UNIVERSITY OF KASHMIR, SRINAGAR

NAAC Accredited Grade-A+

Notification

It is notified for information of all the concerned that the Vice-Chancellor in anticipation of approval of the Academic Council has authorized prescription of syllabus and Course structure (Annexure A) of M.Sc Mathematics(1st to 4th) semesters applicable to batch -2024 & onwards.

Assistant Registrar
(ACADEMIC)

No.F (Pres-syllabus-PG-Mathematics) Acad/KU/24
Date: 22-04-2024

Copy for information to the:-

1. Dean, Academic Affairs, University of Kashmir, Srinagar;
2. Dean, Physical and Mathematical Sciences, University of Kashmir Srinagar.
3 Head, Department of MathamaticsUniversity o Kashmir, Srinagar.
4. Controller of Examinations, University of Kashmir, Srinagar.
5. Assistant Controller, Secrecy/Tabulation/Automation, University of Kashmir, Srinagar;
6. File.

STRUCTURE OF THE COURSE

[Board Members **and** Minute of the Meeting]

M.A./M.Sc. 1st SEMESTER

Course Type	Course Code	Title of the Course	Number of Credits	Number of Hours
Core (CR)	MM24101CR	Abstract Algebra-I	4	64
	MM24102CR	Real Analysis - I	4	64
	MM24103CR	Topology	4	64
	MM24104CR	Theory of Probability	2	32
Discipline Centric Elective (DCE)	MM24105DCE	Theory of Matrices	4	64
	MM24106DCE	Theory of Numbers-I	4	64
	MM24107DCE	Numerical Analysis	4	64
	MM24108DCE	Computational Mathematics	4	64
Generic Electives (GE)	MM24001GE	Numerical Methods	2	32
Open Electives (OE)	MM24001OE	Calculus	2	32

M.A./M.Sc. Mathematics 2nd SEMESTER

Course Type	Course Code	Title of the Course	Number of	Number of

Professor & Head
...tment of ...
University of ...

			Credits	
Core (CR)	MM24201CR	Discrete Mathematics	4	64
	MM24202CR	Real Analysis – II	4	64
	MM24203CR	Complex Analysis-I	4	64
	MM24204CR	Advanced Calculus	2	32
Discipline Centric Elective (DCE)	MM24205DCE	Theory of Numbers – II	4	64
	MM24206DCE	Operations Research	4	64
	MM24207DCE	Biomathematics	4	64
	MM24208DCE	Integral Equations	2	32
	MM24209DCE	Laplace Transforms	2	32
Generic Electives (GE)	MM24002GE	Complex Variables	2	32
Open Electives (OE)	MM24002OE	Matrix Algebra	2	32

M.A./M.Sc. Mathematics 3rd SEMESTER

Course Type	Course Code	Title of the Course	Number of Credits	Number of Hours
Core (CR)	MM 24301CR	Ordinary Differential Equations	4	64
	MM 24302CR	Complex Analysis-II	4	64

Prof... & Head
Department ... Mathematics
Univer...

	MM 24303CR	Functional Analysis-I	4	64
	MM24304CR	Fourier Analysis	2	32
Discipline Centric Elective (DCE)	MM24305DCE	Advanced Graph Theory	4	64
	MM24306DCE	Abstract Measure Theory	4	64
	MM24307DCE	Python for Mathematics	4	64
	MM24308DCE	Wavelet Theory	4	64
Generic Electives (GE)	MM24003GE	Laplace and Fourier Transform	2	32
Open Electives (OE)	MM24003OE	Introduction to Mathematical Modeling	2	32

M.A./M.Sc. Mathematics, 4th SEMESTER

Course Type	Course Code	Title of the Course	Number of Credits	Number of Hours
Core (CR)	MM24401CR	Partial Differential Equations	4	64
	MM24402CR	Differential Geometry	4	64
	MM24403CR	Abstract Algebra-II	4	64
	MM24404CR	Linear Algebra	2	32
Discipline Centric	MM24405DCE	Analytic Theory of Polynomials	4	64

Professor & Head
Department of Mathematics
University of Kashmir

Elective (DCE)				
	MM24406DCE	Mathematical Statistics	4	64
	MM24407DCE	Functional Analysis – II	4	64
	MM24408DCE	Non-Linear Analysis	4	64
	MM24409DCE	Advanced Topics in Topology and Modern Analysis	4	64
	MM24410DCE	Project	4	64
Generic Electives (GE)	MM24004GE	Applied Differential Equations	2	32
Open Electives (OE)	MM24004OE	Discrete Mathematics	2	32

Department of Mathematics
University of Kashmir

ABSTRACT ALGEBRA-I

Course Code: **MM24101CR** Total Credits: **04**
Semester: **MA/M.Sc. 1st Semester** Total Marks: **100**
Continuous Assessment: **Marks 20**, Theory: **Marks 80** Time Duration: **2½ hrs**

Course Objectives: To enable the student to understand group structures, symmetries and various results and properties associated with algebraic structures.

Course Outcomes: After the completion of this course, the students shall be able to understand group/ring structures, define and comprehend various algebraic structures, such as groups, rings, and fields, including their axioms and properties.

UNIT-I

Criterion for a semi-group to be a group, Cyclic groups, Generators of finite/infinite cyclic groups, Structure theorem for cyclic groups, endomorphism, automorphism, Inner automorphism and outer automorphism, Cauchy's and Sylow's theorem for abelian groups, Groups of symmetries, alternating groups, simple groups, groups of order six, simplicity of the alternating group A_n.

UNIT-II

Conjugate classes, class equation of finite groups $(p, 2p, p^2, p^3)$ and its applications, Cauchy's and Sylow's theorems for finite groups, direct product of groups, finite abelian groups, normal and subnormal series, composition series, Jordan Holder theorem for finite groups, Zassenhaus lemma, Schreir's refinement theorem, Solvable groups, examples and theorems.

UNIT-III

Brief review of rings. Field of quotients of an integral domain, embedding of an Integral domain, Euclidean rings with examples such as $\mathbb{Z}[\sqrt{-1}], \mathbb{Z}[\sqrt{2}]$, Principal Ideal Rings (PIR), unique factorization domains (UFD) and Euclidean domains (ED), GCD and LCM in rings, factorization theorem, relationships between Euclidean rings, P.I.R.'s and U.F.D.

UNIT-IV

Polynomial rings, the division algorithm for polynomials, irreducible polynomials, polynomials and the rational field, primitive polynomials, contraction of polynomials, Gauss lemma, Integer monic polynomial, Eisenstein's irreducibility criterion, cyclotomic polynomials, polynomial rings and commutative rings.

Recommended Books

1. J. A. Gallian, Contemporary Abstract Algebra, Cengage Learning, USA, 9th Edition, 2015
2. I. N. Heristein, Topics in Algebra, John Wiley & Sons, 2nd Edition, 1975.
3. P. B. Bhatacharaya and S.K.Jain, Basic Abstract Algebra, Cambridge University Press, 4th Edition, Reprint 2009.
4. J. B. Fragleigh, A First Course in Abstract Algebra, Pearson New International, 2014.
5. K. S. Miller, Elements of Modern Abstract Algebra, Krieger Publishing, 1975.
6. Surjeet Singh and Qazi Zameer-ud-Din, Modern Algebra, Vikas Pub Hou. Pvt Ltd, 8th Edition, 2006

Professor & Head
Department of Mathematics
University of Kashmir

REAL ANALYSIS - I

Course No: **MM24102CR**
Semester: **MA/M.Sc. 1st Semester**
Continuous Assessment: **Marks 20,** Theory: **Marks 80**

Total Credits: **04**
Total Marks: **100**
Time Duration: **2½ hrs**

Course objectives: To study the behavior and properties of real numbers, sequences and series of real numbers and real valued functions and generalized integration in order to tackle day today life problems arising from physical phenomenon.

Course Outcomes: The outcome of this course typically includes a solid understanding of fundamental concepts in real analysis, properties and applications of real analysis in convergence of series and sequences.

....

UNIT-I

Integration: Definition and existence of Riemann–Stieltje's integral, behavior of upper and lower sums under refinement, necessary and sufficient conditions for RS-integrability of continuous and monotonic functions, reduction of an RS-integral to a Riemann integral, basic properties of RS-integrals, differentiability of an indefinite integral of continuous functions, the fundamental theorem of calculus for Riemann integrals.

UNIT-II

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

UNIT-III

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

UNIT-IV

Sequences and series of functions: point wise and uniform convergence, Cauchy criterion for uniform convergence, M_n –test, Weierstrass M-test, Abel's and Dirichlet's test of uniform convergence, uniform convergence and continuity, R-integration and differentiation, Weierstraa approximation theorem, examples of continuous nowhere differentiable functions.

Recommended Books:

1. R. Goldberg, Methods of Real Analysis, Oxyford and IBH Publishing, 2020.
2. W. Rudin, Principles of Mathematical Analysis, McGraw Hill Edu, 3rd Edition, 2017.
3. J. M. Apostol, Mathematical Analysis, Narosa Publishers, 2002.
4. S.C. Saxena and SM Shah : Introduction to Real Variable Theory, Intext Educational Publishers San Francisco, 1972.

A. J.White, Real Analysis: An Introduction, Addison-Wesley; First Edition, 1968.

5. S.C.Malik and Gupta, Real Analysis, New Age International, 2021.

Professor & Head
Department of Mathematics
University of Kashmir

TOPOLOGY

Course No: **MM24103CR** Total Credits: **04**
Semester: **M.A/M.Sc 1st Semester** Total Marks: **100**
Continuous Assessment: **Marks 20, Theory Marks: 80** Time Duration: **2½ Hrs Course**

Objectives: In inculcate the students to study the properties that are preserved through deformations, twisting and stretching of objects without tearing.
Course Outcomes: On completion of a Topology course the students shall have a clear understanding of fundamental concepts in topology, such as open and closed sets, neighborhoods, continuity, compactness, connectedness, and convergence.

UNIT - I
Review of countable and uncountable sets, Schroeder-Bernstein theorem, axiom of choice and its various equivalent forms, definition and examples of metric spaces, open and closed sets, completeness in metric spaces, Baire's category theorem, and applications to the (1) non-existence of a function which is continuous precisely at irrationals (ii) impossibility of approximating the characteristic of rationals on [0, 1] by a sequence of continuous functions.

UNIT - II
Completion of a metric space, Cantor's intersection theorem with examples to demonstrate that each of the conditions in the theorem is essential, uniformly continuous mappings with examples and counter examples, extending uniformity continuous maps, Banach's contraction principle with applications to the inverse function theorem in R.

UNIT - III
Topological spaces; definition and examples, elementary properties, Kuratowski's axioms, continuous mappings and their characterizations, pasting lemma, convergence of nets and continuity in terms of nets, bases and sub bases for a topology, lower limit topology, concepts of first countability, second countability, separability and their relationships, counter examples and behavior under subspaces, product topology and weak topology, compactness and its various characterizations.

UNIT - IV
Heine-Borel theorem, Compactness, Tychnoff's theorem, sequential compactness and total boundedness in metric spaces, Lebesgue's covering lemma, continuous maps on compact spaces, separation axioms and their permanence properties, connectedness and local connectedness, their relationship and basic properties, connected sets in $\mathbb{R}$, Uryson's lemma, Uryson's metrication lemma, Tietize's extension theorem, one point compactification.

Recommended Books:

1. G.F.Simmons, Introduction to Topology and Modern Analysis, VISIONIAS 2020.
2. J. Munkres, Topology, 2nd Edition, Pearson Education, 2021.
3. K.D. Joshi, Introduction to General Topology, New Age International Publishers, 2017.
4. J. L. Kelley, General Topology, Dover Publications Inc. Reprint Edition 2017.
5. S.T. Hu, Introduction to General Topology, Holden Day, 1958.

Professor & Head
Department of Mathematics
University of Kashmir

THEORY OF PROBABILITY

Course No: **MM24104CR** Total Credits: **04**
Semester: **M.A/M.Sc 1st Semester** Total Marks: **50**
Continuous Assessment: **Marks 10, Theory Marks: 40** Time Duration: **1½ Hrs**

Course objectives: To make the students understand random experiments and their behavior in order to measure degree of occurrence of events in various situations.

Course Outcomes: The Theory of Probability course equips students with a comprehensive understanding of the fundamental principles and concepts underlying probability theory. Upon successful completion of this course, students will have understood the core concepts of probability, including sample spaces, events, random variables, and probability distributions etc.

UNIT-I

The probability set functions, its properties, probability density function, the distribution function and its properties, mathematical expectations, some special mathematical expectations, inequalities of Markov, Chebyshev and Jensen.

UNIT-II

Conditional probability, independent events, Baye's theorem, distribution of two and more random variables, marginal and conditional distributions, conditional means and variances, correlation coefficient, stochastic independence and its various criteria.

