UNESA	**UNIVERSITAS NEGERI SURABAYA** **FACULTY OF MATHEMATICS AND NATURAL SCIENCES** **UNDERGRADUATE PROGRAMME OF MATHEMATICS**	**Document Code**

SEMESTER LEARNING PLAN

Name of Module	Code	Module Cluster	Credits		Semester	Date of Preparation
Real Analysis I		Mathematics	**T = 3**	**P = 0**	4	January 28th, 2021

Authorization	Lesson Plan Creator	Module Coordinator	Head of UPM
	Prof. Dr. Manuharawati, M.Si.	Prof. Dr. Manuharawati, M.Si.	**Dr. Raden Sulaiman, M.Si.**

Learning Outcomes	**Programme Learning Outcomes (PLO)**	
	KNO-1	Demonstrate mathematical knowledge and insight.
	SKI-2	Implement basic principles of mathematics to solve simple mathematics problems.
	Course Learning Outcomes (CLO)	
	KNO-1	
	CLO-1	Demonstrate the ability to think structured, reasoned, proof based on deductive-axiomatic analysis, and mathematically induced proof; understand real number systems, rational and irrational numbers, absolute values, neighborhood of a point, the completeness of R, open and closed sets; as well as knowledge of sequences, convergence of sequences, the principle of the K – ε game, sequences tails and monotonous sequences, subsequences, Bolzano-Weierstrass theorem, Cauchy's criterion, contractive sequences, true diverges, and number series.
	SKI-2	
	CLO-2	Skilled in using basic mathematical principles (about the structure of real numbers, real number topology, and real number sequences) in solving problems.
Brief description of module	This course examines the real number system (algebra of real numbers and their properties, rational and irrational numbers, the sequence of real numbers and their properties, absolute values, point circles, supremum and infinity of a set and their properties, intervals and their properties, neighborhood of a point), topology on a real line (specific point of a set and its properties, open and closed sets and their properties), real number sequences (sequence limit, sequence limit properties, sequence tail, monotonous sequence, sequences, divergent sequences, Cauchy criteria, contractive sequences). Learning is carried out by applying a combination of expository approaches, discussion, and question and answer. The	

	assessment is carried out during the learning process with interactive participation, presentations, assignments and midterm examinations, as well as weighted proportional end semester exams.
Study Material: Learning Materials	Real number systems (algebra of real numbers and their properties, rational and irrational numbers, sequences of real numbers and their properties, absolute values, orbits of points, supremum and infimum of a set and their properties, intervals and properties, neighborhood of a point), topology on real lines (specific points of a set and their properties, open and closed sets and their properties), real number sequences (sequence limits, sequence limit properties, sequence tails, monotonous sequences, subset sequences, sequences divergent, Cauchy criterion, contractive sequences).
References	**Primary References**
	[1] **Manuharawati.** 2014. *Analisis Real*. Zifatama: Surabaya.
	Supporting References
	[2] **Bartle, R.G. Sherbert Donald R.** 2011. *Introduction to Real Analysis (Fourth Edition)*, New York, John Wiley and Sons.
Lecturers	Prof. Dr. Manuharawati, M.Si. Dwi Nur Yunianti, M.Sc. Muhammad Jakfar, M.Si.
Prerequisite Modules	Foundations of Mathematics

Week	**Final abilities of each stage of learning**	**Assessment**		**Teaching Methodology**		**Learning Materials**	**Weight (%)**
		Indicators	**Assessment Form**	**Offline**	**Online**		
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
1-2	1. Understanding algebraic properties of $\mathbb{R}$.	1. Stating the axioms in $\mathbb{R}$ on addition and multiplication operations (CLO-1) 2. Proving the theorems relating to the addition property of R (CLO-2) 3. Proving the theorems relating	Quantitative and Tests		Lectures, Responses, and Tutorials using LMS Asynchronous or Synchronous Exercises [6 x 50 minutes]	Algebraic properties of $\mathbb{R}$ [1] [2]	10

		to the multiplication property of R. (CLO-2) 4. Proving the theorems about rational and irrational numbers (CLO-2) 5. Solving problems that involve thinking critically about theorems dealing with the properties of addition and multiplication $\mathbb{R}$, or rational and irrational numbers (CLO-2)					
3	1. Understanding order properties and Innequalities of $\mathbb{R}$	1. Rewriting the definition of the set of positive, negative, non-positive and non-negative numbers in your own language (CLO-1) 2. Proving the theorems relating to the order property of R. (CLO-2)	Quantitative and Tests		Lectures, Responses, and Tutorials using LMS Asynchronous or Synchronous Exercises [3 x 50 minutes]	Order properties of $\mathbb{R}$ [1] [2]	10

