



MODULE HANDBOOK ELECTRICAL SYSTEMS IN BIOMEDICAL APPLICATION





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

INSTITUT TEKNOLOGI SEPULUH NOPEMBER

ENDORSEMENT PAGE



MODULE HANDBOOK
Electrical Systems in Biomedical Application
DEPARTMENT OF BIOMEDICAL ENGINEERING
 INSTITUT TEKNOLOGI SEPULUH NOPEMBER
 Number : 6840/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>	Ir. Sjamsjul Anam, M.T.	Dosen <i>Lecturer</i>		November 18, 2022
Pemeriksa dan Pengendalian <i>Review and Control</i>	Eko Agus Suprayitno, S.Si, 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


MODULE HANDBOOK

ELECTRICAL SYSTEM IN BIOMEDICAL APPLICATION

Module name	Electrical Systems in Biomedical Application	
Module level	Undergraduate	
Code	EB234602	
Course (if applicable)	Electric System in Biomedical Application	
Semester	Sixth Semester (Even)	
Person responsible for the module		
Lecturer	Ir. Sjamsjul Anam, M.T.	
Language	Bahasa Indonesia and English	
Relation to curriculum	Undergraduate degree program, mandatory , 6 th semester.	
Type of teaching, contact hours	Lectures, <60 students	
Workload	1. Lectures : 2 x 50 = 100 minutes per week. 2. Exercises and Assignments : 2 x 50 = 100 minutes (2 hours). 3. Private learning : 2 x 50 = 100 minutes per week.	
Credit points	2 credit points (sks)	
Requirements according to the examination regulations	A student must have attended at least 75% of the lectures to sit in the exams.	
Mandatory prerequisites	-	
Learning outcomes and their corresponding PLOs	Course Learning Outcome (CLO) after completing this module, CLO 1: Students understand and are able to explain the principles of electric power generator, single phase and polyphase electric concepts. CLO 2: Students understand and are able explain the stages of the biomedical electrical installation. CLO 3: Students understand and and are able to analyze and explain the grounding system and safety concepts in using high-voltage medical devices. CLO 4: Students understand and are able to analyze and explain about Electromagnetic Interference (EMI).	PLO-05 PLO-05 PLO-06 PLO-07

	CLO 5: Students understand and are able to analyze and explain the basic of operating the Electrical Surgical Unit (ESU) system.	PLO-07
Content	This course is a mandatory course that discusses electrical system in the biomedical field, especially regarding safety in using high-voltage electrical energy in biomedical equipment. This course also provides an introduction to the Electrical Surgical Unit (ESU) system used in medical world.	
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, 8 ● Mid-term examination ● Final examination 	
Media employed	LCD, whiteboard, websites (myITS Classroom), zoom.	
Reading list	Main : <ol style="list-style-type: none"> 1. Abdul Kadir, 1995, "Energi : Sumber Daya, Inovasi, Tenaga Listrik, Dan Potensi Ekonomi", Universitas Indonesia. 2. Zuhaili, 1977, "Dasar Teknik Tenaga Listrik", Institut Teknologi Bandung. 3. BL. Theraja, 2005, "A Text Book of Electrical Technology", S. Chand & Company Ltd.. 4. John Cadick, Mary Capelli-Schellpfeffer, Dennis Neitzel, 2006, "Electrical Safety Handbook, 3rd edition", McGraw-Hill. 5. Fuller, J., 2012, "Surgical Technology Principles and Practice, 6th edition", W.B. Saunders Company. 	

I. Rencana Pembelajaran Semester / Semester Learning Plan

		INSTITUT TEKNOLOGI SEPULUH NOPEMBER (ITS) FACULTY OF INTELLIGENT ELECTRICAL AND INFORMATICS TECHNOLOGY DEPARTMENT OF BIOMEDICAL ENGINEERING				Document Code
SEMESTER LEARNING PLAN						
MATA KULIAH (MK) COURSE	KODE CODE	Rumpun MK Course Cluster	BOBOT (sks) Credits		SEMESTER	Tgl Penyusunan Compilation Date
Electric System in Biomedical Application	EB234602	Ilmu Dasar Teknik <i>Basic Engineering</i>	T=2	P=0	VI	November 9, 2022
OTORISASI / PENGESAHAN AUTHORIZATION / ENDORSEMENT	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. Norma Hermawan, S.T., M.T., M.Sc.)		(Dr. Achmad Arifin, S.T., M.Eng.)	
Capaian Pembelajaran	CPL-PRODI yang dibebankan pada MK PLO Program Charged to The Course					
Learning Outcomes	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>				
	CPL-06	Mampu menerapkan ilmu pengetahuan, keterampilan, dan metode terkini dalam menyelesaikan permasalahan di bidang Teknik Biomedika.				
	PLO-06	<i>Able to apply the latest knowledge, skills and methods in solving problems in the field of Biomedical Engineering.</i>				
	CPL-07	Mampu merencanakan, menyelesaikan, dan mengevaluasi tugas di dalam batasan-batasan yang ada.				

