MODULE HANDBOOK
BASIC ELECTRONICS AND LABORATORY

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

INSTITUT TEKNOLOGI SEPULUH NOPEMBER

ENDORSEMENT PAGE

	MODULE HANDBOOK **Basic Electronics and Laboratory** **DEPARTMENT OF BIOMEDICAL ENGINEERING** **INSTITUT TEKNOLOGI SEPULUH NOPEMBER** **Number :** B/21346/IT2.IX.5.1.2/PP.03.00.00/2020

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

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MODULE HANDBOOK
BASIC ELECTRONICS AND LABORATORY

Module name	**Basic Electronics and Laboratory**	
Module level	Undergradute	
Code	EB184303	
Course (if applicable)	Basic Electronics and Laboratory	
Semester	First Semester (Gasal)	
Person responsible for the module	Dr. Rachmad Setiawan, S.T., M.T.	
Lecturer		
Language	Bahasa Indonesia and English	
Relation to curriculum	Undergradute degree program, **mandatory**, 3rd semester.	
Type of teaching, contact hours	Lectures, <60 students Tuesday, 08.00-10.50 (GMT+7)	
Workload	1. Lectures : 4 x 50 = 200 minutes per week. 2. Exercises and Assignments : 4 x 50 = 200 minutes per week. 3. Private learning : 4 x 50 = 200 minutes per week.	
Credit points	4 credit points (sks)	
Requirements according to the examination regulations	A student must have attended at least 75% of the lectures to sit in the exams.	
Mandatory prerequisites	-	
Learning outcomes and their corresponding PLOs	Course Learning Outcome (CLO) after completing this module, CLO 1: Students are able to understand and explain basic theories about semiconductor materials and diode components, and are able to identify diode characteristics. CLO 2: Students are able to understand a series of diode applications and are able to design, analyze, and realize a series of diode applications with the correct methodology. CLO 3: Students are able to understand the basic theory of the BJT transistor and are able to explain the basic operations of the BJT transistor. CLO 4: Students are able to understand dc bias circuits and switching and are able to design, analyze, and realize	PLO-01 PLO-05 PLO-01 PLO-05

	dc bias circuits and switching with the correct methodology. CLO 5: Students are able to understand the stages of amplifier circuit design using BJT transistors and are able to design, analyze, and realize single stage and multistage amplifier circuits with the correct methodology. CLO 6: Students are able to understand the basic theory of the FET transistor and explain the stages of amplifier design using a FET transistor. CLO 7: Students are able to understand power amplifier circuits and are able to design, analyze and realize power amplifier circuits using the correct methodology. CLO 8: Students understand and are able to explain the PNPN component application.	PLO-03 PLO-03 PLO-03 PLO-01
Content	Basic Electronics and Laboratory is a mandatory courses that discuss the basic science of electronics, both theoretically and practically. This course aims to make students understand the characteristics of electronic components such as diodes, BJT transistors, FET transistors, and others. In addition, this course also aims to enable students to conduct experiments on theories that have been studied and understood, so that students can be trained and skilled in using components and equipment with the correct procedures. With this understanding and skills, students are expected to be able to apply it on biomedical engineering field.	
Study and examination requirements and forms of examination	• In-class exercises • Assignment 1, 2, 3, 4, 5, 6, 7, 8, 9 • Lab Work 1, 2, 3, 4, 5 • Mid-term examination • Final examination	
Media employed	LCD, whiteboard, websites (myITS Classroom), zoom.	
Reading list	Main : 1. S.M. Sze, “Semiconductor Devices Physics and Technology”, John Wiley & Sons, 1985. 2. David A. Bell, “Solid State Pulse Circuit”, Prentice-Hall, 1976. 3. Floyd, Thomas L., “Electronic Devices : Electron Flow Version 9th Ed”, Prentice-Hall, 2012. Supporting :	

	1. Floyd, Thomas L., and David B., “Fundamentals of Analog Circuit”, Prentice-Hall, 2002. 2. Malvino, A. P., “Electronic Principles”, McGraw-Hill Education, 2015.

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***
Dasar Elektronika dan Laboratorium ***Basic Electronics and Laboratory***	EB184303	*Biomedical Instrumentation and Signal Processing*	T=4	P=0	III	Feb 27, 2020
OTORISASI / PENGESAHAN ***AUTHORIZATION / ENDORSEMENT***	**Dosen Pengembang RPS** ***Developer Lecturer of Semester Learning Plan***		**Koordinator RMK** ***Course Cluster Coordinator***		**Ka DEPARTEMEN** ***Head of Department***	
	(Dr. Rachmad Setiawan, S.T., M.T.)		**(Dr. Rachmad Setiawan, S.T., M.T.)**		**(Dr. Achmad Arifin, S.T., M.Eng.)**	

Capaian Pembelajaran ***Learning Outcomes***	**CPL-PRODI yang dibebankan pada MK** ***PLO Program Charged to The Course***	
	CPL-01 *PLO-01*	Mampu **menerapkan** Ilmu Pengetahuan Alam dan Matematika pada bidang Teknik Biomedika. *Able to **apply** Natural Sciences and Mathematics in the field of Biomedical Engineering*.
	CPL-03 *PLO-03*	Mampu **merancang** dan **melaksanakan** eksperimen laboratorium dan/atau lapangan, **menganalisa** dan **menginterpretasi** data, serta menggunakan penilaian yang obyektif untuk menarik kesimpulan. *Able to **design** and **implement** laboratory experiment and / or field experiments, **analyze** and **interpret** data, and use objective assessments to draw conclusions.*
	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 **mengenali/memanfaatkan** sumber daya lokal dan nasional dengan wawasan global.

