MODULE HANDBOOK

NUMERICAL ANALYSIS

ENDORSEMENT PAGE

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<tr><td></td><td colspan="4" align="center">MODULE HANDBOOK
NUMERICAL ANALYSIS
STATISTICS UNDERGRADUATE PROGRAM
DEPARTMENT OF STATISTICS
INSTITUT TEKNOLOGI SEPULUH NOPEMBER</td></tr>
</table>

Proses *Process*	Penanggung Jawab *Person in Charge*			Tanggal *Date*
	Nama *Name*	Jabatan *Position*	Tanda tangan *Signature*	
Perumus *Preparation*	Adatul Mukarromah, S.Si. M.Si	Dosen Lecturer		
Pemeriksa dan Pengendalian *Review and Control*	Adatul Mukarromah, S.Si. M.Si; Prof. Drs. Nur Iriawan, M.Ikom, Ph.D	Tim kurikulum Curriculum team		
Persetujuan *Approval*	Prof. Nur Iriawan, MIKom., Ph.D	Koordinator RMK Course Cluster Coordinator		
Penetapan *Determination*	Dr. Kartika Fithriasari, M.Si	Kepala Departemen Head of Department		

MODULE HANDBOOK
NUMERICAL ANALYSIS

Module name	NUMERICAL ANALYSIS	
Module level	Undergraduate	
Code	SS234204	
Course (if applicable)	NUMERICAL ANALYSIS	
Semester	2	
Person responsible for the module	Adatul Mukarromah, S.Si. M.Si	
Lecturer	Adatul Mukarromah, S.Si. M.Si; Prof. Drs. Nur Iriawan, M.Ikom, Ph.D	
Language	Bahasa Indonesia and English	
Relation to curriculum	Undergradute degree program, mandatory, 2nd semester.	
Type of teaching, contact hours	Team Based Project (25%) Other SCL Method (31.25%) Non-SCL Method (43.75%)	
Workload	1. Lectures [L] : 3 x 50 = 150 minutes perweek. 2. Exercises and Assignments [EA] : 3 x 60 = 180 minutes (3 hours) perweek. 3. Independent learning : 3 x 60 [IL]= 180 minutes (3 hours) per week	
Credit points	3 credit points (SKS) Equivalent to 4.8 ECTS	
Requirements according to the examination regulations	A student must have attended at least 80% of the lectures to sit in the exams.	
Mandatory prerequisites	-	
Learning outcomes and their corresponding PLOs	CLO.1 Able to use numerical or iterative concept in various calculus topics, namely calculation of: linear and nonlinear equation system solutions, interpolation, differential, optimization, integral, and differential equations. CLO.2 Able to compile MATLAB and Excel computer programs for numerical calculations. CLO.3 Able to calculate errors or errors and able to choose the right decision on the various numeric methods used. CLO.4 Able to model the relationship between quantitative response with quantitative predictors, as well as interpolate and extrapolate. CLO.5 Able to use numeric method for statistical modeling.	PLO-1 PLO-3 PLO-4 PLO-5

	CLO.8 Has professional responsibilities and ethics CLO.9 Able to motivate their self to think creatively and learn throughout life	
Content	Numerical analysis is required if the analytical solution cannot be found in calculus topics, because the function is in the form of a close form. The numerical topic is a method of achieving an iterational approach to get the results. This iteration requires programming. To get learning achievements, learning methods consisting of: lectures, discussions, exercises, programming practicums, and tasks are required.	
Assessment and its weight	Cognitive -Assignment (23%) Quiz (11%) Cognitive - Midterm Exam (15%) Simulator building project (30%) Simulator project presentation (21%)	
Media employed	LCD, whiteboard, websites (myITS Classroom), zoom	
Reading list	1. Chapra, S.C. and Canale, R.P., 2010. Numerical Methods for Engineer. 6th edition. New York: McGraw-Hill Companies. 2. Chapra, S.C. 2012. Applied Numerical Methods, with MATLAB for Engineers and Scientists. 3rd edition. New York : McGraw-Hill Companies. 3. Conte and Carl de Boor. 1995. Elementary Numerical Analysis : Algoritmic Approach. McGraw-Hill. 4. Thomas, King J., 1984. Introduction to Numerical Computation. McGraw-Hill.	

