



# MODULE HANDBOOK

## BIOMEDICAL SIGNAL PROCESSING AND LABORATORY







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

**INSTITUT TEKNOLOGI SEPULUH NOPEMBER**

## ENDORSEMENT PAGE



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

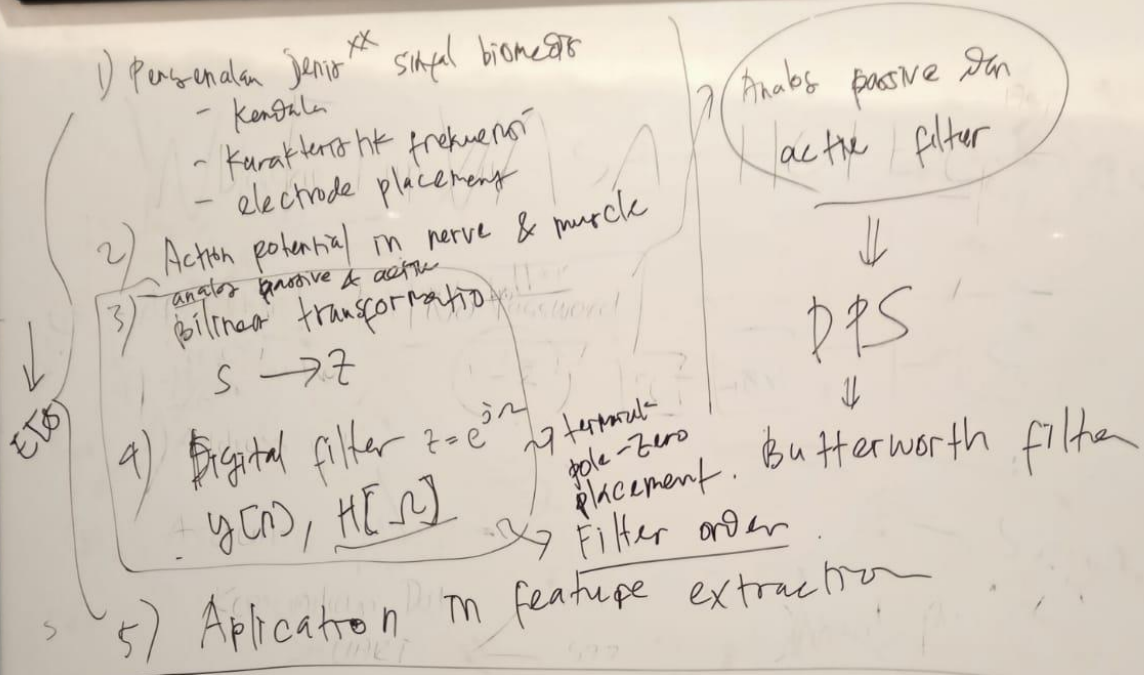
<b>Proses Process</b>	<b>Penanggung Jawab Person in Charge</b>			<b>Tanggal Date</b>
	<b>Nama Name</b>	<b>Jabatan Position</b>	<b>Tandatangan Signature</b>	
Perumus <i>Preparation</i>	Nada Fitriyatul Hikmah, S.T, M.T	Dosen <i>Lecturer</i>		<b>November 18, 2022</b>
Pemeriksa dan Pengendalian <i>Review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