	PLO-05	*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.*
	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 teori dasar tentang bahan semikonduktor dan komponen dioda, serta mampu mengidentifikasi karakteristik dioda. *Students are able to understand and explain basic theories about semiconductor materials and diode components, and are able to identify diode characteristics.*
	CP MK 2 ***CLO 2***	Mahasiswa memahami rangkaian aplikasi dioda dan mampu merancang, menganalisa serta merealisasikan rangkaian aplikasi dioda dengan metodologi yang benar. *Students are able to understand a series of diode applications and are able to design, analyze, and realize a series of diode applications with the correct methodology.*
	CP MK 3 ***CLO 3***	Mahasiswa memahami teori dasar transistor BJT dan mampu menjelaskan operasi dasar dari transistor BJT. *Students are able to understand the basic theory of the BJT transistor and are able to explain the basic operations of the BJT transistor.*
	CP MK 4 ***CLO 4***	Mahasiswa memahami rangkaian *bias dc* dan *switching* dan mampu merancang, menganalisa serta merealisasikan rangkaian *bias dc* dan *switching* dengan metodologi yang benar. *Students are able to understand dc bias circuits and switching and are able to design, analyze, and realize dc bias circuits and switching with the correct methodology.*
	CP MK 5 ***CLO 5***	Mahasiswa memahami tahapan perancangan rangkaian penguat (*amplifier*) menggunakan transistor BJT dan mampu merancang, menganalisa serta merealisasikan rangkaian *amplifier single stage* dan *multistage* dengan metodologi yang benar. *Students are able to understand the stages of amplifier circuit design using BJT transistors and are able to design, analyze, and realize single stage and multistage amplifier circuits with the correct methodology.*
	CP MK 6 ***CLO 6***	Mahasiswa memahami teori dasar transistor FET dan mampu menjelaskan tahapan perancangan penguat menggunakan transistor FET. *Students are able to understand the basic theory of the FET transistor and explain the stages of amplifier design using a FET transistor.*

	CP MK 7 ***CLO 7***	Mahasiswa memahami rangkaian penguat daya dan mampu merancang, menganalisa serta merealisasikan rangkaian penguat daya dengan metodologi yang benar. *Students are able to understand power amplifier circuits and are able to design, analyze and realize power amplifier circuits using the correct methodology*.
	CP MK 8 ***CLO 8***	Mahasiswa memahami dan mampu menjelaskan aplikasi komponen PNPN. *Students understand and are able to explain the PNPN component application*.

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*			√									
CPMK 8 / SUB CPMK 8 *CLO 8 / LLO 8*	√											

Diskripsi Singkat MK

Mata kuliah Dasar Elektronika dan Laboratorium merupakan mata kuliah wajib yang membahas mengenai ilmu dasar elektronika baik secara teori maupun praktek. Mata kuliah ini bertujuan agar mahasiswa memahami karakteristik dari komponen-komponen elektronika seperti diode, transistor BJT, transistor FET, dan lain-lain. Selain itu, mata kuliah ini juga bertujuan agar mahasiswa mampu melakukan eksperimen tentang teori-teori yang sudah dipelajari dan dipahami, sehingga mahasiswa bisa terlatih dan terampil dalam menggunakan komponen dan peralatan dengan prosedur yang benar. Dengan pemahaman dan keterampilan tersebut mahasiswa diharapkan mampu menerapkannya.

Short Description of Course	*Basic Electronics and Laboratory is a mandatory courses that discuss the basic science of electronics, both theoretically and practically. This course aims to make students understand the characteristics of electronic components such as diodes, BJT transistors, FET transistors, and others. In addition, this course also aims to enable students to conduct experiments on theories that have been studied and understood, so that students can be trained and skilled in using components and equipment with the correct procedures. With this understanding and skills, students are expected to be able to apply it on biomedical engineering field.*
Bahan Kajian: Materi pembelajaran ***Course Materials:***	1. Dasar semikonduktor dan dioda / *Basic semiconductors and diodes.* 2. Keterampilan identifikasi karakteristik dioda / *Diode characteristic identification skills.* 3. Keterampilan perancangan rangkaian aplikasi dioda / *Diode application circuit design skills*. 4. Pengenalan disain *amplifier* BJT / *Introduction to the BJT amplifier design.* 5. Keterampilan proses *bias dc* dan *switching* / *DC bias and switching process skills.* 6. Keterampilan perancangan dan analisis *amplifier single stage* dan *multistage* / *Single stage and multistage amplifier design and analysis skills.* 7. Keterampilan perancangan dan analisis penguat daya / *Power amplifier design and analysis skills.* 8. Pengenalan disain *amplifier* FET / *Introduction to the FET amplifier design.* 9. Aplikasi komponen PNPN / *PNPN component applications.*
Pustaka ***References***	**Utama / *Main*:** 1. S.M. Sze, "Semiconductor Devices Physics and Technology", John Wiley & Sons, 1985. 2. David A. Bell, "Solid State Pulse Circuit", Prentice-Hall, 1976. 3. Floyd, Thomas L., "Electronic Devices : Electron Flow Version 9th Ed", Prentice-Hall, 2012. **Pendukung / *Supporting*:** 1. Floyd, Thomas L., and David B., "Fundamentals of Analog Circuit", Prentice-Hall, 2002. 2. Malvino, A. P., "Electronic Principles", McGraw-Hill Education, 2015.
Dosen Pengampu ***Lecturers***	,,,,,,,,,,