Recommended Books:

1. Hogg and Craig, An Introduction to the Mathematical Statistics, Pearson Education, Old Edition 2006.
2. Carl Joseph West, Introduction to Mathematical Statistics, Fogotten Books, 2018.
3. Richard J. Larsen and Morris L. Marx, An Introduction to Mathematical Statistics and its Applications, United States Edition, Pearson.

Professor & Head
Department of Mathematics
University of Kashmir

THEORY OF MATRICES

Course No: **MM24105DCE** Total Credits: **04**
Semester: **M.A/M.Sc 1st Semester** Total Marks: **100**
Continuous Assessment: **Marks 20, Theory Marks: 80** Time Duration: **2½ Hrs**

Course objectives: To inculcate the students to understand and apply the techniques of matrices like linear transformations from a vector space to itself such as reflection, rotation and sharing to solve multivariate problems arising in different disciplines of science and technology.

Course Outcomes: The Theory of Matrices course provides students with a comprehensive understanding of the fundamental principles and applications of matrices. Upon successful completion of this courses students will be able to classify matrices based on their dimensions (e.g., square, rectangular) and special properties (e.g., symmetric, diagonal, orthogonal). Students will understand the significance of eigenvalues, eigenvectors, and determinants in characterizing matrices.

UNIT-I

Eigenvalues and eigenvectors of a matrix and their determination, similarity of matrices, two similar matrices have the same eigenvalues, algebraic and geometric multiplicity of eigenvalues, Mutual relationship between eigenvalues and the corresponding eigenvectors, any system of eigenvectors corresponding to distinct eigenvalues of a matrix are linearly independent, orthogonal reduction of real symmetric matrices, unitary reduction of a Hermitian matrix.

UNIT-II

Determination of diagonal matrices, the necessary and sufficient conditions for a square matrix of order n to be similar to a diagonal matrix. Orthogonal diagonalization of symmetric matrices, triangular form over $\mathbb{C}$ and $\mathbb{R}$, Schur's theorem, normal matrices. Norms on spaces of matrices: Euclidean, Cartesian and taxicab norms, Schur's inequality: If A is a square matrix of order n having eigenvalues $\lambda_k, 1 \le k \le n$, then $\sum|\lambda_k|^2 \le \sum|a_{ij}|^2$. If A is a square matrix of order n having singular values $\sigma_k, 1 \le k \le n$, then $|tr(A)| \le \sum\sigma_k$. If A is a normal matrix and $\lambda_k, 1 \le k \le n$ are its eigenvalues and μ is the eigenvalue of the perturbed matrix $A + \delta A$, then for some $i, \| \mu - \lambda_i \| \le \| \delta A \|$.

UNIT-III

Quadratic forms: Kroneckers and Lagranges reduction, reduction by orthogonal transformation of real quadratic forms, geometrical applications, necessary and sufficient condition for a quadratic form to be positive definite, If the quadratic form $X'AX$ is positive semidefinite and if x_1 actually appears in the form , then $a_{ii} > 0$ rank, A real symmetric matrix A is positive definite if and only if A^{-1} exists and is positive definite and symmetric, Euler's theorem, Hessian matrix, rank, index and signature of a quadratic form. If $A = [a_{ij}]$ is a positive definite matrix of order n, then $|A| \le \prod a_{ii}$

Professor & Head
Department of Mathematics
University of Kashmir

UNIT IV

Gram matrices: the Gram matrix BB^t is always positive definite or positive semi-definite, Hadamard's inequality, If $B = [b_{ij}]$ is an arbitrary non- singular real square matrix of order n, then $|B| \leq \prod[\sum b_{ik}]$. Fundamental scalar function ϕ_k, For any two matrices A and B, $\phi_k(AB) = \phi_k(BA)$, the infinite n −fold integral $I_n = \int \cdots \int e^{X AX} dX$, where $dX = dx_1 \cdots dx_n$. If A is a positive definite matrix, then $I_n = \pi^{n/2}/\sqrt{|A|}$. If A and B are positive definite matrices, then $|\lambda A + (1 - \lambda B)| \leq |A|^{\lambda} |B|^{1-\lambda}$ for $0 \leq \lambda \leq 1$, perturbation of roots of polynomials, companion matrix, Hadamard's theorem, Gerisgorian Disk theorem, Taussky's theorem.

Recommended Books:

1. Richard Bellman, Introduction to Matrix Analysis, McGraw Hill Inc. USA, 2nd Edition 1970.
2. Franz E. Hohn, Elementary Matrix Algebra, Dover Publications, 3rd Edition, 2103.
3. Rajendra Bhatia, Matrix Analysis, Springer.
4. Fuzhen Zhang, Matrix Theory: Basic Results and Techniques (Universitext), Springer, 2nd Editon, 2011.
5. H. Fumio, Petz Dene, Introduction to matrix Analysis and Applications, TRIM (2014).

Professor & Head
Department of Mathematics
University of Kashmir

THEORY OF NUMBERS-I

Course No: **MM24106DCE** Total Credits: **04**
Semester: **M.A/M.Sc 1st Semester** Total Marks: **100**
Continuous Assessment: **Marks 20, Theory Marks: 80** Time Duration: **2½ Hrs Course**

Course objectives: To equip the student with the properties of numbers and the relationship between different sorts of numbers in order to tackle different problems arising in discrete systems.
Course Outcomes: By the end of this course, students should be able to analyze modular arithmetic and congruence relations, solving linear congruence's and applying them to various problems. It will give an introductory understanding of number theory's role in cryptography, including the encryption schemes.

UNIT-I
Divisibility, the division algorithm and its uniqueness, Greatest common divisor and its properties. The Euclidean algorithm, Prime numbers. Euclid's first theorem, Fundamental Theorem of Arithmetic, Divisor of n, Radix-representation. Linear Diophantine equations. Necessary and sufficient condition for solvability of linear Diophantine equations, Positive solutions.

UNIT-II
Sequence of primes, Euclid's Second theorem, Infinitude of primes of the form 4n+3 and of the form 6n+5. No polynomial f(x) with integral coefficients can represent primes for all integral values of x or for all sufficiently large x. Fermat Numbers and their properties. Fermat Numbers are relatively prime. There are arbitrary large gaps in the sequence of primes. Congruences, Complete Residue System (CRS), Reduced Residue System (RRS) and their properties. Fermat and Euler's theorems with applications.

UNIT-III
Euler's φ −function, $\varphi(mn) = \varphi(m)\varphi(n)$, where $gcd(m, n) = 1$, $\sum\varphi(d) = n$ and $\phi(m) = m\prod_p\left(1-\frac{1}{p}\right)$ for $m > 1$. Wilson's theorem and its applications to the solution of the congruence $x^2 \equiv -1(modp)$. Solutions of linear congruences. The necessary and sufficient conditions for the solution of $a_1x_1 + a_2x_2 + \cdots + a_nx_n \equiv c(modm)$, Chinese remained theorem. Congruences of higher degree $F(x) \equiv 0(modm)$, where $F(x)$ is a polynomial. Congruences with prime power and related results. Lagranges theorem, viz, the polynomial congruence of degree n has at most n roots.

UNIT-IV
Factor theorem and its generalization. Polynomial congruences $F(x_1, x_2, \ldots, x_n) \equiv 0(modp)$ in several variables. Equivalence of polynomials. Equivalence theorem on the number of solutions of congruences. Chavalley's theorem, Warning's theorem. Quadratic arms over a field of characteristic not equal to 2. Equivalence of quadratic forms, Witt's theorem. Representation of filled elements. Hermite's theorem on the minima of positive definite quadratic form and its applications to the sum of two, tree and four squares.

Recommended Books:

1. W. J. Leveque, Topics in Number Theory, Vol. 1-, Dover Publications, 2002.
2. I Niven and H.S Zuckerman, An introduction of the Theory of Numbers, Wiley, 5th Edition 2008.
3. David M. Burton, Elementary Number Theory, McGraw Hill Higher Education, 6th Edition 2005.
4. G.H Hardy and Wright, An introduction to the theory of Numbers, Oxford University Press, 6th Edition 2008.

Professor & Head
Department of Mathematics
University of Kashmir

NUMERICAL ANALYSIS

Course No: **MM24107DCE** Total Credits: **04**
Semester: **M.A/M.Sc 1st Semester** Total Marks: **100**
Continuous Assessment: **Marks 20, Theory Marks: 80** Time Duration: **2½ Hrs Course**

Course objectives: To provide the student with different techniques in order to find approximate numerical solutions to the problems where exact solutions are not available.

Course Outcomes: Students will develop the ability to tackle complex mathematical problems and real-world challenges using numerical methods and techniques. They will gain a deep understanding of various numerical algorithms, their underlying principles, and their applications in solving mathematical and scientific problems.

UNIT-I

Introduction to numerical methods, Bisection method, Method of False position, Secant method, Method of iterations, Newton-Raphson method, Ramanunjan's method, Convergence of iteration methods, Solution of system of linear algebraic equations: Dircet methods, Matrix inverse method, Gaussian elimination method, Gauss Jacobi, Eigen value problem.

UNIT-II

Finite difference operators: Backward, Forward and Central difference operators, Shift operator, Relation between operators, Interpolations with equal and unequal intervals, Newton's forward interpolation formula, Lagrange's and Hermite interpolation formula, Linear and quadratic spline interpolations.

UNIT-III

Numerical differentiation, Formulae for derivatives, Derivative using Newton's forward interpolation formula, Difference interpolating formula, Maxima and minima of tabulated functions. Numerical integration, Trapezoidal rule, Simpson's one-third rule, Boole's rule, Errors in numerical integration formula.

UNIT-IV

Numerical solution for the initial value problems for ODE'S, Taylor's series method, Euler's method, Runge-Kutta Method, Picard's method of successive approximations, Boundary value problems in PDE's, Finite difference methods for solution, Classification of second order PDE's, Finite difference approximations for partial derivatives, Solution of one-dimensional Laplace, Heat and wave equations.

Recommended Books:

1. M.K.Jain, S.R.K.Iyengar, R.K.Jain, Numerical methods for scientific and engineering computation, New Age International Publishers, 3rd Edition, 1996.
2. S. S. Sastry, Introductory methods of numerical analysis, PHI Learning, 5th Edition 2012.
3. B. S. Grewal, Numerical methods in engineering & science, KHANNA PUBLISHERS.

Professor & Head
Department of Mathematics
University of Kashmir

COMPUTATIONAL MATHEMATICS

Course Code: **MM24108DCE** Total Credits: **04**
Semester: **MA/M.Sc. 1st Semester** Total Marks: **100**
Continuous Assessment: **Marks 20, Theory: Marks 80** Time Duration: **2½ hrs**

Course Objectives: To develop logical skills and basic technical skills so that students should be able to solve basic computing problems. The students should be able to learn the basic of any computer programming language like C, software MATLAB and Scientific documentation using LaTeX.

Course Outcome: The students after the completion of this course shall be able to apply C programming and mathematical software's to solve various real life problems. Also, the students can handle complex problems and scientific documentation more efficiently.

....

Unit I

Evolution of languages: Machine languages, Assembly languages, High-level languages. Software requirements for programming: System software's like operating system, compiler, linker, loader; Application programs like editor. Algorithm, specification of algorithm. Flowcharts.

Data Types, Identifiers, Variables Constants and Literals. Arithmetic relational logical operators. Basic input/output statements, Control structures: if-else statement, Nested if statement, Switch statement Loops: while loop, do while, for loop, Nested loops. Arrays: Declaration; initialization.

Unit II

Functions; prototype, passing parameters, identifier visibility. Variable scope, lifetime. Multi-file programming, Introduction to macros. Structures and unions: syntax. Pointers: variables, arrarys. Introduction to object oriented programming, Abstraction, Encapsulation, Introduction to classes and objects; Access specifiers, Constructor; destructor; Function overloading; Operator overloading.

Unit III

Basics of MATLAB, Overview of features and workspace, Data types, Arrays : Initialization and definition, Array, functions, 2--D Arrays, Multidimensional Arrays, Processing Array elements, Array sorting, Matrices: Matrix Operations & Functions, Special Matrices. Decision Making using If--Else and Switch, Function definitions, Function arguments, Function returns, Embedded Functions, Files and I/O, Reading from a file, Writing to a file, Formatting output, For Loops, Do While Loop, Plots and Graphs, Plot Types, Plot Formatting, Multiple Plots, Plot Fits.

Unit IV

Installation of Kile and MikeTeX, Simple typesetting, Spaces, Quotes, Dashes, Accents, Special symbols, Text positioning; Fonts: Type Style, Type Size, The Document: Document class, Font and Paper size, Page formats; Page style: Heading declarations, Page numbering, Formatting Lengths, Understanding Latex compilation Basic Syntax, Writing equations, Matrix, Tables, Page Layout – Titles, Abstract Chapters, Sections, References, Equation references, citation. List making environments Table of contents, Generating new commands, Figure handling numbering, List of figures, List of tables, Generating index, Packages: Geometry, Hyperref, amsmath, amssymb, algorithms, algorithmic graphic, color, tiles listing. Classes: article, book, report, beamer, slides.

