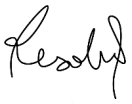
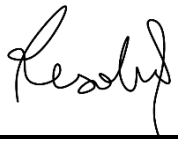
MODULE HANDBOOK
GENOMIC COMPUTATION

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

INSTITUT TEKNOLOGI SEPULUH NOPEMBER

ENDORSEMENT PAGE

	MODULE HANDBOOK **Genomic Computation** **DEPARTMENT OF BIOMEDICAL ENGINEERING** **INSTITUT TEKNOLOGI SEPULUH NOPEMBER** **Number :** B/21391/IT2.IX.5.1.2/PP.03.00.00/2020

Proses ***Process***	**Penanggung Jawab** ***Person in Charge***			**Tanggal** ***Date***
	Nama ***Name***	**Jabatan** ***Position***	**Tandatangan** ***Signature***	
Perumus *Preparation*	Dr. Achmad Arifin, S.T., M.Eng.	Dosen *Lecturer*		**November 23, 2019**
Pemeriksa dan Pengendalian *Review and Control*	Eko Agus Suprayitno, S.Si, M.T.	Tim kurikulum *Curriculum team*		**February 14, 2020**
Persetujuan *Approval*	Ir. Josaphat Pramudijanto, M.Eng.	Koordinator RMK *Course Cluster Coordinator*		**March 06, 2020**
Penetapan *Determination*	Dr. Achmad Arifin, S.T., M.Eng.	Kepala Departemen *Head of Department*		**March 13, 2020**

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MODULE HANDBOOK
GENOMIC COMPUTATION

Module name	**Genomic Computation**	
Module level	Undergradute	
Code	EB184912	
Course (if applicable)	Genomic Computation	
Semester	Specialization	
Person responsible for the module	Dr. Achmad Arifin, S.T., M.Eng.	
Lecturer	Muhammad Yazid, B.Eng., M.Eng.	
Language	Bahasa Indonesia and English	
Relation to curriculum	Undergradute degree program, **specialization**.	
Type of teaching, contact hours	Lectures, <60 studentS	
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	EW4002 – Basic Programming (passed (minimum C))	
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.	PLO-02
	CLO 2: Students understand and able to explain sequence alignment and linear space alignment.	PLO-02
	CLO 3: Students understand and able to explain the basic concepts of Burows-Wheeler Transform and its application.	PLO-03
	CLO 4: Students understand and able to explain the basic concepts of Hidden Markov Model and its application.	PLO-03
	CLO 5: Students understand and able to explain the basic concepts DNA Sequencing and Assembling and its application.	PLO-08

	CLO 6: Students understand and able to explain the basic concepts of RNA Sequence Analysis and its application. CLO 7: Students understand and able to explain examples of DNA analysis application and the latest developments related to genomic computation.	PLO-08 PLO-06
Content	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 : 1. Neil Jones, Pavel Pevzner, "An Introduction to Bioinformatics Algorithms", MIT Press, 2004 2. Nello Cristianini and Matthew W. Hahn, "Introduction to Computational Genomics: A Case Studies Approach", Cambridge University Press, 2006	

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***
Komputasi Genomik ***Genomic Computation***	EB184912	Biocybernetics	T=3	P=0	Peminatan *Specialization*	Oct 25, 2020
OTORISASI / PENGESAHAN ***AUTHORIZATION / ENDORSEMENT***	**Dosen Pengembang RPS** ***Developer Lecturer of Semester Learning Plan***		**Koordinator RMK** ***Course Cluster Coordinator***		**Ka DEPARTEMEN** ***Head of Department***	
	(Dr. Achmad Arifin, S.T., M.Eng.)		**(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 **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-03 *PLO-03*	Mampu **merancang** dan **melaksanakan** eksperimen laboratorium dan/atau lapangan, **menganalisa** dan **menginterpretasi** data, serta menggunakan penilaian yang obyektif untuk menarik kesimpulan. *Able to **design** and **implement** laboratory experiment and / or field experiments, **analyze** and **interpret** data, and use objective assessments to draw conclusions.*