INSTITUT TEKNOLOGI SEPULUH NOPEMBER FAKULTAS SAINS DAN ANALITIKA DATA PROGRAM STUDI SARJANA STATISTIKA DEPARTEMEN STATISTIKA						**Kode Dokumen**	
RENCANA PEMBELAJARAN SEMESTER/ *SEMESTER LEARNING PLAN*							
MATA KULIAH (MK)/ *Course*		**KODE/** *Code*	**Rumpun MK/** *Course Group*	**BOBOT (sks)/** *Weight (credit)*		**SEMESTER/** *Semester*	**Tgl Penyusunan/** *Drafting Date*
ANALISIS NUMERIK/ *NUMERICAL ANALYSIS*		SS234204	SKSD	**T=2**	**P=1**	II	11 Januari 2023/ *January 11, 2023*
OTORISASI/ *AUTHORIZATION*		**Pengembang RPS/** *RPS Developer*	**Koordinator RMK/** *Course Group Coordinator*		**Ketua PRODI/** *Head of Department*		
		Adatul Mukarromah, S.Si. M.Si ; Prof. Drs. Nur Iriawan, M.Ilkom., Ph.D	Prof. Nur Iriawan, M.Ikom, Ph.D		Dr. Kartika Fithriasari, M.Si		
Capaian Pembelajaran (CP)/ *Learning Achievement*	**CPL-PRODI yang dibebankan pada MK/** *PLO*						
	CPL-1 Mampu menerapkan pengetahuan teori statistika, matematika, dan komputasi CPL-3 Mampu menganalisis data dengan metode statistika yang tepat dan mengintepretasikannya CPL-4 Mampu mengindentifikasi,memformulasi, dan menyelesaikan masalah statistika di berbagai bidang terapan CPL-5 Mampu menggunakan teknik komputasi dan perangkat komputer modern yang diperlukan dalam bidang statistika dan sains data *PLO-1 Able to apply statistical, mathematical, and computational theory knowledge* *PLO-3 Able to analyze data with the right statistical methods and interpret it* *PLO-4 Able to identify, formulate, and solve statistical problems in various applied fields* *PLO-5 Able to use the computing techniques and modern computer devices required in the field of statistics and data science*						
	Capaian Pembelajaran Mata Kuliah (CPMK)/ *CLO*						

	CPMK.1 Mampu menggunakan konsep numerik atau iterative pada berbagai topik kalkulus, yaitu perhitungan : solusi sistim persamaan linier dan nonlinier, interpolasi, diferensial, optimasi, integral, dan persamaan diferensial. CPMK.2 Mampu menyusun program komputer MATLAB dan Excel untuk perhitungan secara numerik. CPMK.3 Mampu menghitung kesalahan atau error serta mampu memilih keputusan yang tepat atas berbagai metoden numerik yang digunakan. CPMK.4 Mampu memodelkan hubungan antara respon kuantitatif dengan prediktor kuantitatif, serta melakukan interpolasi dan ekstrapolasi. CPMK.5 Mampu menggunakan metode numeric untuk pemodelan statistika. CPMK.8 Memiliki tanggung jawab dan etika profesi CPMK.9 Mampu memotivasi diri untuk berpikir kreatif dan belajar sepanjang hayat *CLO.1 Able to use numerical or iterative concept in various calculus topics, namely calculation of: linear and nonlinear equation system solutions, interpolation, differential, optimization, integral, and differential equations.* *CLO.2 Able to compile MATLAB and Excel computer programs for numerical calculations.* *CLO.3 Able to calculate errors or errors and able to choose the right decision on the various numeric methods used.* *CLO.4 Able to model the relationship between quantitative response with quantitative predictors, as well as interpolate and extrapolate.* *CLO.5 Able to use numeric method for statistical modeling.* *CLO.8 Has professional responsibilities and ethics* *CLO.9 Able to motivate their self to think creatively and learn throughout life*