Professor & Head
Department of Mathematics
University of Kashmir

NUMERICAL METHODS

Course No: **MM24001GE** | Total Credits: **02**
Semester: **M.A/M.Sc 1st Semester** | Total Marks: **50**
Continuous Assessment: **Marks 10, Theory Marks: 40** | Time Duration: **1½ Hrs Course**

Course objectives: To provide the student with different techniques in order to find approximate numerical solutions to the problems where exact solutions are not available.

Course Outcomes: Students will be aware of and able to utilize numerical computation libraries and software tools that facilitate the implementation of complex numerical methods. They will be able to use interpolation methods to estimate values between known data points and understand approximation techniques like polynomial fitting.

UNIT -I

Solution of algebraic and transcendental and polynomial equations, bisection method, iteration method based on first degree equation, secant method, regula-falsi method, Newton-Raphson method, rate of convergence of Newton- Raphson method & secant method, system of linear algebraic equation, Gauss elimination method, Gauss Jordan method.

UNIT -II

Interpolation and approximation of finite difference operators, Newton's forward, backward interpolation, central difference interpolation, Lagrange's interpolation, Newton Divided Difference interpolation, Hermite interpolation, Spline interpolation, numerical differentiation and Integration.

Recommended Books:

1. M.K. Jain, Numerical Solution of Differential Equations, Wiley Eastern (1979), Second Edition.
2. R.L. Burden, and J. Douglas Faires, Numerical Analysis, P.W.S. Kent Publishing Company, Boston (1989), Fourth edition.
3. S.S. Sastry, Introductory methods of Numerical analysis, Prentice- Hall of India, New Delhi, Fifth Edition (1998).
4. M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical methods for scientific and Engineering computation, Wiley Eastern (1993).

Professor & Head
Department of Mathematics
University of Kashmir

CALCULUS

Course No: **MM24001OE** Total Credits: **02**
Semester: **M.A/M.Sc 1st Semester** Total Marks: **50**
Continuous Assessment: **Marks 10, Theory Marks: 40** Time Duration: **1½ Hrs Course**

Course objectives: To make the student understand the basic concepts of differentiation/integration and apply them to solve day-to-day real life problems.

Course Outcomes: Students shall be able to solve a variety of calculus problems, including finding derivatives and integrals of various functions, using techniques like the chain rule, product rule, and integration by parts.

UNIT -I
Functions, the idea of limits, techniques for computing limits, infinite limits, continuity, derivative, rules for differentiation, derivatives as rate of change, applications of the derivative, maxima and minima, increasing and decreasing functions, mean value theorem and its applications, indeterminate forms, partial differentiation, Euler's theorem.

UNIT -II
Indefinite integral, techniques of integration, definite integral, area of a bounded region, first Order ordinary differential equations and their salutations, variables separable method, homogeneous form, equations reducible to homogeneous form, linear differential equations of the form $dy/dx + Py = Q$ and equations reducible to this form.

Recommended Books:

1. A. Auzeem, S.D.Chopra and M. L. Kochar, Differential Calculus, Kapoor Publications, 2015.
2. William L. Briggs and Lyle Cochran, Calculus, Pearson, 2nd Edition 2014.
3. R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, Narosa, 1st Edition 2002.

Professor & Head
Department of Mathematics
University of Kashmir

DISCRETE MATHEMATICS

Course No: **MM24201CR** Total Credits: **04**
Semester: **M.A/M.Sc 2nd Semester** Total Marks: **100**
Continuous Assessment: **Marks 20, Theory Marks: 80** Time Duration: **2½ Hrs Course**

Course objectives: To expose the students to the theory of graphs and combinatorics and to make them aware of their applications in different branches of science.

Course Outcomes: After the completion of this course, students shall be able to understand the principles of graph theory, including graph terminology, graph representations, connectivity, Eulerian and Hamiltonian paths, and planarity.

UNIT -I

Graphs, traversibility and degrees

Introduction of graphs, paths and cycles, operations on graphs, bipartite graphs and Konigs theorem, Euler graphs and Euler's theorem, Konigsberg bridge problem, Hamiltonian graphs and Dirac's theorem, degree sequences, Wang-Kleitman theorem, Havel-Hakimi theorem, Hakimi's theorem, Erdos- Gallai theorem, degree sets.

UNIT -II

Trees and Signed graphs

Trees and their properties, centres in trees, binary and spanning trees, degrees in trees, Cayley's theorem, fundamental cycles, generation of trees, Helly property, signed graphs, balanced signed graphs and characterizations.

UNIT -III

Connectivity and Planarity

Cut-sets and their properties, vertex connectivity, edge connectivity, Whitney's theorem, Menger's theorem (vertex and edge form), properties of a bond, block graphs, planar graphs, Kuratowski's two graphs, embedding on a sphere, Euler's formula, Kuratowski's theorem, geometric dual, Whitney's theorem on duality, regular polyhedras.

UNIT -IV

Matrices and Digraphs

Incidence matrix $A(G)$, modified incidence matrix A_f, cycle matrix $B(G)$, fundamental cycle matrix B_f, cut-set matrix $C(G)$, fundamental cut set matrix C_f, relation between A_f, B_f and C_f, path matrix, adjacency matrix, matrix tree theorem, types of digraphs, types of connectedness. Euler digraphs, Hamiltonian digraphs, arborescence, matrices in digraphs, Camions theorem in tournaments, characterisation of score sequences, Landau's theorem, oriented graphs and Avery's theorem.

Recommended Books:

1. R. Balakrishnan, K. Ranganathan, A Text Book of Graph Theory, Springer-Verlag, New York.
2. B. Bollobas, Extremal Graph Theory, Springer (2002).
3. F. Harary, Graph Theory, Narosa (2001).
4. Narsingh Deo, Graph Theory with Applications to Eng. and Comp. Sci, PHI. (1979).
5. S. Pirzada, An Introduction to Graph Theory, Universities Press, Orient Blackswan, 2012.

Professor & Head
Department of Mathematics
University of Kashmir

REAL ANALYSIS - II

Course No: **MM24202CR** | Total Credits: 04
Semester: **M.A/M.Sc 2nd Semester** | Total Marks: **100**
Continuous Assessment: **Marks 20, Theory Marks: 80** | Time Duration: **2½ Hrs Course**

Course objectives: To provide the students the notions of length, area and volume with respect to different measures viz., Lebesgue and Borel measure in order to overcome problems arising from Riemann Integration.

Course Outcomes: This course will develop a thorough understanding of real numbers, their properties, and the axiomatic structure of the real number system. This will help the students to recognize the foundational role of real analysis in advanced mathematical areas such as functional analysis, complex analysis, and differential equations.

UNIT -I

Measure theory: definition of outer measure and its basic properties, outer measure of an interval as its length, countable additivity of the outer measure, Borel measurable sets and Lebesgue measurability of Borel sets, Cantor set, existence of non- measurable sets and of measurable sets which are not Borel, outer measure of monotonic sequences of sets.

UNIT -II

Measurable functions and their characterization, algebra of measurable functions, Stienhauss theorem on sets of positive measure, Ostroviski's theorem on measurable solution of $f(x+y) = f(x) + f(y), x, y \in R$, convergence a.e., convergence in measure and almost uniform convergence, their relationship on sets of finite measure, Egoroff's theorem.

UNIT -III

Lebesgue integral of a bounded function, equivalence of L −integrability and measurability for bounded functions, Riemann integral as a Lebesgue integral, basic properties of Lebesgue – integral of a bounded function, fundamental theorem of calculus for bounded derivatives, necessary and sufficient condition for Riemann integrability on $[a, b]$, L −integral of non- negative measurable functions and their basic properties, Fatou's lemma and monotone convergence theorem, L −integral of an arbitrary measurable function and basic properties, dominated convergence theorem and its applications.

UNIT -IV

Absolute continuity and bounded variation, their relationships and counter examples, indefinite integral of an L-integrable function and its absolute continuity, necessary and sufficient condition for bounded variation, Vitali's covering lemma and a. e., differentiability of a monotone function f and $\int f' \le f(b) - f(a)$.

Recommended Books:

1. R. Goldberg, Methods of Real Analysis, Oxford and IBH Publishing (2020).
2. G. De. Barra, Measure theory and Integration, New Age International Private Limited, 3rd Edition, 2022.
3. I. K. Rana , An Introduction to Measure and Integration, Narosa (2007).
4. W. Rudin, Principles of Mathematical Analysis, McGraw Hill, Standard Edition (2023).
5. Chae, Lebesgue Integration, Springer, 2nd Edition (1995).
6. T. M. Apostol, Mathematical Analysis, Narosa 2nd Edition (2002).

Professor & Head
Department of Mathematics
University of Kashmir

COMPLEX ANALYSIS - I

Course No: **MM24203CR** Total Credits: **04**
Semester: **M.A/M.Sc 2nd Semester** Total Marks: **100**
Continuous Assessment: **Marks 20, Theory Marks: 80** Time Duration: **2½ Hrs Course**

Course objectives: To enable the students to understand the extensions of the real analysis problems to the complex domain in order to solve harder problems pertaining to the different disciplines.

Course Outcomes: Course outcomes for a Complex Analysis-I course typically focus on developing a deep understanding of complex numbers, analytic functions, and the theoretical foundations of complex analysis.

UNIT -I

Continuity and differentiability of complex functions, C-R equations and analytic functions, necessary and sufficient condition for a function to be analytic, complex integration, Cauchy Goursat theorem, Cauchy's integral formula, higher order derivatives, Morera's theorem, Cauchy's inequality.

UNIT -II

Liouville's Theorem and its generalization, fundamental theorem of algebra, Taylor's theorem, maximum modulus theorem, Schwarz lemma and its generalizations, zeros of an analytic function and their isolated character, identity theorem, argument principle , Rouche's theorem and its applications.

UNIT -III

Laurant's theorem, classification of singularities, removable singularity, Riemann's theorem, poles and behaviour of a function at a pole, essential singularity, Casorati-Weiersstras theorem on essential singularity, infinite products, convergence and divergence of infinite product, absolute convergence, necessary and sufficient conditions for convergence and absolute convergence.

UNIT -IV

Mobius transformations, their properties and classification, fixed points, cross ratio, inverse points and critical points, conformal mapping, linear transformations carry circles to circles and inverse points to inverse points, mappings of (i) upper half plane on to the unit disc, (ii) unit disc on to the unit disc, (iii) left half plane on to the unit disc and (iv) circle on to a circle. The transformation $w = z^2$ and $w = \frac{1}{2}\left(z + \frac{1}{z}\right)$.

Recommended Books:

1. L. Ahlfors, Complex Analysis, McGraw Hill (2000).
2. E. C.Titchmarsh, Theory of Functions, Oxford Univesity Press, 2nd Edition (1939).
3. J. B. Conway, Functions of a Complex Variable-1, Springer 2nd Edition 7th Printing (1995).
4. Richard Silverman, Complex Analysis, Dover Publications Inc. (1984).
5. H. A. Priestly, Introduction to complex Analysis, Pxford University Press (2008).
6. Z. Nehari, Conformal Mappings, Dover Publications Inc. (2003)

Professor & Head
Department of Mathematics
University of Kashmir

ADVANCED CALCULUS

Course No: **MM24204CR** Total Credits: **02**
Semester: **M.A/M.Sc 2nd Semester** Total Marks: **50**
Continuous Assessment: **Marks 10, Theory Marks: 10** Time Duration: **1½ Hrs Course**

Objectives: To extend the ideas of functions of one variable to several variables in order to study calculus and optimization problems in higher dimensions.

Course Outcomes: To explore more advanced topics of calculus, and developing strong problem-solving skills. It will deepen the understanding of concepts from single-variable calculus, including limits, continuity, differentiation, and integration.

UNIT-I

Functions of several variables in $\mathbb{R}^n$, the directional derivative, directional derivative and continuity, total derivative, matrix of a linear function, Jacobian matrix, chain rule, mean value theorem for differentiable functions.

UNIT-II

Sufficient conditions for differentiability and for the equality of mixed partials, Taylor's theorem for functions from $\mathbb{R}^n$ and $\mathbb{R}$, inverse and implicit function theorem in $\mathbb{R}^n$, extremum problems for functions on $\mathbb{R}^n$, Lagrange's multiplier's, multiple Riemann Integral and change of variable formula for multiple Riemann integrals.

Recommended Books:

1. W. Rudin, Principles of Mathematical Analysis, McGraw Hill, Standard Edition (2023).
2. T. M. Apostol, Mathematical Analysis, Narosa (2002).
3. P. M. Fitzpatrick, Advanced Calculuc, American Mathematical Society, 2nd Edition (2009).
4. James J. Callahan, Advanced Calculus, Springer (2010).

