

Module Handbook

Biomedical Signal Processing and Laboratory



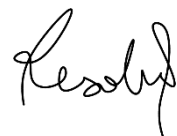
Bachelor Degree Program Department of Biomedical Engineering

Faculty of Intelligent Electrical Technology and Informatics
Institut Teknologi Sepuluh Nopember



MODULE HANDBOOK
Biomedical Signal Processing and Laboratory
DEPARTMENT OF BIOMEDICAL ENGINEERING
INSTITUT TEKNOLOGI SEPULUH NOPEMBER
Number : 6829/IT2.IX.5.1.2/B/PP.03.00.00/2023

ENDORSEMENT PAGE

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 18, 2022
Pemeriksa dan Pengendalian Review and Control	Dr. Norma Hermawan, S.T., M.Sc.	Tim kurikulum Curriculum team		November 20, 2022
Persetujuan Approval	Dr. Rachmad Setiawan, S.T., M.T.	Koordinator RMK Course Cluster Coordinator		April 13, 2023
Penetapan Determination	Dr. Achmad Arifin, S.T., M.Eng.	Kepala Departemen Head of Department		April 17, 2023

MODULE HANDBOOK

Biomedical Signal Processing and Laboratory

Module name	Biomedical Signal Processing and Laboratory	
Module level	Undergraduate	
Code	EB234404	
Course (if applicable)	Biomedical Signal Processing and Laboratory	
Semester	Second Semester (Genap)	
Person responsible for the module	Nada Fitriyatul Hikmah, S.T., M.T.	
Lecturer	Dr. Achmad Arifin, S.T., M.Eng. Muhammad Yazid, B.Eng., M.Eng. Nada Fitriyatul Hikmah, S.T., M.T. Eko Agus Suprayitno, S.Si., M.T. Fauzan Arrofiqi, S.T., M.T., Ph.D. Muhammad Adib Syamlan, S.T., M.T. Rasyida Shabihah Zukro Aini, S.T., M.T. Nabila Puspita Firdi S.T, M.Sc.	
Language	Bahasa Indonesia and English	
Relation to curriculum	Undergraduate degree program, mandatory , 4 th semester	
Type of teaching, contact hours	Lectures, < 60 students Wednesdays, 14.00-16.50 (GMT+7)	
Workload	1. Lectures : 3 x 50 = 150 minutes per week. 2. Exercises and Assignments : 3 x 60 = 180 minutes (3 hours) per week. 3. Private learning : 3 x 60 = 180 minutes (3 hours) per week.	
Credit points	3 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	Engineering Mathematics, Fundamentals of Signal Processing.	
Learning outcomes and their corresponding PLOs	Course Learning Outcome (CLO) after completing this module, CLO 1 : Students are able to understand and explain the origin, process and characteristics of biopotential signals CLO 2 : Students are able to explain and analyze digital filter for biomedical signal processing	PLO-05 PLO-05

	CLO 3 : Students are able to explain and analyze biomedical signal on frequency domain and time-frequency domain CLO 4 : Students are able to implement digital filter for biomedical signal processing on real practice CLO 5 : Students are able to implement and analyze biomedical signal on frequency domain CLO 6 : Students are able to implement and analyze biomedical signal on time-frequency domain CLO 7 : Practicum and Laboratory.	PLO-06 PLO-02 PLO-02 PLO-08 PLO-08
Content	This course studies the sources and characteristics of biopotential signal, digital filter design for biomedical signal, frequency domain analysis and time-frequency domain analysis	
Study and examination requirements and forms of examination	• In-class exercises • Assignment 1, 2, 3, 4, 5 • Lab Works 1, 2, 3, 4 • Mid-term examination • Final examination	
Media employed	LCD, whiteboard, websites (myITS Classroom), zoom.	
Reading list	Main : 1. Metin Akay (Ed), Nonlinear Biomedical Signal Processing, Volume I: Fuzzy Logic, Neural Networks, and New Algorithms. IEEE Press, New York, 2000. 2. Metin Akay (Ed), Nonlinear Biomedical Signal Processing, Volume II: Dynamic Analysis and Modeling. IEEE Press, New York, 2001. Supporting : 3. R. M. Enoka, Neuromechanics of Human Movements, Fifth Edition. Human Kinetics, Boulder, 2015. 4. W. J. Thompkins (Ed), Biomedical Digital Signal Processing, C-Language Examples and Laboratory Experiments for the IBM® PC. Prentice Hall Inc., New Jersey, 2000. 5. D.C. Reddy, Biomedical Signal Processing: Principles and Techniques. McGraw-Hill, New Delhi, 2005.	

