SEMESTER LEARNING PLAN

FINITE DIFFERENCE METHOD COURSES
(23H01121503)

TEACHING TEAM

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

CPL-4 (KU2) - The students are able to use their sufficiently mathematical critical thinking for abstraction and generalization of a mathematical problem

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: Students can understand several mathematical methods and concepts and apply these methods in several other related fields such as industry, economics and agriculture. (CPL3)

CPMK-3: Students can construct several mathematical models, explain procedures, and solve optimization problems using appropriate techniques and interpret the results obtained in other related fields. (CPL6)

CPMK-4: Students are able to communicate ideas, develop their abilities based on local wisdom and easily adapt to communities with different backgrounds (CPL7)

CPMK-2: Students can analyze and implement several different methods to other fields of study. (CPL4)

Sub-CLO

Sub CPMK-1: Understand well the aims and uses of courses in general and course topics in particular and their relationship with other courses (CPMK-1 dan CPMK-4)

Sub CPMK-2: Students can derive the forward difference, backward difference and center difference using Taylor series expansion. Students can determine the Difference Equation for Elliptic Type Partial

Differential Equations (CPMK-2 dan CPMK-3)

Sub CPMK-3: Students are able to apply and analyze backward time centered space and forward time centered space for parabolic type partial differential equation problems (CPMK-3 dan CPMK-2)

Sub CPMK-4: Students are able to solve and analyze hyperbolic type partial differential equation problems using the finite difference method (CPMK-3 dan CPMK-2)

Sub CPMK-5: Students are able to solve problems in polar and cylindrical coordinates using the finite difference method (CPMK-3 dan CPMK-2)

Sub CPMK-6: Students are able to solve Laplace's equation with irregular boundaries (CPMK-3 dan CPMK-2)

Sub CPMK-7: Students are able to solve the two-dimensional heat equation in Cartesian coordinates and in cylindrical coordinates (CPMK-3 dan CPMK-2)

Sub CPMK-8: Students are able to solve the convection-diffusion equation (CPMK-3, CPMK-4 dan CPMK-2)

Learning Analytics

Finite Difference Method

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Students are able to solve the convection-diffusion equation (CPMK-3, CPMK-2 dan CPMK-4)

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Students are able to solve the two-dimensional heat equation in Cartesian coordinates and in cylindrical coordinates (CPMK-3 dan CPMK-2)

↑

Students are able to solve Laplace's equation with irregular boundaries (CPMK-3 dan CPMK-2)

↑

Students are able to solve problems in polar and cylindrical coordinates using the finite difference method (CPMK-3 dan CPMK-2)

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Students are able to solve and analyze hyperbolic type partial differential equation problems using the finite difference method (CPMK-3 dan CPMK-2)

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Students are able to apply and analyze backward time centered space and forward time centered space for parabolic type partial differential equation problems (CPMK-3 dan CPMK-2)

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Students can derive the forward difference, backward difference and center difference using Taylor series expansion. Students can determine the Difference Equation for Elliptic Type Partial Differential Equations (CPMK-2 dan CPMK-3)

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Understand well the aims and uses of courses in general and course topics in particular and their relationship with other courses (CPMK-1 dan CPMK-4)

Have passed the course Differential Equations and Partial Differential Equations

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

Course	Code	Cource Group	Credits	SEMESTER	Compilation Date
Finite Difference Method	23H01121503	Applied Mathematics	3	4	17 Februari 2025

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

Learning Outcomes		
	SLOs that are imposed on the course	
	SLO-3:	Mahasiswa mampu menganalisis suatu masalah matematika dengan logika, analitik, dan struktur sistematis
	SLO-4:	Mahasiswa dapat menggunakan pemikiran kritis matematis mereka yang cukup untuk abstraksi dan generalisasi masalah matematika berdasarkan hasil analisis informasi dan data
	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-3	**CLO-1:** Students can understand several mathematical methods and concepts and apply these methods in several other related fields such as industry, economics and agriculture.
	SLO-6	**CLO-3:** Students can construct several mathematical models, explain procedures, and solve optimization problems using appropriate techniques and interpret the results obtained in other related fields.
	SLO-7	**CLO-4:** Students are able to communicate ideas, develop their abilities based on local wisdom and easily adapt to communities with different backgrounds
	SLO-4	**CLO-2:** Students can analyze and implement several different methods to other fields of study.
	CLO ⇒ Sub-CLO	
	CLO-1	**Sub-CLO-1:**Understand well the aims and uses of courses in general and course topics in particular and their relationship with other courses
	CLO-4	**Sub-CLO-1:**Understand well the aims and uses of courses in general and course topics in particular and their relationship with other courses
		Sub-CLO-8: Students are able to solve the convection-diffusion equation

