

Fundamentals of Biomechanics



Bachelor Degree Program Department of Biomedical Engineering

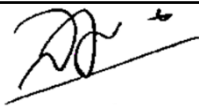
Faculty of Intelligent Electrical Technology and Informatics
Institut Teknologi Sepuluh Nopember



MODULE HANDBOOK
Fundamentals of Biomechanics
DEPARTMENT OF BIOMEDICAL ENGINEERING

INSTITUT TEKNOLOGI SEPULUH NOPEMBER
Number : 6849/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	Dr. Norma Hermawan, S.T., M.Sc.	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	Ir. Josaphat Pramudijanto, M.Eng.	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

MODULE HANDBOOK

FUNDAMENTALS OF BIOMECHANICS

Module name	Fundamentals of Biomechanics
Module level	Undergraduate
Code	EB234403
Course (if applicable)	Fundamentals of Biomechanics
Semester	Second Semester (Genap)
Lecturer	Atar Babgei, S.T., M.Sc. Eko Agus Suprayitno, S.Si., M.T. M. Hilman Fatoni, S.T., M.T. M. Yazid, B.Eng., M.Eng.
Language	Bahasa Indonesia and English
Relation to curriculum	Undergraduate degree program, mandatory , 6 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. 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	-
Learning outcomes and their corresponding PLOs	Course Learning Outcome (CLO) after completing this module CLO 1: Students understand mechanics in general, types of applied mechanics, biomechanics, also magnitudes and units CLO 2: Students understand and able to apply algebra and vectors CLO 3: Students understand and able to explain basic concepts of mechanics: force, moments, and torque CLO 4: Students understand basic biophysiology from human movement system CLO 5: Students understand and able to explain concepts of statics analysis: system stability, free body diagram

	CLO 6: Students are able to explain and analyze statics application on biomechanics as in joints, muscles, and other parts of human movement system CLO 7: Students understand mechanical concept from deforming objects (shape-changing objects) CLO 8: Students understand and able to explain pressure analysis and multi-axial shape deformation on objects CLO 9: Students understand and able to explain mechanical property of biological tissues.	
Content	The Fundamental of Biomechanics is a course that explains theoretical basis and principles of biomechanics. This course provides emphasis on human movement biomechanics, basics of musculoskeletal systems, mechanical principles on musculoskeletal system, and application of mechanics on human movement system.	
Study and examination requirements and forms of examination	• In-class exercises • Assignment 1, 2, 3, 4, 5, 6, 7, 8 • Mid-term examination Final examination	
Media employed	• LCD, whiteboard, websites (myITS Classroom), zoom.	
Reading list	Main: 1. Nihat Özkaya, Margareta Nordin, David Goldsheyder, Dawn Leger; Fundamentals of Biomechanics: Equilibrium, Motion, and Deformation, Third Edition. Springer, New York, 2012 2. Duane Knudson, Fundamentals of Biomechanics (Second Edition). Springer, Chico, 2007. 3. Mark L Latash, Neurophysiological basis of movement. Human Kinetics, USA, 1998. 4. Robert M Enoka, Neuromechanics of human movement, 3rd Ed. Human Kinetics, USA, 2002. 5. J Winters & P E Cargo (Eds), Biomechanics and neural control of posture and movement. Springer-Verlag, USA, 2000.	

