Math 101 **ADVANCED ABSTRACT ALGEBRA**

Unit-I

Double cosets, Conjugate groups, Normal and Subnormal series, Composition series, Jordan Holder theorem, Solvable Groups, Nilpotent Groups.

Unit-II

Vector Space, Subspace, Basis, Dimension, Linear Transformation, Algebra of Linear Transformation, Matrix Representation of Linear Transformation, Characteristic and Minimal Polynomial of Linear Transformation, Diagonalizable Linear Operators, Primary Decomposition Theorem.

Unit-III

Canonical forms, Similarity of Linear Transformations, Invariant Subspaces, Nilpotent transformations, Reduction of triangular form, Invariants, Jordon blocks & Jordon normal forms, Bilinear forms, Quadratic forms.

Unit-IV

Field theory, Extension fields, Roots of polynomials, Algebraic and transcendental extensions, Algebraically closed fields, Splitting fields, Normal extensions, Simple extension, Separable and inseparable extensions, Perfect fields, Finite fields, Primitive elements.

Unit-V

Elements of Galois Theory, Group of automorphisms, Fixed Fields, Galois group, Fundamental theorem of Galois theory, Fundamental theorem of Algebra.

Following topics will be covered through e – learning mode :

Unit-I : Double Cosets, Conjugate Groups
Unit-II : Vector Space, Subspace, Basis, Dimension, Linear Transformation, Algebra of Linear Transformation
Unit-III : Canonical forms, Similarity of Linear Transformations, Invariant Subspaces
Unit-IV : Field theory, Extension fields, Algebraic Extensions
Unit-V : Elements of Galois Theory, Fixed Fields, Normal extensions, Group of automorphisms

Text Books

1. Topics in Algebra by I.N. Herstein, Wiley Eastern Ltd., New Delhi, 1975.
2. Contemporary Abstract Algebra by Joseph A. Gallian, Thomson Press (India) Ltd.
3. Algebra by M. Artin, Prentice-Hall of India1991.
4. Linear algebra by Stephen H. Friedberg, Prentice-Hall of India.

Reference Books

1. Algebra by P.M. Cohn, Vols. I, II & III, John Wiley & Sons, 1982,1989,1991.
2. A Course in Abrstract Algebra by Vijay K Khanna & S K Bhambri,Vikas Publishing House Pvt.Ltd.

Math 102 **ANALYSIS**

Unit-I
Definition and examples of metric spaces. Neighbourhoods, Limit points, lnterior points, Open and closed sets, Closure and interior of a set, Boundary points, Subspace of metric space, Dense subsets. Baire Category theorem, Separable, first countable and second countable spaces.

Unit-II
Metric spaces: compact sets, perfect sets, connected sets, compactness and completeness, Cantor's intersection theorem, Contraction principle, Real number as a complete ordered field, limit and continuity of function defined on metric spaces, limits of functions, continuous functions.

Unit–III
Continuity and Compactness, continuity and connectedness, monotonic functions: definition and existence of Riemann – Stieltjes integral, properties of the integral, integration and differentiation, the fundamental theorem of calculus, integration of vector-valued functions.

Unit-IV
Sequence & Series of function point wise & uniform Convergence, Cauchy Criterion for uniform Convergence, Weierstrass M-Test for uniform Convergence of Series, Uniform Convergence & Continuity, Uniform Convergence & R-S integral, Uniform Convergence & differentiation, Weierstrass approximation Theorem.

Unit-V
Lebesgue outer measure, Measurable sets & its properties, Borel set & their measurability, Non-measurable set, measurable functions, characteristic function & simple function, Littlewood's three Principles.

Following topics will be covered through e – learning mode:

Unit-I: Definition and examples of Metric Spaces
Unit-II: Compact sets, perfect sets, connected sets
Unit-III: Definition and existence of Riemann – Stieltjes integral, properties of the integral
Unit-IV: Sequence & Series of function point wise & uniform Convergence
Unit-V: Lebesgue outer measure, Measurable sets & its properties

Text Books

1. Principles of Mathematical Analysis by Walter Rudin.
2. Real Analysis (UNIT IV & V) by H. L. Royden.

Reference Books

1. Mathematical Analysis by Malik & Arora, New Age International Publisher.
2. Lebsegue Measure & Integration by Jain & Gupta, New Age International Publishers.

Math 103 **INTEGRAL TRANSFORMS**

Unit-I

Laplace Transform, Properties of Laplace Transform, Laplace Transform of the derivatives of function, Inverse Laplace transform, Properties of inverse Laplace transform, Inverse Laplace transform of derivatives, convolution theorem, Heaviside's expansion theorem.

Unit-II

Application of Laplace Transform to solution of differential equations; solutions of initial Value problems, Solution of differential equations with constant coefficients, Solution of system of two simultaneous differential equations, Application of Laplace Transform to the solution of integral equations with convolution type kernel.

Unit-III

Applications of Laplace Transform to the solution of initial –boundary value problems-: Solution of Heat equation, Solution of wave equation, Solution of Laplace equation.

Unit-IV

Fourier Transforms, Fourier sine transform, Fourier cosine transform, inverse Fourier Transform, Inverse Fourier sine Transform, Inverse Fourier cosine Transform, Properties of Fourier Transforms, Modulation theorem, Convolution theorem, Fourier Transform of the derivatives of functions, Parseval's identity.

Unit-V

Application of Fourier Transforms to the solution of initial –boundary value problems-: Solution of Heat equation, Solution of diffusion equation, Solution of wave equation, Solution of Laplace equation.

Following topics will be covered through e – learning mode:

Unit-I: Laplace Transform, Properties of Laplace Transform, Inverse Laplace transform, Properties of inverse Laplace transform
Unit-II: Application of Laplace Transform to solution of differential equations; solutions of initial Value problems
Unit-III: Solution of Heat equation, Solution of wave equation, Solution of Laplace equation.
Unit-IV: Fourier Transforms, Fourier sine transform, Fourier cosine transform
Unit-V: Solution of Heat equation, Solution of diffusion equation, Solution of wave equation.