	PLO-07	Able to plan, complete, and evaluate tasks within existing boundaries.											
	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 tentang prinsip-prinsip pembangkitan tenaga listrik, konsep listrik <i>single phase</i> dan <i>polyphase</i> . <i>Students understand and are able to explain the principles of electric power generator, single phase and polyphase electric concepts.</i>											
	CP MK 2 CLO 2	Mahasiswa memahami dan mampu menjelaskan tentang tahapan instalasi kelistrikan biomedika. <i>Students understand and are able explain the stages of the biomedical electrical installation.</i>											
	CP MK 3 CLO 3	Mahasiswa memahami dan mampu menganalisa serta menjelaskan tentang sistem grounding dan konsep-konsep keamanan dalam menggunakan peralatan-peralatan medis yang bertegangan tinggi. <i>Students understand and and are able to analyze and explain the gounding system and safety concepts in using high-voltage medical devices.</i>											
	CP MK 4 CLO 4	Mahasiswa memahami dan mampu menganalisa serta menjelaskan tentang Electromagnetic Interference (EMI). <i>Students understand and are able to analyze and explain about Electromagnetic Interference (EMI).</i>											
	CP MK 5 CLO 5	Mahasiswa memahami dan mampu menganalisa serta menjelaskan tentang dasar-dasar operasi sistem electrical surgical unit (ESU). <i>Students understand and are able to analyze and explain the basic of operating the Electrical Surgical Unit (ESU) system.</i>											
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 Kelistrikan Biomedika merupakan mata kuliah wajib yang membahas mengenai sistem kelistrikan pada bidang biomedika, terutama menyangkut keamanan (safety) dalam menggunakan energi listrik tegangan tinggi pada peralatan biomedika. Mata kuliah ini juga memberikan pengenalan mengenai system electrical surgical unit (ESU) yang digunakan pada dunia medis. <i>This course is a mandatory course that discusses electrical system in the biomedical field, especially regarding safety in using high-voltage electrical energy in biomedical equipment. This course also provides an introduction to the Electrical Surgical Unit (ESU) system used in medical world.</i>													
Bahan Kajian: Materi pembelajaran Course Materials:	<ol style="list-style-type: none"> 1. Prinsip pembangkitan tenaga listrik / <i>Principles of electric power generator.</i> 2. Pengenalan konsep listrik <i>single phase</i> dan <i>polyphase</i> / <i>Introduction to the concept of electric single phase and polyphase</i> 3. Instalasi kelistrikan biomedika / <i>Biomedical electrical installation</i> 4. Sistem <i>grounding</i> / <i>Grounding system</i> 5. Sistem keamanan kebocoran arus / <i>Current leakage security system</i> 6. <i>Electromagnetic Interference (EMI)</i> 													
Pustaka References	Utama / Main: <ol style="list-style-type: none"> 1. Abdul Kadir, 1995, "Energi : Sumber Daya, Inovasi, Tenaga Listrik, Dan Potensi Ekonomi", Indonesia: Universitas Indonesia. 2. Zuhail, 1977, "Dasar Teknik Tenaga Listrik", Indonesia: Institut Teknologi Bandung. 3. BL. Theraja, 2005, "A Text Book of Electrical Technology", Canada: S. Chand & Company Ltd.. 4. John Cadick, Mary Capelli-Schellpfeffer, Dennis Neitzel, 2006, "Electrical Safety Handbook, 3rd edition", USA: McGraw-Hill. 5. Fuller, J., 2012, "Surgical Technology Principles and Practice, 6th edition", USA: W.B. Saunders Company. 													
Dosen Pengampu Lecturers														
Matakuliah syarat Prerequisite	-													

