

Non-stationary Signal Analysis



Bachelor Degree Program Department of Biomedical Engineering

Faculty of Intelligent Electrical Technology and Informatics
Institut Teknologi Sepuluh Nopember



MODULE HANDBOOK
Non-stationary Signal Analysis
DEPARTMENT OF BIOMEDICAL ENGINEERING
 INSTITUT TEKNOLOGI SEPULUH NOPEMBER
 Number : 6871/IT2.IX.5.1.2/B/PP.03.00.00/2023

ENDORSEMENT PAGE

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

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MODULE HANDBOOK

NON-STATIONARY SIGNAL ANALYSIS

Module name	Non-Stationary Signal Analysis	
Module level	Undergraduate	
Code	EB234702	
Course (if applicable)	Non-Stationary Signal Analysis	
Semester	VII	
Person responsible for the module	Nada Fitriyatul Hikmah, S.T., M.T.	
Lecturer	Nada Fitriyatul Hikmah, S.T., M.T. Eko Agus Suprayitno, S.Si, M.T. Muhammad Adib Syamlan, S.T., M.T.	
Language	Bahasa Indonesia and English	
Relation to curriculum	Undergraduate degree program, mandatory , 7 th semester.	
Type of teaching, contact hours	Lectures, <60 students Tuesdays, 11.00-12.50 (GMT+7)	
Workload	1. Lectures : 3 x 50 = 150 minutes per week. 2. Exercises and Assignments : 3 x 60 = 180 minutes (3 hours) per week. 3. Private learning : 3 x 60 = 180 minutes (3 hours) per week.	
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	EB234404 Biomedical Signal Processing and Laboratory	
Learning outcomes and their corresponding PLOs	Course Learning Outcome (CLO) after completing this module, CLO 1: Students are able to explain and analyze non-stationary symptoms in cardiac system signals. CLO 2: Students are able to explain and analyze non-stationary symptoms in muscular system signals. CLO 3: Students are able to explain and analyze non-stationary symptoms of neural signals CLO 4: Students are able to explain non-stationary analysis of kinematic data in human movement systems	PLO-06 PLO-06 PLO-06 PLO-10

	CLO 5: Students are able to explain the mathematical transformation concept used to analyze non-stationary signals CLO 6: Students are able to perform non-stationary signal analysis process skills and design a processing system to obtain parameter extraction from biomedical signals	PLO-05 PLO-02
Content	This course aims to make students able to explain and analyze non-stationary symptoms in biomedical signals so that the results of the analysis can obtain important parameters. Topics covered include non-stationary symptoms in heart signals, muscular signals, neural signals, and the theory of wavelet transforms, Wigner-Ville, and others. Based on the understanding and ability to analyze non-stationary signals, students are able to use them in the biomedical engineering discipline.	
Study and examination requirements and forms of examination	● Written Assignment 1, 2 ● Demo and Report 1,2,3,4,5,6 ● Mid-term examination ● Final examination	
Media employed	LCD, whiteboard, websites (myITS Classroom), zoom.	
Reading list	Main : 1. Karlheinz Gröchenig, <i>Foundations of Time-Frequency Analysis</i>. Springer Science+Business Media New York, 2001. 2. Leon Cohen, <i>Time-Frequency Analysis</i>. Prentice-Hall PTR, New Jersey, 1995. 3. P. Stoica and R. Moses, <i>Spectral analysis of signals</i>. Prentice-Hall, New Jersey, 2005. Supporting : 1. Franz Hlawatsch François Auger (Ed.), <i>Time-Frequency Analysis: Concepts and Methods</i>. ISTE Ltd and John Wiley & Sons Inc., London & New Jersey, 2008. 2. Brüel & Kjær A/S, <i>Non-stationary Signal Analysis using Wavelet Transform, Short-time Fourier Transform and Wigner-Ville Distribution</i>, Technical Review. No. 2 – 1996. Nærum, 1996.	

