# H.N.B. Garhwal University Srinagar Garhwal

**Department of Mathematics**

**M.A./M.Sc. Mathematics Course Structure**

*(Applicable to the Candidates admitted from the Academic year 2015-16 onwards)*

## Semester – I

### Core Course

<table>
<thead>
<tr>
<th>Paper</th>
<th>Course</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Discrete Structures</td>
<td>SOS/Math/C001</td>
</tr>
<tr>
<td>II</td>
<td>Abstract Algebra</td>
<td>SOS/Math/C002</td>
</tr>
<tr>
<td>III</td>
<td>Mechanics</td>
<td>SOS/Math/C003</td>
</tr>
<tr>
<td>IV</td>
<td>Complex – Analysis</td>
<td>SOS/Math/C004</td>
</tr>
<tr>
<td>V</td>
<td>Operations Research</td>
<td>SOS/Math/C005</td>
</tr>
<tr>
<td>VI</td>
<td>Practical</td>
<td>SOS/Math/C006</td>
</tr>
</tbody>
</table>

## Semester II

### Core Course

<table>
<thead>
<tr>
<th>Paper</th>
<th>Course</th>
<th>Code</th>
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</thead>
<tbody>
<tr>
<td>VII</td>
<td>Abstract Algebra II</td>
<td>SOS/Math/C007</td>
</tr>
<tr>
<td>VIII</td>
<td>Fluid Dynamics (Remove Vth Unit)</td>
<td>SOS/Math/C008</td>
</tr>
<tr>
<td>IX</td>
<td>Operations Research II</td>
<td>SOS/Math/C009</td>
</tr>
<tr>
<td>X</td>
<td>Graph Theory</td>
<td>SOS/Math/C010</td>
</tr>
<tr>
<td>XI</td>
<td>Topology I</td>
<td>SOS/Math/C011</td>
</tr>
<tr>
<td>XII</td>
<td>Practical</td>
<td>SOS/Math/C012</td>
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</tbody>
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## Semester III

### Core Course

<table>
<thead>
<tr>
<th>Paper</th>
<th>Course</th>
<th>Code</th>
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</thead>
<tbody>
<tr>
<td>XIII</td>
<td>Topology II</td>
<td>SOS/Math/C010</td>
</tr>
<tr>
<td>XIV</td>
<td>Measure Theory I</td>
<td>SOS/Math/C014</td>
</tr>
<tr>
<td>XV</td>
<td>Differential Geometry</td>
<td>SOS/Math/C015</td>
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</tbody>
</table>

### Elective Course

<table>
<thead>
<tr>
<th>Paper</th>
<th>Course</th>
<th>Code</th>
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</thead>
<tbody>
<tr>
<td>XVI</td>
<td>Fluid Mechanics</td>
<td>SOS/Math/E001</td>
</tr>
<tr>
<td>XVII</td>
<td>Calculus of Variation</td>
<td>SOS/Math/E002</td>
</tr>
<tr>
<td>XVIII</td>
<td>Computer fundamentals and data structures</td>
<td>SOS/Math/E003</td>
</tr>
<tr>
<td>XIX</td>
<td>Algebraic Coding theory</td>
<td>SOS/Math/E004</td>
</tr>
</tbody>
</table>

### Self- Study Course -

<table>
<thead>
<tr>
<th>Paper</th>
<th>Course</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>XX</td>
<td>From the other Departments (Any one of the following)</td>
<td>SOS/Math/E005</td>
</tr>
<tr>
<td></td>
<td>(a) Mathematical Techniques</td>
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<td>(b) Tensor Analysis and Special Theory of Relativity</td>
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<td></td>
<td>(c) Financial Mathematics</td>
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### Core Course

<table>
<thead>
<tr>
<th>Paper</th>
<th>Course</th>
<th>Code</th>
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</thead>
<tbody>
<tr>
<td>XXI</td>
<td>Viva-voce</td>
<td>SOS/Math/C016</td>
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</tbody>
</table>

## Semester IV:

### Core Course

<table>
<thead>
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<th>Paper</th>
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<th>Code</th>
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<tbody>
<tr>
<td>XXII</td>
<td>Measure Theory II</td>
<td>SOS/Math/C0017</td>
</tr>
<tr>
<td>XXIII</td>
<td>Integral Equations and boundary value problems</td>
<td>SOS/Math/C0018</td>
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Paper XXIV  Functional Analysis                  SOS/Math/C0019