Matakuliah syarat ***Prerequisite***	-

Mg ke/ ***Week***	**Kemampuan akhir tiap tahapan belajar (Sub-CPMK) /** ***Final ability of each learning stage (LLO)***	**Penilaian /** ***Assessment***		**Bantuk Pembelajaran; Metode Pembelajaran; Penugasan Mahasiswa; [Estimasi Waktu] /** ***Form of Learning; Learning Method; Student Assignment; [Estimated Time]***		**Materi Pembelajaran [Pustaka] /** ***Learning Material [Reference]***	**Bobot Penilaian /***Assess-ment Load* **(%)**
		Indikator / ***Indicator***	**Kriteria & Teknik /** ***Criteria & Techniques***				
(1)	**(2)**	**(3)**	**(4)**	**Tatap Muka /** ***In-class*** **(5)**	**Daring /** ***Online*** **(6)**	**(7)**	**(8)**
1-2	Mahasiswa memahami dan mampu menjelaskan teori dasar tentang bahan semikonduktor dan komponen dioda, serta mampu mengidentifikasi karakteristik dioda. *Students are able to understand and explain basic theories about semiconductor*	• Mampu mengenali tentang elektronika, simulator, dan perkembangan teknologi IC. • Mampu mengetahui dasar semikonduktor seperti sifat kelistrikan pada bahan dan pembagiannya.	**Non-tes :** **Tugas 1** Mencari aplikasi *PN Junction* seperti *Photovoltaic* (PV) *Cell*, operasi dan aplikasinya. **Tugas 2** Mencari datasheet dioda Ge dan Si, menjelaskan	• Kuliah, diskusi, tanya jawab, latihan soal, tugas. [TM : 4 x 50”] [BM : 4 x 50”] [PT : 4 x 50”] • *Presentation, discussion, ask*	• Chatting dan diskusi dalam forum platform ITS. • *Chat and discussion in ITS platform forum.*	• Kontrak kuliah: - Motivasi belajar - Rencana pembelajaran - Aturan-aturan perkuliahan - Tujuan perkuliahan - Sistem penilaian,	**13**

	materials and diode components, and are able to identify diode characteristics.	• Mampu merepresentasikan apa saja yang termasuk dalam pengenalan dioda seperti karakteristik komponen, pembiasan pada dioda, dan rangkaian ekivalen dioda. • *Able to recognize about electronics, simulators, and developments in IC technology.* • *Able to know semiconductor basics such as its electrical properties of materials and their distribution.* • *Be able to represent anything that is included in the introduction of a diode such as component characteristics, diode refraction, and diode equivalent circuits.*	parameter-parameter dioda berdasarkan datasheet, Macam-macam dioda dan aplikasinya. **Praktikum 1 :** Identifikasi karakteristik dioda. ***Non-test :*** ***Task 1:*** *Search PN Junction applications such as Photovoltaic (PV) Cell, operations and the applications.* ***Task 2:*** *Search Ge and Si diode datasheet, explain diode parameters based on the datasheet, diode types and the applications.*	*and answer, exercise, assignment.* *[FF : 4 x 50”]* *[SA : 4 x 50”]* *[SS : 4 x 50”]*		buku ajar/sumber pustaka • Pengenalan tentang elektronika dan simulator untuk analisa dan perancangan rangkaian elektronika, perkembangan teknologi IC. • Dasar semikonduktor : atom (elektron, shell, elektron bebas), sifat kelistrikan pada bahan dan pembagiannya (insulator, konduktor dan semikonduktor), bahan semikonduktor (Ge, Si, GaAs), ikatan kovalen, bahan intrinsik, level energi, bahan ektrinsik (tipe N dan tipe P)	

			Lab Work 1: *Characteristics of the diode identification*			• Dioda : pengenalan komponen dioda (*PN Junction*), pembiasan pada dioda (bias mundur, bias maju), karakteristik dioda (ideal dan tidak ideal), level resistansi (*dc, ac, ac average*), rangkaian ekivalen dioda (*ideal, simplified, piecewise-linear*), *transition and diffusion capacitance*, *reverse recovery time*, datasheet dioda, notasi dioda, pengujian dioda, pengenalan dioda zener dan *light emitting diode* (LED) **[Link materi di MyITSClassroom]** • *Course contract:* *- Motivation to*	

						learn *- Lesson plan* *- Lecture rules* *- Course objective* *- Assessment system, textbooks / library resources* • *Introduction to electronics and simulators for the analysis and design of electronic circuits, developments in IC technology.* • *Semiconductor basics: atoms (electrons, shells, free electrons), electrical properties of materials and their distribution (insulators, conductors and semiconductors), semiconductor materials (Ge, Si, GaAs), covalent bonds, intrinsic materials, energy*	

						levels, extrinsic materials (N type and P type) • *Diodes: introduction of diode components (PN Junction), diode refraction (reverse bias, forward bias), diode characteristics (ideal and non-ideal), resistance level (dc, ac, ac average), diode equivalent circuit (ideal, simplified, piecewise-linear), transition and diffusion capacitance, reverse recovery time, diode datasheet, diode notation, diode testing, introduction of zener diodes and light emitting diode (LED)*	

