M.Sc. (Mathematics) Semester I

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 Transform Math	core	4+2	44	40	60				**100**
Math 104	Computer Fundamentals and Programming in C	core	4	4	40	60				**100**
Math 105	Practical	core lab	6	3	40		60			**100**
Math-106	Seminar and Assignment	core	2	1				**50**	**50**	**100**
	Sub-total		30	20	160	240	100	**50**	**50**	**600**
MCS -109	Comprehensive viva-voce			4				**100**		**100**
	Total		**30**	**24**	**160**	**240**	**100**	**150**	**50**	**700**

M.Sc. (Mathematics) SemesterII

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
Math201	Complex Analysis	core	4+2	3	40	60				**100**
Math 202	Differential Equations	core	4+2	3	40	60				**100**
Math 203	Topology	core	4+2	3	40	60				**100**
Math 204	Numerical Methods	core	4	3	40	60				**100**
Math 205	Practical	core lab	6	3	40		60			**100**
Math -206	Seminar and Assignment	core	2	1				**50**		**50**
	Sub-total		30	20	160	240	100	**50**	**50**	**600**
Math -207	Comprehensive viva-voce			4				**100**		**100**
	Total		**30**	**24**	**160**	**240**	**100**	**150**	**50**	**700**

M.Sc. (Mathematics) Semester III

Contact hours 30 **Credits: = 24** **Marks: 700**

	Course Name	Course type	Contact Hours per week	Credits	Examination Scheme					
					Inter. Assessment	Theory	Practical	Seminar/ viva voce	Assignment	Total
Math301	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	6	3						
Math 307	Seminar and Assignment	core	2	1				**50**	**50**	**100**
	Sub-total		30	20	160	240	100	**50**	**50**	**600**
Math 308	Comprehensive viva-voce			4				**100**		**100**
	Total		**30**	**24**	**160**	**240**	**100**	**150**	**50**	**700**

Note: Out of three Elective (centric/ generic) any two are to be chosen.

M.Sc. (Mathematics) Semester IV

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
Math401	Partial Differential Equation	core	4+2	4	40	60				**100**
Math402	Advanced Functional Analysis	EC	4+2	4	40	60				**100**
Math403	Wavelets .	EC	4+2	4	40	60				**100**
Math404	Mathematics of Finance & Insurance	EC	4+2	4	40	60				**100**
Math405	Fuzzy Sets and their Application	EC	4+2	4	40	60				**100**
Math406	Advanced Graph Theory	EC	4+2	4	40	60				**100**
Math407	Biomechanics	EC	4+2	4	40	60				**100**
Math 408	Advanced Mathematical Statistics	EC/EG	4+2	4	40	60				**100**
Math409	Discrete Mathematical Structures	EC	4+2	4	40	60				**100**
Math410	Special Functions	EC	3	4			60			
Math 411	Practical	core lab	3	4		10		**100**		**200**
Math 412	Seminar and Assignment	core	2	1				**50**	**50**	**100**
	Sub-total		30	20	160	240	100	**50**	**50**	**700**
Math 413	Comprehensive viva-voce			4				**100**		**100**
	Total		**30**	**24**	**160**	**240**	**100**	**150**	**50**	**700**

Note: Out of nine 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.

M.Sc. (Mathematics)-CBCS Based Course
Session 2015-2017

Semester-I

Math 101	*Advanced Abstract Algebra*	*(60,40)*
Math 102	*Analysis*	*(60,40)*
Math 103	*Integral Transform*	*(60,40)*
	Any one of the following	
Math 104	*Computer Fundamentals and Programming in C*	*(60,40)*
Math 105	*Mechanics*	*(60,40)*
Math 106	*Practical lab: Practicals with programming in C*	*(60,40)*
Math 107	*Seminar and Assignment*	*(50,50)*
Math 108	*Comprehensive viva-voce*	*(100)*