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
Analisis Sinyal Nonstasioner <i>Non-Stationary Signal Analysis</i>		EB234702	Ilmu Dasar Teknik <i>Basic Engineering</i>	T=3 P=0		VII	
OTORISASI / PENGESAHAN AUTHORIZATION / ENDORSEMENT		Dosen Pengembang RPS Developer Lecturer of Semester Learning Plan		Koordinator RMK Course Cluster Coordinator		Ka DEPARTEMEN Head of Department	
		(Nada Fitriyatul Hikmah, 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-02 PLO-02	Mampu menerapkan ilmu pengetahuan, keterampilan, dan metode terkini dalam menyelesaikan permasalahan di bidang Teknik Biomedika. Able to apply the latest knowledge, skills and methods in solving problems in the field of Biomedical Engineering.				
		CPL-05 PLO-05	Mampu menemukan, memahami, menjelaskan, merumuskan, dan menyelesaikan permasalahan umum pada bidang Teknik dan permasalahan khusus pada bidang Teknik Biomedika yang meliputi instrumentasi biomedika cerdas, teknik rehabilitasi medika, pencitraan dan pengolahan citra medika, serta informatika medika. Able to find, understand, explain, formulate, and solve general problems in the field of Engineering and special problems in the field of Biomedical Engineering which includes intelligent biomedical instrumentation, medical rehabilitation techniques, imaging and processing of medical images, and medical informatics.				

	CPL-06 PLO-06	Mampu merancang dan melaksanakan eksperimen laboratorium dan/atau lapangan, menganalisa dan menginterpretasi data, serta menggunakan penilaian yang obyektif untuk menarik kesimpulan. <i>Able to design and implement laboratory experiment and / or field experiments, analyze and interpret data, and use objective assessments to draw conclusions.</i>
	CPL-10 PLO-10	Mampu bekerja dalam tim lintas disiplin dan budaya serta bertanggung jawab kepada masyarakat dan mematuhi hukum dan etika profesi dalam menyelesaikan masalah Teknik Biomedika. <i>Able to work in interdisciplinary and intercultural teams and be responsible to the community and comply with legal and professional ethics in solving Biomedical Engineering problems.</i>
	Capaian Pembelajaran Mata Kuliah (CPMK) Course Learning Outcome (CLO) - If CLO as description capability of each Learning Stage in the course, then CLO = LLO	
	CP MK 1 CLO 1	Mahasiswa mampu menjelaskan dan menganalisis gejala nonstationer pada sinyal sistem jantung. <i>Students are able to explain and analyze non-stationary symptoms in cardiac system signals.</i>
	CP MK 2 CLO 2	Mahasiswa mampu menjelaskan dan menganalisis gejala nonstationer pada sinyal sistem muscular. <i>Students are able to explain and analyze non-stationary symptoms in muscular system signals.</i>
	CP MK 3 CLO 3	Mahasiswa mampu menjelaskan dan menganalisis gejala nonstationer pada sinyal neural. <i>Students are able to explain and analyze non-stationary symptoms of neural signals.</i>
	CP MK 4 CLO 4	Mahasiswa mampu menjelaskan analisa nonstationer data-data kinematic pada sistem pergerakan manusia. <i>Students are able to explain non-stationary analysis of kinematic data in human movement systems.</i>
	CP MK 5 CLO 5	Mahasiswa mampu menjelaskan konsep transformasi matematik yang digunakan untuk menganalisis sinyal nonstationer. <i>Students are able to explain the mathematical transformation concept used to analyze non-stationary signals.</i>
	CP MK 6 CLO 6	Mahasiswa mampu melakukan keterampilan proses analisa sinyal nonstationer dan mendesain system pengolahan untuk mendapatkan ekstraksi parameter dari sinyal biomedik. <i>Students are able to perform non-stationary signal analysis process skills and design a processing system to obtain parameter extraction from biomedical signals.</i>

