



MODULE HANDBOOK

BIOMEDICAL INSTRUMENTATION SYSTEM AND LABORATORY



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

INSTITUT TEKNOLOGI SEPULUH NOPEMBER

ENDORSEMENT PAGE



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Biomedical Instrumentations System and
Laboratory
DEPARTMENT OF BIOMEDICAL ENGINEERING
 INSTITUT TEKNOLOGI SEPULUH NOPEMBER
 Number : 6827/IT2.IX.5.1.2/B/PP.03.00.00/2023

Proses Process	Penanggung Jawab Person in Charge			Tanggal Date
	Nama Name	Jabatan Position	Tandatangan Signature	
Perumus <i>Preparation</i>	Eko Agus Suprayitno, S.Si, M.T.	Dosen <i>Lecturer</i>		November 18, 2022
Pemeriksa dan Pengendalian <i>Review and Control</i>	Dr. Tri Arief Sardjono, S.T., M.T.	Tim kurikulum <i>Curriculum team</i>		November 20, 2022
Persetujuan <i>Approval</i>	Dr. Rachmad Setiawan, S.T., M.T.	Koordinator RMK <i>Course Cluster Coordinator</i>		April 13, 2023
Penetapan <i>Determination</i>	Dr. Achmad Arifin, S.T., M.Eng.	Kepala Departemen <i>Head of Department</i>		April 17, 2023

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MODULE HANDBOOK

Biomedical Instrumentation System and Laboratory

Module name	Biomedical Instrumentation System and Laboratory	
Module level	Undergraduate	
Code	EB234406	
Course (if applicable)	Biomedical Instrumentations and Laboratory	
Semester	4 (Genap)	
Person responsible for the module		
Lecturer		
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	<ol style="list-style-type: none"> 1. Lectures : 5 x 50 = 100 minutes per week. 2. Exercises and Assignments : 5 x 60 = 120 minutes (2 hours) per week. 3. Private learning : 5 x 60 = 120 minutes (2 hours) per week. 	
Credit points	5 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	<p>Course Learning Outcome (CLO) after completing this module,</p> <p>CLO 1 : Students are able to understand and explain the basic theory of measurement systems and biomedical instrumentation</p> <p>CLO 2 : Students are able to understand and explain the basic theory of operational amplifiers (op-amps) and also be able to design, analyze and formulate a series of op-amp circuits and their application in biomedical instrumentations</p> <p>CLO 3 : Students are able to understand and explain about the origin, the process it produces, and the characteristics of the biopotential signals.</p>	<p>PLO-02</p> <p>PLO-03</p> <p>PLO-02</p>


	<p>CLO 4 : Students are able to understand and explain the functions and principles of sensors and transducers in biomedical instrumentation and the basic concepts of electrodes, the types and equivalent circuits.</p> <p>CLO 5 : Students are able to understand, explain, calculate and analyze the parameters in sensors and transducers</p> <p>CLO 6 : Students are able to understand and explain the stage of sensor design in general through a phenomenon approach and material analogy</p> <p>CLO 7 : Students are able to understand and explain the principles of resistive-based sensors, inductive-based sensors, capacitive-based sensors, optical-based sensors, acoustic-based sensors, general applications and specifically in medical applications and also are able to design, analyze and realize a circuit of signal conditioning from these sensors</p> <p>CLO 8 : Students are able to understand and explain the stages of biomedical instrumentation design (ECG, EMG, EEG), and be able to design, analyze and realize a series of biomedical instrumentation</p>	<p>PLO-02</p> <p>PLO-02</p> <p>PLO-01</p> <p>PLO-05</p> <p>PLO-05</p>
Content	<p>This course studies the ideal operational amplifiers (op-amp) ,the application op-amp, biomedical signals, sensor’s parameters, resistive-based sensor principles, inductive-based sensor principles, capacitive-based sensor principles, optical-based sensors principles, acoustic-based sensor principles, basics of biomedical signals instrumentation which are instrumentation amplifiers, lead-fail detection circuit, baseline restoration circuit, optical isolation circuit and design of software for the data acquisition</p>	
Study and examination requirements and forms of examination	<ul style="list-style-type: none"> • In-class exercises • Assignment 1, 2, 3, 4, 5, 6, 7 • Lab Works 1, 2, 3, 4, 5, 6 • Mid-term examination • Final examination 	
Media employed	<p>LCD, whiteboard, websites (myITS Classroom), zoom.</p>	
Reading list	<p>Main :</p> <ol style="list-style-type: none"> 1. J. G. Webster, “Medical Instrumentation, Application and Design”, Houghton Mifflin Co, 1978 2. Metin Akay, “Biomedical Signal Detection”, IEEE Press 3. Joseph J. Carr, “Sensor and Circuits : Sensors, Transducers, and Supporting Circuits for Electronic Instrumentation, Measurement and Control”, T R Prentice Hall, Englewood Cliffs, New Jersey, 1993 4. Barry E Jones, “Instrumentation Measurement and Feedback, 	

TMH Edition”, McGraw-Hill Book Company (UK) Limited, 1978

Supporting :