Text Books

1. Integral Transforms by Vashishtha and Gupta.
2. Integral Transforms by Goyal and Gupta.

Reference Books

1. Integral Transforms by Sneddon.

Math 104 COMPUTER FUNDAMENTALS AND PROGRAMMING IN C

UNIT-1

An overview of functioning of a computer system, Components of a computer system, I/O and auxiliary storage devices ,machine and high level languages, assembler ,compiler and interpreters, flow charts and pseudo codes, Basic concepts of operating system.

Unit-II

Introduction to C Essentials – Programs development, Functions. Anatomy of a Function. Variables and Constants Expressions. Assignment Statements, Scalar Data types – Declarations, Different Types of integers. Different kinds of Integer Constants Floating – point type Initialization, mixing types Explicit conversions – casts Enumeration Types. the void data type, Type definitions.

Unit-III

Operators and expression in C-Precedence and associativity, Control flow statements Conditional branching, the switch statement, looping, nested loops, the break and continue statement, the go to statement, infinite loops.

Unit-IV

Arrays and multidimensional arrays. Storage classes-fixed vs. automatic duration scope, global variable the register specifier, Functions –user defined and library function, Introduction to pointers, structures and unions.

Unit-V

Introduction to C++: Declaration & Definition of Variables, Data Types, Operators, OOPS Fundamentals: OOPS Versus procedural programming, OOPS terminology, Data abstraction, Data hiding, Encapsulation, Class, Object, Inheritance, Polymorphism.

Following topics will be covered through e – learning mode :

Unit-I: An overview of functioning of a computer system, Components of a computer system
Unit-II: Introduction to C Essentials – Programs development, Functions. Anatomy of a Function, Variables and Constants Expressions. Assignment Statements
Unit-III: Conditional branching, the switch statement, looping, nested loops
Unit-IV: Arrays and multidimensional arrays, Functions –user defined and library function
Unit-V: Declaration & Definition of Variables, Data Types, Operators, OOPS Fundamentals

Text books:

1. Computer fundamental by Rajaraman
2. Operating systems concepts by Peterson
3. Programming in ANSI C by E. Balaguruswamy, Tata-McGraw Hill, New Delhi.
4. Programming in C++ by E. Balaguruswamy, Tata-McGraw Hill, New Delhi.
5. Schaum's outline series.

Reference Books:

1 Let us C by Y. Kanetkar.
2 Brain W Kernigham & Dennis M Ritchie the C Programmed language 2nd edition (ANSI features), Prentice Hall 1989.

Math 201 **COMPLEX ANALYSIS**

Unit-I

Functions of Complex Variables, Limit and Continuity Differentiability, Power Series as an Analytic Function, Exponential and Trigonometric Functions, Complex Logarithms, Zeros of Analytic Functions.

Unit-II

Complex Integration, Curves in the Complex Plane, Basic Properties of Complex Integral, Winding Number of a Curve, Cauchy – Goursat Theorem, Cauchy's Integral formula, Morera's Theorem, Laurent's Series.

Unit-III

Maximum Modulus Principle, Schwarz Lemma, Bilinear Transformations, Mobius Transformation, Cross Ratio, Fixed Point, Conformal Mapping Liouville's theorem

Unit-IV

Isolated and Non-isolated Singularities, Removable Singularty, Poles, Singularty at Infinity , Calculus of Residues, Residue at Finite Point, Residue at the Point at Infinity, Residue Theorem, Number of Zeros and Poles, Rouche's Theorem, Hurwitz's Theorem.

Unit-V

Evaluation of certain Integrals, Integrals of Type $\int_{\alpha}^{2\pi+\alpha} R(\cos\theta, \sin\theta)d\theta,$ Integrals of Type $\int_{-\infty}^{\infty} f(x)dx,$ Integrals of Type $\int_{-\infty}^{\infty} g(x)\cos mx\, dx,$ Singularities on Real Axis

Following topics will be covered through e – learning mode:

Unit-I: Functions of Complex Variables, Limit and Continuity Differentiability
Unit-II: Curves in the Complex Plane, Basic Properties of Complex Integral, Winding Numberof a Curve
Unit-III: Mobius Transformation, Cross Ratio, Fixed Point, Conformal Mapping
Unit-IV: Isolated and Non-isolated Singularities, Removable Singularty, Poles
Unit-V: Evaluation of certain Integrals, Singularities on Real Axis

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Text Book:

1. Foundation of Complex Analysis by S. Ponnusamy, Narosa Publishing House, 1997.

Reference Books:

1. Introduction to Complex Analysis by H.A. Priestly, Clarendon Press, Oxford, 1990.
2. Function of one Complex Variable by J.B. Conway, Springer-Verlag. International student-Edition, Narosa Publishing House, 1980.
3. Complex Analysis by L.V. Ahlfors, McGraw-Hill, 1979.
4. Real and Complex Analysis by Walter Rudin, McGraw-Hill Book Co., 1966

Math 202 **DIFFERENTIAL EQUATIONS**

Unit-I

Preliminaries-Initial value problem and the equivalent integral equation, System of first order ordinary differential equations, concepts of local existence, Existence and uniqueness of solutions of scalar differential Equations, Peano's existence theorem and corollary for scalar case, system of differential Equations, Ascoli-Arzela theorem (Statement only) , Picard-Lindelof theorem, Peano's existence theorem and corollary for vector case.

Unit- II

Differential Inequalities and integral inequalities –Gronwall's inequality, Maximal and Minimal solutions, differential inequalities, Lower and upper function.

Unit- III

Linear systems of differential equation, characteristic polynomials eigen values, eigen vectors, linear homogenous systems and their properties, wronskian, fundamental matrix, Abel-Liouville formula, periodic linear system and Floquet's theorem, Inhomogeous linear systems and variation of constants formula.

