



# MODULE HANDBOOK NUMERICAL METHODS



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

**INSTITUT TEKNOLOGI SEPULUH NOPEMBER**

## ENDORSEMENT PAGE



# MODULE HANDBOOK

## Numerical Methods

### DEPARTMENT OF BIOMEDICAL ENGINEERING

INSTITUT TEKNOLOGI SEPULUH NOPEMBER  
Number : B/21355/IT2.IX.5.1.2/PP.03.00.00/2020


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>	Atar Babgei, S.T., M.Sc.	Dosen <i>Lecturer</i>		November 23, 2019
Pemeriksa dan Pengendalian <i>Review and Control</i>	Nada Fitriyatul. Hikmah., S.T. M.T.	Tim kurikulum <i>Curriculum team</i>		February 11, 2020
Persetujuan <i>Approval</i>	Dr. Rachmad Setiawan, S.T., M.T.	Koordinator RMK <i>Course Cluster Coordinator</i>		March 03, 2020
Penetapan <i>Determination</i>	Dr. Achmad Arifin, S.T., M.Eng.	Kepala Departemen <i>Head of Department</i>		March 10, 2020

+



	<p>CLO 3: Able to implement programming languages or other tools for implementing numerical algorithms.</p> <p>CLO 4: Demonstrate an attitude of responsibility for work in their field of expertise independently.</p> <p>CLO 5: Working together to be able to make the most of their potential</p>	<p>PLO-06</p> <p>PLO-08</p> <p>PLO-08</p>
Content	<p>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.</p>	
Study and examination requirements and forms of examination	<ul style="list-style-type: none"> <li>• In-class exercises</li> <li>• Assignment 1, 2</li> <li>• Mid-term examination</li> <li>• Final examination</li> </ul>	
Media employed	<p>LCD, whiteboard, websites (myITS Classroom), zoom.</p>	
Reading list	<p>Main:</p> <ol style="list-style-type: none"> <li>1. Steven C. Chapra, Raymond P. Canale. NUmberical Methods for Enginers Sixth Edition. Mc Graw Hill Education, New York, 2015.</li> <li>2. Greenbaum and T. P. Chartier. Numerical Methods: Design, Analysis and Computer Implementation of Algorithms. Princeton University Press, 2012.</li> <li>3. W. H. Press, S. A. Teukolsky, W. T. Vetterling, B. P. Flannery. Numerical Recipes: The Art of Scientific Computing. Cambridge University Press, 2007</li> </ol> <p>Supporting:</p> <ol style="list-style-type: none"> <li>1. L. R. Scott. Numerical Analysis. Princeton University Press, 2011.</li> <li>2. E. Suli, D. F. Mayers. An Introduction to Numerical Analysis. Cambridge University Press, 2003.</li> </ol>	

**I. Rencana Pembelajaran Semester / Semester Learning Plan**

		<b>INSTITUT TEKNOLOGI SEPULUH NOPEMBER (ITS)</b> <b>FAKULTAS TEKNOLOGI ELEKTRO DAN INFORMATIKA CERDAS</b> <b>DEPARTEMEN TEKNIK BIOMEDIK</b>				<b>Kode Dokumen</b>	
<b>RENCANA PEMBELAJARAN SEMESTER</b>							
<b>MATA KULIAH (MK)</b> <b>COURSE</b>		<b>KODE</b> <b>CODE</b>	<b>Rumpun MK</b> <b>Course Cluster</b>	<b>BOBOT (sks)</b> <b>Credits</b>		<b>SEMESTER</b>	<b>Tgl Penyusunan</b> <b>Compilation Date</b>
<b>Metode Numerik</b>		<b>EW184901</b>	<b>Ilmu Dasar Teknik</b> <i>Basic Engineering</i>	<b>T=3</b>	<b>P=0</b>	<b>IV</b>	<b>15 Juni 2020</b>
<b>OTORISASI / PENGESAHAN</b> <b>AUTHORIZATION / ENDORSEMENT</b>		<b>Dosen Pengembang RPS</b> <i>Developer Lecturer of Semester Learning Plan</i>		<b>Koordinator RMK</b> <i>Course Cluster Coordinator</i>		<b>Ka DEPARTEMEN</b> <i>Head of Department</i>	
		<b>(Atar Babgei, S.T., M.Sc.)</b>		<b>(M. Hilman Fatoni, S.T., M.T.)</b>		<b>(Dr. Achmad Arifin, S.T., M.Eng.)</b>	
<b>Capaian Pembelajaran</b>		<b>CPL-PRODI yang dibebankan pada MK</b> <b>PLO Program Charged to The Course</b>					
<b>Learning Outcomes</b>		<b>CPL-02</b>  <b>PLO-02</b>	Mampu <b>menemukan, memahami, menjelaskan, merumuskan, dan menyelesaikan</b> 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 <b>find, understand, explain, formulate, and solve</b> 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>				
		<b>CPL-06</b>  <b>PLO-06</b>	Mampu <b>menerapkan</b> ilmu pengetahuan, keterampilan, dan metode terkini dalam menyelesaikan permasalahan di bidang Teknik Biomedika <i>Able to <b>apply</b> the latest knowledge, skills and methods in solving problems in the field of Biomedical Engineering.</i>				