I. Rencana Pembelajaran Semester / *Semester Learning Plan*

		INSTITUT TEKNOLOGI SEPULUH NOPEMBER (ITS) FACULTY OF INTELLIGENT ELECTRICAL AND INFORMATICS TECHNOLOGY DEPARTMENT OF BIOMEDICAL ENGINEERING				Kode Dokumen	
SEMESTER LEARNING PLAN							
MATA KULIAH (MK) COURSE		KODE CODE	Rumpun MK Course Cluster	BOBOT (sks) Credits		SEMESTER	Tgl Penyusunan Compilation Date
Dasar Biomekanika Fundamentals of Biomechanics		EB234403	Biocybernetics	T=3	P=0	IV	Oct 31, 2023
OTORISASI / PENGESAHAN AUTHORIZATION / ENDORSEMENT		Dosen Pengembang RPS Developer Lecturer of Semester Learning Plan		Koordinator RMK Course Cluster Coordinator		Ka DEPARTEMEN Head of Department	
		(Muhammad Adib Syamlan, S.T., M.T.)		(Ir. Josaphat Pramudijanto, M.Eng.)		(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 mengkaji dan memanfaatkan ilmu pengetahuan dan teknologi dalam rangka mengaplikasikannya pada bidang Teknik Biomedik, serta mampu mengambil keputusan secara tepat dari hasil kerja sendiri maupun kerja kelompok dalam bentuk laporan tugas akhir atau bentuk kegiatan lain yang luarannya setara dengan tugas akhir melalui pemikiran logis, kritis, sistematis, dan inovatif Able to study and utilize science and technology in order to apply it to the field of Biomedical Engineering and able to make appropriate decisions from the results of one's own work or group work in the form of final assignment reports or forms of learning activities others whose output is equivalent to the final assignment through logical, critical, systematic and innovative thinking.					
	CPL-04 PLO-04	Mampu menerapkan Ilmu Pengetahuan Alam dan Matematika pada bidang Teknik Biomedika Able to apply Natural Sciences and Mathematics in the field of Biomedical Engineering					

	CPL-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) – Bila CP MK sebagai kemampuan pada tiap tahap pembelajaran CP MK = Sub CP MK												
	CP MK 1 CLO 1	Mahasiswa memahami secara umum bidang mekanika, jenis mekanika terapan, biomekanika, serta besaran dan satuan <i>Students understand mechanics in general, types of applied mechanics, biomechanics, also magnitudes and units</i>											
	CP MK 2 CLO 2	Mahasiswa memahami dan mampu menerapkan penggunaan aljabar dan vektor. <i>Students understand and able to apply algebra and vectors</i>											
	CP MK 3 CLO 3	Mahasiswa memahami dan mampu menjelaskan konsep-konsep dasar dari mekanika: gaya, momen, dan torsi. <i>Students understand and able to explain basic concepts of mechanics: force, moments, and torque</i>											
	CP MK 4 CLO 4	Mahasiswa memahami dasar-dasar biofisiologi dari human movement system. <i>Students understand basic biophysiology from human movement system</i>											
	CP MK 5 CLO 5	Mahasiswa memahami dan mampu menjelaskan konsep dari analisa statika: keseimbangan sistem, free body diagram. <i>Students understand and able to explain concepts of statics analysis: system stability, free body diagram</i>											
	CP MK 6 CLO 6	Mahasiswa mampu menjelaskan dan menganalisa aplikasi statika pada biomekanika seperti pada persendian, otot, dan bagian sistem gerak tubuh manusia lainnya. <i>Students are able to explain and analyze statics application on biomechanics as in joints, muscles, and other parts of human movement system</i>											
	CP MK 7 CLO 7	Mahasiswa memahami konsep mekanik dari benda berubah bentuk <i>Students understand mechanical concept from deforming objects (shape-changing objects)</i>											
	CP MK 8 CLO 8	Mahasiswa memahami dan mampu menjelaskan analisa tekanan dan perubahan bentuk multi-axial pada benda <i>Students understand and able to explain pressure analysis and multi-axial shape deformation on objects</i>											
	CP MK 9 CLO 9	Mahasiswa memahami dan mampu menjelaskan properti mekanik jaringan biologi. <i>Students understand and able to explain mechanical property of biological tissues.</i>											
Peta CPL – CP MK													
Map of PLO - CLO		CPL-01	CPL-02	CPL-03	CPL-04	CPL-05	CPL-06	CPL-07	CPL-08	CPL-09	CPL-10	CPL-11	CPL-12
	CPMK 1 / SUB CPMK 1 CLO 1 / LLO 1				✓								