# MODULE HANDBOOK

## Biomedical Signal Processing and Laboratory

Module name	<b>Biomedical Signal Processing and Laboratory</b>	
Module level	Undergraduate	
Code	EB234404	
Course (if applicable)	Biomedical Signal Processing and Laboratory	
Semester	Second Semester (Genap)	
Person responsible for the module	Nada Fitriyatul Hikmah, S.T., M.T.	
Lecturer		
Language	Bahasa Indonesia and English	
Relation to curriculum	Undergraduate degree program, <b>mandatory</b> , 4 <sup>th</sup> semester	
Type of teaching, contact hours	Lectures, < 60 students Wednesdays, 14.00-16.50 (GMT+7)	
Workload	<ol style="list-style-type: none"> <li>1. Lectures : 3 x 50 = 150 minutes per week.</li> <li>2. Exercises and Assignments : 3 x 60 = 180 minutes (3 hours) per week.</li> <li>3. Private learning : 3 x 60 = 180 minutes (3 hours) per week.</li> </ol>	
Credit points	3 credit points (sks)	
Requirements according to the examination regulations	A student must have attended at least 75% of the lectures to sit in the exams.	
Mandatory prerequisites	Engineering Mathematics, Fundamentals of Signal Processing.	
Learning outcomes and their corresponding PLOs	<p>Course Learning Outcome (CLO) after completing this module,</p> <p>CLO 1 : Students are able to understand and explain the origin, process and characteristics of biopotential signals</p> <p>CLO 2 : Students are able to explain and analyze digital filter for biomedical signal processing</p> <p>CLO 3 : Students are able to explain and analyze biomedical signal on frequency domain and time-frequency domain</p> <p>CLO 4 : Students are able to implement digital filter for biomedical signal processing on real practice</p> <p>CLO 5 : Students are able to implement and analyze biomedical signal on frequency domain</p>	<p>PLO-02</p> <p>PLO-05</p> <p>PLO-03</p> <p>PLO-06</p> <p>PLO-06</p>

	CLO 6 : Students are able to implement and analyze biomedical signal on time-frequency domain	PLO-06
Content	This course studies the sources and characteristics of biopotential signal, digital filter design for biomedical signal, frequency domain analysis and time-frequency domain analysis	
Study and examination requirements and forms of examination	<ul style="list-style-type: none"> <li>• In-class exercises</li> <li>• Assignment 1, 2, 3, 4, 5</li> <li>• Lab Works 1, 2, 3, 4</li> <li>• Mid-term examination</li> <li>• Final examination</li> </ul>	
Media employed	LCD, whiteboard, websites (myITS Classroom), zoom.	
Reading list	<p>Main :</p> <ol style="list-style-type: none"> <li>1. Metin Akay (Ed), Nonlinear Biomedical Signal Processing, Volume I: Fuzzy Logic, Neural Networks, and New Algorithms. IEEE Press, New York, 2000.</li> <li>2. Metin Akay (Ed), Nonlinear Biomedical Signal Processing, Volume II: Dynamic Analysis and Modeling. IEEE Press, New York, 2001.</li> </ol> <p>Supporting :</p> <ol style="list-style-type: none"> <li>3. R. M. Enoka, Neuromechanics of Human Movements, Fifth Edition. Human Kinetics, Boulder, 2015.</li> <li>4. W. J. Thompkins (Ed), Biomedical Digital Signal Processing, C-Language Examples and Laboratory Experiments for the IBM® PC. Prentice Hall Inc., New Jersey, 2000.</li> <li>5. D.C. Reddy, Biomedical Signal Processing: Principles and Techniques. McGraw-Hill, New Delhi, 2005.</li> </ol>	




6) FFT → 2D FFT → 2 weeks

7) Time freq analysis → CWT, DWT → 2 weeks  
 (wiener filter)

8) Adaptive filtering → 2 weeks  
 + skills development

6 weeks state based (kalman filter)

**I. Rencana Pembelajaran Semester / Semester Learning Plan**

		<b>INSTITUT TEKNOLOGI SEPULUH NOPEMBER (ITS)</b> <b>FACULTY OF INTELLIGENT ELECTRICAL AND INFORMATICS TECHNOLOGY</b> <b>BIOMEDICAL ENGINEERING DEPARTMENT</b>				<b>Document Code</b>
<b>SEMESTER LEARNING PLAN</b>						
<b>MATA KULIAH (MK)</b> <b>COURSE</b>	<b>KODE</b> <b>CODE</b>	<b>Rumpun MK</b> <b>Course Cluster</b>	<b>BOBOT (sks)</b> <b>Credits</b>		<b>SEMESTER</b>	<b>Tgl Penyusunan</b> <b>Completion Date</b>
<b>Pengolahan Sinyal Biomedika dan Laboratorium</b> <b>Biomedical Signal Processing and Laboratory</b>	EB234404	Biomedical Instrumentation and Signal Processing	T=3	P=0	IV	Oct 31, 2023
<b>OTORISASI / PENGESAHAN</b> <b>AUTHORIZATION / ENDORSEMENT</b>	<b>Dosen Pengembang RPS</b> <b>Developer Lecturer of Semester Learning Plan</b>		<b>Koordinator RMK</b> <b>Course Cluster Coordinator</b>		<b>Ka DEPARTEMEN</b> <b>Head of Department</b>	
	(Nada Fitriyatul Hikmah, S.T, M.T)		(Dr. Rachmad Setiawan, S.T., M.T.)		(Dr. Achmad Arifin, S.T., M.Eng.)	
<b>Capaian Pembelajaran</b> <b>Learning Outcomes</b>	<b>CPL-PRODI yang dibebankan pada MK</b> <b>PLO Program Charged to The Course</b>					
	CPL-02	Mampu <b>menemukan, memahami, menjelaskan, merumuskan, dan menyelesaikan</b> 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 <b>find, understand, explain, formulate, and solve</b> 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 <b>merancang dan melaksanakan</b> eksperimen laboratorium dan/atau lapangan, <b>menganalisa dan menginterpretasi</b> data, serta menggunakan penilaian yang obyektif untuk menarik kesimpulan				