	CPL-06 *PLO-06*	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-08 *PLO-08*	Mampu **bekerja dalam tim** lintas disiplin dan budaya serta **bertanggung jawab** kepada masyarakat dan **mematuhi hukum** dan **etika profesi** dalam menyelesaikan masalah Teknik Biomedika. 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.
	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 memahami dan mampu menjelaskan tentang konsep dasar komputasi genomik. *Students understand and able to explain the basic concepts of genomic computation.*
	CP MK 2 ***CLO 2***	Mahasiswa memahami dan mampu menjelaskan tentang *sequence alignment* dan *linear space alignment*. *Students understand and able to explain sequence alignment and linear space alignment.*
	CP MK 3 ***CLO 3***	Mahasiswa memahami dan mampu menjelaskan tentang konsep dasar *Burrows-Wheeler Transform* dan penggunaannya. *Students understand and able to explain the basic concepts of Burrows-Wheeler Transform and its application.*
	CP MK 4 ***CLO 4***	Mahasiswa memahami dan mampu menjelaskan tentang konsep dasar *Hidden Markov Model* dan penggunaannya. *Students understand and able to explain the basic concepts of Hidden Markov Model and its application.*
	CP MK 5 ***CLO 5***	Mahasiswa memahami dan mampu menjelaskan tentang konsep dasar *DNA Sequencing and Assembling* dan penggunaannya. *Students understand and able to explain the basic concepts DNA Sequencing and Assembling and its application.*
	CP MK 6 ***CLO 6***	Mahasiswa memahami dan mampu menjelaskan tentang konsep dasar analisa *RNA Sequence* dan penggunaannya. *Students understand and able to explain the basic concepts of RNA Sequence Analysis and its application*.
	CP MK 7 ***CLO 7***	Mahasiswa memahami dan mampu menjelaskan tentang contoh aplikasi analisa DNA serta perkembangan terkini terkait komputasi genomik. *Students understand and able to explain examples of DNA analysis application and the latest developments related to genomic computation.*

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*						√						

Diskripsi Singkat MK

Mata kuliah Komputasi Genomik bertujuan untuk memberikan pemahaman tentang dasar komputasi yang sering digunakan dalam bidang teknik biomedik, dan dalam saat yang bersamaan juga bertujuan untuk memperkuat kemampuan programming mahasiswa.

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.

Bahan Kajian:
Materi pembelajaran

Course Materials:

1. Pengenalan Genomik / *Introduction to Genomics*
2. *Sequence Alignment*
3. *Linear Space Alignment*
4. *Burrows-Wheeler Transform*
5. *Hidden Markov Model*
6. *DNA Sequencing and Assembling*
7. *RNA Sequence Analysis*
8. Contoh aplikasi analisis DNA / *Examples of DNA anlysis applications*

Pustaka ***References***	**Utama / *Main*:** 1. Neil Jones, Pavel Pevzner, "An Introduction to Bioinformatics Algorithms", MIT Press, 2004 2. Nello Cristianini and Matthew W. Hahn, "Introduction to Computational Genomics: A Case Studies Approach", Cambridge University Press, 2006 **Pendukung / *Supporting*:**
Dosen Pengampu ***Lecturers***	Muhammad Yazid
Matakuliah syarat ***Prerequisite***	EW4002 – Basic Programming (passed (minimum C))

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***				
(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 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.* • *Able to format standard data and databases for data sequence.*	**Non-tes :** **Tugas 1:** Tugas mengenai konsep dasar komputasi genomik. (Tugas Tertulis) **Tugas 2:** Mengenai konsep-konsep komputasi yang ada dalam bioinformatics. (Tugas Tertulis) ***Non-test :*** ***Task 1:*** *Task about the basic concepts of genomic computation. (Written Assignments)* ***Task 2:*** *About existing computational concepts in bioinformatics. (Written Assignments)*	• 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 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]**	**Tugas 1 / *Task 1*: 5%** **Tugas 2 / *Task 2*: 5%**

						• *Introduction to Genomics: history, the basics of molecular biology introducting to the biological sciences as the background of computational 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*	
3 – 4	Mahasiswa memahami dan mampu menjelaskan tentang	• Mampu menjelaskan dan menggunakan	**Non-tes :** **Tugas 3:**	• Kuliah dan diskusi.		• *Sequence Alignment: sequence similarity*	**Tugas 3 /** ***Task 3*****:** **5%**