Mg ke/ Week	Kemampuan akhir tiap tahapan belajar (Sub-CPMK) / <i>Final ability of each learning stage (LLO)</i>	Penilaian / <i>Assessment</i>		Bentuk 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>		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1-3	<p>Mahasiswa memahami dan mampu menjelaskan tentang prinsip-prinsip pembangkitan tenaga listrik, konsep listrik single phase dan polyphase.</p> <p><i>Students understand and are able to explain the principles of electric power generator, single phase and polyphase electric concepts.</i></p>	<ul style="list-style-type: none"> Memahami dan mampu menjelaskan mengenai prinsip-prinsip pembangkitan tenaga listrik Memahami dan mampu menjelaskan mengenai konsep listrik <i>single phase</i> dan <i>polyphase</i> <i>Understand be able to explain the principles of electric power generator.</i> <i>Understand be able to explain the single phase and polyphase electric concepts.</i> 	<p>Non-tes : Tugas 1: Mengenai prinsip-prinsip pembangkitan tenaga listrik (Tugas Tertulis).</p> <p>Tugas 2: Mengenai konsep listrik <i>single phase</i> dan <i>polyphase</i> (Tugas Tertulis)</p> <p>Non-test : Task 1: Regarding <i>principles of electric power generator.</i> (Written task)</p> <p>Task 2:</p>	<ul style="list-style-type: none"> Kuliah, diskusi dan tugas. [TM : 3 x (2 x 50'')] [BM : 3 x (2 x 50'')] [PT : 3 x (2 x 50'')] <i>Lectures discussion and assignment.</i> [FF : 3 x (2 x 50'')] [SS : 3 x (2 x 50'')] [SA : 3 x (2 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"> Prinsip pembangkitan tenaga listrik: - Jenis sumber energi terbarukan dan tidak terbarukan, - Potensi energi global - Konsep termodinamika - Macam-macam pembangkit konvensional (PLTU, PLTGU, PLTG, PLTP, PLTN, PLTD dan PLTA) termasuk rangkaian skematik dan proses pembangkitannya - perhitungan daya terbangkitkan dari pembangkit konvensional - permasalahan pembangkit konvensional 	<p>Tugas 1 / Task 1: 3.75</p> <p>Tugas 2 / Task 2: 3.75</p>

			<p><i>Regarding single phase and polyphase electric concepts. (Written task)</i></p>			<ul style="list-style-type: none"> - potensi energi non konvensional - macam-macam pembangkitan non konvensional - perhitungan daya terbangkit beserta prinsip kerjanya (PLTS, PLTB, biomasa, mikrohidro, pasang surut, ombak) - permasalahan dalam pembangkitan energi non konvensional - isu tentang energi baru terbarukan beserta teknologinya ● Pengenalan konsep listrik single phase dan polyphase ● <i>Principles of electric power generator:</i> <ul style="list-style-type: none"> - <i>Types of renewable and un renewable energy sources,</i> - <i>Global energy potential</i> - <i>Thermodynamic concept</i> - <i>Various</i> 	
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						<p><i>conventional generator (Steampowered electric generator, gas and steam powered electric generator, gaspowered electric generator, geothermal power plant, nuclear power plant, dieselpowered electric generator and hydroelectric power plant) including the schematic circuit and its generator process.</i></p> <ul style="list-style-type: none"> - <i>calculation of the power generated from conventional generators</i> - <i>conventional generators problems</i> - <i>potential non conventional energy</i> - <i>Various non conventional generator</i> - <i>calculation of the power generated and its working principles (solarpower electric generator,</i> 	
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						<p><i>windpower electric generator, biomass, micro hydro, tides, waves)</i></p> <p><i>- non conventional generators problems</i></p> <p><i>- Issues about renewable energy and its technology</i></p> <ul style="list-style-type: none"> ● <i>Introduction to the concept of single phase and polyphase electricity</i> 	
4-6	<p>Mahasiswa memahami dan mampu menjelaskan tentang tahapan instalasi kelistrikan biomedika.</p> <p><i>Students understand and are able explain the stages of the biomedical electrical installation.</i></p>	<ul style="list-style-type: none"> ● Memahami dan mampu menjelaskan mengenai listrik pada tubuh manusia ● Memahami dan mampu menjelaskan mengenai instalasi kelistrikan biomedika ● <i>Understand be able to explain the electricity in human body..</i> 	<p>Non-tes :</p> <p>Tugas 3: Mengenai listrik dan tubuh manusia (Tugas Tertulis)</p> <p>Tugas 4: Mengenai instalasi kelistrikan biomedika (Tugas Tertulis)</p> <p>Non-test :</p> <p>Task 3: Regarding lectricity and</p>	<ul style="list-style-type: none"> ● Kuliah, diskusi, dan tugas. [TM : 3 x (2 x 50")] [BM : 3 x (2 x 50")] [PT : 3 x (2 x 50")] ● <i>Lectures discussion and assignment</i> [FF : 3 x (2 x 50")] [SS : 3 x (2 x 50")] [SA :3 x (2 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"> ● Pengenalan tentang kelistrikan biomedika ● Listrik dan tubuh manusia ● Simbol peralatan listrik pada single line diagram dan wiring diagram dalam beberapa standard, contoh SNI, IEC dan ANSI, macam-macam sistem distribusi, kabel ladder, trench, kabel ducting, jenis dan tipe kabel, panel, rele pengaman, circuit breaker, transformator, peralatan pentanahan 	<p>Tugas 3/ Task 3: 3.75</p> <p>Tugas 4/ Task 4: 3.75</p>

