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MODULE HANDBOOK

NUMERICAL ANALYSIS

BACHELOR DEGREE PROGRAM
DEPARTEMENT OF STATISTICS
FACULTY OF SCIENCE AND DATA ANALYTICS
INSTITUT TEKNOLOGI SEPULUH NOPEMBER

ENDORSEMENT PAGE

	MODULE HANDBOOK **NUMERICAL ANALYSIS** **DEPARTMENT OF STATISTICS** **INSTITUT TEKNOLOGI SEPULUH NOPEMBER**

Proses ***Process***	**Penanggung Jawab** ***Person in Charge***			**Tanggal** ***Date***
	Nama ***Name***	**Jabatan** ***Position***	**Tandatangan** ***Signature***	
Perumus *Preparation*	Dr. Kartika Fithriasari, M.Si	Dosen *Lecturer*		**March 28, 2019**
Pemeriksa dan Pengendalian *Review and Control*	Dr. Dra. Kartika Fithriasari, M.Si ; Irhamah, S.Si, M.Si, Ph.D ; Adatul Mukarromah, S.Si. M.Si ; Dra. Wiwiek Setya Winahju, M.S.	Tim kurikulum *Curriculum team*		**April 15, 2019**
Persetujuan *Approval*	Prof. Drs. Nur Iriawan, M.Ilkom., Ph.D	Koordinator RMK *Course Cluster Coordinator*		**July 17, 2019**
Penetapan *Determination*	Dr. Kartika Fithriasari, M.Si	Kepala Departemen *Head of Department*		**July 30, 2019**

MODULE HANDBOOK

NUMERICAL ANALYSIS

Module name	**Numerical Analysis**	
Module level	Undergraduate	
Code	KS184341	
Course (if applicable)	Numerical Analysis	
Semester	Third Semester (Ganjil)	
Person responsible for the module	Dr. Kartika Fithriasari, M.Si	
Lecturer	Dr. Dra. Kartika Fithriasari, M.Si ; Irhamah, S.Si, M.Si, Ph.D ; Adatul Mukarromah, S.Si. M.Si ; Dra. Wiwiek Setya Winahju, M.S.	
Language	Bahasa Indonesia and English	
Relation to curriculum	Undergradute degree program, **mandatory**, 3rd semester.	
Type of teaching, contact hours	Lectures, <50 students	
Workload	1. Lectures : 3 x 50 = 150 minutes per week. 2. Practicum : 135 minutes per week. 3. Exercises and Assignments : 3 x 60 = 180 minutes (3 hours) perweek. 4. 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 80% of the lectures to sit in the exams.	
Mandatory prerequisites	-	
Learning outcomes and their corresponding PLOs	*CLO.1 Able to used 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 modeling 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

	CLO.8 Has professional responsibilities and ethics *CLO.9 Able to motivate theirself to think creatively and learn throughout life*	PLO – 5
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.*	
Study and examination requirements and forms of examination	• In-class exercises • Assignment 1, 2, 3 • Mid-term examination • Final examination	
Media employed	LCD, whiteboard, websites (myITS Classroom), zoom.	
Reading list	1. Chapra, S.C. dan Canale, R.P. Numerical Methods For Engineer, Sixth Edition, McGraw-Hill Companies, New York, 2010. 2. Chapra, S.C. Applied Numerical Methods, with MATLAB for Engineers and Scientists, Third Edition, McGraw-Hill Companies, New York, 2012 3. Conte and Carl de Boor, “Elementary Numerical Analysis : Algoritmic Approach”, McGraw-Hill, 1995 4. Thomas King J, “Introduction to numerical Computation”, McGraw-Hill, 1984	

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RP-S1	Dosen Pengampu	Dr. Dra. Kartika Fithriasari, M.Si ; Irhamah, S.Si, M.Si, Ph.D ; Adatul Mukarromah, S.Si. M.Si ; Dra. Wiwiek Setya Winahju, M.S.

