M. Sc. Mathematics
Choice Base Credit Semester wise Syllabus

Total Marks: 2500
Each Paper: 100 marks theory + 25 marks sessional
Periods Allotted per week per paper: 05 Hrs.
(From the session 2016-2017)

M. Sc. Semester-I

CORE PAPERS

Paper I Algebra I
Paper II Real Analysis I
Paper III Topology I
Paper IV Linear Algebra and Differential Equations
Paper V Integral Equations

M. Sc. Semester-II

CORE PAPERS

Paper VI Algebra II
Paper VII Real Analysis II
Paper VIII Topology II
Paper-IX Differential geometry
Paper X Classical Mechanics

M. Sc. Semester-III

CORE PAPERS

Paper XI Complex Analysis
Paper XII Functional Analysis
Paper XIII Mathematical Methods

CORE ELECTIVE PAPER XIV (Opt any one of the following)

1. Fluid Dynamics I
2. General Relativity

FOUNDATION PAPER- Paper XV (Opt any one of the following)
(Student shall opt for this paper from any other subject other than his /her main subject for post graduation)

1. Elementary Mathematics
2. Elementary Mathematical Methods
3. Elementary Numerical Methods
4. Fuzzy Mathematics I

CORE (SUBJECT CENTRIC) I

(Candidate can opt for paper this paper in their main subject of post-graduation only)
(This paper is only for M.Sc. Mathematics Students)

1. Operations Research I

M. Sc. Semester-IV

CORE PPAPERS

Paper-XVI Dynamical Systems
Paper-XVII Partial Differential Equations
Papers XVIII Advanced Numerical Methods

CORE ELECTIVE PAPER XIX (Opt any one of the following)

1. Fluid Dynamics II
2. Cosmology
3. Operations Research II

FOUNDATION PAPER- XX (Opt any one of the following)
(Student shall opt for this paper from any other subject other than his /her main subject for post graduation)

1. Elementary Discrete Mathematics
2. Fuzzy Mathematics II
3. Linear Programming
4. MATLAB Programming

CORE (SUBJECT CENTRIC) II

(Candidate can opt for paper this paper in their main subject of post-graduation only)

1. Operations Research II

Detailed Syllabus

M. Sc. Mathematics Semester-I

Paper I (Algebra I)

Unit 1:
Permutation Group. Group of Symmetry. Dihedral group. Commutator group. Isomorphism Theorems. Automorphisms. Characteristic subgroup. Conjugacy and G-Sets.

Unit 2:
Normal Series. Solvable groups. Nilpotent groups. Cyclic decomposition of permutation group. Alternating groups. Simplicity of An.

Unit 3:
Direct product, semi-direct product of groups. Sylows theorems. Groups of order 2 p and pq.

Unit 4:
Ideals and Homomorphisms. Sum and direct sum of ideals. Maximal and prime ideals. Nilpotent and Nil ideals. Modules. Submodules. Direct sums. R-homomorphisms and quotient modules. Completely reducible modules. Free modules.

Text Book:
Basic Abstract Algebra :Bhattacharya, Jain, and Nagpal ,Second Edition, Cambridge University Press.

Reference Books:
1. Topics in Algebra, I. N. Herstein, Second Edition, John Wiley.
2. Abstract Algebra: David S.Dummit and Richard M. Foote, John Wiley.

Paper II (Real Analysis I)

Unit 1:
Uniform convergence. Uniform convergence and continuity. Uniform convergence and integration. Uniform convergence and differentiation. Equicontinuous families of functions. The Stone-Weierstrass theorem.

Unit 2:
Differentiation. The Contraction Principle. The Inverse Function Theorem. The Implicit Function Theorem. The Rank Theorem. Partitions of unity.

Unit 3:
The space of tangent vectors at a point of Rn. Another definition of Ta (Rn). Vector fields on open subsets of Rn. Topological manifolds. Differentiable manifolds. Real Projective space. Grassman manifolds. Differentiable functions and mappings.

Unit 4:
Rank of a mapping. Immersion. Sub manifolds. Lie groups. Examples of Lie groups.

Text Books:
1. Principles of Mathematical Analysis (Third Edition): Walter Rudin Mc GRAW – HILL Book Company.
2. An Introduction to Differentiable Manifolds and Riemannian Geometry: W. Boothby, Academic Press, 1975.

Reference Books:
1. Methods of Real Analysis: R.R. Goldberg, John Wiley.
2. Calculus of Several Variables: C Goffman, Harper and Row.

