SEMESTER LEARNING PLAN

NUMERICAL METHODS COURSES
(23H01120503)

TEACHING TEAM

Prof. Dr. Syamsuddin Toaha, M.Sc.
196801141994121001

Prof. Agustinus Ribal, S.Si.,M.Sc., Ph. D
197508161999031001

Dr. Khaeruddin, M.Sc.
196509141991031003

STUDI PROGRAM OF MATHEMATICS - S1
FACULTY OF MATHEMATICS AND NATURAL SCIENCES
HASANUDDIN UNIVERSITY
MAKASSAR
2025

STUDY PROGRAM OF MATEMATIKA - S1
FACULTY OF MATHEMATICS AND NATURAL SCIENCES
HASANUDDIN UNIVERSITY

Vision

The scientific vision is to become a study program with an international reputation in the development of mathematics based on the Indonesian maritime continent by 2030

Vision Strategy

Misson

To fulfill the above vision, the Undergraduate Mathematics Study Program has four missions, namely:

- Organizing innovative and effective mathematics learning to improve the quality and creativity of students in order to compete nationally and internationally.
- Improving a research culture that produces internationally reputable publications.
- Playing an active role in community service activities and collaborating with other academic institutions, government, business, media and society.
- Carry out governance in the Mathematics Study Program that is effective, efficient and transparent based on IT and ISO 9001:2015 standards to achieve the tridharma goals.

Graduate Profiles

Gagal diterjemahkan

PLO charged to courses

CPL-9 (S2) - The students are able to adapt and develop self-abilities, both in mathematics and other relevant areas of science in their professional lives

CPL-2 (P2) - The students are able to identify objects, techniques, and theorems in fundamental mathematics, and making a connection for solving problems

CPL-3 (KU1) - The students are able to analyse a mathematical problem with logic, analytic, and systematic structure

CPL-6 (KK2) - The students are able to apply the mathematical method for solving a mathematical related-problem with or without the aid of computers and software

CPL-7 (KK3) - The students are able to demonstrate mathematical skills which include interpretation, connecting problems, solving problems, and communicating individually or teamwork

Course Learning Outcomes (CLO)

CPMK-1: Identify techniques and methods in solving numerical methods and make connections to solve numerical method problems. (CPL2 dan CPL3)

CPMK-2: Use concepts effectively to solve numerical methods problems in mathematics, science and engineering. (CPL9, CPL2 dan CPL3)

CPMK-3: Demonstrate their understanding of numerical methods concepts through the use of appropriate technology. (CPL2 dan CPL6)

CPMK-4: Communicate mathematical ideas in appropriate contexts both orally and in writing with groups, especially using numerical methods. (CPL2 dan CPL7)

Sub-CLO

Sub CPMK-1: Students are able to explain the meaning of numerical methods, the need for numerical

methods, the stages of numerical methods and errors. (CPMK-1 dan CPMK-2)

Sub CPMK-2: Students are able to apply numerical methods in solving nonlinear equations. Students are able to create computer programs for the given numerical methods (CPMK-1, CPMK-3 dan CPMK-4)

Sub CPMK-3: Students are able to determine the determinant and inverse of a matrix numerically (CPMK-2, CPMK-3 dan CPMK-4)

Sub CPMK-4: Students are able to apply several interpolation methods for curve matching and are able to create computer programs for numerical interpolation methods. (CPMK-2, CPMK-3 dan CPMK-4)

Sub CPMK-5: Students are able to apply the concept of Taylor series expansion in approximating the derivative of a function, and are able to solve derivative approximation problems using computer programs. (CPMK-1, CPMK-3 dan CPMK-4)

Sub CPMK-6: Students are able to apply several numerical methods in determining the integral of a function and are able to create programs for numerical methods. (CPMK-1, CPMK-3 dan CPMK-4)

Sub CPMK-7: Students are able to apply several Taylor series methods, Euler's method, Heun's method and Runge Kutta's method of order 2 and 4 in solving ordinary differential equations. · Able to create computer programs for the numerical methods above. (CPMK-1, CPMK-3 dan CPMK-4)