Bahan Kajian *Study Materials*	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 *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*
CPL yang dibebankan 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 *CPL-1 Able to apply statistical, mathematical, and computational theory knowledge* *CPL-3 Able to analyze data with the right statistical methods and interpret it* *CPL-4 Able to identify, formulate, and solve statistical problems in various applied fields* *CPL-5 Able to use the computing techniques and modern computer devices required in the field of statistics and data science*
CP-MK *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 *CPMK.1 Able to used numerical or iterative concept in various calculus topics, namely calculation of: linear and nonlinear equation system solutions, interpolation, differential, optimization, integral, and differential equations.* *CPMK.2 Able to compile MATLAB and Excel computer programs for numerical calculations.* *CPMK.3 Able to calculate errors or errors and able to choose the right decision on the various numeric methods used.* *CPMK.4 Able to modeling the relationship between quantitative response with quantitative predictors, as well as interpolate and extrapolate.* *CPMK.5 Able to use numeric method for statistical modeling.* *CPMK.8 Has professional responsibilities and ethics* *CPMK.9 Able to motivate theirself to think creatively and learn throughout life*

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Perte-muan/ *Meeting*	**Kemampuan Akhir Sub CP-MK/** *Final Capability*	**Keluasan (materi pembelajaran)/** *Extent (Study Materials)*	**Metode Pembelajaran/** *Learning Methods*	**Estimasi Waktu/** *Estimated Time*	**Bentuk Evaluasi/** *Evaluation Form*	**Kriteria dan Indikator Penilaian/** *Assessment Criteria and Indicator*	**Bobot Penilaian/** *Score Weight*
1	1. Mampu menggunakan 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	Pengertian metode eksak dan pendekatan numerik,perhitungan berbagai kesalahan, serta penerapan angka siknifikansi. ***Kasus*** : Demo Metode 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*	Ceramah interaktif, Diskusi, Latihan. *Interactive Lectures, Discussions, Exercises.*	150 menit *150 minutes*	Tugas, Latihan Soal, Laporan Praktikum *Assignments, Exercises, Practicum Report*	1. Mampu menjelaskan dan membedakan antara metode analitik atau eksak dengan metode numeric atau hampiran/pendekatan. 2. Mampu menghitung akar persamaan atau fungsi nonlinier menggunakan metode grafik, dengan Excel. 3. Mampu menghitung berbagai macam kesalahan 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.*	10% /10% 15% /25%

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	numerik yang diguna-kan.	*Case : Demo of graphic method CLO: 6.1, 6.2, 6.3*					
2,3	4. Mampu memodelkan hubungan antara respon kuantitatif dengan prediktor kuan-titatif, serta melakukan interpolasi dan ekstra-polasi. 5 Mampu menggun-kan metode numeric untuk penaksiran para- meter modal pemode-lan 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*	Perhitungan solusi 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),*	Ceramah in-teraktif, Dis-kusi, Latihan, Praktikum. *Interactive Lectures, Discussions, Exercises.*	300 menit *300 minutes*	Tugas, Latihan Soal, Laporan Praktikum *Assignments, Exercises, Practicum Report*	1. Mampu menghitung 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.*	10% /35%

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	optimization, and differential equations. *2. Able to compile MATLAB and Excel computer programs for numerical calculations.* *3. Able to calculate errors or errors, as well as able to choose the right decision on the various numerical methods used.*	*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*					
4,5,6	*4. Able to modeling 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 solusi persamaan nonlini-er simultan dengan metode numeric Newton Raphson, dengan penerapan pada optimasi OLS dan maksimum li-kelihood. ***Kasus***: Regresi Li-nier Sederhana dan Regresi Logistik.	Ceramah in-teraktif, Dis-kusi, Latihan/ Praktikum. *Interactive Lectures, Discussions, Exercises/Prac tice.*	450 menit *450 minutes*	Tugas, Latihan Soal, Laporan Praktikum *Assignments, Exercises, Practicum Report*	1. Mampu menggunakan Deret Taylor untuk menyusun formula 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.*	10% /45%

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		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*				*3. Be able to explain the advantages and disadvantages of a numerical method in solving nonlinear equations.*	
7		Perhitungan solusi sistim persamaan linier dengan metode: Eliminasi Gauss Naif, Gauss Jordan, serta Elimi-nasi Gauss Seidel. CPMK: 6.1, 6.2	Ceramah interaktif, Diskusi, Latihan/ Praktikum. *Interactive Lectures, Discussions,*	150 menit *150 minutes*	Tugas, Latihan Soal, Laporan Praktikum *Assignments, Exercises, Practicum Report*	1. Mampu menghitung solusi sistim persamaan linier dengan berbagai metode. 2. Mampu menjelaskan kelebihan dan kekurangan suatu metode numerik dalam penyelesaian sistim persamaan linier. *1. Able to calculate solutions of systems of linear equations with various methods.*	