Paper-III (Topology I)

Unit 1:
Countable and Uncountable sets. Examples and related Theorems. Cardinal Numbers and related Theorems. Topological Spaces and Examples.

Unit 2:
Open sets and limit points. Derived Sets. Closed sets and closure operators. Interior, Exterior and boundary operators. Neighbourhoods, bases and relative topologies.

Unit 3:
Connected sets and components. Compact and countably compact spaces. Continuous functions and homeomorphisms.

Unit 4:
T_o and T_1-spaces, T_2-spaces and sequences. Axioms of countability. Separability. Regular and normal spaces.

Text Book:
Foundations of General Topology: W.J. Pervin, Academic press, 1964.

Reference Books:
1. Topology: J.R. Munkres, (second edition), Prentice Hall of India, 2002.
2. Introduction to Topology and Modern Analysis: G.F. Simmons, Mc Graw Hill 1963.
3. General Topology: J.L. Kelley, Van Nostrand, 1995.
4. Introduction to general Topology: K.D. Joshi, Wiley Eastern Ltd. 1983

Paper IV (Linear Algebra and differential equations)

Unit 1:
Matrices and operators, Subspaces, Bases and Dimension. Determinants, trace, and Rank. Direct sum decomposition. Real Eigen Values. Differential equations with Real Distinct Eigen values. Complex Eigen values.

Unit 2:
Complex vector spaces. Real operators with Complex Eigen values. Application of complex linear algebra to differential equations. Review of topology in Rn. New norms for old. Exponential of operators.

Unit 3:.
Homogeneous linear systems. A non-homogeneous equation. Higher order systems. The primary decomposition. The S+N decomposition. Nilpotent canonical forms.

Unit 4:
Jordan and real canonical forms. Canonical forms and differential equations. Higher order linear equations on function spaces. Sinks and sources. Hyperbolic flows. Generic properties of operators. Significance of genericity.

Text Book :
Differential equations, dynamical systems and linear algebra: M.W. Hirsch and S. Smale, Academic Press, 1975.

Reference Book :
Dynamical systems: V.I. Arnold, Springer Verlag, 1992.

Paper V (Integral Equations)

Unit 1:
Preliminary concepts of integral equations. Some problems which give rise to integral equations. Conversion of ordinary differential equations into integral equations. Classification of linear integral equations. Integro-differential equations.

Unit 2:
Fredholm equations. Degenerate kernels. Hermitian and symmetric kernels. The Hilbert-Schmidt theorem. Hermitization and symmetrization of kernels. Solutions of integral equations with Green's function type kernels.

Unit 3:
Types of Voltera equations. Resolvent kernel of Voltera equations, Convolution type kernels. Some miscellaneous types of Voltera equations. Non-linear Voltera equations. Fourier integral equations. Laplace integral equations.

Unit 4:
Hilbert transform. Finite Hilbert transforms. Miscellaneous integral transforms. Approximate methods of solutions for linear integral equations. Approximate evaluation of Eigen values and Eigen functions.

Text Book:
Integral Equations: A short course: LI. G Chambers: International text book company Ltd, 1976.

M. Sc. Mathematics Semester II

Paper VI (Algebra II)

Unit 1:
Unique factorization domains. Principal Ideal domains. Euclidean domains. Polynomial rings over unique factorization domains.

Unit 2:
Irreducible polynomials and Eisenstein criterion. Adjunction of roots. Algebraic extensions. Algebraically closed fields. Splitting fields. Normal extensions. Multiple roots.

Unit 3:
Finite fields. Separable extensions. Automorphism groups, and fixed fields. Fundamental theorem of Galois theory. Fundamental theorem of algebra.

Unit 4:
Roots of unity and Cyclotomic polynomials. Cyclic extensions. Polynomials solvable by radicals. Ruler and compass constructions.

Text Book :
Basic Abstract Algebra: Bhattacharya, Jain, Nagpaul; Second Edition, Cambridge University Press.

Reference Books :
1. Topics in Algebra, I. N. Herstein, Second Edition, John Wiley.
2. Abstract Algebra, David S. Dummit and Richard M.Foote, John Wiley.

Paper VII (Real Analysis II)

Unit 1:
Outer measure.Measurable sets and Lebesgue measure. Anon-measurable set, Measurable functions, Littlewood's three principles.

Unit 2:
The Riemann integral. Lebesgue integral of a bounded function over a set of finite measure. Integral of a non-negative function. General Lebesgue integral. Convergence in measure. Differentiation of monotone functions. Functions of bounded variation. Differentiation of an integral.

