M.SC.-II (New) MATHEMATICS)

SEMESTER-III

Paper-XI : FUNCTIONAL ANALYSIS-I

Unit-I : Normal linear spaces, Banach spaces and examples. Quotient spaces of normed linear spaces and its completeness, equivalent norms, Riesz lemma.

Unit-II : Basic Properties of finite dimensional normed linear spaces and compactness. Weak conver gence and bounded linear transformations, normed linear spaces of bounded linear transformations, Dual spaces with example.

Unit-III : Boundedness theorem and some of its consequences, Open mapping, Hahn Banach theorem for real linear spaces, complex linear spaces and normed linear spaces.

Unit-IV : Reflexive Spaces, Weak sequential compactness, compact operators, solvability of linear equations in Banach spaces, the closed graph theorem.

Unit-V : Inner product spaces, Hilbert spaces, orthogonal sets, Bessel's inequality, complete orthogonal sets, Parseval's identity , structure of Hilbert spaces.

References :

1) Serge Lang, Analysis I & II, Addison-Wesley Publishing Company , Inc. 1967. 2) G .Bachman and L.Narici, Functional Analysis, Academic Press, 1966. 3) N. Dunford and J.T .Schwartz, Linear Operators, Part-I, Interscience, New Y ork, 1958. 4) R.E.Edwards, Functional Analysis, Holt Rinehart and Winston, New York, 1965. 5) C.Goffman and Pedrick, First Course in Functional Analysis, Prentice Hall of India, New Delhi, 1987. 6) P .K. Jain, O.P. Ahuja and Khalil Ahmad, Functional Analysis, New Age International (P) Ltd. & Wiley Eastern Ltd., New Delhi, 1997. 7) R.B. Holmes, Geametric Functional Analysis and its Applications, Springer -Verlag,1975. 8) K.K. Jha, Functional Analysis, Students Friends, 1986. 9) E.Kreyszig, Introductory Functional Analysis with Applications, John Wiley and Sons, New York, 1978.

Paper-XII : ADVANCED MECHANICS

Unit-I : Variational principle and Lagranges Equations : Hamilton's principle, some techniques of the calculus of variations. Derivation of Lagrange' s Equations from Hamilton's Principle.

Unit-II : Generalised coordinates, Halonomic & Non-holonimic systems, Scleronomic and Rheonomic systems, Generalized potential, Lagranges Equations of first kind and second kind, uniqueness of solution, Energy equations for conservative fields.

Unit-III : Legendre transformations and the Hamilton equations of motion, cyclic coordinates and conservation theorems, Routh's equations, Derivation of Hamilton's equations from a variational principle, the principle of least action.

Unit-IV : Canonical transformations : The equations of Canonical transformation, examples of canonical transformations. Poisson's bracket & other canonical invariants (Lagranges Bracket), Poisson's identity

Unit-V : The Hamilton-Jacobi Equation for Hamilton's principle function, The harmonic Oscillator problem as an example of the Hamilton-Jacobi method. The Hamilton-Jacobi Equation for Hamilton's characteristic function, Separation of variables in the Hamilton-Jacobi equation. References:

(1) A.S.Ramsey Dynamics Part-II, the English Language Book Society and Cambridge University Press. (2) Gupta, Kumar and Sharma, Classical Mechanics (3) T.M. Karade, G.S.Khadekar, Lectures on Advanced Mechanics, SonuNilu publication (4) I.D. Landau and E.M. Lifchitz, Vol. I third edition, Perguman press, New Delhi (5) H.Goldstein, Classical Mechanics, Second edition, Narosa Publishing House, New Delhi. (6) N.C.Rana & P .S.Joag ,Classical Mechanics ,Tata Mc Graw Hill

(7) L.M. Katkar,Classical Mechanics(Mathematics),Shivaji University Kolhapur, 2007

Paper-XIII : OPERATIONS RESEARCH

Unit-I : Operation Research & its scope, linear programming, Mathematical formulation, Graphical solution, General linear programming (LP), Simplex method, Use of Artificial variable, (Big-M method), Duality in LP. , Economic Interpretation, dual simplex method.