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		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*	*Exercises/Practice.*			*2. Be able to explain the advantages and disadvantages of a numerical method in solving systems of linear equations*.	
8		**ETS/***Midterm Evaluation*					
9,10		Pemodelan (*curve fitting*), Interpolasi dan Ekstrapolasi. Pemodelan menggunakan model polinomial atau regre-si linier. Interpolasi menggunakan metode : Newton un-tuk Polinomial or-der pertama sam-pai order tinggi, Lagrange, serta Spline Linier dan kuadratik.	Ceramah interaktif, Diskusi, Latihan/ Praktikum. *Interactive Lectures, Discussions, Exercises/Practice.*	300 menit *300 minutes*	Tugas, Latihan Soal, Laporan Praktikum *Assignments, Exercises, Practicum Report*	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 Spline.*	10%/55%

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		CPMK: 6.1, 6.2, 6.3 *Modeling (curve fitting), Interpolation and Extrapolation. Modeling using 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		Integral fungsi menggunakan metode: Rieman,Trapesium, dan Simpson, serta perhitungan probabilitas. Integral Rangkap pada fungsi dengan	Ceramah interaktif, Diskusi, Latihan/ Praktikum. *Interactive Lectures, Discussions,*	150 menit *150 minutes*	Tugas, Latihan Soal, Laporan Praktikum *Assignments, Exercises, Practicum Report*	1. Mampu menyelesaikan integrasi secara nu-merik dengan beberapa metode. 2. Mampu menjelaskan kelebihan dan keku-rangan berbagai metode numerik. *1. Able to complete numerical integration with several methods.*	5% /60%

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		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 Rieman method and the Angle method.* *CPMK: 6.1, 6.2, 6.3*	*Exercises/Practice.*			*2. Be able to explain the advantages and disadvantages of various numerical methods.*	
12		Diferensial fungsi CPMK: 6.1, 6.2, 6.3 *Differentiation function* *CPMK : 6.1, 6.2, 6.3*	Ceramah interaktif, Diskusi, Latihan/ Praktikum. *Interactive Lectures, Discussions, Exercises/Practice.*	150 menit *150 minutes*	Tugas, Latihan Soal, Laporan Praktikum *Assignments, Exercises, Practicum Report*	1. Mampu menyelesaikan diferensial fungsi menggunakan metode numerik, yaitu : langkah maju, langkah mundur, dan tengah. 2. Mampu menjelaskan kelebihan dan kekurangan metode numerik dalam penyelesaian diferensial fungsi. 3. Mampu membedakan berbagai metode pendiferensialan fungsi. *1. Able to complete differential functions*	15% /75%

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						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 function.* *3. Able to distinguish various methods of differentiating functions.*	
13		Regresi Non Linier menggunakan metode Gauss Newton CPMK: 6.1, 6.2, 6.5 *Non Linear Regression using Newton's Gauss method* *CPMK: 6.1, 6.2, 6.5*	Ceramah interaktif, Diskusi, Latihan/ Praktikum. *Interactive Lectures, Discussions, Exercises/Practice.*	150 menit *150 minutes*	Tugas, Latihan Soal, Laporan Praktikum *Assignments, Exercises, Practicum Report*	1. Mampu menghitung vector solusi pada persamaan nonlinier least square. 2. Mampu menghitung vector solusi pada persamaan maksimum likelihood. 3. Menerapkan Newton Raphson dan Gauss Newton pada pemodelan nonlinier di bidang statistika. *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.*	5%/80%
14,15		Persamaan Diferensial CPMK: 6.1, 6.2 *Differential equations* *CPMK : 6.1 6.2*	Ceramah interaktif, Diskusi, Latihan/ Praktikum. *Interactive Lectures,*	300 menit *300 minutes*	Tugas, Latihan Soal, Laporan Praktikum *Assignments, Exercises, Practicum Report*	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.*	15% /95%

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			Discussions, Exercises/Practice.				
16		**EAS/ *Final term***					

PUSTAKA/*References* **:**

1. Chapra, S.C. dan Canale, R.P. Numerical Methods For Engineer, Sixth Edition, McGraw-Hill Companies, New York, 2010.
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