

Module Handbook

Numerical Methods



Bachelor Degree Program Department of Biomedical Engineering

Faculty of Intelligent Electrical Technology and Informatics
Institut Teknologi Sepuluh Nopember



MODULE HANDBOOK
Numerical Methods
DEPARTMENT OF BIOMEDICAL ENGINEERING
INSTITUT TEKNOLOGI SEPULUH NOPEMBER
Number : 6872/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	Eko Agus Suprayitno, S.Si, M.T.	Dosen Lecturer		November 18, 2022
Pemeriksa dan Pengendalian Review and Control	Nada Fitriyatul. Hikmah., S.T. M.T.	Tim kurikulum Curriculum team		November 20, 2022
Persetujuan Approval	Dr. Rachmad Setiawan, S.T., M.T.	Koordinator RMK Course Cluster Coordinator		April 13, 2023
Penetapan Determination	Dr. Achmad Arifin, S.T., M.Eng.	Kepala Departemen Head of Department		April 17, 2023

MODULE HANDBOOK

NUMERICAL METHODS

Module name	Numerical Methods	
Module level	Undergraduate	
Code	EB234306	
Course (if applicable)	Numerical Methods	
Semester	First Semester (Odd)	
Person responsible for the module	Muhammad Yazid, B.Eng., M.Eng.	
Lecturer	Muhammad Yazid, B.Eng., M.Eng. Eko Agus Suprayitno, S.Si, M.T. Nada Fitriyatul Hikmah, S.T., M.T. Rasyida Shabihah Zukro Aini, S.T., M.T. Nabila Puspita Firdi S.T, M.Sc. Rezki El Arif, S.T., M.T., Ph.D Fauzan Arrofiqi, S.T., M.T., Ph.D.	
Language	Bahasa Indonesia and English	
Relation to curriculum	Undergraduate degree program, mandatory , 3 th semester	
Type of teaching, contact hours	Lectures, <60 students	
Workload	1. Lectures : 3 x 50 = 150 minutes per week. 2. Exercises and Assignments : 3 x 60 = 180 minutes (3 hours) per week. 3. Private learning : 3 x 60 = 180 minutes (3 hours) per week.	
Credit points	3 credit points (sks)	
Requirements according to the examination regulations	A student must have attended at least 75% of the lectures to sit in the exams.	
Mandatory prerequisites	Basic Programming	
Learning outcomes and their corresponding PLOs	Course Learning Outcome (CLO) after completing this module, CLO 1: Mastering the concept of error, number representation, Taylor theorem, non-linear equations, linear equations, interpolation, regression, numerical	PLO-04

	integration, numerical derivatives and differential equations CLO 2: Able to apply numerical algorithms to perform error calculations, solve Taylor theorems, non-linear equations, linear equations, interpolations, regression, numerical integration, numerical derivatives and differential equations. CLO 3: Able to implement programming languages or other tools for implementing numerical algorithms. CLO 4: Demonstrate an attitude of responsibility for work in their field of expertise independently. CLO 5: Working together to be able to make the most of their potential	PLO-05 PLO-06 PLO-06 PLO-06
Content	This course aims to develop a basic understanding of numerical algorithms and skills for applying numerical algorithms to solve mathematical problems in computers. In this course, students will learn about how to solve a mathematical problem using a numerical algorithm approach. Topics to be studied include errors, number representations, Taylor theorems, non-linear equations, linear equations, interpolations, regression, numerical integration, numerical derivatives and differential equations.	
Study and examination requirements and forms of examination	• In-class exercises • Assignment 1, 2 • Mid-term examination • Final examination	
Media employed	LCD, whiteboard, websites (myITS Classroom), zoom.	
Reading list	Main: 1. Steven C. Chapra, Raymond P. Canale. Numerical Methods for Engineers Sixth Edition. Mc Graw Hill Education, New York, 2015. 2. Greenbaum and T. P. Chartier. Numerical Methods: Design, Analysis and Computer Implementation of Algorithms. Princeton University Press, 2012. 3. W. H. Press, S. A. Teukolsky, W. T. Vetterling, B. P. Flannery. Numerical Recipes: The Art of Scientific Computing. Cambridge University Press, 2007 Supporting: 1. L. R. Scott. Numerical Analysis. Princeton University Press, 2011. 2. E. Suli, D. F. Mayers. An Introduction to Numerical Analysis. Cambridge University Press, 2003.	

