NEHRU GRAM BHARATI UNIVERSITY

Kotwa- Jamunipur- Dubawal

ALLAHABAD

SYLLABUS

of

M.Sc. (MATHEMATICS)

DEPARTMENT OF MATHEMATICS

FOR

POST GRADUATE CLASSES

Semester-I

(All Course are Compulsory)

M 101. Real Analysis-I

Unit –I: Finite and infinite sets, countable uncountable sets, Schroder-Bernstein theorem, Ordered fields least upper bound property, the field of real numbers, Archimedean property, density of rational number existence of nth root of positive real numbers, the extended real number system: Complex field.

Unit – II: Numerical sequences and their convergence, bounded sequences, Cauchy sequences, construction of real numbers using Cauchy Sequences, series of complex numbers, convergence of Series, Series of nonnegative terms, the number e, the toot test ratio tests, limit supermom and multiplication of series, rearrangements of series (statement of Riemann's Theorem).

Unit – III: Euclidean spaces metric spaces, open and closed sets, limit points interior points, compact spaces; statements only of the following: nested interval theorem, Heine-Borel Theorem, and Bolzano-Weierstrass' theorem. Limits of functions, continuous functions continuity and compactness, uniform continuity,

unit –IV connected sets, connected subsets of real numbers, continuity and connectedness, intermediate value theorem; discontinuities and their classifications, monotonic functions, infinite limits and limits at infinity.

Unit – V: Differentiation of real-valued functions and its elementary properties; Mean value theorems; Taylor's theorem; differentiation of vector-valued functions; elementary properties of Riemaan integral (brief review); integration of vector-valued functions.

References:

1. W. Rudin, Principles of Mathematical Analysis, 5th editon, McGraw Hill Kogakusha Ltd., 2004.
2. T. Apostol, Mathematical Analysis, edition, Addison-Wesley, Publishing Company, 2001.
3. R.G. Bartle and D.R. Sherbert, introduction to Real Analysis, 3 edition, John Wiley & Sons, lnc., New York, 2000.

M 102. Algebra

Unit-I: A brief review of groups, their elementary properties. and examples, subgroups, cyclic groups, homomorphism of groups and Lagrange's theorem; permutation as product groups, permutations, as product of cycles, even and odd permutations, normal subgroups quotient groups, isomorphism theorems, correspondence theorem.

Unit-II: Normal and subnormal series, composition series, Jordan-Holder theorem. Solvable groups.

Unit-III: Group action; Cayley's theorem, group Of symmetries, dihedral groups and their elementary properties; orbit decomposition; counting formula; class equation, consequences for p-groups, Sylow's theorems (proofs using group actions) Applications of Sylow's theorems, conjugacy classes in S and, An simplicity of An. Direct product; structure Vftc classes in S and , %

simplicity of An Direct product; structure of finite. Abelian groups; groups; invariants of a finite abelian group (Statements only).

Unit IV: Basic properties and examples a ring domain division ring and field, direct products' of rings; homeomorphisms of rings. Ideals: factor rings; prime and maximal ideals, principal ideal domain; Eudidean domain, Unique factorization domain.

Unit V: A brief review of polynomial rings over a field; reducible and irreducible polynomials, Gauss' Theorem for reducibility of f(x), Einstein's criterion of irreducibility of f(u) over Q, roots of polynomials; finite fields of orders 4,8,9* and 27 using irreducible polynomials over Z_2 and Z_3.

References:

1. N. Jacobson, Basic Algebra I,3 editlon, Hindustan Publishing corp. New Delhi, 2002.
2. LN. Herstein, Topics in Algebra, 4^{th} edition, Wiley Eastern Limited, New Delhi, 2003.
3. J.B. Fraleigh, A First Course in Abstract Algebra, 4^{th} edition, Narosa Publishing House, New Delhi, 2002.
4. D.S. Dummit and RM. Foote Abstract Algebra. John Wiley & Sons, 2003.
5. M artin, Algebra, Prentice Hall of India, 1984.
6. PB Bhattacharya, S.K. Jain and S.R. Nagpal, Basic abstract Algebra, 3^{rd} edition, Cambridge University Press, 2000.