Unit- IV

Poincare- Bendixson Theory –Autonomous systems, Poincare-Bendixson theorem (statement only), Stability of periodic solutions, foci, nodes and saddle points. Automomous system of ordinary differential equations, Phase Plane, critical points, Stability, Critical Points and Stability of linear systems, Stability by Lyapunov's direct method, Lyapunov functions.

Unit-V

Bifurcation of Fixed Points of Ordinary differential Equation, A Zero Eigenvalue; Examples, What is a "Bifurcation of a Fixed Point", The saddle –Node Bifurcation, The Transcritical Bifurcation, The Pitchfork Bifurcation, A Pure Imaginary Pair of eigenvalues, The Poincare- Andronov –Hopf Bifurcation.

Following topics will be covered through e – learning mode:

Unit-I: Preliminaries-Initial value problem and the equivalent integral equation, System of first order ordinary differential equations, concepts of local existence

Unit-II: Differential Inequalities and integral inequalities

Unit-III: characteristic polynomials eigen values, eigen vectors, linear homogenous systems

Unit-IV: Stability of periodic solutions, foci, nodes and saddle points

Unit-V: Bifurcation of Fixed Points of Ordinary differential Equation, A Zero Eigenvalue, Examples

Text Book:

1. Ordinary Differential Equations by M.Rama Mohan Rao, East-West Press.
2. Introduction to Applied Nonlinear Dynamical Systems and chaos by Stephen Wiggins, Springer, New York.

Reference Books:

1. Ordinary Differential Equations by P. Hartman, John wiley.
2. Theory of Ordinary Differential Equations by E.A.Coddington and DSN, Levinson, McGraw Hill, NY.
3. Differential Equations with Applications and Historical note by G.F.Simmons, Tata McGraw Hill.
4. Ordinary Differentions by W.T. Reid, John Wiley & Sons, NY.
5. Differential Equations and Dynamical Systems, by Lawrence Perko, Springer, Newyork.

Math 203 TOPOLOGY

Unit-I

Topological Spaces: Definition and examples, Open Sets, Closed Sets, Closure neighborhoods, Interior, exterior and boundary, Limit points and derived sets, Basis and Sub basis, Alternate method of defining a topology in terms of Kuratowski Closure operator.

Unit-II

Continuous functions and homeomorphism, Countability, First and Second countable Spaces, Lindelof theorem, Separable Spaces, Second countability and Separability, The product and box topology.

Unit-III

Connected Spaces, Connected Sets in the real line, Components, Path components, local connectedness, Path connectedness, Local Path connectedness.

Unit-IV

Compact Spaces, Lebesgue number lemma, Uniform continuity theorem, Limit point compactness, Local compactness and sequential compactness, One point compactification.

Unit-V

Separation axioms, Hausdroff, Regular and Normal Spaces, The Urysohn lemma, Tietze extension theorem, The Uryshon metrization theorem, Completely regular spaces.

Following topics will be covered through e – learning mode:

Unit-I: Topological Spaces: Definition and examples, Open Sets, Closed Sets, Closure neighborhoods
Unit-II: Countability, First and Second countable Spaces
Unit-III: Connected Spaces, Connected Sets in the real line, Components
Unit-IV: Compact Spaces, Lebesgue number lemma, Uniform continuity theorem
Unit-V: Separation axioms, Hausdroff, Regular and Normal Spaces

Text Books

1. Topology A first course by James R Munkres, Prentice Hall of India, Pvt. Ltd. New Delhi 2000.
2. Introduction to Topology and Modern Analysis by G.F. Simmons, McGraw Hill Book Co.

Reference Books

1. General Topology by J.L. Kelley, Van Nostrand, Reinhold Co. New York.

Math 204 **NUMERICAL METHODS**

Unit-I
Solution of Algebraic Transcendental & 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.

Unit-II
System of linear algebraic equations: Gauss Elimination method, Gauss-Jordan Elimination method, Cholesky method. Iteration methods: Jacobi Iteration method, Gauss-Seidel method.

Unit-III
Interpolation & approximation finite difference operators, Newton's forward and backward interpolation, Central difference interpolation, Lagrange's interpolation, Newton Divided Difference interpolation, Hermite interpolation, Spline interpolation.

Unit-IV
Differentiation and integration: Numerical differentiation, Numerical integration, Newton-cotes formula, Trapezoidal rule, Simpson's one-third rule, Gauss-Legendre integration method, Lobatto integration method, Radau integration method.

Unit-V
Ordinary differential equations- Euler method, Backward Euler method, Midpoint method, Taylor Series method, Runge-Kutta methods, Predictor-Corrector methods.

Following topics will be covered through e – learning mode:

Unit-I: Solution of Algebraic Transcendental & Polynomial equations: Bisection method, Iteration method based on first-degree equation: Secant method
Unit-II: Gauss Elimination method, Gauss-Jordan Elimination method
Unit-III: Interpolation & approximation finite difference operators, Newton's forward and backward interpolation
Unit-IV: Numerical differentiation, Numerical integration
Unit-V: Ordinary differential equations- Euler method, Backward Euler method

Text Books:

1. Numerical method for Scientific & Engineering Computation by M.K. Jain & R. K. Iyengar & R.K. Jain-Wiley Eastern Ltd.
2. Numerical Method by S S Sastry.

Reference Book:

1. Numerical Methods by V.RajaRaman, PHI.

Math 301 **FUNCTIONAL ANALYSIS**

Unit-I
Normed linear spaces, Banach spaces and examples, quotient space of normed linear spaces and its completeness, convex sets and convex functional, lower semi-continuous and upper semi-continuous functions.

Unit-II
Equivalent norms, Riesz lemma, basic properties of finite dimensional normed linear spaces and compactness. Normed linear spaces of bounded linear transformations, dual spaces with examples.

Unit-III
Uniform boundedness theorem and some of its consequences, Open mapping and closed graph theorems, Hahn-Banach theorem for real linear spaces and complex linear spaces.