I. Rencana Pembelajaran Semester / Semester Learning Plan

		INSTITUT TEKNOLOGI SEPULUH NOPEMBER (ITS) FAKULTAS TEKNOLOGI ELEKTRO DAN INFORMATIKA CERDAS DEPARTEMEN TEKNIK BIOMEDIK				Kode Dokumen
RENCANA PEMBELAJARAN SEMESTER						
MATA KULIAH (MK) COURSE		KODE CODE	Rumpun MK Course Cluster	BOBOT (sks) Credits		SEMESTER Tgl Penyusunan Compilation Date
Metode Numerik		EB234306	Ilmu Dasar Teknik	T=3	P=0	III 27 Oktober 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 Yazid, B.Eng., M.Eng.)		(Dr. Rachmad Setiawan S.T., M.T.)		(Dr. Achmad Arifin, S.T., M.Eng.)
Capaian Pembelajaran Learning Outcomes	CPL-PRODI yang dibebankan pada MK PLO Program Charged to The Course					
	CPL-04 PLO-04	Mampu menerapkan Ilmu Pengetahuan Alam dan Matematika pada bidang Teknik Biomedika. <i>Able to apply Natural Sciences and Mathematics in the field of Biomedical Engineering.</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	Mampu merancang dan melaksanakan eksperimen laboratorium dan/atau lapangan, menganalisa dan menginterpretasi data, serta menggunakan penilaian yang obyektif untuk menarik kesimpulan.				

	PLO-06	<i>Able to design and implement laboratory experiment and / or field experiments, analyze and interpret data, and use objective assessments to draw conclusions.</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	Menguasai konsep galat, representasi bilangan, teorema Taylor, persamaan non-linear, persamaan linear, interpolasi, regresi, integrasi numerik, turunan numerik dan persamaan differensial. <i>Mastering the concept of error, number representation, Taylor theorem, non-linear equations, linear equations, interpolation, regression, numerical integration, numerical derivatives and differential equations</i>												
	CP MK 2 CLO 2	Mampu menerapkan algoritma numerik untuk melakukan perhitungan galat, menyelesaikan teorema taylor, persamaan non-linear, persamaan linear, interpolasi, regresi, integrasi numerik, turunan numerik dan persamaan differensial. <i>Able to apply numerical algorithms to perform error calculations, solve Taylor’s theorems, non-linear equations, linear equations, interpolations, regression, numerical integration, numerical derivatives and differential equations.</i>												
	CP MK 3 CLO 3	Mampu menerapkan bahasa pemrograman atau tool lain untuk implementasi algoritma numerik. <i>Able to implement programming languages or other tools for implementing numerical algorithms.</i>												
	CP MK 4 CLO 4	Menunjukkan sikap bertanggungjawab atas pekerjaan di bidang keahliannya secara mandiri. <i>Demonstrate an attitude of responsibility for work in their field of expertise independently.</i>												
	CP MK 5 CLO 5	Bekerja sama untuk dapat memanfaatkan semaksimal mungkin potensi yang dimiliki <i>Working together to be able to make the most of their potential</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						✓						
Diskripsi Singkat MK Short Description of Course	Mata kuliah ini bertujuan untuk mengembangkan pemahaman dasar tentang algoritma numerik dan keterampilan untuk menerapkan algoritma numerik untuk memecahkan masalah matematika di komputer. Pada mata kuliah ini, mahasiswa akan mempelajari tentang bagaimana menyelesaikan suatu permasalahan matematis dengan menggunakan pendekatan algoritma numerik. Topik-topik yang akan dipelajari antara lain galat, representasi bilangan, teorema Taylor, persamaan non-linear, persamaan linear, interpolasi, regresi, integrasi numerik, turunan numerik dan persamaan differensial. <i>This course aims to develop a basic understanding of numerical algorithms and skills for applying numerical algorithms to solve mathematical problems in computers. In this course, students will learn about how to solve a mathematical problem using a numerical algorithm approach. Topics to be studied include errors, number representations, Taylor theorems, non-linear equations, linear equations, interpolations, regression, numerical integration, numerical derivatives and differential equations.</i>												
Bahan Kajian: Materi pembelajaran Course Materials:	1. Analisa Galat, representasi bilangan, Teorema Taylor / Error Analysis, number representation, Taylor's Theorem 2. Persamaan non linier / <i>Non-linear equations</i> 3. Persamaan linier / <i>Linear equations</i> 4. Regresi / <i>Regression</i> 5. Interpolasi / <i>Interpolation</i> 6. Integrasi numerik / <i>Numerical intergation</i> 7. Turunan Numerik / <i>Numeric derivative</i> 8. Persamaan Differensial / <i>Differential equations</i>												
Pustaka References	Utama / Main: 1. Steven C. Chapra, Raymond P. Canale. NUmerical Methods for Enginers Sixth Edition. Mc Graw Hill Education, New York, 2015. 2. Greenbaum and T. P. Chartier. Numerical Methods: Design, Analysis and Computer Implementation of Algorithms. Princeton University Press, 2012. 3. W. H. Press, S. A. Teukolsky, W. T. Vetterling, B. P. Flannery. Numerical Recipes: The Art of Scientific Computing. Cambridge University Press, 2007. Pendukung / Supporting:												