3-4	Mahasiswa memahami rangkaian aplikasi dioda dan mampu merancang, menganalisa serta merealisasikan rangkaian aplikasi dioda dengan metodologi yang benar. *Students are able to understand a series of diode applications and are able to design, analyze, and realize a series of diode applications with the correct methodology.*	• Mampu mengetahui karakteristik dan mengerjakan perhitungan permasalahan rangkaian aplikasi dioda seperti analisa rangkaian dioda dan konfigurasinya. • *Able to know the characteristics and do some calculation of diode application circuits such as diode circuit analysis and its configuration problems.*	**Non-tes :** **Tugas 3:** Mengerjakan soal perhitungan mengenai analisa rangkaian dasar diode, rangkaian penyearah, *clipper*, *clamper*, pengali tegangan dan rangkaian dioda zener. **Praktikum 2 :** Perancangan rangkaian aplikasi dioda ***Non-test :*** ***Task 3:*** *Solving calculation problems regarding diode basic circuit analysis, rectifier circuits, clipper, clampers, voltage multipliers and zener diode circuits*	• Kuliah, diskusi, tanya jawab, latihan soal, tugas. [TM : 4 x 50”] [BM : 4 x 50”] [PT : 4 x 50”] • *Presentation, discussion, ask and answer, exercise, assignment* *[FF : 4 x 50”]* *[SA : 4 x 50”]* *[SS : 4 x 50”]*		• Rangkaian aplikasi dioda : metode analisa rangkaian dioda menggunakan karakteristik aktual, pemodelan dan analisa garis beban (*load-line analysis*), konfigurasi rangkaian dasar dioda (seri, parallel, kombinasi), penyearah, *clipper*, *clamper*, pengali tegangan, rangkaian dioda zener, rangkaian aplikasi dioda yang lain. • *Diode application circuit: the diode circuit analysis method uses actual characteristics, load-line design and analysis, diode basic circuit configuration (series, parallel,*	**10.5**

			***Lab Work 2*:** *Diode application circuit design.*			*combination), rectifier, clipper, clamper, voltage multiplier, zener diode circuit, and other diode applications circuit.*	
5	Mahasiswa memahami teori dasar transistor BJT dan mampu menjelaskan operasi dasar dari transistor BJT. *Students are able to understand the basic theory of the BJT transistor and are able to explain the basic operations of the BJT transistor.*	• Mampu mengenali tentang transistor BJT dan menjelaskan datasheetnya. • Mampu mengerjakan perhitungan konfigurasi bias dasar dan analisa titik kerja batasan operasi pada BJT. • *Able to recognize about BJT transistors and explain the datasheet.* • *Able to perform basic bias configuration calculations and analysis of operating limit work point on BJT.*	**Non-tes :** **Tugas 4:** Mencari datasheet transistor BJT, menjelaskan parameter-parameter transistor BJT berdasarkan datasheet, mengerjakan soal perhitungan mengenai analisa karakteristik BJT (penentuan titik kerja BJT untuk konfigurasi bias dasar). ***Non-test :*** ***Task 4:*** *Searching for the BJT transistor datasheet, explain*	• Kuliah, diskusi, tanya jawab, latihan soal, tugas. [TM : 4 x 50"] [BM : 4 x 50"] [PT : 4 x 50"] • *Presentation, discussion, ask and answer, exercise, assignment* *[FF : 4 x 50"]* *[SA : 4 x 50"]* *[SS : 4 x 50"]*		• Transistor BJT : konstruksi (NPN, PNP), operasi BJT. • Konfigurasi bias dasar dan analisa titik kerja (*common-base, common-emitter, common-collector*), batasan operasi pada BJT. • Datasheet transistor BJT. • *BJT transistor: construction (NPN, PNP), BJT operation.* • *Basic bias configuration and working point analysis (common-base, common-emitter, common-collector), operating limits on the BJT.*	**2.5**

			the parameters of the BJT transistor based on the datasheet, solve calculation problems regarding the characteristic analysis of the BJT (determining the working point of the BJT for basic bias configurations).			• *BJT transistor datasheet.*	
6-7	Mahasiswa memahami rangkaian *bias dc* dan *switching* dan mampu merancang, menganalisa serta merealisasikan rangkaian *bias dc* dan *switching* dengan metodologi yang benar. *Students are able to understand dc bias circuits and switching and are able to design, analyze, and realize dc bias circuits and switching with the correct methodology.*	• Mampu mengenali tentang rangkaian *bias dc* dan *switching* BJT termasuk macam-macam konfigurasi *bias dc* dan analisa garis beban. • Mampu mengerjakan desain dan perhitungan analisa dan perancangan rangkaian *bias dc* dan *switching*. • *Able to recognize about DC bias circuit and BJT switching including various DC*	**Non-tes :** **Tugas 5:** Mengerjakan soal perhitungan mengenai analisa dan perancangan rangkaian *bias dc* dan *switching* serta mencari contoh aplikasinya. **Praktikum 3 :** *Proses bias dc dan switching*.	• Kuliah, diskusi, tanya jawab, latihan soal, tugas. [TM : 4 x 50”] [BM : 4 x 50”] [PT : 4 x 50”] • *Presentation, discussion, ask and answer, exercise, assignment* *[FF : 4 x 50”]* *[SA : 4 x 50”]* *[SS : 4 x 50”]*		• Rangkaian *bias dc* dan *switching* BJT : macam-macam konfigurasi *bias dc (fixed-bias, emitter-bias, voltage-divider bias, collector feedback, emitter-follower, common-base*), analisa garis beban, disain operasi. • Rangkaian *switching* BJT (analisa dan tahapan perancangan)	**10.5**

		bias configurations and load line analysis. • *Able to do the design and calculation of analysis and circuit design of DC bias and switching.*	***Non-test :*** ***Task 5:*** *Solve calculation problems regarding the analysis and design of dc bias circuits and switching then search for some examples of the application.* ***Lab Work 3:*** *DC bias and switching process.*			• Aplikasi rangkaian *bias dc* dan *switching.* • *DC bias circuits and BJT switching: various DC bias configurations (fixed-bias, emitter-bias, voltage-divider bias, collector feedback, emitter-follower, common-base), load line analysis, operation design.* • *BJT switching circuit (analysis and design stages)* • *DC bias circuit and switching applications.*	
8	**EVALUASI TENGAH SEMESTER** ***MID-SEMESTER EXAM***						**17.5**
9 - 10	Mahasiswa memahami tahapan perancangan rangkaian penguat (*amplifier*) menggunakan transistor BJT dan mampu merancang, menganalisa serta	• Mampu menjelaskan rangkaian penguat (*amplifier*) menggunakan transistor BJT.	**Non-tes :** **Tugas 6:** Mengerjakan soal perhitungan mengenai analisa dan perancangan	• Kuliah, diskusi, tanya jawab, latihan soal, tugas. [TM : 4 x 50”] [BM : 4 x 50”] [PT : 4 x 50”]		• Rangkaian penguat (*amplifier*) menggunakan transistor BJT : penguatan dalam *domain ac*, pemodelan	**10.5**