	<p><b>CPL-08</b></p> <p><b>PLO-08</b></p>	<p>Mampu <b>bekerja dalam tim</b> lintas disiplin dan budaya serta <b>bertanggung jawab</b> kepada masyarakat dan <b>mematuhi hukum dan etika profesi</b> dalam menyelesaikan masalah Teknik Biomedika</p> <p><i>Able to <b>work in interdisciplinary and intercultural teams</b> and <b>be responsible</b> to the community and <b>comply with legal and professional ethics</b> in solving Biomedical Engineering problems</i></p>																																																														
<p><b>Capaian Pembelajaran Mata Kuliah (CPMK) – Bila CP MK sebagai kemampuan pada tiap tahap pembelajaran CP MK = Sub CP MK</b></p> <p><b>Course Learning Outcome (CLO) - If CLO as description capability of each Learning Stage in the course, then CLO = LLO</b></p>																																																																
	<p><b>CP MK 1</b></p> <p><b>CLO 1</b></p>	<p>Menguasai konsep galat, representasi bilangan, teorema Taylor, persamaan non-linear, persamaan linear, interpolasi, regresi, integrasi numerik, turunan numerik dan persamaan differensial.</p> <p><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></p>																																																														
	<p><b>CP MK 2</b></p> <p><b>CLO 2</b></p>	<p>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.</p> <p><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></p>																																																														
	<p><b>CP MK 3</b></p> <p><b>CLO 3</b></p>	<p>Mampu menerapkan bahasa pemrograman atau tool lain untuk implementasi algoritma numerik.</p> <p><i>Able to implement programming languages or other tools for implementing numerical algorithms.</i></p>																																																														
	<p><b>CP MK 4</b></p> <p><b>CLO 4</b></p>	<p>Menunjukkan sikap bertanggungjawab atas pekerjaan di bidang keahliannya secara mandiri.</p> <p><i>Demonstrate an attitude of responsibility for work in their field of expertise independently.</i></p>																																																														
	<p><b>CP MK 5</b></p> <p><b>CLO 5</b></p>	<p>Bekerja sama untuk dapat memanfaatkan semaksimal mungkin potensi yang dimiliki</p> <p><i>Working together to be able to make the most of their potential</i></p>																																																														
<p><b>Peta CPL – CP MK</b></p> <p><b>Map of PLO - CLO</b></p>	<table border="1"> <thead> <tr> <th></th> <th>CPL-01</th> <th>CPL-02</th> <th>CPL-03</th> <th>CPL-04</th> <th>CPL-05</th> <th>CPL-06</th> <th>CPL-07</th> <th>CPL-08</th> <th>CPL-09</th> <th>CPL-10</th> <th>CPL-11</th> <th>CPL-12</th> </tr> </thead> <tbody> <tr> <td>CPMK 1 / SUB CPMK 1 CLO 1 / LLO 1</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 CLO 2 / LLO 2</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</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> </tbody> </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 CLO 1 / LLO 1		√											CPMK 2 / SUB CPMK 2 CLO 2 / LLO 2						√							CPMK 3 / SUB CPMK 3						√						
	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								√					
<b>Diskripsi Singkat MK</b>  <b>Short Description of Course</b>	<p>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.</p> <p><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></p>													
<b>Bahan Kajian:</b> Materi pembelajaran  <b>Course Materials:</b>	<ol style="list-style-type: none"> <li>1. Analisa Galat, representasi bilangan, Teorema Taylor / Error Analysis, number representation, Taylor's Theorem</li> <li>2. Persamaan non linier / <i>Non-linear equations</i></li> <li>3. Persamaan linier / <i>Linear equations</i></li> <li>4. Regresi / <i>Regression</i></li> <li>5. Interpolasi / <i>Interpolation</i></li> <li>6. Integrasi numerik / <i>Numerical intergation</i></li> <li>7. Turunan Numerik / <i>Numeric derivative</i></li> <li>8. Persamaan Differensial / <i>Differential equations</i></li> </ol>													
<b>Pustaka</b>  <b>References</b>	<p><b>Utama / Main:</b></p> <ol style="list-style-type: none"> <li>1. Steven C. Chapra, Raymond P. Canale. NUmberical Methods for Enginers Sixth Edition. Mc Graw Hill Education, New York, 2015.</li> <li>2. Greenbaum and T. P. Chartier. Numerical Methods: Design, Analysis and Computer Implementation of Algorithms. Princeton University Press, 2012.</li> </ol>													

