



# MODULE HANDBOOK ULTRASONIC IMAGING



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

**INSTITUT TEKNOLOGI SEPULUH NOPEMBER**

## ENDORSEMENT PAGE



**MODULE HANDBOOK**  
**Ultrasonic Imaging**  
**DEPARTMENT OF BIOMEDICAL ENGINEERING**  
 INSTITUT TEKNOLOGI SEPULUH NOPEMBER  
 Number : 6868/IT2.IX.5.1.2/B/PP.03.00.00/2023

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


# MODULE HANDBOOK

## ULTRASONIC IMAGING

Module name	<b>Ultrasonic Imaging</b>	
Module level	Undergraduate	
Code	EB234907	
Course (if applicable)	Ultrasonic Imaging	
Semester	Specialization	
Person responsible for the module	Nada Fitriyatul Hikmah, S.T., M.T.	
Lecturer	Nada Fitriyatul Hikmah, S.T., M.T. Dr. Tri Arief Sardjono, S.T., M.T.	
Language	Bahasa Indonesia and English	
Relation to curriculum	Undergraduate degree program, <b>specialization</b> .	
Type of teaching, contact hours	Lectures, <60 students	
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 50 = 150 minutes per week.</li> <li>3. Private learning : 3 x 60 = 180 minutes per week.</li> <li>4. Practicum : 1x50 = 50 minutes per practicum.</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	-	
Learning outcomes and their corresponding PLOs	<p>Course Learning Outcome (CLO) after completing this module,</p> <p>CLO 1: Students understand the history of ultrasonic imaging discovery.</p> <p>CLO 2: Students able to identify and explain the function of ultrasonic instrument components.</p> <p>CLO 3: Students understand the physics concepts for ultrasonic imaging.</p> <p>CLO 4: Students understand the Doppler and flow imaging principles.</p> <p>CLO 5: Students able to operate ultrasonic imaging tools and get the desired image results.</p>	<p>PLO-02</p> <p>PLO-05</p> <p>PLO-02</p> <p>PLO-06</p> <p>PLO-07</p>

	CLO 6: Students able to process and analyze ultrasonic imaging results.	PLO-07
Content	This course introduces students to the basic principles of physics and instrumentation in ultrasonic imaging, Doppler flow and Doppler imaging, as well as the latest technology in ultrasonic imaging.	
Study and examination requirements and forms of examination	<ul style="list-style-type: none"> <li>• In-class exercises</li> <li>• Written Assignment 1, 2, 3</li> <li>• Practicum Assignment 1, 2, 3, 4</li> <li>• Presentation 1, 2</li> <li>• Programming Assignment 1</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. KK Shung, "Diagnostic Ultrasound: Imaging and Doppler Flow Measurement," Francis &amp; Taylor.</li> </ol> <p>Supporting :</p> <ol style="list-style-type: none"> <li>1. J.A. Zagzebski, "Essentials of Ultrasound Physics," Mosby.</li> <li>2. T. Szabo, "Diagnostic Ultrasound Imaging: Inside Out," Elsevier Academic Press.</li> <li>3. R.S.C. Cobbold, "Foundations of Biomedical Ultrasound," Oxford University Press.</li> </ol>	

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

		<b>INSTITUT TEKNOLOGI SEPULUH NOPEMBER (ITS)</b> <b>FACULTY OF INTELLIGENT ELECTRICAL AND INFORMATICS TECHNOLOGY</b> <b>DEPARTMENT OF BIOMEDICAL ENGINEERING</b>				<b>Document Code</b>	
		<b>SEMESTER LEARNING PLAN</b>					
MATA KULIAH (MK) <i>COURSE</i>		KODE <i>CODE</i>	Rumpun MK <i>Course Cluster</i>	BOBOT (sks) <i>Credits</i>		SEMESTER	Tgl Penyusunan <i>Compilation Date</i>
Pencitraan Ultrasonik <i>Ultrasonic Imaging</i>		EB234907	Teknik Biomedik <i>Biomedical Engineering</i>	T=3	P=0	Peminatan <i>Specialization</i>	Nov 19, 2022
OTORISASI / PENGESAHAN <i>AUTHORIZATION / ENDORSEMENT</i>		Dosen Pengembang RPS <i>Developer Lecturer of Semester Learning Plan</i>		Koordinator RMK <i>Course Cluster Coordinator</i>		Ka DEPARTEMEN <i>Head of Department</i>	
		(Nada Fitriyatul Hikmah, S.T, M.T)		(Dr. Norma Hermawan, S.T., M.T.)		(Dr. Achmad Arifin, S.T., M.Eng.)	
Capaian Pembelajaran		CPL-PRODI yang dibebankan pada MK <i>PLO Program Charged to The Course</i>					
<i>Learning Outcomes</i>	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-05	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>mengenali/memanfaatkan</b> sumber daya lokal dan nasional dengan wawasan global.					