Course	**CLO-3**	**Sub-CLO-2:**Students can derive the forward difference, backward difference and center difference using Taylor series expansion. Students can determine the Difference Equation for Elliptic Type Partial Differential Equations
		Sub-CLO-3: Students are able to apply and analyze backward time centered space and forward time centered space for parabolic type partial differential equation problems
		Sub-CLO-4: Students are able to solve and analyze hyperbolic type partial differential equation problems using the finite difference method
		Sub-CLO-5: Students are able to solve problems in polar and cylindrical coordinates using the finite difference method
		Sub-CLO-6: Students are able to solve Laplace's equation with irregular boundaries
		Sub-CLO-7: Students are able to solve the two-dimensional heat equation in Cartesian coordinates and in cylindrical coordinates
		Sub-CLO-8: Students are able to solve the convection-diffusion equation
	CLO-2	**Sub-CLO-3:**Students are able to apply and analyze backward time centered space and forward time centered space for parabolic type partial differential equation problems
		Sub-CLO-4: Students are able to solve and analyze hyperbolic type partial differential equation problems using the finite difference method
		Sub-CLO-5: Students are able to solve problems in polar and cylindrical coordinates using the finite difference method
		Sub-CLO-6: Students are able to solve Laplace's equation with irregular boundaries
		Sub-CLO-7: Students are able to solve the two-dimensional heat equation in Cartesian coordinates and in cylindrical coordinates
		Sub-CLO-8: Students are able to solve the convection-diffusion equation
	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**								
				Group task	**Quiz**	**Independent Assignment**	**Case Studies**	**Project Based**	**Written Exam**	**Written Exam**			
SLO-4	CLO-2	SUB-CLO-3	Derivation accuracy and accuracy of application and analysis	5	8	0	0	0	10	0	23		
SLO-4	CLO-2	SUB-CLO-4	Accuracy of completion and analysis	0	8	0	0	0	6.15	0	14.15		
SLO-4	CLO-2	SUB-CLO-5	Accuracy of solutions and analysis	0	0	4	0	0	0	0	4		
SLO-4	CLO-2	SUB-CLO-5	Accuracy of completion	0	0	0	0	5	3.85	0	8.85		

SLOs that are charged on the Course	CPMK	SUB CPMK	Form of Assessment*							Weight	Value	Student Score
			Formative	Sumative								
				Group task	Quiz	Independent Assignment	Case Studies	Project Based	Written Exam	Written Exam			
SLO-4	CLO-2	SUB-CLO-6	Accuracy of completion	0	0	0	10	0	0	10	20		
SLO-6	CLO-3	SUB-CLO-7	Accuracy of completion	0	0	0	10	0	0	0	10		
SLO-7	CLO-4	SUB-CLO-8	Solution accuracy	0	0	0	10	0	0	10	20		
				5	16	4	30	5	20	20	100		

Course Description	The Finite Difference Methods course is an elective course in the study program Mathematics that will give students the ability to apply finite difference methods in solving partial differential equations (PDP) including elliptic type, parabolic type and hyperbolic type. The first part of this course will focus on deriving the finite difference method from the Taylor series which includes forward difference, backward difference and central difference. Furthermore, these methods will be used to solve PDP problems, especially for one-dimensional problems. In the second part, this course will focus on solving PDPs with various boundary conditions and coordinates including polar coordinates and cylindrical coordinates. In the final section, the finite difference method will be used to solve the diffusion convection equation.
Learning Materials/Subjects	1. Taylor expansion for forward difference, backward difference and central difference (Taylor expansion for forward difference, backward difference and central difference). 2. Difference Equations for elliptic type partial differential equations. (Finite difference for elliptic partial differential equations). 3. Difference Equations for parabolic type partial differential equations. (Finite difference for parabolic partial differential equations). 4. Difference Equations for hyperbolic type partial differential equations. (Finite difference for hyperbolic partial differential equations). 5. Various boundary conditions and polar coordinates. (Various boundary conditions and polar coordinates). 6. Irregular boundary condition. (Irregular boundary conditions). 7. Two-dimensional heat equations and cylinder coordinates. (Two-dimensional heat equation and cylinder coordinate). 8. Diffusion convection equation. (Convection - diffusion equation).
Reference	**Main References** 1. Hoffmann, K.A., Chiang, S.T., “Computational Fluid Dynamics for Engineers Volume1, 3rd edition”Engineering Education System,1995 2. Noye, J., “Computational Techniques for Differential Equations”, Elsevier Science Publisher B.V, 1984 3. Leon, L., Pinder, G.F., “ Numerical Solution of Partial Differential Equations in Science and Engineering”, John Wiley & Sons, 1982 **Additional References**