I. Rencana Pembelajaran Semester / *Semester Learning Plan*

		INSTITUT TEKNOLOGI SEPULUH NOPEMBER (ITS) FACULTY OF INTELLIGENT ELECTRICAL AND INFORMATICS TECHNOLOGY BIOMEDICAL ENGINEERING DEPARTMENT					Document Code
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>Completion Date</i>
Pengolahan Sinyal Biomedika dan Laboratorium Biomedical Signal Processing and Laboratory		EB234404	Biomedical Instrumentation and Signal Processing	T=3	P=0	IV	Oct 31, 2023
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-02 PLO-02	Mampu mengkaji dan memanfaatkan ilmu pengetahuan dan teknologi dalam rangka mengaplikasikannya pada bidang Teknik Biomedik, serta mampu mengambil keputusan secara tepat dari hasil kerja sendiri maupun kerja kelompok dalam bentuk laporan tugas akhir atau bentuk kegiatan lain yang luarannya setara dengan tugas akhir melalui pemikiran logis, kritis, sistematis, dan inovatif. <i>Able to study and utilize science and technology in order to apply it to the field of Biomedical Engineering and able to make appropriate decisions from the results of one's own work or group work in the form of final assignment reports or forms of learning activities others whose output is equivalent to the final assignment through logical, critical, systematic and innovative thinking.</i>				

CPL-05	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.
PLO-05	<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	Mampu merancang dan melaksanakan eksperimen laboratorium dan/atau lapangan, menganalisa dan menginterpretasi data, serta menggunakan penilaian yang obyektif untuk menarik kesimpulan
PLO-06	<i>Able to design and implement laboratory experiment and / or field experiments, analyze and interpret data, and use objective assessments to draw conclusions.</i>
CPL-08	Mampu mendesain komponen, sistem, dan proses dalam bidang Teknik Biomedika yang sistematis, logis, dan realistis sesuai dengan spesifikasi yang ditentukan dengan mempertimbangkan aspek keselamatan, sosial, budaya, lingkungan, dan ekonomi dengan mengenali/memanfaatkan sumber daya lokal dan nasional dengan wawasan global.
PLO-08	<i>Able to design components, systems, and processes in the field of Biomedical Engineering that are systematic, logical, and realistic appropriate with specified specifications by considering aspects of safety, social, cultural, environmental, and economic by recognizing / utilizing local and national resources with global insight.</i>
Capaian Pembelajaran Mata Kuliah (CPMK) Course Learning Outcome (CLO) – if CLO as description capability of each Learning Stage in the course, then CLO = LLO	
CP MK 1 CLO 1	Mahasiswa memahami dan mampu menjelaskan asal, proses dihasilkannya, dan karakteristik dari sinyal biopotensial. <i>Students are able to understand and explain the origin, process and characteristics of biopotential signals</i>
CP MK 2 CLO 2	Mahasiswa mampu menjelaskan dan menganalisis filter digital untuk pengolahan sinyal biomedik. <i>Students are able to explain and analyze digital filter for biomedical signal processing</i>
CP MK 3 CLO 3	Mahasiswa mampu menjelaskan dan menganalisis sinyal biomedik berdasarkan domain frekuensi dan domain waktu-frekuensi. <i>Students are able to explain and analyze biomedical signal on frequency domain and time-frequency domain</i>
CP MK 4 CLO 4	Mahasiswa mampu menerapkan filter digital pada pengolahan sinyal biomedik dalam realisasi praktis. <i>Students are able to implement digital filter for biomedical signal processing on real practice</i>
CP MK 5 CLO 5	Mahasiswa mampu menerapkan dan menganalisis domain frekuensi pada sinyal biomedik. <i>Students are able to implement and analyze biomedical signal on frequency domain</i>
CP MK 6	Mahasiswa mampu menerapkan dan menganalisis sinyal biomedik berdasarkan domain waktu-frekuensi.