**Elective Course**

Paper XXV  Biomechanics                     SOS/Math/E006
Paper XXVI  Fuzzy set theory                SOS/Math/E007
Paper XXVII Mathematical modeling         SOS/Math/E008

**Core Course**

Paper XXIX  Viva-voce                     SOS/Math/C0020

**Note:**

1- In Semester I, all paper are compulsory.
2- In Semester II all paper are compulsory.
3- In Semester III, Papers XIII, XIV, XV & XXI are compulsory and choose any two papers out of the Elective Papers XVI, XVII, XVIII & XIX.
4- In Semester V, Papers XXII, XXIII, XXIV & XXIX are compulsory and choose an two out of the Elective Papers XXV, XXVI, XXVII & XXVIII.
5- Each paper carries 100 Marks, which includes two sessional tests (each of 20 Marks) and a main Examination of 60 Marks.

**SEMESTER – I**

**PAPER- I  DESCRETE STRUCTURES**                  SOS/Math/C001

I.   Recurrence relations, linear homogenous 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, Karaugh maps, application of Boolean algebra to switching theory.
IV. Graph, direct graph, undirected graph, relations and graphs, path and circuits, Eulerian and Hamiltonian graphs, planner graphs, connected graphs.

TEXT BOOKS
1. Discrete Mathematics : Khanna & Bhambr
2. Element of Discrete Mathematics: C. I Liu
4. Lattice Theoery: V.K. Khanna
5. Discrete Mathematics: R. Johnsoubaugh

SEMESTER- I

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

I. Class equation and conjugacy classes, Cauchy’s theorem for finite abelian and non-abelian groups, Sylow’s theorems.
II. The normal series and composition series, Jordon-Holder theorem, Solvable groups, External and internal direct products.
III. Ideals, Principal ideals, Quotient rings, Field of quotients, embedding of rings, fundamental theorem on homomorphism and isomorphism.
IV. Prime and maximal ideals, Ring of polynomials, Factorization of polynomials over a field, Factorization theorem in integral domain.

TEXT BOOKS
1. Contemporary Abstract Algebra : Josheph A Gallian
2. A First course in Abstract Algebra : John. B. Fraleigh
3. Modern Algebra : Surject Singh and Quazi Jameerudin
4. Topics in Algebra : I. N. Herstein

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.
III. Hamiltonia’s canonical equations, Hamilton’s principle and principle of least action.
IV. Euler’s equations of motion, Kinetic energy Eulerian angles, Instantaneous axis of rotation.

TEXT BOOKS
1. Dynamics-Pt II: A.S. Ramsay
2. Classic mechanics: H. Goldstein
3. Analytical Mechanics: L.N. Hand and J. Finch
5. Dynamics of Rigid Body: Ray and Sharma
6. Dynamics of Rigid body: S.L. Loney

SEMESTER-I

PAPER-IV COMPLEX ANALYSIS SOS/ Math/C004

I. Complex Integration, Expansion of an angle function as power series, Taylors and
Laurents series, Residue and Poles, Singularities, Classification of Isolated
singularities, Cauchy Residue Theorem.
II. Application of Residue Theorem in evaluation of Improper Real Integers and
evaluation of sum.
III. Conformal Mapping Properties, Mobius Transformation, Elementary examples.
IV. Maximum Modulus Theorem, Mittag-Leffer Theorem, Weirstrases factorization
Theorem, Jensen’s formula, Poisson Jensen formula, Hadmard, three circle
Theorem, Analytic Continuation.

TEXT BOOKS

1. Real and Complex Analysis: W. Rudin
2. Complex Analysis: J.B. Convey
3. Complex Analysis: B. Chaudhary
5. Foundation of Complex Analysis: S. Ponnuomy

SEMESTER –I

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

I. Operation research: an introduction, Methodology of O.R. Features of O.R.
Problems, Applications of O.R. Models Opportunities and shortcomings of O.R.
Approach.
II. Dual simples method, Revised simplex method, Sensitivity analysis.
III. Assignment and transportation problems.
IV. Theory of games, Integer Linear Programming.