	merealisasikan rangkaian *amplifier single stage* dan *multistage* dengan metodologi yang benar. *Students are able to understand the stages of amplifier circuit design using BJT transistors and are able to design, analyze, and realize single stage and multistage amplifier circuits with the correct methodology.*	• Mampu menghitung *two port system* dan parameternya. • Mampu merancang dan menganalisa macam-macam konfigurasi rangkaian *amplifier single stage dan* amplifier multi stage. • Mampu mengenali tentang model hybrid. • *Able to explain amplifier circuit using BJT transistor.* • *Able to calculate two port system and its parameters.* • *Able to design and analyze various single stage amplifier and multi stage amplifier circuit configurations.* • *Able to recognize about the hybrid model.*	rangkaian *amplifier single stage* dan *multistage* serta mencari contoh aplikasinya. **Praktikum 4 :** Perancangan dan analisis *amplifier single stage* dan *multistage*. ***Non-test :*** ***Task 6:*** *Solving calculation problems regarding the analysis and design of single stage and multistage amplifier circuits and find examples of the application.* ***Lab Work 4:*** *Design and analysis of single stage and multistage amplifiers.*	• *Presentation, discussion, ask and answer, exercise, assignment.* *[FF : 4 x 50”]* *[SA : 4 x 50”]* *[SS : 4 x 50”]*		transistor BJT (r_e *model, hybrid π model, hybrid equivalent model*) • *Two port system* dan parameternya : *input impedance* (Zi), *output impedance* (Zo), *voltage gain* (Av), *current gain* (Ai). • Teknik perancangan, analisa dan macam-macam konfigurasi rangkaian *amplifier single stage* (*CE fixed-bias*, *CE voltage-divider bias*, *CE emitter-bias*, *emitter-follower*, *collector feedback*, *collector DC feedback*,CB), efek RL dan RS. • Tahapan perancangan dan analisa amplifier multi stage. • Pengenalan model hybrid.	

						• *The amplifier circuit uses BJT transistors: amplification in the ac domain, BJT transistor modeling (r_e model, hybrid π model, hybrid equivalent model).* • *Two port system and its parameters: input impedance (Zi), output impedance (Zo), voltage gain (Av), current gain (Ai).* • *Design techniques, analysis and various single stage amplifier circuit configurations (CE fixed-bias, CE voltage-divider bias, CE emitter-bias, emitter-follower, collector feedback, collector DC feedback, CB), RL and RS effects.*	

						• *Stages of design and analyze multi stage amplifiers.* • *Introduction of the hybrid model.*	
11 -12	Mahasiswa memahami teori dasar transistor FET dan mampu menjelaskan tahapan perancangan penguat menggunakan transistor FET. *Students are able to understand the basic theory of the FET transistor and explain the stages of amplifier design using a FET transistor.*	• Mampu menjelaskan tentang transistor FET termasuk karakteristik dasar dan data sheetnya. • Mampu menjelaskan hubungan antara BJT dan FET. • Mampu membedakan antara E-MOSFET dan D-MOSFET. • Mampu menghitung dan menganalisa konfigurasi bias FET dan *amplifier* menggunakan FET. • *Able to explain about FET transistor including basic characteristics and its data sheet.* • *Able to explain the relation between BJT and FET.*	**Non tes:** **Tugas 7:** Mengerjakan soal perhitungan mengenai analisa dan perancangan rangkaian penguat FET serta mencari contoh aplikasinya. ***Non-test:*** ***Task 7:*** *Solve calculation problems regarding the analysis and design of the FET amplifier circuit and search examples of its application.*	• Kuliah, diskusi, tanya jawab, latihan soal, tugas. [TM : 4 x 50"] [BM : 4 x 50"] [PT : 4 x 50"] • *Presentation, discussion, ask and answer, exercise, assignment.* *[FF : 4 x 50"]* *[SA : 4 x 50"]* *[SS : 4 x 50"]*		• Pengenalan transistor FET, kontruksi, karakteristik dasar, karakteristik transfer, dan data sheet FET. • Hubungan parameter BJT dan FET. • Pengenalan E-MOSFET dan D-MOSFET. • Metode bias FET dan konfigurasinya: *fixed-bias, self-bias, common gate.* • Analisa dan perancangan *amplifier* menggunakan FET : *small signal model, fixed-bias configuration, self-bias configuration, voltage-divider*	**2.5**

