

Module Handbook

Genomic Computation



Bachelor Degree Program Department of Biomedical Engineering

Faculty of Intelligent Electrical Technology and Informatics
Institut Teknologi Sepuluh Nopember



MODULE HANDBOOK
Genomic Computation
DEPARTMENT OF BIOMEDICAL ENGINEERING
INSTITUT TEKNOLOGI SEPULUH NOPEMBER
Number : 6854/IT2.IX.5.1.2/B/PP.03.00.00/2023

ENDORSEMENT PAGE

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. Achmad Arifin, S.T., M.Eng.	Dosen <i>Lecturer</i>		November 18, 2022
Pemeriksa dan Pengendalian <i>Review and Control</i>	Eko Agus Suprayitno, S.Si, M.T.	Tim kurikulum <i>Curriculum team</i>		November 20, 2022
Persetujuan <i>Approval</i>	Ir. Josaphat Pramudijanto, M.Eng.	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

GENOMIC COMPUTATION

Module name	Genomic Computation	
Module level	Undergraduate	
Code	EB234912	
Course (if applicable)	Genomic Computation	
Semester	Specialization	
Person responsible for the module	Dr. Achmad Arifin, S.T., M.Eng.	
Lecturer	Dr. Achmad Arifin, S.T., M.Eng. Dr. Norma Hermawan, S.T., M.T., M.Sc.	
Language	Bahasa Indonesia and English	
Relation to curriculum	Undergraduate degree program, specialization	
Type of teaching, contact hours	Lectures, <60 students Wednesdays, 11.00-12.50 (GMT+7)	
Workload	1. Lectures : 3 x 50 = 150 minutes per week 2. Exercises and Assignments : 3 x 50 = 150 minutes per week 3. Private learning : 3 x 50 = 150 minutes 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	- Basic Programming (passed with Min. Grade = C) - Biomodeling	
Learning outcomes and their corresponding PLOs	Course Learning Outcome (CLO) after completing this module:	
	CLO 1: Students understand and able to explain the basic concepts of genomic computation, technical skill development on genom and sequence statistics computation.	PLO-02
	CLO 2: Students understand and able to explain gene finding, sequence alignment and linear space alignment.	PLO-05
	CLO 3: Students understand the concept and application of indexes in processing genomic data.	PLO-06
		PLO-10

	CLO 4: Students can use algorithms to complete read alignment and identify haplotypes of organisms.	
Content / Short Description of Course	Genomic Computation course aims to provide an understanding of computing basis that often used in the biomedical engineering field and at the same time also aims to strengthen student programming skills.	
Study and examination requirements and forms of examination	● In-class exercises ● Assignment 1, 2, 3, 4, 5, 6, 7, 8, 9 ● Presentation ● Mid-term examination ● Final examination	
Media employed	LCD, whiteboard, websites (myITS Classroom), zoom	
Reading list	Main : ● Neil Jones, Pavel Pevzner, "An Introduction to Bioinformatics Algorithms," MIT Press, 2004 ● Nello Cristianini and Matthew W. Hahn, "Introduction to Computational Genomics: A Case Studies Approach," Cambridge University Press, 2006 Supporting : ● Richard C. Deonier, Simon Tavaré, Michael S. Waterman, "Computational Genome Analysis, An Introduction" Springer, 2005	

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) <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>
Komputasi Genomik <i>Genomic Computation</i>	EB234912	Peminatan <i>Specialization</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>	
	(Dr. Achmad Arifin, S.T., M.Eng.)		(Ir. Josaphat Pramudijanto, M.Eng.)		(Dr. Achmad Arifin, S.T., M.Eng.)	
Capaian Pembelajaran	CPL-PRODI yang dibebankan pada MK <i>PLO Program Charged to The Course</i>					
Learning Outcomes	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 <i>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.</i>				
	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 <i>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</i>				