TEXT BOOKS


SEMESTER-I

PAPER-VI PRACTICAL SOS/ Math/C006

Based on Paper-I to Paper- V

SEMESTER-II

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

I. Introduction to fields extensions, Finite fields, Algebraic extensions, Simple field Extension, Roots of Polynomials.
II. Splitting Fields, Separable and inseparable extensions, Perfect field.
III. Automorphisms of fields, Fixed fields, Galois’s Theory, Illustrations of Galois’s theory.
IV. Radical extension and solvability, Constructible numbers. The impossibility of certain constructions.

TEXT BOOKS

1. Contemporary Abstract algebra : Josheph A. Gallian
2. A first course in Abstract Algebra : John B. Fraleigh
3. Modern Algebra : Surjeet Singh and Quazi Zameerudin
4. Topics in Algebra : I. N. Herstein

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, Boundry surface.
II. Equation of motion of inviscid fluids, Euler’s equation of motion, Bernouille’s equation, Lanrage’s equation, Conservative field of force, Cauchy’s Integral, Helmholt’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, Stoke’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 dimention; Stream function, Complex potential, Source, Sink, Doublet, Complex potential and images with respect to straight line and circle, Milne-Circle theorem, Blausius theorem.
TEXT BOOKS

1. Foundation to Fluid Mechanics : S.W. Yuan
2. Text book of Fluid Dynamics : F. Chorltron
3. Theoretical Hydro-Dynamics : Bansi Lal

SEMESTER-II

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

I. Inventory control, Deterministic Economic order quality models.
II. Queuing theory, Symbols and notations, Classification of queue, M/M/I queuing models.
III. Markow chain, Project Scheduling by PERT/CPM.
IV. Dynamic programming, non-linear programming, Kuhn-Tueker conditions, Wolfe’s modified simplex method.

TEXT BOOKS


SEMESTER-II

PAPER-X GRAPH THEORY SOS/ Math/C0010

II. Matrix Representation of Graphs.
III. Chromatic number and chromatic polynomials, Matching covering, Chromatic partitioning.
IV. Directed graphs, Digraph and Binary relations, Euler’s digraph, Directed path & connectedness, Acyclic digraph.

TEXT BOOKS

1. Basic Graph Theory : Parthswarthy
2. Graph Theory : N. Deo
3. Graph Theory and Application : C. Vashudev
4. Graph Theory : Harry
SEMESTER-II

PAPER-XI TOPOLOGY-I SOS/
Math/C0011

I. Metric space: open sets, closed sets, closure, interior, exterior, dense and non-dense sets, sequence and subsequence in metric space, complete metric spaces, Cantor’s intersection theorem, Baire’s category theorem.

II. Definition and example of topological spaces, closed sets closure dense subsets, neighborhood, interior and boundary, accumulation points and derived sets, base and sub bases, subspace and relative topology, Kuratowsli closer operator and neighborhood system.

III. Continuity and homeomorphism.

IV. Connectedness: connected and disconnected sets, local connectedness, component and path components, continuity and connectedness, totally disconnected space.

TEXT BOOKS

1. Topology : A First Course : James R. Munkres
2. General Topology : J. L. Kelly
3. Topology and Modern Analysis : G.F. Simmons
4. General Topology : Seymour Lipschutz

SEMESTER-II

PAPER-XII PRACTICAL SOS/
Math/C0012

Based on Paper –VII to Paper- XI

SEMESTER-III

PAPER-XIII TOPOLOGY II SOS/
Math/C0013

I. Compact spaces, sequentially compact spaces, local compactness, continuity and compactness.

II. First and second countable spaces, separability and Lindlof of property.

III. $T_1$ spaces, Hausdorff spaces, regular spaces, normal space, completely normal spaces.

IV. Product spaces, Nets and filters, Urysohn’s lemma, Tietze extension theorem, Tychonoff’s product theorem.

TEXT BOOKS

1. Topology: A First Course : James R. Munkres
2. General Topology : J.L. Kelly
3. Topology and Modern Analysis : G.F. Simmons
4. General Topology : Seymour Lipschutz

SEMESTER-III

PAPER –XIV MEASURE AND INTEGRATION-I SOS/
Math/C0014

I. Denumerable sets, Uncountable sets, Cardinal numbers.
II. Lebesgue measure, Measurable sets, Borel sets, Cantor’s ternary sets and their properties.
III. Measurable functions, set of measure zero, The structure of measurable functions.
IV. Lebesgue Integrals and their properties, Lebesgue integrals for unbounded functions, General Lebesgue integrals.

