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 2024-25

26/7/24

Dr. Mandira Kar
Head,
Department of Mathematics

CHOICE BASED CREDIT SYSTEM (CBCS)

(For PG Programme in Mathematics from the academic year 2023-2024 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

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developments in higher education and the quality assurance expected of it in the light of globalization in higher education.

5. Paper Offered

Semester I

	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 Elective	V	A. Functional Analysis – I
		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 Elective	V	A. Number Theory
		B. Topology- II

Semester III

	Paper	Title of the Paper

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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
Elective		B. Mathematical Statistics

Semester IV

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

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

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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 Development)= 26	5 x 6 = 30 Including Presentation for Viva-Voce	30 x 15 = 450
	1 E Core	5			
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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Credit and Marking Scheme

	Credits	Marks		Total Marks
		Internal	External	
Theory	5	10	40	**50**
Total	**5**	**50**		

Credit and Marking Scheme

	Credits	Marks		Total Marks
		Internal	External	
Theory	3	10	25	**35**
Practical	2	-	15	**15**
Total	**5**	**50**		

Evaluation Scheme

	Marks	
	Internal	**External**
Theory	3 Internal Exams of 5 Marks (During the Semester) (Best 2 will be taken)	1 External Exams (At the End of Semester)

Every paper of 5 credit

Number of lectures In hours per week: 5 Hr. per week

Total number of lectures : 75 Hr.

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ST. ALOYSIUS COLLEGE (AUTO), JABALPUR
DEPARTMENT OF MATHEMATICS 2024-25
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.

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

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DEPARTMENT OF MATHEMATICS 2024-25
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.

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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 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 2024-25
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 $(0,1), (0,1], [0,1), [0,1]$,

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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, Article No. 1.7, 1.9, 1.10 of J. R. Munkre's book, chapter 3 of Seymour Lipschitz's book)

Unit – II: The definition and some examples of topological space, Topological Subspaces, limit point, derived set, Elementary concepts of open sets, closed sets, closure of a set, dense set, everywhere dense and nowhere dense set. Neighborhood of a point on a set in a topological space, isolated point of a set, Interior and boundary of a set. (Chapter 5- S.L. Book)

Unit – III: Continuous maps and homeomorphism of topological spaces, an open base and open sub-base for topological space (As given in the Chapter-II of G.F. Simmons Book, chapter 6-7, of Seymour Lipschitz's book)

Unit – IV: First and Second Countable spaces, Lindelöf theorems, Separable spaces (As given in the Chapter-III of G.F. Simmons Book, chapter 9 of Seymour Lipschitz's book)

Unit – V: Disconnected and Connected sets and spaces, Connectedness on Real line, Components, totally disconnected spaces, Locally Connected Spaces, Topologist's Sine Curve (As given in the Chapter-VI of G.F. Simmons Book, chapter 13 of Seymour Lipschitz's book)

Text Book:

1. Seymour Lipschitz, Theory and Problem of general Topology, Schaum Publishing Co. N.Y., 1965.
2. G. F. Simmons, Topology and Modern Analysis, McGraw Hill International Edition, 1963.

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3. James R. Munkres, Topology, A First Course, Prentice Hall of India Pvt. Ltd. New Delhi., 1988.

Reference Books:

1. K. D. Joshi, Introduction to General Topology, Wiley Eastern Ltd, New Delhi, 1983.
2. I. Kelly, General Toplogy, Van Nostrand, New York, 1995.
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

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real line integrals, The absolute value of a complex integral,The Elementary form of Cauchy's Theorem, Extension of the Cauchy's Theorem.

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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M. Sc. (MATHEMATICS)
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.

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

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 2024-25
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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ST. ALOYSIUS COLLEGE (AUTO), JABALPUR
DEPARTMENT OF MATHEMATICS 2024-25
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.

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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.
6. Ramji Lal, Algebra, Vol. I & II, Shail Publication, 2002.

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DEPARTMENT OF MATHEMATICS 2024-25
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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ST. ALOYSIUS COLLEGE (AUTO), JABALPUR
DEPARTMENT OF MATHEMATICS 2024-25
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.

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4. Ian Sneddon, Elements of Partial Differential Equations, McGraw Hill International Editions, 1957

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ST. ALOYSIUS COLLEGE (AUTO), JABALPUR
DEPARTMENT OF MATHEMATICS 2024-25
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.

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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.

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.

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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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DEPARTMENT OF MATHEMATICS 2024-25
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.

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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.

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*, *7th Edition*, MacGraw-Hill Education, 2010 .

Reference Books:

1. Niven I., Zuckerman, H.S. and Montogomery, H.L., *Introduction to Theory of Numbers*, *5th Edition*, John Wiley & Sons, 1991.
2. Hardy, G.H., and Wright, E.M., *Introduction to Theory of Numbers*, *4th Edition*, Oxford University Press, 1991.
3. Silverman, J.H., *A Friendly Introduction to Number Theory*, *3rd Edition*, Pearson, 2009.
4. Robbins, N., *Beginning Number Theory*, *2nd 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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College with Potential for Excellence (CPE) by UGC

ST. ALOYSIUS COLLEGE (AUTO), JABALPUR
DEPARTMENT OF MATHEMATICS 2024-25
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.