Unit-II : Integer Programming, Branch and Bound technique, Fractional cut plane method, Goal programming, Advanced techniques in LP (upper bound technique)

Unit-III : Parametric linear programming, Transportation problem and assignment problems.

Unit-IV : Queing system, basic properties of queuing system, Element of Queing system, Poisson and Non- Poisson Queing system.

Unit-V : Game and strategies, two person, zero sum games, the maximumminimum principle, games without saddle point, mixed strategies, graphics solution of 2 x n and m x 2 games, dominance properties, general solution of m x n rectangular games.

Reference:

1) G. Hadley, Linear Programming, Narosa publishing House, 1995. 2) G. Hadley, Nonlinear and Dynamic Programming, Addison-Wesley. Reading Mass. 3) Mokhtar S. Bazaraa, Hohn J. Jarvis and Hanif D. Sherali, G. Hadley, Linear Programming and Network flows, John Wiley and Sons. New York, 1990. 4) H. A. Taha, Operation Research- an Introduction, Macmillan Publishing Company, Inc, New York. 5) S. S. Rao, Optimization Theory and Applications, Wiley Eastern Ltd., New Delhi. 6) Prem

Kumar Gupta and D. S. Hira, Operation Research- an Introduction, Chand & Company Ltd., New Delhi. 7) N. S. Kambo, Mathematical programming Techniques. Affiliated EastWest Press Pvt. Ltd., New Delhi, Madras. 8) F. S. Hillier and G. J. Liebermann, Introduction to Operations Research (6th Ed.) McGraw Hill International Edition, Industrial Engineering Series, 1995. 9) Kantiswaroop, P .K. Gupta and Manmohan, Operations Research, Sultan Chand & Sons, New Delhi-2007.

FLUID DYNAMICS-I (OPTIONAL)

Unit-I : Kinematics of fluid in Motion : Real fluids and ideal fluids. Velocity of a fluid at a point stream lines and path lines.Steady and unsteady flows. Velocity potential, vorticity vector , local and particles rates of change. Equation ofcontinuity , worked examples. Acceleration of a fluid. Conditions at a rigid boundary , general analysis of fluid motion.

Unit-II : Pressure of motion of a fluid : Pressure at a point in a fluid at rest. Pressure at a point in a moving fluid, conditions at a boundary of two inviscid immiscible fluids, Euler's Equation of motion. Bernoulli' s equation, worked examples. Discussion of the case of steady motion under conservative body forces, some potential theorem, some special two dimensional flow . Some further aspects of vartex motion.

Unit-III : Sources, sinks and Doublets, images in a rigid infinite plane. Images in a solid spheres. Asci-symmetric flow, Stokes stream function. Some two dimensional flows, meaning of two dimensional flow , use of cylindrical polar coordinate, the stream function, the complex potential for two dimensional, irrotational incompressible flow . Complex velocity potentials for standard two-dimensional flows, uniform stream, line source and link sinks, link system.

Unit-IV : The Milne-Thomsom circle theorem, some application of the circle theorem, extension of the circle theorem, the theorem of W a sins, the use of conformal transformation. Vortex rows, single infinite row of line vortices. The Karnar vortex street.

Unit-V : Elements of Thermodynamics : The equation of state of substance, the first law of Thermodynamics, internel energy of a gas. Specific heat of a gas. Function of state, Entropy, Maxwell's Thermodynamics relation. Iso-thermal Adiabatic and Isentropic Process.