	1. L. R. Scott. Numerical Analysis. Princeton University Press, 2011. 2. E. Suli, D. F. Mayers. An Introduction to Numerical Analysis. Cambridge University Press, 2003.
Dosen Pengampu <i>Lecturers</i>	Muhammad Yazid, B.Eng., M.Eng. Eko Agus Suprayitno, S.Si, M.T. Nada Fitrieyatul Hikmah, S.T., M.T. Rasyida Shabihah Zukro Aini, S.T., M.T. Nabila Puspita Firdi S.T, M.Sc. Rezki El Arif, S.T., M.T., Ph.D Fauzan Arrofiqi, S.T., M.T., Ph.D.
Matakuliah syarat <i>Prerequisite</i>	Basic Programming

Mg Ke/ Week	Kemampuan akhir tiap tahapan belajar (Sub-CPMK) / <i>Final ability of each learning stage (LLO)</i>	Penilaian / Assessment		Bentuk 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 /Assess- ment Load (%)
		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)
1,2	Mahasiswa memahami dan mampu Menguasai konsep analisa Galat, representasi bilangan, Teorema Taylor. <i>Students understand and are able to master the concept of Error analysis, number representation, Taylor's Theorem.</i>	- Mengetahui berbagai cara pengukuran galat dan sumber – sumber galat. - Mengetahui metode representasi biner dan representasi float. - Mengetahui dan mampu menjelaskan teorema taylor dan deret taylor. <i>Know the various ways of measuring errors and sources of error</i> <i>Know the binary and float representation methods.</i>		- Kuliah dan brainstorming, tanya jawab [TM : 3 x 50"] [BM : 3 x 50"] [PT : 3 x 50"] <i>Lectures and brainstorming, ask and answer.</i> [FF : 3 x 50"] [SS : 3 x 60"] [SA : 3 x 60"]	- Chatting dan diskusi dalam forum platform ITS. <i>Chat and discussion in ITS platform forum</i>	- Kontrak kuliah: - Motivasi belajar - Rencana pembelajaran - Aturan-aturan perkuliahan - Tujuan perkuliahan - Sistem penilaian, buku ajar/sumber pustaka - Pengukuran galat, sumber – sumber galat, propagasi galat, representasi biner, representasi float, teorema taylor, deret taylor	

		• <i>Know and be able to explain Taylor Theorems and Taylor series.</i>				• <i>Course contract:</i> - Motivation to learn - Lesson plan - Lecture rules - Course objective - Assessment system, textbooks / library resources • <i>Error measurement, error sources, error propagation, binary representation, float representation, Taylor Theorem, Taylor series</i>	
3,4	Mahasiswa memahami dan mampu Menguasai konsep persamaan non linier. <i>Students understand and are able to master the concept of non-linear equations.</i>	• Mengetahui dan mampu menjelaskan persamaan kuadrat dan persamaan kubik. • Mengetahui dan mampu menjelaskan persamaan metode tertutup menggunakan	Non-tes : Tugas 1 tahap 1: • Mengerjakan soal-soal yang berhubungan dengan teorema taylor dan deret taylor • Mengerjakan soal-soal yang	• Kuliah, diskusi, tanya jawab, latihan soal, tugas [TM : 3 x 50"] [BM : 3 x 50"] [PT : 3 x 50"] • <i>Lectures, discussion, ask and answer, exercise, assignment</i> [FF : 3 x 50"]	• Chatting dan diskusi dalam forum platform ITS • <i>Chat and discussion in ITS platform forum</i>	• Persamaan kuadrat, persamaan kubik, metode tertutup menggunakan biseksi dan regulafalsi, metode terbuka menggunakan titik tetap dan Newton-Rhapson.	7.5