Unit-IV
Reflexive spaces, Reflexivity of Hilbert spaces, Inner product spaces, Hilbert spaces, Orthonormal sets, Bessel's inequality, Complete orthonormal sets and Parseval's identity, Structure of Hilbert Spaces, Projection theorem.

Unit-V
Riesz representation theorem, Adjoint of an operator on a Hilbert space, Self- adjoint operators, Positive, Projection, normal and unitary operators, Introduction to Sobolev spaces, Fundamental theorem of variational calculus, bilinear forms

Following topics will be covered through e – learning mode:

Unit-I: Normed linear spaces, Banach spaces and examples
Unit-II: basic properties of finite dimensional normed linear spaces and compactness
Unit-III: Uniform boundedness theorem and some of its consequences
Unit-IV: Inner product spaces, Hilbert spaces, Orthonormal sets, Bessel's inequality
Unit-V: Adjoint of an operator on a Hilbert space, Self- adjoint operators, Positive, Projection, normal and unitary operators

Text Books:

1. Functional Analysis with Applications by A. H. Siddique, Tata McGraw Hill Publishing Company Ltd. New Delhi.
2. Introductory Functional analysis with Applications by Kreyszig, John Wiley and Sons, New York.

Reference Books:

1. Real Analysis by H.L. Royden, Macmillan Publishing Co. Inc., New York, 4th Edition, 1993.
2. Functional Analysis by B.V. Limaye, Wiley Eastern Ltd.

Math 302 INTEGRAL EQUATIONS AND BOUNDARY VALUE PROBLEMS

Unit-I

Definitions of integral equations and their classification, solution of integral equation, Fredholm integral equations of second kind with separable kernels, solution of Fredholm integral equation with separable kernel, method of successive approximations.

Unit-II

Method of successive substitutions, Iterative scheme for Fredholm integral equations of the second kind, resolvent kernel and its results, application of iterative scheme to Volterra integral equations of the second kind.

Unit-III

Conversion of initial value problem to volterra integral equation and conversion of boundary value problem to Fredholm integral equation, Conversion of Fredholm integral equation to boundary value problems and conversion of Volterra integral equation to initial value problem.

Unit-IV

Orthonormal system of functions, symmetric kernels, fundamental properties of Eigen values and Eigen functions Green's function, for symmetric kernels, Hilbert Schmidt theory and solutions of Fredholm integral equations with symmetric kernels.

Unit-V

Definition of a boundary value problem for an ordinary differential equation of the second order, Dirac delta function, Green's function, Green's function approach to reduce boundary value problems of a differential equation with homogeneous boundary conditions to integral equations.

Following topics will be covered through e – learning mode:

Unit-I: Definitions of integral equations and their classification, solution of integral equation
Unit-II: Method of successive substitutions, resolvent kernel and its results
Unit-III: Conversion of initial value problem to volterra integral equation and conversion of boundary value problem to Fredholm integral equation
Unit-IV: Orthonormal system of functions, symmetric kernels
Unit-V: Dirac delta function, Green's function

Text Books:

1. Linear Integral Equation Theory and Techniques by R.P. Kanwal, Academic Press, New York, 1971.
2. Linear Integral Equation (translated from Russian) by S.G. Mikhlin, Hindustan book Agency, 1960.

Reference Book:

1. Boundary value problems of Mathematical Physics by I. Stakgold, Vol.I, II, Mac Millan, 1969.

Math 303 **OPERATIONS RESEARCH**

Unit-I

Introduction, Nature and Meaning of O.R. Modelling in operations Research, Features of Operation research, scope of operations research Linear Programming Problem: formulation of L.P.P. solution of L.P.P. Graphical Method, Simplex Methods in Duality, Integer Programming.

Unit-II

Assignment problems: Mathematical formulation, reduction theorem, unbalanced assignment problem, Transportation problem formulation, basic feasible solution – North-West-corner method, Least cost method, Vogel's Approximation method, Optimum solution: MODI method.

Unit-III

Job sequencing: Processing n jobs through 2 machines, Processing n jobs through 3 machines, Processing 2 Jobs through m machines, Replacement problems: Replacement policy for items whose maintenance cost increase with time and money value is constant, Money value changes with constant rate.

Unit-IV

Project management: Introduction, network diagram representation, time estimates and critical path with saddle point, rectangular game with out saddle point, Principle of dominance, Graphical method.

Unit-V

Queuing Theory: Introduction, queuing system, Transient and steady traffic inlets, Distribution of arrival distribution of departure, M/M/I: ∞/ FCFS model, nonlinear programming: Kuhn-Tucker conditions.

Following topics will be covered through e – learning mode:

Unit-I: Introduction, Nature and Meaning of O.R. Modelling in operations Research, Features of Operation research
Unit-II: Assignment problems, reduction theorem, unbalanced assignment problem
Unit-III: Job sequencing, Replacement problems
Unit-IV: Project management: Introduction, network diagram representation
Unit-V: Queuing Theory: Introduction, queuing system, Transient and steady traffic inlets

Text Books:

1. Linear Programming by G. Hadley, Narosa Publishing House, 1995.
2. Operations Research by S.D. Sharma.

Reference Books:

1. Introduction to Operations Research (Sixth Edition) by F.S. Hillier and G.J. Lieberman Mc Graw Hill International Edition, Industrial Engineering Series, 1995.
2. Operations Research by R.K. Gupta.

Math 304 **MATHEMATICAL BIOLOGY**

Unit-I

Continuous Growth Models, Delay Models, Linear Analysis of Delay Population Models, Harvesting a Single Natural population, population Model with Age Structure, Fishery Management model.

Unit-II

Predator- Prey models, Lotka- Volterra Systems, Competition Models, Principle of competitive exclusion, Mutualism or Symbiosis, Stability analysis of Predator- Prey Models, Stability – Analysis of Competition Models.