	CPMK 2 / SUB CPMK 2 CLO 2 / LLO 2				√								
	CPMK 3 / SUB CPMK 3 CLO 3 / LLO 3				√								
	CPMK 4 / SUB CPMK 4 CLO 4 / LLO 4									√			
	CPMK 5 / SUB CPMK 5 CLO 5 / LLO 5		√										
	CPMK 6 / SUB CPMK 6 CLO 6 / LLO 6									√			
	CPMK 7 / SUB CPMK 7 CLO 7 / LLO 7		√										
	CPMK 8 / SUB CPMK 8 CLO 8 / LLO 8		√										
	CPMK 9 / SUB CPMK 9 CLO 9 / LLO 9		√										
Diskripsi Singkat MK Short Description of Course	Mata kuliah Dasar Biomekanika merupakan mata kuliah yang membahas landasan teori dan prinsip dalam biomekanika. Mata kuliah ini memberikan penekanan pada biomekanika gerakan manusia, dasar dari sistem muskuloskeletal, prinsip mekanik pada sistem muskuloskeletal, hingga aplikasi mekanika pada sistem gerak tubuh manusia. <i>The Fundamental of Biomechanics is a course that explains theoretical basis and principles of biomechanics. This course provides emphasis on human movement biomechanics, basics of musculoskeletal systems, mechanical principles on musculoskeletal system, and application of mechanics on human movement system.</i>												
Bahan Kajian: Materi pembelajaran Course Materials:	1. Pengenalan bidang mekanik: definisi mekanika, jenis mekanika terapan, biomekanika, hukum pada mekanika, besaran dan satuan / <i>Mechanical introduction: mechanical definition, types of applied mechanics, biomechanics, mechanical laws, magnitude and units</i> 2. Konsep dan analisa menggunakan aljabar vektor. / <i>Concepts and analysis using vector algebra</i> 3. Konsep-konsep dasar dari mekanika: gaya, momen, dan torsi. / <i>Basic concepts of mechanics</i> 4. Dasar-dasar biofisiologi dari human movement system : sistem rangka, sistem otot, persendian, mekanisme kerja otot, dan gerakan umum tubuh manusia / <i>Basic biophysics from human movement system: skeletal system, muscle system, joints, muscle work mechanism and basic human movement</i>												

	5. Konsep dan analisa dari analisa statika : keseimbangan sistem, free-body diagram, hukum Newton. / <i>Concept and analysis of static analysis: system stability, free-body diagrma, Newton laws</i> 6. Aplikasi analisa statika pada biomekanika : elbow, shoulder, spinal column, hip, knee, ankle, dan bagian tubuh manusia lainnya. / <i>Static analysis application upon biomechanics: elbow, shoulder, spinal column, hip, knee, ankle, and other human body parts.</i> 7. Konsep mekanik dari benda berubah bentuk / <i>Mechanical concept of deforming objects (shape-changing objects)</i> 8. Konsep dari analisa tekanan dan perubahan bentuk multi-axial pada benda 9. Properti mekanik jaringan biologi						
Pustaka <i>References</i>	Utama / Main:						
	1. Nihat Özkaya, Margareta Nordin, David Goldsheyder, Dawn Leger; Fundamentals of Biomechanics: Equilibrium, Motion, and Deformation,Third Edition. Springer, New York, 2012 2. Duane Knudson, Fundamentals of Biomechanics (Second Edition). Springer, Chico, 2007. 3. Mark L Latash, Neurophysiological basis of movement. Human Kinetics, USA, 1998. 4. Roger M Enoka, Neuromechanics of human movement, 3rd Ed. Human Kinetics, USA, 2002. 5. J Winters & P E Cargo (Eds), Biomechanics and neural control of posture and movement. Springer-Verlag, USA, 2000.						
	Pendukung / Supporting:						
Dosen Pengampu <i>Lecturer</i>							
Matakuliah syarat <i>Prerequisite</i>	-						
Mg ke/ Week	Kemampuan akhir tiap tahapan belajar (Sub-CPMK) / <i>Final ability of each learning stage (LLO)</i>	Penilaian / Assessment		Bantuk Pembelajaran; Metode Pembelajaran; Penugasan Mahasiswa; [Estimasi Waktu] / <i>Form of Learning; Learning Method; Student Assignment; [Estimated Time]</i>		Materi Pembelajaran [Pustaka] / <i>Learning Material [Reference]</i>	Bobot Penilaian /Assessment Load (%)
(1)	(2)	Indikator / Indicator	Kriteria & Teknik / Criteria & Techniques	Tatap Muka / In-class (5)	Daring / Online (6)	(7)	(8)
1	Mahasiswa memahami secara umum bidang mekanika, jenis mekanika terapan,	● Kelengkapan dan kerapian hasil resume	Tugas 1: ● Resume mengenai:	● Kuliah dan brainstorming, tanya jawab.	● Chatting dan diskusi dalam	● Definisi secara umum dari mekanika.	5