Unit 3:
Absolute continuity.Convex functions. Lp-spaces. Holder and Minkowski inequality. Riesz-Fischer theorem. Approximation in Lp. Bounded linear functionals on Lp-spaces.

Unit 4:
Compact metric spaces. Baire category theorem. Arzela Ascoli theorem. Locally compact spaces. Sigma compact spaces.

Text Book :
Real Analysis, H.L. Royden, Third edition, Prentice Hall, 1988.

Reference Books :
1. Measure theory and Integration, G. de Barra Wiley Eastern Limited, 1981.
2. An introduction to Measure & Integration, Inder K. Rana, Narosa Publishing House

Paper-VIII-Topology-II

Unit 1:
Urysohn's lemma. Tietze extension theorem. Completely regular spaces.Completely normal spaces. Compactness for metric spaces. Properties of metric spaces.

Unit 2:
Quotient topology. Nets and filters.

Unit3:
Product topology : Finite products, product invariant properties, metric products, Tichonov topology, Tichonov theorem.
Unit 4:
Locally finite and discrete families in topological spaces. Paracompact spaces, Urysohn's metrization theorem.

Text books:
1. Foundations of General Topology: W.J. Pervin, Academic press, 1964.
2. Introduction to general Topology: K.D. Joshi, Wiley Eastern Ltd. 1983.

Reference books:
1. Topology: J.R.. Munkres, second edition, Prentice Hall of India, 2002.
2. Introduction to topology and modern analysis :G.F. Simmons, Mc Graw Hill 1963.
3. General Topology: J.L. Kelley, Van Nostrand, 1995.

Paper IX (Differential Geometry)

Unit1:
Definition of surface. Curves on a surface. Surfaces of revolution. Helicoids. Metric. Direction coefficients. Families of curves. Isometric correspondence. Intrinsic properties. Geodesics. Canonical geodesic equations.

Unit2:
Normal property of geodesics. Existence theorems. Geodesic parallels. Geodesic curvature. Gauss Bonnet theorem. Gaussian curvature. Surfaces of constant curvature. Conformal mapping. Geodesic mapping.

Unit 3:
Second fundamental form. Principal curvatures. Lines of curvature. Developables. Developables associated with space curves. Developables associated with curves on surfaces. Minimal surfaces and ruled surfaces. Fundamental equations of Surface theory. Parallel surfaces.

Unit 4: Compact surfaces whose points are umbilics. Hilbert's lemma. Compact surfaces of constant Gaussian or mean curvature. Complete surfaces. Characterisation of complete surfaces. Hilbert's theorem. Conjugate points on geodesics. Intrinsically defined surfaces. Triangulation. Two dimensional Riemannian manifolds. Problem of metrization. Problem of continuation.

Text Book:
An introduction to Differential Geometry: T.J. Wilmore; Oxford University Press

Reference Book:
Geometry of curves and surfaces: do Carmo, Academic Press.

Paper X (Classical Mechanics)

Unit 1:
Variational Principle and Lagrange's equations; Hamilton's Principle, some techniques of calculus of variations, Derivation of Lagrange equations from Hamilton's principle. Extension of principle to nonholonomic systems. Conservation theorems and symmetry properties.

Unit 2: Legendre transformations and the Hamilton equations of motion. Cyclic coordinates and conservation theorems. Routh's procedure and oscillations about steady motion, The Hamiltonian formulation of relativistic mechanics, The Principle of least action.

Unit 3:
The equations of canonical transformation. Examples of canonical transformation. The symplectic approach to canonical transformations. Poisson brackets and other canonical invariants.

Unit 4:
Equations of motion. Infinitesimal canonical transformations and conservation theorems in the Poisson bracket formulation, the angular momentum, Poisson bracket relations, symmetry groups of mechanical systems. Liouville's theorem.

Text Book:
Classical Mechanics: By H. Goldstein, Second Edition Narosa publishing house, New Delhi.

References:
1. Lectures in Analytic Mechanics: F. Gantmacher, MIR Publishers, Moscow, 1975.
2. Classical Mechanics: Narayan Chandra Rana and Pramod Sharad Chandra Jog, Tata Mc Graw Hill.
3. Lectures on Advanced Mechanics: T. M. Karade and G. S. Khadekar Pub: SONU NILU

M. Sc. Mathematics Semester-III

Paper XI (Complex Analysis)

Unit 1:
Impossibility of ordering Complex numbers. Extended complex plane and stereographic projection. Elementary properties and examples of analytic Functions: Power series, analytic functions.

Unit 2:
Analytic functions as mappings, Mobius transformations. Power series representation of analytic functions, zeros of an analytic function, index of a closed curve.