Unit-III

Epidemic models and the dynamics of infectious diseases: Simple epidemic models, SIS, SIR and SIRS Epidemic Models, Modelling Venereal Diseases, Multi- group Model for Gonorrhea, AIDS: Modelling the Transmission Dynamics of HIV.

Unit-IV

Introduction to Compartment models, Discrete and continuous transfers, Discrete population Models for a single species, Discrete logistic model, Discrete delay models for single species, solution by eigen value analysis

Unit-V

Introduction to tracer methods in physiology, Bath-tub models, Continuous infusion into a compartment, Elementary pharmacokinetics, Parameter Estimation in Two-Compartment models, The homogeneous and Non-homogeneous cases.

Following topics will be covered through e – learning mode:

Unit-I: Continuous Growth Models, Delay Models, Linear Analysis of Delay Population Models
Unit-II: Predator- Prey models, Lotka- Volterra Systems, Competition Models
Unit-III: Epidemic models and the dynamics of infectious diseases: Simple epidemic models
Unit-IV: Introduction to Compartment models, Discrete and continuous transfers
Unit-V: Introduction to tracer methods in physiology, Bath-tub models, Elementary pharmacokinetics

Text Books:

1. Mathematical Biology (Biomathematics, Volume 19) by J.D. Murray, Springer Verlag.
2. Linear Models in Biology by M.R. Cullen, Ellis Horwood Ltd.

Reference Books:

1. Mathematical Models in Biology and Medicines by J.N. Kapur.
2. Introduction to Mathematical Biology by S.I. Rubinow, John Wiley & Sons. 1975.

Math 305 **ADVANCED NUMERICAL METHODS**

Unit-I

Introduction, difference calculus, difference operator, linear difference equations, first order equations, general results for linear equations, equations with constant coefficients, equations with variable coefficients.

Unit-II

Classification of partial differential equations, Dirichlet's problem, Cauchy's problem, Finite difference approximations to partial derivatives, Elliptic equation, Numerical solutions of Laplace and Poisson equations, Solution to elliptic equations by relaxation method, solution by Laplace equation by Alternating Direction Implicit (ADI) method.

Unit-III

Parabolic equations, Numerical solution of one dimensional diffusion & heat equations, Schmidt method, Crank-Nicholson method, Iterative methods-Dufort and Frankel method.

Unit-IV

Hyperbolic equations, the one dimensional wave equation, Numerical solutions of one-dimensional wave equation, Numerical solution of one dimensional wave equation by difference schemes, central-difference schemes, D'Alembert solution.

Unit-V

Variational finite element method with application to one-dimensional problem, solution of time dependent problems in one dimension and two dimension & steady state problems using Ritz's method.

Following topics will be covered through e – learning mode:

Unit-I: Introduction, difference calculus, difference operator, linear difference equations
Unit-II: Classification of partial differential equations, Dirichlet's problem, Cauchy's problem
Unit-III: Parabolic equations, Schmidt method, Crank-Nicholson method
Unit-IV: Hyperbolic equations, the one dimensional wave equation
Unit-V: Variational finite element method with application to one-dimensional problem

Text Books:

1. Difference Equation-An Introduction with Applications by Walter G. Kelley and Allan C. Peterson, Academic Press Inc., Harcourt Brace Joranovich Publishers, 1991.
2. Numerical Solution of Differential Equations by M.K.Jain, New Age International (P) Limited, Publishers.

Reference Book:

1. Applied Numerical Analysis by Gerald & Wheatley, Pearson Education.

Math 401 **PARTIAL DIFFERENTIAL EQUATIONS**

Unit-1: Methods of solution of dx/P=dy/Q=dz/R where P, Q, R, are given functions of x, y, and z, Partial Differential Equations and solution of Partial differential equation in three variables. Partial Differential Equations of the First order, Linear Equations of the First-Order, Integral Surfaces passing through a given curve, Surfaces Orthogonal to a given system of Surfaces, Lagrange's equation, nonlinear partial Differential Equations of the first order, cauchy's Method of characteristics, compatible systems of first-order Equations, Charpit's Method, Special Types of first-order Equations.

Unit-2: Introduction, Classification of Second Order Partial Differential Equations (PDE), Canonical Forms, Boundary Value Problems (BVPs), Propeties of Harmonic functions, Separation of Variables method.

Unit-3: Elliptic Differential Equations, Laplace Equation, Poisson Equation, Dirichlet Problem for a Rectangle, Neumann problem for a rectangle, Interior Dirichlet Problem for a Circle, Exterior Dirichlet Problem for a Circle, Interior Neumann Problem for a Circle, Solution of Laplace Equation in Cylindrical Coordinates, Solution of Laplace Equation in Spherical coordinates.

Unit-4: Parabolic Differential Equations, Diffusion Equations, Heat Equation, Occurrence of Diffusion Equation, Boundary Conditions, Elementary Solution of the Diffusion Equation, Dirac Delta Function, Separation of Variables Method, Solution of Diffusion Equation in Cylindrical Coordinates, Solution of Diffusion Equation in Spherical Coordinates.

Unit-5: Hyperbolic Differential Equations, Wave Equation, Occurrence of the Wave Equation, Solution of One-Dimensional Wave Equation by Canonical Reduction, The Initial Value Problem, D'Alemberts Solution, Vibrating String-Variables Separable Solution, Forced Vibrations-Solution of Nonhomogeneous Equation.

Following topics will be covered through e – learning mode:
Unit-I: Partial Differential Equations of the First order, Linear Equations of the First-Order, Integral Surfaces passing through a given curve
Unit-II: Introduction, Classification of Second Order Partial Differential Equations (PDE)
Unit-III: Elliptic Differential Equations, Laplace Equation, Poisson Equation
Unit-IV: Parabolic Differential Equations, Diffusion Equations, Heat Equation
Unit-V: Hyperbolic Differential Equations, Wave Equation, Occurrence of the Wave Equation

Text Books:
1. Introduction to Partial Differential Equations by K.Sankara Rao, PHI
2. Elements of Partial Differential Equations by IAN N. SNEDDON Mc GRAW-HILL Book Company.