	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) – Bila CP MK sebagai kemampuan pada tiap tahap pembelajaran CP MK = Sub CP MK Course Learning Outcome (CLO) - If CLO as description capability of each Learning Stage in the course, then CLO = LLO	
	CP MK 1 CLO 1	Mahasiswa memahami dan mampu menjelaskan tentang konsep dasar komputasi genomik, pengembangan keterampilan teknis pada perhitungan statistik genom dan sekuens. <i>Students understand and able to explain the basic concepts of genomic computation, technical skill development on genom and sequence statistics computation.</i>
	CP MK 2 CLO 2	Mahasiswa memahami dan mampu menjelaskan tentang gene finding, sequence alignment dan linear space alignment. <i>Students understand and able to explain gene finding, sequence alignment and linear space alignment.</i>
	CP MK 3 CLO 3	Mahasiswa memahami konsep dan penerapan index dalam mengolah data genomic. <i>Students understand the concept and application of indexes in processing genomic data.</i>
	CP MK 4 CLO 4	Mahasiswa dapat menggunakan algoritma untuk menyelesaikan read alignment dan mengidentifikasi haplotype dari organisme. <i>Students can use algorithms to complete read alignment and identify haplotypes of organisms.</i>

Peta CPL – CP MK <i>Map of PLO - CLO</i>	<table><tr><td></td><td>CPL-01</td><td>CPL-02</td><td>CPL-03</td><td>CPL-04</td><td>CPL-05</td><td>CPL-06</td><td>CPL-07</td><td>CPL-08</td><td>CPL-09</td><td>CPL-10</td><td>CPL-11</td><td>CPL-12</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></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>										✓		
	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>										✓																																																								
Diskripsi Singkat MK <i>Short Description of Course</i>	Mata kuliah Komputasi Genomik bertujuan untuk memberikan pemahaman tentang dasar komputasi yang sering digunakan dalam bidang teknik biomedik, dan pada saat yang bersamaan juga bertujuan untuk memperkuat kemampuan programming mahasiswa. <i>Genomic Computation course aims to provide an understanding of computing basis that often used in the biomedical engineering field and at the same time also aims to strengthen student programming skills.</i>																																																																	
Bahan Kajian / Materi Pembelajaran <i>Course Materials</i>	1. Pengenalan Genomik / <i>Introduction to Genomics</i> 2. <i>Sequence Alignment</i> 3. <i>Linear Space Alignment</i> 4. <i>Burrows-Wheeler Transform</i> 5. <i>Hidden Markov Model</i> 6. <i>DNA Sequencing and Assembling</i> 7. <i>RNA Sequence Analysis</i> 8. Contoh aplikasi analisis DNA / <i>Examples of DNA anlysis applications</i>																																																																	
Pustaka <i>References</i>	Utama / Main:																																																																	

	- Neil Jones, Pavel Pevzner, "An Introduction to Bioinformatics Algorithms," MIT Press, 2004 - Nello Cristianini and Matthew W. Hahn, "Introduction to Computational Genomics: A Case Studies Approach," Cambridge University Press, 2006
	Pendukung / Supporting:
	Richard C. Deonier, Simon Tavaré, Michael S. Waterman, "Computational Genome Analysis, An Introduction" Springer, 2005
Dosen Pengampu Lecturers	Dr. Achmad Arifin, S.T., M.Eng. Dr. Norma Hermawan, S.T., M.T., M.Sc.
Matakuliah syarat Prerequisite	- Basic Programming (passed with Min. Grade = C) - Biomodeling

