(Syllabus w.e.f. 2020-21)

H.N.B.Garhwal University Srinagar(Garhwal)

M.A/M.Sc. Mathematics Course Structure

Semester–I

Core Course

Paper- I –	Discrete Structures	SOS/Math/ C001
Paper -II –	Abstract Algebra- I	SOS/Math/C002
Paper- III –	Mechanics	SOS/Math/C003
Paper- IV –	Complex Analysis	SOS/Math/C004
Paper -V –	Operations Research -I	SOS/Math/C005
Paper -VI-	Viva-Voce	SOS/Math/C006

Semester-II

Core Course

Paper- VII	Abstract Algebra- II	SOS/Math/C007
Paper- VIII	Fluid Dynamics	SOS/Math/C008
Paper- IX	Operations Research- II	SOS/Math/C009
Paper- X	Real Analysis	SOS/Math/C0010
Paper- XI	Metric Spaces	SOS/Math/C0011
Paper -XII	Viva- Voce	SOS/Math/C0012

Semester-III

Core Course

Paper- XIII	Topology	SOS/Math/C0013
Paper -XIV	Differential Equations	SOS/Math/C0014

Elective Course (Choose any three):

Paper -XV	Differential Geometry	SOS/Math/E001
Paper- XVI	Mathematical Statistics	SOS/Math/E002
Paper- XVII	Calculus of Variations	SOS/Math/E003
Paper- XVIII	Computer Fundamentals and Data Structures	SOS/Math/E004
Paper- XIX	Algebraic Coding Theory	SOS/Math/E005

Self- Study Course

Paper –XX**(Choose any one):**

(a) Mathematical Methods	SOS/Math/ E006 (a)
(b) Tensor Analysis & Special Theory of Relativity	SOS/Math/E006(b)
(c) Financial Mathematics	SOS/Math/E006(c)

Core Course

Paper- XXI Viva-Voce	S0S/Math/C0015

Semester-IV

Core Course

Paper- XXII Measure and Integration	SOS/Math/C0016
Paper –XXIII Functional Analysis	SOS/Math/C0017

Elective Course (Choose any three):

Paper- XXIV Linear Integral Equations	SOS/Math/E007
Paper- XXV Integral Transforms	SOS/Math/E008
Paper- XXVI Fuzzy Set Theory	SOS/Math/E009

Paper- XXVII Mathematical Modeling SOS/Math/E0010

Paper- XXVIII Number Theory SOS/Math/E0011

Core Course

Paper- XXIX Viva-Voce SOS/Math/C0018

Note:

1- In Semester- I all papers are compulsory.

2- In Semester- II all papers are compulsory.

3- In Semester III, papers - XIII, XIV & XXI are compulsory and choose any three papers out of the Elective Papers-XV , XVI, XVII, XVIII & XIX.

4- In Semester-IV, papers -XXII, XXIII, & XXIX are compulsory and choose any three out of the Elective Papers- XXIV, XXV, XXVI, XXVII & XXVIII.

5- Each paper carries 100 marks, which includes two sessional tests (each of 20 marks) and main examination of 60 marks.

Viva-Voce : In this paper evaluation will be based on the students performance in viva voce(based on the papers of concerned semester), comprehensive test and presentation /seminars on any current topic in Mathematics .

SEMESTER- I

PAPER- I DISCRETE STRUCTURES SOS/Math/C001

I. Recurrence relations, Linear homogeneous recurrence relations, Non-homogeneous recurrence relations, Solutions of recurrence relations.

II. Partially ordered sets, Different type of lattices, Sub-lattices, Direct product, Ideal Lattice, Modular and distributive lattices.

III. Boolean algebra, Ideals in Boolean algebra, Boolean rings, Boolean functions, Karnaugh maps, Application of Boolean algebra to switching theory.

IV. Graphs, Direct graphs, Undirected graphs, Relations and graphs, Path and circuits, Eulerian and Hamiltonian graphs, Planner graphs, Connected graphs.

TEXT/REFERENCE BOOKS

1. Element of Discrete Mathematics: C. I. Liu, Mcgraw Higher Edu. ,2012.
2. Discrete Mathematical Structures : H. G. S. Rao, Galgotia Pub. Pvt. Ltd.
3. Lattice and Boolean Algebra: V. K. Khanna, Vikash Pub. House.
4. Discrete Mathematics: R. Johnsonbaugh , Pearson Edu. Ltd., 2014.

SEMESTER- I

PAPER-II ABSTRACT ALGEBRA- I SOS/ Math/C002

I. Simple groups, Conjugacy, Normalization, Centre of a group, Class equation of a group and its consequences, Theorems for finite groups, Cauchy's theorem, Sylow's theorem.

II. Homomorphism, Endomorphism, Automorphism, Inner automorphism, Kernel of a homomorphism, Fundamental theorem on homomorphism of group, Group of automorphisms , Results on group homomorphism.

III. Maximal subgroups, Composition series, Jordan-Holder theorem, Solvable groups, Commutator subgroups, Direct products

IV. Ideals, Algebra of ideals, Principal ideal ring, Units and associates, Polynomials ring, Division and Euclidean algorithm for polynomials, Unique factorization theorem

TEXT/REFERENCE BOOKS

1. Contemporary Abstract Algebra: JoshephA. Gallian, NarosaPub.House P. Ltd.
2. A First course in Abstract Algebra: John. B. Fraleigh, Pearson Edu. Inc. , 2003.
3. Abstract Algebra : V.K. Khanna and S.K. Bhambri, Vikash Pub. House P. Ltd.
4. Topics in Algebra: I. N. Herstein, John Wiley & Sons, New York.

