SEMESTER LEARNING PLAN

REAL ANALYSIS COURSES
(23H01120903)

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

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

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: Describe, explain, interpret and apply concepts to several theorems related to derivatives of functions in R_n (CPL2 dan CPL4)

CPMK-2: Describe, explain, interpret and apply concepts to several theorems related to Riemann integrals. (CPL4 dan CPL7)

CPMK-3: Able to present orally and in writing his understanding of the concepts of function series and function series, as well as present his application to several theorems both independently and in groups. (CPL2 dan CPL7)

Sub-CLO

Sub CPMK-1: Understanding learning contracts. These include: content, goals, objectives, rules and learning assessment system.Understand the meaning of the Derivative Theorem and the basic derivative theorem. (CPMK-1)

Sub CPMK-2: Able to use Charatheodory's theorem to prove the properties of derived functions.Able to understand the conceptual mean value theorem, extreme function theorem, Darboux theorem.Able to understand the first derivative test of the type of uncertainty limit (Hospital's Theorem), the nature of the mean value, Cauchy's mean value theorem and Hospital's rule. (CPMK-2 dan CPMK-3)

Sub CPMK-3: Able to understand the meanings of integral functions by using the concepts of addition of Riemann integrals, Darboux integrals and the Basic Theorem of Calculus (CPMK-1)

Sub CPMK-4: Able to apply the concepts of point convergence and uniform convergence and limit exchange to real function sequences in other areas of mathematics. (CPMK-2 dan CPMK-3)

Sub CPMK-5: Able to apply the concepts and properties of convergence tests of real function series in other areas of mathematics. (CPMK-1)

Sub CPMK-6: Able to apply the concepts of metric spaces, continuity of functions, convergence of sequences, and topology in metric spaces in other areas of mathematics. (CPMK-2 dan CPMK-3)

Learning Analytics

Real Analysis

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Able to apply the concepts of metric spaces, continuity of functions, convergence of sequences, and topology in metric spaces in other areas of mathematics. (CPMK-2 dan CPMK-3)

↑

Able to apply the concepts and properties of convergence tests of real function series in other areas of mathematics. (CPMK-1)

↑

Able to apply the concepts of point convergence and uniform convergence and limit exchange to real function sequences in other areas of mathematics. (CPMK-2 dan CPMK-3)

↑

Able to understand the meanings of integral functions by using the concepts of addition of Riemann integrals, Darboux integrals and the Basic Theorem of Calculus (CPMK-1)

↑

Able to use Charatheodory's theorem to prove the properties of derived functions.Able to understand the conceptual mean value theorem, extreme function theorem, Darboux theorem.Able to understand the first derivative test of the type of uncertainty limit (Hospital's Theorem), the nature of the mean value, Cauchy's mean value theorem and Hospital's rule. (CPMK-2 dan CPMK-3)

↑

Understanding learning contracts. These include: content, goals, objectives, rules and learning assessment system.Understand the meaning of the Derivative Theorem and the basic derivative theorem. (CPMK-1)

Have passed the course Advanced Mathematics and Introduction to Real Analysis

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

Course	Code	Cource Group	Credits	SEMESTER	Compilation Date
Real Analysis	23H01120903	Analysis	3	4	6 Desember 2024

AUTHORITY	SLP Developer Lecturer	Coordinator	Head of Study Program
	Prof. Dr. Budi Nurwahyu, MS., Jusmawati Massalesse, S.Si.,M.Si., Naimah Aris, S.Si.,M.Math., Dr. Muh. Nur, S.Si., M.Si.	Naimah Aris, S.Si.,M.Math.	Dr. Firman, S.Si.,M.Si.