PLO-05	<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</b> / <b>utilizing</b> local and national resources with global insight.</i>
CPL-06 PLO-06	Mampu <b>menerapkan</b> ilmu pengetahuan, keterampilan, dan metode terkini dalam menyelesaikan permasalahan di bidang Teknik Biomedika. Able to <b>apply</b> the latest knowledge, skills and methods in solving problems in the field of Biomedical Engineering.
CPL-07 PLO-07	Mampu <b>merencanakan, menyelesaikan, dan mengevaluasi</b> tugas di dalam batasan-batasan yang ada. Able to <b>plan, complete, and evaluate</b> tasks within existing boundaries.
<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 sejarah penemuan pencitraan ultrasonik. <i>Students understand the history of ultrasonic imaging discovery.</i>
<b>CP MK 2</b> <b>CLO 2</b>	Mahasiswa mampu mengidentifikasi dan menjelaskan fungsi komponen alat ultrasonik. <i>Students able to identify and explain the function of ultrasonic instrument components.</i>
<b>CP MK 3</b> <b>CLO 3</b>	Mahasiswa memahami konsep fisika dari pencitraan ultrasonik. <i>Students understand the physics concepts for ultrasonic imaging.</i>
<b>CP MK 4</b> <b>CLO 4</b>	Mahasiswa memahami prinsip Doppler dan flow imaging. <i>Students understand the Doppler and flow imaging principles.</i>
<b>CP MK 5</b> <b>CLO 5</b>	Mahasiswa mampu mengoperasikan alat pencitraan ultrasonik dan mendapatkan hasil gambar yang diminta <i>Students able to operate ultrasonic imaging tools and get the desired image results.</i>
<b>CP MK 6</b> <b>CLO 6</b>	Mahasiswa mampu mengolah dan menganalisa hasil pencitraan ultrasonik <i>Students able to process and analyze ultrasonic imaging results.</i>

<p><b>Peta CPL – CP MK</b></p> <p><i>Map of PLO - CLO</i></p>	<table border="1"> <thead> <tr> <th></th> <th>CPL-01</th> <th>CPL-02</th> <th>CPL-03</th> <th>CPL-04</th> <th>CPL-05</th> <th>CPL-06</th> <th>CPL-07</th> <th>CPL-08</th> <th>CPL-09</th> <th>CPL-10</th> <th>CPL-11</th> <th>CPL-12</th> </tr> </thead> <tbody> <tr> <td>CPMK 1 / SUB CPMK 1 <i>CLO 1 / LLO 1</i></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 <i>CLO 2 / LLO 2</i></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 <i>CLO 3 / LLO 3</i></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 <i>CLO 4 / LLO 4</i></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 <i>CLO 5 / LLO 5</i></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 <i>CLO 6 / LLO 6</i></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 <i>CLO 1 / LLO 1</i>		√											CPMK 2 / SUB CPMK 2 <i>CLO 2 / LLO 2</i>					√								CPMK 3 / SUB CPMK 3 <i>CLO 3 / LLO 3</i>		√											CPMK 4 / SUB CPMK 4 <i>CLO 4 / LLO 4</i>						√							CPMK 5 / SUB CPMK 5 <i>CLO 5 / LLO 5</i>							√						CPMK 6 / SUB CPMK 6 <i>CLO 6 / LLO 6</i>							√					
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<p><b>Diskripsi Singkat MK</b></p> <p><i>Short Description of Course</i></p>	<p>Mata kuliah ini memperkenalkan mahasiswa tentang dasar prinsip fisika dan instrumentasi pada pencitraan ultrasonik, pengukuran Doppler flow, dan pencitraan Doppler, serta teknologi terbaru dan terkini pada teknik pencitraan ultrasonik.</p> <p><i>This course introduces students to the basic principles of physics and instrumentation in ultrasonic imaging, Doppler flow and Doppler imaging, as well as the latest technology in ultrasonic imaging.</i></p>																																																																																											
<p><b>Bahan Kajian:</b> Materi pembelajaran</p> <p><b>Course Materials:</b></p>	<ol style="list-style-type: none"> <li>1. Dasar konsep fisika dari pencitraan ultrasonik / <i>Basic physics concept of ultrasonic imaging</i></li> <li>2. Transduser dan array pada alat pencitraan ultrasonik / <i>Transducers and arrays in ultrasonic imaging equipment</i></li> <li>3. Mode pencitraan ultrasonik / <i>Ultrasonic imaging mode</i></li> <li>4. Pencitraan Doppler / <i>Doppler imaging</i></li> <li>5. Pencitraan Ultrasonik dengan agen kontras / <i>Ultrasonic imaging with contrast agents</i></li> <li>6. Elastografi dan HIFU / <i>Elastography and HIFU</i></li> <li>7. Ultrasonik intravaskular / <i>Intravascular Ultrasonic</i></li> <li>8. Pencitraan multi dimensi / <i>Muldi-dimensional imaging</i></li> <li>9. Artifacts pada pencitraan ultrasonik / <i>Artifacts on ultrasonic imaging</i></li> </ol>																																																																																											