Unit 3:
Cauchy's theorem and integral formula, the homotopic version of cauchy's theorem and simple connectivity, counting zeros; the open mapping theorem, Goursat's theorem, Classification of singularities, residues, the argument principle.

Unit 4:
The maximum principle. Schwarz's lemma. convex functions and Hadamards three circles theorem. Phragmen-Lindelof theorem.

Text Book:
Functions of one complex variable: John B. Conway, Second edition, Springer international Student Edition.

Reference Book:
Complex Analysis, L.V. Ahlfors. Mc-Graw Hill, 1966.

Paper XII (Functional Analysis)

Unit 1:
Normed spaces, Banach spaces, Further properties of normed spaces. Finite dimensional normed spaces and subspaces. Compactness and finite dimension. Bounded and continuous linear operators.

Unit 2:
Linear functionals. Normed spaces of operators. Dual spaces. Inner product space. Hilbert space. Further properties of inner product spaces. Orthogonal complements and direct sums. Orthonormal sets and sequences. Total orthonormal sets and sequences.

Unit 3:
Representation of functionals on Hilbert spaces. Hilbert adjoint operators, self adjoint, unitary and normal operators. Hahn-Banach Theorem, Hahn-Banach Theorem for complex vector spaces and normed spaces. Reflexive spaces.

Unit 4:
Category theorem, Uniform boundedness theorem, strong and weak convergence, Convergence of sequences of operators and functionals. Open mapping theorem, Closed linear operators and closed graph theorem.

Text Book:
Introductory Functional Analysis with Applications by E. Kreyszig, John Wiley and Sons.

Reference Books:
1. Introduction to Functional Analysis by A.E. Taylor and D.C. Lay, John Wiley and Sons.
2. Introduction to Topology and Modern Analysis: G.F. Simmons, Mc Graw Hill

Paper XIII (Mathematical Methods)

Unit 1:
Fourier integral theorem. Fourier transform. Fourier cosine and sine transform. The convolution integral. Multiple Fourier transform. Solution of partial differential equation by means of Fourier transform.

Unit 2:
Calculations of the Laplace transform of some elementary functions. Laplace transform of derivatives. The convolution of two functions. Inverse formula for the Laplace transform. Solutions of ordinary differential equations by Laplace transform.

Unit 3:
Finite Fourier transform. Finite Sturm-Liouville transforms. Generalized finite Fourier transform.

Unit 4:
Finite Hankel transform. Finite Legendre transform. Finite Mellin transform.

Text Book:
The use of integral transforms: I N. Sneddon, Tata Mc Graw Hill Publishing Company Ltd.

References Books:
Modern Mathematics For Engineers: Edwin F Beckenbach, Second series, Mc Graw Hill Book Company.

CORE ELECTIVE PAPER XIV (Opt any one of the following)

Fluid Dynamics-I

Unit 1:
Real fluids and ideal fluids. Velocity of a fluid at a point. Stream lines and path lines. Steady and unsteady flows. Velocity potential. Velocity vector. Local and particle rate of change. Equation of continuity. Acceleration of a fluid. Condition at a rigid boundary. General analysis of fluid motion. Euler's equation of motion. Bernoulli's equation. Worked examples. Discussion of the case of steady motion under conservative body forces. Some further aspects of vortex motion.

Unit 2:
Sources, sinks and doublets. Images in a rigid infinite plane. Images in solid spheres. Axisymmetric flows. Stokes' stream function. The complex potential for two-dimensional irrotational, incompressible flow. Complex velocity potential for standard two dimensional flow. Uniform stream. Line source and line sink. Line doublets. Line vortices. Two dimensional image systems. The Milne-Thomson circle theorem. Circle Theorem. Some applications of circle theorem. Extension of circle
theorem. The theorem of Blasius.

Unit 3:
The equations of state of a substance, the first law of thermodynamics, internal energy of a gas, functions of state, entropy, Maxwell's thermodynamic relation, Isothermal Adiabatic and Isentropic processes. Compressibility effects in real fluids, the elements of wave motion. One dimensional wave equation, wave equation in two and three dimensions, spherical waves, progressive and stationary waves.

Unit 4:
The speed of sound in a gas, equation of motion of a gas. Sonic, subsonic, supersonic flows; isentropic gas flow. Reservoir discharge through a channel of varying section, investigation of maximum mass flow through a nozzle, shock waves, formation of shock waves, elementary analysis of normal shock waves.

Text Book:
F. Chorlton, Text book of Fluid Dynamics, CBS Publishers, Delhi 1985.