Semester-II

Math 201	*Complex Analysis*	*(60,40)*
Math 202	*Differential Equations*	*(60,40))*
Math 203	*Integral Equations and Boundary Value Problems*	*(60,40)*
	Any one of the following	
Math 204	*Numerical Methods (optional)*	*(60,40))*
Math 205	*Fluid Mechanics (optional)*	*((60,40)*
Math 206	*Practical lab: Practicals with*	
	Programming in C++	*(60,40)*
Math 207	*Practical lab: Practicals with programming in C*	*(60,40)*
Math 208	*Seminar and Assignment*	*(50,50)*
Math 209	*Comprehensive viva-voce*	*(100)*

Semester-III

Math 301	*Functional Analysis*	*(60,40)*
Math 302	*Topology*	*(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 and Assignment*	*(50,50)*
Math 308	*Comprehensive viva-voce*	*(100)*

Semester-IV

Math 401	*Partial Differential Equation*	*(60,40)*
	Any three of the following	
Math 402	*Advanced Functional Analysis*	*(60,40)*
Math 403	*Wavelets*	*(60,40)*
Math 404	*Mathematics of Finance & Insurance*	*(60,40)*
Math 405	*Fuzzy Sets and their Application*	*(60,40)*
Math 406	*Advanced Graph Theory*	*(60,40)*

Math 407	*Biomechanics*	*(60,40)*
Math 408	*Advanced Mathematical Statistics*	*(60,40)*
Math 409	*Discrete Mathematical Structures*	*(60,40)*
Math 410	*Special Functions*	*(60,40)*
Math 411	*Practical lab: Practicals based on Numerical solution of PDE's*	*(60,40)*
Math 412	*Seminar and Assignment*	*(50,50)*
Math 413	*Comprehensive viva-voce*	*(100)*

Math 101 **ADVANCED ABSTRACT ALGEBRA**

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 & Jordon normal forms, Rational Canonical form, Elementary divisors.

Text Books :

1. Topics in Algebra by I.N. Herstein, Wiley Eastern Ltd., New Delhi, 1975.
2. Basic Abstract Algebra (2^{nd} Edition), Cambridge University Press, Indian Edition, 1997.
3. Algebra by M. Artin, Prentice-Hall of India1991.

Reference Books:

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 theory by 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. Roydon.

Reference Books:

1. Mathematical Analysis by Mullick & 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 Boks

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.

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 105 **MECHANICS**

Unit-I

Generalized coordinates, Holonomic and Non–holonomic systems, Scleronomic and Rheonomic systems, Generalized potential. Lagrange's equations of first kind. Lagrange's equations of second Kind, Uniqueness of solution, Energy, equation for conservative fields, Hamilton's variables, Donkin's theorem, Hamilton canonical equations.

Unit-II

Cyclic coordinates, Routh's equations, Poisson's Bracket, Poisson's identity, Jacobi-Poisson Theorem, Motivating Problems of calculus of variations, Shortest distance, Minimum surface of revolution, Brachistochorone Problems, Isoperimetric problems, Geodesic.

Unit-III

Fundamental lemma of calculus of variation, Euler's equation for one dependent function, Generalization of Euler's equations to (i) 'n' dependent functions, (ii) higher order derivatives.

Unit-IV

Conditional extremum under geometric constraints and under integral constraints, Hamilton's Principle, Principle of least action. Poincare Cartan integral invariant, Whittaker's equations, Jacobi''s equations, Statement of Lee Hwa chung's theorem.

Unit-V

Hamilton-Jacobi equation, Jacobi theorem, Method of separation of Variables, Lagrange Brackets, Condition of canonical character of a transformation in terms of Lagrange brackets and Poisson brackets, Invariance of Lagrange brackets and Poisson brackets under canonical transformations.

Text Books:

1. Calculus of Variation by I.M. Gelfand and S.V. Fomin, Prentice Hall.
2. Analytical Mechanics by Louis N. Hand and Janet D. Finch, Cambridge University, Press, 1998.