		• *Able to distinguish between E-MOSFET and D-MOSFET.* • *Able to calculate and analyze bias configuration of FET and amplifier using FET.*				*configuration, common gate configuration, source-follower.* • Aplikasi *amplifier* FET. • *Introduction to the FET transistor, construction, basic characteristics, transfer characteristics, and the FET data sheet.* • *Relationship between BJT and FET parameters.* • *Introduction to the E-MOSFET and D-MOSFET.* • *FET bias method and its configuration: fixed-bias, self-bias, common gate.* • *Analysis and design of amplifiers using FET: small signal model, fixed-bias configuration, self-bias configuration,*	

						voltage-divider configuration, common gate configuration, source-follower. • *FET amplifier applications.*	
13-14	Mahasiswa memahami rangkaian penguat daya dan mampu merancang, menganalisa serta merealisasikan rangkaian penguat daya dengan metodologi yang benar. *Students are able to understand power amplifier circuits and are able to design, analyze and realize power amplifier circuits using the correct methodology.*	• Mampu merepresentasikan rangkaian penguat daya dan tipe-tipe penguat daya. • Mampu menganalisa dan merancang rangkaian penguat daya. • Mampu menjelaskan dan membedakan antara *series-fed class A amplifier* dan t*ransformer-coupled class A amplifier*. • Mampu menjelaskan tentang *class B amplifier, class C and class D amplifiers.* • *Able to represent the power amplifier circuit and the types of power amplifier.*	**Non tes:** **Tugas 8:** Mengerjakan soal perhitungan mengenai analisa dan perancangan rangkaian penguat daya serta mencari contoh aplikasinya **Praktikum 5 :** Perancangan dan analisis penguat daya. ***Non-test :*** ***Task 8:*** *Solve calculation problems regarding the analysis and design of the power amplifier circuit and find examples of its application.*	• Kuliah, diskusi, tanya jawab, latihan soal, tugas. [TM : 4 x 50"] [BM : 4 x 50"] [PT : 4 x 50"] • *Presentation, discussion, ask and answer, exercise, assignment.* *[FF : 4 x 50"]* *[SA : 4 x 50"]* *[SS : 4 x 50"]*		• Pengenalan rangkaian penguat daya dan tipe-tipe penguat daya. • Metode analisa dan perancangan rangkaian penguat daya. • *Series-fed class A amplifier.* • *Transformer-coupled class A amplifier.* • *Class B amplifier.* • *Class C and class D amplifiers.* • *Introduction of power amplifier circuits and types of power amplifiers.* • *Methods of analysis and design of*	**10.5**

		• *Able to analyze and design power amplifier circuit.* • *Able to describe and differentiate between series-fed class A amplifiers and transformer-coupled class A amplifiers.* • *Able to explain about class B amplifiers, class C and class D amplifiers.*	***Lab Work 5:*** *Power amplifier design and analysis.*			*power amplifier circuits.* • *Series-fed class A amplifier.* • *Transformer-coupled class A amplifier.* • *Class B amplifier.* • *Class C and class D amplifiers*	
15	Mahasiswa memahami dan mampu menjelaskan aplikasi komponen PNPN. *Students understand and are able to explain the PNPN component application*.	• Mampu merepresentasikan komponen PNPN, operasi dan rangkaiannya. • Mampu menjelaskan tentang aplikasi komponen PNPN. • *Able to represent PNPN components, operations and its circuit.* • *Able to explain PNPN component applications.*	**Non tes:** **Tugas 9:** Mencari aplikasi komponen PNPN. ***Non-test:*** ***Task 9:*** *Search PNPN component applications.*	• Kuliah, diskusi, tanya jawab, latihan soal, tugas. [TM : 4 x 50"] [BM : 4 x 50"] [PT : 4 x 50"] • *Presentation, discussion, ask and answer, exercise, assignment.* *[FF : 4 x 50"]* *[SA : 4 x 50"]* *[SS : 4 x 50"]*		• Pengenalan komponen PNPN, operasi dan rangkaiannya : *Silicon-controlled rectifiers* (SCRs), *Silicon-controlled switches* (SCSs), *Gate turn-off switches* (GTO), *Light-activated SCRs* (LSCR), *Shockley diodes and diacs*, *Triacs*, *Phototransistors and opto-isolators*, *Unijunction and programmable*	**2.5**

						unijunction transistors. • Aplikasi komponen PNPN. • *Introduction to PNPN components, operations and its circuit: Silicon-controlled rectifiers (SCRs), Silicon-controlled switches (SCSs), Gate turn-off switches (GTO), Light-activated SCRs (LSCR), Shockley diodes and diacs, Triacs, Phototransistors and opto-isolators, Unijunction and programmable unijunction transistors.* • *PNPN component applications.*	
16	**EVALUASI AKHIR SEMESTER** ***FINAL-SEMESTER EXAM***						**20**

TM=Tatap Muka, **PT**=Penugasan Terstuktur, **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 : Basic Electronics and Laboratory**		**RA&E** Write Doc Code
Kode/*code*: **EB184303**	**Bobot sks/*credits* (T/P): 4/0**	**Rumpun MK: Biomedical Instrumentation and Signal Processing** ***Course Cluster: Biomedical Instrumentation and Signal Processing***	Smt: III
OTORISASI ***AUTHORIZATION***	**Penyusun RA & E** ***Compiler A&EP*** **Dr. Rachmad Setiawan, 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)**
1-2	**Sub CP-MK 1:** Mahasiswa memahami dan mampu menjelaskan teori dasar tentang bahan semikonduktor dan komponen dioda, serta mampu mengidentifikasi karakteristik dioda. ***LLO 1:*** *Students are able to understand and explain basic theories about semiconductor materials and diode components, and are able to identify diode characteristics.*	**Non-tes :** **Tugas 1:** Mencari aplikasi *PN Junction* seperti *Photovoltaic* (PV) *Cell*, operasi dan aplikasinya. **Tugas 2:** Mencari datasheet dioda Ge dan Si, menjelaskan parameter-parameter dioda berdasarkan datasheet, Macam-macam dioda dan aplikasinya. **Praktikum 1:** Identifikasi karakteristik dioda. **Tes:** ETS Soal 1 (4.375% dari ETS 17.5%) ***Non-test :*** ***Task 1:*** *Search PN Junction applications such as Photovoltaic (PV) Cell, operations and the applications.* ***Task 2:*** *Search Ge and Si diode datasheet, explain diode parameters based on the datasheet, diode types and the applications.* ***Lab Work 1:*** *Characteristics of the diode identification.*	13