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Unit – II: Separation: T_1 –speces. Hausdorff spaces, Regular, Completely regular spaces and Normal spaces, their cl aracterization 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 2021-2022
M. Sc. (MATHEMATICS)
THIRD SEMESTER
CORE PAPER I: OPERATIONS RESEARCH -1

CREDIT: 5
Max. Marks 40
Min. Marks 14

COURSE OBJECTIVE:

The course aspires to make students understand, apply design and evaluate different types of Linear Programming Problems in Operations Research.

COURSE LEARNING OUTCOMES:

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

CLO1: Comprehend the origin, development, characteristics, phases and applications of Operations Research.

CLO2: Design a LPP in real world objective and evaluate an optimal solution for the linear programming problem by graphical and simplex method

CLO3: Correlate LPP to its corresponding dual LPP and evaluate by simplex, two-phase and Big-M method.

CLO4: Frame and solve transportation problems.

CLO5: Analyze and evaluate replacement problems.

Unit-I: Operations Research and its scope. Origin and Development of Operations Research, Characteristics of Operations Research, Phase of Operations Research, Uses of Operations Research, Role of Operations Research in Decision Making.

Unit-II: Linear Programming Problem, Mathematical Formulation of the Linear Programming Problem, Solution of LPP by Graphical method, Solution of LPP by Simplex method.

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Unit-III: Solution of a Linear Programming Problem by Big-M method, Solution of LPP by Two phase method, concept of duality, Advantages of duality, Dual simplex method, Primal of dual Correspondence.

Unit-IV: Transportation problem, Initial basic feasible solution by North-West Corner Rule, Row Minima Method, Column Minima Method, Matrix Minima Method and Vogel's Approximation method, Optimality test by MODI method, Degeneracy in Transportation Problem, Unbalanced Transportation problem .

Unit-V: Replacement problem: Replacement Policy Theorem, Concepts: Money Value, Present worth factor discount, Replacement problem when money value is constant / money value changes with Time, Individual replacement, and Group replacement.

Text Books:

1. S.D. Sharma; Operations Research.

Reference Books:

1. K. Swarup, P. K. Gupta and Manmohan; Operations Research, Sultan Chand & Sons, New Delhi.
2. H. Hadley; Linear and Dynamic programming, Addison-Wesley Reading Mass.
3. F.S. Hiller and G.J. Lieberman; Industrial Engineering Series, 1995.

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DEPARTMENT OF MATHEMATICS 2024-25
M. Sc. (MATHEMATICS)
THIRD SEMESTER
CORE PAPER II : SPECIAL FUNCTIONS

CREDIT: 5
MAX MARKS: 40
MIN MARKS: 14

COURSE OBJECTIVE:

To make the students see and understand the gamma, beta function and also hypergeometric, Bessel, Legendre and Hermite differential equations.

COURSE LEARNING OUTCOMES:

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

CLO 1 Explain the applications and the usefulness of the gamma and beta functions

CLO 2 Understand Hypergeometric function and their properties.

CLO 3 Gain the concept of Bessel differential equations along with the corresponding recurrence formulas of different functions.

CLO 4 Perform operations Legendre differential equations along with the corresponding recurrence formulas, orthogonal property of different functions.

CLO 5 Perform operations Hermite differential equations along with the corresponding recurrence formulas, orthogonal property of different functions

Unit I Gamma and Beta Functions : The Euler or Mascheroni Constant γ, Gamma Function, A series for $\Gamma'(z)/\Gamma(z)$, Difference equation $\Gamma(z+1) = z\Gamma(z)$, Euler's integral for $\Gamma(z)$, Beta function, value of $\Gamma(z)\,\Gamma(1-z)$, Factorial Function, Legendre's duplication formula, Gauss multiplication theorem, Relations between functions of z and 1 –z.

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Unit - II Hypergoemetric and Generalized Hypergeometric functions: Function 2F1 (a,b;c;z) A simple integral form evaluation of 2F1 (a,b;c;z) Contiguous function relations, Hyper geometrical differential equation and its solutions, F (a,b;c;z) as function of its parameters, Elementary series manipulations, Simple transformation,

Unit-III Bessel function , Definition of Jn (z), Bessel's differential equation, Generating function for Jn (z), Recurrence Relations for Jn (z), Bessel's integral with index half and an odd integer, Orthogonality of Bessel Functions .

Unit-IV Generating function for Legendre polynomials , Rodrigues formula, Bateman's generating function, Additional generating functions, Hypergeometric forms of Pn (x) , Special properties of Pn(x), Some more generating functions, Laplace's first integral form, Orthogonality.

Unit-V Hermite polynomial : Definition of Hermite polynomials Hn(x), Pure recurrence relations, Differential recurrence relations, Rodrigue's formula, Other generating functions, Orthogonality, Expansion of polynomials, more generating functions..

Books Recommended ;

1 Rainville, E.D, ; Special Functions, The Macmillan co., New york 1971,
2 Srivastava, H.M. Gupta, K.C. and Goyal, S.P.; The H-functions of One and Two Variables with applications, South Asian Publication, New Delhi.
3 Saran, N., Sharma S.D. and Trivedi, - Special Functions with application, Pragati prakashan, 1986.

Reference Books.

1 Lebdev, N.N, Special Functions and Their Applications, Prentice Hall, Englewood Cliffs, New jersey, USA 1995.
2 Whittaker, E.T. and Watson, G.N., A Course of Modern Analysis Cambridge University Press, London, 1963.