- 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:**

- L. R. Scott. Numerical Analysis. Princeton University Press, 2011.
- E. Suli, D. F. Mayers. An Introduction to Numerical Analysis. Cambridge University Press, 2003.

**Dosen Pengampu Lecturers** Eko Agus Suprayitno, Nada Fitriyatul Hikmah

**Matakuliah syarat Prerequisite** -

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)	(5)	(6)	(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</i>	<ul style="list-style-type: none"> <li>Mengetahui berbagai cara pengukuran galat dan sumber – sumber galat.</li> <li>Mengetahui metode representasi biner dan representasi float.</li> <li>Mengetahui dan mampu menjelaskan</li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>	<ul style="list-style-type: none"> <li>Kuliah dan brainstorming, tanya jawab [TM : 3 x 50"] [BM : 3 x 50"] [PT : 3 x 50"]</li> <li>Lectures and brainstorming,</li> </ul>	<ul style="list-style-type: none"> <li>Chatting dan diskusi dalam forum platform ITS.</li> <li>Chat and discussion in ITS platform forum</li> </ul>	<ul style="list-style-type: none"> <li>Kontrak kuliah:               <ul style="list-style-type: none"> <li>- Motivasi belajar</li> <li>- Rencana pembelajaran</li> <li>- Aturan-aturan perkuliahan</li> <li>- Tujuan perkuliahan</li> <li>- Sistem penilaian,</li> </ul> </li> </ul>	



	<p><i>representation, Taylor's Theorem.</i></p>	<p>teorema taylor dan deret taylor.</p> <ul style="list-style-type: none"> <li>• <i>Know the various ways of measuring errors and sources of error</i></li> <li>• <i>Know the binary and float representation methods.</i></li> <li>• <i>Know and be able to explain Taylor Theorems and Taylor series.</i></li> </ul>		<p><i>ask and answer.</i>  <i>[FF : 3 x 50"]</i>  <i>[SS : 3 x 60"]</i>  <i>[SA : 3 x 60"]</i></p>		<p>buku ajar/sumber pustaka</p> <ul style="list-style-type: none"> <li>• <i>Pengukuran galat, sumber – sumber galat, propagasi galat, representasi biner, representasi float, teorema taylor, deret taylor</i></li> <li>• <i>Course contract:</i> <ul style="list-style-type: none"> <li>- <i>Motivation to learn</i></li> <li>- <i>Lesson plan</i></li> <li>- <i>Lecture rules</i></li> <li>- <i>Course objective</i></li> <li>- <i>Assessment system, textbooks / library resources</i></li> </ul> </li> <li>• <i>Error measurement, error sources, error propagation, binary representation, float representation, Taylor Theorem, Taylor series</i></li> </ul>	
--	---	--	--	--	--	--	--