Learning Outcomes Course

SLOs that are imposed on the course	
SLO-2:	Mahasiswa mampu mengidentifikasi objek, teknik, dan sifat dalam matematika dasar, dan membuat koneksi untuk menyelesaikan masalah
SLO-4:	Mahasiswa dapat menggunakan pemikiran kritis matematis mereka yang cukup untuk abstraksi dan generalisasi masalah matematika berdasarkan hasil analisis informasi dan data
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:** Describe, explain, interpret and apply concepts to several theorems related to derivatives of functions in R_n
	CLO-3: Able to present orally and in writing his understanding of the concepts of function series and function series, as well as present his application to several theorems both independently and in groups.
SLO-4	**CLO-1:** Describe, explain, interpret and apply concepts to several theorems related to derivatives of functions in R_n
	CLO-2: Describe, explain, interpret and apply concepts to several theorems related to Riemann integrals.
SLO-7	**CLO-2:** Describe, explain, interpret and apply concepts to several theorems related to Riemann integrals.
	CLO-3: Able to present orally and in writing his understanding of the concepts of function series and function series, as well as present his application to several theorems both independently and in groups.
CLO ⇒ Sub-CLO	
	Sub-CLO-1: Understanding learning contracts. These include: content, goals, objectives, rules and learning assessment system.Understand the meaning of the Derivative Theorem and the basic derivative theorem.

CLO-1	**Sub-CLO-3:**Able to understand the meanings of integral functions by using the concepts of addition of Riemann integrals, Darboux integrals and the Basic Theorem of Calculus
	Sub-CLO-5: Able to apply the concepts and properties of convergence tests of real function series in other areas of mathematics.
CLO-2	**Sub-CLO-2:**Able to use Charatheodory's theorem to prove the properties of derived functions.Able to understand the conceptual mean value theorem, extreme function theorem, Darboux theorem.Able to understand the first derivative test of the type of uncertainty limit (Hospital's Theorem), the nature of the mean value, Cauchy's mean value theorem and Hospital's rule.
	Sub-CLO-4: Able to apply the concepts of point convergence and uniform convergence and limit exchange to real function sequences in other areas of mathematics.
	Sub-CLO-6: Able to apply the concepts of metric spaces, continuity of functions, convergence of sequences, and topology in metric spaces in other areas of mathematics.
CLO-3	**Sub-CLO-2:**Able to use Charatheodory's theorem to prove the properties of derived functions.Able to understand the conceptual mean value theorem, extreme function theorem, Darboux theorem.Able to understand the first derivative test of the type of uncertainty limit (Hospital's Theorem), the nature of the mean value, Cauchy's mean value theorem and Hospital's rule.
	Sub-CLO-4: Able to apply the concepts of point convergence and uniform convergence and limit exchange to real function sequences in other areas of mathematics.
	Sub-CLO-6: Able to apply the concepts of metric spaces, continuity of functions, convergence of sequences, and topology in metric spaces in other areas of mathematics.

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	Quiz	Written Exam			
SLO-4	CLO-1	SUB-CLO-1	solve problems to describe geometrically and determine derivative limits.	20	0	8.89	28.89		
SLO-7	CLO-3	SUB-CLO-2	Using Charatheodory's theorem in determining the derivative of a function, proving the properties of the chain rule, function composition and function inverse.	15	0	6.67	21.67		
SLO-4	CLO-1	SUB-CLO-3	Discipline and activeness	10	0	4.44	14.44		
SLO-7	CLO-3	SUB-CLO-4	Discipline, perseverance, activeness	15	0	0	15		
SLO-4	CLO-1	SUB-CLO-5	Discipline, perseverance, activeness	0	5	0	5		

SLOs that are charged on the Course	CPMK	SUB CPMK	Form of Assessment*				Weight	Value	Student Score
			Formative	Sumative					
				Case Studies	Quiz	Written Exam			
SLO-7	CLO-3	SUB-CLO-6	Discipline, perseverance, activeness	15	0	0	15		
				75	5	20	100		

Course Description	This course discusses derivative functions, Riemann integrals, sequences and series of functions, and topology in metric spaces.
Learning Materials/Subjects	1. Tderivative 2. Riemann Integral (Riemann Integral) 3. Sequence of functions 4. Function series (Series of function) 5. Metric space
Reference	**Main References**
	1. Bartle, Robert.G and Sherbert, Donald R., 2000, Introduction to Real Analysis, John Wiley and Sons. 3rd ed.
	Additional References
	2. Budi Nurwahyu. 2019. Common fixed point theorems on generalized ratio contraction mapping in extended rectangular B-metric spaces , International Journal of Mathematics and Mathematical Sciences, pp 1-14. 3. Trench, William F.,2003 , Intoduction to Real Analysis, Pearson Education 4. Rudin, Walter. Principles of Mathematical Analysis. 3rd ed. McGraw-Hill, 1976. 5. Charles C. Pugh, 2015, "Real Mathematical Analysis", Springer International Publishing Switzerland. 2nd ed.
Teaching Team	Prof. Dr. Budi Nurwahyu, MS., Jusmawati Massalesse, S.Si.,M.Si., Naimah Aris, S.Si.,M.Math., Dr. Muh. Nur, S.Si., M.Si.
Course requirement	Advanced Mathematics, Introduction to Real Analysis