References:

(1) Besaint and A.S.Ramsay , A Treatise on Hydrodynamics, Part-II, CBS Publishers, Delhi, 1988. (2) G .K.Batchelor , An Introduction to Fluid Mechanics, Foundation Books, New Delhi, 1994. (3) H. Schlichting, Boundary Layer Theory , McGraw Hill Book Company , New Y ork, 1971. (4) M.D.Raisinghania, Fluid Mechanics (With Hydrodynamics), S.Chand and Company Ltd., New Delhi. (5) L.D.Landen and E.M.Lipschitz, Fluid Mechanics, Pargamon Press, London, 1985. (6) F .Chorlton, T ext Book of Fluid Dynamics, CBS Publishers, Delhi (7) R.K.Rathy, An Introduction to Fluid Dynamics, Oxford and IBH Publishing Company, New Delhi, 1976. (8) A.D. Young, Boundary Layers, AIAA Education Series, Washington, DC, 1989. (9) S.W.Yuan, Foundation of Fluid Mechanics, Prentice Hall of India Private Limited, New Delhi, 1976.

GENERAL RELATIVITY (OPTIONAL)

Unit-I : Einstein's relativity: SR to GR, Principle of equivalence, Principle of covariance and Mach's Principles, Einstein's field equations, Derivation of Einstein's field equations from action principle, Newtonian approximation: Relation betweeng44 and V, Einstein equations compared with Poisson equation.

Unit-II : Schwarzschild exterior solution and its isotropic form, Birkhoff's theorem, planetary orbits, General relativistic Kepler problem, Advance of Perihelion of a planet, Bending of light ray in a gravitational field, gravitational red shift in spectral lines

Unit-III : Schwarzschild interior solutions, field of charged mass point the boundary conditions, covariant conservation law, the tetroid representation of Einstein equations, Eddington's form of Schwarzschild solution. Unit-IV : Gravitational collapse of spherical body, black hole, gravitational collapse of a dust like sphere, Kerr metric, gravitational collapse of a non spherical and rotating body.

Unit-V : Gravitational waves, weak gravitational waves, gravitational waves in curved space time, strong gravitational waves, radiation of gravitational waves.

References: 1) Elements of General Relativity: T .M. Karade, K.S. Adhav, S.D. Katore, M.S. Bendre, Sonu Nilu Publicaton, Einstein Foundation International, Nagpur, first edition June-2014. 2) Introduction to General Relativity - Ronald Adler, Maurice Bazin, Menahem, Schiffer, 2nd Edition, McGraw Hill Company. 3) Mathematical Theory of Relativity: A.S. Eddington, Cambridge University Press, 1965. 4) Relativity: The General Theory - J.L. Synge, North Holland Publishing Company, 1976 5) The Classical Theory of Fields - I.D. Landau and E.M. Lifshitz, Pergamon Press, 1980. 6) An Introduction to Riemannian geometry and the Tensor Calculus C. E. Weatherburn, Cambridge University Press, 1950. 7) Classical theory of fields by L.D. Landau and E.M. Lifshitz.

DIFFERENCE EQUATIONS-I (OPTIONAL)

Unit-I : Introduction : Difference calculus. The difference operator. Generating function and approximate summation.

Unit-II : Linear Difference Equations : First Order Equations, General results for linear equations. Equations with constant coefficients. Applications, Equations with variable coefficients. Non-linear equations that can be linearized.

Unit-III : The Z-transform : Properties, initial and final value theorems, partial sum theorem, convolution theorem. Inverse Ztransforms, solution of difference equation with constant coefficients by Z- transforms.

Unit-IV : Stability Theory : Initial value problems for linear systems. Stability of linear systems. Stability of non-linear system. Chaotic behaviour .

Unit-V : Asymptotic Methods : Introduction, Asymptotic analysis of sums, linear equations, non-linear equations.

Reference Books :

(1) Eugenio Hernandez & Guido Weiss, A First Course on Wavelets, CRC Press, New York, 1996. (2) Chui C.K., An Introduction to Wavelets, Academic Press, 1992. (3) M.W . Wang : Wavelet Transforms & Localization Operators, Berkhauser B Verleg. (4) Gerald Kaiser : A Friendly Guide to W avelets, Birkhauser , 1994. (5) Walter G. Kelley and Allan C. Peterson, Difference Equations : An Introduction with Applications, Academic Press, Inc. Harcourt Brace Joranovich Publishers, 1991.