<p><b>3,4</b></p>	<p>Mahasiswa memahami dan mampu Menguasai konsep persamaan non linier.</p> <p><i>Students understand and are able to master the concept of non-linear equations.</i></p>	<ul style="list-style-type: none"> <li>Mengetahui dan mampu menjelaskan persamaan kuadrat dan persamaan kubik.</li> <li>Mengetahui dan mampu menjelaskan persamaan metode tertutup menggunakan biseksi dan regulafalsi.</li> <li>Mengetahui dan mampu menjelaskan persamaan metode terbuka menggunakan titik tetap dan Newton-Rhapson.</li> <li><i>Know and be able to explain quadratic equations and cubic equations.</i></li> <li><i>Know and be able to explain closed method equations using bisection and regula falsi.</i></li> <li><i>Know and be able to explain open method equations using fixed</i></li> </ul>	<p><b>Non-tes :</b> <b>Tugas 1 tahap 1:</b></p> <ul style="list-style-type: none"> <li>Mengerjakan soal-soal yang berhubungan dengan teorema taylor dan deret taylor</li> <li>Mengerjakan soal-soal yang berhubungan dengan regulafalsi, dan Newton-Rhapson.</li> </ul> <p><b>Non-test:</b> <b>Task 1 stage 1:</b></p> <ul style="list-style-type: none"> <li><i>Solve question related to Taylor Theorem and Taylor series</i></li> <li><i>Solve question related to regula falsi and Newton-Rhapson.</i></li> </ul>	<ul style="list-style-type: none"> <li>Kuliah, diskusi, tanya jawab, latihan soal, tugas [TM : 3 x 50"] [BM : 3 x 50"] [PT : 3 x 50"]</li> <li><i>Lectures, discussion, ask and answer, exercise, assignment</i> [FF : 3 x 50"] [SS : 3 x 50"] [SA : 3 x 50"]</li> </ul>	<ul style="list-style-type: none"> <li>Chatting dan diskusi dalam forum platform ITS</li> <li><i>Chat and discussion in ITS platform forum</i></li> </ul>	<ul style="list-style-type: none"> <li>Persamaan kuadrat, persamaan kubik, metode tertutup menggunakan biseksi dan regulafalsi, metode terbuka menggunakan titik tetap dan Newton-Rhapson.</li> <li><i>Quadratic equations, cubic equations, closed methods using bisection and regula falsi, open methods using fixed points and Newton-Rhapson</i></li> </ul>	<p><b>7.5</b></p>
-------------------	--	--	---	--	---	---	-------------------

		<i>points and Newton-Rhapson.</i>					
5,6	<p>Mahasiswa memahami dan mampu Menguasai konsep persamaan linier</p> <p><i>Students understand and are able to master the concept of linear equations</i></p>	<ul style="list-style-type: none"> <li>Mengetahui dan mampu menjelaskan aljabar matriks.</li> <li>Mengetahui dan mampu menjelaskan eliminasi Gauss, dan eliminasi Gauss Jordan, Gauss-Seidel, Jacobbi</li> <li><i>Know and be able to explain the matrix algebra.</i></li> <li><i>Know and be able to explain the Gauss elimination, and Gauss Jordan elimination, Gauss-Seidel, Jacobbi.</i></li> </ul>	•	<ul style="list-style-type: none"> <li>Kuliah, diskusi, tanya jawab, latihan soal, tugas [TM : 3 x 50"] [BM : 3 x 50"] [PT : 3 x 50"]</li> <li><i>Lectures, discussion, ask and answer, exercise, assignment</i> [FF : 3 x 50"] [SS : 3 x 50"] [SA : 3 x 50"]</li> </ul>	<ul style="list-style-type: none"> <li>Chatting dan diskusi dalam forum platform ITS</li> <li><i>Chat and discussion in ITS platform forum</i></li> </ul>	<ul style="list-style-type: none"> <li>Aljabar matriks, eliminasi Gauss, eliminasi Gauss Jordan, Gauss-Seidel, Jacobbi</li> <li><i>Matrix algebra, Gauss elimination, Gauss Jordan elimination, Gauss Seidel, Jacobbi</i></li> </ul>	
7	<p>Mahasiswa memahami dan mampu Menguasai konsep regresi</p> <p><i>Students understand and are able to master the concept of regression</i></p>	<ul style="list-style-type: none"> <li>Mengetahui dan mampu menjelaskan regresi linier.</li> <li>Mengetahui dan mampu menjelaskan regresi non linier.</li> <li>Mengetahui dan mampu menjelaskan regresi polinomial.</li> </ul>	<p><b>Non-tes :</b></p> <p><b>Tugas 1 tahap 2:</b></p> <ul style="list-style-type: none"> <li>Mengerjakan soal terkait Aljabar matriks, eliminasi Gauss.</li> <li>Mengerjakan soal dan komputasi terkait eliminasi</li> </ul>	<ul style="list-style-type: none"> <li>Kuliah, diskusi, tanya jawab, latihan soal, tugas [TM : 3 x 50"] [BM : 3 x 50"] [PT : 3 x 50"]</li> <li><i>Lectures, discussion, ask</i></li> </ul>	<ul style="list-style-type: none"> <li>Chatting dan diskusi dalam forum platform ITS</li> <li><i>Chat and discussion in ITS platform forum</i></li> </ul>	<ul style="list-style-type: none"> <li>Regresi linier,</li> <li>regresi non linier,</li> <li>regresi polinomial</li> <li><i>Linear regression</i></li> <li><i>Non-linear regression</i></li> <li><i>Polynomial regression</i></li> </ul>	7.5