5. J Bronzino, “Biomedical Engineering Handbook”, IEEE Press
6. Aston Richard, “Principles of Biomedical Instrumentation and Measurement”, Merrill Publishing Company, Singapore, 1990
7. R. Anandanatarajan, “Biomedical Instrumentation and Measurements”, PHI Learning Private Limited, Delhi, 2011
8. L E Kinsler, “Fundamental of Acoustics, Second Edition”, John Wiley & Sons, Inc New York, Chichester, Brisbane and Toronto, 1962
9. Frederick W. Kremkau, Diagnostic Ultrasound: Principles, Instrumentation, and Exercises, Second Edition”, Grune & Stratton, Inc, 1984
10. Bela G. Liptak, Kriszta Venczel, “Process Measurement: Instrument Engineers Handbook, Revised Edition”, Bela G, Liptak, 1969

I. Rencana Pembelajaran Semester / Semester Learning Plan

		INSTITUT TEKNOLOGI SEPULUH NOPEMBER (ITS) FACULTY OF INTELLIGENT ELECTRICAL AND INFORMATICS TECHNOLOGY DEPARTEMEN TEKNIK BIOMEDIK				Document Kode
		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>
Sistem Instrumentasi Biomedika dan Laboratorium <i>Biomedical Instrumentation System and Laboratory</i>	EB234406	Teknik Biomedik	T=5	P=0	V	27 Oktober 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 Fitriyatul 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	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-02	<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	Mampu merancang dan melaksanakan eksperimen laboratorium dan/atau lapangan, menganalisa dan menginterpretasi data, serta menggunakan penilaian yang obyektif untuk menarik kesimpulan				

PLO-03	<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-05	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 mengenal/memanfaatkan sumber daya lokal dan nasional dengan wawasan global.
PLO-05	<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 mampu memahami dan menjelaskan tentang teori dasar sistem pengukuran dan instrumentasi biomedika. <i>Students are able to understand and explain the basic theory of measurement systems and biomedical instrumentation.</i>
CP MK 2 CLO 2	Mahasiswa mampu memahami dan menjelaskan teori dasar <i>operational amplifier</i> (op-amp), serta mampu merancang, menganalisa dan merealisasikan rangkaian aplikasi op-amp dan penerapannya dalam instrumentasi biomedika. <i>Students are able to understand and explain the basic theory of operational amplifiers (op-amps) and also be able to design, analyze and formulate a series of op-amp circuits and their application in biomedical instrumentation.</i>
CP MK 3 CLO 3	Mahasiswa mampu memahami dan menjelaskan tentang asal, proses dihasilkannya, dan karakteristik dari sinyal biopotensial serta macam-macam sinyal biopotensial. <i>Students are able to understand and explain about the origin, the process it produces, and the characteristics of the biopotential signals.</i>
CP MK 4 CLO 4	Mahasiswa mampu memahami dan menjelaskan fungsi dan cara kerja sensor dan transduser dalam instrumentasi biomedika serta konsep dasar elektroda, macam-macam dan rangkaian ekivalennya. <i>Students are able to understand and explain the functions and principles of sensors and transducers in biomedical instrumentation and the basic concepts of electrodes, the types and equivalent circuits.</i>
CP MK 5 CLO 5	Mahasiswa mampu memahami, menjelaskan, menghitung dan menganalisa parameter-parameter pada sensor dan transduser <i>Students are able to understand, explain, calculate and analyze the parameters in sensors and transducers</i>
CP MK 6 CLO 6	Mahasiswa mampu memahami dan menjelaskan tahapan perancangan sensor secara umum melalui pendekatan fenomena dan analogi bahan <i>Students are able to understand and explain the stage of sensor design in general through a phenomenon approach and material analogy</i>