		biseksi dan regulafalsi. - Mengetahui dan mampu menjelaskan persamaan metode terbuka menggunakan titip tetap dan Newton-Rhapson. <i>Know and be able to explain quadratic equations and cubic equations.</i> <i>Know and be able to explain closed method equations using bisection and regula falsi.</i> <i>Know and be able to explain open method equations using fixed points and Newton-Rhapson.</i>	berhubungan dengan regulafalsi, dan Newton-Rhapson. Non-test: Task 1 stage 1: - Solve question related to Taylor Theorem and Taylor series - Solve question related to regula falsi and Newton-Rhapson.	<i>[SS : 3 x 50"]</i> <i>[SA : 3 x 50"]</i>		<i>Quadratic equations, cubic equations, closed methods using bisection and regulafalsi, open methods using fixed points and Newton-Rhapson</i>	
5,6	Mahasiswa memahami dan mampu Menguasai konsep persamaan linier <i>Students understand and are able to master the concept of linear equations</i>	- Mengetahui dan mampu menjelaskan aljabar matriks. - Mengetahui dan mampu menjelaskan eliminasi Gauss, dan eliminasi Gauss		Kuliah, diskusi, tanya jawab, latihan soal, tugas [TM : 3 x 50"] [BM : 3 x 50"] [PT : 3 x 50"]	Chatting dan diskusi dalam forum platform ITS	Aljabar matriks, eliminasi Gauss, eliminasi Gauss Jordan, Gauss-Seidel, Jacobbi	

		Jordan, Gauss-Seidel, Jacobbi • Know and be able to explain the matrix algebra. • Know and be able to explain the Gauss elimination, and Gauss Jordan elimination, Gauss-Seidel, Jacobbi.		• Lectures, discussion, ask and answer, exercise, assignment [FF : 3 x 50"] [SS : 3 x 50"] [SA : 3 x 50"]	• Chat and discussion in ITS platform forum	• Matrix algebra, Gauss elimination, Gauss Jordan elimination, Gauss Seidel, Jacobbi	
7	Mahasiswa memahami dan mampu Menguasai konsep regresi <i>Students understand and are able to master the concept of regression</i>	• Mengetahui dan mampu menjelaskan regresi linier. • Mengetahui dan mampu menjelaskan regresi non linier. • Mengetahui dan mampu menjelaskan regresi polinomial. • Mampu merealisasikan metoda ke dalam perhitungan manual dan program komputer. • Mahasiswa Mampu memahami	Non-tes : Tugas 1 tahap 2: • Mengerjakan soal terkait Aljabar matriks, eliminasi Gauss. • Mengerjakan soal dan komputasi terkait eliminasi Gauss Jordan, dan Gauss-Seidel. • Mengerjakan soal dan	• Kuliah, diskusi, tanya jawab, latihan soal, tugas [TM : 3 x 50"] [BM : 3 x 50"] [PT : 3 x 50"] • Lectures, discussion, ask and answer, exercise, assignment [FF : 3 x 50"] [SS : 3 x 50"] [SA : 3 x 50"]	• Chatting dan diskusi dalam forum platform ITS • Chat and discussion in ITS platform forum	• Regresi linier, • regresi non linier, • regresi polinomial • Linear regression • Non-linear regression • Polynomial regression	7.5

		Penamaan arah bagian tubuh. • <i>Know and be able to explain linear regression</i> • <i>Know and be able to explain non-linear regression</i> • <i>Know and be able to explain polynomial regression</i> • <i>Able to realize method into manual calculations and computer programs</i> • <i>Students are able to understand the naming of the direction of body parts</i>	komputasi terkait Regresi linier, regresi non linier,dan regresi polinomial Non-test: Task 1 stage 2: • <i>Solve questions related to matrix algebra, Gauss elimination</i> • <i>Solve questions and computations related to Gauss Jordan elimination, and Gauss-Seidel</i> • <i>Solve questions and computations related to linear regression, and polynomial regression</i>				
8	EVALUASI TENGAH SEMESTER						35

