

## Courses of Studies

### M.Sc. Mathematics

#### Sem-I

MAT 101.	Advanced Abstract Algebra	4 CH
MAT 102.	Real Analysis	4 CH
MAT 103.	Advanced Differential Equation	4 CH
MAT 104.	Operation Research	4 CH

#### Sem-II

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MAT 201.	Complex Analysis	4 CH
MAT 202.	Topology	4 CH
MAT 203.	Programming in C	4 CH
MAT 204.	Linear Algebra	4 CH

#### Sem-III

MAT 301.	Probability and Stochastic Process	4 CH
MAT 302.	Differential Geometry	4 CH
MAT 303.	Graph Theory	4 CH
MAT 304.	Programming in C++	4 CH
MAT 305.	Seminar	4 CH

#### Sem-IV

MAT 401.	Optimization Technique	4 CH
MAT 402.	Functional Analysis	4 CH
MAT 403.	Numerical Analysis	4 CH
MAT 404.	Operator Theory	4 CH
MAT 405.	Project/ Dissertation	4 CH

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Semester-I

Advanced Abstract Algebra

MAT 101

- Unit I- Direct product of groups (External and Internal) Isomorphism theorems, Diamond isomorphism theorem, Butterfly Lemma, Conjugate classes, Sylows theorem, P-Sylow theorem.
- Unit-II Commutators, Derived subgroups, Normal series and solvable groups, Composition series, Refinement theorem and Jordan-Holder theorem for infinite groups.
- Unit-III Polynomial rings, Euclidean rings, Modulus, Sub-modules, Quotient Modules, Direct sums and Module Homomorphism, Generation of Modules, Cyclic Modules.
- Unit-IV Field Theory, Extension fields, Algebraic and Transcendental extensions, separable and inseparable extensions, Normal extensions, Splitting fields.
- Unit- V Galois Theory, the elements of Galois Theory Fundamental Theorem of galois theory. Solvability by radicals.

Book Prescribed:

Basic Abstract Algebra. P.B. Bhattacharya, S. K. Jain, S. R. Nagpaul  
2<sup>nd</sup> Ed. (Cambridge Univer. Press)

Book Reference

1. Topics in Algebra, I. N. Herstein
2. Fundamental of Abstract Algebra, D. S. Mallick et al
3. First Course on Abstract Algebra, John B. Frank

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Read Analysis

MAT 102

- Unit I- The Riemann- Stieltjes Integral, Definition and Existence of the Integral, Properties of the integral, Integration and Differentiation.
- Unit-II Sequence & series of Functions, Uniform convergence continuity, Integration, Differentiation
- Unit-III Lebesgue Measure and Integral, Introduction, outer measure, Measurable sets and Lebesgue measure. A non-measurable set, measurable function. The Riemann Integral. The Lebesgue integral of a bounded function over a set of finite measure. The integral of a non-negative function. The general Lebesgue integral.
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- Unit-IV Differentiation & Integration – The classical Banach spaces, Differentiation of monotonic function, Function of bounded variation, Differentiation of an integral.
- Unit-V Absolute continuity,  $L^p$  spaces. The Holder and Minkowski's inequality and completeness, bounded linear functional on the  $L^p$  Spaces.

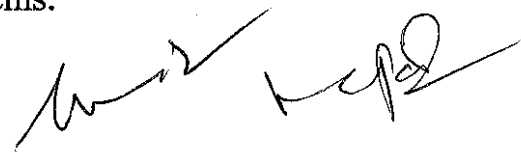
Book Prescribed:

1. Principle of Mathematical Analysis, Walter Rudin
2. Real Analysis, H. L. Royden (3<sup>rd</sup> Edn.)

Advanced Differential Equation

MAT 103

- Unit I - Existence and uniqueness of solution, Lipschitz condition, Gronwall inequality, Successive approximation, Picard's theorem, Continuation and dependence on initial conditions, Existence of solutions in the large, Existence and uniqueness of solution of systems. Fixed point method, systems of linear differential equations, nth order equation as a 1st order systems, systems of 1st order equations.
- Unit-II Existence and uniqueness theorem. Fundamental matrix, non-homogeneous linear systems, Linear systems with constant coefficients. Non-linear differential equations, Existence theorem, External solutions, Upper & Lower solutions. Monotonic iterative method and method of quasi-Linearization. Systems of linear and non-linear systems.



Unit-III Systems of equations with constant co-efficients, linear equations with constant co-efficients. Lyapunov stability, critical points. Boundary value problems for ordinary diff. equation Sturm-Liouville problem, Eigen value & Eigen functions, Expansion of eigen functions, Green's function.