Professor & Head
Department of Mathematics
University of Kashmir

THEORY OF NUMBERS -II

Course No: **MM24205DCE** Total Credits: **04**
Semester: **M.A/M.Sc 2nd Semester** Total Marks: **100**
Continuous Assessment: **Marks 20, Theory Marks: 80** Time Duration: **2½ Hrs Course**

Course objectives: To identify certain number theoretic functions and their properties in order to study real number system in depth for their applications.

Course Outcomes: It typically focus on more advanced topics in number theory, including deeper exploration of properties of integers, prime numbers, and applications.

UNIT -I

Integers belonging to a given exponent (mod p) and related results, converse of Fermat's theorem; If $d|p-1$, the congruence $x^d \equiv 1(modp)$ has exactly d-solutions; If any integer belongs to $t(modp)$, then exactly $\phi(t)$ incongruent numbers belong to $t(modp)$, primitive roots, there are $\phi(p-1)$ primitive roots of an odd prime p, any power of an odd prime has a primitive root, the function λ (m) and its properties, $a^{\lambda(m)} \equiv 1(modm)$, where $(a,m)=1$. There is always an integer which belongs to λ(m) (mod m), primitive λ -roots of m, the numbers having primitive roots are $1,2,4, p^\alpha, 2p^\alpha$ where p is an odd prime.

UNIT -II

Quadratic residues, Euler criterion, the Legendre symbol and its properties, Lemma of Gauss, the law of a quadratic reciprocity, characterization of primes of which 2,-2, 3,-3, 5, 6 and 10 are quadratic residues or non residues, Jacobi symbol and its properties, the reciprocity law for Jacobi symbol.

UNIT -III

Number theoretic functions, some simple properties of $\tau(n), \sigma(n), \phi(n) and \mu(n)$. Mobius inversion formula. Perfect numbers. Necessary and sufficient condition for an even number to be perfect, the function $[x]$ and its properties, average order of magnitudes of $\tau(n), \sigma(n), \phi(n)$, Farey fractions, rational approximation.

UNIT -IV

Simple continued fractions, application of the theory of infinite continued fractions to the approximation of irrationals by rationals, Hurwitz theorem, Relation between Riemann Zeta function and the set of primes, characters, the *L*-Function $L(S,\chi)$ and its properties, Dirichlet's theorem on infinity of primes in an arithmetic progression.

Recommended Books

1. W. J. Leveque Topics in Number Theory, Vol. I-II Addition WPC, INC.
2. I. Niven and H.S. Zuckerman, An introduction of the Theory of Numbers, Wiley 5th Edition (2008)
3. T.M Apostal, Analytic Number Theory, Springer International, Narosa (1998).
4. G.H Hardy and Wright, An introduction to the theory of Numbers, Oxford University Press, 6th Edition (2008).
5. E. Landau, An Elementary Number Theory, American Mathematical Society, 1958.

Professor & Head
Department of Mathematics
University of Kashmir

OPERATIONS RESERACH

Course No: **MM24206DCE** Total Credits: **04**
Semester: **M.A/M.Sc 2nd Semester** Total Marks: **100**
Continuous Assessment: **Marks 20, Theory Marks: 80** Time Duration: **2½ Hrs Course**

Course objectives: To equip the student with methods and trends for taking management decisions and networking.

Course Outcomes: This will develop a solid understanding of optimization techniques and concepts, including linear and nonlinear programming, integer programming, and dynamic programming.

UNIT –I

Definition of operation research, main phases of OR study, linear programming problems (LPP), applications to industrial problems –optimal product links and activity levels, convex sets and convex functions, simplex method and extreme point theorems, Big M and Two phase methods of solving LPP.

UNIT -II

Revised simplex method, assignment problem, Hungarian method, transportation problem, and mathematical formulation of transportation problem, methods of solving (North-West Corner rule, Vogel's method and U.V. method), concept and applications of duality, formulation of dual problem, duality theorems (weak duality and strong duality theorems), dual simplex method, primal- dual relations, complementary slackness theorems and conditions.

UNIT –III

Sensitivity Analysis: changes in the coefficients of the objective function and right hand side constants of constraints, adding a new constraint and a new variable, Project management: PERT and CIM, probability of completing a project.

UNIT –IV

Game theory: Two person zero sum games, games with pure strategies, games with mixed strategies, Min. Max. principle, dominance rule, finding solution of $2 \times 2, 2 \times m, 2 \times m$ games, equivalence between game theory and linear programming problem (LPP), simplex method for game problem.

Recommended Books:

1. C. W. Curchman, R. L. Ackoff and E. L. Arnoff, (1957) Introduction to Operation Research.
2. F. S. Hiller and G. J. Lieberman, Introduction to Operations Research (Sixth Edition), McGraw Hill International, Industries Series, 1995.
3. G. Hadley, Linear programming problem, Narosa publishing House, 1995.
4. S. I. Gauss , Linear Programming, Wiley Eastern.
5. Kanti Swarup, P. K. Gupta and M. M. Singh, Operation Research; Sultan Chand & Sons.

Professor & Head
Department of Mathematics
University of Kashmir

BIOMATHEMATICS

Course No: **MM24207DCE** Total Credits: **04**
Semester: **MA/M.Sc. 2nd Semester** Total Marks: **100**
Continuous Assessment: **Marks 20**, Theory: **Marks 80** Time Duration: 2½ hrs

Course objectives: To enable the student to formulate mathematical models of real life situations especially in ecology, physiology and epidemiology.

Course Outcomes: This course will help the students in learning techniques for formulating real-world problems into mathematical models, establishing optimal solutions of problems arising in theoretical biology.

....

UNIT -I

Introduction to mathematical modeling, types of modeling, classification of mathematical models, formulation, solution and interpretation of a model, linear growth and decay models, non-linear growth and decay models, population models based on Leslie matrices, continuous population models for single species, logistic growth model, Fibonacci's rabbits, the golden ratio and their relation, compartment models, limitations of mathematical models.

UNIT -II

Basic terminology of Ecology, Mathematical models in ecology: models for interacting populations, types of interactions, Lotka - Voltera system, equilibrium points and their stability, Geometrical interpretation of Predator-Prey interaction, almost linear system, stability analysis of the interactions like prey-predator, competition and symbiosis.

UNIT -III

Epidemiology, Mathematical models on communicable diseases, simple and general epidemic models viz SI, SIS, SIR epidemic disease models, the SIR endemic disease model. Sexually transmitted diseases, HIV, window period, ELISA test for the determination of HIV, AIDS and models on AIDS. Vaccination strategies and control measures.

UNIT -IV

Diffusion in biology: Fick's law of diffusion, Fick's perfusion law, Diffusion through a slab. Bio-fluid mechanics: introduction, various types of fluid flows, viscosity, basic equation of fluid, mechanics, continuity equation, equation of motion, the circulatory system, the circulation in heart, blood composition, arteries and arterioles, models in blood flow, Poiseulle's flow and its applications in blood flow in human body, the pulse wave.

Books Recommended

1. J. N. Kapur, Mathematical Modelling, New Age International Publishers.
2. J.D. Murray Mathematical Biology (An Introduction, Vol. I & II), Springer- Verlag.
3. J.N. Kapur, Mathematical Model in Biology and Medicines.
4. S. I. Rubinow, Introduction to Mathematical Biology, John Wiley andSons, 1975.
5. MA Khanday, Introduction to Modeling and Biomathematics, Dilpreet Publishers New Delhi, 2016.
6. Jaffrey R. Chasnov, Mathematical Biology, Hong Kong Press.

Professor & Head
Department of Mathematics
University of Kashmir

INTEGRAL EQUATIONS

Course No: **MM24208DCE** Total Credits: **02**
Semester: **M.A/M.Sc 2nd Semester** Total Marks: **50**
Continuous Assessment: **Marks 10. Theory Marks: 40** Time Duration: **1½ Hrs Course**

Course objectives: To acquaint the student with tackling integral equations that include energy transfer, heat equation, oscillation of a string etc., that may enable them to solve different type of differential equations.

Course Outcomes: Course outcomes for an Integral Equations course typically focus on developing students' understanding of integral equations, their solutions, and their applications in various fields.

UNIT -I
Linear integral equations of the first and second kinds, Volterra and Fredholm integral equations, relations between differential and integral equations, solution of Volterra and Fredholm integral equations by the methods of successive substitutions and successive approximations, iterated and resolvent kernels, Neumann series, reciprocal functions, Volterra's solutions of Fredholm equations.

UNIT -II
Fredholm theorems, Fredholm associated equation, solution of integral equations using Fredholm's determinant and minor, homogeneous integral equations, integral equations with separable kernels, the Fredholm alternatives, symmetric kernels, Hilbert Schmidt theory for symmetric kernels, applications of integral equations to differential equations, initial value problem, boundary value problem, Dirac-Delta function, Green's function approach.

Books Recommended:

1. R. P. Kanwal, Linear Integral Equations (Theory and Technique), Academic Press Birkhauser-1997.
2. W. V. Lovitt, Linear Integral Equations, Dover Publications, Inc. New York, 1950.
3. K. F. Riley, M.P. Hobson and S.T. Bence, Mathematical Methods for Physics and Engineering Cambridge University Press, U.K., 1997.
4. M. D. Raisinghania, Integral Equations and Boundary Value Problems, S.C. Chand India, 2007.
5. Shanti Swarup, Integral Equations (&Boundary Value Problems), Krishna Prakashan Media (P) Ltd. Meerut, India, 2014.

Professor & Head
Department of Mathematics
University of Kashmir

LAPLACE TRANSFORM

Course No: **MM24209DCE** Total Credits: **02**

Semester: **MA/M.Sc. 2nd Semester** Total marks: **50**

Continuous Assessment Marks: **10**, Theory Marks: **40** Time Duration: **1½ hrs**

Course Objectives: To study Laplace transforms and their properties for their applications in other disciplines including solution of differential equations, image processing, signal noise estimation etc.

Course Outcomes: After the completion of the course, students shall be able to use the techniques of Laplace transform in real life problems.

UNIT-I

Definition of Integral Transforms, Laplace transform of elementary functions, Properties of Laplace transforms viz Linearity, translation, Change of Scale property etc. Laplace transform of periodic functions, Dirac-Delta function, Inverse Laplace transform, Laplace transform of derivatives and integrals; Properties of inverse Laplace transform.

UNIT - II

Convolution theorem and Complex inversion formula, Solution of ordinary differential equation with constant and variable coefficients by Laplace transform, Solution of ordinary differential equation with constant and variable coefficients and the solution of simple boundary value problems by Laplace transform. Applications of Laplace transform to solve partial differential equations

Recommended Books:

1. Daniel Lesisch, A Student's Guide to Laplace Transforms, Cambridge University Press, New Edition, 2022.
2. Davies, Brian, Integral Transforms and Their Applications, Springer
3. Erwin, Kreysigz, Advanced Engineering Mathematics, Willey Eastern Pub.,
4. A. N. Das, Differential Equations with Introduction to Laplace Transform, New Central Book Agency; First Edition, 2012.
5. K.S. Rao, Introduction to Partial Differential Equations, K.S. Rao, PHI, India.

Professor & Head
Department of Mathematics
University of Kashmir

COMPLEX VARIABLES

Course No: **MM24002GE** Total Credits: **02**
Semester: **M.A/M.Sc 2nd Semester** Total Marks: **50**
Continuous Assessment: **Marks 10, Theory Marks: 40** Time Duration: **1½ Hrs Course**

Course objectives: To enable the students to understand basic concepts of complex variables as an extension of real number system.

Course Outcomes: Course outcomes for a Complex Variables course typically focus on developing students' understanding of complex numbers, functions, and their applications in various fields.

UNIT -I

Review of complex numbers, De-Movier's theorem and it's applications, functions of a complex variable, continuity and differentiability of complex functions, analytic functions, CR equations, complex integration, Cauchy's theorem (statement only), Cauchy's integral formulae, Liouville's theorem, Fundamental theorem of algebra.

UNIT -II

Maximum modulus principle (statement only), determination of maximum modulus of e^z, sin z, cos z etc, expansion of an analytic function in a power series, Taylor's and Laurant's theorems (statements only), classification of singularities, zeros of analytic functions, argument principle, Rouche's theorem and its applications.

Books Recommended:

1. W. Rudin, Complex Analysis, McGraw Hill, 3rd Edition (2023).
2. Alfhors, Complex Analysis, McGraw Hill (2000).
3. S. Ponaswamy, Foundations of Complex Analysis, Narosa (2011).
4. Schaum Series, Complex Variables, McGraw Hill, 2nd Edition (2017).