		<ul style="list-style-type: none"> • <i>Understand be able to explain the biomedical electrical installations..</i> 	<p><i>human body (Written task)</i></p> <p>Task 4: <i>Regarding biomedical electrical installations (Written task)</i></p>			<p>netral, peralatan pencatu emergency, capacitor bank, koordinasi antar peralatan proteksi, rencana kerja dan syarat-syarat (RKS), Bill of Quantity (BQ)</p> <ul style="list-style-type: none"> • <i>Introduction to biomedical electricity</i> • <i>Electricity and human body</i> • <i>Electrical equipment symbols in single line diagrams and wiring diagrams in several standards, for example SNI, IEC and ANSI, various distribution systems, ladder cables, trenches, ducting cables, types and types of cables, panels, safety relays, circuit breakers, transformers, neutral grounding equipment, emergency supply equipment, capacitor bank, coordination</i> 	
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						<i>between protective equipment, work plan and conditions (RKS), Bill of Quantity (BQ)</i>	
7, 9, 10	<p>Mahasiswa memahami dan mampu menganalisa serta menjelaskan tentang sistem grounding dan konsep-konsep keamanan dalam menggunakan peralatan-peralatan medis yang bertegangan tinggi.</p> <p><i>Students understand and are able to analyze and explain the grounding system and safety concepts in using high-voltage medical devices.</i></p>	<ul style="list-style-type: none"> Memahami dan mampu menjelaskan mengenai sistem grounding, assessment dan manajemen resiko, sistem keamanan kebocoran arus. Memahami dan mampu menjelaskan mengenai sistem keamanan kelistrikan di rumah sakit. <i>Understand be able to explain the grounding system, assessment and risk management, current leakage security system..</i> <i>Understand be able to explain the system of</i> 	<p>Non-tes : Tugas 5: Mengenai sistem grounding, assessment dan manajemen resiko, sistem keamanan kebocoran arus (Tugas Tertulis).</p> <p>Tugas 6: Mengenai keamanan kelistrikan di Rumah Sakit (Tugas Tertulis)</p> <p>Non-test : Task 5: Regarding grounding system, assessment and risk management,</p>	<ul style="list-style-type: none"> Kuliah, diskusi, dan tugas. [TM : 3 x (2 x 50")] [BM : 3 x (2 x 50")] [PT : 3 x (2 x 50")] <i>Lectures discussion and assignment</i> [FF : 3 x (2 x 50")] [SS : 3 x (2 x 50")] [SA : 3 x (2 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"> Pengenalan sistem keamanan Sistem grounding Sistem keamanan kebocoran arus Assessment dan manajemen resiko Keamanan terhadap <i>over voltage, extra-low dan residual voltages, safe practices (RCD, PPE, CB, lockout/tagout, hazardous areas, insulasi listrik), electrical fires, arc flash</i> <i>Electrical safety di Rumah Sakit</i> <i>Introduction of safety system</i> <i>Grounding system</i> <i>Current leakage security system</i> <i>Assessment and risk management</i> <i>Safety against over voltage, extra-low and</i> 	<p>Tugas 5/ Task 5: 3.75</p> <p>Tugas 6/ Task 6: 3.75</p>