Matrik CPL – CPMK

PLO-CLO Matrix

CPMK/*CLO*	CPL-6/*PLO-6*	CPL-7/*PLO-7*	CPL-8/*PLO-8*
CPMK-1/*CLO-1*			
CPMK-2/*CLO-2*			
CPMK-3/*CLO-3*			
CPMK-4/*CLO-4*			
CPMK-5/*CLO-5*			

Deskripsi Singkat MK/ *Course Description*	Analisis numerik diperlukan jika solusi analitik tidak dapat ditemukan dalam topik kalkulus, karena fungsinya dalam bentuk bentuk dekat. Topik numerik adalah metode untuk mencapai pendekatan iterasi untuk mendapatkan hasil. Iterasi ini membutuhkan pemrograman. Untuk mendapatkan prestasi belajar, metode pembelajaran terdiri dari: ceramah, diskusi, latihan, praktikum pemrograman, dan tugas-tugas wajib. *Numerical analysis is required if the analytical solution cannot be found in calculus topics, because the function is in the form of a close form. The numerical topic is a method of achieving an iterational approach to get the results. This iteration requires programming. To get learning achievements, learning methods consisting of: lectures, discussions, exercises, programming practicums, and tasks are required.*
Bahan Kajian: Materi	Dasar Sains, Teori Statistika, Pengumpulan Data, Deskripsi dan Eksplorasi, Komputasi dan Data Processing, Pemodelan, Industri dan Bisnis, Pemerintahan dan Kependudukan, Ekonomi dan Manajemen, Kesehatan dan Lingkungan

Pembelajaran/ *Course Material*	Basic Science, Statistical Theory, Data Collection, Description and Exploration, Computing and Data Processing, Modeling, Industry and Business, Government and Population, Economics and Management, Health and Environment
Pustaka/ *References*	**Utama/***Primary*:
	5. Chapra, S.C. and Canale, R.P., 2010. Numerical Methods for Engineer. 6th edition. New York: McGraw-Hill Companies.
	Pendukung/*Secondary*:
	1. Chapra, S.C. 2012. Applied Numerical Methods, with MATLAB for Engineers and Scientists. 3rd edition. New York : McGraw-Hill Companies. 2. Conte and Carl de Boor. 1995. Elementary Numerical Analysis : Algoritmic Approach. McGraw-Hill. 3. Thomas, King J., 1984. Introduction to Numerical Computation. McGraw-Hill.
Dosen Pengampu/ *Lecturers*	Adatul Mukarromah, S.Si. M.Si ; Prof. Drs. Nur Iriawan, M.Ilkom., Ph.D
Matakuliah syarat/ *Pre-requisite Course*	-

Mg Ke- *Week*	Kemampuan akhir tiap tahapan belajar (Sub-CPMK) *Final capability for each learning step*	Penilaian *Evaluation*		Bantuk Pembelajaran, Metode Pembelajaran, Penugasan Mahasiswa, [Estimasi Waktu] *Learning Format Learning Methods Assignment for Student [Estimated Time]*		Materi Pembelajaran [Pustaka] *Learning Material [References]*	Bobot Penilaian (%) *Evaluation Weight (%)*
		Indikator *Indicator*	Kriteria & Bentuk *Criteria and Format*	Luring *Offline*	Daring *Online*		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1		1. Mampu menjelaskan	Tugas, Latihan	Kuliah dan Praktikum		Pengertian metode	5%

| 1 | 1. Mampu mengguna- kan konsep numerik atau iteratif pada berbagai topik kalkulus, yaitu perhitungan : solusi sistim persamaan linier dan nonlinier, interpolasi, diferensial, optimasi integral, dan persamaan diferensial.
2. Mampu menyusun program komputer MATLAB dan Excel untuk perhitungan secara numerik.