	<p>CP MK 7</p> <p>CLO 7</p>	<p>Mahasiswa mampu memahami dan menjelaskan tentang prinsip sensor berbasis resistif, induktif, kapasitif, optik dan akustik serta aplikasinya secara umum dan khususnya dalam aplikasi medis, serta mampu merancang, menganalisa dan merealisasikan rangkaian pengkondisi sinyal dari sensor tersebut</p> <p><i>Students are able to understand and explain the principles of resistive-based sensors, inductive-based sensors, capacitive-based sensors, optical-based sensors, acoustic-based sensors, general applications and specifically in medical applications and also are able to design, analyze and realize a circuit of signal conditioning from these sensors</i></p>																																																																																																																															
	<p>CP MK 8</p> <p>CLO 8</p>	<p>Mahasiswa mampu memahami dan menjelaskan tahapan perancangan instrumentasi biomedika (ECG, EMG, EEG), serta mampu merancang, menganalisa dan merealisasikan rangkaian instrumentasi biomedika.</p> <p><i>Students are able to understand and explain the stages of biomedical instrumentation design (ECG, EMG, EEG), and be able to design, analyze and realize a series of biomedical instrumentation.</i></p>																																																																																																																															
<p>Peta CPL – CP MK</p> <p>Map of PLO - CLO</p>	<table border="1"> <thead> <tr> <th></th> <th>CPL-01</th> <th>CPL-02</th> <th>CPL-03</th> <th>CPL-04</th> <th>CPL-05</th> <th>CPL-06</th> <th>CPL-07</th> <th>CPL-08</th> <th>CPL-09</th> <th>CPL-10</th> <th>CPL-11</th> <th>CPL-12</th> </tr> </thead> <tbody> <tr> <td>CPMK 1 / SUB CPMK 1 CLO 1 / LLO 1</td> <td></td> <td>√</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>CPMK 2 / SUB CPMK 2 CLO 2 / LLO 2</td> <td></td> <td></td> <td>√</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>CPMK 3 / SUB CPMK 3 CLO 3 / LLO 3</td> <td></td> <td>√</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>CPMK 4 / SUB CPMK 4 CLO 4 / LLO 4</td> <td></td> <td>√</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>CPMK 5 / SUB CPMK 5 CLO 5 / LLO 5</td> <td></td> <td>√</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>CPMK 5 / SUB CPMK 6 CLO 5 / LLO 6</td> <td>√</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>CPMK 5 / SUB CPMK 7 CLO 5 / LLO 7</td> <td></td> <td></td> <td></td> <td></td> <td>√</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>CPMK 5 / SUB CPMK 8 CLO 5 / LLO 8</td> <td></td> <td></td> <td></td> <td></td> <td>√</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table>													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 5 / SUB CPMK 6 CLO 5 / LLO 6	√												CPMK 5 / SUB CPMK 7 CLO 5 / LLO 7					√								CPMK 5 / SUB CPMK 8 CLO 5 / LLO 8					√							
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<p>Diskripsi Singkat MK</p>	<p>Mata kuliah Instrumentasi Biomedika dan Laboratorium merupakan mata kuliah wajib yang membahas tentang dasar-dasar instrumentasi biomedika baik secara teori maupun praktek. Mata kuliah ini bertujuan agar mahasiswa memahami prinsip-prinsip pengukuran dan instrumentasi sinyal biomedika serta mampu mengembangkannya dalam praktek. Dengan pemahaman teori dan keterampilan dalam laboratorium tersebut, mahasiswa</p>																																																																																																																																

Short Description of The Course	<p>diharapkan mampu menerapkannya pada disiplin ilmu biomedik. <i>Biomedical Instrumentation and Laboratory course is a mandatory subject which discuss about the basics of biomedical instrumentation. This course aims to increase the understanding of the students about the principles of measurement and biomedical signal instrumentation. With an understanding of the theory and skills in the laboratory, students are expected to be able to apply it to biomedical disciplines.</i></p>	
Bahan Kajian: Materi pembelajaran Course Materials:	<ol style="list-style-type: none"> 1. Pengenalan karakteristik op-amp ideal / Introduction of ideal op-amp characteristics 2. Aplikasi op-amp sebagai komparator, amplifier, filter dan oscillator / Op-amp applications as comparator, amplifier, filter and oscillator 3. Asal-usul sinyal biomedika / Biomedical signal's sources 4. Parameter sensor / Sensor's parameters 5. Prinsip sensor berbasis resistif / Resistive-based sensor principles 6. Prinsip sensor berbasis induktif / Inductive-based sensor principles 7. Prinsip sensor berbasis kapasitif / Capacitive-based sensor principles 8. Prinsip sensor berbasis optik / Optical-based sensor principles 9. Prinsip sensor berbasis akustik / Acoustic-based sensor principles 10. Desain instrumentasi biomedika / Biomedical instrumentation design 11. Single chip instrumentation amplifier 12. Keterampilan instrumentation amplifier / Instrumentation amplifier skill 13. Keterampilan deteksi kegagalan lead / Lead fail detection skill 14. Keterampilan baseline restoration / Baseline restoration skill 15. Keterampilan optical isolation / Optical isolation skill 16. Keterampilan komputasi / Computation skill 17. Keterampilan perancangan software akuisi data biomedik / Software design and biomedical data acquisition. 	
Pustaka	Utama / Main:	<ol style="list-style-type: none"> 1. J. G. Webster, "Medical Instrumentation, Application and Design", Houghton Mifflin Co, 1978 2. Metin Akay, "Biomedical Signal Detection", IEEE Press 3. Joseph J. Carr, "Sensor and Circuits : Sensors, Transducers, and Suporting Circuits for Electronic Instrumentation, Measurement and Control", T R Prentice Hall, Englewood Cliffs, New Jersey, 1993 4. Barry E Jones, "Instrumentation Measurement and Feedback, TMH Edition", McGraw-Hill Book Company (UK) Limited, 1978
	Pendukung / Supporting:	