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DEPARTMENT OF MATHEMATICS 2024-25
M. Sc. (MATHEMATICS)
THIRD SEMESTER
CORE PAPER III : NUMERICAL METHODS I

CREDIT: 5
MAX MARKS: 40
MIN MARKS: 14

COURSE OBJECTIVE:

Understand the numerical methods and their analysis for solving different types of linear and non-linear systems.

COURSE LEARNING OUTCOMES:

Upon completion of the course, Students will be able to

CLO 1 Solve Hermite Piecewise Interpolation, Piecewise Linear interpolation, Quadratic interpolation, Cubic Interpolation, Piecewise Cubic Interpolation using Hermite Type Data.

CLO 2 Understand Cubic Spline Interpolation, Bivariate Interpolation and Lagrange Bivariate Interpolation.

CLO 3 Understand Euclidean Norm and Uniform for Discrete Data and Continuous Data,

CLO 4 Find Least Square approximation, Legendre Polynomial and ChebeschevPolynomials Approximation.

CLO 5 Understand Numerical Differentiation, Method Based on Interpolation and Method Based on Finite Differences.

UNIT – I :

Hermite Interpolation Piecewise Interpolation, Piecewise Linear Interpolation, Piecewise Quadratic Interpolation, Piecewise Cubic Interpolation, Piecewise Cubic

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Interpolation using Hermite Type Data, spline interpolation, Quadratic spline interpolation.

UNIT – II :

Cubic spline interpolation, Natural Spline. Bivariate interpolation, Lagrange Bivariate interpolation, Newton's Bivariate interpolation for Equispaced Points.

UNIT III :

Approximation, L^p Norm, Euclidean Norm and Uniform Norm for Discrete Data and Continuous Data, Least squares Aproximation, Gram-Schmidt Orthogonalizing Process, Legendre Polynomials, Chebyshev Polynomials.

UNIT IV : Uniform Approximation, Uniform (minimax) Polinomial Approximation (Chebyshev Approximation), Chebyshev Polynomials Approximation and Lanczos Economization, Rational Approximation , Choice of the method.

UNIT V : Numerical differentiation, Method Based on Interpolation, Non-uniform Nodal Points (Linear Interpolation, Quadratic Interpolation), Uniform Nodal Points (Linear Interpolation, Quadratic Interpolation), Method Based on Finite Differences, Method Based on Undetermined Coefficients, Optimum choice of step length.

Text Book :

Numerical Method for scientific and Engineering computation by M.K. Jain , S.R.K. Iyenger , R.K. Jain south Edition (2003) , New Age .

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DEPARTMENT OF MATHEMATICS 2024-25
M. Sc. (MATHEMATICS)
THIRD SEMESTER

CORE ELECTIVE PAPER IV(A): PROGRAMMING IN C

CREDIT: 5
MAX MARKS: 25
MIN MARKS: 09

COURSE OBJECTIVE:

The **course** is designed to provide complete knowledge of **C** language. Students will be able to develop logics which will help them to create programs, applications in **C**.

COURSE LEARNING OUTCOMES:

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

CLO1 Provide exposure to problem-solving through programming.

CLO2 Understand the fundamentals of C programming.

CLO3 Train the student to the basic concepts viz. conditional and decision making, file handling of the C-programming language.

CLO4 Understand the array and multi-dimensional arrays

CLO5 Find Common Programming Error, Program testing and debugging.

UNIT-I

Introduction to C language- History of C Language. Feature of C Language, Character Set in C, Keywords , Constants, Variables in C Type declaration, Types of Output Function and Input Function , Basic Data types. Structure of C Program. A Simple C Program, Compiling a C Program,

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UNIT –II

Operators: Arithmetic operators, Unary operators, Relational and logical operators, Increment and Decrement Operator, Conditional Operator, Bit-wise Operator, Assignment Operators, Precedence & Associativity Expressions.

UNIT –III

Control Statements: Conditional Expressions if statement, if else statement switch and case statement , while loop, do while loop, break, continue and goto statement. Writing programs using conditional expression.

UNIT –IV

Scope of Variable: local and global variable storage classes of C variable. Arrays (single dimension & multidimensional array)

Functions: Introduction to Function, Library Function, User defined Function: Declaration and prototype, Function Definition, Concept of Function parameters and how they are passed, Recursion Function Writing Program Using Recursive and non recursive Functions.

UNIT –V

Pointers: Declaration, Pointer Arithmetic, Structures, arrays of structures, Concept of Union, Differences between structure and Union .

Text Books:- 1 Programming in C- E Balaguruswamy
2 Programming in C- Yashwant Kanetkar.

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St. Aloysius' College (Autonomous), Jabalpur

M.Sc III Semester (Maths)

Programming In C (Program List) Practical

Max Marks: 15
Min Marks: 06

1. Write a program in C for swapping two numbers without using third variable.
2. Write a program in C to find the greatest among three number entered by user.
3. Write a program in C to check the entered integer is even or odd.
4. Write a program in C to check the entered alphabet is vowel or consonant.
5. Write a program in C to print days using switch case.
6. Write a program in C to find factorial of entered number.
7. Write a program in C to print the Fibonacci Series.
8. Write a program in C to check the entered integer is prime or not.
9. Write a program in C for addition of two matrices.
10. Write a program in C for multiplication of two matrices.
11. Write a program in C to print table of entered number.
12. Write a program in C to convert temperature from Fahrenheit to degree Celsius.
13. Write a program in C to check entered number is palindrome or not.
14. Write a program in C to convert decimal number to binary number.
15. Write a program in C to convert binary number to decimal number.
16. Write a program in C to sort elements using bubble sort method
17. Write a program in C to sort elements using selection sort method.
18. Write a program in C to search particular element in array.
19. Write a program in C to find the value of any number using pointer.
20. Write a program in C for finding biggest and smallest number in array, and find sum of the elements.
21. Write a program in C to find value of trigonometric function correct upto 4 decimal places.
22. Write a program in C to enter data in file.