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				
(1)	(2)	(3)	(4)	Tatap Muka / In-class (5)	Daring / Online (6)	(7)	(8)
1 – 2	Mahasiswa memahami dan mampu menjelaskan tentang konsep dasar komputasi genomik Students understand and be able to explain the basic concepts of genomic computation	- Mampu menjelaskan mengenai genomik - Mampu mengatur data standar dan basis data untuk data sequence - Able to explain about genomic	Non-Tes : Tugas 1: Tugas mengenai konsep dasar komputasi genomik (Tugas Tertulis) Tugas 2:	- Kuliah dan diskusi [TM : 2 x 3 x 50"] [BM : 2 x 3 x 50"] [PT : 2 x 3 x 50"] - Lecturers and discussions [FF : 2 x 3 x 50"] [SA : 2 x 3 x 50"] [SS : 2 x 3 x 50"]	- Belajar mandiri melalui Share ITS dan myITSClassroom - Self learning through Share ITS and myITSClassroom	- Pengenalan Genomik: sejarah, dasar-dasar molecular biologi pengenalan pada ilmu biologi yang melatarbelakangi konsep-konsep komputasi yang ada dalam bioinformatics - Anatomi dari genome, model	10

Mg ke/ Week	Kemampuan akhir tiap tahapan belajar (Sub-CPMK) / Final ability of each learning stage (LLO)	Penilaian / Assessment		Bentuk 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)	(7)	(8)
(1)	(2)	(3)	(4)				
		Able to format standard data and databases for data sequence	Mengenai konsep-konsep komputasi yang ada dalam bioinformatics (Tugas Tertulis) Non-Test : Assignment 1: Assignment about the basic concepts of genomic computation (Written Assignments) Assignment 2: About existing computational concepts in bioinformatics (Written Assignments)			probabilistik dari sekuen genome, analisa sequence secara statistik - Format data standar dan basisdata untuk data sequence (GenBank, EMBL, DDBJ) - Gen dan protein, gene finding, pengujian hipotesa [Link materi di MyITSClassroom] - Introduction to Genomics: history, the basics of molecular biology introducing to the biological sciences as the background of computational	

Mg ke/ Week	Kemampuan akhir tiap tahapan belajar (Sub-CPMK) / Final ability of each learning stage (LLO)	Penilaian / Assessment		Bentuk 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)	(7)	
(1)	(2)	(3)	(4)				(8)
						concepts that exist in bioinformatics - Anatomy of the genome, probabilistic models of genome sequences, statistical sequence analysis - Standard data formats and databases for sequence data (GenBank, EMBL, DDBJ) - Genes and proteins, gene finding, hypothesis testing [Course materials link at MyITSClassroom]	
3 – 4	Mahasiswa memahami dan mampu menjelaskan tentang sequence alignment dan linear space alignment	Mampu menjelaskan dan menggunakan <i>Sequence alignment</i> dan	Non-Tes : Tugas 3: Tugas mengenai <i>sequence alignment</i> (Tugas Tertulis)	Kuliah dan diskusi [TM : 2 x 3 x 50"] [BM : 2 x 3 x 50"] [PT : 2 x 3 x 50"]	Belajar mandiri melalui Share ITS dan myITSClassroom	Sequence Alignment: sequence similarity dan homology, global dan local alignment, analisa alignment	10

Mg ke/ Week	Kemampuan akhir tiap tahapan belajar (Sub-CPMK) / Final ability of each learning stage (LLO)	Penilaian / Assessment		Bentuk 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)
	Students understand and be able to explain sequence alignment and linear space alignment	Linear Space Alignment Able to explain and use the Sequence alignment and Linear Space Alignment	Tugas 4: Tugas mengenai linear space alignment (Tugas Tertulis) Non-Test : Assignment 3: About sequence alignment (Written Assignments) Assignment 4: About linear space alignment (Written Assignments)	Lecturers and discussions [FF : 2 x 3 x 50"] [SA : 2 x 3 x 50"] [SS : 2 x 3 x 50"]	Self learning through Share ITS and myITSClassroom	secara statistik, BLAST dan CLUSTAL, multiple sequence alignment, Computing the alignments (Needleman–Wunsch algorithm, Smith–Waterman algorithm) - Linear Space Alignment [Link materi di MyITSClassroom] - Sequence Alignment: sequence similarity and homology, global and local alignment, statistical alignment analysis, BLAST and CLUSTAL, multiple sequence alignment, Computing the	