	10. Efek dan Keselamatan dalam penggunaan pencitraan ultrasonik / <i>Effects and Safety in the use of ultrasonic imaging</i>						
<b>Pustaka</b>  <i>References</i>	<b>Utama / Main:</b>						
	1. KK Shung, "Diagnostic Ultrasound: Imaging and Doppler Flow Measurement," Francis & Taylor.						
	<b>Pendukung / Supporting:</b>						
	1. J.A. Zagzebski, "Essentials of Ultrasound Physics," Mosby. 2. T. Szabo, "Diagnostic Ultrasound Imaging: Inside Out," Elsevier Academic Press. 3. R.S.C. Cobbold, "Foundations of Biomedical Ultrasound," Oxford University Press.						
<b>Dosen Pengampu</b> <i>Lecturers</i>	Nada Fitriyatul Hikmah, Tri Arief Sardjono						
<b>Matakuliah syarat</b> <i>Prerequisite</i>	-						
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 &amp; Techniques</i>	Tatap Muka / <i>In-class</i> (5)	Daring / <i>Online</i> (6)		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)



1	<p>Mahasiswa memahami sejarah penemuan dan konsep pencitraan ultrasonik</p> <p><i>Students understand the history of ultrasonic imaging discovery and the concept of ultrasonic imaging.</i></p>	<ul style="list-style-type: none"> <li>• Mampu menjelaskan sejarah dan konsep fisika pencitraan ultrasonik</li> <li>• <i>Able to explain the history and physics concept of ultrasonic imaging.</i></li> </ul>	<p><b>Non-tes :</b> <b>Tugas 1:</b> Menjelaskan konsep fisika pencitraan ultrasonik (Tugas Tertulis)</p> <p><b>Non-test :</b> <b>Task 1:</b> <i>Explains the physics concept of ultrasonic imaging. (Written Assignments)</i></p>	<ul style="list-style-type: none"> <li>• Kuliah dan diskusi. [TM : 1 x 3 x 50"] [BM : 1 x3 x 60"] [BT : 1 x 3 x 50"]</li> <li>• <i>Lecturers and Discussions.</i> [FF :1 x 3 x 50"] [SA :1 x 3 x 60"] [SS : 1 x 3 x 50"]</li> </ul>	<ul style="list-style-type: none"> <li>• Belajar mandiri melalui Share ITS dan myITSClassroom.</li> <li>• <i>Self learning through Share ITS and myITSClassroom.</i></li> </ul>	<ul style="list-style-type: none"> <li>• Sejarah penemuan teknik pencitraan ultrasonik</li> <li>• Konsep fisika pencitraan ultrasonik</li> </ul> <p><a href="#">[Link materi di MyITSClassroom]</a></p> <ul style="list-style-type: none"> <li>• <i>The history of the invention of the ultrasonic imaging technique</i></li> <li>• <i>Ultrasonic imaging physics concept</i></li> </ul>	2.5
2 – 3	<p>Mahasiswa mampu mengidentifikasi dan menjelaskan fungsi komponen alat ultrasonik.</p> <p><i>Students able to identify and explain the function of</i></p>	<ul style="list-style-type: none"> <li>• Mampu menjelaskan fungsi dari komponen alat pencitraan ultrasonik</li> <li>• <i>Able to explain the functions of the</i></li> </ul>	<p><b>Non-tes :</b> <b>Tugas 2:</b> Menjelaskan komponen-komponen yang diperlukan untuk mendapatkan gambar pencitraan ultrasonik sesuai dengan</p>	<ul style="list-style-type: none"> <li>• Kuliah dan diskusi. [TM : 2 x 3 x 50"] [BM : 2 x 3 x 60"] [BT : 2 x 3 x 50"]</li> </ul>		<ul style="list-style-type: none"> <li>• <i>Transducer</i></li> <li>• <i>Array</i></li> </ul>	5

	<i>ultrasonic instrument components.</i>	<i>components of the ultrasonic imaging equipment.</i>	<p>permintaan (Tugas Tertulis).</p> <p><b>Non-test :</b> <b>Task 2:</b> <i>Describes the components required to obtain an ultrasonic imaging result on request. (Written Assignments)</i></p>	<ul style="list-style-type: none"> <li><i>Lecturers and Discussions.</i> [FF : 2 x 3 x 50"] [SA : 2 x 3 x 60"] [SS : 2 x 3 x 50"]</li> </ul>			
4	<p>Mahasiswa memahami mode yang terdapat pada pencitraan ultrasonik</p> <p><i>Students understand the modes contained in ultrasonic imaging.</i></p>	<ul style="list-style-type: none"> <li>Mempu menghasilkan gambar pencitraan ultrasonik dengan berbagai mode</li> <li>Mampu menjelaskan kelebihan dan kekurangan masing-masing mode pencitraan ultrasonik.</li> <li><i>Able to produce ultrasonic imaging</i></li> </ul>	<p><b>Non-tes :</b> <b>Tugas Praktikum 1:</b> Menghasilkan dan menganalisa gambar pencitraan ultrasonik yang jelas dengan menggunakan beberapa mode yang diajarkan di kelas</p> <p><b>Non-test :</b> <b>Practicum Assigments 1:</b> <i>Generate and analyze clear ultrasonic</i></p>	<ul style="list-style-type: none"> <li>Kuliah dan diskusi. [TM : 2 x 50"] [BM : 3 x 60"] [BT : 3 x 50"] [PK : 1 x 50"]</li> <li><i>Lecturers and Discussions.</i> [FF : 2 x 50"] [SA : 3 x 60"] [SS : 3 x 50"] [PC : 1 x 50"]</li> </ul>		<ul style="list-style-type: none"> <li>Mode Pencitraan Ultrasonik</li> <li><i>Ultrasonic imaging mode</i></li> </ul>	10