Professor & Head
Department of Mathematics
University of Kashmir

MATRIX ALGEBRA

Course No: **MM24002OE** Total Credits: **02**
Semester: **M.A/M.Sc 2nd Semester** Total Marks: **50**
Continuous Assessment: **Marks 10, Theory Marks: 40** Time Duration: **1½ Hrs Course**

Course objectives: To enable the student understand the basic concepts of matrices in order to solve real life problems through solution of equations.

Course Outcomes: Course outcomes for a Matrix Algebra course typically focus on developing students' understanding of matrix operations, properties, and applications in various mathematical and scientific contexts.

UNIT -I

Matrices, types, adjoint and inverse of a matrix, partition of a matrix, matrix polynomials, characteristic equation of a matrix, Cayley Hamilton theorem, elementary transformations, rank of a matrix, determination of rank.

UNIT - II

Normal form with examples, solution of equations, homogenous and non- homogeneous equations, linear dependence and independence, orthogonal and unitary matrices and their determination, eigenvalues and eigenvectors and their determination, similarity of matrices with examples.

Books Recommended

1. Franz E. Hohn, Elementary Matrix Algebra, American Publishing company Pvt. Ltd., Dover Publications, 3rd Edition, (2013).
2. Shanti Narayan, A Text Book of Matrices, S. Chand and company Ltd. S. Chand (2020)
3. Rajendra Bhatia , Matrix Analysis, Springer (1996).

Professor & Head
Department of Mathematics
University of Kashmir

ORDINARY DIFFRENTIAL EQUATIONS

Course No: **MM24301CR**
Semester: **M.A/M.Sc 3rd Semester**
Continuous Assessment: **Marks 20, Theory Marks: 80**

Total Credits: **04**
Total Marks: **100**
Time Duration: **2½ Hrs**

Course objectives: To enable the student to solve problems pertaining to ordinary differential equations for various applications day to day life and to understand the practical importance of solving differential equations and to recognize an appropriate solution method for a given problem. The course enables a student to apprehend and appreciate the importance of establishing the existence and uniqueness of solutions.

Course Outcomes: The course typically focuses on developing students' ability to understand, solve, and analyze various types of ordinary differential equations and their applications. This will help in exploring stability analysis for first-order and second-order autonomous systems including equilibrium points.

UNIT -I

First order ODE, singular solutions, p −discriminate and c −discriminate, initial value problem of first order ODE, general theory of Homogeneous and non-homogeneous linear ODE, simultaneous linear equations with constant coefficients, normal form, factorization of operators, method of variation of parameters, Picard's theorem for the existence and uniqueness of solutions to an initial value problem.

UNIT -II

Solution in Series: (i) roots of an indicial equation, unequal and differing by a quantity not an integer. (ii) roots of an indicial equation, which are equal. (iii) roots of an indicial equation differing by an integer making a coefficient infinite. (iv) roots of an indicial equation differing by an integer making a coefficient indeterminate. Simultaneous equation $dx/P = dy/Q = dz/R$ and its solutions by use of multipliers and a second integral found by the help of first, total differential equations $Pdx + Qdy + Rdz = 0$, necessary and sufficient condition that an equation may be integrable, geometric interpretation of the $Pdx + Qdy + Rdz = 0$

UNIT -III

Existence of solutions, initial value problem, Ascoli- lemma, Cauchy Piano existence theorem, uniqueness of solutions with examples, Lipchitz condition and Gronwall inequality, method of successive approximation, Picard-Lindelof theorem, continuation of solutions, system of differential equations, dependence of solutions on initial conditions and parameters.

UNIT -IV

Maximal and minimal solutions of the system of ordinary differential equations, Caratheodary theorem, linear differential equations, linear homogeneous equations, linear system with constant coefficients, linear systems with periodic coefficients, fundamental matrix and its properties, non-homogeneous linear systems, variation of constant formula, Wronskian and its properties.

Recommended Books:

1. H.T.H. Piaggio, Differential Equations, CBS Publishers and Distributors, New Delhi.
2. D. Somasundaram, Ordinary Differential Equations, Narosa Publishers, New Delhi.
3. P. Hartmen, Ordinary Differential Equations, Society for Industrial and Applied Sciences (1987).
4. W. T. Reid, Ordinary Differential Equations, John Wiley & Sons Inc. (1971).
5. E. A. Coddington and N. Levinson, Theory of Ordinary Differential Equations, McGraw Hill Edu. (2017).

Professor & Head
Department of Mathematics
University of Kashmir

COMPLEX ANALYSIS-II

Course No: **MM24302CR** Total Credits: **04**
Semester: **M.A/M.Sc 3rd Semester** Total Marks: **100**
Continuous Assessment: **Marks 20, Theory Marks: 80** Time Duration: **2½ Hrs**

Objectives: The main aim of this course is to solve definite integrals by the method of Contour integration, bounds for the range of the analytic functions and concept of analytic continuation of a power series in order to have an understanding about the behavior of functions in complex domain.

Course Outcomes: The students shall be able to explore advanced integration techniques in the complex plane, including contour integrals, residue theorem applications, and evaluation of real integrals. This will help in understand the concept of analytic continuation and its applications in extending the domain of validity of complex functions.

UNIT -I

Calculus of Residues, Cauchy's residue theorem, evaluation of integrals by the method of residues, Parseval's Identity, branches of many-valued functions with special reference to $arg(z)$, $log\ z$ and z^n, Blashke's theorem.

UNIT -II

Poisson integral formula for circle and half plane, Poisson-Jensen formula, Estermann's uniqueness theorem, Carlemann's theorem and the uniqueness theorem associated with it, Hadamard's three circle theorem, $logM(r)$ and $logI_2(r)$ as convex function of $logr$, theorem of Borel and Carateodory.

UNIT -III

Power series: Cauchy-Hadamard formula for the radius of convergence, Picard's theorem on power series: If $a_n > a_n + 1$ and $liman = 0$, then the series $\sum a_n z^n$ has radius of convergence equal to 1 and the series converges for $|z| = 1$ except possibly at z =1, a power series represents an analytic function within the circle of convergence, Hadamard - Pringsheim theorem, the principle of analytic continuation, uniqueness of analytic continuation, power series method of analytic continuation, functions with natural boundaries e.g., $\sum z^{n!}, \sum z^{2^n}$. Schwarz reflection principle.

UNIT -IV

Functions with positive real part, Borel's theorem, univalent functions, area theorem, Bieberbach's conjecture (statement only) and Koebe's ¼ theorem. Space of analytic functions, Bloch's theorem, Schottky's theorem, a - points of an analytic function, Picard's theorem for integral functions, Landau's theorem.

Recommended Books:

1. Alfhors, Complex Analysis, McGraw Hill (2000).
2. E. C. Tichtmarsh, Theory of Functions, Oxford University Press, 2nd Edition (1976).
3. J. B. Conway, Functions of a Complex Variable-I, Springer, 2nd Edition (1995).
4. Richard Silverman, Complex Analysis, Dover Publications Inc. (1984).
5. Zeev Nehari, Conformal Mappings, Dover Publications Inc. (2003).
6. W. Rudin, Complex Analysis, McGraw Hill, 3rd Edition (2023).

Professor & Head
Department of Mathematics
University of Kashmir

FUNCITONAL ANALYSIS-I

Course No: **MM24303CR** | Total Credits: **04**
Semester: **MA/M.Sc. 3rd Semester** | Total marks: **100**
Continuous Assessment Marks: **20**, Theory Marks: **80** | Time Duration: **2½ hrs**

Course Objectives: To familiarize with the basic tools of Functional Analysis involving normed spaces, Banach spaces, inner product spaces, Hilbert spaces and their geometric properties, transformation of bounded linear operators from one space to another.

Course Outcomes: After studying this course the student will be able to distinguish between Banach spaces and Hilbert spaces, decompose a Hilbert space in terms of orthogonal complements, check totality of orthonormal sets and sequences, represent a bounded linear functional in terms of inner product and develop understanding to the theory of functional spaces, linear operators and their application in various Mathematical and scientific contexts.

UNIT-I

Banach Spaces: definition and examples, subspaces, quotient spaces, continuous linear operators and their characterization, completeness of the space L(X,Y) of bounded linear operators (and its converse), incompleteness of C[a, b] under the integral norm, finite dimensional Banach spaces, equivalence of norms on finite dimensional space and its consequences, dual of a normed linear space, , duals of l_p^n, C_o, l_p ($p\geq1$), C[a, b].

UNIT-II

Hahn Banach theorem (extension form) and its applications, Uniform boundedness, principle and weak boundedness, dimension of an ∞-dimensional Banach space, conjugate of a continuous linear operator and its properties, Banach-Steinhauss theorem, open mapping and closed graph theorems, counterexamples to Banach-Steinhauss, open mapping theorem and closed graph theorems for incomplete domain and range spaces, separable Banach spaces and the separability of some concrete Banach spaces (C_0, C[0,1], l_p, $p\geq1$), reflexive Banach Spaces, closed subspace and the dual of a reflexive Banach space, examples of reflexive and non-reflexive Banach spaces.

UNIT-III

Hilbert spaces: definition and examples, Cauchy's Schwartz inequality, parallogram law, orthonormal (o.n) systems, Bessel's inequality and Parseval's Identity for complete orthonormal systems, Riesz-Fischer theorem, Gram Schmidt process, o.n basis in separable Hilbert spaces.

UNIT-IV

Projection theorem, Riesz Representation theorem, counterexample to the projection theorem and Rieszrepresentation theorem for incomplete spaces, Hilbert property of the dual of a Hilbert space and counter examples of incomplete inner product spaces, reflexivity of Hilbert space, adjoint of a Hilbert space operator, weak convergence and Bolzano-Weirstrass property in Hilbert Spaces, normal and unitary operators, finite dimensional spectral theorem for normal operators.

Recommended Books:

1. B. V. Limaya, Functional Analysis, New Age International Pvt. Ltd; 3rd edition, 2014.
2. C. Goffman & G. Pedrick, A First Course in Functional Analysis, American Mathematical Society; 2nd edition, 2017.
3. L.A. Lusternick & V.J. Sobolov, Elements of Functional Analysis, Hindustan Publishing Corporation (India); 3rd edition, 2020.
4. J.B. Conway, A Course in Functional Analysis, Springer, 4th Edition, 1994.

Professor & Head
Department of Mathematics
University of Kashmir

FOURIER ANALYSIS

Course No: **MM24304CR**	Total Credits: **02**
Semester: **M.A/M.Sc 3rd Semester**	Total Marks: **50**
Continuous Assessment: **Marks 10, Theory Marks: 40**	Time Duration: **1½ Hrs**

Course objectives: The primary object of this course is to develop Fourier series and Fourier transforms and give conceptual knowledge of Fourier Series and its applications to heat flow and vibrating string problems.

Course Outcomes: The course enables students in developing understanding of Fourier series, Fourier transforms, and their applications in various mathematical and scientific contexts.

UNIT -I

Fourier Series: Motivation and definition of Fourier series, Fourier series over the interval of length 2π, change of the interval, the complex exponential Fourier series, criteria for the convergence of Fourier series, Riemann-Lebesgue lemma, convergence at a point of continuity and at a point of discontinuity, uniform convergence and convergence in mean of the Fourier series.

UNIT -II

Derivatives and Integrals of Fourier Series: Differentiation of Fourier series, differentiation of the sine and cosine series, convergence theorems related to the derived Fourier series, integration of Fourier series, applications of Fourier series to Heat flow and Vibrating string problems.

Books Recommended.

1. E. M. Stein and R. Shakarchi, Fourier Analysis, An Introduction, Princeton University Press, 2002.
2. K. B. Howell, Principles of Fourier Analysis, Chapman & Hall/ CRC, Press, 2001.
3. Lokenath Debnath, Wavelet Transforms and their Applications, Birkhauser, 2002.
4. G. P. Tolstov, Fourier Series, Dover, 1972.
5. I. G. Loukas, Modern Fourier Analysis, Springer, 2011.
6. G. B. Folland, Fourier Analysis and Its Applications, Brooks/Cole Publishing, 1992.

Professor & Head
Department of Mathematics
University of Kashmir

ADVANCED GRAPH THOERY

Course No: **MM24305DCE** | Total Credits: **04**
Semester: **M.A/M.Sc 3rd Semester** | Total Marks: **100**
Continuous Assessment: **Marks 20, Theory Marks: 80** | Time Duration: **2½ Hrs**

Course objectives: To expose the student to the various concepts of graph theory in order to model many types of relations and processes in physical, biological, social and information systems.
Course Outcomes: Course outcomes for an Advanced Graph Theory course focuses on developing students' understanding of advanced graph theory concepts and their applications in various fields.