	Strauss, W. A., 2007: Partial Differential Equations: An Introduction. John Wiley & Sons
Teaching Team	Prof. Agustinus Ribal, S.Si.,M.Sc., Ph. D, Dr. Khaeruddin, M.Sc.
Course requirement	Differential Equations, Partial Differential Equations

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	Understand well the aims and uses of courses in general and course topics in particular and their relationship with other courses (CPMK-1, CPMK-4)	**Formative:** Gagal diterjemahkan **Sumative:** Accuracy in explaining semester learning plans with good.	**Formative Criteria:** **Sumative Criteria:** **Assessment Technique:** Gagal diterjemahkan	**Studying:** Other methods TM: 3x50		College Contract Lecture contract (purpose, scope, material, use of learning and its relationship to other courses and conditions for pass)	0
2-3	Students are able to apply and analyze backward time centered space and forward time centered space for parabolic type partial differential equation problems (CPMK-3, CPMK-2)	**Formative:** Gagal diterjemahkan **Sumative:** • Ability and accuracy of reducing forward difference, backward difference and center difference using expansion Taylor series. • Ability to determine Difference Equations for Equations Elliptic Type Partial Differential.	**Formative Criteria:** Derivation accuracy **Sumative Criteria:** Group task (5) **Assessment Technique:** Gagal diterjemahkan	**Studying:** Cooperative learning (Cooperative learning) TM: 2x2x50 **Studying:** Problem-Based Learning (Problem-based Learning) TM: 2x1x50		Review of partial differential equations, boundary conditions and initial conditions, Taylor series, forward difference, backward difference and central difference, solving Poisson's equation.	5

4-5	Students are able to apply and analyze backward time centered space and forward time centered space for parabolic type partial differential equation problems (CPMK-3, CPMK-2)	**Formative:** Gagal diterjemahkan **Sumative:** Ability to apply and analyze Backward Time Centered Space and forward Time Centered Space for parabolic type partial differential equation problems.	**Formative Criteria:** Accuracy of application and analysis **Sumative Criteria:** Quiz (8) **Assessment Technique:** Test	**Studying:** Cooperative learning (Cooperative learning) TM: 2x2x50 **Studying:** Problem-Based Learning (Problem-based Learning) TM: 1x1x50		Backward Time Centered Space, forward Time Centered Space, stability and consistency analysis	8
6	Students are able to solve and analyze hyperbolic type partial differential equation problems using the finite difference method (CPMK-3, CPMK-2)	**Formative:** Gagal diterjemahkan **Sumative:** Ability to solve and analyze type partial differential equation problems hyperbolic with finite difference method.	**Formative Criteria:** Accuracy of completion and analysis **Sumative Criteria:** Quiz (8) **Assessment Technique:** Test	**Studying:** Cooperative learning (Cooperative learning) TM: 2x2x50 **Studying:** Problem-Based Learning (Problem-based Learning) TM: 1x1x50		Transport equation, Courant method Isaacson Rees, Method Lax and Leapfrog methods as well as stability and consistency analysis.	8
7	Students are able to solve and analyze wave equation problems with certain boundary conditions using the finite difference method ()	**Formative:** Gagal diterjemahkan **Sumative:** Ability to solve and analyze wave equation problems with boundary conditions certain methods using the finite difference method.	**Formative Criteria:** Accuracy of solutions and analysis **Sumative Criteria:** Independent Assignment (4) **Assessment Technique:** Test	**Studying:** Cooperative learning (Cooperative learning) TM: 2x2x50 **Studying:** Problem-Based Learning (Problem-based Learning) TM: 1x1x50		One dimensional wave equation, Centered Time Centered Space (CTCS) as well as analysis of its stability and consistency.	4