<b>PLO-03</b>	<i>Able to <b>design and implement</b> laboratory experiment and / or field experiments, <b>analyze and interpret</b> data, and use objective assessments to draw conclusions.</i>
<b>CPL-05</b>	Mampu <b>mendesain</b> 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 <b>mengenal/memanfaatkan</b> sumber daya lokal dan nasional dengan wawasan global.
<b>PLO-05</b>	<i>Able to <b>design</b> 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 <b>recognizing / utilizing</b> local and national resources with global insight.</i>
<b>CPL-06</b>	Mampu <b>menerapkan</b> ilmu pengetahuan, keterampilan, dan metode terkini dalam menyelesaikan permasalahan di bidang Teknik Biomedika.
<b>PLO-06</b>	<i>Able to apply the latest knowledge, skills and methods in solving problems in the field of Biomedical Engineering.</i>
<b>Capaian Pembelajaran Mata Kuliah (CPMK)</b>	
<b>Course Learning Outcome (CLO) – if CLO as description capability of each Learning Stage in the course, then CLO = LLO</b>	
<b>CP MK 1</b> <b>CLO 1</b>	Mahasiswa memahami dan mampu menjelaskan asal, proses dihasilkannya, dan karakteristik dari sinyal biopotensial. <i>Students are able to understand and explain the origin, process and characteristics of biopotential signals</i>
<b>CP MK 2</b> <b>CLO 2</b>	Mahasiswa mampu menjelaskan dan menganalisis filter digital untuk pengolahan sinyal biomedik. <i>Students are able to explain and analyze digital filter for biomedical signal processing</i>
<b>CP MK 3</b> <b>CLO 3</b>	Mahasiswa mampu menjelaskan dan menganalisis sinyal biomedik berdasarkan domain frekuensi dan domain waktu-frekuensi. <i>Students are able to explain and analyze biomedical signal on frequency domain and time-frequency domain</i>
<b>CP MK 4</b> <b>CLO 4</b>	Mahasiswa mampu menerapkan filter digital pada pengolahan sinyal biomedik dalam realisasi praktis. <i>Students are able to implement digital filter for biomedical signal processing on real practice</i>
<b>CP MK 5</b> <b>CLO 5</b>	Mahasiswa mampu menerapkan dan menganalisis domain frekuensi pada sinyal biomedik. <i>Students are able to implement and analyze biomedical signal on frequency domain</i>
<b>CP MK 6</b> <b>CLO 6</b>	Mahasiswa mampu menerapkan dan menganalisis sinyal biomedik berdasarkan domain waktu-frekuensi. <i>Students are able to implement and analyze biomedical signal on time-frequency domain</i>