Learning Analytics

Numerical Methods

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Students are able to apply several Taylor series methods, Euler's method, Heun's method and Runge Kutta's method of order 2 and 4 in solving ordinary differential equations. · Able to create computer programs for the numerical methods above. (CPMK-1, CPMK-3 dan CPMK-4)

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Students are able to apply several numerical methods in determining the integral of a function and are able to create programs for numerical methods. (CPMK-1, CPMK-3 dan CPMK-4)

↑

Students are able to apply the concept of Taylor series expansion in approximating the derivative of a function, and are able to solve derivative approximation problems using computer programs. (CPMK-1, CPMK-3 dan CPMK-4)

↑

Students are able to apply several interpolation methods for curve matching and are able to create computer programs for numerical interpolation methods. (CPMK-2, CPMK-3 dan CPMK-4)

↑

Students are able to determine the determinant and inverse of a matrix numerically (CPMK-2, CPMK-3 dan CPMK-4)

↑

Students are able to apply numerical methods in solving nonlinear equations. Students are able to create computer programs for the given numerical methods (CPMK-1, CPMK-3 dan CPMK-4)

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Students are able to explain the meaning of numerical methods, the need for numerical methods, the stages of numerical methods and errors. (CPMK-1 dan CPMK-2)

Have passed the course Basic Mathematics I, Basic Mathematics II and Algorithms and Programming

HASANUDDIN UNIVERSITY
FAKULTY OF MATHEMATICS AND NATURAL SCIENCES
STUDY PROGRAM OF MATHEMATICS - S1
SEMESTER LEARNING PLAN

Course	Code	Cource Group	Credits	SEMESTER	Compilation Date
Numerical Methods	23H01120503	Applied Mathematics	3	3	8 Februari 2025

AUTHORITY	SLP Developer Lecturer	Coordinator	Head of Study Program
	Prof. Dr. Syamsuddin Toaha, M.Sc., Prof. Agustinus Ribal, S.Si.,M.Sc., Ph. D	Prof. Agustinus Ribal, S.Si.,M.Sc., Ph. D	Dr. Firman, S.Si.,M.Si.

SLOs that are imposed on the course	
SLO-9:	Mahasiswa dapat beradaptasi dan mengembangkan kemampuan diri, baik dalam matematika dan bidang ilmu lain yang relevan dalam kehidupan profesional mereka, dengan budaya belajar sepanjang hayat
SLO-2:	Mahasiswa mampu mengidentifikasi objek, teknik, dan sifat dalam matematika dasar, dan membuat koneksi untuk menyelesaikan masalah
SLO-3:	Mahasiswa mampu menganalisis suatu masalah matematika dengan logika, analitik, dan struktur sistematis
SLO-6:	Mahasiswa dapat menerapkan metode matematika untuk memecahkan masalah terkait matematika dengan atau tanpa bantuan komputer dan perangkat lunak
SLO-7:	Mahasiswa dapat menunjukkan keterampilan matematika termasuk menghubungkan masalah, menyelesaikan masalah, interpretasi, dan berkomunikasi secara individu atau dengan kerja tim

SLO ⇒ Course Learning Outcomes	
After completing this course, it is expected:	
SLO-2	**CLO-1:** Identify techniques and methods in solving numerical methods and make connections to solve numerical method problems.
	CLO-2: Use concepts effectively to solve numerical methods problems in mathematics, science and engineering.
	CLO-3: Demonstrate their understanding of numerical methods concepts through the use of appropriate technology.
	CLO-4: Communicate mathematical ideas in appropriate contexts both orally and in writing with groups, especially using numerical methods.
SLO-3	**CLO-1:** Identify techniques and methods in solving numerical methods and make connections to solve numerical method problems.
	CLO-2: Use concepts effectively to solve numerical methods problems in mathematics, science and engineering.
SLO-9	**CLO-2:** Use concepts effectively to solve numerical methods problems in mathematics, science and engineering.
SLO-6	**CLO-3:** Demonstrate their understanding of numerical methods concepts through the use of appropriate technology.