Unit-IV Picard's Theorem for boundary value problem series solution of Legendre & Bessel equations.

Unit – V Laplace equation- Boundary value problem for Laplace equation, Fundamental solution. Integral representation and mean value formula for harmonic function, Green's function for Laplace-equation solution of Dirichlet's problem for a ball, Solution of Laplace's equation for a disc, the wave equation and its solution by the method of separation of variables, D'Alembert's solution of wave equation.

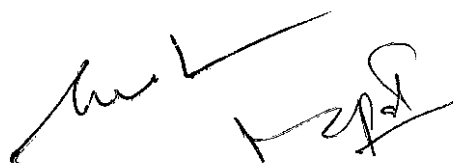
#### Book Prescribed

1. J. Sinharoy & S. Pandhy: A course of ordinary & Partial differential equation Kalyani Pub. Ch- 10, 15, 16 & 17
2. S. D. Deo, V. Lakhmikanthan & V. Roghavendra  
Text book of Ordinary Diff. equation  
IInd Edition TMH Pub.

#### Paper -103

#### Differential Equation (List of Practicals)

1. Obtaining partial derivative of some standard functions.
2. Illustrating principal of superposition for linear partial diff. equation.
3. Classification of 2nd order P.D.E. into parabola, Ellipse.
4. Obtaining the solution of wave equation by Fourier decomposition.
5. Obtaining the solution of wave equation by Fourier transforms.
6. Obtaining the solution of Laplace equation by Fourier transforms.



Operation Research

MAT 104

- Unit I - Convex sets and function, Linear programming.  
Unit-II Duality in Linear Programming, Transportation Problem.  
Unit-III Assignment problems, Revised Simplex method.  
Unit-IV Upper Bounding Technique, Integers Programming Problems, branch and Bounds Gomary Method.  
Unit-V Dynamic Programming, Game Theory

Book Prescribed

1. Operation Research : S. D. Sharma

Reference Book

1. Linear Programming - S. I. Gass  
2. Operation Research - Kanti Swarup  
3. Non-Linear Programming- C. Hadley
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Semester-II

Complex Analysis

MAT 201

- Unit I - Complex Number- The algebra of Complex Numbers, the geometric representation of Complex Numbers.  
Complex Function: Introduction to the concept of analytic functions, Elementary theory of power series, Exponential & trigonometric function.
- Unit- II Analytical functions of mapping:- Conformality, linear transformation, elementary conformal mapping, complex Integration, Fundamental Theorem, Cauchy's Integral Formula.
- Unit-III Local properties of analytic functions, the integral forms of Cauchy's Theorem, Cauchy's Residue Theorem, Contour Integration.
- Unit-IV Zeros of analytic function, The intex of a closed curve, Morera's theorem, Lioville Theorem, Goursat Theorem, Fundamental theorem of Algebra zeros.
- Unit-V Classification of singularities, poles, absolute convergence, Laurents series development, Casorati Weirstrass theorem, Maximum Modulus theorem, Schwartz Lemma.

Book Prescribed

1. Functions of complex variable- J.B. Conway Narosa Pub. Ch-III(1-3)  
IV(2-5,7,8) V(1.3) VI(1.2)
2. Complex Analysis - L. V. Ahlfros M.C. Graw Hill



Topology

MAT 202

- Unit I- Topological space, Basis and order of topology product and subspace topology, closed set, limit points, continuous function, product topology.
- Unit-II- Connected spaces, connected sets in real line, compact spaces, Compact sets in the real line limit point compactness.
- Unit-III- Countability and separation axioms, The Tychonoff theorem.
- Unit IV - Complete metric space, compactness on metric space.
- ~~Unit V- Product spaces, weak topologies, product space of two spaces, product invariant properties for finite products, General product spaces.~~

Book Prescribed

Topology A first course, J. R. Munker (Prentice Hall of India Ltd.)  
CH-II (Excluding 2.11)      III (Excluding 3.8)      IV (Excluding 4.5)  
V (5.1 only)                      VII (7.1 & 7.3 only)

Programming in C

MAT 203

- Unit I- Overview of C, Constants, variables, Data types, Operators and Expressions, Managing I/O Operators.
- Unit-II Decision making & Branching, Looping Arrays, Character, Strings.
- Unit-III User defined functions, Structure and Union.
- Unit-IV Pointers: Introduction, Understanding Pointers, Accessing the address of a variable, chain of pointer, pointer expression.
- Unit-V File Management in C.