TEXT BOOKS

1. Real Analysis : H.L. Royden
2. An Introduction to Measure and Integration : Inder K. Rana
3. Lebesgue Measure and Integration : P.K. Jain and V.P. Gupta
4. Measure Theory and Integration : G. De. Barra

SEMESTER III

PAPER- XV DIFFERENTIAL GEOMETRY SOS/
Math/

I. Curves in space; Arc length, Order of contact, Tangent, Normal, Binormal, Osculating, Plane, Serrent-Frenet formulae, Curvature and torsion. Osculating circle and osculating sphere, Helix, Bertand 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’s indicatrix, Third fundamental form.

TEXT BOOKS

1. Differential Geometry : T.J. Willmore
2. Differential Geometry of Three Dimensions : C.E. Weathburn
4. Introduction to Differential Geometry : A. Goetz
SEMESTER – III

PAPER-XVI  FLUID MECHANICS  SOS/ Math/E001

I. Motion of the cylindrical and Elliptic Cylinders.
II. Motion of Sphere, Motion of a sphere in an infinite mass of the liquid at rest at infinity. Liquid streaming past a fixed sphere, Equation of motion of a sphere, Pressure distribution.
III. General theory of stresses and rate of strains: Newton’s law of viscosity, state of stress, principal stresses and principal directions, Transformations of two and three stresses components and rate of strain components, Relation between stresses and rate of strain components.
IV. Navier-Stokes tequations of motion; Energy equation for viscous fluid, Energy dissipation the to viscosity.

TEXT BOOKS

1. Foundation to Fluid Mechanics : Yuan
2. Text book of Fluid Dynamics : F. Chorltron
3. An Introduction to Fluid Mechanics: G.K. Batchclor
4. Fluid Dynamics : M.D. Raisinghania

SEMESTER-III

PAPER-XVII  CALCULUS OF VARIATION  SOS/ Math/E002

I. Variation of function: Necessary condition for an extremum. Euler’s equation, fixed end point problem for unknown functions. 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.
IV. The second variation of a functional and the formula for second variation, Legendre’s necessary condition. Jacobi’s necessary condition, Conjugate point, Sufficient condition for a weak extremum.

TEXT BOOKS

1. Calculus of Variation: Gelfran and Fomin
2. Calculus of Variation : Esgolac
3. Calculus of Variation : Gupta

SEMESTER III

PAPER-XVIII COMPUTER FUNDAMENTALS AND DATA STRUCTURES

SOS/ Math/E003

I. History and classification of computers, fundamental of computers system: Data types, number system, complements; Floating point representation, normalized floating point representation, fixed point represented arithmetic computations.

II. Logical gates, Boolean algebra, truth tables, logic diagrams, logical expressions/function, Demorgan’s theorem, Karnaugh maps, sum of product and product of sums, 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 and searching algorithms, and graphs.

TEXT BOOKS

2. Introduction to computers, Mc-Graw-Hill : P. Norton
4. Data Structures with C (Schaum’s series) Tata Mc-Graw-Hill : S. Lipschutz

SEMESTER III

PAPER- XIX ALGEBRAIC CODING THEORY

SOS/ Math/E004

I. The communication channel, The coding problem, Types of Codes, Block Codes, Error-Detecting and Error-Correcting Codes, Linear Codes, The Hamming Metric, Description of Linear Block Codes by Matrices, Dual Codes, Standard Array, Syndrome, Step-by-step Decoding Modular Representation.

II. Error-Correction Capabilities of Linear Codes, Bounds on Minimum Distance for Block Codes, Plotkin Bound, Hamming sphere packing Bound, Varshamov-Gilbert-Sacks bound, Bounds for Burst-Error Detecting and Correcting Codes, Important Linear Block Codes.

III. Hamming Codes, Golay Codes, Perfect Codes, Quasi-perfect Codes, Reed-Muller Codes, Codes derived from Hadmard Matrices, Product Codes, Concatenated Codes.