Mg ke/ *Week* (1)	Sub CP-MK / *Lesson Learning Outcomes (LLO)* (2)	Bentuk Asesmen (Penilaian) *Form of Assessment* (3)	Bobot / *Load* (%) (4)
		Test: *Question 1 in Mid Exam (*4.375*% of Mid Exam 17.5%)*	
3-4	**Sub CP-MK 2:** Mahasiswa memahami rangkaian aplikasi dioda dan mampu merancang, menganalisa serta merealisasikan rangkaian aplikasi dioda dengan metodologi yang benar. ***LLO 2:*** *Students are able to understand a series of diode applications and are able to design, analyze, and realize a series of diode applications with the correct methodology*.	**Non-tes :** **Tugas 3:** Mengerjakan soal perhitungan mengenai analisa rangkaian dasar diode, rangkaian penyearah, *clipper*, *clamper*, pengali tegangan dan rangkaian dioda zener. **Praktikum 2:** Perancangan rangkaian aplikasi dioda. **Tes:** ETS Soal 2 (4.375% dari ETS 17.5%) ***Non-test :*** ***Task 3:*** *Solving calculation problems regarding diode basic circuit analysis, rectifier circuits, clipper, clampers, voltage multipliers and zener diode circuits.* ***Lab Work 2:*** *Diode application circuit design.* ***Test:*** *Question 2 in Mid Exam (*4.375*% of Mid Exam* 17.5*%)*	10.5
5	**Sub CP-MK 3:** Mahasiswa memahami teori dasar transistor BJT dan mampu menjelaskan operasi dasar dari transistor BJT. ***LLO 3:*** *Students are able to understand the basic theory of the BJT transistor and are able to explain the basic operations of the BJT transistor.*	**Non-tes :** **Tugas 4:** Mencari datasheet transistor BJT, menjelaskan parameter-parameter transistor BJT berdasarkan datasheet, mengerjakan soal perhitungan mengenai analisa karakteristik BJT (penentuan titik kerja BJT untuk konfigurasi bias dasar). **Tes:** ETS Soal 3 (4.375% dari ETS 17.5%) ***Non-test :*** ***Task 4:*** *Searching for the BJT transistor datasheet, explain the parameters of the BJT transistor based on the datasheet, solve calculation problems regarding the characteristic analysis of the BJT (determining the working point of the BJT for basic bias configurations).*	2.5

Mg ke/ *Week* (1)	Sub CP-MK / *Lesson Learning Outcomes (LLO)* (2)	Bentuk Asesmen (Penilaian) *Form of Assessment* (3)	Bobot / *Load* (%) (4)
		Test: *Question 3 in Mid Exam (*4.375*% of Mid Exam* 17.5*%)*	
6-7	**Sub CP-MK 4:** Mahasiswa memahami rangkaian *bias dc* dan *switching* dan mampu merancang, menganalisa serta merealisasikan rangkaian *bias dc* dan *switching* dengan metodologi yang benar. ***LLO 4:*** *Students are able to understand dc bias circuits and switching and are able to design, analyze, and realize dc bias circuits and switching with the correct methodology.*	**Non-tes :** **Tugas 5:** Mengerjakan soal perhitungan mengenai analisa dan perancangan rangkaian *bias dc* dan *switching* serta mencari contoh aplikasinya. **Praktikum 3:** Proses *bias dc* dan *switching*. **Tes:** ETS Soal 4 (4.375% dari ETS 17.5%) ***Non-test :*** ***Task 5:*** *Solve calculation problems regarding the analysis and design of dc bias circuits and switching then search for some examples of the application.* ***Lab Work 3:*** *DC bias and switching process.* ***Test:*** *Question 4 in Mid Exam (*4.375*% of Mid Exam* 17.5*%)*	10.5
8	**Evaluasi Tengah Semester** ***Mid Exam***	**Tes:** Ujian Tulis/Ujian Daring ***Test:*** *Writing Exams / Online Exams*	17.5
9-10	**Sub CP-MK 5:** Mahasiswa memahami tahapan perancangan rangkaian penguat (*amplifier*) menggunakan transistor BJT dan mampu merancang, menganalisa serta merealisasikan rangkaian *amplifier single stage* dan *multistage* dengan	**Non-tes :** **Tugas 6:** Mengerjakan soal perhitungan mengenai analisa dan perancangan rangkaian *amplifier single stage* dan *multistage* serta mencari contoh aplikasinya. **Praktikum 4:** Perancangan dan analisis *amplifier single stage* dan *multistage*. **Tes:** EAS Soal 1 (5% dari ETS 20%) ***Non-test :*** ***Task 6:***	10.5