		3. Using theorems related to the sequence R to solve math problems. (CLO-2)					
4-5	1. Understanding the absolute value and the neighborhood of a point	1. Rewritibg absolute value definitions in their own language. (CLO-1) 2. Proving the theorems relating to the absolute value property of R. (CLO-1) 3. Describing the neighborhood of a point and examples. (CLO-1) 4. Solving problems that involve critical thinking in terms of absolute value and the the neighborhood of a point. (CLO-2)	Quantitative and Tests		Lectures, Responses, and Tutorials using LMS Asynchronous or Synchronous Exercises [6 x 50 minutes]	Absolute value and Neighborhood of a point [1] [2]	10
6-7	1. Understanding the completeness properties of $\mathbb{R}$	1. Redefining and give examples of upper and lower bounds (CLO-1) 2. Redefining and give examples of supremum and infimum. (CLO-1)	Quantitative and Tests		Lectures, Responses, and Tutorials using LMS Asynchronous or Synchronous Exercises	the completeness properties of $\mathbb{R}$ [1] [2]	10

		3. Proving the theorems relating to supremum and infimum. (CLO-2) 4. Proving the Archimedes theorem (CLO-2) 5. Solving problems that involve critical thinking regarding the supremum, infinity, or nature of archimedes. (CLO-2)			[6 x 50 minutes]		
8	**Midterm Exam**						
9	1. Understanding the concept of intervals, nested intervals, special points on a set	1. Describing the definition of intervals and nested intervals. (CLO-1) 2. Proving the theorems relating to nested intervals. (CLO-2) 3. Describing the definition of a specific point on the set (limit point, interior point, exterior point, boundary point,	Quantitative and Tests		Lectures, Responses, and Tutorials using LMS Asynchronous or Synchronous Exercises [3 x 50 minutes]	Interval and special points on the set [1] [2]	10

		isolated point) (CLO-1) 4. Solving problems related to intervals, nested intervals, special points on the set (CLO-2)					
10-11	1. Understanding the concepts and characteristics of open and closed sets	1. Redefining open sets and examples. (CLO-1) 2. Redefining closed sets and examples. (CLO-1) 3. Proving the theorems about open sets. (CLO-2) 4. Proving the theorems about closed sets. (CLO-2) 5. Solving problems that involve critical thinking regarding open and closed sets. (CLO-2)	Quantitative and Tests		Lectures, Responses, and Tutorials using LMS Asynchronous or Synchronous Exercises [6 x 50 minutes]	Open and closed sets [1] [2]	10
12-15	1. Understanding the concept of sequences and their limits	1. Defining sequences and boundaries and examples (CLO-1) 2. Writing the definition of sequence tails,	Quantitative and Tests		Lectures, Responses, and Tutorials using LMS Asynchronous or Synchronous	Sequences and their limits, tail sequences, monotone sequences, sub sequences, divergent sequences, Bolzano-Weirstras theorem, Cauchy	40

		monotone sequences, sub-sequences, divergent sequences and examples. (CLO-1) 3. Proving Bolzano-Weirstrass theorem. (CLO-2) 4. Defining Cauchy criteria criteria, contractive sequences and examples. (CLO-1) 5. Using the sequence and its limit, the tail of the sequence, the monotone sequence, the sub sequence, the divergent sequence, the Bolzano-Weirstrass theorem, the Cauchy criterion, the contractive sequence, in problems (CLO-2)			Exercises [12 x 50 minutes]	sequences, contractive sequences, [1] [2]	
16	**Final Exam**						

Description:

1. **Assessment Weights: 30% Assignment, 20% Participation, 30% Midterm test, and 30% Final Exam**