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 & Techniques</i>	Tatap Muka / <i>In-class (5)</i>	Daring / <i>Online (6)</i>	(7)	(8)
						alignments (Needleman–Wunsch algorithm, Smith–Waterman algorithm) • Linear Space Alignments [<i>Course materials link at MyITSClassroom</i>]	
5 – 6	Mahasiswa memahami dan mampu menjelaskan tentang konsep dasar Burrows-Wheeler Transform dan penggunaannya <i>Students understand and be able to explain the basic concepts of Burrows-Wheeler Transform and its application</i>	• Mampu menjelaskan konsep Burrows-Wheeler Transform dan penggunaannya • Able to explain the concepts of Burrows-Wheeler Transform and its application	Non-Tes : Tugas 5: Tugas mengenai konsep dasar Burrows-Wheeler Transform dan penggunaannya (Tugas Tertulis) Non-Test : Assignment 5: About the basic concepts of Burrows-Wheeler	• Kuliah dan diskusi [<i>TM : 2 x 3 x 50"</i>] [<i>BM : 2 x 3 x 50"</i>] [<i>PT : 2 x 3 x 50"</i>] • Lecturers and discussions [<i>FF : 2 x 3 x 50"</i>] [<i>SA : 2 x 3 x 50"</i>] [<i>SS : 2 x 3 x 50"</i>]	• Belajar mandiri melalui Share ITS dan myITSClassroom • Self learning through Share ITS and myITSClassroom	• Konsep dasar Burrows-Wheeler Transform dan penggunaannya [<i>Link materi di MyITSClassroom</i>] • The basic concepts of Burrows-Wheeler and its application [<i>Course materials link at MyITSClassroom</i>]	5

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 & Techniques</i>	Tatap Muka / <i>In-class (5)</i>	Daring / <i>Online (6)</i>		
(1)	(2)	(3)	(4)			(7)	(8)
			<i>Transform and its application (Written Assignments)</i>				
7 – 9	Mahasiswa memahami dan mampu menjelaskan tentang konsep dasar <i>Hidden Markov Model</i> dan penggunaannya. <i>Students understand and be able to explain the basic concepts of Hidden Markov Model and its application.</i>	- Mampu menjelaskan dan mengimplementasikan <i>Hidden Markov Model</i>. - Able to explain and implement the <i>Hidden Markov Model</i>	Non-Test : Tugas 6: Tugas mengenai konsep dasar <i>Hidden Markov Model</i> dan penggunaannya. (Tugas Tertulis) Non-Test : Assignment 6: About the basic concepts of <i>Hidden Markov Model</i> and its application (Written Assignments)	- Kuliah dan diskusi [<i>TM : 2 x 3 x 50"</i>] [<i>BM : 2 x 3 x 50"</i>] [<i>PT : 2 x 3 x 50"</i>] - Lecturers and discussions [<i>FF : 2 x 3 x 50"</i>] [<i>SA : 2 x 3 x 50"</i>] [<i>SS : 2 x 3 x 50"</i>]	- Belajar mandiri melalui Share ITS dan myITSClassroom - Self learning through Share ITS and myITSClassroom	<i>Hidden Markov Model (HMM) : Profile HMM, gene finding, Case study (odorant receptors), computational algorithm HMM (Viterbi algorithm, forward algorithm, expectation maximization)</i> <i>[Course materials link at MyITSClassroom]</i>	5
8	EVALUASI TENGAH SEMESTER MID-SEMESTER EXAM						20
10 – 11	Mahasiswa memahami dan mampu menjelaskan tentang konsep dasar <i>DNA</i>	Mampu menjelaskan konsep analisa	Non-Test : Tugas 7:	Kuliah dan diskusi [<i>TM : 2 x 3 x 50"</i>]	Belajar mandiri melalui Share ITS	Konsep dasar <i>DNA Sequencing and</i>	5