SEMESTER- I

PAPER –III MECHANICS SOS/ Math/C003

I. Conservation of linear and angular momentum under finite and impulsive forces, Conservation of energy.

II. Generalized coordinates, Lagrange's equations of motion, Small oscillations.

II. Hamiltonian's canonical equations, Hamilton's principle and principle of least action.

III. Euler's equations of motion, Kinetic energy, Eulerian angles, Instantaneous axis of rotation.

TEXT/REFERENCE BOOKS

1. Dynamics- Part II :A.S. Ramsey, Cambridge University Press, 1944.
2. Classical Mechanics: H. Goldstein, Pearson Education.
3. A Text Book on Dynamics :Ray and Sharma, S. Chand Ltd., 2005.
4. Dynamics of Rigid Body: S.L. Loney, Cambridge University Press.

SEMESTER-I

PAPER-IV COMPLEX ANALYSIS SOS/ Math/C004

I. Power series of analytic functions, Convergence of power series, Radius of convergence, Taylor's and Laurent's series, Residue and poles, Singularities, Classification of singularities.

II. Residues, Residue at infinity, Cauchy residue theorem, Applications of residue theorem in evaluation of improper real integrals.

III. Conformal mapping: properties, Mobius transformation, Elementary examples.

IV. Maximum modulus theorem, Mittag-Leffler theorem, Rouche's theorem, Concept of entire functions with simple example, Analytic continuation.

TEXT/REFERENCE BOOKS

1. Complex Analysis: J.W. Brown and R.V.Churchill, McGraw-Hill Ed. Private Ltd.2015.
2. Complex Analysis: Dennis G. Zill, Jones &Bartlet Learning,2016.
3. Complex Analysis: H. S. Kasana, PHI Learning.
4. Foundation of Complex Analysis: S. Ponnusamy, Alpha Int. Sci.

SEMESTER-I

PAPER –V OPERATIONS RESEARCH –I SOS/ Math/C005

I. An introduction to operations research, Methodology of O.R., Features of O.R. problems, Different models in O.R., Opportunities and shortcomings of O.R. approach.
II. Dual simplex method, Revised simplex method, Sensitivity analysis.
III. Assignment and Transportation problems.
IV. Theory of games, Integer linear programming.

TEXT/REFERENCE BOOKS

1. Operations Research: Kanti Swarup, P.K. Gupta & Man Mohan, S. Chand, 1978.
2. Operations Research: Theory and Applications: J.K. Sharma, Trinity Press, 2016.
3. Operations Research: H.A. Taha, Prentice Hall of India, 2011.
4. Operations Research: R. Bronson, Schaum's Outline Series McGraw Hill, 1982.

SEMESTER-I

PAPER-VI VIVA-VOCE SOS/ Math/C006

SEMESTER-II

PAPER-VII ABSTRACT ALGEBRA-II SOS/ Math/C007

I. Embedding of rings, Ring of residue classes, Fundamental theorem on homomorphism of ring , Prime ideals, Maximal ideal.
II. Euclidean ring, Properties of Euclidean ring, Module, sub-module, Module homomorphism, Linear sum and direct sum of sub-module
III. Extension fields, Simple field extension, Algebraic field extension, Minimal polynomial, Roots of polynomials, Multiple roots.
IV. Splitting field and its examples, Automorphism of field, Fixed field, Normal extension, Galois group: Examples and characterizations, Construction with straight edge and compass.

TEXT/REFERENCE BOOKS

1. Contemporary Abstract Algebra :Josheph A. Gallian, Narosa Pub. House P. Ltd.
2. A First course in Abstract Algebra : John. B. Fraleigh, Pearson Edu. Inc. , 2003.
3. Abstract Algebra : V.K. Khanna and S.K. Bhambri, Vikash Pub. House P. Ltd.
4. Topics in Algebra : I. N. Herstein, John Wiley & Sons, New York.

SEMESTER-II

PAPER-VIII FLUID DYNAMICS SOS/ Math/C008

I. Kinematics of fluids, Lagrangian and Eulerian methods, Local and individual time rates of change, Equation of continuity, Boundary surface.

II. Equation of motion of inviscid fluids, Euler's equation of motion, Bernoulli's equation, Lagrange's equation, Conservative field of force, Cauchy's Integral, Helm- Holtz's equation.

III. Impulsive motion of a fluid, Energy equation of inviscid fluid, General theory of irrotational motion, Connectivity, Flow and circulation, Kelvin's circulation theorem, Stokes's theorem, Permanence of irrotational motions, Green's theorem, Kinetic energy of finite and infinite liquid, Kelvin's minimum energy theorem, Mean value of the velocity potential over a spherical surface.

IV. Motion in two dimensions, Stream function, Complex potential, Source, Sink, Doublet, Complex potential and images with respect to straight line and circle, Milne- Circle theorem, Blausius theorem.