IV. Tree Codes, Convolutional Codes, Description of Linear Tree and Convolutional Codes by Matrices, Standard Array, Bounds on minimum distance for
Convolutional Codes, V-G-S bound, Bounds for Burst-Error Detecting and Correcting Convolutional Codes.

TEXT BOOKS

1. A First Course in Coding Theory: Raymond Hill
2. Error Correcting Coding Theory: Man Young Rhee
3. Error-Correcting Codes: W.W. Peterson and E.J. Weldon, Jr.
4. Algebraic Coding Theory: E.R. Berlekamp

SEMESTER III

PAPER XX SELF-STUDY (From other Department) Any of the XX(a), XX(b) & XX(c) Math SOS /
Math/E005

Paper XX (a) MATHEMATICAL METHOD

1. Hermite Polynomial
2. Laguerre Polynomial
3. Bessel’s Polynomial
4. Chebyshev Polynomial

PAPER XX (B) TENSOR ANALYSIS AND SPECIAL THEORY OF RELATIVITY

SOS./ Math/E005(C)

UNIT I


UNIT II

Metric Tensor- The fundamental and associated tensors- Christoffel’s symbols- Transformations of Chrisffel’s symbols- Covariant Differentiation of Tensors- Formulas for covariant Differentiation- Ricci Theorem- Riemann- Christoffel Tensor and their Properties.

UNIT III
Einstein Tensor – Riemannian and Euclidean Spaces (Existence Theorem)- The e-systems and the generalized Kronecker deltas- Application of the e-systems.

UNIT IV


TEXT BOOKS

1. I.S. Sokolnikoff, Tensor Analysis, John Wiley and Sons, New York, 1964
5. An Introduction to Theory of Relativity, New York, 1942 : P.G. Bergman
6. Riemannian Geometry and Tensor Calculus, Cambridge, 1938 : C.E. Weatherburn

PAPER XX (C) FINANCIAL MATHEMATICS SOS/Math/E005 (c)

UNIT I

SINGLE PERIOD MODELS: Definitions from Finance- Pricing a forward- one- step Binary Model – a ternary Model- Characterization of no arbitrage- Risk-Neutral Probability Measure

UNIT II


UNIT III

BROWNIAN MOTION: Definition of the process- Levy’s Construction of Brownian Motion – The Reflection Principle and Scaling – Martingales I Continuous time.

UNIT 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 BOOKS

3. Damien Lamberton and Bernard Lapeyre, (Translated by Nicolas Rabeau and Farancois Mantion).

PAPER-XXI VIVA-VOCE SOS/Math/C0016

SEMESTER –IV

PAPER-XXII MEASURE AND INTEGRATION-II SOS/Math/C0017

I. Convergence in Measure, Egoroff’s Theorem, Fatou’s Lemma, Convergence Theorems.
II. Dini derivatives, Differentiation of monotone functions, Functions of bounded variations, Differentiation of an integral, Absolute continuous functions, Integral of the derivative.
III. \(L^p\)-spaces, Properties of \(L^p\)- spaces, Holder’s and Minkowshi’s Inequalities.
IV. Signed measure, Hahn-Decomposition theorem, Radom-Nikodym theorem, Product measure.

TEXT BOOKS

1. Real Analysis : H.L. Royden
2. Measure and Integration : S.K. Berberian
3. Lebesgue Measure and Integration : P.K. Jain and V.P. Gupta
SEMESTER-IV

PAPER-XXIII LINEAR INTEGRAL EQUATIONS & BOUNDARY VALUE PROBLEMS SOS/Math/C0018

I. Classification of integral equations, Relation between Differential and Integral equations, Green’s function.

II. Solution of Fredholm Integral Equations, Solution of Volterra Integral Equations.


IV. Perturbation techniques and its applications to mixed boundary value problems, Two-part and three-part boundary value problems, Solutions o electrostatic problems involving a charged circular disk and annular circular disk, a spherical cap, an annular spherical cap in a free space or a bounded space.

TEXT BOOKS

1. Integral Equations : Hilderbrand
2. Linear Integral Equations : V. Lovit
3. Linear Integral Equations : R.P. Kanwal
4. Integral Equations : Li. G. Chanbers

SEMESTER-IV

PAPER XXIV FUNCTIONAL ANALYSIS SOS/Math/C0019

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, Orthogonal Sets.

