B.A./B.SC. MATHEMATICS PART II

PAPER I

ADVANCED CALCULUS

Continuity, Sequential Continuity, Properties of continuous functions.Uniform continuity. Chain rule of differentiabilty. Mean value theorems and their geometrical interpretations. Darboux's intermediate value theorem for derivatives. Taylor's theorem with various forms of remainders. **(10 Marks)**

Limit and continuity of functions of two variables. Partial differentiation. Change of Variables. Euler's theorem on homogeneous functions. Taylor's theorem for functions of two variables. Jacobians. **(10 Marks)**

Envelopes. Evolutes. Maxima, minima and saddle points of functions of two variables. Lagrange's multiplier method. Indeterminate forms. **(10 Marks)**

Beta and Gamma functions. Double and triple integrals. Dirichlet's integrals. Change of order of interation in double integrals. **(10 Marks)**

Definition of a sequence. Theorems on limits of sequences. Bounded and monotonic sequences. Cauchy's convergence criterion. Series of non-negative terms. Comparison tests. Cauchy's root test. Ratio tests. Raabe's, logarithmic, de Morgan and Bertrand's tests. Alternating series. Leibnitz's theorem. Absolute and conditional convergence. **(10 Marks)**

References

1. Gabriel Klaumber, Mathematical Analysis, Marcel Dekkar, Inc. New York, 1975.
2. T.M. Apostol, Mathematical Analysis, Narosa Publishing House, New Delhi, 1985.
3. R.R. Goldberg. Real Analysis, Oxford & I.B.H. Publishing co. New Delhi, 1970.
4. D. Soma Sundaram and B. Choudhary, A First Course in Mathematical Analysis, Narosa Publishing House, New Delhi, 1997.

5. P.K. Jain and S.K. Kaushik, An Introductin to Real Analysis, S. Chand & Co. New Delhi, 2000.

6. Gorakh Prasad. Differential Calculus, Pothishala Pvt. Ltd. Allahabad.

7. Murray R. Spiegel, Theory and Problems of Advanced Calculus, Schaum Publishing Co., New York.

8. Gorakh Prasad. Integral Calculus, Pothishala Pvt. Ltd. Allahabad.

9. S.C. Malik, Mathematical Analysis, Wiley Eastern Ltd., New Delhi.

10. O.E. Stanaitis, An Introducton to Sequences, Series and Intergrals, Holden-Dey, Inc., San Francisco, California.

11. Earl D. Rainville, Infinite Series, The Macmillan Company, New York.

12. Chandrika Prasad, Text Book on Algebra and Theory of Equations, Pothishala Pvt. Ltd., Allahabad.

13. N. Piskunov, Differential and Integral Calculus, Peace Publishers, Moscow.

14. Shanti Narayan, A Course of Mathematical Analysis, S. Chand and Company, New Delhi.

B.A/B.SC. MATHEMATICS PART II

PAPER II

DIFFERENTIAL EQUATIONS

Series solutions of differential equations- Power series method, Bessel, Legendre and hypergeometric equations. Bessel, Legendre and Hypergeometric functions and their properties convergence, recurrence and generating relations. Orthogonality of functions. Sturm-Liouville problem. Orthogonality of eigen-functions. Reality of eigenvalues. Orthogonality of Bessel functions and Legendre polynomials. **(10 Marks)**

Laplace Transformation-Linearity of the Laplace transformation. Existence theorem for Laplace transforms. Laplace transforms of derivatives and integrals. Shifting theorems. Differentiation and Integration of transforms. Convolution theorem. Solution of integral equations and systems of differential equations using the Laplace transformation. **(10 Marks)**

Partial differential equations of the first order. Lagrange's solution. Some special types of equations which can be solved easily by methods other than the general method. Charpit's general method of solution.

Partial differential equations of second and higher ordrs. Classification of linear partial differential equations of second order. homogeneous and non-homogeneous equations with constant coefficients. Partial differential equations reducible to equations with constant coefficients. Monge's methods. **(10 Marks)**

Calculus of Variations-Variational problems with fixed boundaries-Euler's equation for functionals containing first order derivative and one independent variable. Extrernals. Functionals dependent on higher order derivatives. Functionals dependent on more than one independent variable. Variational problems in parametric form. Invariance of Euler's equation under coordinates transformation. **(10 Marks)**

Variational Problems with Moving Boundaries-Functionals dependent on one and two functions. One sided variations.

Sufficient conditions for an Extremum-Jacobi and Legendre conditions. Second Variation. Variational principle of least action. **(10 Marks)**

References

1. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons Inc., New York, 1999.

2. D.A. Murray, Introductory Course on Differential Equations, Orient Longman, (India), 1967.

3. A.R. Forsyth, A Treatise on Differential Equations, Macmillan and Co. Ltd., London.

4. Ian N. Sneddon, Elements of Partial Differential Equations, McGraw-Hill Book Company, 1988.

5. Francis B. Hilderbrand, Advanced Calculus for Applications Prentice Hall of India Pvt. Ltd., New Delhi, 1977.

6. Jane Cronin, Differential equations, Marcel Dekkar, 1994.

7. Frank Ayres, Theory and Problems of Differential Equations, McGraw-Hill Book Company, 1972.

8. Richard Bronson, Theory and Problems of Differential Equations, McGraw-Hill , Inc. 1973.

9. A.S. Gupta, Calculus of Variations with Applications, Prentice-Hall of India, 1997.

10. R. Courant and D. Hilbert, Methods of Mathematical Physics, Vols., I & II, Wiley-Interscience, 1953.

11. I.M. Gelfand and S.V. Fomin, Calculus of Variations, Prentice-Hill, Englewood Cliffs (New Jersey), 1963.

12. A.M. Arthurs,. Complementary Variational Principles, Clarendon Press, Oxford, 1970.

13. V. Komkov, Variational Principles of Continum Mechanics with Engineering Applications, Vol., I, Reidel Publ. Dordrecht, Holland, 1985.