	CLO 6	<i>Students are able to implement and analyze biomedical signal on time-frequency domain</i>											
	CP MK 7 CLO 7	Praktikum dan Laboratorium. Practicum and Laboratory.											
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		√						√				
	CPMK 7 / SUB CPMK 7 CLO 7 / LLO 7		√						√				
Diskripsi Singkat MK Short Description of The Course	Mata kuliah Pengolahan Sinyal Biomedika dan Laboratorium merupakan mata kuliah wajib yang membahas pengolahan sinyal lanjut dengan masukan biosinyal. Matakuliah ini bertujuan agar mahasiswa mampu memahami prinsip-prinsip pengukuran dan sistem pemrosesan sinyal biomedika serta mampu mengembangkannya dalam praktek. Berdasarkan kemampuan dan penerapan pengolahan sinyal tersebut, mahasiswa mampu memanfaatkannya dalam disiplin ilmu teknik biomedik. <i>Biomedical Signal Processing and Laboratory course is a mandatory subject which discuss about the signal processing of biopotential signal. This course aims to make students understand the measurement principles and the development of biomedical signal processing system. Based on the ability and signal processing applicability, students are able to make use of it in biomedical engineering discipline.</i>												
Bahan Kajian: Materi pembelajaran	1. Asal usul, pembangkitan, dan karakteristik sinyal biopotensial. 2. Perencanaan filter digital untuk sinyal biomedik. 3. Analisis domain frekuensi pada sinyal biomedik.												

Course Materials:		4. Analisis domain waktu-frekuensi pada sinyal biomedik. 5. Keterampilan proses perencanaan filter digital. 6. Keterampilan proses analisis domain frekuensi. 7. Keterampilan proses analisis waktu-frekuensi.				
Pustaka		Utama / Main:				
		1. Metin Akay (Ed), Nonlinear Biomedical Signal Processing, Volume I: Fuzzy Logic, Neural Networks, and New Algorithms. IEEE Press, New York, 2000. 2. Metin Akay (Ed), Nonlinear Biomedical Signal Processing, Volume II: Dynamic Analysis and Modeling. IEEE Press, New York, 2001.				
		Pendukung / Supporting:				
		1. R. M. Enoka, Neuromechanics of Human Movements, Fifth Edition. Human Kinetics, Boulder, 2015. 2. W. J. Thompkins (Ed), Biomedical Digital Signal Processing, C-Language Examples and Laboratory Experiments for the IBM® PC. Prentice Hall Inc., New Jersey, 2000. 3. D.C. Reddy, Biomedical Signal Processing: Principles and Techniques. McGraw-Hill, New Delhi, 2005.				
Dosen Pengampu		Dr. Achmad Arifin, S.T., M.Eng. Muhammad Yazid, B.Eng., M.Eng. Nada Fitrieyatul Hikmah, S.T., M.T. Eko Agus Suprayitno, S.Si., M.T. Fauzan Arrofiqi, S.T., M.T., Ph.D. Muhammad Adib Syamlan, S.T., M.T. Rasyida Shabihah Zukro Aini, S.T., M.T. Nabila Puspita Firdi S.T, M.Sc.				
Matakuliah syarat		Engineering Mathematics, Fundamentals of Signal Processing.				
Mg Ke / Week	Kemampuan akhir tiap tahapan belajar (Sub-CPMK) /	Penilaian / Assesment		Bantuk Pembelajaran; Metode Pembelajaran; Penugasan Mahasiswa;	Materi Pembelajaran [Pustaka] /	Bobot Penilaian (%)

