ST. ALOYSIUS' COLLEGE
(AUTONOMOUS) JABALPUR

St. Aloysius College (Autonomous), Jabalpur

Reaccredited 'A+' by NAAC (CGPA – 3.68/4.00)

College with Potential for Excellence by UGC

DST FIST Supported

Department of Mathematics

Syllabus

M.Sc. I to IV Semester

To be implemented in 2022-23

CHOICE BASED CREDIT SYSTEM (CBCS)

(For PG Programme in Mathematics from the academic year 2022-2023 onwards)

1. Eligibility

(i) Admission: Candidates who have passed the qualifying examination (UG) with Mathematics shall be given in admission to M.Sc. Mathematics Degree Programme.

(ii) Degree : The candidates shall have subsequently undergone the prescribed course of study in the college affiliated to the University for a period of not less than two academic years, passed the examinations prescribed and fulfilled such conditions as have been prescribed.

2. Duration

The course is for a period of two years. Each academic year shall comprise of two Semester, viz. Odd and Even Semester. Odd semesters shall be from July to November and Even Semesters shall be from January to April. There shall be not less than 90 working days which shall comprises of minimum 375 teaching clock hours for each semester. (Exclusive of the days for the conduct of Odd and Even Semester examinations).

3. Programme

M.Sc. Mathematics

4. The CBCS System

The Programme will run on Choice Based Credit System (CBCS). It is an instructional package developed to suit the needs of students to keep pace with the developments in higher education and the quality assurance expected of it in the light of globalization in higher education.

5. Paper Offered

Semester I

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	Paper	Title of the Paper
Core	I	Advanced Abstract Algebra- I
Core	II	Real Analysis-I
Core	III	Topology- I
Core	IV	Complex Analysis – I
Core	V	A. Functional Analysis – I
Elective		B. Integral Transform

Semester II

	Paper	Title of the Paper
Core	I	Advanced Abstract Algebra- II
Core	II	Real Analysis-II
Core	III	Ordinary and Partial Differential Equations
Core	IV	Complex Analysis – II
Core	V	A. Number Theory
Elective		B. Topology- II

Semester III

	Paper	Title of the Paper
Core	I	Operation Research – I
Core	II	Special Function
Core	III	A. Numerical Methods - I
Core	IV	A. Programming in C
Elective		B. Functional Analysis – II
Open	V	A. Advanced Discrete Mathematics

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Elective		B. Mathematical Statistics

Semester IV

	Paper	**Title of the Paper**
Core	I	Operation Research – II
Core	II	Numerical Methods - II
Core Elective	III	A. Divergent Series B. Programming in C++
Core Elective	IV	A. Integration Theory B. Fuzzy Sets and Their Applications
Open Elective	V	A. Mathematical Modeling B. Wavelets

CVV- Comprehensive Viva-Voce with maximum marks 100 and minimum marks 40.

6. Details of the Number of Papers / Credits per Paper / No. of Hours in the PG Programme

Theory					
Semester	**No. of Papers**	**Credits per Paper**	**Total Credits**	**Total Hours per Week**	**Total Hours per Semester**
I	4 Core	5	25+ 1(Skill	5 x 6 = 30	30 x 15 =

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	1 E Core	5	Development)= 26	Including Presentation for Viva-Voce	450
II	4 Core	5	25+ 1(Skill Development)= 26	5 x 6 = 30	30 x 15 = 450
	1 E Core	5			
III	4 Core	5	25+ 1(Skill Development)= 26	5 x 6 = 30	30 x 15 = 450
	1 Open Elec.	5			
IV	4 Core	5	25+ 1(Skill Development)= 26	5 x 6 = 30	30 x 15 = 450

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DEPARTMENT OF MATHEMATICS 2022-23
M. Sc. (MATHEMATICS)
FIRST SEMESTER
CORE PAPER I: ADVANCED ABSTRACT ALGEBRA-I

CREDIT: 5
MAX MARKS: 40
MIN MARKS: 14

COURSE OBJECTIVE:

To make the students see and understand the connection and transition between previously studied mathematical concepts and more advanced mathematics.