3. Mampu menghitung kesalahan atau error, serta mampu memilih keputusan yang tepat atas berbagai metode numerik yang diguna- kan.

4. Mampu memodelkan hubungan antara respon kuantitatif dengan prediktor kuan-titatif, serta | dan membedakan an tara metode analitik atau eksak dengan me- tode numeric atau hampiran/pendekatan.
2. Mampu menghitung akar persamaan atau fungsi nonlinier menggunakan metode gra- fik, dengan Excel.
3. Mampu menghitung berbagai macam kesa- lahan hasil pendekatan.
4. Mampu menentukan angka signifikansi dan menggunakannya.

1. Able to explain and distinguish between analytical or exact methods and numerical methods or approximations.
2. Able to calculate the root of the equation or nonlinear functions using the graphing method, with Excel.
3. Able to calculate various kinds of error results of the approach.
4. Able to determine significance figures and use them. | Soal, Laporan Praktikum
Assignments, Exercises, Practicum Report | Case Methods

Lectures and Practices Case Methods

TM: 1×[2x50"]
P: 1×[1x170"]
BM: 1×[2×60"]
PT: 1×[2×60"] | | eksak dan pendekatan numerik,perhitungan berbagai kesalahan, serta penerapan angka siknifikansi.

Kasus : Demo Me- tode Grafik

CPMK: 6.1, 6.2, 6.3

The definition of exact method and numerical approach, calculations of various error, and also application of significant number

Case: Demo of graphic method
CLO: 6.1, 6.2, 6.3 | *5%* |
| 2-3 | | 1. Mampu menghitung | Tugas, Latihan | Kuliah dan Praktikum | | Perhitungan solusi | 10% |

	melakukan interpolasi dan ekstra- polasi. 5 Mampu menggun-kan metode numeric untuk penaksiran para- meter modal pemodelan statistika. *1. Able to use numerical or iterative concept on various topics of calculus, namely calculation of: solutions of linear and nonlinear system of equations, interpolation, differential, integral optimization, and differential equations.* *2. Able to compile MATLAB and Excel computer programs for numerical calculations.*	solusi persamaan non-linier dengan berbagai metode numerik. 2. Mampu menjelaskan kelebihan dan keku-rangan suatu metode numerik dalam penye-lesaian persa maan nonlinier. *1. Able to calculate nonlinear equation solutions with various numerical methods.* *2. Be able to explain the advantages and disadvantages of a numerical method in solving nonlinear equations.*	Soal, Laporan Praktikum *Assignments, Exercises, Practicum Report*	Case Methods *Lectures and Practices Case Methods* **TM: 2×[2x50"]** **P: 2×[1x170"]** **BM: 2×[2×60"]** **PT: 2×[2×60"]**		persamaan nonlinier dengan berbagai metode numeric (tertutup dan terbuka), yaitu : Bisecti-on, Regula Falsi, dan Newton Rhap-son. Perbandingan kelebihan dan kekurangan berbagai metode numerik dalam penyelesaian persamaan nonlinier. CPMK: 6.1, 6.2, 6.3 *Calculation of solutions to nonlinear equations using various numerical methods (Closed and open), namely: Bisection, Regula Falsi, and Newton Rhapson.* *Comparison of the advantages and disadvantages of various numerical methods in solving nonlinear equations. CPMK: 6.1, 6.2, 6.3*	*10%*
4-6	*3. Able to calculate errors or errors, as well*	1. Mampu menggunakan Deret Taylor untuk menyusun formula	Tugas, Latihan Soal, Laporan Praktikum *Assignments,*	Kuliah dan Praktikum Case Methods *Lectures and Practices*		Perhitungan solusi persamaan nonlinier simultan dengan metode numeric	15% *15%*