TEXT/REFERENCE BOOKS

1. Foundation to Fluid Mechanics: S.W. Yuan, Prentice Hall Pvt. Ltd., 1960.
2. Text book of Fluid Dynamics: F. Chorlton, CBS Pub. & Dist. , 2004.
3. Theoretical Hydro-Dynamics: BansiLal, Skylark Pub., 1999.
4. A text book of Fluid – Dynamics: M. Ray & Sharma, S. Chand & Co. Ltd. 2005.

SEMESTER-II

PAPER-IX OPERATIONS RESEARCH-II SOS/ Math/C009

I. Inventory control, Functional role of inventory control, Classification of EOQ models with shortages and without shortages.

II. Queuing theory, Characteristics of Queuing system, Probability distribution in queuing system, Single served queuing model, M|M|1 queuing models, Multiple server queuing models.

III. Markov chain, Application of Markov analysis, State and transition probabilities, Steady state conditions, Sequencing problems, Processing n jobs through two and three machines.

IV. Dynamic programming, Dynamic programming under certainty, Non-linear programming methods, Quadratic programming, Kuhn- Tucker conditions.

TEXT/REFERENCE BOOKS

1. Operations Research: Kanti Swarup, P.K. Gupta & Man Mohan, S. Chand, 1978.
2. Operations Research: Theory and Applications: J.K. Sharma, Trinity Press, 2016.
3. Operations Research: H.A. Taha, Prentice Hall, 2011.
4. Operations Research: R. Bronson, McGraw Hill, 1982.

SEMESTER-II

PAPER-X REAL ANALYSIS SOS/ Math/C0010

I. The Riemann-Stieltjes Integral: Definition and existence of Riemann-Stieltjes integral, Properties of integrals, Integration and differentiation, Fundamental theorem of calculus, Integration of vector-valued functions.

II. Sequences and series of functions, Pointwise and uniform convergence, Cauchy criterion for uniform convergence, Uniform convergence and continuity, Uniform convergence and Riemann-Stieltjes integral, Uniform convergence and differentiation, Weierstrass approximation theorem.

III. Power series, Algebra of power series, Uniqueness theorem for power series, Abel's theorem, Taylor's theorem.

IV. Functions of several variables, Concept of functions of two variables, Continuity, Partial derivatives, Differentiability, Change of variables, The inverse function theorem, The implicit function theorem, Chain rule.

TEXT/REFERENCE BOOKS

1. Mathematical Analysis: S.C. Malik and Savita Arora, New Age Int. 1992.
2. Mathematical Analysis: T.M. Apostol, Pearson Edu. , Taiwan Ltd., 1974.
3. Real analysis: H.L. Royden, Pearson, 2017.
4. Real Analysis: Terence Tao, Springer.

SEMESTER-II

PAPER-XI METRIC SPACES SOS/ Math/C0011

I. Metric on a set, Pseudo-metrics, Equivalent metrics, Limit point, Closed sets, Adherent point, Dense subsets, Interior of a set and its properties, Subspaces, Product spaces.

II. Convergent sequences, Cauchy sequences, Algebra of convergent sequences, Subsequences, Continuity at a point, Continuity over a space, Algebra of real valued continuous functions in a metric space, Homeomorphism, Isometries, Uniform continuity.

III. Complete metric spaces, Completeness and continuous mappings, Cantor's intersection theorem, Contraction mapping theorem, Connectedness in metric spaces, Properties of connectedness.

IV. Compact spaces, Compact subsets of the real line, Compactness and continuous mappings, Sequential compactness, Countable compactness, B-W property, B-W property and boundedness,B-W property and compactness, Compactness and uniform continuity, Lebesgue covering Lemma.

TEXT/REFERENCE BOOKS

1. Introduction to Topology and Modern Analysis: G.F. Simmons, Tata McGraw-Hill.
2. Metric Spaces: E.T. Copson, Cambridge University Press, 1968.
3. Topology : Robert H. Kasriel, Dover Pub. , 2009.
4. Topology of Metric Spaces: S. Kumaresan, Alpha Science Int. , 2011.

SEMESTER-II

PAPER-XII VIVA-VOCE SOS/ Math/C0012

SEMESTER-III

PAPER-XIII TOPOLOGY SOS/ Math/C0013

I. Definition and examples of topological spaces, Closed sets, Closure, Dense subsets, Neighborhoods, Interior, Exterior and accumulation points, Bases and sub bases, subspaces, Product spaces and relative topology.

II. Continuous function, Homeomorphism, Connected and disconnected sets, Components, Locally connected spaces.

III. Countability axioms, First and second countable spaces, Lindelof's theorem, Separable spaces, Second countable and separability, Separable axioms: $T_0, T_1, T_2, T_3, T_{3\frac{1}{2}}, T_4$ and their characterizations.

IV. Compactness, Continuity and compact sets, Basic properties of compactness, Compactness and finite intersection property, Sequentially and countably compact sets, Local compactness, Tychonoff's theorem.

TEXT/REFERENCE BOOKS

1. Topology: A First Course: James R. Munkres, Prentice Hall, Incorporated, 2000.
2. General Topology: J.L. Kelly, Springer, 1975.
3. Topology and Modern Analysis: G.F. Simmons, Tata McGraw-Hill.
4. General Topology: Seymour Lipchitz, Schaum Outline Series.

SEMESTER-III

PAPER –XIV DIFFERENTIAL EQUATIONS SOS/ Math/C0014

I. Ordinary differential equations: Qualitative properties of solution, Oscillation, Wronskian, Sturm separation and comparison theorem, Picard iteration methods, Uniqueness and existence theorem.

