<u>School of Mathematics and Allied Sciences, jiwaji Unversty,Gwalior</u>
<u>Scheme of Examination for M.Sc (Mathematics)-CBCS Based Course (2020-22)</u>

Math 101   <u>**ADVANCED ABSTRACT ALGEBRA**</u>

Unit-I
Sylows First, Second and Third theorems, p-sylow Subgroups, Double cosets conjugate groups, Normal and Subnormal series, Composition series, Jordan Holder theorem, Solvable groups, and commutator subgroups.

Unit-II
Modules, Cyclic modules, Simple modules, finitely generated modules, Fundamental structure theorem for finitely generated modules,

Unit-III
Field theory, Extension fields, Algebraic Extensions, Roots of polynomials, Simple extension, Splitting fields.

Unit-IV
Elements of Galois Theory, Fixed Fields, Normal extensions, Group of automorphisms, Galois group, Fundamental theorem of Galois theory.

Unit-V
Canonical forms, Similarity of Linear Transformations, Invariant Subspaces, Nilpotent transformations, Reduction of triangular form, Invariants, Jordon blocks and Jordon normal forms.

<u>**Text Books :**</u>
1. Topics in Algebra by I.N. Herstein, Wiley Eastern Ltd., New Delhi, 1975.
2. Contemporary Abstract Algebra by Gallian Joseph A., Thomson Press (India) Ltd.
3. Algebra by M. Artin, Prentice-Hall of India1991.

<u>**Reference Books:**</u>
1. Algebra by P.M. Cohn, Vols. I, II & III, John Wiley & Sons, 1982,1989,1991.
2. Basic Algebra, Vols. I & II by N. Jacobson, W.H. Freeman, 1980 (also published by Hindustan Publishing Company).
3. Galois theoryby J.P. Escofier, GTM, Vol. 204, Springer, 2001.
4. Lectures on Modules and Rings by T.Y. Lam, GTM Vol. 189, Springer-Verlag, 1999.

Math 102   **ANALYSIS**

Unit-I

Metric spaces: compact sets, perfect sets, connected sets, compactness and completeness, limit and continuity of function defined on metric spaces, limits of functions, continuous functions.

Unit-II

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–III

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-IV

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

Unit-V

Lebesgue integral of bounded function over a set of finite measure, Integration of Non-negative function,The general Lebesgue integral, Monotonic Convergence Theorem, Lebesgue convergence Theorem, Fatou's Lemma.

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.

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   COMPUTERFUNDAMENTALS 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.

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.

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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

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-1.

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- 2

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

Unit- 3

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- 4

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 Liapunov's direct method, Lyapunov functions.

Unit-5

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.

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.

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 Book :

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.

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,

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.

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.

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.

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.

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.

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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, Pfaffian Differential Equations
and solution of Pfaffian 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.
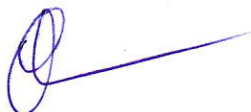
Unit-4

Parabolic Differential Equations, Diffusion Equations, Heat Equation, Occurrence of Diffusion Equation, Boundary Conditions, Elementry 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.

Books Recommended:

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.

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Math 402   ADVANCED FUNCTIONAL ANALYSIS

Unit-I

Differentiation in normed spaces, Gateaux derivative, Frechet Derivative, sub-differential, Fixed-point theorems and their applications, Banach contraction principle and its generalization, Applications of Banach contraction principle.

Unit-IIs

Definition and examples of topological vector spaces, Convex, Balanced and absorbing sets and their properties, Minkowski's functional, Subspace, Product space and quotient space of a topological vector space.

Unit-III

Finite dimensional topological vector spaces, Locally conex topological vector spaces, Normable and metrizable topological vector spaces, complete topological vector spaces.

Unit-IV

Frechet space, Uniform-boundedness principle, Open mapping theorem and closed graph theorem for Frechet spaces, Banach-Alaoglu theorem.
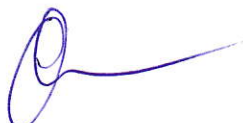
Unit-V

Variational Inequalities, Lions-Stampacchia theory, Physical phenomena represented by variational inequalities, Extreme points and Extremal sets, Krein-Milman's theorem.

Text Books:

1. Functional Analysis With Applications by A.H.Siddiqi, Tata McGraw Hill Publishing Company.
2. Linear Topological Spaces by Kelley J.L., Van Nostrand East West Press, New Delhi.