		<ul style="list-style-type: none"> <li>• Mampu merealisasikan metoda ke dalam perhitungan manual dan program komputer.</li> <li>• Mahasiswa Mampu memahami Penamaan arah bagian tubuh.</li> <li>• <i>Know and be able to explain linear regression</i></li> <li>• <i>Know and be able to explain non-linear regression</i></li> <li>• <i>Know and be able to explain polynomial regression</i></li> <li>• <i>Able to realize method into manual calculations and computer programs</i></li> <li>• <i>Students are able to understand the naming of the direction of body parts</i></li> </ul>	<p>Gauss Jordan, dan Gauss-Seidel.</p> <ul style="list-style-type: none"> <li>• Mengerjakan soal dan komputasi terkait Regresi linier, regresi non linier, dan regresi polinomial</li> </ul> <p><b>Non-test:</b> <b>Task 1 stage 2:</b></p> <ul style="list-style-type: none"> <li>• <i>Solve questions related to matrix algebra, Gauss elimination</i></li> <li>• <i>Solve questions and computations related to Gauss Jordan elimination, and Gauss-Seidel</i></li> <li>• <i>Solve questions and computations related to linear regression, and polynomial regression</i></li> </ul>	<p><i>and answer, exercise, assignment</i>  <i>[FF : 3 x 50"]</i>  <i>[SS : 3 x 50"]</i>  <i>[SA : 3 x 50"]</i></p>			
8	<b>EVALUASI TENGAH SEMESTER MID-SEMESTER EXAM</b>						35

<p><b>9, 10</b></p>	<p>Mahasiswa memahami dan mampu Menguasai konsep interpolasi.</p> <p><i>Students understand and are able to master the concept of interpolation.</i></p>	<ul style="list-style-type: none"> <li>• Mengetahui dan mampu menjelaskan metode langsung.</li> <li>• Mengetahui dan mampu menjelaskan metode selisih terbagi Newton.</li> <li>• Mengetahui dan mampu menjelaskan metode Lagrange.</li> <li>• Mengetahui dan mampu menjelaskan metode Spline.</li> <li>• <i>Know and be able to explain direct method</i></li> <li>• <i>Know and be able to explain Newton's method of divided differences.</i></li> <li>• <i>Know and be able to explain Lagrange method.</i></li> <li>• <i>Know and be able to explain Spline method</i></li> </ul>		<ul style="list-style-type: none"> <li>• Kuliah, diskusi, tanya jawab, latihan soal, tugas [TM : 3 x 50"] [BM : 3 x 50"] [PT : 3 x 50"]</li> <li>• <i>Lectures, discussion, ask and answer, exercise, assignment</i> [FF : 3 x 50"] [SS : 3 x 50"] [SA : 3 x 50"]</li> </ul>	<ul style="list-style-type: none"> <li>• Chatting dan diskusi dalam forum platform ITS</li> <li>• <i>Chat and discussion in ITS platform forum</i></li> </ul>	<ul style="list-style-type: none"> <li>• Metode langsung</li> <li>• Metode selisih terbagi Newton</li> <li>• Metode Lagrange</li> <li>• Metode Spline</li> <li>• <i>Direct method</i></li> <li>• <i>Newton's method of divided differences</i></li> <li>• <i>Lagrange method</i></li> <li>• <i>Spline method</i></li> </ul>	
<p><b>11, 12</b></p>	<p>Mahasiswa memahami dan mampu Menguasai konsep integrasi Numerik.</p>	<ul style="list-style-type: none"> <li>• Mengetahui dan mampu menjelaskan aturan trapesium.</li> <li>• Mengetahui dan mampu menjelaskan</li> </ul>	<p><b>Non-tes :</b> <b>Tugas 2 tahap 1:</b></p> <ul style="list-style-type: none"> <li>• Mengerjakan soal dan komputasi terkait Metode</li> </ul>	<ul style="list-style-type: none"> <li>• Kuliah, diskusi, tanya jawab, latihan soal, tugas [TM : 3 x 50"] [BM : 3 x 50"]</li> </ul>	<ul style="list-style-type: none"> <li>• Chatting dan diskusi dalam forum platform ITS</li> </ul>	<ul style="list-style-type: none"> <li>• Aturan trapesium, aturan Simpson 1/3rd, aturan simpson 3/8</li> </ul>	<p><b>7.5</b></p>