Peta CPL – CP MK <i>Map of PLO - CLO</i>	<table><tr><td></td><td>CPL-0 1</td><td>CPL-0 2</td><td>CPL-0 3</td><td>CPL-0 4</td><td>CPL-0 5</td><td>CPL-0 6</td><td>CPL-0 7</td><td>CPL-0 8</td><td>CPL-0 9</td><td>CPL-1 0</td><td>CPL-1 1</td><td>CPL-1 2</td></tr><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></table>		CPL-0 1	CPL-0 2	CPL-0 3	CPL-0 4	CPL-0 5	CPL-0 6	CPL-0 7	CPL-0 8	CPL-0 9	CPL-1 0	CPL-1 1	CPL-1 2	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>		✓										
	CPL-0 1	CPL-0 2	CPL-0 3	CPL-0 4	CPL-0 5	CPL-0 6	CPL-0 7	CPL-0 8	CPL-0 9	CPL-1 0	CPL-1 1	CPL-1 2																																																																																
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Diskripsi Singkat MK <i>Short Description of Course</i>	Mata kuliah ini bertujuan agar mahasiswa mampu menjelaskan dan menganalisis gejala nonstasioner pada sinyal biomedik sehingga dari hasil analisis tersebut diperoleh parameter-parameter penting. Topik yang dibahas meliputi gejala nonstationer pada sinyal jantung, sinyal muscular, sinyal neural, serta teori transformasi wavelet, Wigner-Ville, dan lainnya. Berdasarkan pemahaman dan kemampuan menganalisis sinyal nonstasioner, mahasiswa mampu memanfaatkannya dalam disiplin ilmu teknik biomedik. <i>This course studies statistics (central tendency, variability, measures of individual in population), data, samples, populations, data presentation in tabular or graphical form, basic concepts of probability, probability, total probability, Bayes theorem , random variables, pdf, cdf, probability distribution (discrete and continuous distribution), estimation and testing, estimation of confidence intervals, hypothesis testing, regression, ANOVA.</i>																																																																																											

Bahan Kajian: Materi pembelajaran Course Materials:	1. Gejala nonstationary pada cardiac system signal / <i>Nonstationary symptoms of the cardiac system signal</i> 2. Gejala nonstationary pada muscular system signal / <i>Nonstationary symptoms of the muscular system signal</i> 3. Gejala nonstationary pada neural signal / <i>Nonstationary symptoms of the neural signal</i> 4. Analisa nonstationary data-data kinematik pada human movement system / <i>Nonstationary analysis of kinematic data on the human movement system</i> 5. Transformasi matematis untuk analisa nonstasioner: macam-macam transformasi wavelet, Wigner-Ville, dan lainnya / <i>Mathematical transformations for non-stationary analysis: various wavelet transforms, Wigner-Ville, and others</i> 6. Keterampilan proses analisa nonstationary signal, desain sistem pengolahan, dan analisa sinyal-sinyal biomedis, meliputi HRV, PCG, EEG, EMG, kinematik / <i>Nonstationary signal analysis process skills, processing system design, and analysis of biomedical signals, including HRV, PCG, EEG, EMG, kinematics</i>
Pustaka References	Utama / Main: 1. Karlheinz Gröchenig, <i>Foundations of Time-Frequency Analysis</i>. Springer Science+Business Media New York, 2001. 2. Leon Cohen, <i>Time-Frequency Analysis</i>. Prentice-Hall PTR, New Jersey, 1995. 3. P. Stoica and R. Moses, <i>Spectral analysis of signals</i>. Prentice-Hall, New Jersey, 2005. Pendukung / Supporting: 1. Franz Hlawatsch François Auger (Ed.), <i>Time-Frequency Analysis: Concepts and Methods</i>. ISTE Ltd and John Wiley & Sons Inc., London & New Jersey, 2008. 2. Brüel & Kjær A/S, <i>Non-stationary Signal Analysis using Wavelet Transform, Short-time Fourier Transform and Wigner-Ville Distribution</i>, Technical Review. No. 2 – 1996. Nærum, 1996.
Dosen Pengampu Lecturers	Nada Fitriyatul Hikmah, S.T., M.T. Eko Agus Suprayitno, S.Si, M.T. Muhammad Adib Syamlan, S.T., M.T.
Matakuliah syarat Prerequisite	EB234404 Pengolahan Sinyal Biomedika dan Laboratorium <i>Biomedical Signal Processing and Laboratory</i>