		<p><i>result in various modes.</i></p> <ul style="list-style-type: none"> <li>• <i>Able to explain the advantages and disadvantages of each ultrasonic imaging mode.</i></li> </ul>	<p><i>imaging results using multiple modes taught in the class.</i></p>				
5 – 7	<p>Mahasiswa memahami prinsip Doppler dan flow imaging.</p> <p><i>Students understand the Doppler and flow imaging principles.</i></p>	<ul style="list-style-type: none"> <li>• Mampu menghasilkan gambar pencitraan ultrasonik dengan berbagai mode</li> <li>• Mampu menjelaskan kelebihan dan kekurangan teknik Doppler pada pencitraan ultrasonik</li> </ul> <ul style="list-style-type: none"> <li>• <i>Able to produce ultrasonic imaging results in various modes.</i></li> <li>• <i>Able to explain the advantages and disadvantages of the Doppler technique in ultrasonic imaging.</i></li> </ul>	<p><b>Non-tes :</b> <b>Tugas Praktikum 2:</b> Menghasilkan dan menganalisa gambar pencitraan ultrasonik yang jelas dengan menggunakan teknik Doppler pada pencitraan ultrasonik</p> <p><b>Non-test :</b> <b>Practicum Assignments 2:</b> <i>Generate and analyze clear ultrasonic imaging results using the Doppler technique of ultrasonic imaging.</i></p>	<ul style="list-style-type: none"> <li>• Kuliah dan diskusi. [TM : 2 x 50"] [BM : 3 x 60"] [BT : 3 x 50"] [PK : 1 x 50"]</li> <li>• <i>Lecturers and Discussions.</i> [FF : 2 x 50"] [SA : 3 x 60"] [SS : 3 x 50"] [PC : 1 x 50"]</li> </ul>		<ul style="list-style-type: none"> <li>• <i>Doppler Ultrasound</i></li> <li>• <i>Color Doppler Imaging</i></li> <li>• <i>Color Power Doppler</i></li> </ul>	<b>10</b>

8	EVALUASI TENGAH SEMESTER MID-SEMESTER EXAM					15	
9	<p>Mahasiswa memahami prinsip penggunaan agen kontras dalam pencitraan ultrasonik.</p> <p><i>Students understand the principles of using contrast agents in ultrasonic imaging.</i></p>	<ul style="list-style-type: none"> <li>Mampu mendeteksi dan menjelaskan efek penggunaan agen kontras pada pencitraan ultrasonik</li> <li><i>Able to detect and explain the effect of using contrast agents on ultrasonic imaging.</i></li> </ul>	<p><b>Non-tes :</b> <b>Tugas Pemrograman 1:</b> Membuat program untuk mendeteksi efek penggunaan agen kontras pada gambar hasil pencitraan ultrasonik</p> <p><b>Non-test :</b> <b>Programming Assignment 1:</b> <i>Create a program to detect the effect of using a contrast agent on ultrasonic imaging results.</i></p>	<ul style="list-style-type: none"> <li>Kuliah dan diskusi. [TM : 3 x 50"] [BM : 3 x 60"] [BT : 3 x 50"]</li> <li><i>Lecturers and Discussions.</i> [FF : 3 x 50"] [SA : 3 x 60"] [SS : 3 x 50"]</li> </ul>		<ul style="list-style-type: none"> <li>Konsep Agen Kontras</li> <li>Macam-macam Agen Kontras</li> <li>Penggunaan Agen Kontras pada Pencitraan Ultrasonik</li> <li><i>Contrast agent concept.</i></li> <li><i>Types of contrast agents.</i></li> <li><i>Use of contrast agents in ultrasonic imaging.</i></li> </ul>	5
10	<p>Mahasiswa memahami prinsip penggunaan ultrasonik berintensitas tinggi dan elastografi pada pencitraan ultrasonik.</p>	<ul style="list-style-type: none"> <li>Mampu menjelaskan dengan benar dan jelas konsep elastografi dan HIFU serta kelebihan dan kekurangannya</li> </ul>	<p><b>Non tes:</b> <b>Presentasi 1:</b> Menjelaskan konsep elastografi dan HIFU melalui makalah jurnal atau konferen yang tersedia.</p>	<ul style="list-style-type: none"> <li>Kuliah dan diskusi. [TM : 3 x 50"] [BM : 3 x 60"] [BT : 3 x 50"]</li> </ul>		<ul style="list-style-type: none"> <li><i>Elastography</i></li> <li><i>HIFU</i></li> </ul>	5