COURSE LEARNING OUTCOMES:

Upon successful completion of this course, the student will be able to:

CLO1	Provide the knowledge of important mathematical concepts in abstract algebra such as groups, Abelian groups, subgroups, cyclic groups, and normal subgroups of a group.
CLO2	Introduce many mathematical concepts such as Cauchy Abelian theorem, Sylow's theorems and various applications of Sylow's theorems.
CLO3	Confer knowledge of series of groups: Normal and Subnormal series, Composition series and their properties.
CLO4	Make the students participate actively in the vital concepts of abstract mathematics like Solvable groups, Nilpotent groups and their characteristics.
CLO5	Appreciate the concepts of Extension field, Splitting field, Finite field, and related theorems.

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Unit-I: Another Counting Principle, Conjugacy Relation, Normalizer of an element of a Group, Class Equation and its theorems, Cauchy theorem for Finite Group (both Abelian and Non-Abelian), Sylow's first and second theorem, Double Coset, Application of Sylow's third theorem in Finite Groups.

Unit-II: Series of Groups: Normal and Subnormal Series, Composition Series, Zassenhaus lemma, Schreir Refinement theorem, Jordon Holder theorem.

Unit-III: Solvable Group and its properties, Commutator Subgroup and its theorem, Nilpotent Group and its properties.

Unit-IV: Fields: Extension Field and its theorem, Finite Extension, Algebraic element and its theorem, Algebraic and Transcendental Extension, Roots of Polynomials, Remainder theorem, Factor theorem, Splitting field and its theorems.

Unit-V: More about Roots: Derivative of a Polynomials and its theorems, Simple Extension and its theorems, Primitive element, Separable Extension, Perfect Field and its theorems, Finite Field and its theorems.

Text Books:

1. I.N. Herstein, Topics in Algebra, Wiley Eastern Ltd., New Delhi, 1975 (For Units I, III, IV,V).
2. Vivek Sahai and Vikas Bist, Algebra, Narosa Publishing House, 1999 (For Unit-II).

Reference Books:

1. P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul, Basic Abstract Algebra (2nd Ed.) , Cambridge University Press, Indian Edition, 1997.
2. I.S. Luther and I.B.S. Passi, Algebra, Vol. I, Groups, Narosa Publishing House, 1996.
3. Surjeet Singh and Quazi Zameeruddin, Modern Algebra, Vikas Publishing House Pvt. Ltd., 1990.

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4. N. Jacobson, Basic Algebra, Vol. I & II, Hindustan Publishing Company, 1980.

5. S. Lang, Algebra, 3rd Edition, Addition-Wesley, 1993.

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ST. ALOYSIUS COLLEGE (AUTO), JABALPUR
DEPARTMENT OF MATHEMATICS 2022-23
M. Sc. (MATHEMATICS)
FIRST SEMESTER
CORE PAPER II : REAL ANALYSIS - I

CREDIT: 5
MAX MARKS: 40
MIN MARKS: 14

COURSE OBJECTIVE:

To make the students see and understand the connection and transition between previously studied Real analysis mathematical concepts and more advanced mathematics.

COURSE LEARNING OUTCOMES:

Upon successful completion of this course, the student will be able to:

CLO1 The basic properties of the field of real numbers.

CLO2 The series of real numbers and convergence.

CLO3 Provide the knowledge of Bolzano- Weirstrass theorem and ability to apply the theorem in a correct mathematical way.

CLO4 Introduce many mathematical concepts studied in Real mathematics such as the real functions

CLO5 limits, continuity, differentiability of real functions and its related theorems.

Unit-I: Definition and existence of Riemann-Stieltjes integral and its Properties, Integration and differentiation, The fundamental theorem of Calculus.

Unit-II: Integration of vector-valued functions, Rectifiable curves. Rearrangements of terms of a series. Riemann's theorem.

Unit-III: Sequences and series of functions, pointwise and uniform convergence, Cauchy criterion for uniform convergence, Weierstrass M-test, Abel's and

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Dirichlet's tests for uniform convergence, uniform convergence and continuity, uniform convergence and Riemann-Stieltjes integration, uniform convergence and differentiation, Weierstrass approximation theorem.

Unit-IV: Power series, uniqueness theorem for power series, Abel's and Tauber's theorems.Functions of several variables, linear transformations.