Reference Books:

1. Topological vector spaces and Distributions by John Horvath, Addison-Wesley Publishing Company, 1966.
2. Modern methods in Topological vector spaces by Albert Wilansky, McGraw-Hill, 1978.
3. Functional Analysis by K.Chandra Sekhar Rao, Narosa 2002.

Math 402   **WAVE LETS**

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.
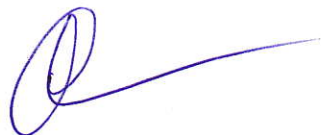
Unit-V

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

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.

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 405   **ADVANCED GRAPH THEORY**

Unit-I

Revision of graph theoretic preliminaries, Operations on graphs, Graph Isomorphism disconnected graph and their Components, Traveling salesman problem, round table problem, Konisberg Bridge problem, Eulerian and Hamiltonian Paths and circuits.

Unit-II

Properties of trees, Distance, centre, radius, diameter eccentricity and related theorems, Graph as a metric space, Rooted and binary trees, Labelled graph and trees spanning tree, weighted spanning tree, Shortest path, Fundamental circuits, Rank and nullity, cutsets and cut vertices, Fundamental cutsets.

Unit-III

Connectivity and separability in graphs, Abstract graphs, geometric graphs, planar graphs, kurtowski two graphs, Embedding and regions of a planar graphs, Detection of planarity, Geometric dual and combinational dual.

Unit-IV

Coloring and covering of graphs, Chromatic. Polynomial, chromatic partitioning, Dimmer problem, Dominating sets, Independent sets, Four colour conjecture.

Unit-V

Digraph and types of digraphs, Digraph and binary relation, Equivalence relation in a graph, Directed path, walk, circuit and connectedness, Eulerian digraph, arborescence matrices A, B and C of digraph, Adjacency metric of a digraph, Algorithms, Kruskal algorithm, Prism algorithm, Dijkastra algorithm.

Text Book:

1.   Graph Theory with Applications to Engineering and Computer Science by Narsingh. Deo.

Reference Book:

1.   Graph Theory by Harary.

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 sumtest, 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.

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 407   **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.

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 Data McGraw 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 formevaluation 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.

Books Recommended:
1. **Rainville, E.D ; Special Functions, The Macmillan co., New york 1971.**
2. **Mathai and Saxena: Generalized Hypergeometric function with Application Statistics and physical Sciences, Springer Verlag, Heidelberg and New York, Lecture Notes No 348,1973**
3. **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.**

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)
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)
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 (60, 40)
Numerical Methods

Math 408	Seminar(100)	
Math 408	Assignment	(100)
Math 409	Comprehensive Vive-Voce	(100)

School of Mathematics and Allied Sciences, jiwaji Unversty,Gwalior
Scheme of Examination for M.Sc (Mathematics)-CBCS Based Course (2020-22)

M.Sc. (Mathematics)-CBCS Semester I
Session 2019-2021

Contact hours 30   Creadits=24   Marks:700

Paper Code	Course Name	Course Type	Contact Hours Per Week	Credits	Examination Scheme					
					Inter Asses Sment	Theory	Pract ical	Seminar Viva Voce	Assign ment	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 2019-2021

Contact hours30   Creadits=24   Marks:700

Paper Code	Course Name	Course Type	Contact Hours Per Week	Credits	Examination Scheme					
					Inter Asses Sment	Theory	Pract ical	Seminar Viva Voce	Assign ment	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

School of Mathematics and Allied Sciences, jiwaji Unversty,Gwalior
Scheme of Examination for M.Sc (Mathematics)-CBCS Based Course (2020-22)

M.Sc. (Mathematics) Semester III
Session 2019-2021

Contact hours 30   Creadits=24   Marks:700

Paper Code	Course Name	Course Type	Contact Hours Per Week	Credits	Examination Scheme					
					Inter Asses Sment	Theory	Pract ical	Seminar Viva Voce	Assign ment	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

School of Mathematics and Allied Sciences, jiwaji Unversty,Gwalior
Scheme of Examination for M.Sc (Mathematics)-CBCS Based Course (2020-22)

M.Sc. (Mathematics) Semester IV
Session 2019-2021

Contact hours 30   Creadits=24   Marks:700

Paper Code	Course Name	Course Type	Contact Hours Per Week	Credits	Examination Scheme					
					Inter Asses Sment	Theory	Pract ical	Seminar Viva Voce	Assign ment	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.