	<ol style="list-style-type: none"> 1. J Bronzino, "Biomedical Engineering Handbook", IEEE Press 2. Aston Richard, "Principles of Biomedical Instrumentation and Measurement", Merrill Publishing Company, Singapore, 1990 3. R. Anandanatarajan, "Biomedical Instrumentation and Measurements", PHI Learning Private Limited, Delhi, 2011 4. L E Kinsler, "Fundamental of Acoustics, Second Edition", John Wiley & Sons, Inc New York, Chichester, Brisbane and Toronto, 1962 5. Frederick W. Kremkau, Diagnostic Ultrasound: Principles, Instrumentation, and Exercises, Second Edition", Grune & Stration, Inc, 1984 6. Bela G. Liptak, Kriszta Venczel, "Process Measurement: Instrument Engineers Handbook, Revised Edition", Bela G, Liptak, 1969 						
Dosen Pengampu	Dr. Rachmad Setiawan. Josaphat Pramudijanto, M.Eng., Dr. Tri Arief Sardjono, Dr. Norma Hermawan						
Matakuliah syarat	Rangkaian Listrik						
Mg Ke / Week	Kemampuan akhir tiap tahapan belajar (Sub-CPMK) / <i>Final ability of each Learning stage (LLO)</i>	Penilaian / <i>Assesment</i>		Bentuk Pembelajaran; Metode Pembelajaran; Penugasan Mahasiswa; <i>[Estimasi Waktu] / Form of Learning; Learning Methods; Student Assignment; [Estimated Time]</i>		Materi Pembelajaran <i>[Pustaka] / Learning Materials [Reference]</i>	Bobot Penilaian (%) / <i>Assesment Load (%)</i>
		Indikator / <i>Indicator</i>	Kriteria & Teknik / <i>Criteria & Techniques</i>	Tatap Muka (5)	Daring (6)		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	Mahasiswa mampu memahami dan menjelaskan tentang teori dasar sistem pengukuran dan instrumentasi biomedika <i>Students able to undertand</i>	<ul style="list-style-type: none"> • Mampu menjelaskan definisi, satuan, aplikasi umum dan elemen pada sitem pengukuran • Mampu menjelaskan karakteristik dan tipe 	Non-tes : Tugas 1 : Mencari paper mengenai peralatan medis yang berkaitan dengan setiap	<ul style="list-style-type: none"> • Kuliah dan brainstorming, tanya jawab [TM : 3 x 50"] [BM : 3 x 50"] [PT : 3 x 50"] 	<ul style="list-style-type: none"> • Chatting dan diskusi dalam forum platform ITS • <i>Chat and discussion in ITS</i> 	<ul style="list-style-type: none"> • Kontrak kuliah: <ul style="list-style-type: none"> - Motivasi belajar - Rencana pembelajaran - Aturan-aturan perkuliahan - Tujuan perkuliahan 	

	<p><i>and describe the theory of basic measurement system and biomedical instrumentations</i></p>	<p>instrumentasi</p> <ul style="list-style-type: none"> • Mampu menjelaskan sistem instrumentasi biomedika beserta parameter dan karakteristiknya • <i>Able to explain the definitions, units, general applications and elements in the measurement system</i> • <i>Able to explain the characteristics and types of instrumentation</i> • <i>Able to explain the biomedical instrumentations system and its parameters and characteristics</i> 	<p>sistem pada tubuh manusia dan membuat ringkasannya tentang tujuan, prinsip kerja dan diagram blok</p> <p>Test : Soal ETS (masuk dalam penilaian ETS)</p> <p>Non-test : Task 1 : <i>Search for papers about medical devices related to every system in human body and make a summary of their purpose, working principles and block diagrams</i></p> <p>Test : <i>Mid-term examination question</i></p>	<ul style="list-style-type: none"> • <i>Presentation and brainstorming, ask and answer.</i> [FF : 3 x 50"] [SA : 3 x 50"] [SS : 3 x 50"] 	<p><i>platform forum</i></p>	<p>- Sistem penilaian, buku ajar/sumber pustaka</p> <ul style="list-style-type: none"> • Defenisi • Satuan pengukuran • Aplikasi secara umum • Elemen sistem pengukuran • Tipe instrumentasi • Karakteristik instrumentasi • Sistem instrumentasi Biomedika (BMI) • Sumber-sumber sinyal biomedika • Karakter BMI • Parameter medis dan fisiologis <p>• <i>Course contract :</i></p> <ul style="list-style-type: none"> - <i>Motivation to learn</i> - <i>Lesson plan</i> - <i>Lectures rules</i> - <i>Course objective</i> - <i>Assessment system, textbooks / library resources</i> <ul style="list-style-type: none"> • <i>Defenition</i> • <i>Units of measurement</i> • <i>General applications</i> 	
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			<i>(included in mid-term examination assessment)</i>			<ul style="list-style-type: none"> • <i>Measuring system elements</i> • <i>Type of instrumentation</i> • <i>Instrumentation characteristics</i> • <i>Biomedical instrumentation system (BMI)</i> • <i>Biomedical signal sources</i> • <i>BMI characteristics</i> • <i>Medical and Physiological parameters</i> 	
2 - 5	<p>Mahasiswa mampu memahami dan menjelaskan teori dasar <i>operational amplifier</i> (op-amp), serta mampu merancang, menganalisa dan merealisasikan rangkaian aplikasi op-amp dan penerapannya dalam instrumentasi biomedika</p> <p><i>Students are able to understand and explain the basic operational amplifier (op-amp) theory, as well as be able to design, analyze</i></p>	<ul style="list-style-type: none"> • Mampu menjelaskan teori dan parameter dari op-amp • Mampu merancang rangkaian dasar op-amp • <i>Able to explain the theory and parameters of op-amp</i> • <i>Able to design basic op-amp circuit</i> 	<p>Non-tes :</p> <p>Tugas 2 Mencari datasheet op-amp dan menjelaskan parameter-parameternya, soal perhitungan mengenai parameter op-amp (Tugas Tertulis)</p> <p>Tugas 3 : Mengerjakan soal perhitungan</p>	<ul style="list-style-type: none"> • Kuliah, diskusi, tanya jawab, tugas dalam platform myITS Classroom <p>[TM : 3 x 50"] [BM : 3 x 50"] [PT : 3 x 50"]</p> <ul style="list-style-type: none"> • <i>Presentation and brainstorming, ask and</i> 	<ul style="list-style-type: none"> • Chatting dan diskusi dalam forum platform ITS • <i>Chat and discussion in ITS platform forum</i> 	<ul style="list-style-type: none"> • Dasar teori dan parameter op-amp <ul style="list-style-type: none"> - <i>Slew rate</i> - <i>Common mode rejection ratio (CMMR)</i> - <i>Input offset voltage</i> - <i>Power supply rejection ratio</i> - <i>Input bias current</i> - <i>Input offset current</i> - <i>Gain bandwidth product</i> • Perancangan rangkaian op-amp dasar <ul style="list-style-type: none"> - Detektor (ZCD,VLD) 	