Mg ke/ *Week* (1)	Sub CP-MK / *Lesson Learning Outcomes (LLO)* (2)	Bentuk Asesmen (Penilaian) *Form of Assessment* (3)	Bobot / *Load* (%) (4)
	metodologi yang benar. ***LLO 5:*** *Students are able to understand the stages of amplifier circuit design using BJT transistors and are able to design, analyze, and realize single stage and multistage amplifier circuits with the correct methodology.*	*Solving calculation problems regarding the analysis and design of single stage and multistage amplifier circuits and find examples of the application.* ***Lab Work 4:*** *Design and analysis of single stage and multistage amplifiers.* ***Test:*** *Question 1 in Final Exam (5% of Mid Exam 20%)*	
11-12	**Sub CP-MK 6:** Mahasiswa memahami teori dasar transistor FET dan mampu menjelaskan tahapan perancangan penguat menggunakan transistor FET. ***LLO 6:*** *Students are able to understand the basic theory of the FET transistor and explain the stages of amplifier design using a FET transistor.*	**Non-tes :** **Tugas 7:** Mengerjakan soal perhitungan mengenai analisa dan perancangan rangkaian penguat FET serta mencari contoh aplikasinya. **Tes:** EAS Soal 2 (5% dari EAS 20%) ***Non-test:*** ***Task 7:*** *Solve calculation problems regarding the analysis and design of the FET amplifier circuit and search examples of its application.* ***Test:*** *Question 2 in Final Exam (5% of Final Exam 20%)*	2.5
13-14	**Sub CP-MK 7:** Mahasiswa memahami rangkaian penguat daya dan mampu merancang,	**Non-tes :** **Tugas 8:** Mengerjakan soal perhitungan mengenai analisa dan perancangan rangkaian penguat daya serta mencari contoh aplikasinya. **Praktikum 5:**	10.5

Mg ke/ *Week* (1)	Sub CP-MK / *Lesson Learning Outcomes (LLO)* (2)	Bentuk Asesmen (Penilaian) *Form of Assessment* (3)	Bobot / *Load* (%) (4)
	menganalisa serta merealisasikan rangkaian penguat daya dengan metodologi yang benar. ***LLO 7:*** *Students are able to understand power amplifier circuits and are able to design, analyze and realize power amplifier circuits using the correct methodology.*	Perancangan dan analisis penguat daya. **Tes:** EAS Soal 3 (5% dari ETS 20%) ***Non-test :*** ***Task 8:*** *Solve calculation problems regarding the analysis and design of the power amplifier circuit and find examples of its application.* ***Lab Work 5:*** *Power amplifier design and analysis.* ***Test:*** *Question 3 in Final Exam (5% of Mid Exam 20%).*	
15	**Sub CP-MK 8:** Mahasiswa memahami dan mampu menjelaskan aplikasi komponen PNPN. ***LLO 8:*** *Students understand and are able to explain the PNPN component application.*	**Non-tes :** **Tugas 9:** Mencari aplikasi komponen PNPN. **Tes:** EAS Soal 4 (5% dari EAS 20%) ***Non-test:*** ***Task 9:*** *Search PNPN component applications.* ***Test:*** *Question 4 in Final Exam (5% of Final Exam 20%)*	2.5
16	**Evaluasi Akhir** ***Final Exam***	**Tes:** Ujian Tulis/Ujian Daring ***Test:*** *Writing Exams / Online Exams*	20
		Total bobot penilaian ***Total assessment load***	**100%**

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

CPL yang dibebankan pada MK / ***PLO charged to the course***	**CPMK** / ***Course Learning Outcome (CLO)***	**Minggu ke** / ***Week***	**Bentuk Asesmen** / ***Form of Assessment***	**Bobot** / ***Load* (%)**
CPL-01 / *PLO-01*	CPMK 1 / *CLO 1*	*Week- 1-2*	*Task 2*	2.5
		Week- 8	*Mid Exam Question 1*	4.375
	CPMK 2 / *CLO 2*	*Week- 3-4*	*Task 3*	2.5
		Week- 8	*Mid Exam Question 2*	4.375
	CPMK 3 / *CLO 3*	*Week- 5*	*Task 4*	2.5
		Week- 8	*Mid Exam Question 3*	4.375
	CPMK 8 / *CLO 8*	*Week- 15*	*Task 9*	2.5
		Week- 16	*Final Exam Question 4*	5
CPL-03 / *PLO-03*	CPMK 1 / *CLO 1*	*Week- 1-2*	*Lab Work 1*	8
	CPMK 2 / *CLO 2*	*Week- 3-4*	*Lab Work 2*	8
	CPMK 4 / *CLO 4*	*Week- 6-7*	*Lab Work 3*	8
	CPMK 5 / *CLO 5*	*Week- 9-10*	*Lab Work 4*	8
	CPMK 7 / *CLO 7*	*Week- 13-14*	*Lab Work 5*	8
CPL-05 / *PLO-05*	CPMK 1 / *CLO 1*	*Week- 1-2*	*Task 1*	2.5
	CPMK 4 / *CLO 4*	*Week- 6-7*	*Task 5*	2.5
		Week- 8	*Mid Exam Question 4*	4.375
	CPMK 5 / *CLO 5*	*Week- 9-10*	*Task 6*	2.5
		Week- 16	*Final Exam Question 1*	5
	CPMK 6 / *CLO 6*	*Week- 11-12*	*Task 7*	2.5
		Week- 16	*Final Exam Question 2*	5
	CPMK 7 / *CLO 7*	*Week- 13-14*	*Task 8*	2.5
		Week- 16	*Final Exam Question 3*	5

				∑ = 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*					0.025								**0.025**
2	*Task 2*	0.025												**0.025**
3	*Task 3*	0.025												**0.025**
4	*Task 4*	0.025												**0.025**
5	*Task 5*					0.025								**0.025**
6	*Task 6*					0.025								**0.025**
7	*Task 7*					0.025								**0.025**
8	*Task 8*					0.025								**0.025**
9	*Task 9*	0.025												**0.025**
10	*Lab Work 1*			0.08										**0.08**
11	*Lab Work 2*			0.08										**0.08**
12	*Lab Work 3*			0.08										**0.08**
13	*Lab Work 4*			0.08										**0.08**
14	*Lab Work 5*			0.08										**0.08**
15	*Mid Exam*	0.13125				0.04375								**0.175**
16	*Final Exam*	0.05				0.15								**0.2**
	Total	0.28125		0.4		0.31875								**1**