Math 402 **WAVELETS**

Unit-I

Haar's simple wavelets, Haar wavelet transforms, Inverse Haar wavelet transforms, Multi dimensional wavelets, Two-dimensional Haar wavelets.

Unit-II

Application of wavelets, Noise reduction, data compression, Edge detection, Daubechies wavelet (DW), approximation of samples with D' wavelets, Fast DW transform and its inverse.

Unit-III

Inner products and orthogonal projection, Applications of orthogonal projection computer graphics, Computation of functions and wavelets, Discrete and fast Fourier transform with inverse and applications.

Unit-IV

Fourier series for periodic functions, its convergence and inversion, uniform convergence of Fourier series, Bessel's inequality, Parsevals inequality.

Unit-V

The Fourier Transform, Convolution and inversion of Fourier transform, weight function, approximate identities.

Following topics will be covered through e – learning mode:

Unit-I: Haar's simple wavelets, Haar wavelet transforms
Unit-II: Application of wavelets, Noise reduction, data compression, Edge detection
Unit-III: Applications of orthogonal projection computer graphics, Computation of functions and wavelets
Unit-IV: Bessel's inequality, Parsevals inequality
Unit-V: The Fourier Transform

Text Books:

1. Wavelets Made Easy by Y. Nievergelt.
2. A first Course on Wavelets by E. Hernandez and G. Weiss.

Reference Book:

1. An Introduction to Wavelets by Chui, Academic Press.

Math 403 **MATHEMATICS OF FINANCE AND INSURANCE**

Unit-I

Elements of Theory of Interest, Cash Flow Valuation, Annuities, Amortization and Sinking Funds, Brief Review of Probability Theory.

Unit-II

Survival Distributions, Life Tables, Valuing Contingent Payments, Life Insurance, Life annuities, Net Premiums, Insurance Models including Expenses.

Unit-III

A Brief Introduction to Financial Markets, Basics of Securities, Stocks, Bonds and Financial Derivatives, Viz Forwards, Futures, Options and Swaps.

Unit-IV

An Introduction to Stochastic Calculus, Stochastic Process, Geometric Brownian motion, Stochastic Integration and Ito's Lemma.

Unit-V

Option Pricing Models -Binomial Model and Black Scholes Option Pricing Model for European Options, Black Scholes Formula and Computation of Greeks.

Following topics will be covered through e – learning mode:

Unit-I: Elements of Theory of Interest, Cash Flow Valuation, Annuities
Unit-II: Survival Distributions, Life Tables, Valuing Contingent Payments
Unit-III: A Brief Introduction to Financial Markets, Basics of Securities, Stocks
Unit-IV: An Introduction to Stochastic Calculus, Stochastic Process
Unit-V: Option Pricing Models -Binomial Model and Black Scholes Option Pricing Model

Text Books:

1. Options, Futures and other Derivatives by John C. Hull, Prentice-Hall of India Pvt. Ltd.
2. An introduction to Mathematical Finance by Sheldon M. Ross, Cambridge University Press.

Reference Books:

1. An Introduction to Mathematics of Financial Derivatives by Salih N. Neftci, Academic Press, Inc.
2. Mathematics of Financial Markets by Robert J. Elliot & P. E. Kopp Springerverlag, New York Inc.

Math 404 **ADVANCED MATHEMATICAL STATISTICS**

Unit-I

Definitions of central tendencies, Measure of dispersions with variance in detail, Method of least square for curve fitting, correlation and regression.

Unit-II

Theory of probability & distributions: various definitions, additive & multiplicative law, Bayes' theorem. Continuous variable, Mathematical expectation, Binomial, Poisson, Normal distribution, Rectangular distribution, Exponential distribution, Moment generation function, marginal & conditional probability distributions & conditional expectation.

Unit-III

Theory of estimators: Unbiasedness, consistency, efficiency, sufficiency, maximum likelihood estimators, Cramer-Rao inequality and its applications confidence intervals with respect to normal distributions.

Unit-IV

Exact sampling distributions & tests- φ^2, t, F, Z distributions & tests, Non-parametric tests: Sign test, Wilcoxon's signed rank sum test, Medial test, Mann Whitney U-test and run test for randomness.

Unit-V

Analysis of variance: one way & two-way classifications. Basic principles of design: Replication, randomization, local control, lay out and analysis of completely randomized, randomized block & latin square design, missing plot techniques in randomized block & latin square design.

Following topics will be covered through e – learning mode:

Unit-I: Definitions of central tendencies, Measure of dispersions with variance in detail

Unit-II: Theory of probability & distributions: various definitions, additive & multiplicative law, Bayes' theorem

Unit-III: Theory of estimators: Unbiasedness, consistency, efficiency, sufficiency

Unit-IV: Non-parametric tests: Sign test, Wilcoxon's signed rank sum test, Medial test, Mann Whitney U-test

Unit-V: Analysis of variance: one way & two-way classifications

Text Books:

1. Mathematical Statistics by C.E. Weatherburn.
2. Fundamentals of Mathematical Statistics by S C Gupta and V K Kapoor- S. Chand & Sons, New Delhi.
3. Fundamentals of Applied Statistics by S C Gupta and V K Kapoor, S Chand & Sons, New Delhi.

Reference Books:

1. An outline of Statistical Theory by Goon, Gupta and Dasgupta.
2. Fundamentals of Statistics by Goon, Gupta Dasgupta.

Math 405 **DISCRETE MATHEMATICAL STRUCTURES**

Unit-I: Lattice-Definition & examples, Distributive lattice, modular lattice, Bounded lattice, complemented lattice, Boolean lattice, Sublattice. Boolean algebra- Definition & examples, Basic Boolean algebra laws Principle of duality, Applications of Boolean algebra, Boolean functions, Disjunctive & Conjunctive normal forms, Switching circuits, Minimization of switches.