	<p><i>and realize a series of op-amp applications and their application in biomedical instrumentation</i></p>		<p>mengenai analisa dan perancangan rangkaian aplikasi op-amp dengan spesifikasi yang sudah ditentukan (Tugas tertulis)</p> <p>Tugas 4 : Mencari aplikasi dari setiap rangkaian op-amp dasar dalam suatu sistem (Tugas tertulis)</p> <p>Tes : Soal ETS (masuk dalam penilaian ETS)</p> <p>Non-test : Task 2 : <i>Search an op-amp datasheet and explain its parameters, calculation questions about the op-amp parameters</i></p>	<p><i>answer.</i> [FF : 3 x 50"] [SA : 3 x 50"] [SS : 3 x 50"]</p>		<ul style="list-style-type: none"> - Komparator - Inverting amplifier - Non-inverting amplifier - voltage follower (buffer) - adder - integrator - derivator - differential amplifier - filter aktif (LPF,HPF,BFF,BSF) <ul style="list-style-type: none"> • <i>Description and parameters of op-amp</i> <ul style="list-style-type: none"> - Slew rate - Common mode rejection ratio (CMMR) - Input offset voltage - Power supply rejection ratio - Input bias current - Input offset current - Gain bandwidth product • <i>Basic op-amp circuit design</i> <ul style="list-style-type: none"> - Detector (ZCD,VLD) 	
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			<p><i>(written task)</i></p> <p>Task 3 : <i>Calculating problems regarding the analysis and design of a series of op-amp applications with predetermined specifications (Written assignment)</i></p> <p>Task 4 : <i>Searchs for the application of any basic op-amp circuit in a system</i></p> <p>Test : <i>Mid-term examination question (included in mid-term examination assessment)</i></p>			<ul style="list-style-type: none"> - <i>Comparator</i> - <i>Inverting amplifier</i> - <i>Non-inverting amplifier</i> - <i>voltage follower (buffer)</i> - <i>Adder</i> - <i>integrator</i> - <i>derivator</i> - <i>differential amplifier</i> - <i>Active filter (LPF, HPF, BFF, BSF)</i> 	
6	Mahasiswa mampu memahami dan menjelaskan	<ul style="list-style-type: none"> • Mampu menjelaskan mengenai asal, proses 	<p>Non-tes :</p> <p>Tugas 5:</p>	<ul style="list-style-type: none"> • Kuliah, diskusi, tanya jawab, 	<ul style="list-style-type: none"> • Chatting dan diskusi dalam 	<ul style="list-style-type: none"> • Sinyal biopotensial: <ul style="list-style-type: none"> - Asal 	