IV. Operators on Hilbert Spaces, Self-Adjoint, Normal and unitary operators orthogonal projection operators.

TEXT BOOKS

2. Topology and Modern Analysis : G.F. Simmons
3. Introductory Functional Analysis with Applications : E. Kreyszig
4. Functional Analysis : B.V. Limaye

SEMESTER-IV
PAPER XXV       BIOMECHANICS       SOS/Math/E006

I. Biomechanics, Method of approach, Tools of investigation, Stresses and rates of strain, Constitutive equations, Newtonian viscous fluid, Hookean elastic solid, Biological transport process, Basic momentum, Heat and mass transport concepts.


III. Biofluid dynamics concept, Transport phenomena and the cardiovascular system.

IV. Biofluid mechanics of organ systems: The lungs, The Kidneys and the lever.

TEXT BOOKS

2. Biofluid Dynamics Taylor and Francis : Clement Kluinestreuer
3. Frontier in Mathematical Biology: S.A. Levin
4. BioMathematics: Ricciardi

SEMESTER-IV

PAPER XXVI       FUZZY SET THEORY       SOS/Math/E007

I. Fuzzy sets: Basic definitions, a-level sets, convex Fuzzy sets, basic operation on Fuzzy sets, type 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.

IV. Fuzzy logic: An overview of classical logic, multivalued logic, fuzzy propositions, fuzzy qualifiers, linguistic variables and hedge.

TEXT BOOKS

1. Fuzzy sets and Fuzzy logic: G.L. Klir and Yuan
2. Fuzzy set theory and its Applications : H.J. Zimmermann
3. Fuzzy set theory, Fuzzy logic and their Applications: A.K. Bhargava

SEMESTER-IV

PAPER XXVII       MATHEMATICAL MODELING       SOS/Math/E008

UNIT I
Mathematical Modeling through Ordinary Differential Equations of First order:
Linear Growth and Decay Models- Non-Linear Growth and Decay Models- Compartment Models- Dynamics problems- Geometrical problems.

UNIT II


UNIT III


UNIT IV


TEXT BOOKS


SEMESTER-IV

PAPER XXVIII THEOREY OF NUMBERS SOS/MATH/E009

I. Well ordering Principle, Division Algorithm, Euclidean Algorithm, Fundamental theorem of Arithmetic , Euclid’s Lemma,
II. Congruences, Residue Classes, linear congruences, Euler’s ø function, tau function, Euler’s theorem, Fermat’s theorem, Wilsons Theorem.
III. Quadratic congruences, Legendre symbol, continued fraction, finite and infinite continued fraction.

IV. Diophantine Equation, Simultaneous linear Diophantine Equations, Sums of Squares, Pell’s Equations.

TEXT BOOKS

1. Elementary number theory : By David M. Burton
2. Theory of Numbers : George Andrews
3. Elementary number theory with Application : Thomas Koshy
4. Fundamental of Number Theory: William J. Lereque

PAPER XXIX VIVA-VOCE SOS/MATH/C0020
All India Universities/Colleges of B. Sc and B.A Mathematics unified syllabus will be applied by UGC now.

- Each course will carry 100 marks.
- In each course, sessional test will carry 30 marks, which includes; one test of 1 hour duration/assignment / (paper/poster) presentation etc. suitable for the course and shall carry 20 marks, 5 marks shall be given for participation in academic activities/ discipline and 5 marks for attendance in the class.
- In each course, the end semester examination shall be of 70 marks.

<table>
<thead>
<tr>
<th>Semester</th>
<th>Core Course(04)</th>
<th>Skill Enhancement Course (SEC) (02)</th>
<th>Discipline Specific Elective (DSE) (02)</th>
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<tbody>
<tr>
<td>1</td>
<td>Differential Calculus</td>
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<td>Real Analysis</td>
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Discipline Specific Electives (DSE)

DSE 1A (choose one)  
1. Matrices  
2. Mechanics  
3. Linear Algebra

DSE 1B (choose one)  
1. Numerical Methods  
2. Complex Analysis  
3. Linear Programming
Skill Enhancement Course (SEC)

SEC 1 (choose one)
1. Logic and Sets
2. Analytical Geometry
3. Integral Calculus

SEC 2 (choose one)
1. Vector Calculus
2. Theory of Equations
3. Number Theory

SEC 3 (choose one)
1. Probability and Statistics
2. Mathematical Finance
3. Mathematical Modeling