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 /Assessment Load (%)
		Indikator / Indicator	Kriteria & Teknik / Criteria & Techniques	Tatap Muka / In-class (5)	Daring / Online (6)		
(1)	(2)	(3)	(4)			(7)	(8)
1 - 3	Mahasiswa mampu menjelaskan dan menganalisis gejala nonstationer pada sinyal sistem jantung. <i>Students are able to explain and analyze non-stationary symptoms in cardiac system signals.</i>	• Kelengkapan dan kerapian hasil tugas. • Ketepatan waktu pengumpulan tugas. • Kebenaran melaksanakan tugas. • Keberhasilan menjelaskan tugas. • Kebenaran jawaban dan analisis. • <i>Completeness and neatness of assignment results.</i> • <i>On time submission of assignments</i> • <i>Correct assignment work.</i> • <i>Success of explaining assignments.</i> • <i>Correct answers and analysis.</i>	Non-tes : Tugas 1: Menjelaskan morfologi sinyal jantung dan parameter klinis yang dapat diperoleh (Tugas Tertulis 1) Tugas 2: Perancangan program analisis sinyal jantung domain waktu-frekuensi dan menjelaskan gejala nonstasionernya (Demo dan Laporan 1) Non-test : Task 1:	• Kuliah dan diskusi [TM : 3 x (3 x 50'')] • Belajar Mandiri – Daring atau Luring melalui Share ITS [BM : 3 x (3 x 50'')] • Penugasan Terstruktur [PT : 3 x (3 x 50'')] • <i>Lectures and discussions [FF : 3 x (3 x 50'')]</i> • <i>Independent Learning - Online or Offline via ITS Share</i>	• Chatting dan diskusi dalam forum platform ITS. • <i>Chat and discussion in ITS platform forum.</i>	• Kontrak kuliah: - Motivasi belajar - Rencana pembelajaran - Aturan-aturan perkuliahan - Tujuan perkuliahan - Sistem penilaian, buku ajar/sumber pustaka • Gejala nonstationary pada cardiac system signal: - Sinyal ECG: gelombang P, QRS, T - Sinyal PCG: sinyal S1 dan S2 - Sinyal carotid pulse [Link materi di MyITSClassroom]	15

			<i>Describe the morphology of cardiac signals and the clinical parameters that can be obtained (Written Assignment 1)</i> Task 2: <i>Designing a time-frequency domain heart signal analysis program and explaining its non-stationary symptoms (Demo and Report 1)</i>	[SA : 3 x (3 x 50")] • <i>Structured Assignments</i> [SS : 3 x (3 x 50")]		• <i>Course contract:</i> - Motivation to learn - Lesson plan - Lecture rules - Course objective - Assessment system, textbooks / library resources • <i>Nonstationary symptoms of cardiac system signals:</i> - ECG signal: P wave, QRS, T - PCG signal: S1 and S2 signals - Carotid pulse signal	
4-5	Mahasiswa mampu menjelaskan dan menganalisis gejala nonstationer pada sinyal sistem muscular. <i>Students are able to explain and analyze non-stationary symptoms in muscular system signals.</i>	• Kelengkapan dan kerapian hasil tugas. • Ketepatan menjelaskan pemahaman materi. • Ketepatan waktu pengumpulan tugas. • Kebenaran melaksanakan tugas. • Keberhasilan menjelaskan tugas.	Non-tes : Tugas 3: Perancangan program linier envelope pada sinyal otot saat kontraksi dan relaksasi (Demo dan Laporan 2) Non-test :	• Kuliah dan diskusi [TM : 2 x (3 x 50")] • Belajar Mandiri – Daring atau Luring melalui Share ITS [BM : 2 x (3 x 50")] • Penugasan Terstruktur		• Gejala nonstationary pada muscular system signal, meliputi sinyal otot saat kontraksi dan relaksasi • <i>Nonstationary symptoms of muscular system signals, including</i>	10