M 103. Complex Analysis

Unit I: Recall of algebra and geometry of C. Stereographic correspondence, complex differentiable functions, analytic functions, Cauchy-Riema an equations, necessary and Sufficient conditions for analyticity chain rule, power series and its radius of convergence, analytic functiOn represented by power series, complex exponential, trigonometric and hyperbolic functions, a branch of logarithmic and its : branch of 1 (b belongs to c) conjugate functions, construction of analytic functions (elementary method).

Unit II: Complex line Integral over a piecewise smooth paths and its elementary properties, length of a curve, necessary and sufficient condition for independent of the line integral, Cauchy theorem for disc, Cauchy-Goursat theorem (statement only), winding number, higher. derivatives, Cauchys integral formula for derivatives.

Unit III: Morera's theorem, Cauchy's estimate, Liouville's theorem, zeros of an analytic function, Funcamental theorem of algebra, Cauchy's theorem in homotopy form (statement only), Cauchy's theorem for simply connected domains, Weierstrass theorem for a uniform Convergent sequence Of analytic functions, Taylor series, isolated singular ities (removable singularities, poles. and isolated essential singularities), Laurent series expansion theorem, singularity at infinity Casorati-Weierstrass theorem.

Unit IV: Open mapping theorem (S mentorly), Maximum modulus theorem Residue and singularity residue at infinity, Cauchy theorem for residue meromorphic function, argument principle, Rouche's theorem and its application.

Evaluation of Contour integrals of the type

$$\int_0^{2x} f(cos\theta, sin\theta) \int_0 f(x)dx, \int_{-8} f(x)dx,$$

$$\int_0 \; f(x)\cos mx, \int_0 \; f(x) sin\, mx$$

Unit V: Schwarz lemma, Mobius transformations, fixed points of a mobius transformation, cross ratio and its invariance under Mobius transformation, mobius transformation as mappings, determination of all Mobius transformations which map (i) R onto R (ii) Im (z)>0 onto

$\{z \in C: |z| < \sigma\} and\ (iii)\{z \in C: |z| < \sigma\}$onto$\{z \in C: |z| < r\}$

References:

1. LV Ahifors, Complex Analysis, McGraw HUt international Ed.
2. J.B. Conway, Functions of Complex variable, Narosa publication, 1973.
3. S.P. Ponnusamy, Fundation of Complex analysis, Narosa publication 1995.
4. A.R. Shastri, An introduction to Complex analys is Macmillan Pubhation.

M 104 Ordinary Differential Equations

Unit-I: Concept of an Ordinary Differential Equation and its solution, Order and degree, Differential equations of Families of Curves, Standard methods for solving specific types of first order equations, General criteria for finding Integrating Factors, Equations of higher degree, Applications.

Unit-II: Picard 's method of Successive Approximations, Lipschitz' conditions, Existence and Uniqueness Theorems of Picard, p-discriminants and c-discriminants, Singular solutions, Linear differential equations of arbitrary order, Linearly independent solutions, General Theory for solutions of linear, Educations Wronskians, Method of Variations of parameters, Method of undetermined multipliers, Reduction of order, Method of inverse Operators, Euler- Cauchy Equations.

Unit- III: Existence and Uniqueness Theorems for systems of first order equations, Global Existence and uniqueness criteria, Equivalent first order systems for higher order equations, Criteria for convertibility of a system of equation into a higher order equation in one of the unknowns, General theory for linear systems, Wronskians and method of variation of parameters, Abel's formula, Matrix methods for linear systems with constant coefficients.

Unit-IV: Power series method for general linear equations for higher order, Solutions near an ordinary point, Regular and Logarithmic solutions near a regular singular point, Legendre equations, Orthogonality relations for Legendre polynomials, Rodrigues' formula, Recurrence relations, Bessel's equation, Bessel funtions of I and II kind, Recurrence Relations, Sturm's comparison theorem, Zeros of Bessel functions, Orthogonality relations, Numercal techniques for differential equations of first and second order, incremental Predictor Corrector methods.

Unit-V: Laplace transforms, Existence criteria, Properties. Transforms of standard functions, Transforms of derivatives and integrals, Derivatives and integrals of Transforms, lnverse Laplace transforms, Existence and uniqueness criteria, Exponential shifts, inverse of products of transforms, Applications to lnitial value problems.