		<i>electrical safety in Hospital.</i>	<i>current leakage security system (Written task)</i> Task 6: <i>Regarding lectrical safety in Hospital (Written task).</i>			<i>residual voltages, safe practices (RCD, PPE, CB, lockout/tagout, hazardous areas, electrical insulation), electrical fires, arc flash</i> ● <i>Electrical safety in hospitals</i>	
8	EVALUASI TENGAH SEMESTER MID-SEMESTER EXAM						30
11-12	<p>Mahasiswa memahami dan mampu menganalisa serta menjelaskan tentang Electromagnetic Interference (EMI).</p> <p><i>Students understand and are able to analyze and explain about Electromagnetic Interference (EMI).</i></p>	<ul style="list-style-type: none"> ● Memahami dan mampu menjelaskan mengenai konsep <i>electromagnetic compatibility (EMC)</i>. ● Memahami dan mampu menjelaskan mengenai <i>Electromagnetic Interference (EMI)</i>. ● <i>Understand be able to explain concept of electromagnetic compatibility (EMC)..</i> 	<p>Non-tes : Tugas 7: Mengenai <i>Electromagnetic Interference (EMI)</i> (Tugas Tertulis)</p> <p>Non-test : Task 7: <i>Regarding Electromagnetic Interference (EMI) (Written task)</i></p>	<ul style="list-style-type: none"> ● Kuliah, diskusi, dan tugas. [TM : 2 x (2 x 50")] [BM : 2 x (2 x 50")] [PT : 2 x (2 x 50")] ● <i>Lectures discussion and assignment [FF : 2 x (2 x 50")] [SS : 2 x (2 x 50")] [SA : 2 x (2 x 50")]</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"> ● Konsep tentang <i>electromagnetic compatibility (EMC)</i> ● <i>Electromagnetic Interference (EMI), coupling dan shielding, grounding dan radiasi</i> ● Pengukuran dan regulasi ● <i>Concept of electromagnetic compatibility</i> ● <i>Electromagnetic Interference (EMI), coupling and shielding, grounding and radiation</i> ● <i>Measurement and regulation..</i> 	Tugas 7 / Task 7 3.75


		<ul style="list-style-type: none"> • <i>Understand be able to explain about Electromagnetic Interference (EMI).</i> 					
13-15	<p>Mahasiswa memahami dan mampu menganalisa serta menjelaskan tentang dasar-dasar operasi sistem electrical surgical unit (ESU).</p> <p><i>Students understand and are able to analyze and explain the basic of operating the Electrical Surgical Unit (ESU) system.</i></p>	<ul style="list-style-type: none"> • Memahami dan mampu menjelaskan mengenai dasar dan komponen <i>electrosurgery</i>. • Memahami dan mampu menjelaskan mengenai jenis <i>electrosurgery</i> • Memahami dan mampu menjelaskan mengenai keamanan pada <i>electrosurgery</i>. • <i>Understand be able to explain the basic and components of electrosurgery.</i> • <i>Understand be able to explain about the types of electrosurgery.</i> 	<p>Non tes: Tugas 8: Mengenai <i>electrical surgery unit</i> (Tugas tertulis).</p> <p>Non-test: Task 8: Regarding <i>electrical surgery unit</i> (Written task)</p>	<ul style="list-style-type: none"> • Kuliah, diskusi, dan tugas. [TM : 3 x (2 x 50")] [BM : 3 x (2 x 50")] [PT : 3 x (2 x 50")] • <i>Lectures discussion and assignment</i> [FF : 3 x (2 x 50")] [SS : 3 x (2 x 50")] [SA :3 x (2 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"> • Dasar-dasar <i>electrosurgery</i> • Komponen-komponen <i>electrosurgery</i> (<i>power unit (generator), active electrode, kontrol, patient return electrode (monopolar circuit only), monopolar electrosurgery (patient return electrode), bipolar electrosurgery</i> • Jenis-jenis operasi <i>electrosurgery</i> (<i>cutting, coagulation, fulguration</i>) • <i>Electrocautery (radio frequency ablation, electrosurgical vessel sealing, argon-enhanced electrosurgery</i> • Keamanan pada <i>electrosurgery</i> (keamanan generator, 	Tugas 8 / Task 8: 3.75