Unit-II: Mathematical Induction, Recursion, Recursion and iteration, closed form expression, sequence of integers, Recurrence relation, linear recurrence relation, Homogeneous recurrence, Recurrence relations obtained from solutions, Solving linear homogeneous recurrence relation, solving linear non-homogeneous recurrence relations, Generating functions, solution of recurrence relation using generating functions.

Unit III: Fuzzy Sets- Basic Definitions, A-level sets convex fuzzy sets, Basic operations on fuzzy sets, Types of fuzzy sets, Cartesian products, Algebraic products, Bounded sum and difference.

Unit IV: Fuzzy Relation and Fuzzy Graphs-Fuzzy relation on Fuzzy sets, Composition of fuzzy relation, Min-Max composition and its properties Fuzzy equivalence relation, fuzzy compatibility relation, fuzzy relation equations, fuzzy graphs, Similarity relation.

Unit V: Graph: Definitions, Walls, Paths, Circuits, Connectivity, Components, Graphs operations, cuts, labeled Graphs, Isomorphism, Trees, Forests, Spanning Trees, Fundamental circuits and Fundamental cutsets, Directed Graphs, Definition Direct trees, Acyclic Directed Graphs, Matrix representation of Graphs, cut matrix, circuit matrix.

Following topics will be covered through e – learning mode:

Unit-I: Lattice-Definition & examples, Distributive lattice, modular lattice, Bounded lattice

Unit-II: Mathematical Induction, Recursion, Recursion and iteration, closed form expression

Unit-III: Fuzzy Sets, Basic operations on fuzzy sets, Types of fuzzy sets, Cartesian products

Unit-IV: fuzzy compatibility relation, fuzzy relation equations, fuzzy graphs, Similarity relation

Unit-V: Graph: Definitions, Walls, Paths, Circuits, Connectivity, Components

Text Books:

1. Discrete Mathematics by N Ch. S N Iyengar, V M Chandra Sekharan, K A Venkatesh, P.S. Arunachalam- Vikas Publishing House Pvt. Ltd.
2. Set Theory-Schaum outline series.
3. Fuzzy sets and fuzzy lasic by G.J Klir and B Yuan, Prentice Hall of India New Delhi.
4. Fuzzy set theory and its Applications by H.J Zimmermann, Allied Publishers Ltd. New Delhi.
5. Graph theory with Applications to Engineering and computer Science by Nar Singh Deo Prentice Hall of India.

Reference Books:

1. Discrete Mathematics and its applications by Kenneth H. Rosen Tata McGraw Hill Pub. Ltd.
2. Discrete Mathematics for Computer Scientists by J K Truss, Pearson Education Asia Ltd.
3. Discrete Mathematical Structures with Applications by J P Tremblay, R. Manohar DataMcGraw Hill Pub. Company Ltd.

Math 406 **SPECIAL FUNCTIONS**

Unit-I

Gamma Function, Beta function, value of $\Gamma(z)\,\Gamma(1-z)$, Factorial Function, Legendre's duplication formula, Gauss multiplication theorem, Gauss hypergeometric Function ${}_2F_1$and its convergence, A simple integral form valuation of ${}_2F_1\,(a,b;c;1)$, Contiguous function relations, Hyper geometric differential equation Elementary series manipulations, Simple transformations.

Unit-II

Generalized hypergeometric function ${}_pF_q$ and its convergence, Whipple's theorem, Dixon's theorem, introduction to Barne's contour integrals.

Unit-III

Bessel function, Definition and differential equation, Generating functions, Recurrence relations, Legendre polynomials,Generating function for Legendre polynomials, Rodrigues formula, Bateman's generating function, Additional generating funtions, Hypergeometric forms, Laplace's first integral form, Orthogonality.

Unit-IV

Definitions of Hermite and Laguerre polynomials, Pure recurrence relations, Differential recurrence relations, Rodrigue's formulae, Other generating functions, Othogonalityfor Laguerre and Hermite polynomials

Unit-V

Definition of Mascrobert's E-function and its expansion in series of ${}_pF_q$, Simple identities and integrals involving E-function, Meijer's G-function, Definition and Simple properties, Simple multiplication theorems, Differential equation for G-function.

Following topics will be covered through e – learning mode:

Unit-I: Gamma Function, Beta function, Elementary series manipulations, Simple transformations

Unit-II: Generalized hypergeometric function ${}_pF_q$ and its convergence

Unit-III: Bessel function, Definition and differential equation, Generating functions

Unit-IV: Definitions of Hermite and Laguerre polynomials, Pure recurrence relations

Unit-V: Simple identities and integrals involving E-function, Meijer's G-function

Textbooks:

- Rainville, E.D ; Special Functions, The Macmillan co., New york 1971.
- Mathai and Saxena: Generalized Hypergeometric function with Application Statistics and physical Sciences, Springer Verlag, Heidelberg and New York, Lecture Notes No 348,1973
- Higher Transcendental Functions by Erdelyi, Vol.I

Reference Books:

1. Lebdev, N.N, Special Functions and Their Applications, Prentice Hall, Englewood Cliffs, New jersey, USA 1995.

2. Whittaker, E.T. and Watson, G.N., A Course of Modern Analysis Cambridge University Press, London, 1963.

School of Mathematics and Allied Sciences, Jiwaji University,Gwalior
Scheme of Examination for M.Sc. (Mathematics)-CBCS Based Course (2021-23)

Semester-I

Math 101	Advanced Abstract Algebra	(60, 40)
Math 102	Analysis	(60, 40)
Math 103	Integral Transforms	(60, 40)
Math 104	Computer Fundamentals and Programming in C	(60, 40)
Math 105	Practical lab: Practicals with programming in C	(60,40)
Math 106	Seminar	(100)
Math 107	Assignment	(100)
Math 108	Comprehensive Vive-Voce	(100)