	biomekanika, serta besaran dan satuan. <i>Students understand mechanics in general, types of applied mechanics, biomechanics, also magnitudes and units</i>	• Ketepatan waktu pengumpulan tugas • Kebenaran melaksanakan tugas • Keberhasilan menjelaskan tugas dengan baik. • <i>Completeness and neatness of resume results</i> • <i>Timeliness of submission of assignments</i> • <i>Correctness of task</i> • <i>Successful in explaining task well</i>	Jenis dan contoh mekanika terapan. Hasil produk dari masing-masing contoh mekanika terapan. Task 1 • Make a resume about: types and examples of applied mechanics, Resulting product of each applied mechanics examples	[TM : 3 x 50"] [BM : 3 x 60"] [PT : 3 x 50"] • <i>Presentation and brainstorming, ask and answer.</i> [FF : 3 x 50"] [SA : 3 x 60"] [SS : 3 x 50"]	forum platform ITS. • <i>Chat and discussion in ITS platform forum.</i>	• Jenis-jenis mekanika terapan • Konsep dan dasar dari biomekanika • Hukum-hukum pada mekanika • Konsep besaran dan satuan • <i>General definition of mechanics</i> • <i>Types of applied mechanics</i> • <i>Concept and basic of biomechanics</i> • <i>Mechanical laws</i> • <i>Concept of magnitude and units</i>	
2	Mahasiswa memahami dan mampu menerapkan penggunaan aljabar dan vektor. <i>Students understand and able to apply algebra and vectors</i>	• Kebenaran pemahaman, jawaban dan analisa • Keberhasilan menjelaskan tugas	Tugas 2: • Mengerjakan soal-soal yang berhubungan dengan aljabar vektor.	• Kuliah dan brainstorming, tanya jawab. [TM : 3 x 50"] [BM : 3 x 60"] [PT : 3 x 50"]	• Chatting dan diskusi dalam forum platform ITS.	• Konsep dari skalar dan vektor • Dot product • Cross product • Aplikasi dari aljabar vektor	5

		• Ketepatan waktu pengumpulan tugas • <i>Correct understanding, answers, and analysis</i> • <i>Successfully explaining task</i> • <i>Timeliness of submission of assignments</i>	• Aplikasi aljabar vektor pada mekanika dan biomekanika <i>Task 2:</i> • <i>Do several questions regarding vector algebra</i> • <i>Vector Algebra application upon mechanics and biomechanics</i>	• <i>Presentation and brainstorming, ask and answer.</i> [FF : 3 x 50"] [SA : 3 x 60"] [SS : 3 x 50"]	• <i>Chat and discussion in ITS platform forum.</i>	• <i>Concepts of scalar and vector</i> • <i>Dot product</i> • <i>Cross product</i> • <i>Vector Algebra application</i>	
3-4	Mahasiswa memahami dan mampu menjelaskan konsep-konsep dasar dari mekanika: gaya, momen, dan torsi. <i>Students understand and able to explain basic concepts of mechanics: force, moments, and torque</i>	• Kebenaran pemahaman, jawaban dan analisa • Keberhasilan menjelaskan tugas • Ketepatan waktu pengumpulan tugas • <i>Correct understanding, answers, and analysis</i> • <i>Successfully explaining task</i> • <i>Timeliness of submission of assignments</i>	Tugas 3: • Menjelaskan perbedaan momen dan torsi. • Mengerjakan soal analisa tentang gaya, momen dan torsi. <i>Task 3</i> • <i>Explain difference of moment and torque</i> • <i>Do analysis question regarding force, moment, and torque</i>	• Kuliah dan brainstorming, tanya jawab. [TM : 2 x 3 x 50"] [BM : 2 x 3 x 60"] [PT : 2 x 3 x 50"] • <i>Presentation and brainstorming, ask and answer.</i> [FF : 2 x 3 x 50"] [SA : 2 x 3 x 60"]	• Chatting dan diskusi dalam forum platform ITS. • <i>Chat and discussion in ITS platform forum.</i>	• Konsep dari gaya, jenis-jenis gaya • Contoh gaya pada biomekanika • Konsep dari momen dan torsi. • Contoh momen dan torsi pada biomekanika • Concepts and types of force • Examples of force in biomechanics • Concepts of moment and torque • Example of moment and torque in biomechanics	5