Book Prescribed

Programming in C - E. Balagurusamy

Book Reference

1. Programming in C - V. Rajaraman
2. Mastering in C - Venugopal



Programing in C (List of Practicals)

1. To calculate mean and standard deviation.
2. To calculate Pearson's Co-efficient of Co-relation.
3. To find area under a curve.
4. Lagrange's Interpolation.
5. Gauss elimination.
6. Inverse of a matrix.
7. To find Eigen value & Eigen vector.
8. Runge Kutta Method.
9. Finding minimax approximation to e by Chebyshev's polynomials.
10. Approximating definite Integral by Newton cotes, Gauss quadrature rule.

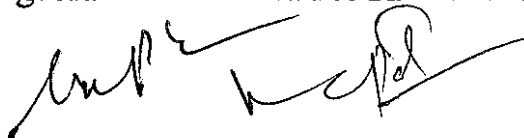
Linear Algebra

MAT 204

- Unit-I Linear Transformations, properties of linear transformation, Matrix of a linear transformation, change of basis, Orthogonal and Unitary transformations, Linear functions, Dual space and Bidual space, Adjoint of a linear transformation.
- Unit-II Matrix: Rank and Nullity, Eigen values Eigen Vectors of Linear Transformation, Characteristics equation of a matrix, Annihilators Definition, Properties and Dimension.
- Unit-III Determinants: Matrix Inversion, Inverse of a matrix by partitioning, characteristic polynomial, Minimal Polynomial, Cayley-Hamilton theorem & Diagonality, Diagonalisation.
- Unit-IV Canonical and Bilinear forms, Jordan forms. The Rational forms, Bilinear forms, Definition and Examples. The matrix of a bilinear form, Orthogonality, Classification of Bilinear forms.
- Unit-V Inner product space: Real inner product, Norm of a vector and normed vector space, Orthogonality, Principal axis theorem, Unitary spaces, Cauchy Schwartz's inequality.

Book Prescribed:

1. Topic in Algebra- I. N. Herstein
2. Linear Algebra - K. Hoffman & R. Kunz Ch. 8 (8.1 – 8.5)



## Semester-III

### Probability and Stochastic Process

MAT 301

- Unit I Random variables: Introduction, Function of random variables, moments and generating functions. Multiple random variables, Independent random variables, functions of several random variables, covariance, correlation and moments, conditional expectation.
- Unit II Some special distribution: The Bivariate and Multivariate Normal Distribution .The exponential family of distribution.
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- ~~Unit III Limit Theorem: Modes of Convergence, the weak law of large numbers Strong law of large numbers, limiting Moment generating functions, Central limit theorems.~~
- Unit IV Sample Moments and their distributions: Random sampling, sample characteristics and their distribution, Chi- square, T & F distributions Exact sampling distribution.
- Unit V Stochastic processes: Definition with examples, Markov chains Chapman Kolmogorov equations, classification of states, limiting probabilities, some applications: the gambler's Ruin problem. Continuous- time, Markov chains, Birth and death processes, Transition probability function.

### Book Prescribed

1. An Introduction to probability statistics by V. K. Rohatagi & A. K. Md Ehasanes Saleh , John Wiley & Sans.
2. An Introduction to Probability Models by Sheldon M. Ross Academic Press.





- Unit I Theory of curves: Space curves, Tangent, contact of curves and surfaces, osculating plane, principal normal and binormal, curvature, Torsion Serret- Frenet's Formula.
- Unit II Osculating circle and osculating sphere, Existence and Uniqueness theorem, Bertrand curves, Involute, Evolutes.
- Unit III Rules surface, Developable surface, Tangent plane to a ruled surface, Necessary and sufficient condition that a surface  $f = 0$  should represent a developable surface.
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- Unit IV Metric of a surface, First, Second and third fundamental forms, Fundamental magnitudes of some important surfaces, orthogonal trajectories, Normal Curvature, Meunier's Theorem.
- Unit V Principal directions and Principal curvatures, First curvature, Mean Curvature, Gaussian Curvature, Umbilic, Radius of curvature of any normal section at an umbilic as  $Z=F(x,y)$ . Radius of curvature at a given section through any point on  $Z=F(x,y)$ , Lines of curvature, Principal radius, Relation between fundamental forms, Asymptotic lines.

Book Prescribed

1. Differential Geometry E. Kreyzig (Dover pub)
2. Elements of Differential Geometry.  
R. S. Millman & G. D. Parker (Prentice Hall Pub.)