<b>Peta CPL – CP MK</b>  <b>Map of PLO - CLO</b>	<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 6 / SUB CPMK 6 CLO 6 / 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> </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 6 / SUB CPMK 6 CLO 6 / LLO 6						√						
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<b>Diskripsi Singkat MK</b>  <b>Short Description of The Course</b>	<p>Mata kuliah Pengolahan Sinyal Biomedika dan Laboratorium merupakan mata kuliah wajib yang membahas pengolahan sinyal lanjut dengan masukan biosinyal. Matakuliah ini bertujuan agar mahasiswa mampu memahami prinsip-prinsip pengukuran dan sistem pemrosesan sinyal biomedika serta mampu mengembangkannya dalam praktek. Berdasarkan kemampuan dan penerapan pengolahan sinyal tersebut, mahasiswa mampu memanfaatkannya dalam disiplin ilmu teknik biomedik.</p> <p><i>Biomedical Signal Processing and Laboratory course is a mandatory subject which discuss about the signal processing of biopotential signal. This course aims to make students understand the measurement principles and the development of biomedical signal processing system. Based on the ability and signal processing applicability, students are able to make use of it in biomedical engineering discipline.</i></p>																																																																																											
<b>Bahan Kajian:</b> Materi pembelajaran  <b>Course Materials:</b>	<ol style="list-style-type: none"> <li>1. Asal usul, pembangkitan, dan karakteristik sinyal biopotensial.</li> <li>2. Perencanaan filter digital untuk sinyal biomedik.</li> <li>3. Analisis domain frekuensi pada sinyal biomedik.</li> <li>4. Analisis domain waktu-frekuensi pada sinyal biomedik.</li> <li>5. Keterampilan proses perencanaan filter digital.</li> <li>6. Keterampilan proses analisis domain frekuensi.</li> <li>7. Keterampilan proses analisis waktu-frekuensi.</li> </ol>																																																																																											
<b>Pustaka</b>	<b>Utama / Main:</b>																																																																																											



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<b>Dosen Pengampu</b>							
<b>Matakuliah syarat</b>		Engineering Mathematics, Fundamentals of Signal Processing.					
Mg Ke / Week	Kemampuan akhir tiap tahapan belajar (Sub-CPMK) / Final ability of each Learning stage (LLO)	Penilaian / Assesment		Bantuk Pembelajaran; Metode Pembelajaran; Penugasan Mahasiswa; [ Estimasi Waktu] / Form of Learning; Learning Methods; Student Assignment; [ Estimated Time]	Materi Pembelajaran [Pustaka] / Learning Materials [Reference]	Bobot Penilaian (%) / Assessment Load (%)	
		Indikator / Indicator	Kriteria & Teknik / Criteria & Techniques				Tatap Muka (5)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1 - 2	Mahasiswa memahami dan mampu menjelaskan asal, proses dihasilkannya, dan karakteristik dari sinyal biopotensial.  Students are able to	<ul style="list-style-type: none"> <li>• Mampu menjelaskan perbedaan dari aksi potensial yang dihasilkan dari beberapa sumber</li> <li>• Mampu menjelaskan karakteristik dan tipe</li> </ul>	<b>Non-tes :</b> <b>Tugas 1 :</b> Resume mengenai perbedaan potensial aksi pada saraf,	<ul style="list-style-type: none"> <li>• Kuliah dan brainstorming, tanya jawab [TM : 3 x 50"] [BM : 3 x 50"] [PT : 3 x 50"]</li> </ul>	<ul style="list-style-type: none"> <li>• Chatting dan diskusi dalam forum platform ITS</li> <li>• Chat and discussion in ITS</li> </ul>	<ul style="list-style-type: none"> <li>• Kontrak kuliah: <ul style="list-style-type: none"> <li>- Motivasi belajar</li> <li>- Rencana pembelajaran</li> <li>- Aturan-aturan perkuliahan</li> <li>- Tujuan</li> </ul> </li> </ul>	5