		● Kebenaran jawaban dan analisis. ● <i>Completeness and neatness of assignment results.</i> ● <i>Accuracy in explaining understanding of the material.</i> ● <i>On time submission of assignments</i> ● <i>Correct assignment work.</i> ● <i>Success of explaining assignments.</i> ● <i>Correct answers and analysis.</i>	Task 3: <i>Designing a linear envelope program signals the muscles during contraction and relaxation (Demo and Report 2)</i>	[PT : 2 x (3 x 50")] ● <i>Lectures and discussions [FF : 2 x (3 x 50")]</i> ● <i>Independent Learning - Online or Offline via ITS Share [SA : 2 x (3 x 50")]</i> ● <i>Structured Assignments [SS : 2 x (3 x 50")]</i>		<i>muscle signals during contraction and relaxation</i>	
6 - 7	Mahasiswa mampu menjelaskan dan menganalisis gejala nonstationer pada sinyal neural. <i>Students are able to explain and analyze non-stationary symptoms of neural signals.</i>	● Kelengkapan dan kerapian hasil tugas. ● Ketepatan menjelaskan pemahaman materi. ● Ketepatan waktu pengumpulan tugas. ● Kebenaran melaksanakan tugas. ● Keberhasilan menjelaskan tugas.	Non-tes : Tugas 4: Perancangan program analisis domain frekuensi pada sinyal neural (Demo dan Laporan 3). Non-test : Task 4:	● Kuliah dan diskusi [TM : 2 x (3 x 50")] ● Belajar Mandiri – Daring atau Luring melalui Share ITS [BM : 2 x (3 x 50")] ● Penugasan Terstruktur		● Gejala nonstationary pada sinyal neural pada saat terjadi stimulus dan tidak ● <i>Nonstationary symptoms in neural signals when there is a stimulus and not.</i>	10

		● Kebenaran jawaban dan analisis. ● <i>Completeness and neatness of assignment results.</i> ● <i>Accuracy in explaining understanding of the material.</i> ● <i>On time submission of assignments</i> ● <i>Correct assignment work.</i> ● <i>Success of explaining assignments.</i> ● <i>Correct answers and analysis.</i>	<i>Designing a frequency domain analysis program for neural signals (Demo and Report 3).</i>	[PT : 2 x (3 x 50")] ● <i>Lectures and discussions [FF : 2 x (3 x 50")]</i> ● <i>Independent Learning - Online or Offline via ITS Share [SA : 2 x (3 x 50")]</i> ● <i>Structured Assignments [SS : 2 x (3 x 50")]</i>			
8	EVALUASI TENGAH SEMESTER MID-SEMESTER EXAM						15
9 - 10	Mahasiswa mampu menjelaskan analisa nonstationer data-data kinematik pada sistem pergerakan manusia. <i>Students are able to explain non-stationary analysis of kinematic data in human movement systems.</i>	● Ketepatan waktu pengumpulan tugas. ● Kebenaran melaksanakan tugas. ● Keberhasilan menjelaskan tugas. ● Kebenaran jawaban dan analisis. ● <i>On time submission of assignments</i>	Non-tes : Tugas 5: Penjelasan mengenai sistem pergerakan manusia dan parameternya (Tugas Tertulis 2) Tugas 6:	● Kuliah dan diskusi [TM : 2 x (3 x 50")] ● Belajar Mandiri – Daring atau Luring melalui Share ITS [BM : 2 x (3 x 50")] ● Penugasan Terstruktur		● Teknik sampling. ● Estimasi titik. ● Estimasi interval untuk rata-rata atau proporsi dari sebuah populasi dengan satu grup sampel. ● Estimasi interval untuk rata-rata atau proporsi dari sebuah populasi	15