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DEPARTMENT OF MATHEMATICS 2024-25
M. Sc. (MATHEMATICS)
THIRD SEMESTER
CORE ELECTIVE PAPER IV(B) : FUNCTIONAL ANALYSIS - II

CREDIT: 5
MAX MARKS: 40
MIN MARKS: 14

COURSE OBJECTIVE:

This course will cover the properties of Hilbert space including orthogonal complements, orthonormal set together with related identities and inequalities. Also the important notion of linear operator on a Hilbert space including adjoint operators, self adjoint operators and unitary operators will be dealt.

COURSE LEARNING OUTCOMES:

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

CLO1 Have a knowledge of Hilbert space and its properties.
CLO2 Understand the concept of orthogonal complements, orthonormal set.
CLO3 Have a knowledge of Theory of linear operators, adjoint operators, self adjoint operators and unitary operators.
CLO4 Comprehend important theorems like the uniform boundedness theorem, open mapping theorem, closed graph theorem and Riesz representation theorem.
CLO5 Understand the concept of Projection, Normal and Unitary operators.

Unit-I: Uniform boundedness theorem and some of its consequences, open mapping and closed graph theorem, Hanh-Banach theorem for real linear spaces.

Unit-II: Hanh-Banch theorem for complex linear spaces and normaed linear spaces, Eeflixive spaces, Hilbert spaces, Orthonormal sets, Bessel's inequality.

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Unit-III:. Complete orthonormal sets and Parseval's identity, Projection Mapping, Projection theorem.

Unit-IV: Structure of Hilbert spaces, Riesz representation theorem, Adjoint of an operator on a Hilbert space, Reflexivity of Hilbert spaces.

Unit-V: Self -Adjoint operators, Positive Operators, Projection, Normal and Unitary operators.

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.

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DEPARTMENT OF MATHEMATICS 2024-25
M. Sc. (MATHEMATICS)
THIRD SEMESTER

OPEN ELECTIVE PAPER V(A) ADVANCED DISCRETE MATHEMATICS

CREDIT: 5
MAX MARKS: 40
MIN MARKS: 14

COURSE OBJECTIVE:

The course aspires to make students understand, analyze and evaluate algebraic structures, lattices. Boolean algebra, graphs and trees

COURSE LEARNING OUTCOMES:

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

CLO 1	Understand and analyze the basic principles and results of algebraic structures, semi groups, monoids and their properties.
CLO 2	Understand and reframe concept of different kinds of lattices
CLO 3	Understand and implement concepts of Boolean Algebra
CLO 4	Comprehend and apply different types of graphs and circuit in real life problems
CLO 5	Demonstrate different traversal methods for trees and graphs

Unit-I: Algebraic systems, semigroup, monoid, subsemigroup and submonoid definition and examples, direct product of semigroup, homomorphism and isomorphism of semi group, homomorphism and isomorphism of monoid.

Unit-II: Partial order relation, total order relation, partially ordered set- poset, chain, antichain, definition and examples, Hasse diagram, dual of a poset, homomorphism and isomorphism of a poset. Lattices as posets, lattices as algebraic systems, complete lattice, complemented lattice, bounded lattice, distributive lattice, dual of a lattice, sub lattices, definition, examples and general

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properties of a lattices, direct product of lattices, homomorphism and isomorphism of lattices.

Unit-III: Boolean lattice, Boolean algebra, definition, examples and general properties, principle of duality, sub Boolean algebra, direct product of Boolean algebra, homomorphism and isomorphism of Boolean algebra.

Unit-IV: Edges, incidence and adjacency of edges, vertex, degree of a vertex, even, odd, isolated and pendant vertex, simple graph, multi graph, regular graph, null graph, finite graph, infinite graph, digraph, planar graph, non planar graph, complete graph, bipartite graph, definition and general properties, hand shaking lemma, isomorphic graphs, homeomorphic graphs, subgraph, vertex disjoint subgraph, edge disjoint subgraph, walk, path and circuit, labeled graph, weighted graph, shortest path in weighted graph, Dijkstra's algorithm, matrix representation of graphs and digraphs.

Unit-V: Connected graph, disconnected graph, components, minimally connected graph, definition and general properties. Tree, pendant vertex in a tree, internal vertex in a tree, distance and centers in a tree, radius of a tree, diameter of a tree, path length of a tree, rooted tree, binary tree, strictly binary tree, levels and height of a binary tree, definition and examples. Applications: Konigsberg bridge problem, utilities problem, Chinese postman problem and determining the longest monotonically increasing subsequence,

Text Books:

1. H. K. Pathak and J. P. Chauhan; Advanced Discrete Mathematics, Shiksha Sahitya Prakashan.
2. J. P. Tremblay & R. Manohar; Discrete Mathematical Structures with Applications to Computer Science, McGraw-Hill Book Co., 1997.