	<p><i>understand and explain the origin, process and characteristics of biopotential signals</i></p>	<p>sinyal biopotensial</p> <ul style="list-style-type: none"> <li>• <i>Able to explain the difference of action potential signal from other source</i></li> <li>• <i>Able to explain the characteristics and types of biopotential signal</i></li> </ul>	<p>jaringan otot rangka, dan jaringan otot jantung (Tugas tertulis)</p> <p><b>Tes :</b> Soal ETS 1</p> <p><b>Non-test :</b> <b>Task 1 :</b> <i>Make a resume about the difference of action potential in nerve, skeletal muscle tissue, and heart muscle tissue (Written assignment)</i></p> <p><b>Test :</b> <i>Mid-term examination question 1</i></p>	<ul style="list-style-type: none"> <li>• <i>Presentation and brainstorming, ask and answer.</i> <i>[FF : 3 x 50"]</i> <i>[SA : 3 x 50"]</i> <i>[SS : 3 x 50"]</i></li> </ul>	<p><i>platform forum</i></p>	<p>perkuliahan</p> <ul style="list-style-type: none"> <li>- Sistem penilaian, buku ajar/sumber pustaka</li> <li>• Sinyal Biopotensial <ul style="list-style-type: none"> <li>- Asal usul</li> <li>- Karakteristik</li> <li>- Potensial aksi pada saraf</li> <li>- Potensial aksi pada jaringan otot rangka</li> <li>- Potensial aksi pada jaringan otot jantung</li> </ul> </li> <li>• <i>Course contract :</i> <ul style="list-style-type: none"> <li>- <i>Motivation to learn</i></li> <li>- <i>Lesson plan</i></li> <li>- <i>Lectures rules</i></li> <li>- <i>Course objective</i></li> <li>- <i>Assessment system, textbooks / library resources</i></li> </ul> </li> <li>• <i>Biopotential signal</i> <ul style="list-style-type: none"> <li>- <i>Sources</i></li> <li>- <i>Characteristics</i></li> </ul> </li> </ul>	
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						<ul style="list-style-type: none"> <li>- <i>Action potential in nerve</i></li> <li>- <i>Action potential in skeletal muscle tissue</i></li> <li>- <i>Action potential in heart muscle tissue</i></li> </ul>	
3 - 4	<p>Mahasiswa mampu menjelaskan dan menganalisis filter digital untuk pengolahan sinyal biomedik.</p> <p><i>Students are able to explain and analyze digital filter for biomedical signal processing applications</i></p>	<ul style="list-style-type: none"> <li>• Mampu merancang filter digital dengan metode pole-zero</li> <li>• Mampu merancang infinite impulse response filter</li> <li>• Mampu merancang moving average filter</li> <li>• <i>Able to design pole-zero digital filter</i></li> <li>• <i>Able to design infinite impulse response filter</i></li> <li>• <i>Able to design moving average filter</i></li> </ul>	<p><b>Non-tes :</b> <b>Tugas 2</b> Perancangan program komputer filter digital pole zero dan menganalisis pengaruh parameter r dan teta pada filter (Demo dan laporan)</p> <p><b>Tes :</b> Soal ETS 2</p> <p><b>Non-test :</b> <b>Task 2 :</b> <i>Computer program software design for</i></p>	<ul style="list-style-type: none"> <li>• Kuliah, diskusi, tanya jawab, tugas dalam platform myITS Classroom</li> <li>[TM : 3 x 50"]</li> <li>[BM : 3 x 50"]</li> <li>[PT : 3 x 50"]</li> <li>• <i>Presentation and brainstorming, ask and answer.</i></li> <li>[FF : 3 x 50"]</li> <li>[SA : 3 x 50"]</li> <li>[SS : 3 x 50"]</li> </ul>	<ul style="list-style-type: none"> <li>• Chatting dan diskusi dalam forum platform ITS</li> <li>• <i>Chat and discussion in ITS platform forum</i></li> </ul>	<ul style="list-style-type: none"> <li>• Filter digital : <ul style="list-style-type: none"> <li>- Metode pole-zero</li> <li>- Infinite Impulse Response (IIR)</li> <li>- Moving average filter</li> </ul> </li> <li>• <i>Digital filter :</i> <ul style="list-style-type: none"> <li>- <i>Pole-zero method</i></li> <li>- <i>Infinite Impulse Response (IIR)</i></li> <li>- <i>Moving average filter</i></li> </ul> </li> </ul>	10