II. Ordinary points, Regular and singular points, Frobenius series solution for Legendre's and Bessel's differential equations with generating functions.

III. Classification of PDE of 2^{nd} order and canonical forms, Concept of separation of variable solution.

IV. Solution of heat diffusion, Laplace and wave equations, Non-linear partial differential equation of second order.

TEXT/REFERENCE BOOKS

1. Differential equation with Applications and Historical notes: G.F. Simmons, CRC Press, Taylor & Francis Group.
2. A Course in ODE : B. Rai, D.P. Chaudhary & H.I.Freedman, Alpha Sci. Int. Ltd.
3. Advanced Differential Equations: M.D. Raisinghania, S. Chand Pvt. Ltd., 2008.

SEMESTER- III

PAPER- XV DIFFERENTIAL GEOMETRY SOS/ Math/ E001

I. Curves in space; Arc length, Order of contact, Tangent, Normal, Binormal, Osculating, Plane, Serret-Frenet formulae, Curvature and torsion. Osculating circle and osculating sphere, Helix, Bertrand curves.

II. Behaviour of a curve in the neighbourhood of a point. Concept of a surface, Envelope and developable surface, Parametric curves, Family of the surfaces, Edge of regression, Ruled surfaces, Central points.

III. Fundamental forms and curvature of surfaces: First fundamental form. Second fundamental form of the surfaces of revolution, Weingarten's equation, Direction coefficients, Family of curves.

IV. Local non-intrinsic properties of a surface Normal curvature, Principal directions, Principal curvatures, Minimal surface, Lines of curvature. Rodrigues and Monge's theorem, Euler's theorem, Joachimisthal's theorem, Dupin'sindicatrix, Third fundamental form.

TEXT/REFERENCE BOOKS

1. Differential Geometry: T.J. Willmore, Dover Pub. Inc., New York.
2. Differential Geometry of Three Dimensions: C.E. Weathrburn, Cambridge Univ. Press.
3. Elements of Differential Geometry: R.S. Millman & G.D. Parket, Prentice Hall.
4. Introduction to Differential Geometry: A. Goctz, Addison Wesley Pub. Co., 1970.

SEMESTER – III

PAPER-XVI MATHEMATICAL STATISTICS SOS/ Math/E002

I. Elements of probability, Sample space, Discrete probability, Baye's theorem, Random variables and distribution functions, Mathematical expectations and moments.

II. Some standard discrete and continuous univariate distributions: Binomial, Poisson, Normal, Gamma and Beta distributions.

III. Correlation, Rank correlation, Regression line, Multiple and partial correlation of three variables only, Data reduction techniques, Canonical correlation.

IV. Concepts of sampling, Stratified sampling and systematic sampling, Test of hypothesis: t,z ,chi square test.

TEXT/REFERENCE BOOKS

1. Fundamental of Mathematical Statistics : S.C. Gupta and V.K. Kapoor, S. Chand.
2. Advanced Theory of Statistics : M.G. Kandall.
3. A first Course on Mathematical Statistics: C.E. Weatherburn, Cambridge Univ. Press, 1968.

SEMESTER-III

PAPER-XVII CALCULUS OF VARIATIONS SOS/ Math/E003

I. Variation of functional, Continuity and differentiability of functional, Necessary condition for an extremum, Euler's equation, Variational problems in parametric form, Functional depending on higher order derivatives and variational problems with subsidiary condition.

II. The isoperimetric problem, Invariance of Euler's equation under coordinate transformation, General variational of functional, Variable end point problems, Transversality condition transversal theorem, Weierstrass-Endmann corner condition.

III. Sufficient condition for extremum: secondvariation, Legendre's and Jacobi's necessary condition, Canonical transformation, Noether's theorem, The principle of least action, Conservation law, Hamilton Jacobi's equations.

IV. Transformation of ODE and PDE into functionals and their solutions by Ritze, Galerkin, Collocationand Kantrovitch methods.

TEXT/REFERENCE BOOKS

1. Calculus of Variation: Gelfrand and Fomin, Dover Pub. Inc., New York.
2. Calculus of Variation: Elsgolt , University Press of the Pacific, 2003.
3. Calculus of Variation: A.S.Gupta, PHI Learning Pvt. Ltd., 2015.

SEMESTER- III

PAPER-XVIII COMPUTER FUNDAMENTALS AND DATA STRUCTURES SOS/ Math/E004

I. History and classification of computers, Fundamentals of computer system: Data types, Number system, Complements; Floating point representation, Normalized floating point representation, Fixed point represented arithmetic computations.

II. Truth tables, Boolean algebra, De-Morgan's theorem, Logical gates, Logic diagram, Logical expressions/functions, Karnaugh maps, Sum of product and product of sum, Combinational circuits and integrated circuits.

III. Introduction to data structures, Arrays, Stack and queues, Linked lists, Singly and doubly linked lists, Binary trees, Operations on binary trees and applications.

IV. Sorting, Searching, Algorithms and graphs.

TEXT/REFERENCE BOOKS

1. Fundamental of Computers :V. Raja Raman, PHI Learning Pvt. Ltd.
2. Introduction to Computers :P. Norto, Glencoe/ McGraw-Hill, 1998.
3. Data Structures with C: S.Lipschutz, Tata McGraw-Hill Pvt. Ltd.