				[SS : 2 x 3 x 50"]			
5-6	Mahasiswa memahami dasar-dasar biofisiologi dari human movement system. <i>Students understand basic biophysiology from human movement system</i>	• Kelengkapan dan kerapian hasil resume • Ketepatan waktu pengumpulan tugas • Kebenaran melaksanakan tugas • Keberhasilan menjelaskan tugas dengan baik. • <i>Completeness and neatness of resume results</i> • <i>Timeliness of submission of assignments</i> • <i>Correctness of task</i> • <i>Successful in explaining task well</i>	Tugas 4: • Resume tentang mekanisme terjadinya gerakan dilihat dari level organisasi yang paling rendah. Task 4 • <i>Resume about movement-resulting mechanism from lowest organism's perspective</i>	• Kuliah dan brainstorming, tanya jawab. [TM : 2 x 3 x 50"] [BM : 2 x 3 x 60"] [PT : 2 x 3 x 60"] • <i>Presentation and brainstorming, ask and answer.</i> [FF : 2 x 3 x 50"] [SA : 2 x 3 x 60"] [SS : 2 x 3 x 60"]	• Chatting dan diskusi dalam forum platform ITS. • <i>Chat and discussion in ITS platform forum.</i>	• Sistem organ pembentuk <i>human movement system</i> : sistem rangka, sistem otot • Level organisasi dari sistem muskuloskeletal • Mekanisme terjadinya gerakan pada otot manusia • Gerakan manusia secara umum dan penamaannya • Penamaan arah bagian tubuh. • Jenis-jenis sendi. • <i>Forming organ system of human movement system: skeletal system, muscular system</i> • <i>Organization level from musculoskeletal level</i> • <i>Movement-resulting mechanism in human muscles</i>	5

						• <i>Human general movement and its nomenclature</i> • <i>Human direction terms</i> • <i>Types of joints</i>	
7	Mahasiswa memahami dan mampu menjelaskan konsep dari analisa statika: keseimbangan sistem, free body diagram. <i>Students understand and able to explain concepts of statics analysis: system stability, free body diagram</i>	• Kebenaran pemahaman, jawaban dan analisa • Keberhasilan menjelaskan tugas • Ketepatan waktu pengumpulan tugas • <i>Correct understanding, answers, and analysis</i> • <i>Successfully explaining task</i> • <i>Timeliness of submission of assignments</i>	Tugas 5: • Mengerjakan soal tentang analisa statika struktur tertentu. Task 5 • Do questions regarding static analysis of a certain structure	• Kuliah dan brainstorming, tanya jawab. [TM : 3 x 50"] [BM : 3 x 60"] [PT : 3 x 50"] • <i>Presentation and brainstorming, ask and answer.</i> [FF : 3 x 50"] [SA : 3 x 60"] [SS : 3 x 50"]	• Chatting dan diskusi dalam forum platform ITS. • <i>Chat and discussion in ITS platform forum.</i>	• Hukum Newton tentang keseimbangan • Prosedur analisa keseimbangan sistem • <i>Free body diagram</i> • Analogi support atau joint pada bidang mekanika secara umum dengan biomekanika • Jenis-jenis struktur : <i>simply supported structures</i>, sistem katrol dan <i>traction devices, built in structures</i>. • <i>Newton law regarding stability</i> • <i>System stability analysis procedure</i> • <i>Free body diagram</i> • <i>Support or joint analogy in general</i>	5