	<i>Final ability of each Learning stage (LLO)</i>	<i>Indikator / Indicator</i>	<i>Kriteria & Teknik / Criteria & Techniques</i>	<i>[Estimasi Waktu] / Form of Learning; Learning Methods; Student Assignment; [Estimated Time]</i>		<i>Learning Materials [Reference]</i>	<i>/ Assessment Load (%)</i>
(1)	(2)	(3)	(4)	Tatap Muka (5)	Daring (6)	(7)	(8)
1 - 2	Mahasiswa memahami dan mampu menjelaskan asal, proses dihasilkannya, dan karakteristik dari sinyal biopotensial. <i>Students are able to understand and explain the origin, process and characteristics of biopotential signals</i>	• Mampu menjelaskan perbedaan dari aksi potensial yang dihasilkan dari beberapa sumber • Mampu menjelaskan karakteristik dan tipe sinyal biopotensial • <i>Able to explain the difference of action potential signal from other source</i> • <i>Able to explain the characteristics and types of biopotential signal</i>	Non-tes : Tugas 1 : Resume mengenai perbedaan potensial aksi pada saraf, jaringan otot rangka, dan jaringan otot jantung (Tugas tertulis) Tes : Soal ETS 1 Non-test : Task 1 : <i>Make a resume about the difference of action potential in nerve, skeletal muscle tissue, and heart muscle</i>	• Kuliah dan brainstorming, tanya jawab [TM : 3 x 50"] [BM : 3 x 50"] [PT : 3 x 50"] • <i>Presentation and brainstorming, ask and answer. [FF : 3 x 50"] [SA : 3 x 50"] [SS : 3 x 50"]</i>	• Chatting dan diskusi dalam forum platform ITS • <i>Chat and discussion in ITS platform forum</i>	• Kontrak kuliah: - Motivasi belajar - Rencana pembelajaran - Aturan-aturan perkuliahan - Tujuan perkuliahan - Sistem penilaian, buku ajar/sumber pustaka • Sinyal Biopotensial - Asal usul - Karakteristik - Potensial aksi pada saraf - Potensial aksi pada jaringan otot rangka - Potensial aksi pada jaringan otot jantung • <i>Course contract :</i> - <i>Motivation to learn</i>	5

			tissue (Written assignment) Test : Mid-term examination question 1			- Lesson plan - Lectures rules - Course objective - Assessment system, textbooks / library resources • Biopotential signal - Sources - Characteristics - Action potential in nerve - Action potential in skeletal muscle tissue - Action potential in heart muscle tissue	
3 - 4	Mahasiswa mampu menjelaskan dan menganalisis filter digital untuk pengolahan sinyal biomedik. <i>Students are able to explain and analyze digital filter for</i>	• Mampu merancang filter digital dengan metode pole-zero • Mampu merancang infinite impulse response filter • Mampu merancang moving average filter	Non-tes : Tugas 2 Perancangan program komputer filter digital pole zero dan menganalisis pengaruh	• Kuliah, diskusi, tanya jawab, tugas dalam platform myITS Classroom [TM : 3 x 50"] [BM : 3 x 50"]	• Chatting dan diskusi dalam forum platform ITS • Chat and discussion in ITS platform forum	• Filter digital : - Metode pole-zero - Infinite Impulses Response (IIR) - Moving average filter	10

	<i>biomedical signal processing applications</i>	• Able to design pole-zero digital filter • Able to design infinite impulse response filter • Able to design moving average filter	parameter r dan $teta$ pada filter (Demo dan laporan) Tes : Soal ETS 2 Non-test : Task 2 : Computer program software design for digital pole-zero filter and analyzing the r and $teta$ parameter effect on the filter (Demonstration and report) Test : Mid-term examination question 2	[PT : 3 x 50"] • Presentation and brainstorming, ask and answer. [FF : 3 x 50"] [SA : 3 x 50"] [SS : 3 x 50"]		• Digital filter : - Pole-zero method - Infinite Impulse Response (IIR) - Moving average filter	
5 - 7	Mahasiswa mampu menjelaskan dan menganalisis sinyal biomedik berdasarkan domain frekuensi dan domain waktu-frekuensi.	• Mampu merancang beberapa teknik analisa sinyal biomedis pada domain frekuensi dan domain waktu-frekuensi	Non-tes : Tugas 3: Perancangan program komputer anaisis domain frekuensi dengan	• Kuliah, diskusi, tanya jawab, tugas dalam platform myITS Classroom	• Chatting dan diskusi dalam forum platform ITS	• Analisis sinyal biomedik domain frekuensi dan waktu-frekuensi : - DFT - FFT	20