References:

1. B Ral, D.P. Choudhury and H.l. Freedman, A Course in Ordinary Differential Equations, Narosa Publishing House, New Delhi, 2002
2. E.A. coddington, An lntroduction to Ordionary Differential Equations. Prentice Hall of India, “New Delhi, 1968,
3. L. Elsgolts, Differential Equations and Calculus of Variations, Mir Publishers, 1970.
4. G. F. Simons, Differential Equations, Tata MacGraw Hill, New Delhi, 1972.

Semester-II
(All Course are Compulsory)
M 201. Real Analysis-II

Unit-I: Functions of several-variables, Directional derivative Partial derivative, Total derivative.

Unit-II: Jacobian, Chain rule and Mean-value theorems, lnterchange of the order of differentiation. Higher derivatives.

Unit-III: Taylor’s theorem, Inverse function theorem, Implicit function theorem. Extremum problems, Extremum problems with constraints Lagrange’s multiplier method.

Unit-IV: Multiple integerals: Existence and Properties of integrals, iterated integrals, change of variables.

Unit-V: Gradien, div, Curl, Laplacian in cartesian, cylindrical and spherical coordinates, line integrals, surface integrals. Theorem of Green, Gauss and Stokes.

References:

1. T.M. Appstol, Mathematical Analysis, edition, Mdison-Wesley Publishing Company, 2001.
2. T.M. Apostol, Calculus-II 2' edition, John Wiley & Sons, 2003.
3. W. Rudin, Principles of Mathematical Analysis, 5 edition, McGraw Hill-Kogakusha Ltd. 2004.
4. R. & Battle, The elements of Real Analysis, 2" edition, Jon Wiley & Sons lnc., New York 1976.

M 202. Ring Theory

Unit- I: Ring, Homomorphisms of rings, Ideals, factor rings, Endomorphism of rings, idempotent and Nilpotent elements, Matrix rings, Modules and their Lattice, change of rings, Bimodules, Annihilators, Module homomorphisms factor theorem, Ecxact sequences, Five lemma, Faithful and balanced module, Biendomorphism rings.

Unit- II: Direct summands, split exact sequences, Large and Small submodules, Direct products, Internal and external Direct sums. Decomposition of rings, idempotents. Semisimple modules, and Jacobson radical Generation and cogeneration, Trace and Reject, Finite generation and cogeneration.

Unit- III: Chain conditions, Composition series, jordan- Holder theorem, fitting's lemma Indecomposable decomposition of modules, Azumaya decomposition and Krui Schmidt Theorem.

Unit- IV: Simple Artinian rings, Wedderburn's theorem, Wedderburn-Artin theorem, Jacobson density theorem, Primitive Jacobson radical of rings, Nakayana lemma, Simiprimitive rings, Local Hopkin's theorem, Levitzki's theorem.

Unit- V: Projective and Injective modules, Hom functor, Exact Functors, Dual basis lemma, projective covers, Injective Test lemma (Bear's criterion), injective Envelopes, Direct sum of injectives, Injective cogenerators. Tensor products and functors, flat modules.

References:

1. F. W. Anderson and K. R. Fuller, Rings and Categories of Modules, Springer, GTM No.13, 1974.
2. N. Jacobson, Basic Algebra ll. Hindustan Publishing Corporation, New Delhi, 1984.
3. T. Y. Lam, Lectures on modules and Rings, Springer GTM, 189, 199.
4. L.H. Rowen, Ring Theory, Academic Press, 1991.

M 203. Topology

Unit I: Definition and examples of topological spaces (including metric spaces). Open and closed sets, Subspaces and relative topology. Closure and interior, Accumulation points and derived sets, Dense sets Neighbourhoods, Boundary, Bases and sub-bases. Alternative methods of defininga topology in terms of the Kuratowski closure operator and neighbourhood systems. Homeomorphism, First and second countability and separable Lindelof spaces.

Unit II: The separation axioms T_0, T_1, T_3 $T_{3\frac{1}{2}}$ and T_4, their characterizations and basic properties, Urysohn's lemma, and theorem.

Unit III: Compactness, Basic properties of compactness the finite intersection property; local compactness, One-point compactification.

Unit IV: Connected spaces and their basic properties, Connectedness of the real line, Components, Locally connected spaces.