ADVANCED COMPLEX ANALYSIS (OPTIONAL)

Unit-I : Montel's Theorem, Spaces of Meromaophic functions, The Riemann mapping Theorem, The Weierstrass factorization Theorem, Factorization of Sine function.

Unit-II : The Gamma Function and its properties, The Riemann Zeta function, Riemann's functional Equation, Euler's Theorem,Mittage-Leffler's Theorem.

Unit-III : Monodromy theorem and its consequences, The Sheaf of Germs of Analytic function on an open set, Harmonic function on a disc, Harnack's inequality, Dirichlet's problem, Green's function.

Unit-IV : Canonical Products, Jensen's formula, Poisson-Jensen's formula, The genus and order of an entire function, exponent of convergence, Hadamard's factorization Theorem.

Unit-V : The range of an Analytic function, Bloch theorem, Little Picard's theorem, Schottky's theorem, univalent function, Bieberbach's conjecture theorem, Cobe's"1/4".

References:

1) S. Ponnusamy, Foundation of Complex Analysis, Narosa Publishing House, 1967. 2) H. S. Kasana, Complex variables: Theory and Application, PHI Learning Pvt. Ltd., New Delhi. 3) Schaum's outline series Complex Analysis, Tata McGraw Hill Education Pvt. Ltd., New Delhi (2010). 4) J. N. Sharma, Complex Variables, Pragati Publication. 5) A. R. Vasistha, Complex Variables, Krishna Publication. 6) Murray R. Spiegel, Seymour Lipschutz, Jon J. Schiller, Dennis Spellman., Schaum's outline series Complex Analysis, Tata McGraw Hill Education Pvt. Ltd., 3rd Edition, New Delhi 2010. 7) Walter Rudin, Real & Complex Analysis, McGraw Hill Book Co., 1966. 8) J. Ward Brown, Ruel V. Churchill, Complex variables and Application, McGraw Hill International Edition (2009). 9) H. A. Priestly, Introduction to Complex Analysis, Clarendon Press, Oxford, 1990. 10) Liang-Shin Hahn & Bernhard Epstein, Classical Complex Analysis, Jones & Berlett Publishers. International London, 1996. 11) L. V. Ahlfors, Complex Analysis, McGraw Hill, 1979. 12) S. Lang, Complex Analysis, Addison Wesley, 1977.1998. 13) D. Sarason, Complex Function Theory, Hindustan Book, Agency, Delhi, 1994. 14) Mark J. Ablowitz and A. S. Fokar, Complex variables: Introduction & Application, Cambridge University Press, South Asian Edition, 56.

23 24 15) E. Hille, Analytic Function Theory (2 Vols), Gonn & Co. 1959. 16) W. H. J. Fuchs, Topics in the Theory of Function of Complex Variable, D. Van Nostrand Co., 1967. 17) C. Carathedory, Theory of Functions (2 Vols), Chelsea Publishing Company, 1964. 18) M. Heins, Complex Function Theory, Academic Press, 1968. 19) S. Saks & A. Zygmund, Analytic Functions, Monografie, Matematyczne, 1952. 20) E. C. Titchmarsh, the Theory of Functions, Oxford University Press, London. 21) W. A. Veech, A Second Course in Complex Analysis, W. A. Benjamin, 1967. 22) Complex variables and Applications, Jams Ward Brown, Ruel V. Churchill, McGraw Hill International Edition (2009). 23) Dennis G. Zill, Patrick D. Shanhan Jones and Burtlett, A First Course in Complex Analysis with application (Second edition) Publisher (2010). 24) John Mathew and Howell, Complex Analysis for Mathematician and Engineers. 25) Functions of one complex variable - J. B. Conway, Springer Verlag International Students Edition, Narosa Publishing House, 1980.

BANACH ALGEBRAS-I (OPTIONAL)

Unit-I : Definition of Banach Algebra and Examples. Singular and non-singular elements. The abstract index. The spectrum of an element.

Unit-II : The Spectral radius. Gelfund formula. Multiplicative linear functionals and the maximal ideal space. Gleason Kahane Zelazko theorem.