	<i>Students are able to explain and analyze biomedical signal on frequency domain and time-frequency domain</i>	• <i>Able to design many biomedical signal analysis technique in frequency domain and time-frequency domain</i>	DFT dan FFT, serta menganalisis perbedaan keduanya (Demo dan laporan) Tugas 4: Perancangan program komputer CWT dan analisis sinyal menggunakan dekomposisi skala DWT (Demo dan laporan) Tes : Soal EAS 1 dan 2 Non-test : Task 3 : <i>Computer program design for frequency domain analysis using DFT and FFT, also analyzing their differences (Demonstration and report)</i>	[TM : 3 x 50"] [BM : 3 x 50"] [PT : 3 x 50"] • <i>Presentation and brainstorming, ask and answer.</i> [FF : 3 x 50"] [SA : 3 x 50"] [SS : 3 x 50"]	• <i>Chat and discussion in ITS platform forum</i>	- STFT - CWT - DWT • <i>Biomedical signal analysis on frequency and time-frequency domain :</i> - DFT - FFT - STFT - CWT - DWT	
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			Task 4 : Computer program design for CWT and signal analysis using DWT (Demonstration and report) Test : Fiinal examination question 1 and 2				
8	EVALUASI TENGAH SEMESTER						15
9 - 10	Mahasiswa mampu menerapkan filter digital pada pengolahan sinyal biomedik dalam realisasi praktis. <i>Students are able to implement digital filter for biomedical signal processing on real practice</i>	• Mampu merancang dan mengimplementasikan filter digital (LPF, HPF, BPF, BSF) • Able to design and implement digital filter (LPF. HPF, BPF, BSF)	Non-tes : Praktikum lab 1: Perancangan filter digital dengan menggunakan modul pengolahan sinyal Tes : Soal EAS 3 Non-test : Lab works 1: Digital filter design using signal processing module	• Kuliah, diskusi, tanya jawab, tugas dalam platform myITS Classroom [TM : 3 x 50"] [BM : 3 x 50"] [PT : 3 x 50"] • Presentation and brainstorming, ask and answer. [FF : 3 x 50"]	• Chatting dan diskusi dalam forum platform ITS • Chat and discussion in ITS platform forum	• Keterampilan penerapan filter digital : - LPF - HPF - BPF - BSF • Digital filter application skills : - LPF - HPF - BPF - BSF	10

			Test : <i>Final examination question 3</i>	[SA : 3 x 50"] [SS : 3 x 50"]			
11 - 12	Mahasiswa mampu menerapkan dan menganalisis domain frekuensi pada sinyal biomedik. <i>Students are able to implement and analyze biomedical signal on frequency domain</i>	• Mampu merancang dan mengimplementasikan teknik analisis domain frekuensi (DFT, FFT) • Able to design and implement frequency domain analysis technique (DFT, FFT)	Non-tes Praktikum Lab 2: Analisis domain frekuensi dengan menggunakan modul pengolahan sinyal Tugas 5: Menghitung nilai parameter jantung (misalnya heartrate) dengan menggunakan modul ECG (Demo dan laporan) Test : Soal EAS 4 Non-test : Lab works 2: Frequency domain analysis using signal processing module	• Kuliah, diskusi, tanya jawab, tugas dalam platform myITS Classroom [TM : 3 x 50"] [BM : 3 x 50"] [PT : 3 x 50"] • Presentation and brainstorming, ask and answer. [FF : 3 x 50"] [SA : 3 x 50"] [SS : 3 x 50"]	• Chatting dan diskusi dalam forum platform ITS • Chat and discussion in ITS platform forum	• Keterampilan penerapan analisis domain frekuensi : - DFT - FFT • Frequency domain analysis application skills : - DFT - FFT	15

			Task 5 : Calculating value of heart parameter (ex. heartrate) using ECG module (Demonstration and report) Test : Final examination question 4				
13 - 15	Mahasiswa mampu menerapkan dan menganalisis sinyal biomedik berdasarkan domain waktu-frekuensi. <i>Students are able to implement and analyze biomedical signal on time-frequency domain</i>	• Mampu merancang dan mengimplementasikan teknik analisis domain waktu-frekuensi (STFT, CWT) • Able to design and implement the time-frequency domain analysis technique (STFT, CWT)	Non-test : Praktikum Lab 3: Analisis domain waktu-frekuensi dengan menggunakan modul pengolahan sinyal Tes : Soal EAS 5 Non-test : Lab works 3: Time-frequency domain analysis using signal processing module	• Kuliah, diskusi, tanya jawab, tugas dalam platform myITS Classroom [TM : 3 x 50"] [BM : 3 x 50"] [PT : 3 x 50"] • Presentation and brainstorming, ask and answer. [FF : 3 x 50"] [SA : 3 x 50"] [SS : 3 x 50"]	• Chatting dan diskusi dalam forum platform ITS • Chat and discussion in ITS platform forum	• Keterampilan penerapan analisis domain waktu-frekuensi : - STFT - CWT • Time-frequency domain analysis application skills : - STFT - CWT	10

			<i>Test :</i> <i>Final examination</i> <i>question 5</i>				
16	EVALUASI AKHIR SEMESTER						15

TM=Tatap Muka, **PT**=Penugasan Terstruktur, **BM**=Belajar Mandiri.