Reference Books:

1. C. L. Liu; Elements of Discrete Mathematics, McGraw-Hill Book Co.

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DEPARTMENT OF MATHEMATICS 2024-25
M. Sc. (MATHEMATICS)
THIRD SEMESTER
OPEN ELECTIVE PAPER V(B) MATHEMATICAL STATISTICS

CREDIT: 5
MAX MARKS: 40
MIN MARKS: 14

COURSE OBJECTIVE:

Recognize the importance and value of mathematical and statistical thinking, training, and approach to problem solving, on a diverse variety of discipline and be familiar with a variety of examples where mathematics or statistics helps accurately explain abstract or physical phenomena.

COURSE OUTCOME:

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

CLO1 Properties of statistical models,

CLO2 Knowledge of Probability theory including conditional probability. Distribution such as Bionomial, Poisson etc.

CLO3 Understand and apply the concepts of t and F Distributions and other distribution functions.

CLO4 Construct tests and estimators, and derive their properties

CLO5 Know about important theorems like Rao –Blackwell theorem-The Rao Cramer's inequality

UNIT –I: The probability set function –Random variables –The probability density function – The distribution function-Mathematical expectations-Some special mathematical expectations – Chebyshev inequality.

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UNIT – II Conditional probability –Marginal and conditional distributions-The Correlation coefficient-Stochastic Independence. The Binomial, Poisson, Gamma, chi-square normal distribution.

UNIT – III: Distributions of functions of Random variables –Sampling theory-Transformation of Variables of Discrete type-Transformation of Variables of the continues type.

UNIT – IV: The t and F Distributions – Distribution of order statistics –The moment –generating function Technique-The Distribution of X and.Limiting distribution –Stochastic convergence-Limiting moment generating function-The central limit theorem –Some theorems on Limiting Distribution.

UNIT-V: Point estimation-Measures of quality of estimations-confidence intervals for meansconfidence intervals for difference of Means-confidence intervals for variances. A Sufficient statistics for a parameters- The Rao –Blackwell theorem-The Rao Cramer's inequality.

Text Book: Introduction to Mathematical Statistics by Robert V. Hogg Allen T. Craig, Macmillan publishing co., Inc., New York -1978,

References : 1. Mathematical Statistics by J.N. Kapur, H.C. Saxena- S. Chand Publications 2.Introduction to Mathematical Statistics Robert V Hogg, Allencraig, Joseph W Mekean , Pearson Publishers

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DEPARTMENT OF MATHEMATICS 2024-25
M. Sc. (MATHEMATICS)
FOURTH SEMESTER
CORE PAPER I: OPERATION RESEARCH-II

CREDIT: 5
MAX MARKS: 40
MIN MARKS: 14

COURSE OBJECTIVE:

The course aspires to make students comprehend, formulate, analyze and determine optimal solution to real life problems.

COURSE LEARNING OUTCOMES:

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

CLO 1 Formulate, solve and apply assignment problems so that cost is minimized.

CLO 2 Frame and evaluate job sequencing problems

CLO 3 Deduce the practicality of game theory and implement the techniques in real life perspective.

CLO 4 Develop a working knowledge of concepts and methods related to designing of networks, CPM-PERT, design, manage and complete projects in optimal time.

CLO 5 Understand the concepts of various inventory models, EOQ, multi items deterministic model and evaluate the cost involved therein. Control resource allocation and manage inventory.

Unit-I: Mathematical formulation of assignment problem, assignment algorithm, solution of assignment problem by Hungarian method, rules to draw minimum number of lines, unbalanced assignment problem, maximal assignment problem, traveling salesman problem.

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Unit-II: Sequencing problem, Johnson's algorithm, idle time, elapsed time, processing n jobs on two machines, n jobs on three machines, n jobs on m machines, processing two jobs through m machines.

Unit-III: Two person zero-sum game, maximin-minimax principle, games with/without saddle points, graphical solution of (2 x m) and (m x 2) games, principal of dominance, value of the game, optimal strategies.

Unit-IV: Introduction, historical development and applications of CPM and PERT, concepts, network diagram representation, Fulkerson's rule, backward pass computation, forward pass computation ,total float, free float, independent float, network construction, CPM and PERT calculations, Project management by CPM and PERT.

Unit V: Inventory theory, types of inventory models, cost involved in inventory problems, variables in inventory problems, average inventory, concept of EOQ, economic lot size system with uniform and non-uniform demand, economic lot size with finite rate of replacement, production lot size model, multi items deterministic models with one constraint, limitation on investment, floor space and inventory.

TEXT BOOKS:

1. S. D. Sharma; Operations Research.

REFERENCE BOOKS:

1. K. Swarup; P.K. Gupta and Manmohan, Operations Research, Sultan Chand & Sons, New Delhi.
2. H. A. Taha; Operations Research- An introduction, Macmillan Publishing Co. Inc. New York.
3. P. K. Gupta and D. S. Hira; Operations Research, an Introduction, S. Chand & Company Ltd. New Delhi.

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DEPARTMENT OF MATHEMATICS 2024-25
M. Sc. (MATHEMATICS)
FOURTH SEMESTER
CORE PAPER II : NUMERICAL METHODS II

CREDIT: 5
MAX MARKS: 40
MIN MARKS: 14

COURSE OBJECTIVE:

The students will learn extrapolation methods and the mathematical theory of finite element methods.