SEMESTER -III

PAPER- XIX ALGEBRAIC CODING THEORY SOS/ Math/E005

I. The communication channel, The coding problem, Types of codes, Error-detecting and error-correcting codes, Linear codes, Hamming metric, Description of linear block codes by matrices.

II. Dual codes, Standard array, Step-by-step decoding, Modular representation, Error-correction, Capabilities of linear codes, Bounds of minimum distance for block codes, Plotkin bound, Hamming sphere packing bound, Bounds for burst-error detecting and correcting codes.

III. Important linear block codes, Hamming codes, Golaycodes, Perfect codes, Quasi-perfect codes, Reed-Muller codes, Codes derived from Hadamard matrices, Product codes, Concatenated codes.

IV. A double error correcting decimal code and an introduction to BCH codes, BCH bounds, Cyclic codes, Matrix representation of cyclic codes, Error detection and cyclic codes, MDS codes.

TEXT/REFERENCE BOOKS

1. Fundamental of Error- Correcting Codes: V. Pless and W.C. Huffman, Cambridge Univ. Press.
2. A First Course in Coding Theory: Ramond Hill, Oxford Univ. Press.
3. Error Correcting Coding Theory: M.Y. Rhee, McGraw-Hill, 1989.
4. Algebraic Coding Theory: E.R. Berlckamp, World Sci. Pub. Pvt. Ltd.

SEMESTER -III

PAPER -XX SELF-STUDY: (Choose any one):

Paper -XX (a) MATHEMATICAL METHODS SOS/Math/E006 (a)

I Hermitepolynomiasl.
II Chebyshev polynomials.
III Laguerre polynomials.
IV Hypergeometric Functions.

TEXT/REFERENCE BOOKS

1. The Special Functions and their Applications: Y. L. Luke, Acad. Press, New York.
2. Special Functions: G.E. Andrews, R. Askey, R. Roy, Cambridge Univ. Press.

PAPER- XX (b) TENSOR ANALYSIS AND SPECIAL THEORY OF RELATIVITY SOS/Math/E006 (b)

I. Invariance – Transformations of coordinates and its properties, Transformation by invariance, Transformations by covariance and contra variance, Tensor and their lows of transformations, Algebras of tensors-Quotient Tensors, Symmetric and skew symmetric tensors, Relative tensors.
II. Metric Tensor, The fundamental and associated tensors, Christoffel's symbols, Transformations of Christoffel's symbols, Covariant differentiation of tensors, Formulas for covariant differentiation, Ricci theorem, Riemann-Christoffel tensor and their properties.
III. Einstein tensor, Riemannian and Euclidean Spaces (Existence Theorem), The e- systems and the generalized Kronecker delta, Application of the e-systems.
IV. Special theory of relativity, Galilean transformation, Maxwell's equations, The ether theory, The principle of relativity, Relativistic kinematics, Lorentz transformation equations, Events and simultaneity, Example of Einstein strain, Time dilation, Longitudinal Contraction, Invariant Interval, Proper time and proper distance, World line, Example of twin paradox , Addition of velocities, Relativistic Doppler's effect.

TEXT/REFERENCE BOOKS

1. Tensor Analysis: I.S. Sokolnikoff, John Wiley and Sons, New York, 1964.
2. Classical Dynamics: D. Greenwood, Prentice Hall of India, New Delhi, 1985.
3. Tensor Calculus, Toronto, 1949 :J.L. Synge and A. Schild.
4. An Introduction to Theory of Relativity, New York, 1942: P.G. Bergman.

PAPER- XX (c) FINANCIAL MATHEMATICS SOS/Math/E006 (c)

I. Single period model, Definitions of finance- pricing, Forward- one- step binary model, Ternary model- Characterization of no arbitrage, Risk-neutral probability measure

II. Bi normal trees and discrete parameter martingales, Multi-period binary model, American options, Discrete parameter martingales and Markov processes, Martingale theorems, Binomial representation theorem overturn to continuous models

III. Brownian motion, Definition of the process, Levy's construction of brownian motion, The reflection principle and scaling, Martingales, Continuous time.

IV. Stochastic calculus, Non-differentiability of stock prices, Stochastic integration, Ito's formula, Integration by parts and stochastic, Fubini theorem, Girsanov theorem, Brownian martingale representation theorem, Geometric brownian motion, The Feynman- Kac representation.

TEXT/REFERENCE BOOKS

1. A Course in Financial Calculus: Alison Etheridge, Cambridge Univ. Press, 2002.
2. Financial Calculus: An Introduction to Derivatives Pricing : Martin Boxter and Andrew Rennie, Cambridge Univ. Press, 1996.
3. Introduction to Stochastic Calculus Applied to Finance: Damien Lamberton and Bernard Lapeyre, Chapman and Hall, 1996.
4. Martingale Methods in Financial Madeling: Marek Musiela and Marek Ruthowshi, Springer Verlag, New York, 1988.

PAPER-XXI VIVA-VOCE SOS/Math/C0015

SEMESTER –IV

PAPER-XXII MEASURE AND INTEGRATION SOS/Math/C0016

I. Lebesgue outer measure, Measure of open and closed sets, Borel sets, Measurable sets, Measure of cantor's ternary set, Non-measurable sets.

II. Measurable functions, Algebra of measurable functions, Step functions, Characteristic function, Simple functions, Convergence in measure, Egoroff's theorem, Riesz theorem.