Unit V: (Tychonoff) Product topology in terms of the standard sub-base and its characterizations, Product topology and separation axioms, connectedness. countability properties and compactness (including

Tychonoff's theorem)

References:

1. J.L Kelley, General Topology, Van Nostr and,1995.
2. KD Joshi, Introduction to General Topology, Wiley Eastern 1983.
3. James. R. Munkres, Topology21. Editich, Pearson International, 2000.
4. J Dugundji, Topology, Prentice-Hail of India,1966.
5. George F. Simmons. Introduction to Topology and Moden Analysis McGraw-Hill, 1963.
6. S. Willard, General Topology, Mdison-wesley, 1970.

M 204. Discrete Mathematics

Unit – I: Mathematical Logic and Relations: Statements, Logical connectives, Truth tables. Equivalence, lnference and deduction, Predicates, Quantifiers. Relations, and their compositions, Equivalence relations, Closures of relations, Transitive closure and the Warshall's algorithm, Partial ordering relation, Hasse diagram, Recursive functions.

Unit – II: Semigroups & Monoids: Semigroups, Monoids,

Homomorphism, isomorphism and the-basic isomorphism theorem.

Unit- III: Boolean Algebra: Boolean algebra and their various identites, Homomorphism's and isomorphism's. Atoms and the Stone's theorem (finite case), Boolean functions, their simplification and their applications to combinational circuits.

Unit-IV: Combinatortics & Recurrence Relations: Permutation, Combination, Principle of inclusion and exclusion, Recurrence relations.

Unit-V: Graph theory: Basic concepts of graphs, directed graphs and trees, adjacncy and incidence matrices, spanning tree, kruskal's and prim's algorithms, shortest path, dijkstra's algorithm, planar Graphs, Graph colouring, Eulerian and Hamiltonian graphs.

References:

1. J.P. Trembley and R.R Manohar, Discrete Mathematical Structures with Applications to Computer Science, McGraw Hill.
2. L.L. Dornhoff and E.F. Hohn, Applied Modern Algebra, McMillan Publishing Co., 1978.
3. N. Deo, Graph Theory with Applications to Engineering and Computer Science, Prentice Hall of India, 1980,
4. R. Johnsonbaugh. Discrete Mathematics, Pearson Education, 2001.
5. R.R Grimaldi, Discrete and Combinatorial Mathematics, Pearson Education, 1999.
6. C.L. LIu, Elements of Discrete Mathematics, McGraw-Hill, 1977.
7. l. Rosen, Discrete Mathematics, Tata McGraw Hill.

8. B. Kolman, R. Busby, S.C. Ross, Discrete Mathematical Structures, Prentice Hall of India, 2008.
9. S.K. sarkar, A Text Book of Discrete mathematics, S. chand pub., 9^{th} Ed. 2016.

Semester-III

M 301. Functional Analysis

Unit I: Normed linear spaces, Quotient Norm, Banach spaces and examples, espaces as Banach spaces, Bounded linear transformations on normed linear spaces, B (x,y) as a normed linear space.

Unit- II: Open mapping and closed graph theorems, Uniform boundedness principle, Hahn-Banach theorem and its applications, Dual space, Separabillty, Reflexivity, Weak and weak convergence of operators, Compact operators and their basic properties.

Unit- III: Inner product spaces, Hilbert spaces. Orthogonal sets, Bessel's inequality, Complete orthonormal sets and Parseval's identity, Structure of Hilbert spaces.

Unit- IV: Projection theorem, Riesz representation theorem Riesz-Fischer theorem, Adjoint of an operator on a Hilbert space, Reflexivity of Hilbert spaces.

Unit- V: Self-adjoint operators, Positive, projection, normal and unitary operators and their basic properties.

References:

1. G. Bachman and L. Narici, Fuctional Analysis, Academic Press, 1966.
2. J.B. Conway, A First Course in Functional Analysis, Springer 2000.
3. R.E. Edwards, Functional Analysis, Holt Rinehart and Winston 1965.
4. C. Goffman and G. Pedrick First Course in Functional Analysis Prentice- Hall of India, 1987.
5. B.V. Lirnaye, Functional Analysis, New Age International, 1996.
6. G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill, 1963.

M 302. Differential Geometry

Unit- I: Graph and level sets, vector fields, the tangent space, surfaces, orientation, the Guass map, geodesics, parallel transport,

Unit- II: The Weingarten map, curvature of plane curves; arc length and line integrals, curvature of surfaces, parameterized surfaces, surface area and volume, surfaces with boundary, the Gauss-Bonnet Theorem.