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
1-2	Understanding learning contracts. These include: content, goals, objectives, rules and learning assessment system.Understand the meaning of the Derivative Theorem and the basic derivative theorem. (CPMK-1)	**Formative:** Discipline, Activeness, Short questions and answers. **Sumative:** Precision of geometric depiction and boundary interpretation derivative. Accuracy of using derivative definitions in proving the properties of functions derivative	**Formative Criteria:** solve problems to describe geometrically and determine derivative limits. dinilai dengan rubrik 04 **Sumative Criteria:** Case Studies (20) dinilai dengan rubrik 01 **Assessment Technique:** Test and Non-Test	**Studying:** Collaborative learning (Collaborative Learning) TM: 1x3x50; PT: 1x3x60; BM: 1x3x50.	**Studying:** Self-Directed Learning Doing Case Study Assignment 1. TM: 3x50 minutes	Learning contract DERIVATIVES: Derivatives and Basic Theorems of Derivatives. **- Reference number 1 and 3.**	20

3-4	Able to use Charatheodory's theorem to prove the properties of derived functions.Able to understand the conceptual mean value theorem, extreme function theorem, Darboux theorem.Able to understand the first derivative test of the type of uncertainty limit (Hospital's Theorem), the nature of the mean value, Cauchy's mean value theorem and Hospital's rule. (CPMK-2, CPMK-3)	**Formative:** Discipline, activeness, questions and answers. **Sumative:** Able to utilize Charatheodory's theorem in determining the derivative of a function, prove chain rule properties, function composition and function inverse Able to interpret geometrically, prove, and solve questions/exercises using the Mean Value Theorem, Extremum Function Theorem, Darboux Theorem Able to prove Hospital's Theorem, Mean Value Theorem, Cauchy's Mean Value Theorem, derived middle value properties and Lhospital's rule, as well as using L'Hospital's rule on indefinite forms	**Formative Criteria:** Using Charatheodory's theorem in determining the derivative of a function, proving the properties of the chain rule, function composition and function inverse. dinilai dengan rubrik 01 **Sumative Criteria:** Case Studies (15) dinilai dengan rubrik 01 **Assessment Technique:** Test and Non-Test	**Studying:** Collaborative learning (Collaborative Learning) TM: 3x3x50 minutes; PT: 3x3x60; BM: 3x3x50;	**Studying:** Self-Directed Learning Doing Case Study Assignment 2. TM: 3x3x50; PT: 3x3x60; BM: 3x3x50 minutes.	Chain rule, Charatatheodory's theorem and inverse derivatives function Mean value theorem, extreme function theorem, Darboux Shape of uncertainty function limits, Cauchy's mean value theorem and Hospital's rule	15

5-7	Able to understand the meanings of integral functions by using the concepts of addition of Riemann integrals, Darboux integrals and the Basic Theorem of Calculus (CPMK-1)	**Formative:** Students are able to show a disciplined attitude and are active in learning. **Sumative:** able to explain the relationship between the Riemann integral and the Darboux integral able to use Cauchy's criterion and finite properties to prove the Riemann integral of a able to understand the Basic Theorem of Calculus in integral fiction Reimann	**Formative Criteria:** Discipline and activeness dinilai dengan rubrik 04 **Sumative Criteria:** Case Studies (10) dinilai dengan rubrik 01 **Assessment Technique:** Test and Non-Test	**Studying:** Collaborative learning (Collaborative Learning) TM: 3x3x50; PT: 3x3x60; BM: 3x3x50;	**Studying:** Self-Directed Learning Doing Case Study Assignment 3. TM: 3x3x50; PT: 3x3x60; BM: 3x3x50 minutes.	INTEGRAL: Riemann Integral, Integral Darboux and the Fundamental Theorem of Calculus. **- Reference no 1, 3, and 4.**	10
8	WRITTEN EXAMINATION						20
9-11	Able to apply the concepts of point convergence and uniform convergence and limit exchange to real function sequences in other areas of mathematics. (CPMK-2, CPMK-3)	**Formative:** Able to show a disciplined, diligent and active attitude in class discussions. **Sumative:** able to properly interpret the definition of real function sequences, convergence pointwise and uniform convergence able to apply Cauchy's criterion in proving uniform convergence of a sequence function	**Formative Criteria:** Discipline, perseverance, activeness dinilai dengan rubrik 04 **Sumative Criteria:** Case Studies (15) dinilai dengan rubrik 01 **Assessment Technique:** Test and Non-Test	**Studying:** Case Study, Collaborative Learning TM: 3x3x50; PT: 3x3x60; BM: 3x3x50;	**Studying:** Self-Directed Learning Doing Case Study Assignment 4 TM: 3x3x50; PT: 3x3x60; BM: 3x3x50 minutes.	Real Sequence Functions: Real sequence functions and Sequence functions converge. **- Reference no 1, 2, and 4.**	15