Unit-III : The Gelfand Transforms, the spectral mapping theorem. Isometric Gelfand transform. Maximal ideal spaces for disc algebra and the algebra 1 (Z).

Unit-IV : C* - algebras : Definition and examples, self-adjoint, unitary, normal, positive and projection elements in C* - algebras.

Unit-V : Commutative C* algebras. C* - homomorphisms. Representation of commutative C*-algebras.

References:

(1) M.A. Naimark, Normed Algebras, Groningen, Netherlands, 1972. (2) C.E. Rickart, General Theory of Banach Algebras, V o n Nostrand, 1960. (3) T. W. Palmer , Banach Algebras V ol.-I, Cambridge University Press,1994.

M.Sc. II (New) Mathematics

SEMESTER-IV

Paper-XVI : FUNCTIONAL ANALYSIS-II

Unit-I : Riesz Representation theorem, adjoint of an operator on a Hilbert space, Reflexivity of Hilbert spaces, self adjoint operators, normal and unitary operators.

Unit-II : Spectral properties of bounded linear operators, basic concepts, further properties of solvent and spectrum, use of complex analysis in spectral theory .

Unit-III : Compact linear operators on normed spaces, further properties of compact linear operators, spectral properties of compact linear operators on normed spaces.

Unit-IV : Spectral properties of bounded self-adjoint linear operators, further spectral properties of bounded self-adjoint linear operators.

Unit-V : Positive operator , square root of positive operator , projection operators, spectral family.

References:

1) Serge Lang, Analysis I & II, Addison-Wesley Publishing Company , Inc. 1967. 2) G .Bachman and L.Narici, Functional Analysis, Academic Press, 1966. 3) N. Dunford and J.T .Schwartz, Linear Operators, Part-I, Interscience, New Y ork, 1958. 4) R.E.Edwards, Functional Analysis, Holt Rinehart and Winston, New York, 1965. 5) C.Goffman and Pedrick, First Course in Functional Analysis, Prentice Hall of India, New Delhi, 1987. 6) P .K. Jain, O.P. Ahuja and Khalil Ahmad, Functional Analysis, New Age International (P) Ltd. & Wiley Eastern Ltd., New Delhi, 1997. 7) R.B. Holmes, Geametric Functional Analysis and its Applications, Springer -Verlag,1975. 8) K.K. Jha, Functional Analysis, Students Friends, 1986.

25 26 9) E.Kreyszig, Introductory Functional Analysis with Applications, John Wiley and Sons, New York, 1978.

Paper-XVII : PARTIAL DIFFERENTIAL EQUATIONS

Unit-I : Curves and Surfaces, Genesis of first order P.D.E.,Classification of intergals, Linear Equations of the first order,Pfaffian differential Equations, Compatible systems, Charpit's Method ,Jacobi's Method, Integral Surfaces through a given curve.

Unit-II : Quasi-Linear equations, Non-linear first order P.D.E., genesis of second order P.D.E.,Classification of second order P.D.E

Unit-III : One dimensional Wave equation, Vibrations of an infinite string , Vibrations of a Semi-infinite string,Riemann,s Method, Vibrations of a string of finite Length.

Unit-IV : Laplace's Equation, Boundary value problems, Maximum and Minimum Principles, The Cauchy problem, The Dirichlet Problem for the upper half plane, The Neumann problem for the upper half plane, The Dirichlet problem for a circle, The Dirichlet Exterior problem for a circle, The Neumann problem for a circle, The Dirichlet problem for a Rectangle , Harnack's Theorem, Laplace's equation-Green function, The Dirichlet problem for a half plane,The Dirichlet problem for a circle.

Unit-V : Heat conduction problem: Heat conduction- Infinite rod case, Heat conduction-finite rod case, Duhamel's principle:Wave equation, Heat conduction equation. Classcification in the case of n – variables, Families of equipotential surfaces, Kelvin's inversion theorem.

