

Course Title: Real Analysis

Course Code: MATH-204

Course Type: Major Math

Prerequisites: Single Variable Calculus

Credit Hours: 3 (3 + 0)

Course Objectives: After completion of this course, the students will be able to:

- Understand the concepts of countable and uncountable sets, cardinal and ordinal numbers and well-ordering principal
- Explore real numbers, sequences, limits, and key theorems in analysis.
- Analyze series and apply various convergence tests.
- Explore continuous functions, sequences and series of functions.
- Master the concepts of derivative and its application in extrema.

Course Contents:

Sets and Numbers: Countable and uncountable sets, Cardinal numbers, Arithmetic of cardinal numbers, Ordered sets, well-ordered sets, Bounded sets, Supremum and infimum, Ordinal numbers, Well-ordering theorem, Axiom of choice, Zorn's lemma.

Sequences and Series: The definition of a limit, Properties of limits, Monotonic sequences, Subsequences and the Bolzano-Weierstrass theorem, Cauchy sequences. Series of real numbers, Convergence of series, Special series, Convergence tests (Divergence, Comparison, Cauchy Condensation, Ratio, Root, Leibniz alternating series tests).

Continuous Functions: Functions, Limits of functions, Continuity, Properties of Continuous functions, Intermediate value theorem, Extreme value theorem, Fixed point theorems.

Sequences and Series of Functions: Definition of point-wise and uniform convergence, Examples of uniform convergence, Cauchy criterion for uniform convergence.

Derivatives: The derivative, Definition of the derivative, Differentiation and continuity, Derivative of inverse functions, The chain rule., Maximizers and minimizers, Rolle's theorem and the Mean Value theorem, The derivative of vector-valued functions of several variables. Applications in Extrema.

Recommended Books:

1. Bartle, G. R. and Sherbert, R. D., *Introduction to Real Analysis*, Wiley, 4th edition, 2011.
2. Fraenkel, A. A., *Abstract Set Theory*, North-Holland Publishing, Amsterdam, 1966.
3. Gaskill, H. S. and Narayanaswami, P. P., *Elements of Real Analysis*, Prentice Hall, 1st edition, 1997.

4. Parzynski, W. R., *Introduction to Mathematical Analysis*, McGraw Hill College, 1st edition, 1983.
5. Rudin, W., *Principles of Mathematical Analysis*, McGraw-Hill Publishing Company, 3rd edition, 1976.
6. Suppes, P., *Axiomatic Set Theory*, Dover Publications, Inc., New York, 1972.