Learning Outcomes Course	**SLO-7**	**CLO-4:** Communicate mathematical ideas in appropriate contexts both orally and in writing with groups, especially using numerical methods.
	CLO ⇒ Sub-CLO	
	CLO-1	**Sub-CLO-1:**Students are able to explain the meaning of numerical methods, the need for numerical methods, the stages of numerical methods and errors.
		Sub-CLO-2: Students are able to apply numerical methods in solving nonlinear equations. Students are able to create computer programs for the given numerical methods
		Sub-CLO-5: Students are able to apply the concept of Taylor series expansion in approximating the derivative of a function, and are able to solve derivative approximation problems using computer programs.
		Sub-CLO-6: Students are able to apply several numerical methods in determining the integral of a function and are able to create programs for numerical methods.
		Sub-CLO-7: Students are able to apply several Taylor series methods, Euler's method, Heun's method and Runge Kutta's method of order 2 and 4 in solving ordinary differential equations. · Able to create computer programs for the numerical methods above.
	CLO-2	**Sub-CLO-1:**Students are able to explain the meaning of numerical methods, the need for numerical methods, the stages of numerical methods and errors.
		Sub-CLO-3: Students are able to determine the determinant and inverse of a matrix numerically
		Sub-CLO-4: Students are able to apply several interpolation methods for curve matching and are able to create computer programs for numerical interpolation methods.
	CLO-3	**Sub-CLO-2:**Students are able to apply numerical methods in solving nonlinear equations. Students are able to create computer programs for the given numerical methods
		Sub-CLO-3: Students are able to determine the determinant and inverse of a matrix numerically
		Sub-CLO-4: Students are able to apply several interpolation methods for curve matching and are able to create computer programs for numerical interpolation methods.
		Sub-CLO-5: Students are able to apply the concept of Taylor series expansion in approximating the derivative of a function, and are able to solve derivative approximation problems using computer programs.
		Sub-CLO-6: Students are able to apply several numerical methods in determining the integral of a function and are able to create programs for numerical methods.
		Sub-CLO-7: Students are able to apply several Taylor series methods, Euler's method, Heun's method and Runge Kutta's method of order 2 and 4 in solving ordinary differential equations. · Able to create computer programs for the numerical methods above.
	CLO-4	**Sub-CLO-2:**Students are able to apply numerical methods in solving nonlinear equations. Students are able to create computer programs for the given numerical methods
		Sub-CLO-3: Students are able to determine the determinant and inverse of a matrix numerically
		Sub-CLO-4: Students are able to apply several interpolation methods for curve matching and are able to create computer programs for numerical interpolation methods.
		Sub-CLO-5: Students are able to apply the concept of Taylor series expansion in approximating the derivative of a function, and are able to solve derivative approximation problems using computer programs.

	Sub-CLO-6: Students are able to apply several numerical methods in determining the integral of a function and are able to create programs for numerical methods.
	Sub-CLO-7: Students are able to apply several Taylor series methods, Euler's method, Heun's method and Runge Kutta's method of order 2 and 4 in solving ordinary differential equations. · Able to create computer programs for the numerical methods above.

Correlation between SLOs/CLOs to Sub-CLOs

SLOs that are charged on the Course	CPMK	SUB CPMK	Form of Assessment*				Weight	Value	Student Score
			Formative	Sumative					
				Case Studies	Written Exam	Written Exam			
SLO-7	CLO-4	SUB-CLO-2		15	15	0	30		
SLO-7	CLO-4	SUB-CLO-3		10	10	0	20		
SLO-7	CLO-4	SUB-CLO-4		5	0	5	10		
SLO-7	CLO-4	SUB-CLO-5		5	0	5	10		
SLO-7	CLO-4	SUB-CLO-6		5	0	5	10		
SLO-7	CLO-4	SUB-CLO-7		10	0	10	20		
				50	25	25	100		