SEC 4 (choose one)
1. Boolean Algebra
2. Transportation and Game Theory
3. Graph Theory
Core 1.1: Differential Calculus
Limit and Continuity (ε and δ definition), Types of discontinuities, Differentiability of functions, Successive differentiation, Leibnitz’s theorem, and its applications to problems of type $e^{ax+bx} \sin x$, $e^{ax+bx} \cos x$, $(ax+b)^n \cos x$.
Partial differentiation, Euler’s theorem on homogeneous functions.
Tangents and normals, Curvature, Asymptotes, Singular points, Tracing of curves.
Parametric representation of curves and tracing of parametric curves, Polar coordinates and tracing of curves in polar coordinates. Rolle’s theorem, Mean Value theorems, Taylor’s theorem with Lagrange’s and Cauchy’s forms of remainder, Taylor’s series, Maclaurin’s series of sin x, cos x, $e^{ax}$, $\log(1+x)$, $(1+x)^m$.
Maxima and Minima, Indeterminate forms concavity and inflection points, asymptotes, curve tracing in Cartesian coordinates, tracing in polar coordinates of standard curves, L’Hospital’s rule and applications in business, economics and life sciences.

Core 2.1: Differential Equations
First order exact differential equations. Integrating factors, rules to find an integrating factor. First order higher degree equations solvable for x, y, p.


Core 3.1: Real Analysis
Finite and infinite sets, examples of countable and uncountable sets. Real line, bounded sets, suprema and infima, completeness property of R, Archimedean
property of \( \mathbb{R} \), intervals. Concept of cluster points and statement of Bolzano-Weierstrass theorem.

Real Sequence, Bounded sequence, Cauchy convergence criterion for sequences. Cauchy’s theorem on limits, order preservation and squeeze theorem, monotone sequences and their convergence (monotone convergence theorem without proof).

**Infinite series** Cauchy convergence criterion for series, positive term series, geometric series, comparison test, convergence of p-series, Root test, Ratio test, alternating series, Leibnitz’s test (Tests of Convergence without proof). Definition and examples of absolute and conditional convergence. Sequences and series of functions, Pointwise and uniform convergence. Mn-test and M-test.

**Core 4.1: Algebra**
Definition and examples of groups, examples of abelian and non-abelian groups, the group \( \mathbb{Z}_n \) of integers under addition modulo \( n \) and the group \( \mathbb{U}(n) \) of units under multiplication modulo \( n \). Cyclic groups from number systems, complex roots of unity, circle group, the general linear group \( \text{GL}_n(n,\mathbb{R}) \), groups of symmetries of (i) an isosceles triangle, (ii) an equilateral triangle, (iii) a rectangle, and (iv) a square, the permutation group \( \text{Sym}(n) \), Group of quaternions.

Subgroups, cyclic subgroups, the concept of a subgroup generated by a subset and the commutator subgroup of group, examples of subgroups including the center of a group. Cosets, Index of subgroup, Lagrange’s theorem, order of an element, Normal subgroups: their definition, examples, and characterizations, Quotient groups.

Definition and examples of rings, examples of commutative and non-commutative rings: rings from number systems, \( \mathbb{Z}_n \) the ring of integers modulo \( n \), ring of real quaternions, rings of matrices, polynomial rings, and rings of continuous functions. Subrings and ideals, Integral domains and fields, examples of fields: \( \mathbb{Z}_p, \mathbb{Q}, \mathbb{R}, \text{and } \mathbb{C} \).

**DSE 1A.1: Matrices**
\( \mathbb{R}, \mathbb{R}^2, \mathbb{R}^3 \) as vector spaces over \( \mathbb{R} \). Standard basis for each of them. Concept of Linear Independence and examples of different bases. Subspaces of \( \mathbb{R}^2, \mathbb{R}^3 \).

DSE 1A.2: Mechanics
Conditions of equilibrium of a particle and of coplanar forces acting on a rigid Body, Laws of friction, Problems of equilibrium under forces including friction, Centre of gravity, Work and potential energy. Velocity and acceleration of a particle along a curve: radial and transverse components (plane curve), tangential and normal components (space curve), Simple harmonic motion, Simple Pendulum.