	<p><i>Students understand the principles of using high-intensity ultrasonic and elastography in ultrasonic imaging.</i></p>	<p>dibanding teknik pencitraan lainnya</p> <ul style="list-style-type: none"> <li>• <i>Able to explain correctly and clearly the concept of elastography and HIFU and its advantages and disadvantages compared to other imaging techniques.</i></li> </ul>	<p><b>Non-test:</b> <b>Presentation 1:</b> Explain the concept of elastography and HIFU through available journal or conference papers.</p>	<ul style="list-style-type: none"> <li>• <i>Lecturers and Discussions.</i> [FF : 3 x 50"] [SA : 3 x 60"] [SS : 3 x 50"]</li> </ul>			
11	<p>Mahasiswa memahami prinsip pencitraan ultrasonik pada intravaskular.</p> <p><i>Students understand the principles of intravascular ultrasonic imaging.</i></p>	<ul style="list-style-type: none"> <li>• Mampu menjelaskan dengan benar dan jelas konsep intravascular ultrasound serta kelebihan dan kekurangannya dibanding teknik pencitraan lainnya</li> <li>• <i>Able to correctly and clearly explain the concept of intravascular</i></li> </ul>	<p><b>Non tes:</b> <b>Presentasi 2:</b> Menjelaskan konsep intravascular ultrasound melalui makalah jurnal atau konferen yang tersedia.</p> <p><b>Non-test:</b> <b>Presentation 2:</b> Explain the concept of intravascular ultrasonic through</p>	<ul style="list-style-type: none"> <li>• Kuliah dan diskusi. [TM : 3 x 50"] [BM : 3 x 60"] [BT : 3 x 50"]</li> <li>• <i>Lecturers and Discussions.</i> [FF : 3 x 50"] [SA : 3 x 60"] [SS : 3 x 50"]</li> </ul>		<ul style="list-style-type: none"> <li>• <i>Intravascular Ultrasound</i></li> </ul>	5

		<i>ultrasound and its advantages and disadvantages over other imaging techniques.</i>	available journal or conference papers.				
<b>12</b>	<p>Mahasiswa memahami prinsip pencitraan ultrasonik pada multi dimension.</p> <p><i>Students understand the principles of ultrasonic imaging in multi-dimension.</i></p>	<ul style="list-style-type: none"> <li>• Mampu menghasilkan gambar multi dimensi pencitraan ultrasonik</li> <li>• Mampu menjelaskan kelebihan dan kekurangan teknik pencitraan multi dimensi dengan ultrasonik</li> <li>• <i>Able to produce multi-dimensional ultrasonic imaging result.</i></li> <li>• <i>Able to explain the advantages and disadvantages of multi-dimensional ultrasonic imaging techniques.</i></li> </ul>	<p><b>Non tes:</b> <b>Tugas Praktikum 3:</b> Menghasilkan dan menganalisa gambar multi dimensi</p> <p><b>Non-test:</b> <b>Practicum Assignment 3:</b> <i>Produce and analyze multi-modal dimensional images.</i></p>	<ul style="list-style-type: none"> <li>• Kuliah dan diskusi. [TM : 2 x 50"] [BM : 3 x 60"] [BT : 3 x 50"] [PK : 1 x 50"]</li> <li>• <i>Lecturers and Discussions.</i> [FF : 2 x 50"] [SA : 3 x 60"] [SS : 3 x 50"] [PC : 1 x 50"]</li> </ul>		<ul style="list-style-type: none"> <li>• Konsep pencitraan multi dimensi</li> <li>• Pengolahan citra multi dimensi ultrasonik</li> <li>• <i>Multi-dimensional imaging concept</i></li> <li>• <i>Ultrasonic multi-dimensional image processing</i></li> </ul>	<b>10</b>


<p><b>13</b></p>	<p>Mahasiswa memahami artifak yang mungkin terjadi pada pencitraan ultrasonik.</p> <p><i>Students understand the artifacts that may occur in ultrasonic imaging.</i></p>	<ul style="list-style-type: none"> <li>• Mampu mendeteksi artifak pada gambar hasil pencitraan ultrasonik</li> <li>• Mampu menganalisa penyebab kemunculan artifak pada gambar hasil pencitraan ultrasonik</li> <li>• <i>Able to detect artifacts in ultrasonic imaging results.</i></li> <li>• <i>Able to analyze the cause of the appearance of artifacts on ultrasonic imaging results.</i></li> </ul>	<p><b>Non tes:</b> <b>Tugas Praktikum 4:</b> Mendeteksi dan menganalisa artifak pada contoh gambar pencitraan ultrasonik</p> <p><b>Non-test:</b> <b>Practicum Assignment 4:</b> <i>Detect and analyze artifacts on samples of ultrasonic imaging results.</i></p>	<ul style="list-style-type: none"> <li>• Kuliah dan diskusi. [TM : 2 x 50"] [BM : 3 x 60"] [BT : 3 x 50"] [PK : 1 x 50"]</li> <li>• <i>Lecturers and Discussions.</i> [FF : 2 x 50"] [SA : 3 x 60"] [SS : 3 x 50"] [PC : 1 x 50"]</li> </ul>		<ul style="list-style-type: none"> <li>• Macam-macam Artifak pada Pencitraan Ultrasonik</li> <li>• Penghapusan Artifak saat akuisisi gambar</li> <li>• Penghapusan Artifak saat pengolahan citra</li> <li>• <i>Various artifacts in ultrasonic imaging.</i></li> <li>• <i>Artifact removal during image acquisition.</i></li> <li>• <i>Artifact removal during image processing.</i></li> </ul>	<p><b>10</b></p>
<p><b>14</b></p>	<p>Mahasiswa memahami efek biologis dan keselamatan yang harus diperhatikan saat menggunakan alat pencitraan ultrasonik.</p>	<ul style="list-style-type: none"> <li>• Mampu menjelaskan efek biologis dan keselamatan yang mungkin terjadi dan pencegahannya</li> </ul>	<p><b>Non tes:</b> <b>Tugas 3:</b> Menjelaskan efek biologis dan keselamatan dalam</p>	<ul style="list-style-type: none"> <li>• Kuliah dan diskusi. [TM : 3 x 50"] [BM : 3 x 60"] [BT : 3 x 50"]</li> </ul>		<ul style="list-style-type: none"> <li>• <i>Bioeffect</i></li> <li>• <i>Safety</i></li> </ul>	<p><b>2.5</b></p>