Unit- III: Riemannian Geometry of surfaces, Parallel translation and connections,

Unit- IV: structural equations and curvature, interpretation of curvature,

Unit- V: Geodesic: coordinates systems, isometries and spaces of constant curvature.

References.

1. W. Kuhnel, Differential Geometry-curves-surfaces-Manifolds, AMS 2006
2. Mishchenko and A. Formentko, A course of differential Geometry and Topology, Mir Publishers Moscow, 1988.
3. A. Pressley, Elementary Differential Geometry, SUMS, 'Springer, 2004
4. J. A. Thorpe, Elementary Topics in Differential Geometry, Springer, 2004.

Any two courses out of the following optional papers

M 303.Galois Theory

Unit- I: Extension fields, finite extensions; algebraic and transcend entail elements, adjunction of algebraic elements, Kronecker theorem, algebraic extensions, splitting fields-existence and uniqueness; e ension of base field isomorphism to splitting fields.

Unit- II: Simple and multiple roots of polynomials, criterion for simple roots, separable and inseparable polynomials; perfect fields.

Unit- III: Separable and inseparable extensions, finite fields, prime fields and their relation to splitting fields, frobenius endomorphism's, roots of unity and cyclotomic polynomials.

Unit- IV: Algebraically closed fields and algebraic closures, primitive element theorem, normed extensions, automorphism groups and fixed fields, galois pairing, determination of galois groups,

Unit- V: Fundamental theorem of galois theory, abelion and Solvability by radicals; solvability of algebraic equation; symmetric functions; ruler and compass constructions, Fundamental theorem of algebra.

References:

1. N. jacobson, Basic Alla, Edition, Hids Publishing corporation, New Delhi, 2002
2. I.N. Herstein, Topics in Algebra, 4-edition, Wiely Eastern Limited, New Delhi., 2003
3. J. B. Fraleigh, A First Course in Abstract Algebra , 4th Edition, Narosa Publishing House New Delhi, 2002
4. D. S. Durnmit and R.M Foote, Abstract Algebra 2nd Edition, John Wiley, 2002
5. P. B. Bhattacharya, S.K. Jain and S.R. Nagpal, Bac. Abstract Algebra, 3rd Edition, Cambridge University Press, 2000.

M 304. Geometric Algebra

Unit- I: Definition and examples of algebras, unital and division Algebra, Fresenius' theorem, homomorphism and isomorphism of algebras, dimension and sub algebras.

Unit- II: Geometric products, Axiomatic deyelopment of Geometric algebra, outer product, grading and bases, multivectors, bivectors and its products, multiplication of multivectors, Products of vectors and bivectors, bivector algebra, trivectors, Rotors, Construction of a rotor, Rotation of multivectors, Rotor composition law.

Unit- III: Geometric algebra of plane and space matrix representation, Pauli algebra, algebra of physical space-time, Space time algebra, space-time paths, space-time frames, relative vectors, even Sub algebra, Lorentz transformation, Lorentz group and rigid body dynamics.

Unit- IV: Vector derivative, scalar fields, vector fields, multivector fields, curvilinear coordinates, spacetime/ vector derivative, characteristic surfaces and propagation, application of the fundamental theorem of geometric calculus.

Unit- V: Maxwell's equations, vector potential; electromagnetic field strength, integral and conservation theorms, Pauli spin or Pauli observables, Dirac spinors, spinor and rotation, relativistic quantum states, Dirac-Hestenes equations. Plane-wave states, non-relativistic reduction and Dirac equation in a gravitational brake ground (brief review)

References:

1. C. Doran and A. Lasenby, Geometric Algebra for Physicists, Cambridge University Press, 2003.
2. D. Hestenes, Spacetive Algebra, Gordon and Breach, New York, 1966.
3. D. Hestenes and G. Sobczyk, Clifford Algebra to geometric Calculus,D. REidel Publishing Company, Dordrecht, 1984.
4. P. Lounesto, Cliffordl Algebras and Spinors, Cambridge University Press, 19.97.
5. R Ablamowicz. and G. Sobzyk (eds.) Lectures on clifford (Geometric) Algebras and Applications, Birkhauser, Boston (2004).

M305. Mechanics

Unit- I: System of Particles –Energy and Momentum methods. Use of Centroed. Motion of a Rigid Body- Euler's Theorem, Angular momenturm and kinetic energy.

Unit- II: Euler's equation of motion of rigid body with one point fixed, Eulerian angles, motion of a symmetrical top.