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 & Techniques</i>	Tatap Muka / <i>In-class (5)</i>	Daring / <i>Online (6)</i>		
(1)	(2)	(3)	(4)			(7)	(8)
	<i>Sequencing and Assembling dan penggunaannya</i> <i>Students understand and be able to explain the basic concepts DNA Sequencing and Assembling and its application.</i>	<i>DNA Sequence and Assembling dan penggunaannya</i> Able to explain the concepts of DNA Sequence and Assembling and its application	Tugas mengenai konsep dasar <i>DNA Sequencing and Assembling</i> dan penggunaannya (Tugas Tertulis) Non-Test : Assignment 7: About the basic concepts of DNA Sequencing and Assembling and its application (Written Assignments)	[BM : 2 x 3 x 50"] [PT : 2 x 3 x 50"] Lecturers and discussions [FF : 2 x 3 x 50"] [SA : 2 x 3 x 50"] [SS : 2 x 3 x 50"]	dan myITSClassroom Self learning through Share ITS and myITSClassroom	<i>Assembling dan penggunaannya</i> [Link materi di MyITSClassroom] The basic concepts of DNA Sequencing and Assembling and its application [Course materials link at MyITSClassroom]	
12 – 13	Mahasiswa memahami dan mampu menjelaskan tentang konsep dasar analisa <i>RNA Sequence</i> dan penggunaannya <i>Students understand and be able to explain the basic</i>	Mampu menjelaskan konsep analisa <i>RNA Sequence</i> dan penggunaannya	Non Tes: Tugas 8: Tugas mengenai konsep dasar analisa <i>RNA Sequence</i> dan penggunaannya	Kuliah dan diskusi [TM : 2 x 3 x 50"] [BM : 2 x 3 x 50"] [PT : 2 x 3 x 50"]	- Belajar mandiri melalui Share ITS dan myITSClassroom - Self learning through Share	Konsep dasar analisa <i>RNA Sequence</i> dan penggunaannya [Link materi di MyITSClassroom]	5

Mg ke/ Week	Kemampuan akhir tiap tahapan belajar (Sub-CPMK) / Final ability of each learning stage (LLO)	Penilaian / Assessment		Bentuk 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)
	concepts of RNA Sequence Analysis and its application	Able to explain the concepts of RNA Sequence and its application	(Tugas Tertulis) Non-Test: Assignment 8: About the basic concepts of RNA Sequence and its application (Written Assignments)	Lecturers and discussions [FF : 2 x 3 x 50"] [SA : 2 x 3 x 50"] [SS : 2 x 3 x 50"]	ITS and myITSClassroom	The basic concepts of RNA Sequence and its application [Course materials link at MyITSClassroom]	
14 – 15	Mahasiswa memahami dan mampu menjelaskan tentang contoh aplikasi analisa DNA serta perkembangan terkini terkait komputasi genomik <i>Students understand and be able to explain examples of DNA analysis application and the latest developments related to genomic computation</i>	- Mampu menjelaskan konsep analisa RNA Sequence dan penggunaannya. - Able to explain the concepts of RNA Sequence and its application.	Non Tes: Tugas 9: Tugas mengenai contoh aplikasi analisa DNA serta perkembangan terkini terkait komputasi genomik (Tugas Tertulis) Presentasi:	- Kuliah dan diskusi [TM : 2 x 3 x 50"] [BM : 2 x 3 x 50"] [PT : 2 x 3 x 50"] - Lecturers and discussions [FF : 2 x 3 x 50"] [SA : 2 x 3 x 50"] [SS : 2 x 3 x 50"]	- Belajar mandiri melalui Share ITS dan myITSClassroom - Self learning through Share ITS and myITSClassroom	- Konsep dasar analisa RNA Sequence dan penggunaannya [Link materi di MyITSClassroom] - The basic concepts of RNA Sequence and its application	20