References :

(1) I.N. Sneddon : Elements of Partial Differential Equation, Mc Graw Hill, International Editon, New York. (2) Phoolan Prasad, Renuka Ravindram :Partial Differential equations, New Age and International Publishers. (3) Lawrence C. Evans: Partial Differential Equations, Vol. 19, AMS, 1998. (4) T. Amaranath : An elementary course in Partial Differential Equations, 2nd Ed. Narosa Publishing House, New Delhi. (5) R.J. Leveque, Finite difference methods for ordinary and partial differential equations, July-2007

Paper-XVIII : NUMERICAL ANALYSIS

Unit I : Solution of Algebric and Transcendental equations: The Bisection Method, The Method of False Position, The Iterative Method, Newton-Raphson Method, Secant Method, Muller's Method. System of Nonlinear equations by Iterative and Newton-Raphson Method, Rate of Convergence. Solved problems.

Unit II : Finite Differences: Forward and backward differences, Newton's for formulae Interpolation, Central difference interpolation formulae, Stirling' formula, Bessel's formula, Lagrange's interpolation formula, Error in Lagrange's interpolation formula. Hermite interpolation, Divided differences and their properties, Spline interpolation.

Unit III : Numerical differentiation and integration: Numerical differentiation, error in Numerical differentiation, The Cubic Spline Method. Numerical integration: Trapezoidal rule, Simpson's 1/3 Rule, Simpson's 3/8 Rule, Use of Cubic Splines, Romberg integration. Newton's-Cotes integration formulae, Euler's- Maclaurin formula.

Unit IV : Solution of system of linear equations: Direct method, Matrix Inversion Method, Gauss Elimination Method, Gauss-Jordan Method, Modification of Gauss Method, LU Decomposition, LU Decomposition from Gauss Method, Solution of system by Iterative Methods. The Eigen value problems, Eigen value of a symmetric Tridiagonal matrix.

Unit V : Numerical Solution of Ordinary Differential Equation: Solution by Taylor's series, Picard's Method of Successive approximations, Euler's Method, error estimate for the Euler's Method, Modified Euler's Method, and Runge-Kutta Method. Simultaneous and Higher-Order equations. Boundary value problems: Finite-difference Method, The Shooting Method, The Cubic Spline Method.

References: 1) S. S. Sastry, Introductory Methods of Numerical Analysis, 4th edition. PHI Learning Pvt. Ltd., New Delhi, 2010. 2) Francis Scheid, Schaum's outline Numerical Analysis, Tata McGraw Hill Education Pvt. Ltd., 2rd Edition, New Delhi 2009. 3) M. K. Jain, S. R. K. Iyengar and R. K. Jain, Numerical Methods Problems and Solutions, Wiley Eastern Ltd, New Delhi, 1994. 4) M. K. Jain, S. R. K. Iyengar and R. K. Jain, Numerical Methods Problems and Solutions, New Age International Ltd, 1996.5) M. K. Jain, S. R. K. Iyengar and R. K. Jain, Numerical Methods for Scientific and Engineering Computation, New age International publisher, India, 5th Edition, 2007. 6) C. F. Gerald and P. O. Wheatley Applied Numerical Analysis, Pearson Education, India, 7th Edition, 2008. 7) M. Pal, Numerical Methods for Scientific and Engineering Computation, Narosa Publication. 8) S. D. Comte and Carl de Boor, Elementary Numerical Analysis- An algorithmic approach, 3rd Edition, McGraw Hill, International Book Company, 1980. 9) F. B. Hildebrand, Introduction to Numerical Analysis, McGraw Hill, New York, 1956. 10) C. E. Froberg, Numerical Mathematical Analysis, 2nd Edition, AddisonWesley, 1979.

FLUID DYNAMICS-II

Unit-I : Gas Dynamics : Compressibility effects in real fluids, the elements of wave motion, one dimensional wave equation, wave equation in two and in three dimensions, spherical waves, progressive and stationary waves, the speed of sound in gas equation of motion of a gas, subsonic, sonic and supersonic flows, isentropic gas flow , Reservoir discharge through a channel of varying section. Investigation of maximum mass flow through a nozzle. Shockwaves, formation of shockwaves, elementary analysis of normal shock waves.