MID-SEMESTER EXAM							
9, 10	Mahasiswa memahami dan mampu Menguasai konsep interpolasi. <i>Students understand and are able to master the concept of interpolation.</i>	- Mengetahui dan mampu menjelaskan metode langsung. - Mengetahui dan mampu menjelaskan metode selisih terbagi Newton. - Mengetahui dan mampu menjelaskan metode Lagrange. - Mengetahui dan mampu menjelaskan metode Spline. <i>Know and be able to explain direct method</i> <i>Know and be able to explain Newton's method of divided differences.</i> <i>Know and be able to explain Lagrange method.</i> <i>Know and be able to explain Spline method</i>		- Kuliah, diskusi, tanya jawab, latihan soal, tugas [TM : 3 x 50"] [BM : 3 x 50"] [PT : 3 x 50"] <i>Lectures, discussion, ask and answer, exercise, assignment</i> [FF : 3 x 50"] [SS : 3 x 50"] [SA : 3 x 50"]	- Chatting dan diskusi dalam forum platform ITS <i>Chat and discussion in ITS platform forum</i>	- Metode langsung - Metode selisih terbagi Newton - Metode Lagrange - Metode Spline <i>Direct method</i> <i>Newton's method of divided differences</i> <i>Lagrange method</i> <i>Spline method</i>	

11, 12	Mahasiswa memahami dan mampu Menguasai konsep integrasi Numerik. <i>Students understand and are able to master the concept of Numerical integration</i>	● Mengetahui dan mampu menjelaskan aturan trapesium. ● Mengetahui dan mampu menjelaskan aturan Simpson 1/3rd, aturan simpson's 3/8 ● <i>Know and be able to explain trapezoidal rule.</i> ● <i>Know and be able to explain Simpson's 1/3 rule, and Simpson's 3/8 rule.</i>	Non-tes : Tugas 2 tahap 1: ● Mengerjakan soal dan komputasi terkait Metode langsung, metode selisih terbagi Newton, ● Mengerjakan soal dan komputasi terkait Aturan trapesium, aturan Simpson 1/3rd. Non-test: Task 2 stage 1: ● <i>Solve questions and computations related to direct method, Newton's method of</i>	● Kuliah, diskusi, tanya jawab, latihan soal, tugas [TM : 3 x 50"] [BM : 3 x 50"] [PT : 3 x 50"] ● <i>Lectures, discussion, ask and answer, exercise, assignment</i> [FF : 3 x 50"] [SS : 3 x 50"] [SA : 3 x 50"]	● Chatting dan diskusi dalam forum platform ITS ● <i>Chat and discussion in ITS platform forum</i>	● Aturan trapesium, aturan Simpson 1/3rd, aturan simpson 3/8 ● <i>Trapezoidal rule, Simpson's 1/3 rule, Simpson's 3/8 rule</i>	7.5
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			divided differences. Solve questions and computations related to trapezoidal rule, Simpson's 1/3 rule.				
13	Mahasiswa memahami dan mampu Menguasai konsep turunan numerik <i>Students understand and are able to master the concept of numerical derivatives</i>	- Mengetahui dan mampu menjelaskan metoda pendekatan tengah. - Mengetahui dan mampu menjelaskan metoda pendekatan maju. - Mengetahui dan mampu menjelaskan metoda pendekatan mundur. <i>Know and be able to explain the middle approach method.</i> <i>Know and be able to explain advanced approach method.</i>		- Kuliah, diskusi, tanya jawab, latihan soal, tugas [TM : 3 x 50"] [BM : 3 x 50"] [PT : 3 x 50"] - Lectures, discussion, ask and answer, exercise, assignment [FF : 3 x 50"] [SS : 3 x 50"] [SA : 3 x 50"]	- Chatting dan diskusi dalam forum platform ITS - Chat and discussion in ITS platform forum	- Metoda pendekatan tengah, maju, mundur - Middle, forward, backward approach method.	