Mg ke/ Week	Kemampuan akhir tiap tahapan belajar (Sub-CPMK) / Final ability of each learning stage (LLO)	Penilaian / Assessment		Bantuk Pembelajaran; Metode Pembelajaran; Penugasan Mahasiswa; [Estimasi Waktu] / Form of Learning; Learning Method; Student Assignment; [Estimated Time]		Materi Pembelajaran [Pustaka] / Learning Material [Reference]	Bobot Penilaian /Assess- ment Load (%)
		Indikator / Indicator	Kriteria & Teknik / Criteria & Techniques	Tatap Muka / In-class (5)	Daring / Online (6)	(7)	(8)
(1)	(2)	(3)	(4)			[Course materials link at MyITSClassroom]	
			Penentuan tema presentasi diberikan pada minggu ke – 9. Proses presentasi dilakukan pada minggu ke – 14-15 (Tugas Presentasi) Non-Test: Assignment 9: <i>About examples of DNA analysis applications and current developments related to genomic computation (Written Assignments)</i> Presentation: <i>Defining the theme of the presentation is given in week 9. The presentation is</i>				

Mg ke/ Week	Kemampuan akhir tiap tahapan belajar (Sub-CPMK) / Final ability of each learning stage (LLO)	Penilaian / Assessment		Bentuk 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)	(7)	
(1)	(2)	(3)	(4)				(8)
			carried out on week 14 – 15 (Presentation Assignment)				
16	EVALUASI AKHIR SEMESTER FINAL-SEMESTER EXAM						20

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 : Genomic Computation		RA&E
			Write Doc Code
Kode/code: EB234912	Bobot sks/credits (T/P): 3/0	Rumpun MK: Biocybernetics Course Cluster: Biocybernetics	Peminatan Specialization
OTORISASI AUTHORIZATION	Penyusun RA & E Compiler A&EP Dr. Achmad Arifin, S.T., M.Eng.	Koordinator RMK Course Cluster Coordinator Ir. Josaphat Pramudijanto, M.Eng.	Ka DEPARTEMEN Head of Department Dr. Achmad Arifin, S.T., M.Eng.

Mg ke/ Week (1)	Sub CP-MK / Lesson Learning Outcomes (LLO) (2)	Bentuk Asesmen (Penilaian) Form of Assessment (3)	Bobot / Load (%) (4)
1 – 2	Sub CP-MK 1: Mahasiswa memahami dan mampu menjelaskan tentang konsep dasar komputasi genomik LLO 1: <i>Students understand and be able to explain the basic concepts of genomic computation</i>	Non-Tes : Tugas 1: Tugas mengenai konsep dasar komputasi genomik (Tugas Tertulis) Tugas 2: Mengenai konsep-konsep komputasi yang ada dalam bioinformatics (Tugas Tertulis) Tes: ETS Soal 1 (4% dari ETS 20%) Non-Test : Assignment 1: <i>Assignment about the basic concepts of genomic computation.</i> <i>(Written Assignments)</i> Assignment 2: <i>About existing computational concepts in bioinformatics.</i> <i>(Written Assignments)</i> Test: Question 1 in Mid Exam (4% of Mid Exam 20%)	Tugas 1 / Assignment 1: 5% Tugas 2 / Assignment 2: 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 2: Mahasiswa memahami dan mampu menjelaskan tentang <i>sequence alignment</i> dan <i>linear space alignment</i> LLO 2: <i>Students understand and be able to explain sequence alignment and linear space alignment</i>	Non-Tes : Tugas 3: Tugas mengenai <i>sequence alignment</i> (Tugas Tertulis) Tugas 4: Tugas mengenai <i>linear space alignment</i> (Tugas Tertulis) Tes: ETS Soal 2 (4% dari ETS 20%) Non-Test : Assignment 3: <i>About sequence alignment.</i> (Written Assignments) Assignment 4: <i>About linear space alignment.</i> (Written Assignments) Test: <i>Question 2 in Mid Exam (4% of Mid Exam 20%)</i>	Tugas 3 / Assignment 3: 5% Tugas 4 / Assignment 4: 5%
5 – 6	Sub CP-MK 3: Mahasiswa memahami dan mampu menjelaskan tentang konsep dasar <i>Burrows-Wheeler Transform</i> dan penggunaannya LLO 3: <i>Students understand and be able to explain the basic concepts of Burrows-Wheeler Transform and its application</i>	Non-Tes : Tugas 5: Tugas mengenai konsep dasar <i>Burrows-Wheeler Transform</i> dan penggunaannya (Tugas Tertulis) Tes: ETS Soal 3 (4% dari ETS 20%) EAS Soal 1 (2% dari EAS 20%) Non-Test : Assignment 5: <i>About the basic concepts of Burrows-Wheeler Transform and its application.</i> (Written Assignments)	Tugas 5 / Assignment 5: 5%