Unit- III: Generalized coordinates. Velocities and momenta, Holonomic and nonholonomic systems, D' Alembert's Principle, Lagrange's equations of motion, Conservative forces, Lagrange's equations for impulsive forces.

Unit- IV: Theory of small Oscillations of conservative holonomic dynamical system, Hamilton's equations of motion, Variational Principle and Principle of Least Action.

Unit- V: Contact transformations, Generating functions, Poisson's Brackets, Hamilton Jacobi equation.

References:

1. H. Goldstein, Classical Mechanics, Narosa Publishing House, 1980.
2. F. Chariton, Text book of Dynamics, 2nd edition, CBS Publishers, 1985.
3. R.H. Takwale & P.S. Puranik, Introduction to Classical Mechanics, Tata McGraw Hill Publishing Co., new Delhi.

M 306. Basic number Theory

Unit-I: Divisibility in integers, Division Algorithrn in integers, Well ordering property in the set of positive integers, Greatest common divisor and least common multiple and algorithms to find them; Primes, Fundamental Theorem of Arithmetic, Euclid's theorem, Fermat and Mersenne Primes, Infinitude of Primes of certain types. Congruence's, Euler's phi function, Euler-Fermat theorem, Fermat's little theorem, Wilson's theorem.

Unit-II: Linear congruence equations, Chinese Remainder theorem, Multiplicativity and expression for (n), Congruence equtions of higher degree, Prime power congruences, Power residues.

Unit-III: Quadratic Residues, Legendre symbols, Gauss' lemma, Quadratic Reciprocity law and applications, Jacobi symbol, Tests of Primality, Factors of Mersenne numbers.

Unit-IV: Multiplicative functions, functions τ, a and μ and and their multiplicativity, Moebius inversion formula and its converse, Group structure under convolution product and relations between various standar functions, Diophantine equations: $ax + by = c, x^2 + y^2 = z^2, x^4 + y^4 = z^2$, Sums of squares, Waring's problem, Binary quadratic forms over integers. Farey sequences, Rational approximations, Hurwitz' Theorem.

Unit-V: Simple continued fractions, Infinite continued fractions and irrational numbers, Periodicity, Pell's equation. Distribution of primes, Function $\pi(x)$, Tschebyschef's theorem, Bertrand's postulate. Partition function, Ferrer's graph, Formal power series, Euler's identity, Euler's formula for (n), Jacobi's formula.

References:

1. Niven and T. Zuckerman, An Introduction to the Theory of Numbers, Wiley Eastern.\
2. G.H. Hardy and E.M. Wright, Theory of Numbers, Oxford University Press & E.L.B.S.
3. D.E. Burton, Elementary Number Theory, Tata McGraw-Hill.
4. S.G. Telang, M. Nadkarni& J. Dani, Number Theory, Tata McGraw-Hill.

M 307. Measure and INtegration

Unit- I: Review of Riemann Integral, Its drawbacks and Lebesgue's recipe to extend it. Extension of length function, Semi-algebra and algebra of sets, Lebesgue outer measure, Measurable sets, Measure space, Complete measure space.

Unit- II: The Lebesgue measure on R, Properties af Lebesgue measure, Uniqueness of

Unit- III: Lebesgue Measure, Construction of non-measurable subsets of R.

Unit- IV: Lebesgre Integration: The integration of non-negative functions, Measurable functions, Fatou's Lemma, Integrable functions and their properties, Lebesgues dominated convergence theorem.

Unit- V: Absolutely continuous function, Lebesgue-Young theorem (without proof), Fundamental theorem of Integral calculus and its applications. Product of two measure spaces, Fubini's theorem. Lp-spaces, Holder's inequality, Minkowski's inequality, Riesz-Fischer Theorem (Completion of Lp-space)

References:

1. lnder K. Rana, An introduction Measure and integration, Narosa, 1997.
2. G. de Barra, Measure Theory and integration, John Wiley & Sons, 1981.
3. J.L. Kelly. T.P. Srinivasan, Measure and Integration Springer, 1988.

M 308. Calculus of variations and Integral Equations

Unit- I: Euler's equations, Functional dependence order derivatives, Functional dependence on functions of several independent variables. Variational problems with moving boundaries.

Unit- II: One sided variation, Variational problems with subsidiary conditions, isoperimetric problems, Rayleigh-Ritz method, Galerkin's method.