Reference Book

1. Differential Geometry by D. Somasundaram (Narosa Pub.)
2. Schaum's out line of Diff. Geometry by M.M. Lipschutz (M.C. Graw hill)

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Graph Theory

MAT 303

- Unit I Introduction, Paths & Circuits, Trees.
- Unit II Fundamental Circuits, Cut set and cut vertices
- Unit III Planar and Dual Graphs.
- Unit IV Vector spaces of graph.
- Unit V Matrix representation of graphs, colouring.

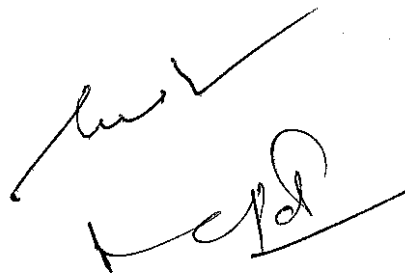
~~Covering & Partitioning, directed graphs.~~

Book Prescribed

Graph Theory with application to Engg. and Computer Science,  
N. Deo (Prentice Hall of India Ltd.)  
CH- (I-IX)

Book Reference

- 1) Graph Theory - F. Hanary
- 2) Graph Theory & Application by Bondy & Murty (Mac Millian)

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Unit I Principles of object oriented programming

Object oriented programming

Basic concept of O.O.P, Benefit of OPP, Application of OPP.

Structure of a C++ Programme- Creating compiling and linking a C++ programme, Tokens, Expression and control Structure- Key words, Identifiers, Data type, User defined data types, Derived data types, Symbolic constant, variables, operators in C++.

~~Unit II Function in C++, Function prototyping, call by Reference, Inline function, Default argument, Function overloading, classes and objects, Defining class & member function.~~

Unit- III- Structures of a C++ program with class, nesting of member, memory allocation for object, static data member, Static member function, Friend function, Pointers to data member.

Unit- IV Constructors and destructors- Default and parameterized constructors, copy & dynamic constructors , Constructors with default arguments, Dynamic initialization of objects, constructors overloading, destructors, and its function.

Unit-V Operator overloading and type conversation- Defining operators overloading, overloading unary and binary operators, Over loading binary operators using friend function, Manipulation of Strings using operators, Rules for overloading operators, Type conversions.

Book Prescribed

Object oriented programming with C++: E, Balagurusamy Ch. (1 to 9)

Reference Book

1. Object Oriented Programming Turbo C++ : Rober Lafore
2. Mastering in C++ : Venugopal

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Paper – 304

Programming in C++ (List of Practicals)

1. Integrate a function using Simpson's 1/3 Rule.
2. Solve the system of equations using Gauss-Seidal method.
3. Solve differential equations using Runge-Kutta fourth order method.
4. Multiplication, Addition of two matrices using three dimensional arrays.
5. Calculate the sum of the series  $\frac{1}{1} + \frac{1}{2} + \frac{1}{3} + \dots + \frac{1}{N}$  for any positive integer.
6. Write a programming that prompts the user to enter the lengths of three sides of triangle and then outputs a message indicating wheather the triangle is a right angled triangle or scalen triangle.
7. Calculate the factorial of any natural number.

SEMINAR

MAT 305

Semester-IV

Optimization Technique

MAT 401

- Unit I One dimensional optimization: Introduction, Function Comparison methods, Polynomial interpolation, Iterative methods.
- Unit II Gradient based optimization method (I)- Calculus of  $R^n$ , Method of steepest descent, Conjugate gradient method, The generalized gradient method, gradient projection method.
- Unit III Gradient based optimization method (II): Newton type method (Newton's method, Marquardt's method), Quasi-Newton methods.
- Unit IV Linear programming, convex analysis, Simplex method, Two phase simplex method, Duality, Dual simplex method.
- Unit V Constrained optimization method: Lagrange multipliers, Kuhn-Tucker conditions, Convex Optimization, Penalty function techniques methods of multiplier, linear constrained problems, cutting plane method.

Book Recommended

1. M. C. Joshi and K. Moudgalya-  
Optimization : Theory & Practice, Norosa Pub. New Delhi.
2. J. A. Snyman, Practical Mathematical Optimization,  
Springer Sciences 2005



- Unit I Definition and examples of Matric Space, open set, closed set, Neighbourhood, Convergence, Cauchy sequence, Completeness, Definition of a continuous mapping space, Banach space, properties of normed space, finite dimensional normed spaces and subspaces.
- Unit II Compactness and finite dimensional linear operator, Bounded and continuous linear operators, Linear functional and operator on finite dimensional spaces, Normed spaces of operators, Dual space.
- Unit III Inner product space and its properties. Hilbert space, Orthonormal sets and sequences, total orthonormal sets and sequences. Representation of functional on Hilbert spaces, Hilbert adjoint operators self adjoints, Unitary and normal operator.
- Unit IV Fundamental Theorems for normed and Banach spaces, Zern's Lemma, Hahn Banch theorem, Hahn Normed space. Application to bounded linear functional on  $C[a,b]$ , Ajoint operator.
- Unit V Reflexive spaces, Bair's category theorem, Uniform boundedness theorem, Strong and weak convergence open mapping theorem, closed linear operator, Closed graph theorem.