Reference Books:
1. G.K. Batchelor, An Introduction to fluid Mechanics, Foundation Books, New Delhi 1994.
2. M.D. Raisinghania, fluid Mechanics, S. Chand and Company, Delhi.

General Relativity

Unit 1:
Tensor Algebra, Riemannian geometry, Curvature Tensor: Covariant Curvature tensor, Ricci tensor, Einstein Tensor, The Bianchi identity.

Unit 2:
The principle of covariance, The principle of equivalence, Geodesic principle, Newton's equations of motion as an approximation of geodesic equations, Poisson's equations as an approximation to Einstein field equations.

Unit 3:
Gravitational field equations in free space, Exterior Schwarzchild's solution and its isotropic form, Birkhoff's theorem, Schwarzchild singularity, planetary orbit, Advance of Perihelion of a planet, Bending of light rays in the gravitational filed, Gravitational Red shift in the spectral lines.

Unit 4: Gravitational field equations for non empty space, Linearization of the field equations, The Weyl's solution of linearized Field equations, Interior Schwarzchild's solution.

Text Book:
Introduction to General Relativity: Ronald Adler, Maurice Bezin and Manamen Schiffer, McGraw-Hill Kogakusha Ltd.

References Books:

1. Introduction to theory of relativity, Rosser W.G.V., ELBS(1972).
2. Relativity Special, General and Cosmology, Rindler W., Pub. Oxford University Press (2003).
3. The Classical Theory of Fields By Landau I.D. and Lifshitz E.M., Pub. Pergamon Press (1978).
4. General Theory of Relativity BY T. M. Karade and G. S. Khadekar, Pub. SONU NILU

FOUNDATION COURSE I

FOUNDATION PAPER

Paper XV (Opt any one of the following)

(Student shall opt for this paper from any other subject other than his /her main subject for post graduation)

Elementary Mathematics

Unit 1:

Differentiation: Derivative of a constant function, derivative of trigonometric functions, derivative of inverse trigonometric functions, derivative of $y = log_a x$, hyperbolic function, derivation of parametrically defined functions, logarithmic differentiation.

Unit 2:

Integration: Methods of integration, integration by substitution, three important forms of integrals, six important integrals, integration by parts, definite integrals, reduction formulae.

Unit 3:

Matrices & Determinant: Transpose of matrix, orthogonal matrices, unitary matrices, Hermitian and Skew-Hermitian matrices, idempotent matrix, Involutory matrix, minors and factors, properties of determinants, determinants-general treatment, symmetric & Skew-symmetric determinant.

Unit 4:

Complex Number: Definition, conjugate, modulus and argument, Algebra of complex number (Addition, Subtraction, Multiplication and Division), power and square root of complex number, properties of complex number, Argand diagram, solution of quadratic equation in complex number system.

Text Books:

1. Differential Calculus by Shanti Narayan (Unit 1 & Unit 2)
2. An Introduction to Matrices by S.C. Gupta (Unit 3 & Unit 4)

Elementary Mathematical Methods

Unit 1:

The Laplace Transform: Piece-wise or Sectional continuity, Functional of exponential order, Function of class A, The transform concept, Some Standard result.

Unit 2:

The Inverse Laplace Transform: Definition, Null function, Uniqueness of inverse Laplace Transform, partial Fractions, Heaviside's expansion formula, The complex inversion formula.

Unit 3:

Applications to Differential Equations, Hankel Transform, Mellin Transforms.

Unit 4: Fourier Transform

The Infinite Fourier Transform: Infinite Fourier sine transform of F(x), Infinite Fourier cosine transform of F(x), The Infinite Fourier transform of F(x), Relationship between Fourier and Laplace transform.

The finite Fourier Transform and Fourier Integral: : Finite Fourier sine transform of F(x), Finite Fourier cosine transform of F(x),Fourier Integral Theorem.

Text Book:

1. Integral Transforms by J.K.Goyal, K.P.Gupta, Pragati Prakashan (14^{th} Edition 2010).

Numerical Method

Unit 1:

Numerical Differentiation: Remainder or Error Committed in Computing Derivative, Differentiation formulae, Estimation of Error differentiation formula based on Newton's Forward, Backward and Stirling's formula.

Numerical Integration: Trapezoidal Rule, Simpson's 1/3 and 3/8 rules. Romberg's method. Two and Three point Gaussian quadrature formulae –Double integrals using trapezoidal and Simpsons's rules. Weddle's rule, Error in Integration Formulae.

Unit 2:

Solution of Algebraic and Transcendental: Bisection method, Newton Raphson's Methos, Regula-Falsi Method, The Secant method, The method of successive approximations, Comparison of Iterative method.