	<p>tentang asal, proses dihasilkannya, dan karakteristik dari sinyal biopotensial serta macam-macam sinyal biopotensial</p> <p><i>Students are able to understand and explain about the origin, process it produces, and the characteristics of the biopotential signal as well as various biopotential signals</i></p>	<p>dan karakteristik dari sinyal biopotensial</p> <ul style="list-style-type: none"> • <i>Able to explain the origin, generating process and the characteristics of biopotential signals</i> 	<p>Mengenal asal, proses dihasilkannya dan karakteristik dari sinyal biopotensial serta macam-macam sinyal biopotensial (Tugas tertulis)</p> <p>Test : Soal ETS (masuk dalam penilaian ETS)</p> <p>Task 5 : <i>Recognizing the origin, the process it generates and the characteristics of the biopotential signal and the kinds of biopotential signals (Written assignment)</i></p> <p>Test : <i>Mid-term examination</i></p>	<p>tugas dalam platform myITS Classroom</p> <p>[TM : 3 x 50"] [BM : 3 x 50"] [PT : 3 x 50"]</p> <ul style="list-style-type: none"> • <i>Presentation and brainstorming, ask and answer.</i> [FF : 3 x 50"] [SA : 3 x 50"] [SS : 3 x 50"] 	<p>forum platform ITS</p> <ul style="list-style-type: none"> • <i>Chat and discussion in ITS platform forum</i> 	<ul style="list-style-type: none"> - Proses yang dihasilkan - Karakteristik <ul style="list-style-type: none"> • <i>Biopotential signals:</i> <ul style="list-style-type: none"> - <i>Origin</i> - <i>Process</i> - <i>Characteristics</i> 	
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			<i>question (included in mid-term examination assessment)</i>				
7	<p>Mahasiswa mampu memahami dan menjelaskan fungsi dan cara kerja sensor dan transduser dalam instrumentasi biomedika serta konsep dasar elektroda, macam-macam dan rangkaian ekivalennya</p> <p><i>Students are able to understand and explain the functions and workings of sensor and transducers in biomedical instrumentation and the basic concepts of electrodes, their types and equivalent circuits</i></p>	<ul style="list-style-type: none"> • Mampu menjelaskan mengenai defenisi dan karakteristik dari sensor dan transduser biomedika • mampu menjelaskan mengenai sensor yang berbasis resistif, induktif dan kapasitif • Mampu menjelaskan mengenai teori dasar elektrode • <i>Able to explain about the defenition and characteristics of biomedical sensor and transducers</i> • <i>Able to explain about the resistive, inductive and capacitive based sensors</i> • <i>Able to explain about the theory of</i> 	<p>Non-tes : Tugas 6: Mengenai fungsi dan cara kerja sensor dan transduser dalam instrumentasi biomedika serta konsep dasar elektroda, macam-macam dan rangkaian ekivalensinya (Tugas tertulis)</p> <p>Tes : Soal ETS (masuk dalam penilaian ETS)</p> <p>Task 6 : <i>About the functions and workings of</i></p>	<ul style="list-style-type: none"> • Kuliah, diskusi, tanya jawab, tugas dalam platform myITS Classroom [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"] 	<ul style="list-style-type: none"> • Chatting dan diskusi dalam forum platform ITS • <i>Chat and discussion in ITS platform forum</i> 	<ul style="list-style-type: none"> • Defenisi dan karakteristik dari sensor dan transduer biomedika • Sensor berbasis reistif <ul style="list-style-type: none"> - Displacement sensor - Strain gauges • Sensor berbasis induktif (LVDT) • Sensor berbasis kapasitif • Teori dasar elektrode <ul style="list-style-type: none"> - Defenisi - Prinsip kerja - Electrode-electrolyte interface - Electrode model circuit - Tipe elektroda • <i>Defenition and characteristics of biomedical sensor and</i> 	


		<i>electodes</i>	<i>sensor and transducers in biomedical instrumentation and the basic concepts of electrodes, their types and equivalent circuits</i> Test : <i>Mid-term examination question (included in mid-term examination assessment)</i>			<i>transducer</i> <ul style="list-style-type: none"> • <i>Resistive based sensor</i> <ul style="list-style-type: none"> - <i>Displacement sensor</i> - <i>Strain gauges</i> • <i>Inductive based sensor (LVDT)</i> • <i>Capacitive based sensor</i> • <i>Electrode introduction</i> <ul style="list-style-type: none"> - <i>Defenition</i> - <i>Working principle</i> - <i>Electrode-electrolyte interface</i> - <i>Electrode model circuit</i> • <i>Electrode types</i> 	
8	EVALUASI TENGAH SEMESTER						35
9 - 15	Mahasiswa mampu memahami dan menjelaskan tahapan perancangan intrumentasi biomedika (ECG, EMG, EEG), serta mampu merancang, menganalisa dan merealisasikan rangkaian instrumentasi biomedika <i>Students are able to</i>	<ul style="list-style-type: none"> • Mampu merancang instrumentasi biomedika untuk ECG, EMG, dan EEG • Mampu menganalisa dan merancang peralatan medis lainnya • Mampu menjelaskan perkembangan instrumentasi 	Non-tes : Tugas 7: Mengenai analisa dan perancangan instrumentasi biomedika (Tugas tertulis) Praktikum 1 - 6: Rangkaian instrumentation	<ul style="list-style-type: none"> • Kuliah, diskusi, tanya jawab, tugas dalam platform myITS Classroom [TM : 3 x 50"] [BM : 3 x 50"] [PT : 3 x 50"] 	<ul style="list-style-type: none"> • Chatting dan diskusi dalam forum platform ITS • <i>Chat and discussion in ITS platform forum</i> 	<ul style="list-style-type: none"> • Merancang dan menganalisa instrumentasi biomedik (ECG, EMG, EEG) • Metode pengukuran • Parameter penguat biopotensial • Diagram blok ECG, EMG, EEG • Rangkaian proteksi • Rangkaian deteksi 	