			<p><i>digital pole-zero filter and analyzing the r and teta parameter effect on the filter (Demonstration and report)</i></p> <p><b>Test :</b> <i>Mid-term examination question 2</i></p>				
5 - 7	<p>Mahasiswa mampu menjelaskan dan menganalisis sinyal biomedik berdasarkan domain frekuensi dan domain waktu-frekuensi.</p> <p><i>Students are able to explain and analyze biomedical signal on frequency domain and time-frequency domain</i></p>	<ul style="list-style-type: none"> <li>• Mampu merancang beberapa teknik analisa sinyal biomedis pada domain frekuensi dan domain waktu-frekuensi</li> <li>• <i>Able to design many biomedical signal analysis technique in frequency domain and time-frequency domain</i></li> </ul>	<p><b>Non-tes :</b> <b>Tugas 3:</b> Perancangan program komputer analisis domain frekuensi dengan DFT dan FFT, serta menganalisis perbedaan keduanya (Demo dan laporan)</p> <p><b>Tugas 4:</b> Perancangan program komputer CWT dan analisis sinyal menggunakan</p>	<ul style="list-style-type: none"> <li>• Kuliah, diskusi, tanya jawab, tugas dalam platform myITS Classroom  [TM : 3 x 50"] [BM : 3 x 50"] [PT : 3 x 50"]</li> <li>• <i>Presentation and brainstorming, ask and answer.</i> [FF : 3 x 50"] [SA : 3 x 50"] [SS : 3 x 50"]</li> </ul>	<ul style="list-style-type: none"> <li>• Chatting dan diskusi dalam forum platform ITS</li> <li>• <i>Chat and discussion in ITS platform forum</i></li> </ul>	<ul style="list-style-type: none"> <li>• Analisis sinyal biomedik domain frekuensi dan waktu-frekuensi : <ul style="list-style-type: none"> <li>- DFT</li> <li>- FFT</li> <li>- STFT</li> <li>- CWT</li> <li>- DWT</li> </ul> </li> <li>• <i>Biomdical signal analysis on frequency and time-frequency domain :</i> <ul style="list-style-type: none"> <li>- DFT</li> <li>- FFT</li> <li>- STFT</li> <li>- CWT</li> </ul> </li> </ul>	<b>20</b>

			<p>dekomposisi skala DWT (Demo dan laporan)</p> <p><b>Tes :</b> Soal EAS 1 dan 2</p> <p><b>Non-test :</b></p> <p><b>Task 3 :</b> <i>Computer program design for frequency domain analysis using DFT and FFT, also analyzing their differences (Demonstration and report)</i></p> <p><b>Task 4 :</b> <i>Computer program design for CWT and signal analysis using DWT (Demonstration and report)</i></p> <p><b>Test :</b> <i>Final examination question 1 and 2</i></p>			- DWT	
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<b>8</b>	<b>EVALUASI TENGAH SEMESTER</b>						<b>15</b>
<b>9 - 10</b>	<p>Mahasiswa mampu menerapkan filter digital pada pengolahan sinyal biomedik dalam realisasi praktis.</p> <p><i>Students are able to implement digital filter for biomedical signal processing on real practice</i></p>	<ul style="list-style-type: none"> <li>Mampu merancang dan mengimplementasikan filter digital (LPF, HPF, BPF, BSF)</li> <li>Able to design and implement digital filter ( LPF, HPF, BPF, BSF)</li> </ul>	<p><b>Non-tes :</b> <b>Praktikum lab 1:</b> Perancangan filter digital dengan menggunakan modul pengolahan sinyal</p> <p><b>Tes :</b> Soal EAS 3</p> <p><b>Non-test :</b> <b>Lab works 1:</b> Digital filter design using signal processing module</p> <p><b>Test :</b> Final examination question 3</p>	<ul style="list-style-type: none"> <li>Kuliah, diskusi, tanya jawab, tugas dalam platform myITS Classroom [TM : 3 x 50"] [BM : 3 x 50"] [PT : 3 x 50"]</li> <li>Presentation and brainstorming, ask and answer. [FF : 3 x 50"] [SA : 3 x 50"] [SS : 3 x 50"]</li> </ul>	<ul style="list-style-type: none"> <li>Chatting dan diskusi dalam forum platform ITS</li> <li>Chat and discussion in ITS platform forum</li> </ul>	<ul style="list-style-type: none"> <li>Keterampilan penerapan filter digital : <ul style="list-style-type: none"> <li>LPF</li> <li>HPF</li> <li>BPF</li> <li>BSF</li> </ul> </li> <li>Digital filter application skills : <ul style="list-style-type: none"> <li>LPF</li> <li>HPF</li> <li>BPF</li> <li>BSF</li> </ul> </li> </ul>	<b>10</b>
<b>11 - 12</b>	<p>Mahasiswa mampu menerapkan dan menganalisis domain frekuensi pada sinyal biomedik.</p> <p><i>Students are able to implement and analyze</i></p>	<ul style="list-style-type: none"> <li>Mampu merancang dan mengimplementasikan teknik analisis domain frekuensi (DFT, FFT)</li> </ul>	<p><b>Non-tes</b> <b>Praktikum Lab 2:</b> Analisis domain frekuensi dengan menggunakan modul pengolahan sinyal</p>	<ul style="list-style-type: none"> <li>Kuliah, diskusi, tanya jawab, tugas dalam platform myITS Classroom [TM : 3 x 50"]</li> </ul>	<ul style="list-style-type: none"> <li>Chatting dan diskusi dalam forum platform ITS</li> <li>Chat and discussion in ITS</li> </ul>	<ul style="list-style-type: none"> <li>Keterampilan penerapan analisis domain frekuensi : <ul style="list-style-type: none"> <li>DFT</li> <li>FFT</li> </ul> </li> <li>Frequency domain</li> </ul>	<b>15</b>