	<p><i>Students understand and are able to master the concept of Numerical integration</i></p>	<p>aturan Simpson 1/3rd, aturan simpson's 3/8</p> <ul style="list-style-type: none"> <li>• <i>Know and be able to explain trapezoidal rule.</i></li> <li>• <i>Know and be able to explain Simpson's 1/3 rule, and Simpson's 3/8 rule.</i></li> </ul>	<p>langsung, metode selisih terbagi Newton,</p> <ul style="list-style-type: none"> <li>• <i>Mengerjakan soal dan komputasi terkait Aturan trapesium, aturan Simpson 1/3rd.</i></li> </ul> <p><b>Non-test:</b> <b>Task 2 stage 1:</b></p> <ul style="list-style-type: none"> <li>• <i>Solve questions and computations related to direct method, Newton's method of divided differences.</i></li> <li>• <i>Solve questions and computations related to trapezoidal rule, Simpson's 1/3 rule.</i></li> </ul>	<p>[PT : 3 x 50"]</p> <ul style="list-style-type: none"> <li>• <i>Lectures, discussion, ask and answer, exercise, assignment</i> [FF : 3 x 50"] [SS : 3 x 50"] [SA : 3 x 50"]</li> </ul>	<ul style="list-style-type: none"> <li>• <i>Chat and discussion in ITS platform forum</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Trapezoidal rule, Simpson's 1/3 rule, Simpson's 3/8 rule</i></li> </ul>	
--	---	--	--	--	--	---	--


13	<p>Mahasiswa memahami dan mampu Menguasai konsep turunan numerik</p> <p><i>Students understand and are able to master the concept of numerical derivatives</i></p>	<ul style="list-style-type: none"> <li>Mengetahui dan mampu menjelaskan metoda pendekatan tengah.</li> <li>Mengetahui dan mampu menjelaskan metoda pendekatan maju.</li> <li>Mengetahui dan mampu menjelaskan metoda pendekatan mundur.</li> <li><i>Know and be able to explain the middle approach method.</i></li> <li><i>Know and be able to explain advanced approach method.</i></li> <li><i>Know and be able to explain backward approach method.</i></li> </ul>		<ul style="list-style-type: none"> <li>Kuliah, diskusi, tanya jawab, latihan soal, tugas [TM : 3 x 50"] [BM : 3 x 50"] [PT : 3 x 50"]</li> <li><i>Lectures, discussion, ask and answer, exercise, assignment</i> [FF : 3 x 50"] [SS : 3 x 50"] [SA : 3 x 50"]</li> </ul>	<ul style="list-style-type: none"> <li>Chatting dan diskusi dalam forum platform ITS</li> <li><i>Chat and discussion in ITS platform forum</i></li> </ul>	<ul style="list-style-type: none"> <li>Metoda pendekatan tengah, maju, mundur</li> <li><i>Middle, forward, backward approach method.</i></li> </ul>	
14	<p>Mahasiswa memahami dan mampu Menguasai konsep persamaan diferensial</p> <p><i>Students understand and are able to master the concept of differential equations</i></p>	<ul style="list-style-type: none"> <li>Mengetahui dan mampu menjelaskan metode Euler.</li> <li>Mengetahui dan mampu menjelaskan metode Runge Kutta 2nd dan Runge Kutta 3th.</li> </ul>	<p><b>Non-tes :</b> <b>Tugas 2 tahap 2:</b></p> <ul style="list-style-type: none"> <li>Mengerjakan soal dan komputasi terkait Metode Euler, Runge Kutta</li> </ul>	<ul style="list-style-type: none"> <li>Kuliah, diskusi, tanya jawab, latihan soal, tugas [TM : 3 x 50"] [BM : 3 x 50"] [PT : 3 x 50"]</li> </ul>	<ul style="list-style-type: none"> <li>Chatting dan diskusi dalam forum platform ITS</li> <li><i>Chat and discussion in ITS platform forum</i></li> </ul>	<ul style="list-style-type: none"> <li>Metode Euler, Runge Kutta 2nd, Runge Kutta 3th, Finite Difference method</li> <li><i>Euler's method, 2<sup>nd</sup> order Runge Kutta, 3<sup>rd</sup> order Runge</i></li> </ul>	7.5