	as able to choose the right decision on the various numerical methods used. *4. Able to be modelling the relationship between quantitative response with quantitative predictors, as well as interpolate and extra- pattern.* *5 Able to use numerical methods for assessing the capital meters of statistical modeling*	perhitungan akar sistim persamaan non linier. 2. Mampu menghitung solusi sistim persama- an non linier dengan berbagai metode. 3. Mampu menjelaskan kelebihan dan kekura- ngan suatu metode numerik dalam penyele- saian persamaan nonlinier. *1. Able to use Taylor Series to compile a formula for calculating the roots of non- linear equations.* *2. Able to calculate system solutions of non- linear equations with various methods.* *3. Be able to explain the advantages and disadvantages of a numerical method in solving nonlinear equations.*	*Exercises, Practicum Report*	*Case Methods* **TM: 3×[2x50"]** **P: 3×[1x170"]** **BM: 3×[2×60"]** **PT: 3×[2×60"]**		Newton Raphson, dengan penerapan pada optimasi OLS dan maksimum li- kelihood. **Kasus**: Regresi Linier Sederhana dan Regresi Logistik. CPMK: 6.1, 6.2, 6.3, 6.4, 6.5 *Simultaneous calculation of nonlinear equation solutions using Newton Raphson numeric method, with application of OLS optimization and maximum likelihood.* *Case: Simple Linear Regression and Logistic Regression.* *CPMK: 6.1, 6.2, 6.3, 6.4, 6.5*	
7		1.Mampu menghitung solusi sistim persamaan linier dengan berbagai metode. 2.Mampu menjelaskan kelebihan dan keku-	Tugas, Latihan Soal, Laporan Praktikum *Assignments, Exercises, Practicum Report*	Kuliah dan Praktikum Case Methods *Lectures and Practices Case Methods*		Perhitungan solusi sistim persamaan linier dengan meto- de: Eliminasi Gauss Naif, Gauss Jordan, serta Elimi-nasi	20% *20%*

		rangan suatu metode numerik dalam penye-lesaian sistim persamaan linier. 1. *Able to calculate solutions of systems of linear equations with various methods.* 2. *Be able to explain the advantages and disadvantages of a numerical method in solving systems of linear equations.*		**TM: 1×[2x50"]** **P: 1×[1x170"]** **BM: 1×[2×60"]** **PT: 1×[2×60"]**		Gauss Seidel. CPMK: 6.1, 6.2 *Calculation of solutions for systems of linear equations with the method: Elimination of Gauss Naif, Gauss Jordan, and Elimination of Gauss Seidel.* *CPMK: 6.1, 6.2*	
8/8		ETS/*Midterm*					
9-10 *9-10*		1. Mampu membentuk model polinomial dan model nonlinier, serta menggunakannya untuk melakukan interpolasi. 2. Mampu melakukan interpolasi menggunakan metode : Newton, Lagrange, dan Spline. 1. *Able to form polynomial and nonlinear models and use them to perform interpolation.* 2. *Able to perform interpolation using the methods: Newton, Lagrange, and*	Tugas, Latihan Soal, Laporan Praktikum *Assignments, Exercises, Practicum Report*	Kuliah dan Praktikum Case Methods *Lectures and Practices Case Methods* **TM: 2×[2x50"]** **P: 2×[1x170"]** **BM: 2×[2×60"]** **PT: 2×[2×60"]**		Pemodelan (*curve fitting*), Interpolasi dan Ekstrapolasi. Pemodelan meng-gunakan model po-linomial atau regre-si linier. Interpolasi menggunakan me-tode : Newton un-tuk Polinomial or-der pertama sam-pai order tinggi, Lagrange, serta Spline Linier dan kuadratik. CPMK: 6.1, 6.2, 6.3 *Modeling (curve fitting), Interpolation and Extrapolation. Modeling using*	10% *10%*