						<i>mechanics with biomechanics</i> • Structure types: simply supported structures, pulley system, and traction devices, built-in structures	
8	EVALUASI TENGAH SEMESTER MID-SEMESTER EXAM						25
9-11	Mahasiswa mampu menjelaskan dan menganalisa aplikasi statika pada persendian, otot, dan bagian sistem gerak tubuh manusia lainnya. <i>Students are able to explain and analyze statics application on biomechanics as in joints, muscles, and other parts of human movement system</i>	• Kebenaran pemahaman, jawaban dan analisa • Keberhasilan menjelaskan tugas • Ketepatan waktu pengumpulan tugas • <i>Correct understanding, answers, and analysis</i> • <i>Successfully explaining task</i> • <i>Timeliness of submission of assignments</i>	Tugas 6: • Mengerjakan soal tentang aplikasi statika pada persendian tubuh manusia. Task 6 • <i>Do questions regarding static application upon human joints</i>	• Kuliah dan brainstorming, tanya jawab. [TM : 3 x 3 x 50"] [BM : 3 x 3 x 60"] [PT : 3 x 3 x 60"] • <i>Presentation and brainstorming, ask and answer.</i> [FF : 3 x 3 x 50"] [SA : 3 x 3 x 60"] [SS : 3 x 3 x 60"]	• Chatting dan diskusi dalam forum platform ITS. • <i>Chat and discussion in ITS platform forum.</i>	• Review tentang persendian pada tubuh manusia. • Aplikasi analisa statika pada <i>elbow, shoulder, spinal column, knee, ankle, hip.</i> • <i>Review about human joints</i> • <i>Static analysis application in elbow, shoulder, spinal, column, knee, ankle, and hip</i>	10

12	Mahasiswa memahami konsep mekanik dari benda berubah bentuk <i>Students understand mechanical concept from deforming objects (shape-changing objects)</i>	• Kelengkapan dan kerapian hasil resume • Ketepatan waktu pengumpulan tugas • Kebenaran melaksanakan tugas • Keberhasilan menjelaskan tugas dengan baik. • <i>Completeness and neatness of resume results</i> • <i>Timeliness of submission of assignments</i> • <i>Correctness of task</i> • <i>Successful in explaining task well</i>	Tugas 7: • Resume tentang konsep mekanik benda berubah bentuk Task 7 • <i>Resume about mechanical concept of deforming objects</i>	• Kuliah dan brainstorming, tanya jawab. [TM : 3 x 50"] [BM : 3 x 60"] [PT : 3 x 60"] • <i>Presentation and brainstorming, ask and answer.</i> [FF : 3 x 50"] [SA : 3 x 60"] [SS : 3 x 60"]	• Chatting dan diskusi dalam forum platform ITS. • <i>Chat and discussion in ITS platform forum.</i>	• Konsep deformasi • Tegangan dan regangan • <i>Stress-strain diagram</i> • Deformasi elastic • Hukum Hooke • <i>Deformation concept</i> • <i>Stress and strain</i> • <i>Stress-strain diagram</i> • <i>Elastic deformation</i> • <i>Hooke law</i>	5
13-14	Mahasiswa memahami dan mampu menjelaskan analisa tekanan dan perubahan bentuk multi-axial pada benda serta mampu menjelaskan properti mekanik jaringan biologi <i>Students understand and able to explain pressure analysis and multi-axial shape deformation on objects and</i>	• Kebenaran pemahaman, jawaban dan analisa • Keberhasilan menjelaskan tugas • Ketepatan waktu pengumpulan tugas • <i>Correct understanding, answers, and analysis</i> • <i>Successfully explaining task</i>	Tugas 8: • Mengerjakan soal tentang analisa <i>stress</i>, konsep dari properti mekanik bagian tubuh. Task 8 • <i>Do questions regarding stress analysis,</i>	• Kuliah dan brainstorming, tanya jawab. [TM : 2 x 3 x 50"] [BM : 2 x 3 x 60"] [PT : 2 x 3 x 60"] • <i>Presentation and brainstorming,</i>	• Chatting dan diskusi dalam forum platform ITS. • <i>Chat and discussion in ITS platform forum.</i>	• Rasio Poissons • Tegangan biaxial dan triaxial • <i>Stress analysis</i> • <i>Fatigue dan endurance</i> • Viscoelasticity • Perbedaan elasticity dan viscoelasticity • Properti mekanik dari tulang, tendon, ligamen, otot	5