UNIT I
Colorings: Vertex coloring, chromatic number $\chi(G)$, bounds for $\chi(G)$, Brooks theorem, edge coloring, Vizing's theorem, map coloring, six color theorem, five color theorem, every graph is four colourable iff every cubic bridgeless plane map is 4-colorable, every planar graph is 4-colorable iff $\chi'(G) = 3$. Heawood map coloring theorem, uniquely colorable graphs

UNIT - II
Matchings: Matchings and 1-factors, Berge's theorem, Hall's theorem, 1-factor theorem of Tutte, antifactor sets, f-factor theorem, f-factor theorem implies1-factor theorem, Erdos- Gallai theorem follows from f-factor theorem, degree factors, *k*-factor theorem, factorization of K_n.

UNIT - III
Edge graphs and eccentricity sequences: Edge graphs, Whitney's theorem on edge graphs, Beineke's theorem, edge graphs of trees, edge graphs and traversibility, total graphs, eccentricity sequences and sets, Lesniak theorem for trees, construction of trees, neighbourhoods, Lesniak theorem graphs.

UNIT -IV
Groups in graphs and graph spectra: Automorphism groups of graphs, graph with a given group, Frucht's theorem, Cayley digraph, spectrum of a graph, spectrum of some graphs-regular graph, compliment of a graph, edge graph, complete graph, complete bipartite, cycle and path, Laplacian spectrum, energy of a graph, Laplacian energy.

Recommended Books:

1. R. Balakrishnan, K. Ranganathan, A Text Book of Graph Theory, Springer-Verlag, New York (2012).
2. B. Bollobas, Extremal Graph Theory, Springer (2002).
3. F. Harary, Graph Theory, Narosa (2001).
4. Narsingh Deo, Graph Theory with Applications to Eng. and Comp. Sci, PHI. (1979).
5. S. Pirzada, An Introduction to Graph Theory, Universities Press, Orient Blackswan, (2012).
6. W. T. Tutte, Graph Theory, Cambridge University Press. (2016).
7. D. B. West, Introduction to Graph Theory, Pearson (2022).

Professor & Head
Department of Mathematics
University of Kashmir

ABSTRACT MEASURE THEORY

Course No: **MM24306DCE**	Total Credits: **04**
Semester: **M.A/M.Sc 3rd Semester**	Total Marks: **100**
Continuous Assessment Marks **20**, Theory Marks: **80**	Time Duration: **2½ Hrs**

Course objectives: To extend the concept of measure to abstract spaces for various measures in order to obtain corresponding analogs of various results of Lebesgue measure which involves general theory of measure spaces and measurable functions, Lebesgue measure on the real line, the sigma algebras, a brief introduction to L_p −spaces and related topics.

Course Outcomes: The course shall help the students in developing understanding of measure theory concepts, abstract integration, and their applications in various mathematical contexts.

UNIT-I

Semi-ring, ring, algebra and σ −algebra of sets, measures on semi-rings, outer measure associated with a set function and basic properties, measurable sets associated with an outer measure as a σ − algebra , outer measure induced by a measure, non measurable sets.

UNIT-II

Finite and σ- Finite measure spaces, Measurable sets of finite measure space, Improper Riemann integral as a Lebesgue integral, calculation of some improper Riemann integrable functions, approximation of integrable functions, Riemann Lebesgue lemma.

UNIT-III

Product measures and product σ −algebra, measurable rectangles, monotone class and elementary sets, expressing a double integral as an iterated integral, examples of non-integrable functions whose iterated integrals exist (and are equal), Integration on product spaces, Fubini theorem.

UNIT-IV

For $f \in L_1[a,b], F' = f a.e.$ on $[a,b]$, if f is absolutely continuous on (a,b) with $f(x) = 0 a.e.$, then f is constant. Characterization of an absolutely continuous function as an indefinite Lebesgue integral. Non-Lebesgue integrability of $x^2 sin(1/x^2)$ on $[0,1]$. Fundamental theorem of calculus for the Lebesgue integral. A brief introduction to L_p spaces. Holder's and Minkowski's inequalities.

Recommended Books:

1. C. D. Aliprantis and O. Burkinshaw, Principles of Real Analysis, Academic Press Inc. 2nd Edition (1990).
2. Goldberg , R, Methods of Real Analysis, Oxford and IBH Publishing Company (2020).
3. T. M. Apostol, Mathematical Analysis, Narosa (2002).
4. Royden, L, Real Analysis, Pearson Education India, 4th Edition (2015).
5. Chae, S.B., Lebesgue Integration, Springer Verlag, 2nd Edition (1995).
6. Rudin, W., Principles of Mathematical Analysis, McGraw Hill (2023)
7. Barra, De. G., Measure theory and Integration, New Age International Publishers, 3rd Edition (2022).
8. Rana , I. K., An Introduction to Measure and Integration, Narosa Publications.

Professor & Head
Department of Mathematics
University of Kashmir

Python for Mathematics

Course Code MM18307DCE **Total Credits: 04**
Semester: M.A./M. Sc 3rd Semester **Total Marks:100**
Continuous Assessment: 20 Theory: 80 **Time Duration:2 ½ hours**

Course Objectives: To enable the students to write basic programs in Python and to implement some fundamental mathematical algorithms with a view to experiment with different mathematicalconcepts both graphically, symbolically and numerically .

Course Outcomes: After the completion of the course, the students will learn the basic syntax of Python, explore mathematically oriented algorithms, and delve into plotting and data structures andthe basics of neural networks.

Unit I:
Introduction to Python: History and Features. Setting up the Python Environment Variables, Data Types, and Operators, Control Structures: Conditional Statements and Loops. Functions and Modules, Lists, Tuples, and Dictionaries Sets, Trees and Graphs: Basic Concepts and Implementations, Python as the language of deep learning and AI.

Unit II:
Functions: Defining a function, calling a function, Advantages of functions, types of function parameters, Formal parameters, Actual parameters, anonymous functions, global and local variables Modules: Importing module, Creating & exploring modules, Math module, Random module, Time module

File Input-Output: Opening and closing file, Various types of file modes, reading and writing to files, manipulating directories, Exception Handling: Introduction to Exception, Various keywords to handle exception try, catch, except, else, finally, raise-Regular Expressions-Concept of regular expression, various types of regular expressions.

Unit III:
Plotting and Visualization: Introduction to Matplotlib and Seaborn. Plotting Basic Mathematical Functions, Visualizing Data: Histograms, Scatter Plots, and Box Plots, introduction to pandas and data analytics.

Unit IV:
Introduction to Artificial Intelligence: Early Concepts and Developments in AI, Milestones in AI: From Symbolic AI to Machine Learning, Traditional and Ensemble Approaches for Decision making. Introduction to Neural Networks and Deep Learning-

Recommended Books:

1. Python for Data Analysis" by Wes McKinney
2. Python Programming for the Absolute Beginner" by Michael Dawson
3. Numerical Python: Scientific Computing and Data Science Applications with NumPy, SciPy andMatplotlib" by Robert Johansson
4. Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville
5. 5.Artificial Intelligence: A Modern Approach" by Stuart Russell and Peter Norvig
6. Artificial Intelligence: A Guide to Intelligent Systems by Michael Negnevitsky

WAVELET THEORY

Course Code: **MM24308DCE** Total Credits: **04**
Semester: **MA/M.Sc. 3rd Semester** Total Marks: **100**
Continuous Assessment: **Marks 20, Theory: Marks 80** Time Duration: **2½ hrs**

Course Objectives: To inculcate the students about Wavelet theory through different types of wavelets and their properties.
Course Outcome: The students after the completion of this course shall be able to apply wavelet transforms and their properties in understanding the signals in both time and frequency domains.

Unit –I

Time Frequency Analysis and Wavelet Transforms: Gabor transforms, basic properties of Gabor transforms, continuous and discrete wavelet transforms with examples, basic properties of wavelet transforms, examples of Haar wavelet, Mexican hat wavelet and their Fourier transforms, dyadic orthonormal wavelet bases for $L^2(\mathbb{R})$.

Unit –II

Multiresolution Analysis and Construction of Wavelets: Definition and examples of multiresolution analysis (MRA), properties of scaling functions and orthonormal wavelet bases, construction of orthonormal wavelets with special reference to Haar wavelet, Franklin wavelet and Battle- Lemarie wavelet, Spline wavelets, construction of compactly supported wavelets, Daubechie's wavelets and algorithms.

Unit –III

Other Wavelet Constructions and Characterizations: Introduction to basic equations, some applications of basic equations, characterization of MRA wavelets and scaling functions, construction of biorthogonal wavelets, wavelet packets, definition and examples of wavelets in higher dimensions.

Unit –IV

Further Extensions of Multiresolution Analysis: Periodic multiresolution analysis and the construction of periodic wavelets, multiresolution analysis associated with integer dilation factor (M-band wavelets), harmonic wavelets, properties of harmonic scaling functions.

Books Recommended

1. L. Debnath, Wavelet Transforms and their Applications, Birkhauser, 2002.
2. I. Daubechies, Ten Lectures on Wavelets, CBS-NSF Regional Conferences in Applied Mathematics, 61, SIAM, Philadelphia, PA, 1992.
3. K. Ahmad and F. A. Shah, Introduction to Wavelets with Applications, Real World Education Publishers, New Delhi, 2013.
4. C. K. Chui, An Introduction to Wavelets, Academic Press, New York, 1992.
5. M. Pinsky, Introduction to Fourier Analysis and Wavelets, Brooks/Cole, 2002.E. Hernandez and G. Weiss, A First Course on Wavelets, CRC Press, New York (1996).

Professor & Head
Department of Mathematics
University of Kashmir

LAPLACE AND FOURIER TRANSFORMATIONS

Course No: **MM24003GE** | Total Credits: **02**
Semester: **M.A/M.Sc 3rd Semester** | Total Marks: **50**
Continuous Assessment: **Marks 10, Theory Marks: 40** | Time Duration: **1½ Hrs**

Objectives: To formulate and solve differential equations, illustrate Laplace and Fourier transform through practical applications and solve initial and boundary value problems using Laplace/Fourier transform.

Course Outcomes: Upon successful completion of this course, students will be able to: Solve differential equations with initial conditions using Laplace transform. Evaluate the Fourier transform of a continuous function and be familiar with its basic properties.

UNIT -I

Definition of Laplace transformation and some examples on Laplace transformation of elementary functions, piecewise continuity, sufficient conditions for the existence of Laplace transform, linearity property, first and second translation (shifting property), Laplace transform of derivatives, Laplace transform of integrals, Inverse Laplace transform, Inverse Laplace transform of derivatives and integrals, the convolution property, methods of finding inverse Laplace transform, the complex inversion formula, the Heaviside expansion formula.

UNIT -II

Periodic functions, Definition and examples of Fourier series, Dirichlet's conditions, determination of Fourier coefficients, even and odd functions and their Fourier expansion, change of interval, half range series. Fourier transform, inverse Fourier transform, Fourier sine and cosine transforms and their inversion, properties of Fourier transforms, Fourier transform of the derivative, convolution theorem, discrete Fourier transform and fast Fourier transform and their properties.

Recommended Books.

1. Murrey R. Spiegel, Laplace Transforms, Schaum's Outline Series, McGraw Hill Education.

2. I. N. Sneddon, The use of Integral Transforms, McGraw-Hill, Singapore 1972.

3. R. R. Goldberg, Fourier Transforms, Cambridge University Press, 1961.

4. D. Brain, Integral Transforms and their applications, Springer, 2002.

Professor & Head
Departmen athematics
Univer Kashmir

INTRODUCTION TO MATHEMATICAL MODELLING

Course No: **MM24003OE** Total Credits: **02**
Semester: **M.A/M.Sc 3rd Semester** Total Marks: **50**
Continuous Assessment: **Marks 10, Theory Marks: 40** Time Duration: **1½ Hrs**

Objectives: To enable the student to formulate mathematical models of real life problems and find their solutions and present application-driven mathematics motivated by problems from within and outside mathematics.

Course Outcomes: The course will enable students to understand concept of modelling and simulation and to construct mathematical models of real world problems and solve them using mathematical techniques.

UNIT -I

Introduction to mathematical modeling, types of modeling, classification of mathematical models, formulation, solution and interpretation of a model, models in population dynamics, linear growth and decay models, non-linear growth and decay models, continuous population models for single species, delay models, logistic growth model, discrete models, age structured populations, Fibonacci's rabbits, the golden ratio, compartment models, limitations of mathematical models.

UNIT -II

Mathematical modeling through system of ordinary differential equations, compartment models through system of ODE's, modeling in economics, medicine, international trade, gravitation; planetary motion; basic theory of linear difference equations with constant coefficients, mathematical models through difference equations in population dynamics, finance and genetics, modeling through graphs.

Books Recommended:

1. J. N. Kapur, Mathematical Modelling in Biology and Medicine, New Age International Publishers (2000).
2. Neil Gerschenfeld : The nature of Mathematical modeling, Cambridge University Press, 1999.
3. A. C. Fowler : Mathematical Models in Applied Sciences, Cambridge University Press, 1997.
4. M. R. Cullen, Linear Models in Biology, John Wiley & Sons (1985).