12	Able to apply the concepts and properties of convergence tests of real function series in other areas of mathematics. (CPMK-1)	**Formative:** Able to demonstrate a disciplined, diligent and active attitude in class discussions. **Sumative:** able to interpret the convergence of function series. able to prove the properties of the real function series convergence test criteria.	**Formative Criteria:** Discipline, perseverance, activeness dinilai dengan rubrik 04 **Sumative Criteria:** Quiz (5) dinilai dengan rubrik 01 **Assessment Technique:** Test and Non-Test	**Studying:** Case Study, Collaborative Learning TM: 1x3x50; PT: 1x3x60; BM: 1x3x50;	**Studying:** Self-Directed Learning Doing Case Study Assignment 5 TM: 1x3x50; PT: 1x3x60; BM: 1x3x50 minutes.	Function Sequence: Absolute Convergence Convergent Sequence Test. **- Reference number 1 and 3.**	5
13-15	Able to apply the concepts of metric spaces, continuity of functions, convergence of sequences, and topology in metric spaces in other areas of mathematics. (CPMK-2, CPMK-3)	**Formative:** Able to demonstrate a disciplined, diligent and active attitude in class discussions. **Sumative:** able to provide examples of metric spaces, complete metric spaces, continuous functions, and convergent sequences in metric space able to prove the properties of continuous functions and sequences converges in metric space. able to prove the nature of open sets, compact set, connected set in topological metric space.	**Formative Criteria:** Discipline, perseverance, activeness dinilai dengan rubrik 04 **Sumative Criteria:** Case Studies (15) dinilai dengan rubrik 01 **Assessment Technique:** Test and Non-Test	**Studying:** Group discussion (Small Group Discussion), Case Study (Case Study), Collaborative Learning (Collaborative Learning) TM: 3x3x50; PT: 3x3x60; BM: 3x3x50;	**Studying:** Self-Directed Learning Doing Case Study Assignment 6 TM: 3x3x50; PT: 3x3x60; BM: 3x3x50 minutes.	Metric space: metric space and nature Function continuity and convergence of sequences in metric space Topology in metric space **- Reference number 1 and 2.**	15
							100

Matrix of SLO, CLO, and Assessment Method

SLO / CLO	CLO-1	CLO-2	CLO-3
CPL-2 (P2)	Case Studies (Weight 20%) Case Studies (Weight 10%) Quiz (Weight 5%)		Case Studies (Weight 15%) Case Studies (Weight 15%) Case Studies (Weight 15%)
CPL-4 (KU2)	Case Studies (Weight 20%) Case Studies (Weight 10%) Quiz (Weight 5%)	Case Studies (Weight 15%) Case Studies (Weight 15%) Case Studies (Weight 15%)	
CPL-7 (KK3)		Case Studies (Weight 15%) Case Studies (Weight 15%) Case Studies (Weight 15%)	Case Studies (Weight 15%) Case Studies (Weight 15%) Case Studies (Weight 15%)

Evaluation Type and Assessment Weight

Type	Assessment Weight
Case Studies	75
Quiz	5
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
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SLO-7	CLO-3	SUB-CLO-4	Discipline, perseverance, activeness	15	0	0	15		
SLO-4	CLO-1	SUB-CLO-5	Discipline, perseverance, activeness	0	5	0	5		
SLO-7	CLO-3	SUB-CLO-6	Discipline, perseverance, activeness	15	0	0	15		
				75	5	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