	<p><i>understand and explain the stages of biomedical instrumentation design (ECG, EMG, EEG) and be able to design, analyze and realize a series of biomedical instrumentation</i></p>	<p>biomedis terkini</p> <ul style="list-style-type: none"> • <i>Able to design biomedical instrumentation for ECG, EMG, and EEG</i> • <i>Able to analyze and design other medical equipment</i> • <i>Able to explain the latest developments in biomedical instrumentations</i> 	<p>amplifier dan filter, deteksi kegagalan lead, baseline restoration, optical isolation, komputasi, perancangan software akuisi data biomedik</p> <p>Tes : 5 soal UAS</p> <p>Task 7 : <i>About analysis and design of biomedical instrumentations (Written assignment)</i></p> <p>Lab works 1 - 6 : <i>Instrumentation amplifier and filter, lead fail detection, optical isolation, baseline restoration, computation and software design</i></p>	<ul style="list-style-type: none"> • <i>Presentation and brainstorming, ask and answer.</i> [FF : 3 x 50"] [SA : 3 x 50"] [SS : 3 x 50"] 		<p>kegagalan lead</p> <ul style="list-style-type: none"> • <i>Rangkaian penguat instrumentasi</i> • <i>Pengenalan single chip instrumentation amplifier</i> • <i>Implementasi filter untuk ECG, EMG, EEG</i> • <i>baseline restoration</i> • <i>Rangkaian optical isolation</i> • <i>Komputasi</i> • <i>Perancangan software akuisisi data biomedik</i> • <i>Analisa dan perancangan peralatan medis lainnya</i> • <i>Perkembangan terkini mengenai teknologi instrumentasi biomedika</i> <ul style="list-style-type: none"> • <i>Design of biomedical instrumentation for ECG, EMG, and EEG</i> • <i>Measurement methods</i> • <i>Biopotential amplifier parameters</i> • <i>Block diagram for ECG, EMG, EEG</i> 	
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			<p><i>for biomedical data acquisition.</i></p> <p>Test : <i>5 Final examination question</i></p>			<ul style="list-style-type: none"> • <i>Protection circuit</i> • <i>Lead fail detection circuit</i> • <i>Instrumentation amplifier circuit</i> • <i>Introduction of single chip instrumentation amplifier</i> • <i>Filter implementations for ECG, EMG, EEG</i> • <i>Baseline restoration circuit</i> • <i>Optical isolation circuit</i> • <i>Computation</i> • <i>Software design for biomedical data acquisition</i> • <i>Design and analysis for other medical equipment</i> • <i>Latest developments in biomedical instrumentations</i> 	
16	EVALUASI AKHIR SEMESTER						

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 Instrumentations and Laboratory		RA&E
			Write Doc Code
Kode / Code : EB234406	Bobot sks / Credits (T/P): 3/0	Rumpun MK: Course Cluster :	Smt: V
OTORISASI AUTHORIZATION	Penyusun RA & E Compiler A&EP Nada Fitriyatul H, 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 mampu memahami dan menjelaskan tentang teori dasar sistem pengukuran dan instrumentasi biomedika LLO 1 : <i>Students able to undertand and describe the theory of basic measurement system and biomedical instrumentations</i>	Non-tes : Tugas 1 : Mencari paper mengenai peralatan medis yang berkaitan dengan setiap sistem pada tubuh manusia dan membuat ringkasannya tentang tujuan, prinsip kerja dan diagram blok Tes : ETS Soal 1 Non-test : Task 1 : <i>Search for papers about medical devices related to every system in human body and make a summary of their purpose, working principles and block diagrams</i> Test : <i>Mid-term examination question 1</i>	5
2 - 5	Sub CP-MK 2: Mahasiswa mampu memahami dan menjelaskan teori dasar <i>operational amplifier</i> (op-amp), serta mampu merancang,	Non-tes : Tugas 2 Mencari datasheet op-amp dan menjelaskan parameter-parameternya, soal perhitungan mengenai parameter op-amp (Tugas Tertulis) Tugas 3 : Mengerjakan soal perhitungan mengenai analisa dan perancangan rangkaian aplikasi op-amp dengan spesifikasi	15

Mg ke / Week (1)	Sub CP-MK / Lesson Learning Outcomes (LLO) (2)	Bentuk Asesmen (Penilaian) Form of Assessment (3)	Bobot / Load (%) (4)
	<p>menganalisa dan merealisasikan rangkaian aplikasi op-amp dan penerapannya dalam instrumentasi biomedika</p> <p>LLO 2 : <i>Students are able to understand and explain the basic operational amplifier (op-amp) theory, as well as be able to design, analyze and realize a series of op-amp applications and their application in biomedical instrumentation.</i></p>	<p>yang sudah ditentukan (Tugas tertulis)</p> <p>Tugas 4 : Mencari aplikasi dari setiap rangkaian op-amp dasar dalam suatu sistem (Tugas tertulis)</p> <p>Tes : Soal ETS 2</p> <p>Non-test : Task 2 : <i>Search an op-amp datasheet and explain its parameters, calculation questions about the op-amp parameters (written task)</i></p> <p>Task 3 : <i>Calculating problems regarding the analysis and design of a series of op-amp applications with predetermined specifications (Written assignment)</i></p> <p>Task 4 : <i>Searchs for the application of any basic op-amp circuit in a system</i></p> <p>Test : <i>Mid-term examination question 2</i></p>	
6	<p>Sub CP-MK 3:</p> <p>Mahasiswa mampu memahami dan menjelaskan tentang asal, proses dihasilkannya, dan karakteristik dari sinyal biopotensial serta macam-macam sinyal biopotensial</p> <p>LLO 3 : <i>Students are able to understand and explain about the origin, process it produces, and the characteristics of the biopotential signal as well as various</i></p>	<p>Non-tes : Tugas 5: Mengenal asal, proses dihasilkannya dan karakteristik dari sinyal biopotensial serta macam-macam sinyal biopotensial (Tugas tertulis)</p> <p>Tes : Soal ETS 3</p> <p>Task 5 : <i>Recognizing the origin, the process it generates and the characteristics og the biopotential signal and the kinds of biopotential signals (Written assignment)</i></p> <p>Test : <i>Mid-term examination question 3</i></p>	5