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		Spline.				*polynomial or linear regression models. Interpolation using the method: Newton for first order polynomial to high order, Lagrange, and Linear and quadratic spline.* *CPMK: 6.1, 6.2, 6.3*	
11		1.Mampu menyelesaikan integrasi secara numerik dengan beberapa metode. 2.Mampu menjelaskan kelebihan dan keku-rangan berbagai metode numerik. *1. Able to complete numerical integration with several methods.* *2. Be able to explain the advantages and disadvantages of various numerical methods.*	Tugas, Latihan Soal, Laporan Praktikum *Assignments, Exercises, Practicum Report*	Kuliah dan Praktikum Case Methods *Lectures and Practices Case Methods* **TM: 2×[2x50"]** **P: 2×[1x170"]** **BM: 2×[2×60"]** **PT: 2×[2×60"]**		Integral fungsi menggunakan me-tode: Rieman,Tra-pesium, dan Simp-son, serta perhitu-ngan probabilitas. Integral Rangkap pada fungsi dengan metode Rieman dan metode Sudut. CPMK: 6.1, 6.2, 6.3 *Integral functions using the methods: Reimann, Trapezium, and Simpson, along with probability calculations. Duplicate Integral on the function with the Riemann method and the Angle method.* *CPMK: 6.1, 6.2, 6.3*	10% *10%*
12		1. Mampu menyelesaikan diferensial fungsi menggunakan metode numerik, yaitu : lang-	Tugas, Latihan Soal, Laporan Praktikum *Assignments,*	Kuliah dan Praktikum Case Methods *Lectures and Practices*		Diferensial fungsi CPMK: 6.1, 6.2, 6.3	10% *10%*

		kah maju, langkah mundur, dan tengah. 2. Mampu menjelaskan kelebihan dan kekura-ngan metode numerik dalam penyelesaian diferensial fungsi. 3. Mampu membedakan berbagai metode pen-diferensialan fungsi. *1. Be able to solve differential functions using numerical methods, namely: step forward, step backward, and middle.* *2. Be able to explain the advantages and disadvantages of numerical methods in solving differential functions.* *3. Be able to distinguish various methods of differentiating functions.*	*Exercises, Practicum Report*	*Case Methods* **TM: 1×[2x50"]** **P: 1×[1x170"]** **BM: 1×[2×60"]** **PT: 1×[2×60"]**		*Differentiation function* *CPMK: 6.1, 6.2, 6.3*	
13		1. Mampu menghitung vector solusi pada per-samaan nonlinier least square. 2. Mampu menghitung vector solusi pada per-samaan maksimum likelihood. 3. Menerapkan Newton Raphson dan Gauss Newton pada pemodelan nonlinier di bidang statistika.	Tugas, Latihan Soal, Laporan Praktikum *Assignments, Exercises, Practicum Report*	Kuliah dan Praktikum Case Methods *Lectures and Practices Case Methods* **TM: 1×[2x50"]** **P: 1×[1x170"]** **BM: 1×[2×60"]** **PT: 1×[2×60"]**		Regresi Non-Linier menggunakan me-tode Gauss Newton CPMK: 6.1, 6.2, 6.5 *Non-Linear Regression using Newton's Gauss method* *CPMK: 6.1, 6.2, 6.5*	10% *10%*

		1. Able to calculate the solution vector in the least square nonlinear equation. *2. Able to calculate the solution vector in the maximum likelihood equation.* *3. Applying Newton Raphson and Gauss Newton to the nonlinear modeling in statistics field.*					
14-15		Mampu menyelesaikan Persamaan Diferensial Biasa dan nilai batas menggunakan metode numerik, yaitu : Euler dan Runge Kuta. *Able to solve Ordinary Differential Equations and limit values using numerical methods, namely: Euler and Runge Kuta.*	Tugas, Latihan Soal, Laporan Praktikum *Assignments, Exercises, Practicum Report*	Kuliah dan Praktikum Case Methods *Lectures and Practices Case Methods* **TM: 2×[2x50"]** **P: 2×[1x170"]** **BM: 2×[2×60"]** **PT: 2×[2×60"]**		Persamaan Diferensial CPMK: 6.1, 6.2 *Differential equations CPMK: 6.1 6.2*	10% *10%*
16/16	Evaluasi Akhir Semester / *Final Exam*						

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