodik / <i>Fourier Representation of Continuous-Time Periodical Signal</i> 4. Transformasi Fourier waktu kontinyu / <i>Fourier Transform of Continuous Time Signal</i> 5. Transformasi Laplace / <i>Laplace Transform</i> 6. Proses sampling dan rekonstruksi sinyal: Proses sampling sinyal kontinyu, Teorema Nyquist, Rekonstruksi Sinyal, Up-sampling, Down-sampling, sampling and hold / <i>Signal sampling and reconstruction process: Continuous signal sampling process, Nyquist Theorem, Signal Reconstruction, Up-sampling, Down-sampling, hold and sampling</i> 7. Representasi Fourier waktu diskrit dari sinyal periodik / <i>Fourier Representation of Discrete-Time Periodical Signal</i> 8. Transformasi Fourier Diskrit dan Fast Fourier Transform (FFT) / <i>Discrete Fourier Transform and Fast Fourier Transform (FFT)</i> 9. Transformasi Z / <i>Z Transform</i> 10. Perancangan filter digital: LPF, HPF, BPF, BSF, FIR, IIR / <i>Designing Digital Filter: LPF, HPF, BPF, BSF, FIR, IIR</i>
Pustaka References	Utama / Main: 1. Alan V. Oppenheim and Alan Wilsky, "Signals and Systems," 2nd Ed., Prentice Hall. 2. L. C. Ludeman, "Fundamentals of Digital Signal Processing", Harper and Row, 1986. 3. John G. Proakis, Dimitris G. Manolakis, "Digital Signal Processing: Principles, Algorithms, Applications," Prentice Hall, 1996. Pendukung / Supporting: 1. Paulo S.R. Diniz, Eduardo A.B. da Silva, dan Sergio L. Netto, "Digital Signal Processing: System Analysis and Design," Cambridge University Press, 2002. 2. Monson H. Hayes, "Digital Signal Processing," Schaum's Outlines Series, McGraw Hill, 1999.

3. Andre Quinquins, "Digital Signal Processing with MATLAB," John Wiley, 2007.							
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;</i> [<i>Estimated Time</i>]		Materi Pembelajaran [<i>Pustaka</i>] / <i>Learning Material</i> [<i>Reference</i>]	Bobot Penilaian / <i>Assessment Load (%)</i>
		Indikator / <i>Indicator</i>	Kriteria & Teknik / <i>Criteria & Techniques</i>	Tatap Muka / <i>In-class (5)</i>	Daring / <i>Online (6)</i>	(7)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	Mahasiswa memahami dasar analisa sinyal dan sistem <i>Students understand fundamental signal and system analysis</i>	- Mampu menentukan klasifikasi sebuah sinyal berdasarkan karakteristiknya - Mampu melakukan analisa terhadap suatu sinyal	Tugas Tertulis 1 Melakukan analisa dasar terhadap sinyal Menentukan karakteristik sebuah sistem	- Kuliah dan brainstorming, tanya jawab. [TM : 4 x 50"] [BM : 4 x 60"] [PT : 4 x 50"] <i>Presentation and</i>	- Chatting dan diskusi dalam forum platform ITS. <i>Chat and discussion in ITS platform forum.</i>	- Pengertian Sinyal dan Sistem - Klasifikasi Sinyal - Macam-macam sinyal - Karakteristik sistem	7.5

		• Mampu menentukan karakteristik dari sebuah sistem • Mampu merepresentasikan sinyal dan hasil transformasi sinyal tersebut dengan menggunakan MATLAB • <i>Able to classify signal based on its characteristics</i> • <i>Able to analyze certain signal</i> • <i>Able to determine characteristics of a system</i> • <i>Able to represent signal and its transformation using MATLAB</i>	• Tugas Pemrograman 1 Merepresentasi kan sinyal dengan menggunakan MATLAB • <i>Written Task 1 Basic analysis of signal, determining system characteristics</i> • <i>Programming Task 1 Representing signal using Matlab</i>	<i>brainstorming, ask and answer.</i> <i>[FF : 4 x 50"]</i> <i>[SA : 4 x 60"]</i> <i>[SS : 4 x 50"]</i>		• <i>Understanding Signal and System</i> • <i>Signal Classification</i> • <i>Types of Signal</i> • <i>System Characteristics</i>	
2	Mahasiswa memahami dan mampu melakukan analisa terhadap sistem linear dan tidak berubah terhadap waktu (LTI) pada domain waktu <i>Students understand and able to analyze Linear Time Invariant System in time domain</i>	• Mampu menentukan respon sebuah sistem dengan menggunakan konvolusi • Mampu menentukan respon terhadap unit impuls dan step berdasarkan persamaan beda dan diferensial	• Tugas Tertulis 2 Menghitung respon sistem dengan menggunakan konvolusi; Menentukan karakteristik sistem LTI	• Kuliah dan brainstorming, tanya jawab. [TM : 4 x 50"] [BM : 4 x 60"] [PT : 4 x 50"] • <i>Presentation and brainstorming,</i>	• Chatting dan diskusi dalam forum platform ITS. • <i>Chat and discussion in ITS platform forum.</i>	• Sistem LTI • Respon terhadap unit Impuls • Konvolusi waktu kontinu dan diskrit • Karakteristik sistem LTI berdasarkan respon terhadap unit impuls	5