8	Written Exam						20
9	Students are able to solve Boundary Value Equations using the Finite Difference Method ()	**Formative:** Gagal diterjemahkan **Sumative:** Ability to apply finite difference methods in solving value problems boundaries	**Formative Criteria:** Accuracy of completion and analysis **Sumative Criteria:** **Assessment Technique:** Test			Solving Boundary Value Equations using Different Methods Until	0
10	Students are able to solve boundary value problems using the finite difference method. ()	**Formative:** Gagal diterjemahkan **Sumative:** Ability to solve boundary value problems with different methods until.	**Formative Criteria:** Accuracy of completion **Sumative Criteria:** Case Studies (10) dinilai dengan rubrik 01 **Assessment Technique:** Test	**Studying:** Cooperative learning (Cooperative learning) TM: 1x2x50 **Studying:** Problem-Based Learning (Problem-based Learning) TM: 2x1x50		Solving Laplace's equation and Heat Equation with with Dirichlet, Neumann, and Robin boundary conditions	10
11-12	Students are able to solve problems in polar and cylindrical coordinates using the finite difference method (CPMK-3, CPMK-2)	**Formative:** Gagal diterjemahkan **Sumative:** Ability to solve boundary value problems using finite difference methods in coordinates polar and various boundary conditions including irregular boundary conditions.	**Formative Criteria:** Accuracy of completion **Sumative Criteria:** Project Based (5) **Assessment Technique:** Test	**Studying:** Cooperative learning (Cooperative learning) TM: 2x2x50 **Studying:** Project-Based Learning (Project-based Learning) TM: 1x1x50		Solving the 1-D Heat Equation in Polar Coordinates and Laplace's Equation in Cylindrical coordinates	5

13	Students are able to solve Laplace's equation with irregular boundaries (CPMK-3, CPMK-2)	**Formative:** Gagal diterjemahkan **Sumative:** Ability to solve problems with Laplace's Equation that has infinite limits regular.	**Formative Criteria:** Accuracy of completion **Sumative Criteria:** Case Studies (10) dinilai dengan rubrik 01 **Assessment Technique:** Non Test	**Studying:** Cooperative learning (Cooperative learning) TM: 2x2x50 **Studying:** Problem-Based Learning (Problem-based Learning) TM: 1x1x50		Solving the Lalpace/Poisson Equation with infinite limits in order.	10
14	Students are able to solve the two-dimensional heat equation in Cartesian coordinates and in cylindrical coordinates (CPMK-3, CPMK-2)	**Formative:** Gagal diterjemahkan **Sumative:** Ability to solve two-dimensional Heat equations in both Cartesian and Cartesian coordinates cylindrical coordinates.	**Formative Criteria:** Solution accuracy **Sumative Criteria:** **Assessment Technique:** Test	**Studying:** Cooperative learning (Cooperative learning) TM: 2x2x50 **Studying:** Project-Based Learning (Project-based Learning) TM: 2x1x50		Two-Dimensional Heat Equation	0

15	Students are able to solve the convection-diffusion equation (CPMK-3, CPMK-2, CPMK-4)	**Formative:** Gagal diterjemahkan **Sumative:** Ability to solve equations convection-diffusion.	**Formative Criteria:** Solution accuracy **Sumative Criteria:** Case Studies (10) dinilai dengan rubrik 01 **Assessment Technique:** Test	**Studying:** Cooperative learning (Cooperative learning) TM: 1x2x50 **Studying:** Project-Based Learning (Project-based Learning) TM: 1x1x50		Convection-Diffusion Equation	10
16	Written Exam						20
							100

Matrix of SLO, CLO, and Assessment Method

SLO / CLO	CLO-1	CLO-2	CLO-2	CLO-3	CLO-4
CPL-3 (KU1)					
CPL-4 (KU2)			Group task (Weight 5%) Quiz (Weight 8%) Quiz (Weight 8%) Project Based (Weight 5%) Case Studies (Weight 10%) Case Studies (Weight 10%)		
CPL-6 (KK2)				Group task (Weight 5%) Quiz (Weight 8%) Quiz (Weight 8%) Project Based (Weight 5%) Case Studies (Weight 10%) Case Studies (Weight 10%)	
CPL-7 (KK3)					Case Studies (Weight 10%)

Evaluation Type and Assessment Weight

Type	Assessment Weight
Group task	5
Quiz	16
Independent Assignment	4
Case Studies	30
Project Based	5
Written Exam	20
Written Exam	20
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								
				Group task	Quiz	Independent Assignment	Case Studies	Project Based	Written Exam	Written Exam			
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SLO-4	CLO-2	SUB-CLO-4	Accuracy of completion and analysis	0	8	0	0	0	6.15	0	14.15		
SLO-4	CLO-2	SUB-CLO-5	Accuracy of solutions and analysis	0	0	4	0	0	0	0	4		
SLO-4	CLO-2	SUB-CLO-5	Accuracy of completion	0	0	0	0	5	3.85	0	8.85		
SLO-4	CLO-2	SUB-CLO-6	Accuracy of completion	0	0	0	10	0	0	10	20		
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SLO-7	CLO-4	SUB-CLO-8	Solution accuracy	0	0	0	10	0	0	10	20		
				5	16	4	30	5	20	20	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