Unit- III: Classification of integral equations, Neumann's siterative method for Fredhoim's equation of second kind,

Unit- IV: Volterra type integral equation, integral. Equation of fivst kind convolution type integral

Unit- V: Noninear voltera equations. Hilbert Schmidt theory.

References:

1. A.S. Gupta, Calculus of variations, Prentice Hall of India Put. Ltd. 2003.
2. I.M. Gelfand and S.V. Francis. Calculus of variations, Prentice Hall. New Jersey, 2000.
3. L.G. Chambers, Intergral equation, International Text book company Ltd. London, 1976.
4. F.G. Tricomi, Integral equation, Inter science New York 1957.
5. R.P. Kanwal, Linear Integral equation : Theory and Technique, Birkhauser 1997.

Semester-IV

Any Four from the following Optional Papers

M 401. Wavelet Analysis

Unit- I: Preliminaries: Fourier series and Fourier Transforms. Orthogonal wavelet bases: Orthogonal systems and translates,

Unit- II: Multiresolution analysis, Examples of multiresolution analysis, construction of orthogonal wavelets bases and examples,

Unit- III: General spline wavelets.

Unit- IV: Discrete wavelet transforms: scaling function from scaling sequences, smooth compactly supported wavelets,

Unit- V: Debauchies wavelets. image analysis with smooth wavelets.

References:

1. David Walunt, An Introduction to Wavelet Analysis.
2. Stephan Mllat, A Wavelet tour of signal processing. Academic press, 1988.
3. R.S. Pathak, The Wavelet Transforms, 2009.

M 402. Homological Algebra

Unit- I: Categories and functors, Duality. products and coproducts, Pullbacks and pushouts, Abelian categories, modules, Free modules. Projective and injective modules.

Unit- II: Derivative functors, projective resolutions, tensor, exterior and symmetric algebras, injective resolutions, Ext and Tour.

Unit- III: Chain complexes, Long exact sequences/Chain homotopy, Elementary properties of Ext. Computation of some Ext Groups, Ext'and n-extentions. Elementary properties of Tor, Tor and torsion, Universal coefficient theorem.

Unit- IV: Homological dimensions. Ring of smaiensions, Change of rings theorem, Koszul complexes and logical chomolgy

Unit- V: Exact couples and five-term sequence, Derived complex and spectral sequences.

References:

1. J.J. Rotman, An Introdluction to Homological Algebra, Academic Press, 1979.
2. D.G. Northcott. A Course of Homological Algebra, Cambridge University Press, 1973.
3. C.A. Weibel, An Introduction to Homological Algebra Cambridge University Press, 1994.
4. M. Osborne, Basic Hornological Algebra, Springer, 2000.

M 403. Differential manifolds

Unit- I: Prerequisite: Real Analysis-TI (M 201) and Topology (M 203).

The derivative, continuously differentiable tunctions, the inverse function theorem, the implicit function theorem.

Unit- II: Topological manifolds, partitions of unity, imbedding and immersons, manlfold with boundary, submanifolds.

Unit- III: Tangent vectors and differentials, Sard's theorem and regular values, Local properties of immersions and submersions.

Unit- IV: Vector fields and flows, tangent bundles, Embedding in Euclidean sqaces, smootlh maps and their differentials.

Unit- V: Smooth manifolds, smooth manifolds with boundary, smooth sub-manifolds, construction of smooth functons. Classical Lie groups.

References:

1. G.E. Bredon, Topology and Geometry, Springer-Verlag, 1993.
2. L. Conlon Differential Manifolds, 2 Birkhauser, 2003.
3. A Kosiorki, differential maniforlds, Academic Press, 1992.

4. J.R. munkres, analysis on manifolds, Addison wesly publishing company 1991.

M 404. Theory of Relativity

Unit- I: The special theory of relativity: inertial frames of reference: postulates of the, special theory of relativity; Lorentz transformations; length contraction, time dilation; variation of mass; compositon of velocities; relativistic mechanics; world events, word regious and light cone; Minkowski space-time; equivalence of mass and energy.

Unit- II: Energy-momentum tensors: the action principle; the electromagnetic theory; energy-momentum tensors (general); energy-momentum tensors (special cases); conservation laws.