COURSE LEARNING OUTCOMES:

Upon completion of the course, Students will be able to

CLO 1 Understand extrapolation methods, Richardson's extrapolation and ordinary differential equations.

CLO 2 Knowledge of multi step methods, explicit multistep methods and implicit multistep method.

CLO 3 Solve boundary value problem with different conditions, linear second order differential equations by different methods.

CLO 4 Understand Finite difference methods and Linear Second Order Differential Equation.

CLO 5 Understand finite element methods and linear Lagrange polynomial.

Unit 1 Extrapolation methods, Richardson's Extrapolation, Ordinary differential equations, Reduction of Higher order Equations to the system of first order

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Differential Equations, system of Linear first order Differential Equations with Constant Coefficients, Difference Equations.

Unit 2 Multi step methods, Explicit Multistep Methods, Adams-Bashforth Methods (i=0), Nystrom Methods (i=1), Implicit Multistep Methods, Adams-Moulton Method (i=0), Milne-Simpson Method (i=1), Predicator and corrector methods, $P(EC)^m E$ Method, PM_pCM_c Method, Stability analysis of multistep methods.

Unit 3 Ordinary Differential Equations: Boundary value problems, Initial Value Problem Method (Shooting method), Boundary conditions of the first kind, Boundary conditions of the second kind, Boundary conditions of the third kind.

Unit 4 Finite difference methods, Linear Second Order Differential Equation, Derivative Boundary Conditions, Fourth Order Method when u' is absent, Nonlinear Second Order Differential Equation u''=f(x,u), Newton-Raphson Method, Nonlinear Second Order Differential Equation u''=f(x,u,u').

Unit 5 Finite element method, Solution of the Variation Problem, Ritz Method, Finite Elements, Linear Lagrange Polynomial, Ritz Finite element method, Finite element Solution of Linear Boundary value problems, Assembly of element Equations, Mixed Boundary Conditions .

Text Book

Numerical Method for scientific and Engineering computation by M.K. Jain, S.R. K. Iyenger, R. K. Jain south Edition(2003), New Age.

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M. Sc. (MATHEMATICS)
FOURTH SEMESTER
CORE ELECTIVE PAPER – III(A) : DIVERGENT SERIES

CREDIT: 5
MAX MARKS: 40
MIN MARKS: 14

COURSE OBJECTIVE:

The course aim to provide students with a firm grounding in the theory and techniques of divergent series. Also comprehend the Important theorems like the Consistency theorem for Cesaro Summability, Limitation Theorem etc.

COURSE LEARNING OUTCOMES:

Upon completion of the course, Students will be able to

CLO1 Understand order relations, asymptotic relation, the method of arithmetic, Holder and Abel means.

CLO2 Find cubic spline interpolation, bivariate interpolation and Lagrange bivariate interpolation.

CLO3 Understand the concept of Able's transformation, Cesaro mean, change of order of summation, relation between Cesaro and Able's Summability.

CLO4 Understand Abelian methods of summability, regularity of Abelian means, inclusion theorem,

CLO5 Understand the concept of Euler mean, limitation theorem and regularity theorem.

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Unit-1: Definitions and Examples of Order Relations (big 0, little 0), Asymptotic Relation. The method of Arithmetic means, Holder means, Abel means, The Transformation matrix and regularity theorem for each mean.

Unit-2: Abel's Transformation and its applications, Cesaro means, Definition and examples, Identities relating Cesaro sums, change of order of summation. Relation between Cesaro and Abel's Summability: Theorems 55, 56, and 57.

Unit-3: Consistency theorem for Cesaro Summability, Regularity Theorems for Cesaro's method. Cesaro means of both integral and non-integral orders.

Unit-4: Limitation Theorems, Tauberian conditions and Tauberian Theorems, Littlewood's extension of Tauber's first Theorem.

Unit-5: Abelian method (A, λ) of summability, Regularity of Abelian means, Inclusion theorem, Euler mean, Regularity theorem.

Text Books:

1. G.H. Hardy, Divergent Series, Oxford, University Press, 1948.

Reference Books:

1. A. Dold and B. Eckmann (eds.) Absolute Summability of Fourier Series, Lecture Notes in Math. Springer-Verlag, 1984.

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M. Sc. (MATHEMATICS)
FOURTH SEMESTER
CORE ELECTIVE PAPER III(B): PROGRAMMING IN C++

CREDIT: 5
MAX MARKS: 25
MIN MARKS: 09

COURSE OBJECTIVE:

The **course** is designed to provide complete knowledge of **C++** language. Students will be able to develop logics which will help them to create programs, applications in **C++**.

COURSE LEARNING OUTCOMES:

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

CLO1. Comprehend the use of object-oriented concepts to implement object oriented programs in C++ with applications to encapsulation, inheritance and polymorphism.
CLO2. Develop knowledge of basic data structures for storage and retrieval of ordered or unordered data.
CLO3. Realize the applications of data structures including the ability to implement algorithms for the creation, insertion, deletion, searching,
CLO4. Understand sorting of each data structure.
CLO5. Understand data base design normalization upto BCNF, distributive system– clouds.

Unit 1: object oriented programming, class and scope, nested classes, pointer class member class initialization, assignment and distribution.