	<p><i>biomedical signal on frequency domain</i></p>	<ul style="list-style-type: none"> <li>• <i>Able to design and implement frequency domain analysis technique (DFT, FFT)</i></li> </ul>	<p><b>Tugas 5:</b> Menghitung nilai parameter jantung (misalnya heartrate) dengan menggunakan modul ECG (Demo dan laporan)</p> <p><b>Test :</b> Soal EAS 4</p> <p><b>Non-test :</b> <b>Lab works 2:</b> <i>Frequency domain analysis using signal processing module</i></p> <p><b>Task 5 :</b> <i>Calculating value of heart parameter ( ex. heartrate) using ECG module (Demonstration and report)</i></p> <p><b>Test :</b> <i>Final examination question 4</i></p>	<p>[BM : 3 x 50"] [PT : 3 x 50"]</p> <ul style="list-style-type: none"> <li>• <i>Presentation and brainstorming, ask and answer.</i> [FF : 3 x 50"] [SA : 3 x 50"] [SS : 3 x 50"]</li> </ul>	<p><i>platform forum</i></p>	<p><i>analysis application skills :</i></p> <ul style="list-style-type: none"> <li>- <i>DFT</i></li> <li>- <i>FFT</i></li> </ul>	
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13 - 15	<p>Mahasiswa mampu menerapkan dan menganalisis sinyal biomedik berdasarkan domain waktu-frekuensi.</p> <p><i>Students are able to implement and analyze biomedical signal on time-frequency domain</i></p>	<ul style="list-style-type: none"> <li>• Mampu merancang dan mengimplementasikan teknik analisis domain waktu-frekuensi (STFT, CWT)</li> <li>• <i>Able to design and implement the time-frequency domain analysis technique (STFT, CWT)</i></li> </ul>	<p><b>Non-tes :</b>  <b>Praktikum Lab 3:</b>          Analisis domain waktu-frekuensi dengan menggunakan modul pengolahan sinyal</p> <p><b>Tes :</b>          Soal EAS 5</p> <p><b>Non-test :</b>  <b>Lab works 3:</b>  <i>Time-frequency domain analysis using signal processing module</i></p> <p><b>Test :</b>  <i>Final examination question 5</i></p>	<ul style="list-style-type: none"> <li>• Kuliah, diskusi, tanya jawab, tugas dalam platform myITS Classroom            [TM : 3 x 50"]            [BM : 3 x 50"]            [PT : 3 x 50"]</li> <li>• <i>Presentation and brainstorming, ask and answer.</i>            [FF : 3 x 50"]            [SA : 3 x 50"]            [SS : 3 x 50"]</li> </ul>	<ul style="list-style-type: none"> <li>• Chatting dan diskusi dalam forum platform ITS</li> <li>• <i>Chat and discussion in ITS platform forum</i></li> </ul>	<ul style="list-style-type: none"> <li>• Keterampilan penerapan analisis domain waktu-frekuensi :           <ul style="list-style-type: none"> <li>- STFT</li> <li>- CWT</li> </ul> </li> <li>• Time-frequency domain analysis application skills :           <ul style="list-style-type: none"> <li>- STFT</li> <li>- CWT</li> </ul> </li> </ul>	10
16	<b>EVALUASI AKHIR SEMESTER</b>						15