Unit-V: Derivatives in an open subset of Rn, Chain rule, Partial derivatives, interchange of the order of differentiation, Derivatives of higher orders, Taylor's theorem, Inverse function theorem.

Text Book: Water Rudin, Principles of Mathematical Analysis, McGraw Hill, 1978.

Reference Books: 1. T.M. Apostal, Mathematical Analysis, Narosa.
2. H.L. Royden, Real Analysis, Macmillan (Indian Edition)

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DEPARTMENT OF MATHEMATICS 2022-23
M. Sc. (MATHEMATICS)
FIRST SEMESTER
CORE PAPER III: TOPOLOGY-I

CREDIT: 5
MAX MARKS: 40
MIN MARKS: 14

COURSE OBJECTIVE:

To classify sets with various properties like finiteness, infiniteness, countability, unaccountability, etc. To present an introduction to the essentials of general topology with an emphasis on those aspects which are basic to higher mathematics. To stress on ideas of abstraction and aesthetics, development of mathematical tools and use of mathematical language.

COURSE LEARNING OUTCOME

Upon successful completion of this course, the student will be able to:

CLO1. Understand the concept of cardinality.
CLO2. Recall basic concepts of topology.
CLO3. Develop their abstract thinking skills.
CLO4. Gain in mathematical maturity.
CLO5. Gain competency in writing proofs.

Unit –I: Equivalent Sets, Denumerable, Countable, infinite and uncountable sets. The Continuum, Schoreder-Bernstein theorem, Concept of cardinality, equivalence of $(0,1)$, $(0,1]$, $[0,1)$, $[0,1]$,

Cantor's theorem and Continuum Hypothesis, Partially ordered sets, First and the last elements, Maximal & Minimal elements, upper and lower bounds, Zorn's Lemma, Axiom of Choice and Well-ordering principle . (As given in chapter -1,

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3. K. Chandra Shekhara Rao, Topology, Narosa Publications, 2009.
4. J. P. Chauhan and J. N. Sharma, Topology, Krishana Publications, 2015.

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M. Sc. (MATHEMATICS)
FIRST SEMESTER

CORE PAPER IV: COMPLEX ANALYSIS -I

CREDIT: 5
MAX MARKS: 40
MIN MARKS: 14

COURSE OBJECTIVE:

Understand complex numbers provide a satisfying extension of the real numbers, a function of complex variable and carry out basic mathematical operations with complex numbers.

COURSE LEARNING OUTCOME

On completion of syllabus student will be able to

CLO 1 – Understand the significance of differentiability for complex functions and be familiar with the Cauchy –Riemann equations.

CLO 2- Evaluate integrals along a path in the complex plane and understand the statement of Cauchy's theorem.

CLO 3- Compute the Taylor and Laurent expansions of simple functions, determining the nature of singularities and calculating residues.

CLO 4- Use the Cauchy Residue theorem to evaluate integrals and sum series.

CLO 5 - Understand about Bilinear transformations, cross ratio and fixed points.

UNIT I : Complex integration, Rectifiable arcs, Contours, Complex line integrals, Evaluation of some integrals by direct definition, Complex integral as sum of two real line integrals, The absolute value of a complex integral,The Elementary form of Cauchy's Theorem, Extension of the Cauchy's Theorem,

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UNIT II : Cauchy integral formula,Cauchy's Integral formula for the derivative of an analytic function, Cauchy's Integral formula for Higher order Derivatives. Morera's theorem, Cauchy's inequality theorem, Liouville's theorem, Taylor's theorem.

UNIT III : Laurent Theorem, Singularities,Poles and zeros of a Meromorphic function, The argument principle, Rouche'stheorem,The fundamental Theorem of algebra, The maximum modulus principle, Schwartz lemma.

UNIT IV : Residues, Cauchy's residue theorem,Evaluation of certain integrals, Integrals of type $\int_0^{2\pi} R(\cos\theta, \sin\theta)d\theta$, Integrals of type $\int_{-\infty}^{\infty} f(x)dx$, Integrals of type $\int_{-\infty}^{\infty} \frac{P(x)}{Q(x)} \sin mx\, dx, \int_{-\infty}^{\infty} \frac{P(x)}{Q(x)} \cos mx\, dx$, Case of poles on the real axis.