		<ul style="list-style-type: none"> <li>• Mengetahui dan mampu menjelaskan Finite Difference method</li> <li>• Know and be able to explain Euler's method</li> <li>• Know and be able to explain 2<sup>nd</sup> Order Runge Kutta and 3<sup>rd</sup> Order Runge Kutta</li> <li>• Know and able to explain Finite Difference method</li> </ul>	<p><b>Non-test:</b> <b>Task 2 stage 2:</b></p> <ul style="list-style-type: none"> <li>• Solve questions and computations related Euler's method, Runge Kutta</li> </ul>	<ul style="list-style-type: none"> <li>• Lectures, discussion, ask and answer, exercise, assignment [FF : 3 x 50"] [SS : 3 x 50"] [SA : 3 x 50"]</li> </ul>		Kutta, Finite Difference method	
15-16	<b>EVALUASI AKHIR SEMESTER FINAL-SEMESTER EXAM</b>						35

**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*

	<b>ASSESSMENT &amp; EVALUATION PLAN</b> <b>BACHELOR DEGREE PROGRAM OF BIOMEDICAL ENGINEERING - FTEIC ITS</b> <b>Course : Numerical Methods</b>		<b>RA&amp;E</b>
			Write Doc Code
<b>Kode/code:</b> <b>EW184004</b>	<b>Bobot sks/credits (T/P): 3/0</b>	<b>Rumpun MK: Ilmu Dasar Teknik</b> <b>Course Cluster: Basic Engineering</b>	Smt: IV
<b>OTORISASI</b> <b>AUTHORIZATION</b>	<b>Penyusun RA &amp; E</b> <b>Compiler A&amp;EP</b>  <b>Atar Babgei, S.T., M.Sc.</b>	<b>Koordinator RMK</b> <b>Course Cluster Coordinator</b>  <b>Muhammad Hilman Fatoni, S.T., M.T.</b>	<b>Ka DEP</b> <b>Head of DEP</b>  <b>Dr. Achmad Arifin, S.T., M.Eng.</b>

Mg ke/ Week (1)	Sub CP-MK / Lesson Learning Outcomes (LLO) (2)	Bentuk Asesmen (Penilaian) Form of Assessment (3)	Bobot / Load (%) (4)
2	<b>Sub CP-MK 1:</b>  Mahasiswa memahami dan mampu menguasai konsep analisa Galat, representasi bilangan, Teorema Taylor.  <b>LLO 1:</b> <i>Students understand and are able to master the concept of Error analysis, number representation, Taylor's Theorem.</i>	<b>Tes:</b> ETS Soal 1 (7% dari ETS 35%)  <b>Test:</b> Question 1 in Mid Exam (7% of Mid Exam 35%)	7
4	<b>Sub CP-MK 2:</b>  Mahasiswa memahami dan mampu menguasai konsep persamaan non linier.  <b>LLO 2:</b> <i>Students understand and are able to master the concept</i>	<b>Non-tes :</b> <b>Tugas 1 tahap 1:</b> <ul style="list-style-type: none"> <li>• Mengerjakan soal-soal yang berhubungan dengan teorema taylor dan deret taylor</li> <li>• Mengerjakan soal-soal yang berhubungan dengan regulafalsi, dan Newton-Rhapon.</li> </ul> <b>Tes :</b> ETS Soal 2 (8% dari ETS 35%)  <b>Non-test:</b> <b>Task 1 stage 1:</b>	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>	<ul style="list-style-type: none"> <li>• Solve question related to Taylor Theorem and Taylor series</li> <li>• Solve question related to regula falsi and Newton-Rhapson.</li> </ul> <p><b>Test:</b></p> <ul style="list-style-type: none"> <li>• Question 2 in Mid Exam (2% of Mid Exam 35%)</li> </ul>	
5	<p><b>Sub CP-MK 3:</b></p> <p>Mahasiswa memahami dan mampu menguasai konsep persamaan linier.</p> <p><b>LLO 3:</b> <i>Students understand and are able to master the concept of linear equations</i></p>	<p><b>Tes :</b> ETS Soal 3 (10% dari ETS 35%)</p> <p><b>Test:</b> <i>Question 3 in Mid Exam (10% of Mid Exam 35%)</i></p>	10
7	<p><b>Sub CP-MK 4:</b></p> <p>Mahasiswa memahami dan mampu menguasai konsep regresi.</p> <p><b>LLO 4:</b> <i>Students understand and are able to master the concept of regression</i></p>	<p><b>Non-tes :</b></p> <p><b>Tugas 1 tahap 2:</b></p> <ul style="list-style-type: none"> <li>• Mengerjakan soal terkait Aljabar matriks, eliminasi Gauss.</li> <li>• Mengerjakan soal dan komputasi terkait eliminasi Gauss Jordan, dan Gauss-Seidel.</li> <li>• Mengerjakan soal dan komputasi terkait Regresi linier, regresi non linier, dan regresi polinomial.</li> </ul> <p><b>Tes :</b> ETS Soal 4 (10% dari ETS 35%)</p> <p><b>Non-test:</b></p> <p><b>Task 1 stage 2:</b></p> <ul style="list-style-type: none"> <li>• Solve questions related to matrix algebra, Gauss elimination</li> <li>• Solve questions and computations related to Gauss Jordan elimination, and Gauss-Seidel</li> <li>• Solve questions and computations related to linear regression, and polynomial regression</li> </ul> <p><b>Test:</b> <i>Question 4 in Mid Exam (10% of Mid Exam 35%)</i></p>	7.5 10
9	<b>Sub CP-MK 5:</b>	<p><b>Tes :</b> EAS Soal 1 (17.5% dari EAS 35%)</p>	17.5