		• Mampu menentukan karakteristik sebuah sistem LTI • Mampu menentukan respon sebuah sistem LTI melalui program konvolusi yang dibuat sendiri di MATLAB • <i>Able to determine system's response using convolution</i> • <i>Able to determine the response of impulse unit and step based on differential equation</i> • <i>Able to determine LTI System characteristics</i> • <i>Able to determine LTI System's response using convolution program, self made through MATLAB</i>	berdasarkan respon terhadap unit impuls; Menghitung respon terhadap unit impuls dan step dengan menggunakan persamaan diferensial dan beda • Tugas Pemrograman 2 Membuat program untuk menghitung konvolusi dengan menggunakan MATLAB • <i>Written Task 2 Calculate system's response using convolution; determining LTI System's characteristics based on</i>	<i>ask and answer.</i> [FF : 4 x 50"] [SA : 4 x 60"] [SS : 4 x 50"]		• Respon terhadap unit impuls dan step dengan menggunakan persamaan differensial dan beda • <i>LTI System</i> • <i>Response of unit impulse</i> • <i>Continuous and Discrete Time convolution</i> • <i>LTI System Characteristics based on response of unit impulse</i> • <i>Response of impulse and step units using differential equations</i>	
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			<i>respons of unit impulse and step using differential equation</i> • <i>Programming Task 2 Creating a program to calculate convolution using MATLAB</i>				
3,4	Mahasiswa memahami dan mampu melakukan analisa sinyal waktu kontinu seperti fungsi singular, eksponensial dan geometri kompleks, representasi dan transformasi Fourier <i>Students understand and are able to analyze continuous-time signal such as: singularity function, exponential and geometrical complex, Fourier transform and representation</i>	• Mampu merepresentasikan sinyal dalam bentuk Representasi atau Transformasi Fourier sesuai dengan karakteristiknya • Mampu melakukan analisa sinyal dan sistem dalam domain frekuensi dan mentransformasi balik ke domain waktu	• Tugas Tertulis 3 Merepresentasikan sinyal periodik dalam bentuk Representasi Fourier Menentukan transformasi sinyal menggunakan karakteristik Representasi Fourier Merepresentasikan sinyal waktu kontinu dalam bentuk	• 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"]	• Chatting dan diskusi dalam forum platform ITS. • <i>Chat and discussion in ITS platform forum.</i>	• Representasi Fourier dalam bentuk Trigonometri • Representasi Fourier dalam bentuk kompleks eksponensial • Karakteristik Representasi Fourier • Tranformasi Fourier • Karakteristik Transformasi Fourier	10