Unit 3:

System of Linear Algebraic Equations: Gauss-Elimination Method, Gauss-Jacobi Iteration Method, Gauss-Seidel Iteration Method, Matrix Inversion Method, Gauss-Jordon's Matrix Inversion Method.

Unit 4:

Numerical Solutions of Ordinary Differential Equation of First order: Euler method, Euler Modified method, Picard's Method, Picards Method of Successive approximation, Taylor series method, Runge-Kutta method. Multistep methods: Milne's and Adam's predictor and corrector methods.

Text Book:

1. Numerical Analysis and Computational Procedure by S A Molla, Books and Allied (P) Ltd.
2. Computer Orianted Numerical Method by V. Rajaraman Prentice Hall of India (P). Ltd.
3. Advanced Engineering Mathematics by Ervin Kreyszing, New Age International (P) Ltd.
4. Numerical methods with programming in C by Veerarjan, T and Ramachandran, T. Second Editiion, Tata McGraw-Hill Publishing. Co. Ltd, 2007.
5. Numerical Methods for Scientisits and Engineers by Sankara Rao K, 3rd Edition, Printice Hall of India Private Ltd, New Delhi, 2007.

Fuzzy Mathematics-I

Unit 1:
Crisp Sets. Fuzzy Sets. Fuzzy sets versus Crisp sets Operations on Fuzzy sets.

Unit 2:
Fuzzy Arithmetic.

Unit 3:
Fuzzy relations.

Unit 4:
Fuzzy relation equations.

Text Book:
Fuzzy Sets and Fuzzy Logic, theory and applications. George J. Klir and Bo Yuan, Prentice Hall India.

CORE (SUBJECT CENTRIC) I
(Candidate can opt for this paper in their main subject of post-graduation only)

Operational Research I

Unit 1:
Simplex method, Theory of Simplex method, duality, dual simplex method.

Unit 2:
Transportation and Assignment problems.

Unit 3:
Two-person Zero-sum games. Games with mixed strategies, graphical solution, solution by linear programming.

Unit 4:
Dynamic programming

Text book:
Operations Research: Kanti Swarup P.K. Gupta and Man Mohan: Sultan Chand and Sons New Delhi.

Reference books :

1. Linear programming: G. Hadley, Narosa Publishing House1995.
2. Introduction to operations Research: F.S. Hillier and G.J.Lieberman (Sixth Edition), Mc Graw Hill
3. International Edition 1995.
4. Operations Research – In Introduction: H.A Taha, Macmillan publishing company inc, New York

M. Sc. Mathematics Semester IV

Paper XVI Dynamical Systems

Unit 1:
Dynamical systems and vector fields. The fundamental theorem. Existence and uniqueness. Continuity of solutions in initial conditions. On extending solutions. Global solutions. The flow of a differential equation.

Unit 2:
Nonlinear sinks. Stability. Liapunov function. Gradient systems. Gradients and inner products.

Unit 3:
Limit sets, local sections and flow boxes, monotone sequences in planar dynamical systems. The Poincare Bendixson theorem, Applications of Poincare-Bendixson theorem; one species, predator and prey, competing species.

Unit 4:
Asymptotic stability of closed orbits, discrete dynamical systems. Stability and closed orbits. Non Autonomous equations and differentiability of flows. Persistence of equilibria, persistence of closed orbits. Structural stability.

Text Book:
Differential equations, dynamical systems & linear algebra: M.W. Hirsch & S. Smale, Academic Press, 1975.

Reference Book:
Dynamical systems: V.I. Arnold, Springer Verlag, 1992.

Paper XVII Partial Differential Equations

Unit 1:
First order partial differential equations in two independent variables and the Cauchy problem. Semilinear and quasi linear equations in two independent variables. First order non linear equations in two independent variables. Complete integral.

Unit 2:
Classification of second order partial differential equations. Potential theory and elliptic differential equations (sections 2.1-2.5).

Unit 3:
The diffusion equation and parabolic differential equations (sections 3.1-3.4).

Unit 4:
The Wave equation (sections 4.1, 4.2, 4.4, 4.8, 4.9)

Text Book:
Partial Differential Equations: Phoolan Prasad and Renuka Ravindran; New Age International (P) Limited.

Paper XVIII Numerical Analysis

Unit 1:
Simple enclosure methods, Secant method, Newton's method, general theory for one point iteration methods. Aitken extrapolation for linearly convergent sequences, Error tests, Numerical evaluation of multiple roots, roots of polynomials, Mullers method, Non-linear systems of equations, Newton's method for non- linear systems.