		<ul style="list-style-type: none"> • <i>Understand be able to explain the safety of electrosurgery</i> 				<p>keamanan pada <i>active electrode</i>), faktor-faktor berbahaya dalam <i>minimally invasive surgery</i> (<i>capacitive coupling, directing coupling, monitoring active electrode, monitoring return electrode</i>, pasien dengan implant elektronika)</p> <ul style="list-style-type: none"> • <i>Electrosurgery basics</i> • <i>Electrosurgery components (power unit (generator), active electrode, control, patient return electrode (monopolar circuit only), monopolar electrosurgery (patient return electrode), bipolar electrosurgery</i> • <i>Types of electrosurgery (cutting, coagulation, fulguration)</i> • <i>Electrocautery (radio frequency ablation, electrosurgical vessel</i> 	
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						<i>sealing, argon-enhanced electrosurgery</i> <ul style="list-style-type: none"> • <i>Safety at electrosurgery (generator safety, safety at active electrodes), hazardous factors in minimally invasive surgery (capacitive coupling, directing coupling, active electrode monitoring, return electrode monitoring, patients with electronic implants)</i> 	
16	EVALUASI AKHIR SEMESTER						40
	FINAL-SEMESTER EXAM						

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 : Electrical System in Biomedical Application		RA&E
			Write Doc Code
Kode/code: EB234602	Bobot sks/credits (T/P): 2/0	Rumpun MK: Ilmu Dasar Teknik Course Cluster: Basic Engineering	Smt: VI
OTORISASI AUTHORIZATION	Penyusun RA & E Compiler A&EP Nada Fitriyatul H, S.T, M.T	Koordinator RMK Course Cluster Coordinator Dr. Norma Hermawan, 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)
1-3	<p>Sub CP-MK 1: Mahasiswa memahami dan mampu menjelaskan tentang prinsip-prinsip pembangkitan tenaga listrik, konsep listrik <i>single phase</i> dan <i>polyphase</i>.</p> <p>LLO 1: <i>Students understand and are able to explain the principles of electric power generator, single phase and</i></p>	<p>Non-tes : Tugas 1: Mengenai prinsip-prinsip pembangkitan tenaga listrik (Tugas Tertulis). Tugas 2: Mengenai konsep listrik <i>single phase</i> dan <i>polyphase</i> (Tugas Tertulis) Tes: ETS Soal 1 dan Soal 2 (10% dari ETS 30%)</p> <p>Non-test : Task 1: <i>Regarding rinciples of electric power generator. (Written task)</i> Task 2: <i>Regarding ingle phase and polyphase electric concepts. (Written task)</i> Test:</p>	<p>Tugas 1 / Task 1: 3.75</p> <p>Tugas 2 / Task 2: 3.75</p>

	<i>polyphase electric concepts.</i>	<i>Questions 1 dan 2 in Mid Exam (10% of Mid Exam 30%)</i>	
4-6	<p>Sub CP-MK 2: Mahasiswa memahami dan mampu menjelaskan tentang tahapan instalasi kelistrikan biomedika.</p> <p>LLO 2: <i>Students understand and are able explain the stages of the biomedical electrical installation.</i></p>	<p>Non-tes : Tugas 3: Mengenai listrik dan tubuh manusia (Tugas Tertulis)</p> <p>Tugas 4: Mengenai instalasi kelistrikan biomedika (Tugas Tertulis)</p> <p>Tes: ETS Soal 3 dan Soal 4 (10% dari ETS 30%)</p> <p>Non-test : Task 3: <i>Regarding electricity and human body (Written task)</i></p> <p>Task 4: <i>Regarding biomedical electrical installations (Written task).</i></p> <p>Test: <i>Questions 3 and 4 in Mid Exam (10% of Mid Exam 30%)</i></p>	<p>Tugas 3/ <i>Task 3:</i> 3.75</p> <p>Tugas 4/ <i>Task 4:</i> 3.75</p>
7, 9, 10	<p>Sub CP-MK 3: Mahasiswa memahami dan mampu menganalisa serta menjelaskan tentang sistem grounding dan konsep-konsep keamanan dalam menggunakan peralatan-peralatan medis yang bertegangan tinggi.</p> <p>LLO 3: <i>Students understand and are able to analyze and explain the gounding system</i></p>	<p>Non-tes : Tugas 5: Mengenai sistem grounding, assessment dan manajemen resiko, sistem keamanan kebocoran arus (Tugas Tertulis).</p> <p>Tugas 6: Mengenai keamanan kelistrikan di Rumah Sakit (Tugas Tertulis)</p> <p>Tes: ETS Soal 5 dan Soal 6 (10% dari ETS 30%)</p> <p>Non-test : Task 5: <i>Regarding grounding system, assessment and risk management, current leakage security system (Written task)</i></p> <p>Task 6: <i>Regarding electrical safety in Hospital (Written task).</i></p> <p>Test: <i>Questions 5 and 6 in Mid Exam (10% of Mid Exam 30%)</i></p>	<p>Tugas 5/ <i>Task 5:</i> 3.75</p> <p>Tugas 6/ <i>Task 6:</i> 3.75</p>