	able to explain mechanical property of biological tissues	• Timeliness of submission of assignments	concepts from human mechanical property	ask and answer. [FF : 2 x 3 x 50"] [SA : 2 x 3 x 60"] [SS : 2 x 3 x 60"]		rangka, cartilage. • Poissons ratio • Biaxial and triaxial stress • Stress analysis • Fatigue and endurance • Viscoelasticity • Difference of elasticity and viscoelasticity • Mechanical property of bones, tendons, ligaments, skeletal muscle, and cartilage	
15-16	EVALUASI AKHIR SEMESTER FINAL-SEMESTER EXAM						30

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 : Fundamentals of Biomechanics		RA&E
			Write Doc Code
Kode/code: EB234403	Bobot sks/credits (T/P): 3/0	Rumpun MK: Biocybernetics Course Cluster: Biocybernetics	Smt: IV
OTORISASI AUTHORIZATION	Penyusun RA & E Compiler A&EP Nada Fitriyatul H, S.T, M.T	Koordinator RMK Course Cluster Coordinator Dr. Norma Hermawan, S.T., M.Sc.	Ka DEP Head of DEP Dr. Norma Hermawan, S.T., M.Sc.

Mg ke/ Week (1)	Sub CP-MK / Lesson Learning Outcomes (LLO) (2)	Bentuk Asesmen (Penilaian) Form of Assessment (3)	Bobot / Load (%) (4)
1	Sub CP-MK 1: Mahasiswa memahami secara umum bidang mekanika, jenis mekanika terapan, biomekanika, serta besaran dan satuan. LLO 1: <i>Students understand mechanics in general, types of applied mechanics, biomechanics, also magnitudes and units</i>	Tugas 1: - Resume mengenai: Jenis dan contoh mekanika terapan. Hasil produk dari masing-masing contoh mekanika terapan. Task 1 <i>Make a resume about: types and examples of applied mechanics, Resulting product of each applied mechanics examples</i>	5
2	Sub CP-MK 2: Mahasiswa memahami dan mampu menerapkan penggunaan aljabar dan vektor. LLO 2: <i>Students understand and able to apply algebra and vectors</i>	Tugas 2: - Mengerjakan soal-soal yang berhubungan dengan aljabar vektor. - Aplikasi aljabar vektor pada mekanika dan biomekanika Task 2: <i>Do several questions regarding vector algebra</i> <i>Vector Algebra application upon mechanics and biomechanics</i> <i>1 soal pada ETS (1 Question in Midterm Exam)</i>	5

Mg ke/ Week (1)	Sub CP-MK / Lesson Learning Outcomes (LLO) (2)	Bentuk Asesmen (Penilaian) Form of Assessment (3)	Bobot / Load (%) (4)
3-4	Sub CP-MK 3: Mahasiswa memahami dan mampu menjelaskan konsep-konsep dasar dari mekanika: gaya, momen, dan torsi. LLO 3: <i>Students understand and able to explain basic concepts of mechanics: force, moments, and torque</i>	Tugas 3: - Menjelaskan perbedaan momen dan torsi. - Mengerjakan soal analisa tentang gaya, momen dan torsi. <i>Task 3</i> <i>Explain difference of moment and torque</i> <i>Do analysis question regarding force, moment, and torque</i> 1 soal pada ETS (1 Question in Midterm Exam)	5
5-6	Sub CP-MK 4: Mahasiswa memahami dasar-dasar biofisiologi dari human movement system. LLO 4: <i>Students understand basic biophysiology from human movement system</i>	Tugas 4: - Resume tentang mekanisme terjadinya gerakan dilihat dari level organisasi yang paling rendah. <i>Task 4</i> <i>Resume about movement-resulting mechanism from lowest organism's perspective</i> 1 soal pada ETS (1 Question in Midterm Exam)	5
7	Sub CP-MK 5: Mahasiswa memahami dan mampu menjelaskan konsep dari analisa statika: keseimbangan sistem, free body diagram. LLO 5: <i>Students understand and able to explain concepts of statics</i>	Tugas 5: - Mengerjakan soal tentang analisa statika struktur tertentu. <i>Task 5</i> <i>Do questions regarding static analysis of a certain structure</i> 2 soal pada ETS (2 Questions in Midterm Exam) 1 soal pada ETS (1 Question in Final Exam)	5