III. Lebesgue Integral and their properties, General Lebesgue integrals, Lebesgue integrals for unbounded functions, Convergence theorems, Fatou Lemma.

IV. Functions of bounded variations, Absolutely continuity, Variation function, Jordan-decomposition theorem, Indefinite integral and its characterizations, Differentiation of an integral, Lebesgue differentiation theorem.

TEXT/REFERENCE BOOKS

1. Real Analysis: H.L. Royden, Pearson, 2017.
2. Measure and Integration: S.K. Berberian, The Macmillan Company, 1965.
3. Lebesgue Measure and Integration: P.K. Jain and V.P. Gupta, Wiley, 1986.
4. Measure Theory and Integration: G. De. Barra, Horwood, 2003.

SEMESTER-IV

PAPER- XXIII FUNCTIONAL ANALYSIS SOS/Math/C0017

I. Normed linear spaces, Banach spaces, Subspaces, Quotient Spaces, Equivalent, Norms.

II. Bounded linear Transformation/operators, Hahn- Banach theorem, Open mapping theorem, Closed graph theorem, Uniform boundedness principle.

III. Inner product spaces, Hilbert spaces, Orthogonality of vectors, Orthogonal complements and projection theorem, Riesz representation theorem, Orthonormal Sets.

IV. Operators on Hilbert Spaces, Self-adjoint, Normal and unitary operators, Orthogonal projection operators.

TEXT/REFERENCE BOOKS

1. Functional Analysis: P.K. Jain, O.P. Ahuza and Khalil Ahamad, Wiley, 1996.
2. Topology and Modern Analysis: G.F. Simmons, Tata McGraw-Hill.
3. Introductory functional Analysis with Applications: E. Kreyszig, Wiley, 1989.
4. Functional Analysis: B.V. Limaye, New Age Int. Pvt. Ltd.

SEMESTER IV

Paper-XXIV LINEAR INTEGRAL EQUATIONS SOS/Math/E007

I. Classification of integral equations, Relation between differential and integral Equations, Fredholm integral equations, Fredholm equations of second kind with separable kernels, Eigen values and Eigen functions

II. Volterra integral equations, Resolvent kernel of Volterra equation, Convolution type kernel, Integral equations with symmetric kernel.

III. Method of successive approximation for Fredholm and Volterra equations of the second kind.

IV. Classical Fredholm theory, Singular integral equations, Hilbert type integral equations, Integral equation with Green's function type kernels.

TEXT/REFERENCE BOOKS

1. Integral Equations and Boundary Value Problem : M.D. Raisinghania, S. Chand.
2. Linear Integral Equations: W. V. Lovit, Dover Pub. Int. New York.
3. Linear Integral Equations: R.P. Kanwal, BirkhauserBoston, 1996.
4. Integral Equations: L. G. Chambers, International Textbook Co., 1976.

SEMESTER– IV

PAPER-XXV INTEGRAL TRANSFORMS SOS/ Math/E008

I. Orthogonal set of functions, Fourier series, Fourier sine and cosine series, Half range expansions, Fourier integral Theorem, Fourier Transform and their Basic Properties.

II. Fourier Cosine Transform, Fourier Sine Transform, Transforms of Derivatives, Fourier Transforms of simple Functions, Fourier Transforms of Rational Functions, Convolution Integral, Parseval's Theorem for Cosine and Sine Transforms, Inversion Theorem, Solution of Partial Differential Equations using Fourier Transforms, Solution of Laplace and Diffusion equations.

III. Laplace Transform: Definition, Transform of some elementary functions, rules of manipulation of Laplace Transform, Transform of Derivatives, Relation involving Integrals, The error function, Transform of Bessel functions, Periodic functions, Convolution of two functions.

IV. Inverse Laplace Transform and their Properties, First &Second Shifting Properties, Inverse Laplace Transforms of Derivative and Integrals, Tauberian Theorem, Solution of Initial value problems for linear equations with constant coefficients, Linear differential equations with variable coefficients.

TEXT/REFERENCE BOOKS

1. Integral Transforms and Their Applications by Lokenath Debnath & Dambaru Bhatta, Chapman & Hall/CRC, Taylor and Francis Group , London, New York, 2007.
2. Integral Transforms in Applied Mathematics by John W. Miles, Cambridge University Press,2010.
3. Ian N. Sneddon, Fourier Transforms , Dover Publications,2010 .
4. Advanced Engineering Mathematics by H.K. Dass, S. Chand , New Delhi,2015.

SEMESTER-IV

PAPER- XXVI FUZZY SET THEORY SOS/Math/E009

I. Fuzzy sets, Basic definitions, Alpha-cut sets, Convex fuzzy sets, Basic operation on fuzzy sets, Types of fuzzy sets, Cartesian products, Algebraic products, Bounded sum and differences, t-norms and t-corners.

II. The extension principle, The Zadeh's extension principle, Images and inverse image of fuzzy sets, Fuzzy numbers, Element of fuzzy arithmetic.

III. Fuzzy relation and fuzzy graphs. Fuzzy relation on fuzzy sets, composition of fuzzy relation, min-max composition and properties, equivalence relations, fuzzy compatibility relation, Fuzzy relation equations.

IV. Fuzzy logic, An overview of classical logic, Multivalued logic, Fuzzy propositions, Fuzzy qualifiers, Linguistic variables and hedge.