DSE 1A.3: Linear Algebra
Vector spaces, subspaces, algebra of subspaces, quotient spaces, linear combination of vectors, linear span, linear independence, basis and dimension, dimension of subspaces. Linear transformations, null space, range, rank and nullity of a linear transformation, matrix representation of a linear transformation, algebra of linear transformations. Dual Space, Dual Basis, Double Dual, Eigen values and Eigen vectors, Characteristic Polynomial. Isomorphisms, Isomorphism theorems, invertibility and isomorphisms, change of coordinate matrix.

DSE 1B.1: Numerical Methods
Integration: trapezoidal rule, Simpson’s rule, Euler’s method.

**DSE 1B.2: Complex Analysis**
Limits, Limits involving the point at infinity, continuity. Properties of complex numbers, regions in the complex plane, functions of complex variable, mappings. Derivatives, differentiation formulas, Cauchy-Riemann equations, sufficient conditions for differentiability.

**DSE 1B.3: Linear Programming**

**SEC 1.1: Logic and Sets**
Introduction, propositions, truth table, negation, conjunction and disjunction. Implications, biconditional propositions, converse, contra positive and inverse propositions and precedence of logical operators. Propositional equivalence: Logical equivalences. Predicates and quantifiers: Introduction, Quantifiers, Binding variables and Negations.
SEC 1.2: Analytical Geometry
Techniques for sketching parabola, ellipse and hyperbola. Sphere, Cone, Cylindrical Surfaces, Central Conicoids.

SEC 1.3: Integral Calculus

SEC 2.1: Vector Calculus

SEC 2.2: Theory of Equations
General properties of polynomials, Graphical representation of a polynomials, maximum and minimum values of a polynomials, General properties of equations, Descarte’s rule of signs positive and negative rule, Relation between the roots and the coefficients of equations.


SEC 2.3: Number Theory
Division algorithm, Lame’s theorem, linear Diophantine equation, fundamental theorem of arithmetic, prime counting function, statement of prime number theorem, Goldbach conjecture, binary and decimal representation of integers, linear congruences, complete set of residues.

Number theoretic functions, sum and number of divisors, totally multiplicative functions, definition and properties of the Dirichlet product, the Möbius inversion formula, the greatest integer function, Euler’s phi-function.

SEC 3.1: Probability and Statistics
Sample space, probability axioms, real random variables (discrete and continuous), cumulative distribution function, probability mass/density functions, mathematical expectation, moments, moment generating function, characteristic function, discrete distributions: uniform, binomial, Poisson, continuous distributions: uniform, normal, exponential. Joint cumulative distribution function and its properties, joint probability density functions, marginal and conditional distributions, expectation of function of two random variables, conditional expectations, independent random variables.

**SEC 3.2: Mathematical Finance**
Basic principles: Comparison, arbitrage and risk aversion, Interest (simple and compound, discrete and continuous), time value of money, inflation, net present value, internal rate of return (calculation by bisection and Newton-Raphson methods), comparison of NPV and IRR. Bonds, bond prices and yields. Floating-rate bonds, immunization. Asset return, short selling, portfolio return, (brief introduction to expectation, variance, covariance and correlation), random returns, portfolio mean return and variance, diversification, portfolio diagram, feasible set.

**SEC 3.3: Mathematical Modeling**

**SEC 4.1: Boolean Algebra**
Definition, examples and basic properties of ordered sets, maps between ordered sets, duality principle, maximal and minimal elements, lattices as ordered sets, complete lattices, lattices as algebraic structures, sublattices, products and homomorphisms. Definition, examples and properties of modular and distributive lattices, Boolean algebras, Boolean polynomials, minimal forms of Boolean
polynomials, Quinn-McCluskey method, Karnaugh diagrams, switching circuits and applications of switching circuits.

**SEC 4.2: Transportation and Game Theory**
Game theory: formulation of two person zero sum games, solving two person zero sum games, games with mixed strategies, graphical solution procedure.

**SEC4.3: Graph Theory**
Definition, examples and basic properties of graphs, pseudographs, complete graphs, bi-partite graphs, isomorphism of graphs, paths and circuits, Eulerian circuits, Hamiltonian cycles, the adjacency matrix, weighted graph, travelling salesman’s problem, shortest path, Dijkstra’s algorithm, Floyd-Warshall algorithm.