		• <i>Correct assignment work.</i> • <i>Success of explaining assignments.</i> • <i>Correct answers and analysis.</i>	Perancangan program ekstraksi parameter temporan dan joint angle dari data analisis Gait (Demo dan Laporan 4) Non-test : Task 5: An explanation of the human movement system and its parameters (Written Assignment 2) Task 6: The design of the extraction program for temporal parameters and joint angle from Gait analysis data (Demo and Report 4)	[PT : 2 x (3 x 50")] • <i>Lectures and discussions</i> [FF : 2 x (3 x 50")] • <i>Independent Learning - Online or Offline via ITS Share</i> [SA : 2 x (3 x 50")] • <i>Structured Assignments</i> [SS : 2 x (3 x 50")]		dengan dua grup sampel. • <i>Sampling technique.</i> • <i>Point estimation.</i> • <i>Interval estimation for averages or proportions of a population with one sample group.</i> • <i>Interval estimation for averages or proportions of a population with two sample groups.</i>	
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11 -12	Mahasiswa mampu menjelaskan konsep transformasi matematik yang digunakan untuk menganalisis sinyal nonstationer. <i>Students are able to explain the mathematical transformation concept used to analyze non-stationary signals.</i>	• Ketepatan waktu pengumpulan tugas. • Kebenaran melaksanakan tugas. • Keberhasilan menjelaskan program. • Kebenaran jawaban dan analisis. . • <i>On time submission of assignments</i> • <i>Correct assignment work.</i> • <i>Success of explaining programs. Correct answers and analysis.</i>	Non tes: Tugas 7: Program transformasi wavelet dengan sinyal masukan berupa sinyal biomedik (Demo dan Laporan 5) Non-test: Task 7: Program a wavelet transformation with an input signal in the form of a biomedical signal (Demo and Report 5)	• Kuliah dan diskusi [TM : 2 x (3 x 50'')] • Belajar Mandiri – Daring atau Luring melalui Share ITS [BM : 2 x (3 x 50'')] • Penugasan Terstruktur [PT : 2 x (3 x 50'')] • Lectures and discussions [FF : 2 x (3 x 50'')] • Independent Learning - Online or Offline via ITS Share [SA : 2 x (3 x 50'')] • Structured Assignments [SS : 2 x (3 x 50'')]		• Transformasi matematis untuk analisa nonstasioner: - Transformasi wavelet - Wigner-Ville • <i>Mathematical transformations for non-stationary analysis:</i> - Wavelet transformation - Wigner-Ville	10
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13-15	Mahasiswa mampu melakukan keterampilan proses analisa sinyal nonstationer dan mendesain system pengolahan untuk mendapatkan ekstraksi parameter dari sinyal biomedik. <i>Students are able to perform non-stationary signal analysis process skills and design a processing system to obtain parameter extraction from biomedical signals.</i>	• Ketepatan waktu pengumpulan tugas. • Kebenaran melaksanakan tugas. • Keberhasilan menjelaskan program. • Kebenaran jawaban dan analisis. . • On time submission of assignments • Correct assignment work. • Success of explaining programs. • Correct answers and analysis.	Tugas 8: Perancangan program ekstraksi parameter dari sinyal biomedik (Demo dan Laporan 6) Task 8: <i>Design a parameter extraction program from a biomedical signal (Demo and Report 6)</i>	• Kuliah dan diskusi [TM : 2 x (3 x 50'')] • Belajar Mandiri – Daring atau Luring melalui Share ITS [BM : 2 x (3 x 50'')] • Penugasan Terstruktur [PT : 2 x (3 x 50'')] • Lectures and discussions [FF : 2 x (3 x 50'')] • Independent Learning - Online or Offline via ITS Share [SA : 2 x (3 x 50'')] • Structured Assignments [SS : 2 x (3 x 50'')]		• Analisa sinyal biomedis: - Heart Rate Variability (HRV) - PCG - EEG - EMG - Kinematik • Biomedical signal analysis: - Heart Rate Variability (HRV) - PCG - EEG - EMG - Kinematic	10
16	EVALUASI AKHIR SEMESTER FINAL-SEMESTER EXAM						15

TM=Tatap Muka, **PT**=Penugasan Terstruktur, **BM**=Belajar Mandiri.
FF = *Face to Face*, **SA** = *Structured Assignment*, **SS** = *Self Study*.