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

	ASSESSMENT & EVALUATION PLAN BACHELOR DEGREE PROGRAM OF BIOMEDICAL ENGINEERING – FTEIC ITS Course : Biomedical Signal Processing and Laboratory			RA&E
				Write Doc Code
Kode / Code : EB234404	Bobot sks / Credits (T/P): 3/0	Rumpun MK: Instrumentasi Biomedik dan Pemrosesan Sinyal <i>Course Cluster : Biomedical Instrumentation and Signal Processing</i>	Smt: IV	
OTORISASI <i>AUTHORIZATION</i>	Penyusun RA & E <i>Compiler A&EP</i> Nada Fitriyatul H, S.T, M.T	Koordinator RMK <i>Course Cluster Coordinator</i> Dr. Rachmad Setiawan, S.T., M.T.	Ka DEP <i>Head of DEP</i> 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 menjelaskan asal, proses dihasilkannya, dan karakteristik dari sinyal biopotensial. LLO 2 : <i>Students are able to understand and explain the origin, process and characteristics of biopotential signals</i>	Non-tes : Tugas 1 : Resume mengenai perbedaan potensial aksi pada saraf, jaringan otot rangka, dan jaringan otot jantung (Tugas tertulis) Tes : Soal ETS 1 Non-test : Task 1 : <i>Make a resume about the difference of action potential in nerve, skeletal muscle tissue, and heart muscle tissue (Written assignment)</i> Test : <i>Mid-term examination question 1</i>	5
3 - 4	Sub CP-MK 2: Mahasiswa mampu menjelaskan dan menganalisis filter digital untuk	Non-tes : Tugas 2 Perancangan program komputer filter digital pole zero dan menganalisis pengaruh parameter r dan teta pada filter (Demo dan laporan)	10

Mg ke / Week (1)	Sub CP-MK / Lesson Learning Outcomes (LLO) (2)	Bentuk Asesmen (Penilaian) Form of Assessment (3)	Bobot / Load (%) (4)
	pengolahan sinyal biomedik. LLO 2 : <i>Students are able to explain and analyze digital filter for biomedical signal processing applications</i>	Tes : Soal ETS 2 Non-test : Task 2 : <i>Computer program software design for digital pole-zero filter and analyzing the r and $teta$ parameter effect on the filter (Demonstration and report)</i> Test : <i>Mid-term examination question 2</i>	
5 - 7	Sub CP-MK 3: Mahasiswa mampu menjelaskan dan menganalisis sinyal biomedik berdasarkan domain frekuensi dan domain waktu-frekuensi. LLO 3 : <i>Students are able to explain and analyze biomedical signal on frequency domain and time-frequency domain</i>	Non-tes : Tugas 3: Perancangan program komputer anaisis domain frekuensi dengan DFT dan FFT, serta menganalisis perbedaan keduanya (Demo dan laporan) Tugas 4: Perancangan program komputer CWT dan analisis sinyal menggunakan dekomposisi skala DWT (Demo dan laporan) Tes : Soal EAS 1 dan 2 Non-test : Task 3 : <i>Computer program design for frequency domain analysis using DFT and FFT, also analyzing their differences (Demonstration and report)</i> Task 4 : <i>Computer program design for CWT and signal analysis using DWT (Demonstration and report)</i> Test : <i>Final examination question 1 and 2</i>	20
8	Evaluasi Tengah Semester Mid Exam	Tes: Ujian Tulis/Ujian Daring Test: <i>Writing Exams / Online Exams</i>	15
9 - 10	Sub CP-MK 4: Mahasiswa mampu menerapkan filter digital pada	Non-tes : Praktikum lab 1:	10