Mg ke/ Week (1)	Sub CP-MK / Lesson Learning Outcomes (LLO) (2)	Bentuk Asesmen (Penilaian) Form of Assessment (3)	Bobot / Load (%) (4)
		Test: Questions 3 in Mid Exam (4% of Mid Exam 20%) Questions 1 in Final Exam (2% of Final Exam 20%)	
7 – 9	Sub CP-MK 4: Mahasiswa memahami dan mampu menjelaskan tentang konsep dasar <i>Hidden Markov Model</i> dan penggunaannya LLO 4: <i>Students understand and be able to explain the basic concepts of Hidden Markov Model and its application</i>	Non-Tes : Tugas 6: Tugas mengenai konsep dasar <i>Hidden Markov Model</i> dan penggunaannya (Tugas Tertulis) Tes: ETS Soal 4 dan Soal 5 (8% dari ETS 20%) EAS Soal 2 (3% dari EAS 20%) Non-Test : Assignment 6: <i>About the basic concepts of Hidden Markov Model and its application. (Written Assignments)</i> Test: Questions 2 in Final Exam (3% of Final Exam 20%)	Tugas 6 / Assignment 6: 5%
8	Evaluasi Tengah Semester Mid Exam	Tes: Ujian Tulis/Ujian Daring Test: Writing Exams / Online Exams	20
10–11	Sub CP-MK 5: Mahasiswa memahami dan mampu menjelaskan tentang konsep dasar <i>DNA Sequencing and Assembling</i> dan penggunaannya LLO 5: <i>Students understand and be able to explain the</i>	Non-Tes : Tugas 7: Tugas mengenai konsep dasar <i>DNA Sequencing and Assembling</i> dan penggunaannya (Tugas Tertulis) Tes: EAS Soal No 3 (4% dari EAS 20%) Non-Test : Assignment 7:	Tugas 7 / Assignment 7: 5%

