2-Year Master's Program in Mathematics (NEP-2020)
REAL ANALYSIS

Master's Mathematics (1st Semester) Total Credits: 04
Course Code: MMTHCRA126 (15 hours per credit) Total Marks: 100
Continuous Assessment: Marks 30, Theory: Marks 70 Time Duration: 2½ hrs

Course Learning Outcomes(CLO's): After completion of this course, students shall be able to:

CLO1. Understand the concepts of Riemann–Stieltjes integration, including conditions of integrability and applications of the fundamental theorem of calculus.

CLO2. Analyze the convergence of improper integrals and apply classical inequalities in mathematical proofs.

CLO3. Examine uniform convergence of sequences and series of functions, and apply related theorems like Weierstrass M-test and approximation theorem.

CLO4. Analyze the convergence of sequence of functions and series.

UNIT-I

Riemann Integration: Lower and upper sums, Refinement of a Partition, Behavior of Lower and Upper Sums under Refinement, Definition and Existence of the Riemann Integral, Necessary and sufficient condition for R-integrability of a bounded function, Algebra of Riemann integrals, R-Integrability of Continuous, Monotone and Discontinuous functions (having finite number of discontinuity) in an interval. Mean value theorem, primitive, Fundamental theorem for integral calculus. Generalization of Riemann integration to Riemann Stieltjes integration.

UNIT-II

Improper integrals: integration of unbounded functions with finite limit of integration, comparison tests for convergence, Cauchy's test, infinite range of integration, absolute convergence, integrand as a product of functions, Abel's and Dirichlet's test. Inequalities: arithmetic-geometric means equality, inequalities of; Cauchy-Schwartz, Jensen, Holder & Minkowski, inequality on the product of arithmetic means of two sets of positive numbers.

UNIT-III

Infinite series: Carleman's theorem, conditional and absolute convergence, multiplication of series, Merten's theorem, Dirichlet's theorem, Riemann's rearrangement theorem. Young's form of Taylor's theorem, generalized second derivative, Bernstein's theorem and Abel's limit theorem.

UNIT-IV

Sequences and series of functions: Point wise and uniform convergence, Cauchy criterion for uniform convergence, Mn-test, Weierstrass M-test, Abel's and Dirichlet's test of uniform convergence, uniform convergence and continuity, Riemann integration and differentiation, Weierstrass approximation theorem, examples of continuous nowhere differentiable functions.

CLO-PLO Mapping Matrix (Strength version)

CLO ↓ PLO →	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	Average CLO
MMTHCRA126.1	3	3	1	1	3	1	1	3	**2**
MMTHCRA126.2	3	2	2	2	2	3	2	2	**2.25**
MMTHCRA126.3	3	3	2	2	2	2	3	3	**2.5**
MMTHCRA126.4	3	1	2	2	3	3	1	2	**2.12**
Average PLO	**3**	**2.25**	**1.75**	**1.75**	**2.5**	**2.25**	**1.75**	**2.5**	**2.22**

Recommended Books:

1. S.C.Malik and S. Arora, Mathematical Analysis, New Age International, Pvt. Ltd, 7th Edition, 2024.
2. W. Rudin, Principles of Mathematical Analysis, McGraw Hill Edu, third Edition, 2017.
3. T. M. Apostol, Mathematical Analysis, Narosa Publishers, 2002.
4. A. J.White, Real Analysis: An Introduction, Addison-Wesley; First Edition, 1968.
5. R. Goldberg, Methods of Real Analysis, Oxyford and IBH Publishing, 2020.