	sequence alignment dan *linear space alignment*. *Students understand and able to explain sequence alignment and linear space alignment.*	*Sequence alignment* dan *Linear Space Alignment*. • *Able to explain and use the Sequence alignment and Linear Space Alignment.*	Tugas mengenai *sequence alignment.* (Tugas Tertulis) **Tugas 4**: Tugas mengenai *linear space alignment.* (Tugas Tertulis) ***Non-test :*** ***Task 3:*** *About sequence alignment.* *(Written Assignments)* ***Task 4:*** *About linear space alignment.* *(Written Assignments)*	[TM : 2 x 3 x 50"] [BM : 2 x 3 x 50"] [PT : 2 x 3 x 50"] • *Lecturers and disscusions.* *[FF : 2 x 3 x 50"]* *[SA : 2 x 3 x 50"]* *[SS : 2 x 3 x 50"]*		*dan homology, global dan local alignment, analisa alignment secara statistik, BLAST dan CLUSTAL, multiple sequence alignment, Computing the alignments (Needleman–Wunsch algorithm, Smith–Waterman algorithm)* • *Linear Space Alignment*	**Tugas 4 / *Task 4*: 5%**
5 – 6	Mahasiswa memahami dan mampu menjelaskan tentang konsep dasar Burrows-	• Mampu menjelaskan konsep Burrows-Wheeler Transform	**Non-tes :** **Tugas 5:** Tugas mengenai konsep dasar *Burrows-*	• Kuliah dan diskusi [TM : 2 x 3 x 50"]		• Konsep dasar Burrows-Wheeler Transform dan penggunaannya	**Tugas 5 / *Task 5*: 5%**

	Wheeler Transform dan penggunaannya. *Students understand and able to explain the basic concepts of Burrows-Wheeler Transform and its application.*	dan penggunaannya. • *Able to explain the concepts of Burrows-Wheeler Transform and its application.*	*Wheeler Transform* dan penggunaannya. (Tugas Tertulis) ***Non-test :*** ***Task 5:*** *About the basic concepts of Burrows-Wheeler Transform 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"]*		• *The basic concepts of Burrows-Wheeler and its application*	
7 – 9	Mahasiswa memahami dan mampu menjelaskan tentang konsep dasar *Hidden Markov Model* dan penggunaannya. *Students understand and able to explain the basic concepts of Hidden Markov Model and its application.*	• Mampu menjelaskan dan mengimplementasikan *Hidden Markov Model*. • *Able to explain and implement the Hidden Markov Model.*	**Non-tes :** **Tugas 6:** Tugas mengenai konsep dasar *Hidden Markov Model* dan penggunaannya. (Tugas Tertulis) ***Non-test :*** ***Task 6:*** *About the basic concepts of Hidden Markov Model and its application.*	• 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"]*		• *Hidden Markov Model (HMM) : Profile HMM, gene finding, Case study (odorant receptors), computational algorithm HMM (Viterbi algorithm, forward algorithm, expectation maximization)*	**Tugas 6 / *Task 6*: 5%**

			(Written Assignments)	*[SS : 2 x 3 x 50”]*			
8	**EVALUASI TENGAH SEMESTER** ***MID-SEMESTER EXAM***						**20**
10 – 11	Mahasiswa memahami dan mampu menjelaskan tentang konsep dasar *DNA Sequencing and Assembling* dan penggunaannya. *Students understand and able to explain the basic concepts DNA Sequencing and Assembling and its application.*	• Mampu menjelaskan konsep analisa *DNA Sequence and Assembling* dan penggunaannya. • *Able to explain the concepts of DNA Sequence and Assembling and its application.*	**Non-tes :** **Tugas 7:** Tugas mengenai konsep dasar *DNA Sequencing and Assembling* dan penggunaannya. (Tugas Tertulis) ***Non-test :*** ***Task 7:*** *About the basic concepts of DNA Sequencing and Assembling and its application.* *(Written Assignments)*	• 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”]*		• Konsep dasar *DNA Sequencing and Assembling* dan penggunaannya. • *The basic concepts of DNA Sequencing and Assembling and its application.*	**Tugas 7 / *Task 7*: 5%**
12 – 13	Mahasiswa memahami dan mampu menjelaskan tentang konsep dasar analisa *RNA Sequence* dan penggunaannya.	• Mampu menjelaskan konsep analisa *RNA Sequence* dan penggunaannya.	**Non tes:** **Tugas 8:** Tugas mengenai konsep dasar analisa RNA Sequence dan penggunaannya. (Tugas Tertulis)	• Kuliah dan Diskusi. [TM : 2 x 3 x 50”] [BM : 2 x 3 x 50”]		• Konsep dasar analisa *RNA Sequence* dan penggunaannya.	**Tugas 8 / *Task 8*: 5%**