Unit-II : Viscous Flow : Stress components in a real fluid, relation between cartesian components of stress, translation motion of fluid element, the rate of strain quadric and principal stresses. Some further properties of the rate of strain quadric and principal stresses, stress analysis in fluid motion, relation between stress and rate of strain, the coefficient of viscosity and Laminar flow .

Unit-III : The Navier stokes equations of motion of a viscous fluid, some solvable problem in viscous flow , steady motion between parallel planes, steady flow through tube of uniform circular cross section, steady flow between cocentric rotating cylinders, diffusion of vorticity energy dissipation due to viscosity steady flow past a fixed sphere.

Unit-IV : Magnetohydrodynamics : Nature of Magnetohydrodynamics, Maxwell' s electromagnetic field equation, medium at rest, medium in motion, the equation of motion of a conducting fluid rate of flow of charge, simplification of the electromagnetic field equations, the magnetic Renolds number , Alfvens theorem, the magnetic body force, Ferraro' s laws of isorotation.

Unit-V : Dynamical similarity , Buckingham p-theorem, Reynold number , Prandt' s boundary layer, Boundary layer equations in two dimensions, Blasing solutions, boundary layer thickness, displacement thickness, Karmar integral conditions, seperation of boundary layer flow .

References:

(1) Besaint and A.S.Ramsay , A Treatise on Hydrodynamics, Part-II, CBS Publishers, Delhi, 1988. (2) G .K.Batchelor , An Introduction to Fluid Mechanics, Foundation Books, New Delhi, 1994. (3) H. Schlichting, Boundary Layer Theory , McGraw Hill Book Company , New Y ork, 1971. (4) M.D.Raisinghania, Fluid Mechanics (With Hydrodynamics), S.Chand and Company Ltd., New Delhi. (5) L.D.Landen and E.M.Lipschitz, Fluid Mechanics, Pargamon Press, London, 1985. (6) F .Chorlton, T ext Book of Fluid Dynamics, CBS Publishers, Delhi (7) R.K.Rathy , An Introduction to Fluid Dynamics, Oxford and IBH Publishing Company, New Delhi, 1976. (8) A.D. Young, Boundary Layers, AIAA Education Series, Washington, DC, 1989. (9) S.W.Yuan, Foundation of Fluid Mechanics, Prentice Hall of India Private Limited, New Delhi, 1976.

RELATIVISTIC COSMOLOGY (OPTIONAL)

Unit-I : Einstein Field Equations with Cosmological term, static cosmological models of Einstein and De-sitter, their derivations, properties and comparison with the actual Universe.

Unit-II : Cosmological principle, Hubble' s law, Weyls Postulate, Steady State Cosmological models, Derivation of RobersonWalker Metric, Further Properties.

Unit-III : Motion of particles and light rays in R-W model: Material particles, Radial motion of a particle, General motion, light rays. The red shift in R-W model, Hubble's and Deceleration parameters.

Unit-IV : Fundamental equation of dynamical cosmology: Density and pressure of present universe, the matter dominated era of the present universe, Friedman models: closed model, Flat model, Open model"

Unit-V : Gravitational lensing, weak gravitational waves, gravitational waves in curved space time, strong gravitational waves, radiation of gravitational waves

References:

1) Introduction to General Relativity - Ronald Adler, Maurice Bazin, Menahem, Schiffer. 2) Mathematical Theory of Relativity: A.S. Eddington, Cambridge University Press, 1965. 3) Relativity: The General Theory - J. L. Synge, North Holland Publishing Company, 1976. 4) The Classical Theory of

Fields - I.D. Landau and E.M. Lifshitz, Pergamon Press, 1980. 5) An Introduction to Riemannian geometry and the Tensor Calculus C. E. Weatherburn, Cambridge University Press, 1950. 6) Classical theory of fields by L.D. Landau and E.M. Lifshitz. 7) Lectures on Relativity: T .M. Karade, et al Einstein Foundation International, Nagpur.