TEXT/REFERENCE BOOKS

1. Fuzzy sets and Fuzzy logic: G.L. Klir and Yuan, World Sci. Pub. Co. Pvt. Ltd.
2. Fuzzy set theory and its Applications: H.J. Zimmermann, Springer, 1991.
3. Fuzzy set theory, Fuzzy logic and their Applications: A.K. Bhargava, S. Chand.
4. First Course on Fuzzy Theory and Applications :Kwang H. Lee, Springer, 2004.

SEMESTER-IV

PAPER- XXVII MATHEMATICAL MODELING SOS/Math/E010

I. Mathematical Modeling through ordinary differential equations of first order, Linear growth and decay models, Non-linear growth and decay models, Compartment models- dynamics problem, Geometrical problems.

II. Mathematical Modeling through systems of ordinary differential equations of first order, Population dynamics, Epidemics-compartment models, Economics, Medicine, Arm- race, Battles and international trade- dynamics.

III. Mathematical modeling through ordinary differential equations of second order, Planetary motions, Circular motion, Motion of satellites, Mathematical modeling through linear differential equations of second order, Miscellaneous mathematical models.

IV. Mathematical modeling through difference equations, Simple models, Basic theory of linear difference equations with constant coefficients, Economics and finance- population- dynamics and genetics- probability theory.

TEXT/REFERENCE BOOKS

1. Mathematical Modeling: J.N. Kapur, New Age Int. Pvt. Ltd. 2008.

2. Mathematical Models in Biology and Medicine: J. N. Kapur, New Delhi, Affiliated East-West Press, 1985.

3. Mathematical Modeling: Dick Clements, Cambridge Univ. Press, 2012.

4. The Nature of Mathematical Modeling: Neil Gershenfeld, Cambridge Univ. Press.

SEMESTER-IV

PAPER- XXVIII NUMBER THEORY SOS/MATH/E011

I. The division algorithm, The gcd, The Euclidean algorithm, Diophantine equation $ax + by = c$, The fundamental theorem of arithmetic, The sieve of Eratosthenes, Goldbach conjucture.

II. The theory of congruences, Binary and decimal representation of integers, Linear congruences and Chinese remainder theorem, Fermat's theorem, Wilson's theorem.

III. Number theoretic function, Tau and sigma function, the Mobius inversion formula, The greatest integer function, Euler's phi function, Properties of phi function, Euler theorem.

IV. The order of an integer modulo n, Primitive roots for primes, Composite numbers having primitive roots, The theory of indices, Continued fraction, Approximation of irrationals by rationals.

TEXT/REFERENCE BOOKS

1. Elementary Number Theory: David M. Burton, McGraw-Hill.

2. Theory of Numbers: George Andrews, Courier Corporation, 1994.

3. Elementary Number Theory with Applications: Thomas Koshy, Harcourt Acad. Pres

PAPER-XXIX VIVA-VOCE SOS/MATH/C0018

(Revised Syllabus w.e.f. 2020-21)
H.N.B. Garhwal University Srinagar (Garhwal), Uttarakhand

Pre-Ph.D. Mathematics Course Structure

Core Course:

Paper I. Research Methodology SOS/MAT/PHD/C001 (4 Credits)

Paper II. Research & Publication Ethics and MATLAB SOS/MAT/PHD/C002 (3 Credits)

Elective Course:

Paper III. Applied Functional Analysis SOS/MAT/PHD/E001 (4 Credits)

Paper IV. Partial Differential Equations SOS/MAT/PHD/E002 (4 Credits)

Paper V. Mathematical Analysis SOS/MAT/PHD/E003 (4 Credits)

Paper VI. Fluid Dynamics with Computational Technique SOS/MAT/PHD/E004 (4 Credits)

Paper VII. Differential Geometry SOS/MAT/PHD/E005 (4 Credits)

Paper VIII. Algebraic Topology SOS/MAT/PHD/E006 (4 Credits)

Note :

1. Papers I and II are compulsory.
2. Choose any two papers out of elective papers (III-VIII).
3. Each papers carries 100 marks which includes two sessional tests (each of 20 marks)

PAPER I: RESEARCH METHODOLOGY (SOS/MAT/PHD/C001)

04 credits

I. Perception of research, meaning of research, objective of research, different approaches to research, empirical and theoretical research, qualities of a research work, inductive and deductive logics.

II. The scientific method, examples of scientific methods, different phases in scientific method, the use of computers in obtaining proofs of mathematical results, valid and invalid generalization.

III. Problem posing, the soul of research methodology, chains of open ended problems, the art of solving problems, Polya's scheme for solving problems, model building in mathematics.

IV. Basic idea of probability distribution, Elementary sampling theory (a brief introduction), test of significance T, F, Z and Chi-square distribution (a brief introduction).

TEXT BOOKS

1. Research Methodology for Scientists and Engineers: J.N. Kapur, Mathematical Sciences Trust Society.
2. Fundamentals of Research Methodology and Statistics : Y.K. Singh, New Age International.
3. Thesis and Assignment Writing : Anderson and Jonathon. Wiley Eastern Bombay.
4. How to write Assignments, Research papers, Dissertation and Thesis : V.H. Bedkar, Karak publication New Delhi.

PAPER II:RESEARCH & PUBLICATION ETHICS and MATLAB(SOS/MAT/PHD/C002)

Part (A): 02 credits.