	Students understand and able to explain the basic concepts of RNA Sequence Analysis and its application.	• *Able to explain the concepts of RNA Sequence and its application.*	***Non-test:*** ***Task 8:*** *About the basic concepts of RNA Sequence and its application.* *(Written Assignments)*	[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"]*		• *The basic concepts of RNA Sequence and its application.*	
14 – 15	Mahasiswa memahami dan mampu menjelaskan tentang contoh aplikasi analisa DNA serta perkembangan terkini terkait komputasi genomik. *Students understand and able to explain examples of DNA analysis application and the latest developments related to genomic computation.*	• 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:** Penentuan tema presentasi diberikan pada minggu ke – 9. Proses presentasi dilakukan pada minggu ke – 14-15 (Tugas 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"]*		• Konsep dasar analisa *RNA Sequence* dan penggunaannya. • *The basic concepts of RNA Sequence and its application.*	**Tugas 8 / *Task 8*: 5%** **Presentasi / *Presentations*: 15%**

			Non-test: ***Task 9:*** *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 Task)*				
16	**EVALUASI AKHIR SEMESTER** ***FINAL-SEMESTER EXAM***						**20**

TM=Tatap Muka, **PT**=Penugasan Terstuktur, **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*: **EB184912**	**Bobot sks/*credits* (T/P): 3/0**	**Rumpun MK: Biocybernetics** ***Course Cluster: Biocybernetics***	Smt: Selection
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 DEP** ***Head of DEP*** **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:*** *Students understand and able to explain the basic concepts of genomic computation.*	**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 :*** ***Task 1:*** *Task about the basic concepts of genomic computation. (Written Assignments)* ***Task 2:*** *About existing computational concepts in bioinformatics. (Written Assignments)* ***Test:*** *Question 1 in Mid Exam (4% of Mid Exam 20%)*	Tugas 1 / *Task 1*: 5% Tugas 2 / *Task 2*: 5%
3 – 4	**Sub CP-MK 2:** Mahasiswa memahami dan mampu menjelaskan tentang *sequence*	**Non-tes :** **Tugas 3:** Tugas mengenai *sequence alignment* (Tugas Tertulis).	Tugas 3 / *Task 3*: 5%

Mg ke/ *Week* (1)	Sub CP-MK / *Lesson Learning Outcomes (LLO)* (2)	Bentuk Asesmen (Penilaian) *Form of Assessment* (3)	Bobot / *Load* (%) (4)
	alignment dan *linear space alignment*. ***LLO 2:*** *Students understand and able to explain sequence alignment and linear space alignment.*	**Tugas 4**: Tugas mengenai *linear space alignment* (Tugas Tertulis) **Tes:** ETS Soal 2 (4% dari ETS 20%) ***Non-test :*** ***Task 3:*** *About sequence alignment.* *(Written Assignments)* ***Task 4:*** *About linear space alignment.* *(Written Assignments)* ***Test:*** *Question 2 in Mid Exam (4% of Mid Exam 20%)*	Tugas 4 / *Task 4*: 5%
5 – 6	**Sub CP-MK 3:** Mahasiswa memahami dan mampu menjelaskan tentang konsep dasar *Burrows-Wheeler Transform* dan penggunaannya. ***LLO 3:*** *Students understand and able to explain the basic concepts of Burrows-Wheeler Transform and its application.*	**Non-tes :** **Tugas 5:** Tugas mengenai konsep dasar *Burrows-Wheeler Transform* dan penggunaannya (Tugas Tertulis). **Tes:** ETS Soal 3 (4% dari ETS 20%) EAS Soal 1 (2% dari EAS 20%) ***Non-test :*** ***Task 5:*** *About the basic concepts of Burrows-Wheeler Transform and its application.* *(Written Assignments)* ***Test:*** *Questions 3 in Mid Exam (4% of Mid Exam 20%)* *Questions 1 in Final Exam (2% of Final Exam 20%)*	Tugas 5 / *Task 5*: 5%
7 – 9	**Sub CP-MK 4:** Mahasiswa memahami dan mampu menjelaskan tentang konsep dasar *Hidden Markov Model* dan penggunaannya.	**Non-tes :** **Tugas 6:** Tugas mengenai konsep dasar *Hidden Markov Model* dan penggunaannya (Tugas Tertulis). **Tes:** ETS Soal 4 dan Soal 5 (8% dari ETS 20%) EAS Soal 2 (3% dari EAS 20%)	Tugas 6 / *Task 6*: 5%