UNIT V : Bilinear transformations, Elementary Transformations,Product of two Bilinear transformations, The linear group, Cross Ratio, Preservation of Cross Ratio under Bilinear transformations, Two important families of circles, Fixed point of a Bilinear transformations, Normal form of a Bilinear transformation.

Text Book:

1. J.B. Convey, Function of one complex variable, Springer-Verlag, 1980.

Reference Books:

1.S. Ponnuswamy, Foundation of complex analysis, Narosa Publishing House,1997.
2. L.V. Ahlfors, complex analysis, McGraw Hill,1979.
3. M.L. Khanna, Complex Analysis
4. H.K. Pathak, Complex Analysis

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FIRST SEMESTER

CORE ELECTIVE PAPER V(A) :FUNCTIONAL ANALYSIS - I

CREDIT: 5
MAX MARKS: 40
MIN MARKS: 14

COURSE OBJECTIVE:

To get familiar with concepts of a normed linear spaces. To achieve knowledge and understanding of Banach spaces and their various properties. To give a working knowledge of the basic properties of Quotient spaces, bounded linear operators and functionals. To show the use of abstract algebraic/topological structures in studying spaces of functions.

COURSE LEARNING OUTCOME:

Upon successful completion of this course, the student will be able to:

CLO1. Appreciate how functional analysis uses and unifies ideas from vector spaces, the theory of metrics, and complex analysis.

CLO2. Work comfortably with Banach spaces.

CLO3. Understand normed linear spaces and their compatibilities.

CLO4. Enhance the knowledge regarding Quotient spaces.

CLO5. Understand basic theorems including Hahn Banach Theorem.

CLO6. Acquire knowledge of bounded operators and functionals.

Unit-I: Normed linear spaces, Banach spaces and examples, Properties of Normed linear spaces, Basic properties of finite dimensional normed linear spaces.

Unit-II: Finite dimensional Normed linear spaces & Sub spaces, Equivalent norms, Riesz Lemma and Compactness.

Unit-III: Definition and properties of cosets in normed linear spaces. Quotient space of normed linear spaces and its completeness.

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Unit-IV: Bounded linear operators & continuous operators, Normed Linear spaces operators.

Unit-V: Linear functional, bounded linear functional, Dual spaces with examples. Hahn-Banach theorem.

Text Book:

1. G. F. Simmons, Topology and Modern Analysis , McGraw Hill International Edition, 1963.
2. E. Kreyszig, Introductory Functional Analysis with Applications, John Wiley & Sons, New York, 1978.

Reference Books:

1. R. E. Edward, Functional Analysis, Dover Publication, New York, 1995.
2. P. K. Jain, O. P. Ahuja and Khalil Ahmed, Functional Analysis, New Age International (P) Ltd. Publ, 2004.

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DEPARTMENT OF MATHEMATICS 2022-23
M. SC. (MATHEMATICS) FIRST SEMESTER

CORE ELECTIVE PAPER V(B): INTEGRAL TRANSFORM

CREDIT: 5
MAX MARKS: 40
MIN MARKS: 14

COURSE OBJECTIVE:

The course is aimed at exposing the students to Laplace and Fourier Transforms of different functions and their applications in solving Differential equations, Partial Differential equations, Initial Value and Boundary Value Problems.

COURSE LEARNING OUTCOMES:

Upon successful completion of this course, the student will be able to:

CLO 1 Understand the Laplace Transform and Inverse Laplace Transform of standard functions.

CLO 2 Apply the appropriate shift theorems in finding Laplace and Inverse Laplace transforms of elementary functions.

CLO 3 Explain and apply to find the solution of Heat Conduction Equation, Boundary Value Problems and electric circuits. Also, they will be able to apply the Laplace Transform to beam and dynamics.

CLO 4 Evaluate the Fourier transform, Complex Fourier Transform, Fourier Sine transform and Fourier cosine transform of elementary functions.

CLO 5 Evaluate the Fourier Transform of the derivatives.

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Unit –I:

Laplace Transform, Properties of Laplace Transform, Laplace Transform of Derivatives of function, Inverse Laplace Transform, Properties of Inverse Laplace Transform, Inverse Laplace Transform of Derivatives, Convolution theorem.