		• Mampu melakukan analisa sinyal dalam domain frekuensi dengan menggunakan MATLAB • <i>Able to represent signal according to the representation or Fourier's transformation according to the characteristics</i> • <i>Able to analyze signal and system in frequency domain and transform it back to time domain</i> • <i>Able to analyze signal in frequency domain using MATLAB</i>	Transformasi Fourier Menentukan respon frekuensi sebuah sistem berdasarkan karakteristik Transformasi Fourier • Tugas Pemrograman 3 Membuat program untuk merepresentasikan sinyal dalam domain frekuensi • <i>Written Task 3 Representing periodic signals in Fourier representation, determining signal transformation using Fourier's representation characteristics, Representing</i>	<i>[SS : 2 x 4 x 50"]</i>		• <i>Representing Fourier through Trigonometry</i> • <i>Fourier representation using exponential complex</i> • <i>Fourier representation characteristics</i> • <i>Fourier Transformation</i> • <i>Fourier transformartion characteristics</i>	
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			<i>continuous-time signals by Fourier Transformation, Determining frequency response of system based on Fourier's transformation characteristics</i> • <i>Programming Task 3 Create a program to represent signal in frequency domain</i>				
5	Mahasiswa memahami dan mampu melakukan analisa terhadap sistem linear dan tidak berubah terhadap waktu (LTI) pada domain Laplace. <i>Students understand and able to analyze Linear Time Invariant System in Laplace domain</i>	• Mampu merepresentasikan sinyal dan sistem pada domain Laplace • Mampu menentukan respon sistem LTI pada domain Laplace dan mentransformasikan kembali pada domain waktu	• Tugas Tertulis 4 Merepresentasi kan sinyal dan sistem LTI pada domain Laplace Melakukan analisa terhadap sinyal dan sistem LTI pada domain Laplace • Quiz 1	• 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"]</i>	• Chatting dan diskusi dalam forum platform ITS. • <i>Chat and discussion in ITS platform forum.</i>	• Transformasi Laplace • Analisa Sistem LTI pada domain Laplace: Fungsi Transfer, Diagram Pole dan Zero • <i>Laplace Transformation</i> • <i>LTI System Analysis on Laplace domain: Transfer</i>	12.5

		• Mampu menganalisa kestabilan sistem berdasarkan diagram pole dan zero • <i>Able to represent signal and system on Laplace domain</i> • <i>Able to determine LTI System response on Laplace domain and transform back to time domain</i> • <i>Able to analyze system stability based on pole and zero diagram</i>	• <i>Written Task 4 Represent LTI signal and system on Laplace domain Analyze signal and LTI system on Laplace domain</i> • <i>Quiz 1</i>	[SA : 4 x 60"] [SS : 4 x 60"]		<i>Function, Pole and Zero Diagram</i>	
6,7	Mahasiswa mampu melakukan proses sampling dan rekonstruksi sinyal <i>Students able to do signal sampling and signal reconstruction process</i>	• Mampu melakukan sampling sinyal menjadi sinyal diskrit • Mampu merekonstruksi ulang sinyal diskrit menjadi sinyal kontinu • <i>Able to sample signal into a discrete signal</i> • <i>Able to reconstruct discrete signal into continuous signal</i>	• Tugas Pemrograman 4 Membuat program untuk melakukan sampling sinyal kontinu dan merekonstruksi nya kembali • <i>Programming Task 4 Creating a program to sample continuous signal</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>	• Chatting dan diskusi dalam forum platform ITS. • <i>Chat and discussion in ITS platform forum.</i>	• Sampling and Hold • Rekonstruksi sinyal diskrit menjadi sinyal kontinu • <i>Sampling and Hold</i> • <i>Discrete signal reconstruction into continuous signal</i>	2.5

			<i>and reconstruct it back</i>	<i>[FF : 2 x 4 x 50"]</i> <i>[SA : 2 x 4 x 60"]</i> <i>[SS : 2 x 4 x 60"]</i>			
8	EVALUASI TENGAH SEMESTER MID-SEMESTER EXAM						15
9, 10	Mahasiswa memahami dan mampu melakukan analisa sinyal waktu diskrit seperti fungsi singular, eksponensial dan geometri kompleks, representasi dan transformasi Fourier <i>Students understand and are able to analyze discrete-time signal such as: singularity function, exponential and geometrical complex, Fourier transform and representation</i>	- Mampu merepresentasikan sinyal dalam bentuk Representasi atau Transformasi Fourier sesuai dengan karakteristiknya - Mampu melakukan analisa sinyal dan sistem dalam domain frekuensi dan mentransformasi balik ke domain waktu - Mampu melakukan analisa sinyal dalam domain frekuensi dengan menggunakan MATLAB	Tugas Tertulis 5 Merepresentasikan sinyal periodik dalam bentuk Representasi Fourier Menentukan transformasi sinyal menggunakan karakteristik Representasi Fourier Merepresentasikan sinyal waktu kontinu dalam bentuk	- 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> [FF : 2 x 4 x 50"] [SA : 2 x 4 x 60"]	- Chatting dan diskusi dalam forum platform ITS. <i>Chat and discussion in ITS platform forum.</i>	- Representasi Fourier dalam bentuk Trigonometri - Representasi Fourier dalam bentuk kompleks eksponensial - Karakteristik Representasi Fourier - Tranformasi Fourier - Karakteristik Transformasi Fourier <i>Fourier Transformation</i>	10