	<p><i>Students understand the biological and safety effects that must be considered when using ultrasonic imaging equipment.</i></p>	<p>dalam menggunakan alat pencitraan ultrasonik.</p> <ul style="list-style-type: none"> <li><i>Able to explain the biological and safety effects of using ultrasonic imaging equipment.</i></li> </ul>	<p>penggunaan alat pencitraan ultrasonik (Tugas Tertulis).</p> <p><b>Non-test:</b> <b>Task 3:</b> <i>Describe the biological and safety effects of using ultrasonic imaging equipments. (Written Assignments)</i></p>	<ul style="list-style-type: none"> <li><i>Lecturers and Discussions.</i> <i>[FF : 3 x 50"]</i> <i>[SA : 3 x 60"]</i> <i>[SS : 3 x 50"]</i></li> </ul>			
15-16	<b>EVALUASI AKHIR SEMESTER FINAL-SEMESTER EXAM</b>						20

TM=Tatap Muka, BT=Belajar Terstruktur, BM=Belajar Mandiri, PK=Praktikum  
FF = Face to Face, SA = Structured Study, SS = Self Study, PC=Practicum



## 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 : Ultrasonic Imaging</b>		<b>RA&amp;E</b>
			Write Doc Code
Kode/code: <b>EB234907</b>	Bobot sks/credits (T/P): <b>3/0</b>	Rumpun MK: <b>Teknik Biomedik</b> Course Cluster: <b>Biomedical Engineering</b>	Smt: Peminatan <i>Spezialization</i>
<b>OTORISASI</b> <i>AUTHORIZATION</i>	Penyusun RA & E <i>Compiler A&amp;EP</i>  <b>Nada Fitriyatul H, S.T, M.T</b>	Koordinator RMK <i>Course Cluster Coordinator</i>  <b>Muhammad Hilman Fatoni, S.T., M.T.</b>	<b>Ka DEP</b> <i>Head of DEP</i>  <b>Dr. Achmad Arifin, S.T., M.Eng.</b>

Mg ke/ Week (1)	Sub CP-MK / <i>Lesson Learning</i> <i>Outcomes (LLO)</i> (2)	Bentuk Asesmen (Penilaian) <i>Form of Assessment</i> (3)	Bobot / <i>Load (%)</i> (4)
<b>1</b>	<p><b>Sub CP-MK 1:</b> Mahasiswa memahami sejarah penemuan dan konsep pencitraan ultrasonik</p> <p><b>LLO 1:</b> <i>Students understand the history of ultrasonic imaging discovery and the concept of ultrasonic imaging.</i></p>	<p><b>Non-tes :</b> <b>Tugas 1:</b> Menjelaskan konsep fisika pencitraan ultrasonik (Tugas Tertulis)</p> <p><b>Tes:</b> ETS Soal 1 (3% dari ETS 15%)</p> <p><b>Non-test :</b> <b>Task 1:</b> <i>Explains the physics concept of ultrasonic imaging. (Written Assignments)</i></p> <p><b>Test:</b> <i>Question 1 in Mid Exam (3% of Mid Exam 15%)</i></p>	2.5
<b>2 – 3</b>	<p><b>Sub CP-MK 2:</b> Mahasiswa mampu mengidentifikasi dan menjelaskan fungsi komponen alat ultrasonik.</p> <p><b>LLO 2:</b> <i>Students able to identify and explain the function of ultrasonic</i></p>	<p><b>Non-tes :</b> <b>Tugas 2:</b> Menjelaskan komponen-komponen yang diperlukan untuk mendapatkan gambar pencitraan ultrasonik sesuai dengan permintaan (Tugas Tertulis).</p> <p><b>Tes:</b> ETS Soal 2 (4% dari ETS 15%) EAS Soal 1 (3% dari EAS 20%)</p> <p><b>Non-test :</b></p>	5