Course Description	This course provides several basic and important concepts about numerical methods. This course provides students with the opportunity to practice creative thinking in solving numerical method problems. With reference to the targets above, this course is given with an emphasis on giving students relatively a lot of time to do problem-solving ranging from simple problems to quite complex ones. This course provides additional skills in the form of using computer tools to create simple simulations to understand mathematics using numerical methods. The material for this course includes: This course introduces several numerical methods for solving mathematical problems, such as determining the roots of nonlinear equations, solving Systems of Linear Equations, Interpolation, Derivative Approaches, Integrals, and Differential Equations.
Learning Materials/Subjects	1. Transmission Error Transmission 2. Roots of Non-Linear Equations, 3. Systems of Linear Equations 4. Interpolation 5. Numerical Derivation 6. Numerical Differential Equations 7. Numerical Integrals

Reference	**Main References**
	1. An Introduction to Numerical Methods A MATLAB Approach,Abdelwahab Kharab, Ronald B. Guenther,Chapman and Hall/CRC, 2002 2. Advance Engineering Mathematics , Michael D. Greenberg (2rd edition), Prentice Hall,1998
	Additional References
	1. Abbaszadeh, M., Azis, M. I., & Dehghan, M. (2024). A mesh-free method using Pascal polynomials for analyzing space-fractional PDEs in irregular biological geometries. *Engineering Analysis with Boundary Elements, 169*, 105932. https://doi.org/10.1016/j.enganabound.2024.105932
Teaching Team	Prof. Dr. Syamsuddin Toaha, M.Sc., Prof. Agustinus Ribal, S.Si.,M.Sc., Ph. D, Dr. Khaeruddin, M.Sc.
Course requirement	Basic Mathematics I, Basic Mathematics II, Algorithms and Programming

Week	**Sub CPMK (End-of-stage learning ability)**	**Penilaian (*Assesment*)**		**Learning Forms and Methods [time estimate]**		**Content**	**Weight of Assessment (%)**
		Indicator	**Techniques & Criteria**	**Offline**	**Online**		
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1	Students are able to explain the meaning of numerical methods, the need for numerical methods, the stages of numerical methods and errors. (CPMK-1, CPMK-2)	**Formative:** Gagal diterjemahkan **Sumative:** Students can provide an overview of the meaning and use of numerical methods and their stages and can explain errors in numerical methods	**Formative Criteria:** **Sumative Criteria:** **Assessment Technique:** Gagal diterjemahkan	**Studying:** Group discussion (Small Group Discussion) Gagal diterjemahkan 3x2x50		Learning Contract, Description & Course Competencies, Introduction to Numerical Methods, Reasons for Using Numerical Methods, Characteristics of Numerical Methods, Stages of solving numerical methods, Algorithm Review.	0

2-4	Students are able to apply numerical methods in solving nonlinear equations. Students are able to create computer programs for the given numerical methods (CPMK-1, CPMK-3, CPMK-4)	**Formative:** Gagal diterjemahkan **Sumative:** Students can find the roots of nonlinear equations and can create programs to carry out iterations according to the numerical methods given using computer assistance.	**Formative Criteria:** **Sumative Criteria:** Case Studies (15) dinilai dengan rubrik 01 **Assessment Technique:** Gagal diterjemahkan	**Studying:** Group discussion (Small Group Discussion) Gagal diterjemahkan 3x2x50		Solving Nonlinear Equations · Split Two Method · False Position Method · Initial Guess Problem / Root Localization. · Polynomial Root Localization · False Position Modification Method · Newton-Raphson Method · Bowstring / Sekan Method · Comparison between Confined and Open methods · Modification of Newton's Method for Polynomials	15
5-7	Students are able to determine the determinant and inverse of a matrix numerically (CPMK-2, CPMK-3, CPMK-4)	**Formative:** Gagal diterjemahkan **Sumative:** Students can use matrix concepts to solve Systems of Linear Equations numerically.	**Formative Criteria:** **Sumative Criteria:** Case Studies (10) dinilai dengan rubrik 01 **Assessment Technique:** Gagal diterjemahkan	**Studying:** Group discussion (Small Group Discussion) 3x2x50		Matrix and System of Linear Equations 1. System of linear equations (SPL). 2. Upper and lower triangular SPL. 3.Gaussian Elimination Method 4. Determinant calculation. 5. Inverse calculation. 6. Elimination modification Gauss. 7.Triangle factorization. 8.Jacobi method and Gauss Seidel method	10