	<i>and safety concepts in using high-voltage medical devices.</i>		
8	Evaluasi Tengah Semester <i>Mid Exam</i>	Tes: Ujian Tulis/Ujian Daring Test: <i>Writing Exams / Online Exams</i>	30
11-12	Sub CP-MK 4: Mahasiswa memahami dan mampu menganalisa serta menjelaskan tentang Electromagnetic Interference (EMI). LLO 4: <i>Students understand and are able to analyze and explain about Electromagnetic Interference (EMI).</i>	Non-tes : Tugas 7: Mengenai Electromagnetic Interference (EMI) (Tugas Tertulis) Tes: EAS Soal 1 dan Soal 2 (20% dari EAS 40%) Non-test : Task 7: <i>Regarding Electromagnetic Interference (EMI) (Written task)</i> Test: <i>Questions 1 and 2 in Final Exam (20% of Final Exam 40%)</i>	Tugas 7 / <i>Task 7</i> 3.75
13-15	Sub CP-MK 5: Mahasiswa memahami dan mampu menganalisa serta menjelaskan tentang dasar-dasar operasi sistem electrical surgical unit (ESU). LLO 5: <i>Students understand and are able to analyze and explain the basic of operating the Electrical Surgical Unit (ESU) system.</i>	Non-tes : Tugas 8: Mengenai electrical surgery unit (Tugas tertulis). Tes: EAS Soal 3 dan Soal 4 (20% dari EAS 40%) Non-test: Task 3: <i>Regarding Electrical surgery unit (Written task)</i> Test: <i>Questions 3 and 4 in Final Exam (20% of Final Exam 40%)</i>	Tugas 8 / <i>Task 8:</i> 3.75

16	Evaluasi Akhir <i>Final Exam</i>	Tes: Ujian Tulis/Ujian Daring Test: <i>Writing Exams / Online Exams</i>	40
Total bobot penilaian Total assessment load			100%

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

CPL yang dibebankan pada MK / <i>PLO charged to the course</i>	CPMK / <i>Course Learning Outcome (CLO)</i>	Minggu ke / <i>Week</i>	Bentuk Asesmen / <i>Form of Assessment</i>	Bobot / <i>Load (%)</i>
CPL-05 / <i>PLO-05</i>	CPMK 1 / <i>CLO 1</i>	Week- 1-3	Task 1	3.75
			Task 2	3.75
		Week- 8	Mid Exam Questions 1 and 2	10
	CPMK 2 / <i>CLO 2</i>	Week- 4-6	Task 3	3.75
			Task 4	3.75
		Week- 8	Mid Exam Questions 3 and 4	10
CPL-06 / <i>PLO-06</i>	CPMK 3 / <i>CLO 3</i>	Week- 7,9,10	Task 5	3.75
			Task 6	3.75
		Week- 8	Mid Exam Questions 5 and 6	10
CPL-07 / <i>PLO-07</i>	CPMK 4 / <i>CLO 4</i>	Week- 11-12	Task 7	3.75
			Final Exam Questions 1 and 2	20
	CPMK 5 / <i>CLO 5</i>	Week- 13-15	Final Exam Question 4	3.75
		Week- 16	Final Exam Questions 3 and 4	20
				Σ = 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					0.0375								0.0375

2	Task 2					0.0375								0.0375
3	Task 3					0.0375								0.0375
4	Task 4					0.0375								0.0375
5	Task 5						0.0375							0.0375
6	Task 6						0.0375							0.0375
7	Task 7							0.0375						0.0375
8	Task 8							0.0375						0.0375
9	Mid Exam					0.2	0.1							0.3
10	Final Exam							0.4						0.4
	<i>Total</i>					0.35	0.175	0.475						1