Mg ke/ Week (1)	Sub CP-MK / Lesson Learning Outcomes (LLO) (2)	Bentuk Asesmen (Penilaian) Form of Assessment (3)	Bobot / Load (%) (4)
	<i>instrument components.</i>	<p><b>Task 2:</b> <i>Describes the components required to obtain an ultrasonic imaging result on request. (Written Assignments)</i></p> <p><b>Test:</b> <i>Question 2 in Mid Exam (4% of Mid Exam 15%) Question 1 in Final Exam (3% of Final Exam 20%)</i></p>	
4	<p><b>Sub CP-MK 3:</b> Mahasiswa memahami mode yang terdapat pada pencitraan ultrasonik</p> <p><b>LLO 3:</b> <i>Students understand the modes contained in ultrasonic imaging</i></p>	<p><b>Non-tes :</b> <b>Tugas Praktikum 1:</b> Menghasilkan dan menganalisa gambar pencitraan ultrasonik yang jelas dengan menggunakan beberapa mode yang diajarkan di kelas</p> <p><b>Tes:</b> ETS Soal 3 (4% dari ETS 15%) EAS Soal 2 (3% dari EAS 20%)</p> <p><b>Non-test :</b> <b>Practicum Assignments 1:</b> <i>Generate and analyze clear ultrasonic imaging results using multiple modes taught in the class.</i></p> <p><b>Test:</b> <i>Questions 3 in Mid Exam (4% of Mid Exam 15%) Questions 2 in Final Exam (3% of Final Exam 20%)</i></p>	10
5 – 7	<p><b>Sub CP-MK 4:</b> Mahasiswa memahami prinsip Doppler dan flow imaging.</p> <p><b>LLO 4:</b> <i>Students understand the Doppler and flow imaging principles</i></p>	<p><b>Non-tes :</b> <b>Tugas Praktikum 2:</b> Menghasilkan dan menganalisa gambar pencitraan ultrasonik yang jelas dengan menggunakan teknik Doppler pada pencitraan ultrasonik</p> <p><b>Tes:</b> ETS Soal 4 (4% dari ETS 15%) EAS Soal 3 (2% dari EAS 20%)</p> <p><b>Non-test :</b> <b>Practicum Assignments 2:</b> <i>Generate and analyze clear ultrasonic imaging results using the Doppler technique of ultrasonic imaging.</i></p> <p><b>Test:</b> <i>Questions 4 in Mid Exam (4% of Mid Exam 15%) Questions 3 in Final Exam (2% of Final Exam 20%)</i></p>	10

Mg ke/ Week (1)	Sub CP-MK / Lesson Learning Outcomes (LLO) (2)	Bentuk Asesmen (Penilaian) Form of Assessment (3)	Bobot / Load (%) (4)
8	<p><b>Evaluasi Tengah Semester</b></p> <p><i>Mid Exam</i></p>	<p><b>Tes:</b> Ujian Tulis/Ujian Daring</p> <p><b>Test:</b> <i>Writing Exams / Online Exams</i></p>	15
9	<p><b>Sub CP-MK 5:</b> Mahasiswa memahami prinsip penggunaan agen kontras dalam pencitraan ultrasonik.</p> <p><b>LLO 5:</b> <i>Students understand the principles of using contrast agents in ultrasonic imaging</i></p>	<p><b>Non-tes :</b> <b>Tugas Pemrograman 1:</b> Membuat program untuk mendeteksi efek penggunaan agen kontras pada gambar hasil pencitraan ultrasonik</p> <p><b>Tes:</b> EAS Soal 4 (2% dari EAS 20%)</p> <p><b>Non-test :</b> <b>Programming Assignment 1:</b> <i>Create a program to detect the effect of using a contrast agent on ultrasonic imaging results.</i></p> <p><b>Test:</b> <i>Question 4 in Final Exam (2% of Final Exam 20%)</i></p>	5
10	<p><b>Sub CP-MK 6:</b> Mahasiswa memahami prinsip penggunaan ultrasonik berintensitas tinggi dan elastografi pada pencitraan ultrasonik.</p> <p><b>LLO 6:</b> <i>Students understand the principles of using high-intensity ultrasonic and elastography in ultrasonic imaging</i></p>	<p><b>Non tes:</b> <b>Presentasi 1:</b> Menjelaskan konsep elastografi dan HIFU melalui makalah jurnal atau konferen yang tersedia.</p> <p><b>Tes:</b> EAS Soal 5 (2% dari EAS 20%)</p> <p><b>Non-test:</b> <b>Presentation 1:</b> Explain the concept of elastography and HIFU through available journal or conference papers.</p> <p><b>Test:</b> <i>Question 5 in Final Exam (2% of Final Exam 20%)</i></p>	5
11	<p><b>Sub CP-MK 7:</b> Mahasiswa memahami prinsip pencitraan ultrasonik pada intravaskular.</p>	<p><b>Non tes:</b> <b>Presentasi 2:</b> Menjelaskan konsep intravascular ultrasound melalui makalah jurnal atau konferen yang tersedia.</p> <p><b>Tes:</b> EAS Soal 6 (2% dari EAS 20%)</p>	5