Unit 2: over load function and operators templates including class templates, class inheritance and subtyping, multiple and inheritance.

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Unit 3: data structure analysis of algorithm q, W, O, o, w notations, lists , stacks, and Queues, sequential and linked representation, tree, binary tree – search tree implementation, B – tree (concept only)

Unit 4: Hashing – open and closed, sorting :sort, shell sort , heap sort and their analysis.

data base system –role of data base system, data base system architecture.

Unit 5: Introduction to relational algebra and relational calculus. SQL-O basis features Including views, integrity constrains, data base design normalization upto BCNF, distributive system– clouds.

Reference books:

1 B, stroustrup, the C++ programming language, Addison – Wesley.
2 C.I date, introduction to data base system, Addison- Wesley.

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M.Sc.(MATHEMATICS)
FOURTH SEMESTER
PRACTICAL – PROGRAMMING IN C++

MAX: 15
MIN: 6

1. Write a program in C++ language to define nested class.
2. write a program in C++ to implement multiple inheritance.
3. write a program in C++ for operator overloading.
4. write a program in C++ using function overloading to calculate area of circle, square and rectangle.
5. Write a program showing implementation of stack class having the functionality of push ,pop operations.
6. Write a program to implement a queue class with required operations/ functions.
7. Write a program to implementing linked list as a class. Also perform some required operations like inserting, deleting nodes.
8. Write a program in C++ Convert time from seconds to HH:MM:SS format using class.
9. Write a program in C++ to implement the Heap sort algorithm.
10. Write a program in C++ language for use of sort, shell sort, quick-sort.

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DEPARTMENT OF MATHEMATICS 2024-25
M. Sc. (MATHEMATICS)
FOURTH SEMESTER
CORE ELECTIVE PAPER IV(B): FUZZY SETS AND THEIR APPLICATIONS

CREDIT: 5
MAX MARKS: 40
MIN MARKS: 14

COURSE OBJECTIVE:

Provide an understanding of **the** basic mathematical elements of **the** theory of **fuzzy sets**. Provide an emphasis on **the** differences and similarities between **fuzzy sets** and classical **sets** theories.

COURSE LEARNING OUTCOMES:

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

CLO1. Understand the difference between crisp sets and fuzzy sets, Fuzzy membership function, types and operations of fuzzy sets and their properties.

CLO2. Fuzzy numbers and fuzzy arithmetic.

CLO3. Basic concepts of fuzzy relations, fuzzy graphs and fuzzy logic.

CLO4. Knowledge of m fuzzy sets and intuitionistic fuzzy sets

CLO5. Understand Fuzzy relations, Crisp v/s Fuzzy relations.

Unit-I: Support height nucleus of a fuzzy set, cardinality of a fuzzy set containment of two fuzzy sets, degree of subsethood, Fuzzy set, Membership function, Basic definition and concepts, Types of Fuzzy sets- normal subnormal fuzzy set, normalization α-cut set, strong α-cut, convex fuzzy set, necessary and sufficient condition for convexity of a fuzzy set,

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Unit II: Operations on fuzzy sets, Union, Intersection, Complement of a fuzzy set, Decomposition of fuzzy sets, Cartesian Product, Algebraic product, Product of a fuzzy set with a crisp number, contract intensification and fuzzification Bounded sum and difference, t-norms, t-conorms, Power of a fuzzy set, Disjunctive sum of two fuzzy sets, examples.

Unit-III: Properties of fuzzy sets- commutative, associative, distributive, idempotent, identity, involution, De-Morgan's laws, and their proofs, equality of two fuzzy sets, examples.

Unit-IV: The Zadeh Extension Principle, Fuzzy numbers, Fuzzy arithmetic

Unit V: Fuzzy relations, Crisp v/s Fuzzy relations, Composite Fuzzy relation, Binary Fuzzy relations, Fuzzy equivalence relation, Fuzzy compatibility relation, Fuzzy relation equation, Similarity relations Fuzzy graphs.

Fuzzy logic- classical logic, multivalued logic, Fuzzy prepositions, Fuzzy quantifiers, Linguistic variables and Hedges, Inference from conditional Fuzzy preposition

Text Book-

1. G.J. Klir and Yuan, Fuzzy sets and Fuzzy Logic: The compositional rule of inference, Prentice Hall of India, New Delhi, 1995.
2. H.J. Zimmermann, Fuzzy set Theory and its Applications, Allied publishers Ltd, New Delhi 1991.

Reference Books:

1. Pundir and Pundir ,Fuzzy Sets and their Applications , Pragati Prakashan, Meerut, 2012

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2. Timothy J.Ross, Fuzzy Logic with Engineering Applications, John Wiley & Sons, 2010

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DEPARTMENT OF MATHEMATICS 2024-25
M. SC. (MATHEMATICS) FORTH SEMESTER

CORE ELECTIVE PAPER IV(A)- INTEGRATION THEORY

CREDIT: 5
MAX MARKS: 40
MIN MARKS: 14

COURSE OBJECTIVE:

Recognize the importance and value of Measure spaces, Measurable functions, Integration, Convergence theorems and be familiar with a variety of measure and measurability.

COURSE LEARNING OUTCOMES:

On successful completion of this course students will be able to:

CLO1. Understand the basic principles of signed measures, The Radon- Nikodym theorem, Lebesgue decomposition.