		• <i>Know and be able to explain backward approach method.</i>					
14	Mahasiswa memahami dan mampu Menguasai konsep persamaan diferensial <i>Students understand and are able to master the concept of differential equations</i>	• Mengetahui dan mampu menjelaskan metode Euler. • Mengetahui dan mampu menjelaskan metode Runge Kutta 2nd dan Runge Kutta 3th. • Mengetahui dan mampu menjelaskan Finite Difference method • <i>Know and be able to explain Euler's method</i> • <i>Know and be able to explain 2nd Order Runge Kutta and 3rd Order Runge Kutta</i> • <i>Know and able to explain Finite Difference method</i>	Non-tes : Tugas 2 tahap 2: • Mengerjakan soal dan komputasi terkait Metode Euler, Runge Kutta Non-test: Task 2 stage 2: • <i>Solve questions and computations related Euler's method, Runge Kutta</i>	• Kuliah, diskusi, tanya jawab, latihan soal, tugas [TM : 3 x 50"] [BM : 3 x 50"] [PT : 3 x 50"] • <i>Lectures, discussion, ask and answer, exercise, assignment</i> [FF : 3 x 50"] [SS : 3 x 50"] [SA : 3 x 50"]	• Chatting dan diskusi dalam forum platform ITS • <i>Chat and discussion in ITS platform forum</i>	• Metode Euler, Runge Kutta 2nd, Runge Kutta 3th, Finite Difference method • <i>Euler's mehod, 2nd order Runge Kutta, 3rd order Runge Kutta, Finite Difference method</i>	7.5
15-16	EVALUASI AKHIR SEMESTER FINAL-SEMESTER EXAM						35

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		RA&E
			Write Doc Code
Kode/code: EB234306	Bobot sks/credits (T/P): 3/0	Rumpun MK: Ilmu Dasar Teknik <i>Course Cluster: Basic Engineering</i>	Smt: III
OTORISASI <i>AUTHORIZATION</i>	Penyusun RA & E <i>Compiler A&EP</i> Muhammad Yazid, B.Eng., M.Eng.	Koordinator RMK <i>Course Cluster Coordinator</i> Dr. Rachmad Setiawan S.T., M.T.	Ka DEP <i>Head of DEP</i> 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)
2	Sub CP-MK 1: Mahasiswa memahami dan mampu menguasai konsep analisa Galat, representasi bilangan, Teorema Taylor. LLO 1: <i>Students understand and are able to master the concept of Error analysis, number representation, Taylor's Theorem.</i>	Tes: ETS Soal 1 (7% dari ETS 35%) Test: <i>Question 1 in Mid Exam (7% of Mid Exam 35%)</i>	7
4	Sub CP-MK 2: Mahasiswa memahami dan mampu menguasai konsep persamaan non linier. LLO 2: <i>Students understand and are able to master the concept</i>	Non-tes : Tugas 1 tahap 1: ● Mengerjakan soal-soal yang berhubungan dengan teorema taylor dan deret taylor ● Mengerjakan soal-soal yang berhubungan dengan regulafalsi, dan Newton-Rhapson. Tes : ETS Soal 2 (8% dari ETS 35%)	7.5 8

Mg ke/ Week (1)	Sub CP-MK / Lesson Learning Outcomes (LLO) (2)	Bentuk Asesmen (Penilaian) Form of Assessment (3)	Bobot / Load (%) (4)
	<i>of non-linear equations</i>	Non-test: Task 1 stage 1: • Solve question related to Taylor Theorem and Taylor series • Solve question related to regula falsi and Newton-Rhapson. Test: • Question 2 in Mid Exam (2% of Mid Exam 35%)	
5	Sub CP-MK 3: Mahasiswa memahami dan mampu menguasai konsep persamaan linier. LLO 3: <i>Students understand and are able to master the concept of linear equations</i>	Tes : ETS Soal 3 (10% dari ETS 35%) Test: <i>Question 3 in Mid Exam (10% of Mid Exam 35%)</i>	10
7	Sub CP-MK 4: Mahasiswa memahami dan mampu menguasai konsep regresi. LLO 4: <i>Students understand and are able to master the concept of regression</i>	Non-tes : Tugas 1 tahap 2: • Mengerjakan soal terkait Aljabar matriks, eliminasi Gauss. • Mengerjakan soal dan komputasi terkait eliminasi Gauss Jordan, dan Gauss-Seidel. • Mengerjakan soal dan komputasi terkait Regresi linier, regresi non linier, dan regresi polinomial. Tes : ETS Soal 4 (10% dari ETS 35%) Non-test: Task 1 stage 2: • Solve questions related to matrix algebra, Gauss elimination • Solve questions and computations related to Gauss Jordan elimination, and Gauss-Seidel • Solve questions and computations related to linear regression, and polynomial regression Test:	7.5 10