Unit – II:

Application of Laplace Transforms to solution of differential equations, solution of initial value problem, Laplace's equations, Laplace wave equation. Application of Laplace Transforms in Heat Conduction equation.

Unit – III:

Application of Laplace Transforms to Boundary Value Problems, Electric Circuits, and Application to Beams.

Unit – IV:

The Fourier Transform, The complex Fourier Transform, Inversion Formula, Fourier Cosine and Sine transform properties of Fourier transforms, Convolution &Parseval's identity.

Unit – V:

Fourier Transform of the derivatives, Finite Fourier sine & Cosine Transform, Inversion Operational and combined Fourier transform.

Books recommended:

Text Book:

1. J.K. Goyal& K. P. Gupta, Integral Transform, PragatiPrakashan, Meerut.
2. A. R. Vashishtha& R. K. Gupta, Integral Transform, Krishna Prakashan Media(P), Limited.

Reference Book:

1. I. N. Sneddon, Integral Transform, Tata McGraw-Hill, New York.

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M. Sc. (MATHEMATICS)
SECOND SEMESTER
CORE PAPER I: ADVANCED ABSTRACT ALGEBRA-II

CREDIT: 5
MAX MARKS: 40
MIN MARKS: 14

COURSE OBJECTIVE:

Give the students experience, knowledge, and confidence to move forward in the study of mathematics.

COURSE LEARNING OUTCOMES:

Upon successful completion of this course, the student will be able to:

CLO1 Impart knowledge of some fundamental results and techniques from the Galois theory.

CLO2 Analyze and demonstrate examples of modules and rings,

CLO3 Discuss general properties of Modules, Sub modules and Quotient module.

CLO4 Confer knowledge of Noetherian, Artinian modules and rings.

CLO5 Appreciate the concepts of finitely generated module over principal ideal domain and its application to finitely generated Abelian groups.

Unit-I: The element of Galois theory: Automorphism of a Field, Group of Automorphisms of a Field, Fixed field and its theorems, Normal Extension and its theorems, Fundamental theorem of Galois theory.

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Unit-II: Introduction of Modules, Examples, General properties of Modules, Submodules and Direct Sum of Submodules, R-homomorphisms and Quotient Modules.

Unit-III: Finitely generated modules, Cyclic modules, Simple modules, Semi-simple modules, Schur's lemma, Free Modules, Rank of a Module.

Unit-IV: Noetherian and Artinian Modules: Examples and theorems, Ascending and Descending Chain Condition (acc and dcc), Noetherian and Artinian Rings, Examples, Hilbert Basis theorem.

Unit-V: Finitely Generated Modules over a Principal Ideal Domain, Fundamental Structure theorem of Finitely Generated Modules over a Principal Ideal Domain, Applications to Finitely Generated Abelian Groups.

Text Books :

1. I.N. Herstein, Topics in Algebra, Wiley Eastern Ltd., New Delhi, 1975 (For Units II, III, IV,V).
2. A.R.Vasishtha, Modern Algebra, Krishna Prakashan Mandir, Meerut (U.P.) (For Unit I).
3. P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul, Basic Abstract Algebra (2nd Ed.), Cambridge University Press, Indian Edition, 1997 (For Units II, III, IV,V).

Reference Books:

1. Vivek Sahai and Vikas Bist, Algebra, Narosa Publishing House, 1999.
2. I.S. Luther and I.B.S. Passi, Algebra, Vol. I, Groups, Narosa Publishing House, 1996.
3. Surjeet Singh and Quazi Zameeruddin, Modern Algebra, Vikas Publishing House Pvt. Ltd., 1990.
4. N. Jacobson, Basic Algebra, Vol. I & II, Hindustan Publishing Company, 1980.

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5. S. Lang, Algebra, 3rd Edition, Addition-Wesley, 1993.
6. Ramji Lal, Algebra, Vol. I & II, Shail Publication, 2002.

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DEPARTMENT OF MATHEMATICS 2022-23
M. Sc. (MATHEMATICS)
SECOND SEMESTER
CORE PAPER II : REAL ANALYSIS – II

CREDIT: 5
MAX MARKS: 40
MIN MARKS: 14

COURSE OBJECTIVE:

To make the students see and understand the connection and transition between previously studied length of sets concepts and more advanced length concept viz. Measure.