CLO2. Comprehend the basic principles of outer measure and measurability, extension theorem,

CLO3. Understand Lebesgue-Steiltjes integral, product measures, Fubini's theorem.

CLO4. Appreciate the basic principles of Baire sets, Baire measure, continuous functions with compact support,

CLO5. Understand regularity of measures on locally compact spaces, integration of continuous functions with compact support, Riesz- Markoff theorem.

Unit I: Measure spaces, Measurable functions, Integration, Convergence theorems.

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Unit II: Signed measures, The Radon-Nikodym theorem, Lebesgue decomposition, LP spaces, Riesz representation theorem.

Unit III: Outer measure and measurability, The extension theorem, Lebesgue-Steiltjes integral, Product measures, Fubini's theorem.

Unit IV: Baire sets, Baire Measure, Continuous functions with compact support, Regularity of measures on locally compact spaces.

Unit V: Integration of continuous functions with compact support, Riesz- Markoff theorem.

Recommanded Books :

1. H.L. Royden, Real Analysis, Mc millan Pub. Co. Inc. New York, 4th Edition, 1993.
2. G.de.Barra., Measure Theory and Integration, Wiley Eastern Limited, 1981
3. Inder K. Rana. An introduction to Measure & Integration Narosa Pub. House, Delhi,1997.
4. P.K. Jain, N.P. Gupta, Lebesgure Measure and Interation New Age International (P) Ltd., New Delhi, 1986.

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DEPARTMENT OF MATHEMATICS 2024-25
M. Sc. (MATHEMATICS)
FOURTH SEMESTER
OPEN ELECTIVE PAPER V(A) MATHEMATICAL MODELING

CREDIT: 5
MAX MARKS: 40
MIN MARKS: 14

COURSE OBJECTIVE:

The course aspires to make students understand and formulate mathematical models in real life situations

COURSE LEARNING OUTCOMES:

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

CLO 1 Understand the concepts and techniques of mathematical modeling and its applications in real life situations.
CLO 2 Frame simple mathematical models with the help of differential equations and its application to evaluate linear growth and decay models.
CLO 3. Develop mathematical model through difference equations in finance, population dynamics and genetics.
CLO 4 Implement techniques and model situations through graphs.
CLO 5 Establish mathematical models via linear programming in forest management, transportation and assignment.

Unit I Simple situations requiring mathematical modeling, techniques of mathematical modeling, Classifications, Characteristics and limitations of mathematical models, Some simple illustrations.
Unit II Mathematical modeling through differential equations, linear growth and decay models, non-linear growth and decay models, Compartment models,

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Mathematical modeling in dynamics through ordinary differential equations of first order.

Unit III Mathematical models through difference equations, some simple models, and Basic theory of linear difference equations with constant coefficients, Mathematical modeling through difference equations in economic and finance, Mathematical modeling through difference equations in population dynamic and genetics.

Unit IV Situations that can be modeled through graphs. Mathematical models in terms of Directed graphs, Mathematical models in terms of signed graphs, Mathematical models in terms of weighted digraphs.

Unit V Mathematical modeling through linear programming, Linear programming models in forest management. Transportation and assignment models.

Reference Books:

1. J. N. Kapur: Mathematical Modeling, Wiley Eastern.
2. D. N. Burghes: Mathematical Modeling in the Social Management and Life Science, Ellie
Herwood and John Wiley.
3. F. Charlton; Ordinary Differential and Difference Equations, Van Nostrand.

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DEPARTMENT OF MATHEMATICS 2024-25
M. Sc. (MATHEMATICS)
FOURTH SEMESTER
OPEN ELECTIVE PAPER V (B) : WAVELETS

CREDIT: 5
MAX MARKS: 40
MIN MARKS: 14

COURSE OBJECTIVE:

To expose the students to the basics of **wavelet** theory and to illustrate the use of **wavelet** processing.

COURSE LEARNING OUTCOMES:

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

CLO1. Understand Fourier analysis
CLO2. Comprehend wavelets, orthogonal wavelets, wavelet series, linear phase filtering
CLO3. Identify orthogonal two-scale symbols.
CLO4. Understand the concept of Linear phase filtering, Compactly supported wavelets.
CLO5. Construction of Compactly supported orthogonal wavelets.

Unit I. Fourier Analysis: Fourier and inverse Fourier transforms, Convolution and delta function, Fourier transform of Square integrable functions. Fourier series, Basic Convergence Theory and Poisson's Summation formula.

Unit II. Wavelet Transforms and Time Frequency Analysis: The Gabor Transform. Short-time Fourier transforms and the uncertainity principle. The integral wavelet transforms Dyadic wavelets and inversions. Frames.

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Unit III. Wavelet Series. Scaling Functions and Wavelets: Multi resolution analysis, scaling functions with finite two scale relations. Direct sum decomposition of L2 (R) .

Unit IV. Linear phase filtering, Compactly supported wavelets, Wavelets and their duals, Orthogonal Wavelets and Wavelet packets, Example of orthogonal Wavelets.

Unit V. Identification of orthogonal two-scale symbols, Construction of Compactly supported orthogonal wavelets, Orthogonal wavelet packets, orthogonal decomposition of wavelet series.

References:

1. C.K.Chui, A First Course in Wavelets, Academic press NY 1996.
2. I. Daubechies, Ten Lectures in Wavelets, Society for Industrial and Applied Maths, 1992.

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