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

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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.
1. 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 Books:

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 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 Books:

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

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 205 **FLUID MECHANICS**

Unit-I

Lagrangian and Eulerian methods, equation of continuity, types of flow lines, velocity potential, stream function irrotationel and rotational motions, vortex lines.

Unit-II

Lagrange's and Euler's equation of motion, Burnoulli's theorem, irrotational motion in two dimensions, complex velocity potential, sources, sinks conformal mapping, theorem of Blasius.

Unit-III

Motion of a sphere through a liquid at rest as infinity, equation of motion of a sphere, stress components in a real fluid.

Unit-IV

Relations between rectangular components of stress convection between stresses and gradients of velocity, Plane Poiceuille and Coquette flows between two parallel plate, flow through tubes of uniform, cross-section in the former of circle, Annulus under constant pressure gradient.

Unit-V

Dynamical similarity, Reynolds number, Prandt's boundary layer, boundary layer equations in two dimension, Blasius solution, boundary layer thickness, displacement thickness, Karman integral conditions, separation of boundary layer flow.

Text Books:

1. A Text book of fluid mechanics in SI Units by R.K Rajput.
2. An Introduction to fluid Dynamics by R.K. Rathy, Oxford and IBH Published Co.

Reference Books:

1. Fluid Mechanics (Springer) by Joseph H. Spurk.
2. Fluid Mechanics by Irfan A. Khan (H.R.W.).
3. An introduction to Fluid Mechanics by G.K. Batchelor, Foundation Books, New Delhi, 1994.

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 **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 and Neighbourhood systems.

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. Simonons McGraw Hill Book Co.

Reference Book :

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

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 R.K. Gupta.

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 S.D. Sharma.

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.

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.

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-II

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 403 **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, Bessens 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 404 **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.
1. 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 **FUZZY SETS AND THEIR APPLICATIONS**

Unit- I

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, t-Norms and t- co norms.

Unit-II

The Extension Principle – The Zadeh's extension principle, Image and inverse image of fuzzy sets, Fuzzy numbers, Elements of fuzzy arithmetic.

Unit-III

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

Unit-IV

Possibility Theory-Fuzzy measures, Evidence theory, Necessity measure, Possibility measure, Possibility distribution, Possibility theory and fuzzy sets, Possibility theory versus probability theory.

Unit-V

Fuzzy Logic-An overview of classical logic, Multivalued logics, Fuzzy propositions, Fuzzy quantifiers, Linguistic variables and hedges, Inference from conditional fuzzy propositions, the compositional rule of inference.

Text Books:

1. Fuzzy set theory and its Applications by H.J. Zimmermann, Allied Publishers Ltd., New Delhi, 1991.
2. Fuzzy sets and Fuzzy logic by G.J. Klir and B. Yuan Prentice-Hall of India, New Delhi, 1995.

Refenence Book:

1. Fuzzy Sets, Uncertainty and Information by G.J.Klir, Tina A. Folger Prentice-Hall of India.

Math 406 **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 407 **BIO-MECHANICS**

Unit-I

Bio-physics of Human Cardio-vascular system: Types of Blood Vessels, Properties of Blood. Flow in Tubes, Poiseuibles law, Erythrocyte sedimentation Rate I stoke's low, pulsatile flow, Flow in elastic vessels.

Unit-II

Bio-physics of Human Thermo-regulation Heat flow in Human Dermal and sub-dermal ports; Derivation of Governing partial differential Equations Incorporating Micro-circulation and Perspiration.

Unit-III

Solution of steady stale and Unsteady –state flow problems in one dimension, application of finite element method and exact solutions.

Unit-IV

Diffusion processes in biology: diffusion in Tissue, Fick's principle, One, two and three Dimensionals diffusion Problems and their solution, Water Transport, Diffusion Through Membranes.