Mg ke / Week (1)	Sub CP-MK / Lesson Learning Outcomes (LLO) (2)	Bentuk Asesmen (Penilaian) Form of Assessment (3)	Bobot / Load (%) (4)
	pengolahan sinyal biomedik dalam realisasi praktis. LLO 5 : <i>Students are able to implement digital filter for biomedical signal processing on real practice</i>	Perancangan filter digital dengan menggunakan modul pengolahan sinyal Tes : Soal EAS 3 Non-test : Lab works 1: <i>Digital filter design using signal processing module</i> Test : <i>Final examination question 3</i>	
11-12	Sub CP-MK 5 : Mahasiswa mampu menerapkan dan menganalisis domain frekuensi pada sinyal biomedik. LLO 5 : <i>Students are able to implement and analyze biomedical signal on frequency domain</i>	Non-tes Praktikum Lab 2: Analisis domain frekuensi dengan menggunakan modul pengolahan sinyal Tugas 5: Menghitung nilai parameter jantung (misalnya heartrate) dengan menggunakan modul ECG (Demo dan laporan) Test : Soal EAS 4 Non-test : Lab works 2: <i>Frequency domain analysis using signal processing module</i> Task 5 : <i>Calculating value of heart parameter (ex. heartrate) using ECG module (Demonstration and report)</i> Test : <i>Final examination question 4</i>	15
13-15	Sub CP-MK 6 : Mahasiswa mampu menerapkan dan menganalisis sinyal biomedik berdasarkan domain waktu-frekuensi. LLO 6 :	Non-tes : Praktikum Lab 3: Analisis domain waktu-frekuensi dengan menggunakan modul pengolahan sinyal Tes : Soal EAS 5 Non-test :	10

Mg ke / Week (1)	Sub CP-MK / Lesson Learning Outcomes (LLO) (2)	Bentuk Asesmen (Penilaian) Form of Assessment (3)	Bobot / Load (%) (4)
	<i>Students are able to implement and analyze biomedical signal on time-frequency domain</i>	Lab works 3: <i>Time-frequency domain analysis using signal processing module</i> Test : <i>Final examination question 5</i>	
16	Evaluasi Akhir Final Exam	Tes: Ujian Tulis/Ujian Daring Test: <i>Writing Exams / Online Exams</i>	15
Total bobot penilaian			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>Courses Learning Outcome (CLO)</i>	Minggu ke / <i>Week</i>	Bentuk Asesmen / <i>Form of Assessment</i>	Bobot / <i>Load (%)</i>
CPL-02 / <i>PLO-02</i>	CPMK 4 / <i>CLO 4</i>	Week 9	Lab Works 1	10
		Week 16	Final Exam Question 3	3
	CPMK 5 / <i>CLO 5</i>	Week 11	Task 5	5
		Week 12	Lab Works 2	10
		Week 16	Final Exam Question 4	3
	CPMK 6 / <i>CLO 6</i>	Week 13	Lab Works 3	10
		Week 16	Final Exam Question 5	3
CPL-05 / <i>PLO-05</i>	CPMK 1 / <i>CLO 1</i>	Week 1	Task 1	5
		Week 8	Mid Exam Question 1	7.5
CPL-06 / <i>PLO-06</i>	CPMK 3 / <i>CLO 3</i>	Week 5	Task 3	10
		Week 7	Task 4	10
		Week 16	Final Exam Question 1 - 2	6
CPL-08 / <i>PLO-08</i>	CPMK 2 / <i>CLO 2</i>	Week 3	Task 2	10
		Week 8	Mid Exam Question 2	7.5
				$\Sigma = 100\%$

No	Bentuk Asesmen	CPL-01	CPL-02	CPL-03	CPL-04	CPL-05	CPL-06	CPL-07	CPL-08	CPL-09	CPL-10	CPL-11	CPL-12	Total
1	Tugas 1 (Tugas 1-4)		0.03			0.08	0.03		0.03					0.15

No	Bentuk Asesmen	CPL-01	CPL-02	CPL-03	CPL-04	CPL-05	CPL-06	CPL-07	CPL-08	CPL-09	CPL-10	CPL-11	CPL-12	Total
	Assignment 1 (Task 1-4)													
2	Evaluasi Tengah Semester Midterm Exam		0.06			0.05	0.03		0.09					0.23
3	Tugas 2 (Tugas 5) Assignment 2		0.03			0.05	0.03		0.05					0.15
4	Final Project Final Project		0.11						0.11					0.23
5	Praktikum dan Laboratorium (Praktikum 1-3) Practicum and Laboratory		0.13						0.13					0.25

No	Bentuk Asesmen	CPL-01	CPL-02	CPL-03	CPL-04	CPL-05	CPL-06	CPL-07	CPL-08	CPL-09	CPL-10	CPL-11	CPL-1 2	Total
	y (Lab Works 1-3)													
	Total		0.35			0.18	0.08		0.40					1