Minggu/ Week (1)	Sub CP-MK / Lesson Learning Outcomes (LLO) (2)	Bentuk Asesmen (Penilaian) Form of Assessment (3)	Bobot / Load (%) (4)
	<i>basic concepts DNA Sequencing and Assembling and its application</i>	<i>About the basic concepts of DNA Sequencing and Assembling and its application. (Written Assignments)</i> Test: <i>Question 3 in Final Exam (4% of Final Exam 20%)</i>	
12–13	Sub CP-MK 6: Mahasiswa memahami dan mampu menjelaskan tentang konsep dasar analisa <i>RNA Sequence</i> dan penggunaannya LLO 6: <i>Students understand and be able to explain the basic concepts of RNA Sequence Analysis and its application</i>	Non Tes: Tugas 8: Tugas mengenai konsep dasar analisa <i>RNA Sequence</i> dan penggunaannya (Tugas Tertulis) Tes: EAS Soal 4 dan 5 (7% dari EAS 20%) Non-Test: Assignment 8: <i>About the basic concepts of RNA Sequence and its application (Written Assignments)</i> Test: <i>Question 4 and 5 in Final Exam (7% of Final Exam 20%)</i>	Tugas 8 / Assignment 8: 5%
14–15	Sub CP-MK 7: Mahasiswa memahami dan mampu menjelaskan tentang contoh aplikasi analisa DNA serta perkembangan terkini terkait komputasi genomik LLO 7: <i>Students understand and be able to explain examples of DNA analysis application and the latest developments related to genomic computation</i>	Non Tes: Tugas 9: Tugas mengenai contoh aplikasi analisa DNA serta perkembangan terkini terkait komputasi genomik (Tugas Tertulis) Presentasi: Penentuan tema presentasi diberikan pada minggu ke – 9. Proses presentasi dilakukan pada minggu ke – 14 – 15 (Tugas Presentasi) Tes: EAS Soal 6 dan 7 (4% dari EAS 20%) Non-Test: Assignment 9:	Tugas 9 / Assignment 9: 5% Presentasi / Presentation: 15%

Minggu/ Week (1)	Sub CP-MK / Lesson Learning Outcomes (LLO) (2)	Bentuk Asesmen (Penilaian) Form of Assessment (3)	Bobot / Load (%) (4)
		About examples of DNA analysis applications and current developments related to genomic computation (Written Assignments) Presentation: Defining the theme of the presentation is given in week 9. The presentation is carried out on week 14 – 15 (Presentation Assignment) Test: Question 6 and 7 in Final Exam (4% of Final Exam 20%)	
16	Evaluasi Akhir <i>Final Exam</i>	Tes: Ujian Tulis/Ujian Daring Test: Writing Exams / Online Exams	20
Total bobot penilaian Total assessment load			100%

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

CPL yang dibebankan pada MK / <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 7 / CLO 7	Week- 14-15	Assignment 9 and Presentation	20
		Week- 16	Final Exam Question 6 and 7	4
CPL-05 / PLO-05	CPMK 1 / CLO 1	Week- 1-2	Assignment 1 and Assignment 2	10
		Week- 8	Mid Exam Question 1	4
	CPMK 2 / CLO 2	Week- 3-4	Assignment 3 and Assignment 4	10
		Week- 8	Mid Exam Question 2	4
CPL-06 / PLO-06	CPMK 3 / CLO 3	Week- 5-6	Assignment 5	5
		Week- 8	Mid Exam Question 3	4
		Week- 16	Final Exam Question 1	2
	CPMK 4 / CLO 4	Week- 7-9	Assignment 6	5
		Week- 8	Mid Exam Question 4 and 5	8
		Week- 16	Final Exam Question 2	3
CPL-10 / PLO-10	CPMK 5 / CLO 5	Week- 10-11	Assignment 7	5
		Week- 16	Final Exam Question 3	4
	CPMK 6 / CLO 6	Week- 12-13	Assignment 8	5
		Week- 16	Final Exam Question 4 and 5	7
				$\Sigma = 100\%$

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 (Tugas 1, Tugas 2,		0.25											0.05

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
	Tugas 3, Tugas 4) Assignment 1 (Assignment 1, Assignment 2, Assignment 3, Assignment 4)													
2	Tugas Akhir 1 (Evaluasi Tengah Semester) Final Project 1 (Mid Term Exam)					0.25								0.05
3	Tugas 2 (Tugas 5, Tugas 6, Tugas 7, Tugas 8) Assignment 2 (Assignment 5, Assignment 6, Assignment 7, Assignment 8)						0.25							0.05
4	Tugas Akhir 2 (Evaluasi Akhir Semester)										0.25			0.05

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
	Final Project 2 (Final Exam)													
	Total		0.25			0.25	0.25				0.25			1



BIOMEDICAL ENGINEERING ITS

2022-2023