Core VIII **Semester IV**

REAL ANALYSIS-II

Course Objective:

As a second course in real analysis, the objective is to learn on the concept of differentiation, Riemann Integration and their applications. The series of functions and the improper integrals have also been introduced.

Learning Outcomes: After completing the course the student will be able to

- Learn working out problems on derivatives of function and their applications.
- Learn about Riemann Integration and their properties including Improper Integrals.
- Learn on pointwise and uniform convergence of power series.
- Learn to calculate value of improper integrals.

Unit I

Differentiabilityofafunction ata pointandinaninterval, Caratheodory'stheorem, algebra of differentiablefunctions, relative extrema, interior extremumtheorem.Rolle'stheorem, Mean value theorems, Cauchy's meanvalue theorem, Lagrange mean value theorem, intermediate value propertyofderivatives,Darboux'stheorem, applications of mean value theorem, Taylor's theorem and applications.

Unit II

Riemann integration: partitions, conditions of integrability, definition of Riemann integral properties of the Riemann integral, Riemann integral as limit of a sum, mean value theorem for integrals, integration by parts, Fundamental theorems of calculus, Taylor theorem with remainder.

Unit III

Pointwise and uniform convergence of sequence of functions, Cauchy criterion for uniform convergence and Weierstrass M-test, uniform convergence and continuity, term by term integration and differentiation of a series, power series, Abel's theorem, Weierstrass approximation theorem, Taylor series

Unit IV

Improper integrals, integration of unbounded functions with finite limits of integration, comparison tests of convergence, infinite range of integration, integrand as product of

functions convergent at infinity, absolutely convergent integral,tests of convergence, convergence of Beta and Gamma functions, applications.

Books Recommended:

- ✓ *R.G. Bartle D.R. Sherbert, Introduction to Real Analysis, John Wiley and Sons (Asia) Pvt. Ltd., Singapore*
- ✓ *G. Das and S. Pattanayak, Fundamentals of Mathematics Analysis, TMH Publishing Co.*
- ✓ *S. C. Mallik and S. Arora, Mathematical Analysis, New Age International Ltd., New Delhi.*

Book for Reference:

- ✓ *K. A. Ross, Elementary Analysis: The theory of Calculus, Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.*
- ✓ *Charles G. Denlinger, Elements of Real Analysis, Jones and Bartlett (Student Edition), 2011.*
- ✓ *A. Kumar, S. Kumaresan, A basic course in Real Analysis, CRC Press, 2014*
- ✓ *e-Learning Source http://ndl.iitkgp.ac.in ; http://ocw.mit.edu ; http://mathforum.org*
- ✓ *Suggested digital platform: NPTEL/SWAYAM/MOOCs.*

Core IX

Complex Analysis-I

Course Objectives:

The objective of the course is to introduce the theories for functions of a complex variable. The concepts of analyticity and complex integration and its applications, are discuss in detail. This course is prerequisite to many other advance analysis courses such as advanced complex analysis, geometric functions, theory, potential theory, theory of entire and meromorphic functions, etc.

Learning Outcomes:

After completing the course the student will be able to

- Understand the geometric aspects of complex numbers system, convergence of series of complex numbers.
- Understand the significance of complex differentiability, analyticity and construction of analytic functions from given harmonic functions.
- Relate the notion of line integral, Cauchy fundamental theorems on integrals and its applications.
- Classify the nature of singularities, properties of zeros and poles and be able to know the applications of residue theorem.

Unit I

Basic properties of complex number and, Stereographic projection, power series, absolute convergence, uniform convergence, Cauchy-Hadamard formula for the radius of convergence, circle of convergence, exponential, logarithmic, sine and cosine functions for complex numbers.

Unit II

Continuity and differentiability of a complex valued function, analytic function, necessary and sufficient conditions for analytic functions, Cauchy-Riemann equations (Cartesian and polar form), harmonic and conjugate harmonic functions, construction of analytic function (Milne-Thomson's method).

Unit III

Line integral, path independence, complex integration, Green's theorem, anti-derivative

theorem, Cauchy-Goursat theorem, Cauchy integral formula, Cauchy's inequality, derivative of analytic function and its generalizations, Liouville's theorem, Morera's theorem, Taylor's and Laurent's theorem, expansion of analytical function in Taylor and Laurent series.

Unit IV

Zeroes of an analytic function, singularities of complex functions and its classifications, residues, Cauchy's residue theorem, residue at infinity, residues at poles and its examples, maximum modulus theorem.

Books Recommended:

- ✓ *Elias M. Stein & Rami Shakarchi: Complex Analysis, Princeton University press, Princeton and Oxford, 2003.*
- ✓ *Joseph Bak and Donald J. Newman: Complex analysis (3rd Edition), Undergraduate Texts in Mathematics, Springer-Verlag, NewYork, 1997.*

Books for Reference:

- ✓ *S. Ponnusamy and Herb Silverman: Complex variables with Applications: Birkhauser, (2006) (Indian Edition 2012).*
- ✓ *H. A. Priestly: Introduction to Complex Analysis, Oxford University Press, 2008.*
- ✓ *Donald Sarason: Complex Function Theory: AMS, Second Edition, 2007.*
- ✓ *James Ward Brown and RuelV.Churchill: Complex Variables and Applications (Eighth Edition), McGraw-Hill International Edition, 2009.*
- ✓ *Suggested digital platform: NPTEL/SWAYAM/MOOCs*
- ✓ *e-Learning Source http://ndl.iitkgp.ac.in ; http://ocw.mit.edu ; http://mathforum.org*

Core X

Algebra-II

Course Objectives:

To present a systematic study on finite abelian groups, Sylow's theorems and Modules.

Learning Outcomes:

After completing the course the student will be able to

- Know on finite abelian groups, the class equation and Sylow's theorems.
- Know on applications of Sylow's theoremsand test the simplicity of groups.
- Learn on group action, composition series, nilpotent groups and solvable groups.
- Solve problems in modules and related results.

Unit I

Fundamental theorem of finite abelian groups, isomorphism classes of abelian groups, proof of the fundamental theorem, Sylow's theorems, conjugacy classes, the class equation, Sylow's first theorem, Cauchy theorem, Sylow's second and third theorems.

Unit II

Application of Sylow's theorem, finite simple groups, non-simplicity tests, the simplicity of alternating group A_5, free groups, classification of groups of order up to 15, characterization of dihedral groups.

Unit III

Group actions and permutation representations, composition series and holder programs, nilpotent groups, solvable groups.

Unit IV

Introduction to modules, definition and examples, direct sum, free modules, quotient modules, homomorphisms, simple modules, modules over PIDs.

Books Recommended:

- ✓ *Joseph A. Gallian, Contemporary Abstract Algebra (4th Edition), Narosa Publishing House, New Delhi, 1999.(IX Edition 2010).*
- ✓ *D. S. Dummit, R. M. Foote, Abstract Algebra, Wiley-India edition, 2013.*
- ✓ *C. Musili, Introduction to Rings and Modules, Narosa Publishing House.*

Books for Reference:

- ✓ *John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.*
- ✓ *N. Herstein, Topics in Algebra, Wiley Eastern Limited, India, 1975.*
- ✓ *M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.*
- ✓ *S. Nanda, Topics in Algebra, Allied Publishers, New Delhi.*
- ✓ *Suggested digital platform: NPTEL/SWAYAM/MOOCs*
- ✓ *e-Learning Source http://ndl.iitkgp.ac.in; http://ocw.mit.edu; http://mathforum.org*