Unit- III: General Theory of Relativity: introduction; principle of covariance; principle of equivalence; derivation of Einstein's equation; Newtonian approximation of Einstein's equations.

Unit- IV: Solution of Einstein's equation and test of general relativity: Schwarzchildc solution; particle and photon orbits in S. chwarzschild space-titime; gravitational red shift; planetary motion; bending of light; radar echo delay.

Unit- V: Brans-Dicke theory: scalar tensor theory and higher derivative gravity; Kaluzaklein theory.

References:

1. R.K. Pathria The Theory of Relativity (second. edition), Hindustan Publishing Co. Delhi, 1994.

2. J.V. Narlikar, General Relativity & Cosmology (second edition) Macmillan Co of India Limited,. 1988.
3. S. K. Srivastava and K.P. Singha, Aspects of Gravitational Interactions, Nova Science Publishers Inc. Commack, New York, 1998.
4. W. Rindler, Essential Relativity, Springer-Verlag, 1977.
5. R.M. Wald, General Relativity, University of Chicago Press, 1984.
6. Ronald Adler, Maurice Bezin and Manamen Schiffer, Introduction to General Relativity, McGreaw-Hill Kogakusha Ltd.
7. Rosser W.G.V, Introduction to theory of relativity, ELBS (1972) .
8. Rindler W., Relativity Special, General and Cosmology, Oxford University Press (2003).

M 405. Fluid Mechanics

Unit-I: Motion of a continuum, Velocity and Acceleration: Stream lines, Path lines, Reynolds transport theorem, Euler's equation of motion, Steady motion, Bernoulli's equation, Helmholtz equation of motion, Kinematics of vorticity and circulation.

Unit-II: Motion in two dimensions-Stream function, lrrotational motion, Velocity and Complex potentials, Cauchy-Riemann's equations, Sources and Sinks, Doublets; Image system of a simple source and a doublet with respect to a plane and a circle, Milne-Thomson Circle Theorem, Blasius Theorem Kinematics of irrotation; Rate of strain tensor, Body and Surface forces, Stress Principle of Cauchy; Equations for conservtion of Mass, linear and angular Momentum, Newtonian fluids, Constitutive equations for Newtonian fluids; Navier-Stokes equations in Vector and general Tensor forms, Navier-Stokes equations in orthogonal coordinate systems (particularly in Cartesian, cylindrical and spherical coordinate systems.)

Unit –IV : Dynamical Similarity, Role of Reynolds number in Fluid dynamics; Some Exact solutions-Steady flow between parallel plates, Couette flow between coaxial rotating cylinders, Steady flow between pipes of uniform cross-section, Small Reynolds number flow, Stokes equations, steady flow past a sphere.

Unit-V: Boundary layer concept, 2-dimensional boundary layer equations, separation phenomena; boundary layer thickness, Karman's Integral method.

References:

1. F. Chorlton. Text book of Fluid, dynamics, CBS Publishers.
2. W.H. Besant and A.S. Ramsey, A treaties on Hydrodynamics, CSB Publishers.
3. ZUA, Warsi, Fluid dynamics, CRC Press, 1999.

M. Sc IV- (Biomathematics) (M 406)

Unit I : Dimensional Analysis in Mathematical Physiology, Budckingham's π Theorem, mathematics of diffusion, Fick's Law of diffusion, Diffusion Through a Membrane, Convective Transport.

Unit II : Population Biology: Malthusion Model, Logistic model, Equilibrum Analysis, Stability & Classification of equilibrium points, predator- Prey Models, Lotka- Volterra Model,

Unit III : Biofluid mechanics: Basic Equations of Viscous Fluid motion, Poiseuille’s Pulsatile Flow of Blood, Analysis of Arterial Flow Dynamics

Unit IV: Blood flow in Veins: Elastic Instability, Steady Flow in Callapsible Tube,unsteady Flow in Veins: Heart Mechanics- Equations, Active Contraction to Heart Muscle, Fluid and solid Mechanics of Heart

Unit V: Micro-circulation: Introduction, Pressure and velocity destribution in micro vessels, Velocity- Hematocrit Relation, Bolus Flow, Stokes flow, mechanics of flow at law Reynolds number,

Blood flow in pulmonary blood vessels.

Book Recomeded:

1. J. Mazumdar, An Introduction to Mathemathical physiology & Biology, Cambridge university Press
2. Y. C Fung, Biomechanics, Springer New York.