8	Written Exam						25
9-10	Students are able to apply several interpolation methods for curve matching and are able to create computer programs for numerical interpolation methods. (CPMK-2, CPMK-3, CPMK-4)	**Formative:** Gagal diterjemahkan **Sumative:** Students are able to find functions that represents the given data and is able to predict pairs of data points in the range of existing data through the functions that have been obtained and is able to create coding programs for numerical interpolation problems.	**Formative Criteria:** **Sumative Criteria:** Case Studies (5) dinilai dengan rubrik 01 **Assessment Technique:** Gagal diterjemahkan	**Studying:** Group discussion (Small Group Discussion) Gagal diterjemahkan 2x2x50		Curve fitting using the interpolation method 1.Taylor polynomials. 2.Lagrange interpolation polynomials. 3.Newton interpolation polynomials. 4.Piecewise interpolation and Cubic splines 5. Regression (linear and non-linear) Curve fitting for interpolation method	5
11	Students are able to apply the concept of Taylor series expansion in approximating the derivative of a function, and are able to solve derivative approximation problems using computer programs. (CPMK-1, CPMK-3, CPMK-4)	**Formative:** Gagal diterjemahkan **Sumative:** Students can make differences up to forward differences, backward differences, middle differences, cutting errors to estimate errors from Taylor series expansions and are able to create computer programs for approximation problems derivative	**Formative Criteria:** **Sumative Criteria:** Case Studies (5) **Assessment Technique:** Gagal diterjemahkan	**Studying:** Group discussion (Small Group Discussion) 1x2x50		Calculating the approximate value of the derivative with error using Taylor series expansion -Forward difference method -Backward difference method -Mid difference method -Truncation error	5

12-13	Students are able to apply several numerical methods in determining the integral of a function and are able to create programs for numerical methods. (CPMK-1, CPMK-3, CPMK-4)	**Formative:** Gagal diterjemahkan **Sumative:** Students can use numerical methods to calculate the integral of a function using the Simpson 1/3 trapezium rule, Simpson 3/8 trapezium composit rule, Simpson 1/3, Simpson 3/8, Romberg integral and the Gauss quadrature method	**Formative Criteria:** **Sumative Criteria:** Case Studies (5) **Assessment Technique:** Gagal diterjemahkan	**Studying:** Group discussion (Small Group Discussion) Gagal diterjemahkan 2x2x50		Numerical Integration 1. Trapezium rule, Simpson1/3, Simpson 3/8 2. Composite trapezium rule, Simpson1/3, Simpson 3/8 3.Romberg integral 4.Gaussian quadrature	5
14-15	Students are able to apply several Taylor series methods, Euler's method, Heun's method and Runge Kutta's method of order 2 and 4 in solving ordinary differential equations. · Able to create computer programs for the numerical methods above. (CPMK-1, CPMK-3, CPMK-4)	**Formative:** Gagal diterjemahkan **Sumative:** Students can find solutions to ordinary differential equations using numerical methods such as the Taylor series method, the Taylor Series method, the Taylor Series method, and the Taylor Series method. Euler, Heun's method and Runge kutta's method and being able to create programs on a computer regarding the above problems.	**Formative Criteria:** **Sumative Criteria:** Case Studies (10) dinilai dengan rubrik 01 **Assessment Technique:** Gagal diterjemahkan	**Studying:** Group discussion (Small Group Discussion) 2x2x50		Introduction to solutions of ordinary differential equations 1.Taylor series method. 2.Euler and Heun method 3. Runge Kutta method 2nd and 4th order (Supporting [1])	10
16	Written Exam						25