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

	ASSESSMENT & EVALUATION PLAN BACHELOR DEGREE PROGRAM OF BIOMEDICAL ENGINEERING - FTEIC ITS Course : Non-Stationary Signal Analysis		RA&E
			Write Doc Code
Kode/code: EB234702	Bobot sks/credits (T/P): 3/0	Rumpun MK: Ilmu Dasar Teknik Course Cluster: Basic Engineering	Smt: VII
OTORISASI <i>AUTHORIZATION</i>	Penyusun RA & E <i>Compiler A&EP</i> Nada Fitriyatul Hikmah, S.T., M.T.	Koordinator RMK <i>Course Cluster Coordinator</i> Dr. Rachmad Setiawan, S.T., M.T.	Ka DEP <i>Head of DEP</i> Dr. Norma Hermawan, S.T., M.Sc.

Mg ke/ Week (1)	Sub CP-MK / <i>Lesson Learning Outcomes (LLO)</i> (2)	Bentuk Asesmen (Penilaian) <i>Form of Assessment</i> (3)	Bobot / Load (%) (4)
1-3	Sub CP-MK 1: Mahasiswa mampu menjelaskan dan menganalisis gejala nonstationer pada sinyal sistem jantung. LLO 1: <i>Students are able to explain and analyze non-stationary symptoms in cardiac system signals.</i>	Non-tes : Tugas 1: Menjelaskan morfologi sinyal jantung dan parameter klinis yang dapat diperoleh (Tugas Tertulis 1) Tugas 2: Perancangan program analisis sinyal jantung domain waktu-frekuensi dan menjelaskan gejala nonstasionernya (Demo dan Laporan 1) Tes: 1 Soal Pada ETS (20% dari ETS 15%) Non-test : Task 1: <i>Describe the morphology of cardiac signals and the clinical parameters that can be obtained (Written Assignment 1)</i> Task 2: <i>Designing a time-frequency domain heart signal analysis program and explaining its non-stationary symptoms (Demo and Report 1)</i>	15

		Test: 1 question on Mid Exam (20% of Mid Exam 15%)	
4-5	Sub CP-MK 2: Mahasiswa mampu menjelaskan dan menganalisis gejala nonstationer pada sinyal sistem muscular. LLO 2: <i>Students are able to explain and analyze non-stationary symptoms in muscular system signals.</i>	Non-tes : Tugas 3: Perancangan program linier envelope pada sinyal otot saat kontraksi dan relaksasi (Demo dan Laporan 2) Tes: 1 Soal Pada ETS (15% dari ETS 15%) Non-test : Task 3: <i>Designing a linear envelope program signals the muscles during contraction and relaxation (Demo and Report 2)</i> Test: 1 Question in Mid Exam (15% of Mid Exam 15%)	10
6-7	Sub CP-MK 3: Mahasiswa mampu menjelaskan dan menganalisis gejala nonstationer pada sinyal neural. LLO 3: <i>Students are able to explain and analyze non-stationary symptoms of neural signals.</i>	Non-tes : Tugas 4: Perancangan program analisis domain frekuensi pada sinyal neural (Demo dan Laporan 3). Tes: 1 Soal Pada ETS (15% dari ETS 15%) Non-test : Task 4: <i>Designing a frequency domain analysis program for neural signals (Demo and Report 3).</i> Test: 1 Question in Mid Exam (15% of Mid Exam 15%)	10
8	Evaluasi Tengah Semester Mid Exam	Tes: Ujian Tulis/Ujian Daring Test: Writing Exams / Online Exams	15
9-10	Sub CP-MK 4: Mahasiswa mampu menjelaskan analisa nonstationer	Non-tes : Tugas 5: Penjelasan mengenai sistem pergerakan manusia dan parameternya (Tugas Tertulis 2)	10