Unit 2:
Polynomial interpolation theory, Newton's divided differences, finite difference and table oriented interpolation formulas. Forward-differences. Hermite interpolation.

Unit 3: The Weierstrass theorem and Taylor's theorem. The minimax approximation problem, the least square approximation problem, orthogonal polynomial, economisation of Taylor series, minimax approximation.

Unit 4:
The trapezoidal rule and Simpson's rule, Newton- Cotes integration formulas.

Text book:
An Introduction to Numerical Analysis by K. E. Atkinson, Johan Wiley and sons, Inc.

CORE ELECTIVE PAPER XIX (Opt any one of the following)

Fluid Dynamics-II

Unit 1:
Stress components in a real fluid, relation between Cartesian components of stress translation motion of fluid elements, the rate of strain quadric and principal stresses, some further properties of the rate of the strain quadric, stress analysis in fluid motion, relation between stress and rate of strain, the coefficient of viscosity and laminar flow, the Navier-Stokes equations of motion of a viscous fluid, some solvable problems in viscous flow, diffusion of vorticity, energy dissipation due to viscosity, steady flow past a fixed sphere.

Unit 2:
Nature of magneto-hydrodynamics, Maxwell electromagnetic field equations; Motion at rest, Motion in medium , Equation of motion of conducting fluid, Rate of flow of charge, Simplification of electromagnetic field equation. Magnetic Reynold number; Alfven's theorem, The magnetic body force. Ferraro's Law of Isorotation.

Unit 3:
Dynamical similarity, Buckingham Theorem. Renold number. Prandtl's boundary layer, Boundary layer equation in two dimensions, Blasius solutions, Boundary layer thickness, Displacement thickness. Karman integral conditions, Separation of boundary layer flow.

Unit 4:
Turbulence: Definition of turbulence and introductory concepts. Equations of motion for turbulent flow. Reynolds Stresses Cylindrical coordinates. Equation for the conservation of a transferable scalar quantity in a turbulent flow. Double correlations between turbulence-velocity components. Change in double velocity correlation with time. Introduction to triple velocity correlations. Features of the double longitudinal and lateral correlations in a homogeneous turbulence. Integral scale of turbulence.

Text Books:
1. Text book of Fluid Dynamics: F. Chorlton; CBS Publishers, Delhi 1985.
2. Fluid Mechanics: Joseph Spurk; Springer.
3. Turbulence by J.O. Hinze, 2nd edition, Mc Graw-Hill, chapter 1 sections 1.1 to 1.7
4. Fluid Mechanics by M.D. Raisinghania, S. Chand and Company, Delhi.

Reference Books:
1. An Introduction to fluid Mechanics: G.K. Batchelor; Foundation Books, New Delhi, 1994.
2. Boundary Layer Theory: H. Schichting; Mc Graw Hill Book Company, New York 1971.

Cosmology

Unit 1:
Static cosmological models of Einstein and de Sitter and their derivation and its Properties: (i) The geometry of the Universe (ii) Density and pressure (iii) Motion of test particle (iv) Doppler shift (v) comparison with actual universe, Comparison between Einstein and de-Sitter models.

Unit 2:
Cosmological principle, Hubble law, Weyl's postulate,Derivation of Robertson Walker Metric and its properties, Motion of a particle and light rays in FRW model, Red shift, Deceleration parameter and Hubble's constant, Matter Dominated era.

Unit 3:
Friedman Model, Fundamental equation of dynamical cosmology, density and pressure of the present universe, Matter dominated era of the universe, critical density, flat, closed and open universe, age of the universe.

Unit 4:
Steady state cosmology, Distance measure in cosmology, Comoving distance, Apparent luminosity and luminosity distance, Angular diameter and Lookback time, Galaxy count

Text Books:

1. Relativity, Thermodynamics and Cosmology: Richard C. Tolman, Oxford Press
2. Gravitation and Cosmology : Principles and Applications of the General Theory of Relativity by Steven Weinberg.
3. General Theory of Relativity By T. M. Karade and G. S. Khadekar, Pub. SONU NILU

References Books:

1. The Classical Theory of Fields, By Landau I.D. and Lifshitz E.M., Pub. Pergamon Press (1978).
2. The Theory of Relativity Moller C, Pub. Oxford University Press (1982).
3. Introduction to theory of relativity, Rosser W.G.V., ELBS (1972).
4. Relativity Special, General and Cosmology, Rindler W., Pub. Oxford University Press (2003).
5. Relativity: The General Theory, Synge J.L., North Holland Pub. Comp. (1971).