COURSE LEARNING OUTCOMES:

Upon successful completion of this course, the student will be able to:

CLO1 The basic tools, concepts and results of measure theory and appreciate its importance in the wider context of mathematics.

CLO2 The knowledge of null sets, outer measure, measurable sets and Lebesgue measure, sigma-fields.

CLO3 Introduce many mathematical concepts studied in mathematics such as the Lebesgue integration, Fatou's Lemma, Monotone and Dominated Convergence Theorems.

CLO4 Understand the concept of Convex function and its geometrical representation

CLO5 Understand the concept of Dual space and convergence in measure

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Unit-I: Lebesgue outer measure. Measurable sets. Regularity. Measurable functions. Borel and Lebesgue measurability. Non-measurable sets.

Unit-II: Integration of Non-negative functions. The General integral. Integration of Series, Reimann and Lebesgue Integrals.

Unit-III: The Four derivatives. Functions of Bounded variation. Lebesgue Differentiation Theorem, Differentiation and Integration.

Unit-IV: The LP-spaces, Convex functions, Jensen's inequality. Holder and Minkowski inequalities. Completeness of LP.

Unit-V: Dual of space when $1 \leq P < \infty$, Convergence in Measure, Uniform Convergence and almost Uniform Convergence.

Text Book: G. de Barra. Measure Theory and Integration, Wiley Eastern (Indian Ed.).

Reference Books:

1. Walter Rudin, Principles of Mathematical Analysis, McGraw-Hill, International student edition.
2. H.L. Royden, Real Analysis, Macmillan, Indian Edition.

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M. Sc. (MATHEMATICS)
SECOND SEMESTER
CORE ELECTIVE PAPER V(B): TOPOLOGY-II

CREDIT: 5
MAX MARKS: 40
MIN MARKS: 14

Course Objective:

To train the students in the area of topology. To give adequate knowledge of the subject that can be used by the students for further applications in their respective sphere of interest.

COURSE LEARNING OUTCOME

Upon successful completion of this course, the student will be able to:

CLO-1 Acquisition of knowledge in various topics of topology.

CLO 2 Appreciation of beauty of profound mathematical results such as Heine-Borel theorem and Urysohn's Lemma.

CLO 3 Understanding the dynamics of methods of mathematical proof.

CLO 4 Understanding the Nets, Filters, Convergence, Ultra Filters and Compactness.

CLO 5 Understanding the fundamental group, covering spaces and Homotopy of Paths.

Unit –I: Continuous functions and compact sets, Basic properties of Compactness, Compactness and Finite Intersection Property, Product of spaces, Projection maps, Tychonoff's theorem, Local compactness, Heine Boral theorem.

Unit – II: Separation: T_1 –speces, Hausdorff spaces, Regular, Completely regular spaces and Normal spaces, their characterization and basic properties (As given in the Chapter-V of G.F. Simmons Book)

Unit – III: Urysohn's Lemma, Tietze extension theorem, one-point compactification, the stone-cechcompactification, Urysohn Metrization theorem (As given in the Chapter-V of G.F. Simmons Book)

Unit – IV: Net's & Filters, Topology and convergence of Nets, Housdorffness& Nets, Compactness & Nets, Filters and Convergence, Ultra Filters and Compactness.

Unit – V: The fundamental group and covering spaces, Homotopy of Paths, The Fundamental Group, Homomorphism, Covering spaces, The Fundamental Group of the circle.

Text Book:

4. James R. Munkres, Topology, A First Course, Prentice Hall of India Pvt. Ltd. New Delhi.
5. G. F. Simmons, Topology and Modern Analysis , McGraw Hill International Edition, 1963.

Reference Books:

5. K. D. Joshi, Introduction to General Topology, Wiley Eastern Ltd, New Delhi.
6. J. L. Kelly, General Toplogy, Van Nostrand, New York, 1995.
7. K. Chandra Shekhara Rao, Topology, Narosa Publications.
8. J. P. Chauhan and J. N. Sharma, Krishana Publications.