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



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

	<b>ASSESSMENT &amp; EVALUATION PLAN</b> <b>BACHELOR DEGREE PROGRAM OF BIOMEDICAL ENGINEERING – FTEIC ITS</b> <b>Course : Biomedical Signal Processing and Laboratory</b>		<b>RA&amp;E</b>
			Write Doc Code
<b>Kode / Code :</b> <b>EB234404</b>	<b>Bobot sks / Credits (T/P): 3/0</b>	<b>Rumpun MK: Instrumentasi Biomedik dan Pemrosesan Sinyal</b> <b>Course Cluster : Biomedical Instrumentation and Signal Processing</b>	Smt: IV
<b>OTORISASI AUTHORIZATION</b>	<b>Penyusun RA &amp; E Compiler A&amp;EP</b>  <b>Nada Fitriyatul H, S.T, M.T</b>	<b>Koordinator RMK Course Cluster Coordinator</b>  <b>Dr. Rachmad Setiawan, S.T., M.T.</b>	<b>Ka DEP Head of DEP</b>  <b>Dr. Achmad Arifin, S.T., M.Eng.</b>

Mg ke / Week (1)	Sub CP-MK / Lesson Learning Outcomes (LLO) (2)	Bentuk Asesmen (Penilaian) Form of Assessment (3)	Bobot / Load (%) (4)
1 - 2	<p><b>Sub CP-MK 1:</b> Mahasiswa memahami dan mampu menjelaskan asal, proses dihasilkannya, dan karakteristik dari sinyal biopotensial.</p> <p><b>LLO 2 :</b> <i>Students are able to understand and explain the origin, process and characteristics of biopotential signals</i></p>	<p><b>Non-tes :</b> <b>Tugas 1 :</b> Resume mengenai perbedaan potensial aksi pada saraf, jaringan otot rangka, dan jaringan otot jantung (Tugas tertulis)</p> <p><b>Tes :</b> Soal ETS 1</p> <p><b>Non-test :</b> <b>Task 1 :</b> <i>Make a resume about the difference of action potential in nerve, skeletal muscle tissue, and heart muscle tissue (Written assignment)</i></p> <p><b>Test :</b> <i>Mid-term examination question 1</i></p>	5
3 - 4	<p><b>Sub CP-MK 2:</b> Mahasiswa mampu menjelaskan dan menganalisis filter digital untuk pengolahan sinyal biomedik.</p>	<p><b>Non-tes :</b> <b>Tugas 2</b> Perancangan program komputer filter digital pole zero dan menganalisis pengaruh parameter r dan teta pada filter (Demo dan laporan)</p>	10

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

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

Mg ke / Week (1)	Sub CP-MK / Lesson Learning Outcomes (LLO) (2)	Bentuk Asesmen (Penilaian) Form of Assessment (3)	Bobot / Load (%) (4)
	<i>Final Exam</i>	Ujian Tulis/Ujian Daring  <i>Test:</i> <i>Writing Exams / Online Exams</i>	
<b>Total bobot penilaian</b>			<b>100%</b>

**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	7.5
CPL-03 / <i>PLO-03</i>	CPMK 3 / <i>CLO 3</i>	Week 5	Task 3	10
		Week 7	Task 4	10
		Week 16	Final Exam Question 1 - 2	6
CPL-05 / <i>PLO-05</i>	CPMK 2 / <i>CLO 2</i>	Week 3	Task 2	10
		Week 8	Mid Exam Question 2	7.5
CPL-06 / <i>PLO-06</i>	CPMK 4 / <i>CLO 4</i>	Week 9	Lab Works 1	10
		Week 16	Final Exam Question 3	3
		Week 11	Task 5	5
	CPMK 5 / <i>CLO 5</i>	Week 12	Lab Works 2	10
		Week 16	Final Exam Question 4	3
		Week 13	Lab Works 3	10
	CPMK 6 / <i>CLO 6</i>	Week 16	Final Exam Question 5	3
				<b>Σ = 100%</b>

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											<b>0.05</b>
2	Task 2					0.10								<b>0.10</b>
3	Task 3			0.10										<b>0.10</b>
4	Task 4			0.10										<b>0.10</b>
5	Task 5					0.05	0.05							<b>0.10</b>

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
6	Mid Exam		0.075			0.075								<b>0.15</b>
7	Lab Works						0.25							<b>0.25</b>
8	Final Exam			0.06		0.09								<b>0.15</b>
	Total		0.125	0.26		0.315	0.30							<b>1</b>