Book Prescribed

Introductory Functional Analysis with Application by Erwin Kreyszig.


Ch. 1 (1.1-1.5) 2(2.2-2.10) 3(3.1-3., 3.6, 3.8-3.10)

Ch. 4 (4.1-4.8, 4.12, 4.13)

Reference Books

First course in Functional Analysis by G.Goffman & G. Pedrick,

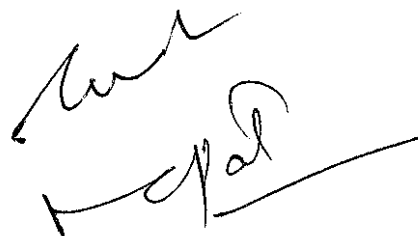
Printice Hall of India.



- Unit I Approximation of functions: Weierstrass and Taylors theorem, Minimum approximation problem least square approximation problem, Orthogonal Polynomials.
- Unit II Numerical solution of system of linear equations, Gaussian Elimination, Pivoting and scaling in Gaussian Elimination, Variants of Gaussian elimination, Error analysis Residual Correction method, iteration methods.
- Unit III Differentiation & Integration: Introduction Numerical Differentiation, Optimum choice of step length, extrapolation method, Partial Differentiation, Numerical Integration, Method based on interpolation, Methods based on undermination Coefficient, Composite Integration method.
- Unit IV Ordinary Differential Equations, Initial value problem, Introduction, Difference Equations, Numerical methods, Single step methods, Stability analysis of single step methods, Multistep methods.
- Unit V Eigen value location, error and stability results, Hermite interpolation, Piecewise Polynomial interpolation.

Books Prescribed

1. M. K. Jain, S.R.K. Iyengar, R. K. Jain  
Numerical method for Science & Engg. Computation.
2. An introduction to Numerical Analysis (2nd Ed.)  
Kendall E. Atkinson (Wiley)

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Paper – 403

Numerical Analysis (List of Practicals)

1. Gauss- Seidal interation method.
2. Lagrange Interpolation or Newton Interpolation.
3. Gaussian Quadrature method.
4. Fixed point interative method.
5. Gauss elimination method.

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6. Initial value problems for first and second order O.D.E.
7. Fourth order Runge-Kutta method.
8. Inversion of a non-singular square matrix.
9. B.V.P. for 2nd order O.D.E by finite difference method.
10. Solution of one-dimentional wave equation by finite difference method.

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- Unit I Spectral Theory in dimensional normal space: Basic concepts, Spectral properties of bounded linear operators, Further properties of resolvent and spectrum.
- Unit II Banach Algebra, Introduction, Complex homomorphism, Basic properties of spectra.
- Unit III Commutative Banach Algebra: Ideals and homomorphisms, Gelfand transform, Involution.
- Unit IV Compact linear operator on normed spaces, Further properties of compact linear operators, Spectral properties of compact linear operators, Spectral properties of bounded self Adjoint linear operators, Further spectral properties of bounded self Adjoint linear Operator.
- Unit V Positive operators, Projection & Unbalanced linear operators and their Hilbert Adjoint operators. Symmetric and Self- Adjoint linear operators, Closed linear operators and closures, Spectral properties of self- Adjoint linear operators.

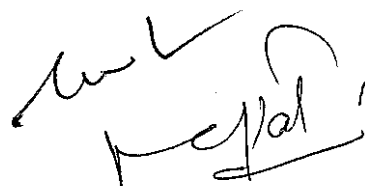
Book Prescribed

1. Introductory Functional Analysis with Application by Erwin Kreyszig  
Ch 7 (7.1-7.7) 8 (8.1-8.3) 9(9.1-9.3, 9.5)  
Ch 10 (10.1-10.4)

Functional analysis: Walter Rudin Tata McGraw Hill Ch 10(10.1-10.20),  
11(11.1-11.20) Ch12 (12.1-12.36)

Book Reference

1. Principal of functional Analysis- M.Schechter
2. Theory of linear operator, Vol I, II Pitman Pub House, Akhietzer & Glaze man.
3. Basic operator Theory – Gohberg & Goldberg.

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