I. Research and Publication Ethics: Theory: - Philosophy and ethics, Scientific conduct, Publication ethics.

II. Research and Publication Ethics: Practice: - Open access publishing, Publication misconduct, Databases and research metrics.

Part (B): 01 credit.

III. Introduction to programming in MATLAB, Applications of MATLAB, Numerical solution of algebraic and transcendental equations, System of linear equations and initial value problems.

TEXT BOOKS:

1. Ethics in Research Practice and Innovation, Antonio Sandu, Ana Frunza and Elena Unguru, IGI Global.

2. An Introduction to Programming and Numerical Methods in MATLAB: S.R. Otto and J.P. Denier, Springer.

3.Numerical Methods with MATLAB for Engineers and Scientists : S. Chapra, Mc-Graw-Hill.

Elective (Choose any two of the following papers III-VII, each of 04 credits)

PAPER III: APPLIED FUNCTIONAL ANALYSIS (SOS/MAT/PHD/E001)

I. Banach fixed point theorem and its applications.
II. Approximation in normed spaces, Approximation in Hilbert spaces.
III. Spectral theory of linear operators in normed spaces.
IV. Spectral theory of bounded self-adjoint operators.

TEXT BOOKS

1. Introductory Functional Analysis with Applications :Kreyszig, John Wiley & Sons.
2. Functional Analysis : W. Rudin, McGraw-Hill.
3. Introduction to Hilbert spaces : S. Berberian, Oxford Univ. Press.
4. Introduction to Approximation Theory : E. W. Chency, McGraw-Hill.

PAPER IV:PARTIAL DIFFERENTIAL EQUATIONS WITH APPLICATIONS

(SOS/MAT/PHD/E002)

I. First order partial differential equations.
II. Principles for higher-order equations.
III. The wave equations.
IV. The heat equations.

TEXT BOOKS

1. Partial Differential Equations : Methods and Applications : R.C. Mcowen, Pearson Education.
2. Partial Differential Equations : L. Bers, F. John and M. Schechter, John Wiley and Sons.
3. Introduction to Partial Differential Equations : G. Folland, Princeton Univ. Press.
4. Partial Differential Equations : F. John, Springer-Verlag, New York.

PAPER V: MATHEMATICAL ANALYSIS (SOS/MAT/PHD/E003)

I. Power series : Properties of functions expressible as powerseries, Abel's theorem,
II. Fourier series : Fourier coefficient, periodic functions, piecewise monotonic functions, Fourier series for even and odd functions, half range series.
III. Function of several variables: Explicit and implicit functions, function oftwo variables, repeated limits, continuity, partial derivatives, differentiability, Young's theorem, Schwarz theorem.
IV. Differentials of higher order, functions of functions, chain rule, change of variables, Taylor's theorem, functions of several variables, implicit function theorem.

TEXT BOOKS

1. Mathematical Analysis :Apostol, Narosa Publishing House.
2. Foundations of Modern Analysis : J. Dieudonne's Academic Press.
3. Principles of Mathematical Analysis : W. Rudin, McGraw-Hill.
4. A first Course in Real Analysis : S.K. Berberian, Springer-Verlag, New York.

PAPER VI: FLUID DYNAMICS WITH COMPUTATIONAL TECHNIQUES

(SOS/MAT/PHD/E004)

I. Laminar flow of viscous incompressible fluids.
II. Boundary layer theory.
III. Dimensional analysis.
IV. Fundamentals of finite element technique.

TEXT BOOKS

1. Foundation of Fluid Mechanics : S.W. Yuan, Prentice Hall Pvt. Ltd., 1960.
2. Text Book of Fluid Dynamics : F. Chorlton, CBS Pub. & Dist., 2004.
3. Fluid Dynamics : Hughes and Brighton, McGraw Higher Ed, 2007.
4. Finite Element Method : J.N. Reddy, McGraw-Hill, 2007.

PAPER VII: DIFFERENTIAL GEOMETRY (SOS/MAT/PHD/E005)

I. Riemannian geometry.
II. Kaehlerian, Hermitian and Tachibana spaces.
III. Manifolds and submanifolds.
IV. Hypersurfaces

TEXT BOOKS

1. Differential Geometry :K. Yano& M. Kon, World Sci. Pub. Pvt. Ltd.
2. Differential Geometry :Weatherburn, Cambridge Univ. Press, 1930.
3. Differential Manifold :R.S. Mishra, Indian national Sci. Acad., 1978.

PAPER VIII: ALGEBRAIC TOPOLOGY (SOS/MAT/PHD/E006)

I. The fundamental group, homotopy, contractive spaces and homotopy type, the fundamental group of circle.
II. Finite simplical complexes, polyhedral and triangulations, simplical approximation.
III. Orientation of simplical complexes, simplical chain complex and homology, properties of integral homology groups.
IV. Induced homomorphism, degree of a map and its applications, invariance of homology groups, homotopy invariance, Lefschetz fixed point theorem.

TEXT BOOKS

1. Algebraic Topology :StyaDeo, Hindustan Book Agency, India, 2006.
2. Algebraic Topology : William Fulton, Springer, Verlag.
3. A Basic Course in Algebraic Topology : W.S. Massely, Springer, 2007.
4. Elements of Algebraic Topology : James Munkres, CRC Press.