Professor & Head
Department of Mathematics
University of Kashmir

PARTIAL DIFFRENTIAL EQUATIONS

Course No: **MM24401CR** Total Credits: **04**
Semester: **MA/M.Sc. 4th Semester** Total Marks: **100**
Continuous Assessment Marks: **20**, Theory Marks: **80** Time Duration: 2½ hrs

Course objectives: To familiarize the students with the fundamental concepts of PDE's and their solutions in the context of Laplace, Heat and Wave equations.

Course Outcomes: Course outcomes for a Partial Differential Equations (PDE) course focuses on developing students' understanding of PDEs, their classification, solution techniques, and applications in various mathematical and scientific contexts.

UNIT -I

Introduction to partial differential equations, partial differential equations of first order, linear and non-linear partial differential equations, Lagrange's method for the solution of linear partial differential equations, Charpits method and Jacobi methods for the solution of non-linear partial differential equations, initial-value problems for quasi-linear first-order equations, Cauchy's method of characteristics.

UNIT -II

Origin of second order partial differential equations, linear partial differential equations with constant coefficients, methods for solution of second order partial differential equations, classification of second order partial differential equations, canonical forms, adjoint operators, Riemann's method, Monge's method for the solution of non-linear partial differential equations.

UNIT -III

Derivation of Laplace and heat equations, boundary value problems, Drichlet's and Neumann problems for a circle and sphere; solutions by separation of variables method, cylindrical coordinates and spherical polar coordinate system, maximum-minimum principle, uniqueness theorem, Sturm-Liouville theory.

UNIT -IV

Derivation of wave equation, D' Alembert's solution of one dimensional wave equation, separation of variables method, periodic solutions; method of eigen functions, Duhamel's principle for wave equation, Laplace and Fourier transforms and their applications to partial differential equations, Green function method and its applications.

Recommended Books:

1. Robert C. Mc Owen, Partial Differential Equations-Methods and Applications, Pearson Education, Delhi, 2004.
2. L. C. Evans, Partial Differential Equations, GTM, AMS, 1998
3. Diran Basmadjian, The Art of Modelling in Science and Engineering, Chapman & Hall/CRC, 1999.
4. E. DiBenedetto, Partial Differential Equations, Birkhauser, Boston, 1995.
5. F. John, Partial Differential Equations, 3rd ed., Narosa Publ. Co., New Delhi, 1979.
6. E. Zauderer, Partial Differential Equations of Applied Mathematics, 2nd Ed., John Wiley and Sons, New York, 1989.

Professor & Head
Department of Mathematics
University of Kashmir

DIFFERENTIAL GEOMETRY

Course No: **MM24402CR** Total Credits: **04**
Semester: **MA/M.Sc. 4th Semester** Total Marks: **100**
Continuous Assessment Marks: **20**, Theory Marks: **80** Time Duration: **2½ hrs**

Course Objectives: To inculcate the students about the geometric properties of curves, surfaces and their higher-dimensional analogs using the methods of calculus. Christoffel symbols, regular surfaces, geodesics and isometry between surfaces.

Course Outcome: After the completion of this course, the students shall be able to understand basic properties of curves and surfaces. They shall be able to use various properties of curves and surfaces in the geometry of the nature.

UNIT -I

Curves: differentiable curves, regular points, parameterization and reparameterization of curves, unit speed curves, arc-length is independent of parameterization, plane curves, curvature of plane curves, osculating circle. Space curves, Serret-Frenet frame, fundamental theorem of space curves. Characterization of helices and curves on sphere in terms of their curvature and torsion, evolutes and involutes of space curves, Isoperimetric inequality, Four vertex theorem.

UNIT -II

Surfaces: regular surfaces with examples, coordinate charts or curvilinear coordinates, change of coordinates, tangent plane at a regular point, normal to the surface, orientable surface, differentiable mapping between regular surfaces and their differential, first fundamental form, line element, invariance of a line element under change of coordinates, angle between two curves, condition of orthogonality of coordinate curves, area of bounded region, invariance of area under change of coordinates.

UNIT -III

Curvature of a Surface: normal curvature, principal curvatures and principle directions, classification of points with prescribed principal curvatures, Euler's formula, Gauss map and its differential, second fundamental form, normal curvature in terms of second fundamental form. Meunier theorem, Gaussian and mean curvature, Hilbert's theorem and its applications. Weingarten equation, surface of revolution, surfaces with constant positive or negative Gaussian curvature, Gaussian curvature in terms of area, line of curvature, Rodrigue's formula for line of curvature, equivalence of surfaces, isometry between surfaces, local isometry, and characterization of local isometry.

UNIT -IV

Christoffel symbols, expressing Christoffel symbols in terms of metric coefficients and their derivative, Theorema egrerium. Gauss equations and Manardi Codazzi equations for surfaces, fundamental theorem for regular surface. (Statement only). Geodesics: geodesic curvature, geodesic curvature is intrinsic, equations of geodesic, geodesic on sphere and pseudo sphere, geodesic as distance minimizing curves. Gauss-Bonnet theorem (statement only), geodesic triangle on sphere, implication of Gauss-Bonnet theorem for geodesic triangle.

Recommended Books:

1. M.P. Do Carmo, Differential geometry of curves and surfaces, Dover Publications, 2nd Ed. 2016.
2. W. Klingenberg, A course in Differential Geometry, Spring Verlag, Edition, 2013.
3. C. E. Weatherburn, Differential Geometry of Three dimensions, Cambridge Univ. Press, 2016.
4. T. Willmore, An Introduction to Differential Geometry, Oxford University Press, 1997.
5. Sebastian Montiel, Antonio Ros, Curves and surfaces, AMS, 2nd Edition, 2009.

Professor & Head
Department of Mathematics
University of Kashmir

ABSTRACT ALGEBRA -II

Course No: **MM24403CR** Total Credits: **04**
Semester: **MA/M.Sc. 4th Semester** Total Marks: **100**
Continuous Assessment Marks: **20**, Theory Marks: **80** Time Duration: **2½ hrs**

Course Objectives: To expose the students to Galios theory in problem solving context and to apply the group theoretic information to deduce results about fields and polynomials.

Course Outcomes: After the completion of this course, Students' shall make use of advanced understanding of abstract algebraic structures and their applications. Field structures, fundamental theory of Galios theory and their applications in linear algebra and other related disciplines.

UNIT - I

Relation and ordering, partially ordered sets, lattices, properties of lattices, lattices as algebraic systems, sub-lattices, direct product and homomorphism, modular lattices, complete lattices, bounds of lattices, distributive Lattice, complemented lattices.

UNIT - II

Modules, sub-modules, quotient modules, homomorphism and isomorphism theorem, cyclic modules, simple modules, semi-simple modules, Schuer's lemma, free modules, ascending chain condition and maximum condition, and their equivalence, descending chain condition and minimum condition and their equivalence, direct sums of modules, finitely generated modules.

UNIT - III

Fields: Prime fields and their structure, extensions of fields, algebraic numbers and algebraic extensions of a field, roots of polynomials, remainder and factor theorems, splitting field of a polynomial, existence and uniqueness of splitting fields of polynomials, simple extension of a field.

UNIT - IV

Separable and in-separable extensions, the primitive element theorem, finite fields, perfect fields, the elements of Galois theory, automorphisms of fields, normal extensions, fundamental theorem of Galois theory, construction with straight edge and compass, R^n is a field iff $n = 1, 2$.

Recommended Books

1. J. A. Gallian, Contemporary Abstract Algebra, Cengage Learning, USA, 9th Edition, 2015
2. I. N. Heristein, Topics in Algebra, John Wiley & Sons, 2nd Edition, 1975.
3. P. B. Bhatacharaya and S.K.Jain, Basic Abstract Algebra, Cambridge University Press, 4th Edition, Reprint 2009.
4. J. B. Fragleigh, A First Course in Abstract Algebra, Pearson New International, 2014.
5. K. S. Miller, Elements of Modern Abstract Algebra, Krieger Publishing, 1975.
6. Surjeet Singh and Qazi Zameer-ud-Din, Modern Algebra, Vikas Pub Hou. Pvt Ltd, 8th Edition, 2006

Professor & Head
Department of Mathematics
University of Kashmir

LINEAR ALGEBRA

Course Code: **MM24404CR** — Total Credits: **02**
Semester: **MA/M.Sc. 4th Semester** — Total Marks: **50**
Continuous Assessment: **Marks 10**, Theory: **Marks 40** — Time Duration: **1½ hrs**

Course objectives: To inculcate the students to study linear functions and their representations through matrices and vector spaces.

Course Outcomes: This course shall help the students in developing students' understanding of fundamental concepts in linear algebra and their ability to apply these concepts to various mathematical. In particular this will help in understanding bilinear and quadratic forms, including symmetric matrices, diagonalization of quadratic forms, and applications.

....

UNIT -I

Linear transformation, algebra of linear transformations, linear operators, invertible linear transformations, matrix representation of a Linear transformation, linear functionals, dual spaces, dual basis, annihilators, eigenvalues and eigenvectors of linear transformation, diagonalization, similarity of linear transformation.

UNIT -II

Canonical forms: triangular form, invariance, invariant direct sum decomposition, primary decomposition, nilpotent operators, Jordon canonical form, cyclic subspaces, rational canonical form, quotient spaces, bilinear forms, alternating bilinear forms, symmetric bilinear forms, quadratic forms.

Books Recommended:

1. Robort A. Beezer, A first course in linear algebra, Organge Grove Books, 2009.
2. John B. Fraleigh and Raymond, Linear Algebra, Pearson Publishers, 3rd Edition, 1995.
3. A. K. Sharma, Linear Algebra, Discovery Edition, 1st Edition, 2016.
4. Vivek Sahai and Vikas Bist, Linear Algebra, Alpha Science International Ltd., 2001.

Professor & Head
Department of Mathematics
University of Kashmir

ANALYTIC THEORY OF POLYNOMIALS

Course Code: **MM24405DCE** Total Credits: **04**
Semester: **MA/M.Sc. 4th Semester** Total Marks: **100**
Continuous Assessment: **Marks 20**, Theory: **Marks 80** Time Duration: **2½ hrs**

Course objectives: To expose the student toward the study of polynomials, their extremal problems, zeros, critical points and their location.

Course Outcomes: This course shall help the students in finding roots of complex polynomial equations, including the Fundamental Theorem of Algebra and the location of roots in the complex plane.

....

UNIT -I

Introduction, the fundamental theorem of algebra (revisited), symmetric polynomials, the continuity theorem, orthogonal polynomials, general properties, the classical orthogonal polynomials, tools from matrix analysis.

UNIT -II

Critical points in terms of zeros, fundamental results and critical points, convex hulls and Gauss-Lucas theorem, some applications of Gauss-Lucas theorem, extensions of Gauss-Lucas theorem, average distance from a line or a point, real polynomials and Jenson's theorem, extensions of Jenson's theorem.

UNIT -III

Derivative estimates on the unit interval, inequalities of S. Bernstein and A. Markov, extensions of higher order derivatives, two other extensions, dependence of the bounds on the zeros, some special classes, Bernstein Theorem on unit disk and its generalization, L^p analog of Bernstein's inequality.

UNIT -IV

Coefficient estimates, polynomials on the unit circles, coefficients of real trigonometric polynomials, polynomials on the unit interval. (Scope of above syllabus as given in the book "Analytic Theory of Polynomials" by Rahman and Schmeisser).

Recommended Books:

1. Q. I. Rahman and G.Schmeisser, Analytic Theory of Polynomials, Claredon Press, 2002.
2. Morris Marden, Geometry of Polynomials, AMS, 2nd Edition, 1949.
3. G. V. Milovanovic, D.S.Mitrinovic and Th. M. Rassias, Topics in Polynomials, Extremal Properties, Problems, Inequalities, Zeroes, World Scientific Publishers, 1994.
4. G. Polya and G. Szego, Problems and Theorems in Analysis, Springer Verlag New York Heidelberg Berlin, 1998th Edition, 1997.

MATHEMATICAL STATISTICS

Course Code: **MM24406DCE** | Total Credits: **04**
Semester: **MA/M.Sc. 4th Semester** | Total Marks: **100**
Continuous Assessment: **Marks 20,** Theory: **Marks 80** | Time Duration: **2½ hrs**

Course objectives: To provide and develop ideas about probability theory and mathematical statistics for stochastic processes and decision-makings.

Course Outcomes: After the completion of this course, the students can apply various statistical and probabilistic methods in exploring applications of various real life situations with stochastic behavior.

....

UNIT -I

Some Special Distributions, Bernoulli, Binomial, trinomial, multinomial, negative binomial, Poisson, gamma, chi-square, beta, Cauchy, exponential, geometric, normal and bivariate normal distributions.