		• <i>Able to represent signal in Fourier representation or transformation abiding with its characteristics</i> • <i>Able to analyze signal and system in frequency domain and retransform it back to time domain</i> • <i>Able to analyze signal in frequency domain using MATLAB</i>	Transformasi Fourier Menentukan respon frekuensi sebuah sistem berdasarkan karakteristik Transformasi Fourier • <i>Written Task 5 Represent periodic signals with Fourier representation, determining signal transformation using Fourier Representation characteristics, Representing continuous-time signal with Fourier Transformation, determining frequency response using Fourier</i>	[SS : 2 x 4 x 60"]		<i>using trigonometry</i> • <i>Fourier transformation using exponential complex</i> • <i>Fourier Representation characteristics</i> • <i>Fourier Transformation</i> • <i>Fourier Transformation characteristics</i>	
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			<i>Transformation characteristics</i> • Tugas Pemrograman 5 • Membuat program untuk merepresentasikan sinyal dalam domain frekuensi				
11	Mahasiswa memahami dan mampu melakukan analisa terhadap sistem linear dan tidak berubah terhadap waktu (LTI) pada domain Z <i>Students understand and able to analyze Linear Time Invariant System in Z domain</i>	• Mampu merepresentasikan sinyal dan sistem pada domain Laplace • Mampu menentukan respon sistem LTI pada domain Laplace dan mentransformasikan kembali pada domain waktu • <i>Able to represent signal and system in Laplace domain</i> • <i>Able to determine LTI System response in Laplace domain and transform it back to time domain</i>	• Tugas Tertulis 6 Merepresentasikan sinyal dan sistem LTI pada domain Z Melakukan analisa terhadap sinyal dan sistem LTI pada domain Z • <i>Written Task 6 Represent signal and LTI system in Z domain, able to analyze signal and LTI Systems in Z 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>	• Transformasi Z • Karakteristik Transformasi Z • Analisa sistem LTI dengan Transformasi Z • <i>Z Transformation</i> • <i>Z Transformation characteristics</i> • <i>LTI System analysis using Z Transformation</i>	2.5

12,13, 14	Mahasiswa mampu merancang filter digital sederhana <i>Students are able to design simple digital filters</i>	• Mampu mendesain filter digital sederhana sesuai dengan ketentuan • <i>Able to design digital filter as required</i>	• Tugas Pemrograman 6 Membuat program filter digital sederhana • Quiz 2 • <i>Programming Task 6 Creating simple digital filter</i> • Quiz 2	• 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>	• LPF (Low Pass Filter) • HPF (High Pass Filter) • BPF (Band Pass Filter) • FIR (Finite Impulse Response) • IIR (Infinite Impulse Response)	15
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 Signal Processing			RA&E
				Write Doc Code
Kode/code: EB184401	Bobot sks/credits (T/P): 4/0	Rumpun MK: Biomedical Instrumentation and Signal Processing Course Cluster: Biomedical Instrumentation and Signal Processing	Smt: IV	
OTORISASI AUTHORIZATION	Penyusun RA & E Compiler A&EP Nada Fitriyatul Hikmah, S.T., M.T.	Koordinator RMK Course Cluster Coordinator Dr. Rachmad Setiawan, S.T., M.T.	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	Sub CP-MK 1: Mahasiswa memahami dasar analisa sinyal dan sistem LLO 1: <i>Students understand fundamental signal and system analysis</i>	- Tugas Tertulis 1 Melakukan analisa dasar terhadap sinyal Menentukan karakteristik sebuah sistem - Tugas Pemrograman 1 Merepresentasikan sinyal dengan menggunakan MATLAB - Written Task 1 Basic analysis of signal, determining system characteristics - Programming Task 1 Representing signal using Matlab 1 soal pada Quiz 1 (1 Question in Quiz 1) 1 soal pada ETS (1 Question in Midterm Exam)	7.5
2	Sub CP-MK 2: Mahasiswa memahami dan mampu melakukan analisa terhadap sistem linear dan tidak berubah	Tugas Tertulis 2 Menghitung respon sistem dengan menggunakan konvolusi; Menentukan karakteristik sistem LTI berdasarkan respon terhadap unit impuls; Menghitung respon terhadap unit impuls dan step dengan menggunakan persamaan diferensial dan beda	5