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DEPARTMENT OF MATHEMATICS 2022-23
M. Sc. (MATHEMATICS)
SECOND SEMESTER
CORE PAPER III: ORDINARY AND PARTIAL DIFFERENTIAL EQUATION

CREDIT: 5
MAX MARKS: 40
MIN MARKS: 14

COURSE OBJECTIVE:

To make the students see and understand the ordinary and partial differential equation and also different methods to solve differential equation at ordinary and singular points.

COURSE LEARNING OUTCOMES:

Upon successful completion of this course, the student will be able to:

CLO1. Understand ordinary differential equation and find the solution.

CLO2. Understand partially differential equation and find the solution by various method.

CLO3. Apply power series method to solve differential equations.

CLO4. Evaluate Laplace transform of a function its inverse. Find the Laplace transform of derivatives, integrals and periodic functions.

CLO5. Apply Laplace transforms to solve initial-value problems for linear differential equations with constant coefficients.

UNIT I Exact differential equations and adjoints , The adjoint operator, Lagrange's identity , Strum-Liouville differential equation , Eigen values , The

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normal form, change of independent's variable, Lagrange's method of variation of parameters.

UNIT II Partial differential equation, Construction of partial differential equation of first order, Lagrange's linear equation, Charpit's general method of solutions, Green's functions, Domain and range of the operators, One dimensional Green's functions, Construction of Green's functions.

UNIT III Power series solution and special functions, A review of power series, Series solution of first order linear equations, Second order linear equations, Ordinary points, Regular singular points, Gauss's hypergeometric series.

UNIT-IV Laplace Transforms, Integral transforms, A few remarks on the theory, Conditions for the existence of Laplace transforms, Applications to differential equations.

UNIT-V Derivatives and intergrals of Laplace transforms, Convolutions and Abel's Mechanical problem. More about convolutions, The unit step and impulse functions.

Text Books:

1. G.F.Sinmons, Differential Equation with applications and Historical Notes, McGraw Hill international Editions, 1991(for Units IV&V)

2. B.P Parashar; Differential and Integral Equations, CBS publishers and Distributors Ltd. 1992(for Units I,II&III).

Reference Books:

1. H.T.H. Piaggio, An Elementary Treatise on differential Equations and Their Applications, Indian Reprint,1966.
2. E.A. Coddington, An Introduction, The Solution of Ordinary Differential Equations, Indian reprint.
3. B.L.Ince and I.N.Sneddon, The Solution of Ordinary Differential Equations,Longman.1987.
4. Ian Sneddon, Elements of Partial Differential Equations, McGraw Hill International Editions, 1957

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ST. ALOYSIUS COLLEGE

DEPARTMENT OF MATHEMATICS 2022-23
M. Sc. (MATHEMATICS)
SECOND SEMESTER
CORE PAPER IV : COMPLEX ANALYSIS II

CREDIT: 5
MAX MARKS: 40
MIN MARKS: 14

COURSE OBJECTIVE:

Learn techniques of analysis that make practical problems easy (e.g. graphical rotation and scaling as an example of complex multiplication) , Appreciate how mathematics is used in design(e.g. conformal mapping).

COURSE LEARNING OUTCOME

Upon successful completion of this course, the student will be able to:

CLO 1 Perform basic algebraic manipulation with complex numbers
CLO 2 Understand the geometric interpretation of complex numbers
CLO 3 Know methods of finding the nth roots of complex numbers and the solutions of simple polynomial equations.
CLO 4 Use analytical functions and conformal mappings;
CLO 5 Compute definite integrals using residue calculus;

UNIT 1. Weierstrass factorization theorem, Gamma function, Euler's Gamma function, Properties of Gamma function, Gauss' Formula, Functional Equation, The Riemann Zeta function, Extention of Zeta Function, Riemann's functional Equation.

UNIT 2. Mittage-Leffler's theorem, Analytic Continuation, Uniqueness of Analytic Continuation, Power series Method of Analytic Continuation, Schwarz's Reflection Principal for Symmetric Region.

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UNIT 3. Harmonic functions, Basic Properties of Harmonic Functions, Harmonic Conjugates, Mean-Valued Theorem for Harmonic Functions, Harmonic Functions on a Disc, Poisson Kernel, Proposition, Harnack's inequality.