Semester-II

Math 201	Complex Analysis	(60, 40)
Math 202	Differential Equations	(60, 40)
Math 203	Topology	(60, 40)
Math 204	Numerical Methods	(60, 40)
Math 205	Practical lab: Practicals with Programming in C++	(60,40)
Math 206	Seminar	(100)
Math 207	Assignment	(100)
Math 208	Comprehensive Vive-Voce	(100)

Semester-III

Math 301	Functional Analysis	(60, 40)
Math 302	Integral Equations and Boundary Value Problems	(60, 40)
	Any two of the following	
Math 303	Operations Research (optional)	(60, 40)
Math 304	Mathematical Biology (optional)	(60, 40)
Math 305	Advanced Numerical Methods (optional)	(60, 40)
	Dynamical System and Control (Swayam Course)	(100)
	Scientific Computing using MATLAB (Swayam Course)	(100)
Math 306	Practical lab: Practicals based on Optional papers offered by the students	(60,40)
Math 307	Seminar	(100)
Math 308	Assignment	(100)
Math 309	Comprehensive Vive-Voce	(100)

Semester-IV

Math 401	Partial Differential Equations	(60, 40)

Any three of the following

Math 402	Wavelets	(60, 40)
Math 403	Mathematics of Finance & Insurance	(60, 40)
	Mathematical Finance (Swayam Course)	(100)
Math 404	Advanced Mathematical Statistics	(60, 40)
Math 405	Discrete Mathematical Structures	(60, 40)
Math 406	Special Functions	(60, 40)
Math 407	Practical lab: Practicals based on Numerical Methods	(60, 40)
Math 408	Seminar	(100)
Math 408	Assignment	(100)
Math 409	Comprehensive Vive-Voce	(100)

School of Mathematics and Allied Sciences, Jiwaji University,Gwalior
Scheme of Examination for M.Sc. (Mathematics)-CBCS Based Course (2021-23)

M.Sc. (Mathematics)-CBCS Semester I
Session 2021-2023

Contact hours: 30 Credits=24 Marks:700

Paper Code	Course Name	Course Type	Contact Hours Per Week	Credits	Examination Scheme					
					Inter Assessment	Theory	Practical	Seminar Viva Voce	Assignment	Total
Math 101	Advanced Abstract Algebra	Core	4+2	4	40	60				100
Math 102	Analysis	Core	4+2	4	40	60				100
Math 103	Integral Transforms	Core	4+2	4	40	60				100
Math 104	Computer Fundamentals and Programming in C	Core	4+2	4	40	60				100
Math 105	Practical	Core lab	3	2	40		60			100
Math 106	Seminar and Assignment	Core	3	1+1=2				50	50	100
	Sub-Total		30	20	200	240	60	50	50	600
Math 107	Comprehensive Vive-Voce			4				100		100
Total			30	24	200	240	60	150	50	700

M.Sc. (Mathematics) Semester II
Session 2021-2023

Contact hours: 30 Credits=24 Marks:700

Paper Code	Course Name	Course Type	Contact Hours Per Week	Credits	Examination Scheme					
					Inter Asses Sment	Theory	Practical	Seminar Viva Voce	Assignment	Total
Math 201	Complex Analysis	Core	4+2	4	40	60				100
Math 202	Differential Equations	Core	4+2	4	40	60				100
Math 203	Topology	Core	4+2	4	40	60				100
Math 204	Numerical Methods	Core	4+2	4	40	60				100
Math 205	Practical	Core lab	3	2	40		60			100
Math 206	Seminar and Assignment	Core	3	1+1=2				50	50	100
	Sub-Total		30	20	200	240	100	60	50	600
Math 207	Comprehensive Vive-Voce			4				100		100
Total			30	24	200	240	60	150	50	700

M.Sc. (Mathematics) Semester III
Session 2021-2023

Contact hours: 30 Credits=24 Marks:700

Paper Code	Course Name	Course Type	Contact Hours Per Week	Credits	Examination Scheme					
					Inter Asses Sment	Theory	Practical	Seminar Viva Voce	Assignment	Total
Math 301	Functional Analysis	Core	4+2	4	40	60				100
Math 302	Integral Equations and Boundary Value Problems	Core	4+2	4	40	60				100
Math 303	Operations Research	EC/EG	4+2	4	40	60				100
Math 304	Mathematical Biology	EC	4+2	4	40	60				100
Math 305	Advanced Numerical Methods	EC	4+2	4	40	60				100
Math 306	Practical	Core lab	3	2	40		60			100
Math 307	Seminar and Assignment	Core	3	1+1=2				50	50	100
	Sub-Total		30	20	200	240	60	50	50	600
Math 308	Comprehensive Vive-Voce			4				100		100
Total			30	24	200	240	60	150	50	700

Note: Out of three Elective (Centric/generic) any two are to be Chosen

M.Sc. (Mathematics) Semester IV
Session 2021-2023

Contact hours: 30 Credits=24 Marks:700

Paper Code	Course Name	Course Type	Contact Hours Per Week	Credits	Examination Scheme					
					Inter Asses Sment	Theory	Practical	Seminar Viva Voce	Assignment	Total
Math 401	Partial Differential Equations	Core	4+2	4	40	60				100
Math 402	Wavelets	EC	4+2	4	40	60				100
Math 403	Mathematics of Finance & Insurance	EC	4+2	4	40	60				100
Math 404	Advanced Mathematical Statistics	EC/EG	4+2	4	40	60				100
Math 405	Discrete Mathematical Structures	EC	4+2	4	40	60				100
Math 406	Special Functions	EC	4+2	4	40	60				100
Math 407	Practical	Core Lab	3	2	40		60			100
Math 408	Seminar and Assignment		3	1+1=2				50	50	100
	Sub-Total	Co re	30	20	200	240	60	50	50	600
Math 409	Comprehensive Vive-Voce			4				100		100
Total			30	24	200	240	60	150	50	700

Note: Out of Five Elective (Centric/generic) any three are to be Chosen. One of The elective Papers Can also be chosen from the other generic papers offered by the faculty of science.