Mg ke/ Week (1)	Sub CP-MK / Lesson Learning Outcomes (LLO) (2)	Bentuk Asesmen (Penilaian) Form of Assessment (3)	Bobot / Load (%) (4)
	terhadap waktu (LTI) pada domain waktu LLO 2: <i>Students understand and able to analyze Linear Time Invariant System in time domain</i>	- Tugas Pemrograman 2 Membuat program untuk menghitung konvolusi dengan menggunakan MATLAB <i>Written Task 2</i> <i>Calculate system's response using convolution; determining LTI System's characteristics based on respons of unit impulse and step using differential equation</i> <i>Programming Task 2</i> <i>Creating a program to calculate convolution using MATLAB</i> 1 soal pada Quiz 1 (1 Question in Quiz 1) 2 soal pada ETS (2 Questions in Midterm Exam) 1 soal pada EAS (2 Questions in Final Exam)	
3-4	Sub CP-MK 3: Mahasiswa memahami dan mampu melakukan analisa sinyal waktu kontinu seperti fungsi singular, eksponensial dan geometri kompleks, representasi dan transformasi Fourier LLO 3: <i>Students understand and are able to analyze continuous-time signal such as: singularity function, exponential and geometrical complex, Fourier transform and representation</i>	- Tugas Tertulis 3 Merepresentasikan sinyal periodik dalam bentuk Representasi Fourier Menentukan transformasi sinyal menggunakan karakteristik Representasi Fourier Merepresentasikan sinyal waktu kontinu dalam bentuk Transformasi Fourier Menentukan respon frekuensi sebuah sistem berdasarkan karakteristik Transformasi Fourier - Tugas Pemrograman 3 Membuat program untuk merepresentasikan sinyal dalam domain frekuensi <i>Written Task 3</i> <i>Representing periodic signals in Fourier representation, determining signal transformation using Fourier's representation characteristics, Representing continuous-time signals by Fourier Transformation, Determining frequency response of system based on Fourier's transformation characteristics</i> <i>Programming Task 3</i> <i>Create a program to represent signal in frequency domain</i> 1 soal pada Quiz 1 (1 Question in Quiz 1) 2 soal pada ETS (2 Questions in Midterm Exam) 1 soal pada EAS (2 Questions in Final Exam)	10

Mg ke/ Week (1)	Sub CP-MK / Lesson Learning Outcomes (LLO) (2)	Bentuk Asesmen (Penilaian) Form of Assessment (3)	Bobot / Load (%) (4)
5	Sub CP-MK 4: Mahasiswa memahami dan mampu melakukan analisa sinyal waktu kontinu seperti fungsi singular, eksponensial dan geometri kompleks, representasi dan transformasi Fourier LLO 4: <i>Students understand and are able to analyze continuous-time signal such as: singularity function, exponential and geometrical complex, Fourier transform and representation</i>	• Tugas Tertulis 4 Merepresentasikan sinyal dan sistem LTI pada domain Laplace Melakukan analisa terhadap sinyal dan sistem LTI pada domain Laplace • Quiz 1 • <i>Written Task 4</i> <i>Represent LTI signal and system on Laplace domain</i> <i>Analyze signal and LTI system on Laplace domain</i> • Quiz 1 • 2 soal pada ETS (2 Questions in Midterm Exam) • 1 soal pada EAS (1 Questions in Final Exam)	12.5
6-7	Sub CP-MK 5: Mahasiswa mampu melakukan proses sampling dan rekonstruksi sinyal LLO 5: <i>Students able to do signal sampling and signal reconstruction process</i>	• Tugas Pemrograman 4 Membuat program untuk melakukan sampling sinyal kontinu dan merekonstruksi nya kembali • <i>Programming Task 4</i> <i>Creating a program to sample continuous signal and reconstruct it back</i> • 1 soal pada EAS (1 Questions in Final Exam)	2.5
8	Evaluasi Tengah Semester Midterm Exam	Tes: Ujian Tulis/Ujian Daring Test: <i>Writing Exams / Online Exams</i>	15
9-10	Sub CP-MK 6: Mahasiswa memahami dan mampu melakukan analisa sinyal waktu diskrit seperti fungsi singular,	• Tugas Tertulis 5 Merepresentasikan sinyal periodik dalam bentuk Representasi Fourier Menentukan transformasi sinyal menggunakan karakteristik Representasi Fourier Merepresentasikan sinyal waktu kontinu dalam bentuk Transformasi Fourier	10