Mg ke/ Week (1)	Sub CP-MK / Lesson Learning Outcomes (LLO) (2)	Bentuk Asesmen (Penilaian) Form of Assessment (3)	Bobot / Load (%) (4)
	<i>analysis: system stability, free body diagram</i>		
8	Evaluasi Tengah Semester Midterm Exam	Tes: Ujian Tulis/Ujian Daring Test: • <i>Writing Exams / Online Exams</i>	25
9-11	Sub CP-MK 6: Mahasiswa mampu menjelaskan dan menganalisa aplikasi statika pada biomekanika seperti pada persendian, otot, dan bagian sistem gerak tubuh manusia lainnya. LLO 6: <i>Students are able to explain and analyze statics application on biomechanics as in joints, muscles, and other parts of human movement system</i>	Tugas 6: • Mengerjakan soal tentang aplikasi statika pada persendian tubuh manusia. <i>Task 6</i> • <i>Do questions regarding static application upon human joints</i> • <i>2 soal pada EAS (2 Questions in Final Exam)</i>	10
12	Sub CP-MK 7: Mahasiswa memahami konsep mekanik dari benda berubah bentuk LLO 7: <i>Students understand mechanical concept from deforming objects (shape-changing objects)</i>	Tugas 7: • Resume tentang konsep mekanik benda berubah bentuk <i>Task 7</i> • <i>Resume about mechanical concept of deforming objects</i> • <i>1 soal pada EAS (1 Question in Final Exam)</i>	5
13-14	Sub CP-MK 8: Mahasiswa memahami dan mampu menjelaskan	Tugas 8: • Mengerjakan soal tentang analisa <i>stress</i> , konsep dari properti mekanik bagian tubuh.	5

Mg ke/ Week (1)	Sub CP-MK / Lesson Learning Outcomes (LLO) (2)	Bentuk Asesmen (Penilaian) Form of Assessment (3)	Bobot / Load (%) (4)
	analisa tekanan dan perubahan bentuk multi-axial pada benda serta mampu menjelaskan properti mekanik jaringan biologi LLO 8: <i>Students understand and able to explain pressure analysis and multi-axial shape deformation on objects and able to explain mechanical property of biological tissues</i>	Task 8 - Do questions regarding stress analysis, concepts from human mechanical property 1 soal pada EAS (1 Question in Final Exam)	
15-16	Evaluasi Akhir Final Exam	Tes: Ujian Tulis/Ujian Daring Test: Writing Exams / Online Exams	30
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-01 / PLO-01	CPMK 1 / CLO 1	Week-1	Task 1	5
	CPMK 2 / CLO 2	Week-2	Task 2	5
		Week-8	Mid Exam Question 1	
	CPMK 3 / CLO 3	Week-3,4	Task 3	5
		Week-8	Mid Exam Question 2	
CPL-06 / PLO-06	CPMK 5 / CLO 5	Week-7	Task 5	5
		Week-8	Mid Exam Question 4 and 5	
		Week-16	Final Exam Question 1	
	CPMK 7 / CLO 7	Week-12	Task 7	5
		Week-16	Final Exam Question 4	
CPL-08 / PLO-08	CPMK 4 / CLO 4	Week-5,6	Task 4	5
		Week-8	Mid Exam Question 3	
	CPMK 6 / CLO 6	Week-9,10,11	Task 6	5
		Week-16	Final Exam Question 2 and 3	
	CPMK 8-9 / CLO 8-9	Week-13,14	Task 8	10
		Week-16	Final Exam 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 (4 Tugas Tulis)		0.04		2.60						0.02			2.65

	Assignment 1 (4 Written Assignment)													
2	Evaluasi Tengah Semester Mid Exam		0.06		0.18						0.07			0.30
3	Tugas 2 (4 Tugas Tulis) Assignment 2 (4 Written Assignment)		0.14		0						0.06			0.20
4	Evaluasi Akhir Semester Final Exam		0.2		0						0.11			0.33
	Total		0.45		2.78						0.25			3.48