Mg ke/ *Week* (1)	Sub CP-MK / *Lesson Learning Outcomes (LLO)* (2)	Bentuk Asesmen (Penilaian) *Form of Assessment* (3)	Bobot / *Load* (%) (4)
	LLO 4: *Students understand and able to explain the basic concepts of Hidden Markov Model and its application.*	***Non-test :*** ***Task 6:*** *About the basic concepts of Hidden Markov Model and its application.* *(Written Assignments)* ***Test:*** *Questions 2 in Final Exam (3% of Final Exam 20%)*	
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 *DNA Sequencing and Assembling* dan penggunaannya. ***LLO 5:*** *Students understand and able to explain the basic concepts DNA Sequencing and Assembling and its application.*	**Non-tes :** **Tugas 7:** Tugas mengenai konsep *dasar DNA Squencing and Assembling* dan penggunaannya (Tugas Tertulis) **Tes:** EAS Soal No 3 (4% dari EAS 20%) ***Non-test :*** ***Task 7:*** *About the basic concepts of DNA Sequencing and Assembling and its application.* *(Written Assignments)* ***Test:*** *Question 3 in Final Exam (4% of Final Exam 20%)*	Tugas 7 / *Task 7*: 5%
12–13	**Sub CP-MK 6:** Mahasiswa memahami dan mampu menjelaskan tentang konsep dasar analisa *RNA Sequence* dan penggunaannya. ***LLO 6:*** *Students understand and able to explain the basic concepts of RNA Sequence*	**Non tes:** **Tugas 8:** Tugas mengenai konsep dasar analisa *RNA Sequence* dan penggunaannya (Tugas Tertulis) **Tes:** EAS Soal 4 dan 5 (7% dari EAS 20%) ***Non-test:*** ***Task 8:*** *About the basic concepts of RNA Sequence and its application.* *(Written Assignments)* ***Test:*** *Question 4 and 5 in Final Exam (7% of Final Exam 20%)*	Tugas 8 / *Task 8*: 5%

Mg ke/ *Week* (1)	Sub CP-MK / *Lesson Learning Outcomes (LLO)* (2)	Bentuk Asesmen (Penilaian) *Form of Assessment* (3)	Bobot / *Load* (%) (4)
	Analysis and its application.		
14–15	**Sub CP-MK 7:** Mahasiswa memahami dan mampu menjelaskan tentang contoh aplikasi analisa DNA serta perkembangan terkini terkait komputasi genomik. ***LLO 7:*** *Students understand and able to explain examples of DNA analysis application and the latest developments related to genomic computation.*	**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:*** ***Task 9:*** *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 Task)* ***Test:*** *Question 6 and 7 in Final Exam (4% of Final Exam 20%)*	Tugas 9 / *Task 9*: 5% Presentasi / *Presentation*: 15%
16	**Evaluasi Akhir** ***Final Exam***	**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 / ***PLO charged to the course***	**CPMK** / ***Course Learning Outcome (CLO)***	**Minggu ke** / ***Week***	**Bentuk Asesmen** / ***Form of Assessment***	**Bobot** / ***Load* (%)**
CPL-02 / *PLO-02*	CPMK 1 / *CLO 1*	*Week- 1-2*	*Task 1 and Task 2*	10
		Week- 8	*Mid Exam Question 1*	4
	CPMK 2 / *CLO 2*	*Week- 3-4*	*Task 3 and Task 4*	10
		Week- 8	*Mid Exam Question 2*	4
CPL-03 / *PLO-03*	CPMK 3 / *CLO 3*	*Week- 5-6*	*Task 5*	5
		Week- 8	*Mid Exam Question 3*	4
		Week- 16	*Final Exam Question 1*	2
	CPMK 4 / *CLO 4*	*Week- 7-9*	*Task 6*	5
		Week- 8	*Mid Exam Question 4 and 5*	8
		Week- 16	*Final Exam Question 2*	3
CPL-08 / *PLO-08*	CPMK 5 / *CLO 5*	*Week- 10-11*	*Task 7*	5
		Week- 16	*Final Exam Question 3*	4
	CPMK 6 / *CLO 6*	*Week- 12-13*	*Task 8*	5
		Week- 16	*Final Exam Question 4 and 5*	7
CPL-06 / *PLO-06*	CPMK 7 / *CLO 7*	*Week- 14-15*	*Task 9 and Presentation*	20
		Week- 16	*Final Exam Question 6 and 7*	4
				∑ = 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	*Task 1*		0.05											**0.05**
2	*Task 2*		0.05											**0.05**
3	*Task 3*		0.05											**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*
4	*Task 4*		0.05											**0.05**
5	*Task 5*			0.05										**0.05**
6	*Task 6*			0.05										**0.05**
7	*Task 7*								0.05					**0.05**
8	*Task 8*								0.05					**0.05**
9	*Task 9*						0.05							**0.05**
10	*Presentation*						0.15							**0.15**
11	*Mid Exam*		0.08	0.12										**0.2**
12	*Final Exam*			0.05			0.04		0.11					**0.2**
	Total		0.28	0.27			0.24		0.21					**1**