Mg ke/ Week (1)	Sub CP-MK / Lesson Learning Outcomes (LLO) (2)	Bentuk Asesmen (Penilaian) Form of Assessment (3)	Bobot / Load (%) (4)
	eksponensial dan geometri kompleks, representasi dan transformasi Fourier LLO 6: <i>Students understand and are able to analyze discrete-time signal such as: singularity function, exponential and geometrical complex, Fourier transform and representation</i>	Menentukan respon frekuensi sebuah sistem berdasarkan karakteristik Transformasi Fourier • <i>Written Task 5</i> <i>Represent periodic signals with Fourier representation, determining signal transformation using Fourier Representation characteristics, Representing continuous-time signal with Fourier Transformation, determining frequency response using Fourier</i> • 1 soal pada Quiz 2 (1 Question in Quiz 2) • 2 soal pada EAS (2 Questions in Final Exam)	
11	Sub CP-MK 7: Mahasiswa memahami dan mampu melakukan analisa terhadap sistem linear dan tidak berubah terhadap waktu (LTI) pada domain Z LLO 7: <i>Students understand and able to analyze Linear Time Invariant System in Z domain</i>	• Tugas Tertulis 6 Merepresentasikan sinyal dan sistem LTI pada domain Z Melakukan analisa terhadap sinyal dan sistem LTI pada domain Z • <i>Written Task 6</i> <i>Represent signal and LTI system in Z domain, able to analyze signal and LTI Systems in Z domain</i> • 1 soal pada Quiz 2 (1 Question in Quiz 2) • 1 soal pada EAS (1 Question in Final Exam)	2.5
12-14	Sub CP-MK 8: Mahasiswa mampu merancang filter digital sederhana LLO 8: <i>Students are able to design simple digital filters</i>	• Tugas Pemrograman 6 Membuat program filter digital sederhana • Quiz 2 • <i>Programming Task 6</i> <i>Creating simple digital filter</i> • Quiz 2 • 1 soal pada EAS (1 Question in Final Exam)	5
16	Evaluasi Akhir Final Exam	Tes: Ujian Tulis/Ujian Daring Test: Writing Exams / Online Exams	20

Mg ke/ Week (1)	Sub CP-MK / Lesson Learning Outcomes (LLO) (2)	Bentuk Asesmen (Penilaian) Form of Assessment (3)	Bobot / Load (%) (4)
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 / PLO charged to the course	CPMK / Course Learning Outcome (CLO)	Minggu ke / Week	Bentuk Asesmen / Form of Assessment	Bobot / Load (%)
CPL-01 / PLO-01	CPMK 2 / CLO 2	Week-2	Task 2 + Demo 2	5
		Week-5	Quiz 1 Question 2	
		Week-8	Mid Exam Question 1 and 2	
		Week-16	Final Exam Question 1	
CPL-02 / PLO-02	CPMK 1 / CLO 1	Week-1	Task 1 + Demo 1	7.5
		Week-5	Quiz 1 Question 1	
		Week-8	Mid Exam Question 1	
	CPMK 3 / CLO 3	Week-3	Task 3 + Demo 3	10
		Week-5	Quiz 1 Question 2	
		Week-8	Mid Exam Question 1 and 2	
		Week-16	Final Exam Question 2	
	CPMK 4 / CLO 4	Week-4	Task 4	12.5
		Week-8	Mid Exam Question 1 and 2	
		Week-16	Final Exam Question 3	
	CPMK 6 / CLO 6	Week-9,10	Task 5	10
		Week-12,13,14	Quiz 2 Question 1	
		Week-16	Final Exam Question 5	
	CPMK 7 / CLO 7	Week-11	Task 6	2.5
		Week-12,13,14	Quiz 2 Question 2	
		Week-16	Final Exam Question 6	
CPL-06 / PLO-06	CPMK 5 / CLO 5	Week-6,7	Demo 4	2.5
		Week-16	Final Exam Question 4	
	CPMK 8 / CLO 8	Week-12,13,14	Demo 6	5
		Week-16	Final Exam Question 7	
				$\Sigma = 100\%$

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		0.075											0.075
2	Task 2	0.05												0.05
3	Task 3		0.1											0.1
4	Task 4 (W)		0.025											0.025
5	Task 4 (P)						0.025							0.025
6	Task 5		0.1											0.1
7	Task 6 (W)		0.025											0.025
8	Task 6 (P)						0.05							0.05
9	Quiz 1	0.1												0.1
10	Quiz 2	0.1												0.1
11	Mid Exam	0.15												0.15
12	Final Exam	0.2												0.2
	Total	0.60	0.325				0.075							1