Mg ke/ Week (1)	Sub CP-MK / Lesson Learning Outcomes (LLO) (2)	Bentuk Asesmen (Penilaian) Form of Assessment (3)	Bobot / Load (%) (4)
		Question 4 in Mid Exam (10% of Mid Exam 35%)	
9	Sub CP-MK 5: Mahasiswa memahami dan mampu menguasai konsep interpolasi. LLO 5: <i>Students understand and are able to master the concept of interpolation</i>	Tes : EAS Soal 1 (17.5% dari EAS 35%) Test: Question 1 in Final Exam (17.5% of Final Exam 35%)	17.5
11	Sub CP-MK 6: Mahasiswa memahami dan mampu menguasai konsep integrasi Numerik. LLO 6: <i>Students understand and are able to master the concept of Numerical integration</i>	Non-tes : Tugas 2 tahap 1: • Mengerjakan soal dan komputasi terkait Metode langsung, metode selisih terbagi Newton, • Mengerjakan soal dan komputasi terkait Aturan trapesium, aturan Simpson 1/3rd. Non-test: Task 2 stage 1: • Solve questions and computations related to direct method, Newton's method of divided differences. • Solve questions and computations related to trapezoidal rule, Simpson's 1/3 rule	7.5
13	Sub CP-MK 7: Mahasiswa memahami dan mampu menguasai konsep turunan numerik. LLO 7: <i>Students understand and are able to master the concept of numerical derivatives</i>	Tes : EAS Soal 2 (7.5% dari EAS 35%) Test: Question 2 in Final Exam (7.5% of Final Exam 35%)	7.5

Mg ke/ Week (1)	Sub CP-MK / Lesson Learning Outcomes (LLO) (2)	Bentuk Asesmen (Penilaian) Form of Assessment (3)	Bobot / Load (%) (4)
14	Sub CP-MK 8: Mahasiswa memahami dan mampu menguasai konsep persamaan diferential. LLO 8: <i>Students understand and are able to master the concept of differential equations</i>	Non-tes : Tugas 2 tahap 2: • Mengerjakan soal dan komputasi terkait Metode Euler, Runge Kutta Tes : EAS Soal 3 (10% dari EAS 35%) Non-test: Task 2 stage 2: • Solve questions and computations related Euler's method, Runge Kutta Test: Question 3 in Final Exam (10% of Final Exam 35%)	7.5 10
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 4 / CLO 4	Week- 7	Task 1 stage 2	7.5
		Week- 8	Mid Exam Question 4	10
CPL-05 / PLO-05	CPMK 1 / CLO 1	Week- 8	Mid Exam Question 1	7
	CPMK 2 / CLO 2	Week- 4	Task 1 stage 1	7.5
		Week- 8	Mid Exam Question 2	8
	CPMK 3 / CLO 3	Week- 8	Mid Exam Question 3	10
CPL-10 / PLO-10	CPMK 5 / CLO 5	Week- 16	Final Exam Question 1	17.5
	CPMK 6 / CLO 6	Week- 11	Task 2 stage 1	7.5
	CPMK 7 / CLO 7	Week- 16	Final Exam Question 2	7.5
	CPMK 8 / CLO 8	Week- 14	Task 2 stage 2	7.5
		Week- 16	Final Exam Question 3	10
				$\Sigma = 100\%$

No	Bentuk Asesmen	CPL-01	CPL-02	CPL-03	CPL-04	CPL-05	CPL-06	CPL-07	CPL-08	CPL-09	CPL-10	CPL-11	CPL-12	Total
1	Tugas (Tugas 1 2, tahap 1 2) Assignme nt				0.1		0.05							0.15

No	Bentuk Asesmen	CPL-01	CPL-02	CPL-03	CPL-04	CPL-05	CPL-06	CPL-07	CPL-08	CPL-09	CPL-10	CPL-11	CPL-12	Total
	(Task 1 2, stage 1 2)													
2	Kuis Quiz					0.2								0.2
3	ETS Midterm Exam				0.05	0.1	0.225							0.375
4	EAS Final Exam					0.1	0.175							0.275
	Total				0.15	0.4	0.45							1