UNIT 4. Calculus of Residues, Evaluation of Certain integrals, Integral of type Case of poles on the Real Axis(Indenting Method), Integrals of Many Valued Function such as Z^a , log Z, A Quadrant or a sector of a circle as the contour.

UNIT 5. Conformal mappings,Sufficient condition for w=f(z) to represent a Conformal Mapping,Necessary condition for w=f(z) to represent a Conformal Mapping, Certain type of transformations, Translation $w=z+\alpha$, rotation only, Magnification only,Magnification and rotation both,Translation, Magnification and Rotation, Rotation and Inversion.

Text Book :

J.B. Convey, Function of one complex variable, Springer-Verlag, 1980.

Reference Books:

1. S. Ponnuswamy, Foundation of complex analysis, Narosa Publishing House,1997.

2. L.V. Ahlfors, complex analysis,McGraw Hill,1979.

3. E. C. Tichmarsh. The theory of functions. Oxford University, Press, London.

4. Dr. H.K.Pathak, Complex Analysis

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ST. ALOYSIUS COLLEGE (AUTO), JABALPUR
DEPARTMENT OF MATHEMATICS 2022-23
M. Sc. (MATHEMATICS)
SECOND SEMESTER
CORE ELECTIVE PAPER V(A): NUMBER THEORY

CREDIT: 5
MAX MARKS: 40
MIN MARKS: 14

COURSE OBJECTIVE:

To expose students Number Theory as a beautiful subject of Mathematics because of its treasure of fascinating problems and academic appeal. To understand the idea behind the famous quotation of Gauss on number theory. To allow students to experience mathematics as imaginative, empirical science.

COURSE LEARNING OUTCOMES:

Upon successful completion of this course, the student will be able to:

CLO1. Recall the results in number theory.
CLO2. Explain the concepts in number theory.
CLO3. Develop mathematical proofs of statements.
CLO4. Explore counter examples to false statements.
CLO5. Apply results from number theory in cryptography etc.

Unit-I: Divisibility theory in integers: Division algorithm, Greatest common divisor, Euclidean algorithm.
Primes and their distribution: The fundamental theorem of arithmetic, the sieve of Eratosthenes, the Goldbach conjecture.
Unit-II: The theory of congruence: Basic properties of congruences, binary and decimal representations of integers.
Fermat's Little theorem and pseudoprimes, Wilson's theorem, the Fermat-Kraitchik Factorisation Method, Chinese Remainder Theorem.
Unit-III: Number-Theoretic Functions: $\varphi(n)$, $d(n)$, $\sigma(n)$, $\mu(n)$ and their properties, Mobius inversion formula, the greatest integer function, Euler' theorem.

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Unit-IV: Primitive roots: The order of an integer modulo n, Lagrange's theorem, composite numbers having primitive roots, the theory of indices. Euler's criterion, Legendre's symbol and its properties, Quadratic Reciprocity Law.

Unit-V: Introduction to Cryptography: From Caesar cipher to public key cryptography, the Knapsack cryptosystem, an application of primitive roots to cryptography.

Numbers of special form: Mersenne primes and perfect numbers.

Certain Diophantine equations: $ax + by = c$, $x^2 + y^2 = z^2$, Fermat's Last Theorem (without proof)

Text book –

1. Burton, D.M., *Elementary Number Theory*, 7^{th} *Edition*, MacGraw-Hill Education, 2010 .

Reference Books:

1. Niven I., Zuckerman, H.S. and Montogomery, H.L., *Introduction to Theory of Numbers*, 5^{th} *Edition*, John Wiley & Sons, 1991.
2. Hardy, G.H., and Wright, E.M., *Introduction to Theory of Numbers*, 4^{th} *Edition*, Oxford University Press, 1991.
3. Silverman, J.H., *A Friendly Introduction to Number Theory*, 3^{rd} *Edition*, Pearson, 2009.
4. Robbins, N., *Beginning Number Theory*, 2^{nd} *Edition*, Jones and Bartlett Publishers, 2006.
5. Chowdhury, K.C., *A First Course in Theory of Numbers*, Asian Books Pvt. Ltd., 2007.
6. Stewart, B. M., Theory of Numbers, The Mac-millan copany, 1964.
7. Koshy T. Elementary Number Theory, Academic Press , 2007.

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