	100

Matrix of SLO, CLO, and Assessment Method

SLO / CLO	CLO-1	CLO-2	CLO-3	CLO-4
CPL-2 (P2)	Case Studies (Weight 15%) Case Studies (Weight 5%) Case Studies (Weight 5%) Case Studies (Weight 10%)	Case Studies (Weight 10%) Case Studies (Weight 5%)	Case Studies (Weight 15%) Case Studies (Weight 10%) Case Studies (Weight 5%) Case Studies (Weight 5%) Case Studies (Weight 5%) Case Studies (Weight 10%)	Case Studies (Weight 15%) Case Studies (Weight 10%) Case Studies (Weight 5%) Case Studies (Weight 5%) Case Studies (Weight 5%) Case Studies (Weight 10%)
CPL-3 (KU1)	Case Studies (Weight 15%) Case Studies (Weight 5%) Case Studies (Weight 5%) Case Studies (Weight 10%)	Case Studies (Weight 10%) Case Studies (Weight 5%)		
CPL-6 (KK2)			Case Studies (Weight 15%) Case Studies (Weight 10%) Case Studies (Weight 5%) Case Studies (Weight 5%) Case Studies (Weight 5%) Case Studies (Weight 10%)	

SLO / CLO	CLO-1	CLO-2	CLO-3	CLO-4
CPL-7 (KK3)				Case Studies (Weight 15%) Case Studies (Weight 10%) Case Studies (Weight 5%) Case Studies (Weight 5%) Case Studies (Weight 5%) Case Studies (Weight 10%)
CPL-9 (S2)		Case Studies (Weight 10%) Case Studies (Weight 5%)		

Evaluation Type and Assessment Weight

Type	Assessment Weight
Case Studies	50
Written Exam	25
Written Exam	25
Total	100

Assessment and Evaluation of Student Achievement of CLOs

SLOs that are charged on the Course	CLO	SUB CLO	Form of Assessment*				Weight	Value	Student Score
			Formative	Sumative					
				Case Studies	Written Exam	Written Exam			
SLO-7	CLO-4	SUB-CLO-2		15	15	0	30		
SLO-7	CLO-4	SUB-CLO-3		10	10	0	20		
SLO-7	CLO-4	SUB-CLO-4		5	0	5	10		
SLO-7	CLO-4	SUB-CLO-5		5	0	5	10		
SLO-7	CLO-4	SUB-CLO-6		5	0	5	10		
SLO-7	CLO-4	SUB-CLO-7		10	0	10	20		
				50	25	25	100		

Lampiran Rubrik 01 | ASSESMENT TERTULIS

Kriteria Penilaian	Bobot/Skor Penilaian				
	5	4	3	2	1/0
Konsep/ metode yang digunakan	Penjelasan konsep /metode (*) sangat lengkap dan akurat	Penjelasan konsep/metode (*) cukup jelas tetapi beberapa informasi tidak dituliskan secara lengkap.	Penjelasan konsep/metode (*) kurang jelas dan banyak informasi yang tidak dituliskan	Penjelasan yang dituliskan hampir tidak berkaitan dengan konsep/ metode (*)	Tidak memberikan konsep yang dibutuhkan
Sistematika penulisan/ pembuktian	Sistematika penulisan/ pembuktian sangat jelas dan terstruktur	Sistematika penulisan/ pembuktian cukup jelas namun ada langkah yang hilang	Sistematika penulisan/ pembuktian kurang jelas	Sistematika penulisan/ pembuktian tidak jelas	Jawaban tidak benar/ tidak ada
Interpretasi geometri/ kualitatif/ kuantitatif.	Interpretasi geometri/ kualitatif/ kuantitaBtif (*) tepat dan lengkap	Interpretasi geometri/ kualitatif/ kuantitatif (*) cukup lengkap/ tepat	Interpretasi geometri/ kualitatif/ kuantitatif (*) kurang lengkap/ tepat	Interpretasi geometri/ kualitatif/ kuantitatif(*) tidak lengkap/ tepat	Interpretasi geometri/ kualitatif/kuantitatif(*) tidak benar
Perhitungan/kesimpulan	Perhitungan/ kesimpulan sangat akurat/tepat dan disertai alasan yang mendasarinya	Perhitungan/ kesimpulan cukup akurat/tepat dan disertai alasan yang mendasarinya	Kesimpulan cukup tepat, namun tidak disertai alasan yang jelas	Perhitungan/ kesimpulan kurang akurat/tepat dan tidak disertai alasan yang mendasarinya	Perhitungan/kesimpulan salah