FONDATION COURSE II

FOUNDATION PAPER XX (Opt any one of the following)

(Student shall opt for this paper from any other subject other than his /her main subject for post graduation)

Discrete Mathematics

Unit 1:

Mathematical Logic: Introduction, Proposition, compound Proposition, Proposition and truth tables, logical equivalence, algebra of Proposition, conditional Proposition, converse, contra positive & inverse, bi conditional statement, negation of compound statements, tautologies & contradictions, normal forms, logic in proof.

Unit 2:

Lattice: Lattice as partially ordered sets, their properties, lattices as algebraic system, sub lattices, and some special lattices eg. Complete, complemented and distributive lattices.

Unit 3:

Boolean algebra and Logic Circuits: Boolean algebra, basic operations, Boolean functions, De-Morgan's theorem, logic gate, sum of products and product of sum forms, normal form, expression of Boolean function as a canonical form, simplification of Boolean expression by algebraic method, Boolean expression form logic & switching network.

Unit 4:

Graph Theory: Basic terminology, simple graph, multigraph, degree of a vertex, types of a graph, sub graphs of isomorphic graphs, matrix representation of graphs, Euler's theorem on the existence of Eulerian path & circuits, directed graph, weighted graphs, strong connectivity, chromatic number.

Text Book:
Discrete Mathematical structures with applications to computer science by J.P. Tremblay and R. Manohar, McGraw-Hill book company,1997.

Fuzzy Mathematics-II

Unit 1:
Possibility theory

Unit 2:
Fuzzy Logic

Unit3:
Constructing Fuzzy sets and operations on Fuzzy sets. Approximate reasoning.

Unit4:
Fuzzy Systems. Pattern Recognition.

Text Book:
Fuzzy Sets and Fuzzy Logic, theory and applications by George J. Klir and Bo Yuan, Prentice Hall, India.

Linear Programming

Unit 1:
Mathematical formulation of L.P.P. Graphical method for solution of LPP.

Unit 2:
Simplex method. Theory and problems. Computational procedure. Artificial variables inverse of a matrix using simplex method.

Unit 3:
Duality in L.P.P. Concept of duality, properties, dual simplex method, its algorithm

Unit 4:
Transportation and assignment problems, various methods.

Text Book:
Operations Research by R.K. Gupta, KRISHNA Prakashan Media (P) Ltd. (30^{th} Edition: 2012)

Matlab Programming

Unit 1:
Input output of data from Matlab command. File types. Creating, saving and executing the script
file. Creating and executing functions file. Working with files and directories.

Unit 2:
Matrix manipulation. Creating vectors. Arithmetic operations. Relational operations. Logical operations. Matrix functions. Determinant of matrix. Eiugen values and Eigen vectors. Programming in Matlab: function files, sub functions, global variations, loops, branches and control flow. Interactive input. Recursion. Publishing a report. Controlling command windows. Command line editing.

Unit 3:
Linear Algebra and interpolation: Solving the linear equation. Gaussian elimination, matrix factorization, curve fitting, polynomial curve fitting, least squares curve fitting. General non linear fits. Interpolation.

Unit 4:
Differential equations and graphics: First order and second order ODE. Double integration. Roots of polynomial. Two and three dimensional plots. Matlab plotting tools. Mesh and surface plots.

Text Books:

1. Applied numerical Methods using MATLAB: Won Young Yang, Tae-Sang-Chung, John Morris: John Wiley and Sons.
2. Solving ODE's with Matlab: L.F. Shampine, I Gladwell, S. Thompson; Cambridge University Press. Getting Started with MATLAB 7: Rudra Pratap; Oxford Press

CORE (SUBJECT CENTRIC) II

(Candidate can opt for this paper in their main subject of post-graduation only)

Operations Research–II

Unit 1:
Integer programming.

Unit 2:
Queuing theory and sequencing.

Unit 3:
Non- Linear programming- one and multi- Variable unconstrained optimization, Kuhn-Tuckerconditions for constrained optimization.

Unit 4:
Quadratic programming, fraction programming and goal programming.

Text book:

Kanti-Swarup P.K. Gupta and Man Mohan: Operations Research, Sultan Chand and Sons New Delhi.

Reference books :

1. G. Hadley: Linear programming, Narosa Publishing House1995.
2. 2.F.S. Hillier and G.J.Lieberman: Introduction to operations Research (Sixth Edition) Mc Graw Hill
3. International Edition 1995.
4. 3.H.A Taha: Operations Research – In Introduction, Macmillan publishing company inc, New York