Unit-V

Respiratory Gas flows, flow in Airways, Interaction Between convection and diffusion, Exchange between Alveolar Gas and Erythrocytes, Pulmonary function Test, Dynamics of Ventilation system.

Text Books:

1. Introduction to Mathematical Biology by S.I. Rubinow, J.Wiley & Sons.
2. Biomechanics by Y.C. Fung, Springer-verlag.
3. Introduction to Biomathematics by V.P. Saxena, Vishwa Prakashan (Wiley-Eastern)

Reference Book:

1. Biofluid Dynamics by Mazumdar.

Math 408 **ADVANCED MATHEMATICAL STATISTICS**

Unit-I

Definitions of central tendencies, Measure of dispersions with variance in detail, Method of least square for curve fitting, correlation & 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 & V K Kapoor- S. Chand & Sons, New Delhi.
3. Fundamentals of Applied Statistics by S C Gupta & V K Kapoor, S Chand & Sons, New Delhi.

Reference Books:

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

Math 409 **DISCRETE MATHEMATICAL STRUCTURES**

Unit-I

Relation, Equivalence relation, Partitioning, Fundamental theorem on equivalence relation, ordered sets, First and last elements, maximal and minimal elements, upper and lower bounds, similar sets, Totally ordered sets, well ordered sets, Axioms of choice, Zorn's lemma, Well ordering theorem (Statements only), Inclusion exclusion principle & Pigeon Hole principle.

Unit-II

Mathematical logic: Propositions and logical operators, Contradictions and Tautologies, Equivalence & Implication, Duality NAND and NOR connections, Functionally complete sets, Two-state devices and statement logic, Normal forms, Predicate calculus, Free and bound variables.

Unit-III

Lattice-Definition & examples, Distributive lattice, modular lattice, Bounded lattice, complemented lattice, Boolean lattice, Sublattice.

Unit-IV

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-V

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.

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.

Reference Books:

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

Math 410 Special Functions

Unit-I

Gamma and Beta Functions

Gamma Function, A series for $\Gamma'(z)/\Gamma(z)$, Difference equation $\Gamma(z+1) = z\Gamma(z)$, Euler's integral for $\Gamma(z)$, Beta function, value of $\Gamma(z)\Gamma(1-z)$, Factorial Function, Legendre's duplication formula, Gauss multiplication theorem, The behaviour of $\log \Gamma(z)$ for large $|z|$

Unit-II

Hypergoemetric and Generalized Hypergeometric functions:

Gauss hypergeometric Function ${}_2F_1$ and its convergence A simple integral form evaluation of ${}_2F_1(a,b;c;1)$, Contiguous function relations, Hyper geometric differential equation Elementary series manipulations, Simple transformation, Generalized hypergeometric function ${}_pF_q$ and its convergence, Whipple's theorem, Dixon's theorem.

Unit-III

Bessel function and Legendre polynomials

Definition of $J_n(z)$, Bessel's differential equation, Generating function, Recurrence relations, Generating function for Legendre polynomials, Rodrigues formula, Bateman's generating function, Additional generating funtions, Hypergeometric forms of $P_n(X)$, Special properties of P_n, Some more generating functions, Laplace's first integral form, Orthogonality.

Unit-IV

Hermite and Laguerre polynomials

Definition of Hermite and Laguerre polynomials, Pure recurrence relations, Differential recurrence relations, Rodrigue's formula, Other generating functions, Othogonality for Laguerre and Hermite polynomials

Unit-V

Mascrobert's E- function and Meijer's G-Function

Definition of Mascrobert's E-function and its expansion in series of ${}_pF_q$ simple 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 in Statistics and physical Sciences, Springer Verlag, Heidelberg and New York, Lecture Notes No 348,1973**
3. **Saran, N., Sharma S.D. and Trivedi, - Special Functions with application, Pragati prakashan, 1986.**

Reference Books:

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