Mg ke/ Week (1)	Sub CP-MK / Lesson Learning Outcomes (LLO) (2)	Bentuk Asesmen (Penilaian) Form of Assessment (3)	Bobot / Load (%) (4)
	<p>Mahasiswa memahami dan mampu menguasai konsep interpolasi.</p> <p><b>LLO 5:</b> <i>Students understand and are able to master the concept of interpolation</i></p>	<p><b>Test:</b> <i>Question 1 in Final Exam (17.5% of Final Exam 35%)</i></p>	
11	<p><b>Sub CP-MK 6:</b></p> <p>Mahasiswa memahami dan mampu menguasai konsep integrasi Numerik.</p> <p><b>LLO 6:</b> <i>Students understand and are able to master the concept of Numerical integration</i></p>	<p><b>Non-tes :</b> <b>Tugas 2 tahap 1:</b></p> <ul style="list-style-type: none"> <li>• Mengerjakan soal dan komputasi terkait Metode langsung, metode selisih terbagi Newton,</li> <li>• Mengerjakan soal dan komputasi terkait Aturan trapesium, aturan Simpson 1/3rd.</li> </ul> <p><b>Non-test:</b> <b>Task 2 stage 1:</b></p> <ul style="list-style-type: none"> <li>• <i>Solve questions and computations related to direct method, Newton's method of divided differences.</i></li> <li>• <i>Solve questions and computations related to trapezoidal rule, Simpson's 1/3 rule</i></li> </ul>	7.5
13	<p><b>Sub CP-MK 7:</b></p> <p>Mahasiswa memahami dan mampu menguasai konsep turunan numerik.</p> <p><b>LLO 7:</b> <i>Students understand and are able to master the concept of numerical derivatives</i></p>	<p><b>Tes :</b> EAS Soal 2 (7.5% dari EAS 35%)</p> <p><b>Test:</b> <i>Question 2 in Final Exam (7.5% of Final Exam 35%)</i></p>	7.5
14	<p><b>Sub CP-MK 8:</b></p> <p>Mahasiswa memahami dan mampu menguasai</p>	<p><b>Non-tes :</b> <b>Tugas 2 tahap 2:</b></p> <ul style="list-style-type: none"> <li>• Mengerjakan soal dan komputasi terkait Metode Euler, Runge Kutta</li> </ul> <p><b>Tes :</b></p>	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)
	konsep persamaan diferensial.  <b>LLO 8:</b> <i>Students understand and are able to master the concept of differential equations</i>	EAS Soal 3 (10% dari EAS 35%)  <b>Non-test:</b> <b>Task 2 stage 2:</b> <ul style="list-style-type: none"> <li>• Solve questions and computations related Euler's method, Runge Kutta</li> </ul> <b>Test:</b> Question 3 in Final Exam (10% of Final Exam 35%)	
<b>Total bobot penilaian</b> <b>Total assessment load</b>			<b>100%</b>

**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- 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
CPL-06 / PLO-06	CPMK 3 / CLO 3	Week- 8	Mid Exam Question 3	10
	CPMK 4 / CLO 4	Week- 7	Task 1 stage 2	7.5
		Week- 8	Mid Exam Question 4	10
CPL-08 / PLO-08	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 1		0.075				0.075							0.15
2	ETS		0.25				0.1							0.35
3	Tugas 2								0.15					0.15
4	EAS								0.35					0.35
	Total		0.325				0.175		0.5					1