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 7:</b> <i>Students understand the principles of intravascular ultrasonic imaging</i></p>	<p><b>Non-test:</b> <b>Presentation 2:</b> Explain the concept of intravascular ultrasonic through available journal or conference papers.</p> <p><b>Test:</b> Question 6 in Final Exam (2% of Final Exam 20%)</p>	
12	<p><b>Sub CP-MK 8:</b> Mahasiswa memahami prinsip pencitraan ultrasonik pada multi dimension</p> <p><b>LLO 8:</b> <i>Students understand the principles of ultrasonic in multi-dimensions</i></p>	<p><b>Non tes:</b> <b>Tugas Praktikum 3:</b> Menghasilkan dan menganalisa gambar multi dimensi</p> <p><b>Tes:</b> EAS Soal 7 (2% dari EAS 20%)</p> <p><b>Non-test:</b> <b>Practicum Assignment 3:</b> <i>Produce and analyze multi-modal dimensional images.</i></p> <p><b>Test:</b> Question 7 in Final Exam (2% of Final Exam 20%)</p>	10
13	<p><b>Sub CP-MK 9:</b> Mahasiswa memahami artefak yang mungkin terjadi pada pencitraan ultrasonik</p> <p><b>LLO 9:</b> <i>Students understand the artifacts that may occur in ultrasonic imaging</i></p>	<p><b>Non tes:</b> <b>Tugas Praktikum 4:</b> Mendeteksi dan menganalisa artefak pada contoh gambar pencitraan ultrasonik</p> <p><b>Tes:</b> EAS Soal 8 (2% dari EAS 20%)</p> <p><b>Non-test:</b> <b>Practicum Assignment 4:</b> <i>Detect and analyze artifacts on samples of ultrasonic imaging results.</i></p> <p><b>Test:</b> Question 8 in Final Exam (2% of Final Exam 20%)</p>	10
14	<p><b>Sub CP-MK 10:</b> Mahasiswa memahami efek biologis dan keselamatan yang harus diperhatikan saat menggunakan</p>	<p><b>Non tes:</b> <b>Tugas 3:</b> Menjelaskan efek biologis dan keselamatan dalam penggunaan alat pencitraan ultrasonik (Tugas Tertulis).</p> <p><b>Tes:</b> EAS Soal 9 (2% dari EAS 20%)</p>	2.5

Mg ke/ Week (1)	Sub CP-MK / Lesson Learning Outcomes (LLO) (2)	Bentuk Asesmen (Penilaian) Form of Assessment (3)	Bobot / Load (%) (4)
	<p>alat pencitraan ultrasonik</p> <p><b>LLO 10:</b> Students understand the biological effects and safety that must be considered when using ultrasonic imaging equipment</p>	<p><b>Non-test:</b> <b>Task 3:</b> <i>Describe the biological and safety effects of using ultrasonic imaging equipments.</i> <i>(Written Assignments)</i></p> <p><b>Test:</b> <i>Question 9 in Final Exam (2% of Final Exam 20%)</i></p>	
15-16	<p><b>Evaluasi Akhir</b></p> <p><b>Final Exam</b></p>	<p><b>Tes:</b> Ujian Tulis/Ujian Daring</p> <p><b>Test:</b> <i>Writing Exams / Online Exams</i></p>	20
<b>Total bobot penilaian</b> <b>Total assessment load</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>Course 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 dan 3/ <i>CLO 1 and 3</i>	Week- 1	Task 1	2.5
		Week- 8	Mid Exam Question 1	3
CPL-05 / <i>PLO-05</i>	CPMK 2 / <i>CLO 2</i>	Week- 2-3	Task 2	5
		Week- 8	Mid Exam Question 2	4
		Week- 16	Final Exam Question 1	3
CPL-06 / <i>PLO-06</i>	CPMK 4 / <i>CLO 4</i>	Week- 5-7	Practicum Assignments 2	10
		Week- 8	Mid Exam Question 4	4
		Week- 16	Final Exam Question 3	2
CPL-07 / <i>PLO-07</i>	CPMK 5 / <i>CLO 5</i>	Week- 4	Practicum Assignments 1	10
		Week- 9	Programming Assignment 1	5
		Week- 10	Presentation 1	5
		Week- 12	Practicum Assignments 3	10
		Week- 14	Task 3	2.5
		Week- 8	Mid Exam Question 3	4
		Week- 16	Final Exam Question 2, 4, 5, 7, 9	11
CPMK 6 / <i>CLO 6</i>	Week- 11	Presentation 2	5	
	Week- 13	Practicum Assignment 4	10	
	Week- 16	Final Exam Question 6, 8	4	
				<b>Σ = 100%</b>

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

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
2	Task 2					0.05								0.05
3	Task 3							0.025						0.025
4	Practicum Assignments 1							0.1						0.1
5	Practicum Assignments 2						0.1							0.1
6	Practicum Assignments 3							0.1						0.1
7	Practicum Assignments 4							0.1						0.1
8	Programming Assignment 1							0.05						0.05
9	Presentation 1							0.05						0.05
10	Presentation 2							0.05						0.05
11	Mid Exam		0.03			0.04	0.04	0.04						0.15
12	Final Exam					0.03	0.02	0.15						0.2
	Total		0.055			0.12	0.16	0.665						1