	data-data kinematik pada sistem pergerakan manusia. LLO 4: <i>Students are able to explain non-stationary analysis of kinematic data in human movement systems.</i>	Tugas 6: Perancangan program ekstraksi parameter temporan dan joint angle dari data analisis Gait (Demo dan Laporan 4) Tes: 1 Soal Pada EAS (20% dari EAS 15%) Non-test : Task 5: <i>An explanation of the human movement system and its parameters (Written Assignment 2)</i> Task 6: <i>The design of the extraction program for temporal parameters and joint angle from Gait analysis data (Demo and Report 4)</i> Test: 1 Question in Final Exam (20% of Final Exam 15%)	
11-1 2	Sub CP-MK 5: Mahasiswa mampu menjelaskan konsep transformasi matematik yang digunakan untuk menganalisis sinyal nonstationer. LLO 5: <i>Students are able to explain the mathematical transformation concept used to analyze non-stationary signals.</i>	Non-tes : Tugas 7: Program transformasi wavelet dengan sinyal masukan berupa sinyal biomedik (Demo dan Laporan 5) Tes: 1 Soal Pada EAS (15% dari EAS 15%) Non-test: Task 7: <i>Program a wavelet transformation with an input signal in the form of a biomedical signal (Demo and Report 5)</i> Test: 1 Question in Final Exam (15% of Final Exam 15%)	10
13-1 5	Sub CP-MK 6: Mahasiswa mampu menentukan hubungan antara dua variabel atau lebih.	Non-tes Tugas 8: Perancangan program ekstraksi parameter dari sinyal biomedik (Demo dan Laporan 6) Tes: 1 Soal Pada EAS (15% dari EAS 15%)	10

	LLO 6: <i>Students are able to determine the relationship between two or more variables.</i>	Non-test: Task 8: <i>Design a parameter extraction program from a biomedical signal (Demo and Report 6)</i> Test: <i>Question 4 in Final Exam (15% of Final Exam 15%)</i>	
16	Evaluasi Akhir Final Exam	Tes: Ujian Tulis/Ujian Daring Test: <i>Writing Exams / Online Exams</i>	15
Total bobot penilaian Total assessment load			100%

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

CPL yang dibebankan pada MK / <i>PLO charged to the course</i>	CPMK / <i>Course Learning Outcome (CLO)</i>	Minggu ke / <i>Week</i>	Bentuk Asesmen / <i>Form of Assessment</i>	Bobot / <i>Load (%)</i>
CPL-02 / PLO-02	CPMK 6 / CLO 6	Week- 13-15	Programming Assignment 6	5
		Week- 16	Final Exam 1 Question	15
CPL-05 / PLO-05	CPMK 5 / CLO 5	Week- 11-12	Programming Assignment 5	5
		Week 16	Final Exam 1 Question	10
CPL-06 / PLO-06	CPMK 1 / CLO 1	Week- 1-3	Programming Assignment 1	5
		Week- 1-3	Written Assignment 1	5
		Week- 8	Mid Exam 1 Question	10
	CPMK 2 / CLO 2	Week- 4-5	Programming Assignment 2	5
		Week- 8	Mid Exam 1 Question	10
	CPMK 3 / CLO 3	Week- 6-7	Programming Assignment 3	5
		Week- 8	Mid Exam 1 Question	10
CPL-10 / PLO-10	CPMK 4 / CLO 4	Week- 9-10	Programming Assignment 4	5
		Week- 9-10	Written Assignment 1	5
		Week- 16	Final Exam 1 Question	5
				$\Sigma = 100\%$

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	Tugas 1 (1 Tugas Tertulis dan 3 Tugas Pemograman) <i>Task 1 (1 Written Assignment and 3 Programming Assignment)</i>						0.2							0.2
2	Tugas 2 (1 Tugas Tertulis dan 3 Tugas Pemograman) <i>Task 2 (1 Written Assignment and 3 Programming Assignment)</i>		0.05			0.05					0.05			0.15
3	Evaluasi Tengah Semester						0.3							0.3

	(3 Soal) <i>Mid Term Exam</i> (3 Question)													
4	Evaluasi Akhir Semester (3 Soal) <i>Final Term Exam</i> (3 Question)		0.15			0.1					0.1			0.35
	<i>Total</i>		0.2			0.15	0.5				0.15			1