UNIT -II

Distribution of functions of random variables, distribution function method, change of variables method, moment generating function method, t and F distributions, Dirichlet distribution, distribution of order statistics, distribution of X and nS^2/σ^2, limiting distributions, different modes of convergence, central limit theorem.

UNIT -III

Interval estimation, confidence interval for mean, confidence interval for variance, confidence interval for difference of means and confidence interval for the ratio of variances, point estimation, sufficient statistics, Fisher-Neyman criterion, factorization theorem, Rao- Blackwell theorem, best statistic (MvUE), Complete Sufficient Statistic, exponential class of pdfs.

UNIT -IV

Rao-Crammer inequality, efficient and consistent estimators, maximum likelihood estimators (MLE's), testing of hypotheses, definitions and examples, best or most powerful (MP) tests, Neyman Pearson theorem, uniformly most powerful (UMP) tests, likelihood ratio test, chi-square test.

Recommended Books

1. Hogg and Craig, An Introduction to Mathematical Statistics, Pearson, 7th Edition, 2012.
2. A. Mood and F. Grayball, An Introduction to Mathematical Statistics, McGraw Hill, 3rd Edition, 2017.
3. C. R. Rao, Linear Statistical Inference and its Applications, Wiley 2nd Edition, 2009.
4. V. K. Rohatgi, An Introduction to Probability and Statistics, Wiley 2nd Edition, 2008.

Professor & Head
Department of Mathematics
University of Kashmir

FUNCTIONAL ANALYSIS - II

Course Code: **MM24407DCE** Total Credits: **04**
Semester: **MA/M.Sc. 4th Semester** Total Marks: **100**
Continuous Assessment: **Marks 20**, Theory: **Marks 80** Time Duration: **2½ hrs**

Course Objectives: To enable the student to understand the properties of Banach spaces in terms of bounded linear operators, separability and reflexivity of such spaces.

Course Outcomes: The students shall be able to undergo various advanced topics in the field of functional analysis with main focus on duality, completeness, Banach's advanced theorems and Mazur-Ulam theorem.

....

Unit -I
Relationship between analytic and geometric forms of Hahn-Banach theorem, applications of Hahn-Banach theorem, Banach limits, Markov-Kakutani theorem for a commuting family of maps, complemented subspaces of Banach spaces, complentability of dual of a Banach space in its bidual, uncomplementability of c_0 and l_∞.

Unit -II
Dual of subspaces, quotient spaces of a normed linear space, weak and weak* topologies on a Banach space, Goldstine's theorem, Banach Alaoglu theorem and its simple consequences, Banach's closed range theorem, injective and surjective bounded linear mappings between Banach spaces.

Unit -III
l_∞ and $C[0,1]$ as universal separable Banach spaces, l_1 as quotient universal separable Banach spaces, Reflexivity of Banach spaces and weak compactness, Completeness of $L_p[a,b]$, extreme points, Krein-Milman theorem and its simple consequences.

Unit -IV
Dual of $l_\infty, C(X)$ *and* L_p spaces. Mazur-Ulam theorem on isometries between real normed spaces, Muntz theorem in $C[a,b]$.

Recommended Books:

1. J. B. Conway, A First Course in Functional Analysis, Springer Verlag, 4th Edition, 1997.
2. R. E. Megginson, An Introduction to Banach Space theory, Springer Verlag, GTM, Vol. 183, 1998th Edition, 1998.
3. Lawrence Bagget, Functional Analysis, A Primer, Chapman and Hall, 1991.
4. B. Ballobas, Linear Analysis (Cambridge University. Press, 2nd Edition, 1999.
5. B. Beauzamy, Introduction to Banach Spaces and their geometry, Elsevier Science, 2nd Edition, 1985.
6. Walter Rudin, Functional Analysis, Tata McGrawHill, 2nd Edition, 1990

Professor & Head
Department of Mathematics
University of Kashmir

NON-LINEAR ANALYSIS

Course Code: **MM24408DCE** | Total Credits: **04**
Semester: **MA/M.Sc. 4th Semester** | Total Marks: **100**
Continuous Assessment: **Marks 20,** Theory: **Marks 80** | Time Duration: **2½ hrs**

Course Objectives: To inculcate the students about various methods to solve problems involving the homogeneous and non-homogeneous operators. Projection mappings, bilinear forms and variational inequalities shall be taught in the course.

Course Outcome: After the completion of this course, students shall be able to apply operators arising in various real life situations.

Unit - I

Convex Sets, best approximation properties, topological properties, separation, non-expansive operators, projectors onto convex sets, fixed points of non-expansive operators, averaged non-expansive operators, Fejer monotone sequences, convex cones, generalized interiors, polar and dual cones, tangent and normal cones, convex functions, variants, between linearity and convexity, uniform and strong convexity, quasiconvexity.

Unit - II

Gateaux Derivative, Frechet Derivative, lower semicontinuous convex functions, subdifferential of convex functions, directional derivatives, characterization of convexity and strict convexity, directional derivatives and subgradients, Gateaux and Frechet differentiability, differentiability and continuity

Unit - III

Monotone operators, strong notions of monotonicity such as para, cyclic, strict, uniform and strong monotonicity, maximal monotone operator and their properties, bivariate functions and maximal monotonicity, Debrunner-Flor theorem, Minty theorem, Rockfeller's cyclic monotonicity theorem, monotone operators on R.

Unit - IV

Reisz-Representation theorem, projection mappings and their properties, characterization of projection onto convex sets and their geometrical interpretation, Billinear forms and its applications, Lax-Milgram lemma, minimization of functionals, variational inequalities, relationship between abstract minimization problems and variational inequalities, Lions Stampacchia theorem for existence of solution of variational inequality.

Recommended Books:

1. H. H. Bauschke and P. L. Combettes, Convex Analysis and Monotone Operator Theory in Hilbert Spaces, Springer New York, 2011.
2. D. Kinderlehrer and G. Stampacchia, An Introduction to Variational Inequalities and Their Applications, Academic Press, New York, 1980.
3. A. H. Siddiqi, K. Ahmed and Manchanda, P. Introduction to Functional Analysis with Applications, Anamaya Publishers, New Delhi-2006.
4. I. Ekland and R. Temam, Convex Analysis and Variational Problems, W.Takahashi, Nonlinear Functional Analysis, North-Holland Publishing Company-Ammsterdam, 1976.
5. M. C. Joshi and R. K. Bose, Nonlinear Functional Analysis and its Applications, Willey Eastern Limited, 1985.

Professor & Head
Department of Mathematics
University of Kashmir

ADVANCED TOPICS IN TOPOLOGY AND MODERN ANALYSIS

Course Code: **MM24409DCE** Total Credits: **04**
Semester: **MA/M.Sc. 4th Semester** Total Marks: **100**
Continuous Assessment: **Marks 20**, Theory: **Marks 80** Time Duration: **2½ hrs**

Course Objectives: To provide the students an integrated development of modern analysis and topology through the integrating vehicle of uniforms spaces.

Course Outcome: After the successful completion of the course, the students shall be able to apply topological and other concepts from analysis, Uniform spaces in measure and other related problems.

....

Unit -I
Uniform spaces, definition and examples, uniform topology, metrizability complete regularity of uniform spaces, pre-compactness and compactness in uniform spaces, uniform continuity.

Unit -II
Uniform continuity, uniform continuous maps on compact spaces Cauchy convergence and completeness in uniform spaces, initial uniformity, simple applications to function spaces, Arzela-Ascoli theorem.

Unit -III
Abstract harmonic analysis, definition of a topological group and its basic properties, subgroups and quotient groups, product groups and projective limits, properties of topological groups involving connectedness, invariant metrics and Kakutani theorem, structure theory for compact and locally compact, Abelian groups.

Unit -IV
Some special theory for compact and locally compact Abelian groups, Haar integral and Haar measure, invariant means defined for all bounded functions, convolution of functions and measures, elements of representation theory, unitary representations of locally compact groups.

Recommended Books:

1. I. M. James, Uniform Spaces, Springer Verlag, 1987th Edition, 1987.
2. K. D. Joshi, Introduction to General Topology, New Age International Pvt Ltd, 2017.
3. S. K. Berberian, Lectures on Operator Theory and Functional Analysis, Springer Verlag, 1974th Edition, 2014.
4. G. B. Folland, Real Analysis, John Wiley, 2nd Edition, 1999.
5. G. Murdeshwar, General Topology, New Age International Pvt. Ltd, 3rd Edition, 2020.
6. E. Hewitt & K.A Ross, Abstract Harmonic Analysis-I, Springer Verlag, 1979.

Professor & Head
Department of Mathematics
University of Kashmir

PROJECT

Course Code: **MM24410DCE** Total Credits: **04**
Semester: **MA/M.Sc. 4th Semester** Total Marks: **200**
Internal: **Marks 50,** Theory: External: **Marks 150**

Course Objectives: To develop the skill of writing mathematical topics and presentations of proofs of fundamental results pertaining to the subject.

Course Outcome: The project work can work as an interface between master's programme and research. The students shall be able to choose their research topics for advanced studies.

Note: The student opting for project will have to work on the research problem in any one of the following areas:

i. **Complex Analysis**

ii. **Graph Theory**

iii. **Mathematical Biology**

iv. **Any other course (Depending upon the specializations of the faculty)**

The students opting for the project shall be guided by the faculty members in their specializations or based on their expertise. The project work comprises of survey, dissertation and final viva-voce. The dissertation will carry 100 marks, 50 internal and 50 external marks.

Professor & Head
Department of Mathematics
University of Kashmir

APPLIED DIFFERENTIAL EQUATIONS

Course Code: **MM24004GE**	Total Credits: **02**
Semester: MA/M.Sc. **4th Semester**	Total Marks: **50**
Continuous Assessment: **Marks 10**, Theory: **Marks 40**	Time Duration: **1½ hrs**

Course objectives: To develop basic foundation of differential equations for their utility in other disciplines, like economics, management, life sciences and Information technology.

Course Outcomes: This course shall help the students in developing techniques and tools for applications in other disciplines using differential equations.

....

Unit –I

Introduction: order and degree of a differential equation, formation and solution of a differential equation, variable separable method, homogeneous and Bernoulli's differential equations, exact differential equations, integrating factors, linear differential equations with constant coefficients, particular integrals. Applications of first order differential equations in growth and decay of populations, simple models on tumor dynamics and Leslie Matrices.

Unit -II

Radioactivity and carbon dating, Newton' s law of cooling, second order differential equations, diffusion equation including Laplace, Heat and wave equations. Differential equations in epidemics and models on interaction among species like Lotka-Voltera system.

Books Recommended:

1. Zafar Ahsan, Differential Equations and their Applications, 2nd Ed., PHI, New Delhi, 2004.
2. H.T.H. Piaggo, Differential Equation, PHI New Delhi, 2004.
3. MA Khanday, Introduction to Modeling and Biomathematics, Dilpreet Publishers, New Delhi, 2016
4. Richard Courant, Edward James, McShane, Sam Sloan, Marvin Jay GReenberg, Differential and Integral Calculuss, Ishi Press, 2010.

Professor & Head
Department of Mathematics
University of Kashmir

DISCRETE MATHEMATICS

Course Code: **MM24004OE** | Total Credits: **02**
Semester: **MA/M.Sc. 4th Semester** | Total Marks: **50**
Continuous Assessment: **Marks 10**, Theory: **Marks 40** | Time Duration: **1½ hrs**

Course Objectives: To introduce the student to various concepts of Boolean Algebra and Lattices to be applied in day to day problems related to networking structure, transportation etc.

Course Outcome: The students shall be able to use Lattices, ordered relations, Boolean algebra and their properties in information technology and other physical phenomena.

Unit-I

Lattices: Set operations, product sets, equivalence relations, relation and ordering, partially ordered sets, chain or completely ordered sets, lattices properties, lattices and algebraic systems, sub-lattices, direct product and homomorphism, modular lattices, complete lattices, distributive lattices, complemented lattices.

Unit-II

Boolean Algebra: Introduction, binary operations, algebraic structure, Boolean algebra, general properties of Boolean algebra, Boolean expressions, principle of Duality, Boolean algebra as a lattice, sub-Boolean algebra, direct product and homomorphism, representation theorem.

Recommended Books:

1. Schaum's Outlines, Discrete Mathematics, Ind. Edition Tata McGraw-Hill Publishing Company Ltd. New Delhi, 1976.
2. Harish Mittal, Vinay K.Goyal, Deepak K. Goyal, I. K, A Text Book of Discrete Mathematics, Int. Publishing House Pvt. Ltd (2010).
3. Kolman, Busby, Discrete Mathematical Structures, Pross. Sixth Edition, PHI Laming Pvt. Ltd. (2010).
4. Richard Johnsonbaugh, Discrete Mathematics, sixth edition, Pearson Prentice Hall (2007).

Professor & Head
Department of Mathematics
University of Kashmir