Mg ke / Week (1)	Sub CP-MK / Lesson Learning Outcomes (LLO) (2)	Bentuk Asesmen (Penilaian) Form of Assessment (3)	Bobot / Load (%) (4)
	<i>biopotensial signals</i>		
7	<p>Sub CP-MK 4:</p> <p>Mahasiswa mampu memahami dan menjelaskan fungsi dan cara kerja sensor dan transduser dalam instrumentasi biomedika serta konsep dasar elektroda, macam-macam dan rangkaian ekivalennya</p> <p>LLO 4 : <i>Students are able to understand and explain the functions and workings of sensor and transducers in biomedical instrumentation and the basic concepts of electrodes, their types and equivalent circuits</i></p>	<p>Non-tes :</p> <p>Tugas 6: Mengenai fungsi dan cara kerja sensor dan transduser dalam instrumentasi biomedika serta konsep dasar elektroda, macam-macam dan rangkaian ekivalensinya (Tugas tertulis)</p> <p>Tes : Soal ETS 4</p> <p>Task 6 : <i>About the functions and workings of sensor and transducers in biomedical instrumentation and the basic concepts of electrodes, their types and equivalent circuits</i></p> <p>Test : <i>Mid-term examination question 4</i></p>	5
8	<p>Evaluasi Tengah Semester</p> <p>Mid Exam</p>	<p>Tes: Ujian Tulis/Ujian Daring</p> <p>Test: <i>Writing Exams / Online Exams</i></p>	15
9 - 15	<p>Sub CP-MK 5:</p> <p>Mahasiswa mampu memahami dan menjelaskan tahapan perancangan instrumentasi biomedika (ECG, EMG, EEG), serta mampu merancang, menganalisa dan</p>	<p>Non-tes :</p> <p>Tugas 7: Mengenai analisa dan perancangan instrumentasi biomedika (Tugas tertulis)</p> <p>Praktikum 1 - 6: Rangkaian instrumentation amplifier dan filter, deteksi kegagalan lead, baseline restoration, optical isolation, komputasi, perancangan software akuisi data biomedik</p> <p>Tes : 5 Soal UAS</p>	40

Mg ke / Week (1)	Sub CP-MK / Lesson Learning Outcomes (LLO) (2)	Bentuk Asesmen (Penilaian) Form of Assessment (3)	Bobot / Load (%) (4)
	<p>merealisasikan rangkaian instrumentasi biomedika</p> <p>LLO 5 : Students are able to understand and explain the stages of biomedical instrumentation design (ECG, EMG, EEG) and be able to design, analyze and realize a series of biomedical instrumentation</p>	<p>Task 7 : About analysis and design of biomedical instrumentations (Written assignment)</p> <p>Lab works 1 - 6 : Instrumentation amplifier and filter, lead fall detection, optical isolation, baseline restoration, computation and software design for biomedical data acquisition.</p> <p>Test : 5 Final examination questions</p>	
16	<p>Evaluasi Akhir</p> <p>Final Exam</p>	<p>Tes: Ujian Tulis/Ujian Daring</p> <p>Test: Writing Exams / Online Exams</p>	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 1 / <i>CLO 1</i>	Week 1	Task 1	5
		Week 8	Mid Exam Question 1	3.75
	CPMK 3 / <i>CLO 3</i>	Week 6	Task 5	5
		Week 8	Mid Exam Question 3	3.75
CPL-03 / <i>PLO-03</i>	CPMK 4 / <i>CLO 4</i>	Week 7	Task 6	5
		Week 8	Mid Exam Question 4	3.75
	CPMK 2 / <i>CLO 2</i>	Week 2	Task 2	5
		Week 3	Task 3	5
CPL-05 / <i>PLO-05</i>	CPMK 5 / <i>CLO 5</i>	Week 4 - 5	Task 4	5
		Week 8	Mid Exam Question 2	3.75
	CPMK 5 / <i>CLO 5</i>	Week 9	Task 7	5
		Week 10 - 15	Lab Works 1 - 6	35
		Week 16	Final Exam Question 1 - 5	15
				Σ = 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	Task 1		0.05											0.05
2	Task 2			0.05										0.05
3	Task 3			0.05										0.05
4	Task 4			0.05										0.05
5	Task 5		0.05											0.05
6	Task 6		0.05											0.05

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
7	Mid Exam		0.1125	0.375										0.15
8	Task 7					0.05								0.05
9	Lab Works					0.35								0.35
10	Final Exam					0.15								0.15
	Total		0.30	0.15		0.55								1