DIFFERENCE EQUATIONS-II (OPTIONAL)

Unit-I : The Self-adjoint Second Order Linear Equations : Introduction, S turmian theory , Green' s functions. Disconjugacy , the Riccati equations. Oscillation.

Unit-II : The Sturm-Liouville Problem : Introduction, Finite Fourieranalysis, A non-homogeneous problem.

Unit-III : Discrete Calculation of Variation : Introduction. Necessary conditions. Sufficient conditions and disconjugacy .

Unit-IV : Boundary Value Problems for Non Linear Equations : Introduction, the Lipschitz case. Existence of solutions. Boundary value problems for differential equations.

Unit-V : Partial Differential Equations. Discretization of partial differential equations. Solution of partial differential equations.

References :

(1) Calvin Ahlbrandt and Allan C. Peterson, Discrete Hamiltonian Systems. Difference Equations, continued Fractions and Riccati Equations : Kluwer , Boston, 1996. (2) Pundir S.K. and Pundir R., Difference Equations, Pragati Prakashan, Meerut, 2006. (3) Walter G.Kelley and Allan C. Peterson, Difference Equations : An Introduction with Applications, Academic Press, Inc., Harcourt Brace Joranovich Publishers, 1991.

(407) : LIE GROUPS (OPTIONAL) Lie Groups : Topics for Review Only : (No question to be set on this topic) Charts and coordinates, analytic structures. Real functions on a manifold. Tangent vectors. The dual vector space. Differentials. Infinitesimal. Transformations and differential forms. Mappings of manifolds. Submanifolds. Product of manifolds.

Unit-I : Topological Groups. The family of nuclei of a topological group. Subgroups and homomorphic images. Connected topological groups.

Unit-II : Local Groups : Lie groups. Local lie groups. Analytic subgroups of a lie group. One dimensional lie groups.

Unit-III : The Commutator of two infinitesimal transformations. The algebra of infinitesimal right translations. Lie groups of transformations.

Unit-IV : The lie algebra of sub-group. One parameter subgroup. Taylor ' s theorem for Lie groups. The Exponential mapping.

Unit-V : The Exterior algebra of a vector space. The algebra of differential forms. Exterior differentiation. Maurer-Chartan forms. The Maurer Cartan relations. Statement of the lie fundamental theorems. The converses of Lie' s first and second theorems.

References:

(1) P .M. Cohn ,Lie Groups , Cambridge University Press, 1961. (2) A.S. Sagle and R.E.Walde, Introduction to Lie Groups and Lie Algebras ,Academic Press, 1973.

31 (3) Lie Groups and Compact Groups by John F . Price (Cambridge University Press) (4) Theory of Lie Groups by Claude Cherallay (Princeton University Press)

BANACH ALGEBRAS-II (OPTIONAL)

Unit-I : Sub algebras of C* - algebra and the spectrum. The spectral theorem. The continuous functional calculus. Positive linear functionals and states in C*-algebras. The GNS construction.

Unit-II : Strong and weak operator topologies. Von Newmann Algebras. Monotone Sequence of Operators. Range Projections.

Unit-III : The Commutant. The double commutant theorem. The Kaplansky Density theorem. L as V on Newmann Algebra,Maximal Abelian Algebras.

Unit-IV : Abelian V on Newman Algebras. Cycling and Seperating vectors. Representation of Abelian V on Newmann Algebras, the L functional calculus. Connectedness of the Unitary group.

Unit-V : The Projection lattice. Kaplansky' s formula. The centre of a V on Newmann Algebra. Various types of projections. Centrally orthogonal projections, type decomposition.

Reference Books: (1) C.E. Ricart, General Theory of Banach Algebras, V on-Nostrand, 1960. (2) T.W.Palmer , Banach Algebras, V ol.-I, Cambridge University Press, 1994. (3) M.A.Naimark, Normed Algebras, Noordhoff, Groningen, Netherlands, 1972..

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