14. J.T. Oden and J.N. Reddy. Variational Method in Theoretical Mechanics, Springer-Verlag, 1976.

B.A./B/SC. MATHEMATICS PART II

PAPER III

MECHANICS

STATICS

20 Marks

Analyticai conditions of equilibrium of Coplanar forces. Virtual work. Catenary.

Forces in three dimensions. Poinsot's central axis. Wrenches. Null lines and planes. Stable and unstable equilibrium.

DYNAMICS

30 Marks

Velocities and accelerations along radial and transverse directions, and along tangential and normal directions, Simple harmonic motion. Elastic strings.

Motion on smooth and rough plane curves. Motion in a resisting medium. Motion of particles of varying mass.

Central Orbits. Kepler's laws of motion.

Motion of a particle in three dimensions. Acceleration in terms of different coordinate systems.

References

1. S.L. Loney, Statics, Macmillan and Company, London.
2. R.S. Verma, A text book on Statics, Pothishala Pvt. Ltd., Allahabad.
3 S.L. Loney, An Elementay Treatise on the Dynamics of a Particle and of Rigid bodies, Cambridge University Press, 1956.

B.A./B.SC. MATHEMATICS PART III

PAPER I

ANALYSIS

REAL ANALYSIS

25 Marks

Riemann integral. Integrability of continuous and monotonic functions. The fundamental theorem of intergral calculus. Mean value theorems of intergral calculus.

Improper integrals and their convergence, Comparison tests, Abel's and Dirichlet's tests. Frullani's integral . Integral as a function of a parameter. Contiunity, derivability and integrability of an intergral of a function of a parameter.

Series of arbitrary terms. Convergence, divergence and Oscillation. Abel's and Dirichlet's tests. Multiplication of series. Double series.

Partial derivation and differentiability of real-valued functions of two variables. Schwarz and Young's theorem. Implicit function theorem.

Fourier series. Fourier expansion of piecewise monotonic functions.

COMPLEX ANALYSIS

30 Marks

Complex numbers as ordered pairs. Geometric representation of complex numbers. Stereographic projection.

Continuity and differentiability of Complex functions, Analytic functions, Cauchy-Riemann equations. Harmonic functions.

Elementary functions. Mapping by elementary functions.

Mobius transformations, fixed points. Cross ratio, Inverse points and critical mappings. Conformal mappings.

METRIC SPACES

20 Marks

Definition and examples of metric spaces. Neighbourhoods. Limit points. Interior points. Open and closed sets. Closuer and interior. Boundary points. Sub-space of a metric space. Cauchy sequences. Completeness. Cantor's intersection theorem. Contraction principle. Construction of real numbers as the completion of

the incomplete metric space of rationals. Real numbers as a complete ordered field. Dense subsets. Baire Category theorem. Separable, second countable and first countable spaces. Continuous functions, Extension theorem. Uniform continuity. Isometry and homomorphism. Equivalent metrics. Compactness. Sequential compactness. Totally bounded spaces. Finite intersection property. Continuous functions and compact sets. Connectedness. components. Continuous functions and connected sets.

References

1. T.M. Apostol, Mathematical Analysis, Norosa Publishing House, New Delhi, 1985.
2. R.R. Goldberg, Real Analysis, Oxford & IBH Publishing Co., New Delhi, 1970.
3. S. Lang, Undergraduate Analysis, Springer-Verlag, New York, 1983.
4. D. Somasundaram and B, Choudhary. A first Course in Mathematical Analysis, Narosa Publishing House, New Delhi, 1997.
5. Shanti Narayan, A Course of Mathematical Analysis, S. Chand & Co. New Delhi.
6. P.K. Jain S.K. Kaushik, An Introduction to Real Analysis, S. Chand & Co., New Delhi, 2000.
7. R.V. Churchill & J.W. Brown, Complex Variables and Applications, 5th Edition, McGraw-Hill, New York, 1990.
8. Mark J. Ablowitz & A.S. Fokas, Complex Variables : Introduction and Applications, Cambridge University Press, South Asian Edition, 1998.
9. Shanti Narayan, Theory of Functions of a Complex Variable, S.Chand & Co. New Delhi.
10. E.T. Copson, Metric Spaces, Cambridge University Press, 1968
11. P.K. Jain and K. Ahmad, Metric Spaces, Narosa Publishing House, New Delhi, 1996.
12. G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill, 1963.

B.A./B.SC MATHEMTICS PART III

PAPER II

NUMERICAL ANALYSIS

NUMERICAL ANALYSIS 55 Marks

Soultion of Equations:Bisection, Secant, Regula Falsi, Newton's Method, Roots of Polynomials.

Interpolation : Lagrange and Hermite Interpolation, Divided Differences, Difference Schemes, Interpolation Formulas using Differences.

Numerical Differentiation.

Numerical Quadrature : Newton Cote's Formulas, Gauss Quadrature Formulas, Chebychev's Formulas.

Linear Equations : Direct Methods for Solving Systems of linear equations (Guass Elimination, LU Decompostion, Cholesky Decompositon), Iterative Methods (Jacobi, Gauss-Seidel, Relaxation Methods).

The Algebraic Eigenvalue problem: Jacobi's Method, Givens' Method, Householder's Method, Power Method, QR Method, Lanczos' Method.

Ordinary Differential Equations : Euler Method, Single-step Methods, Runge-Kutta's Method, Multi-step Methods, Milne-Simpson Method, Methods Based on Numerical Integration, Methods Based on Numerical Differentiation, Boundary Value Problems, Eigenvalue Probelms.

Approximation: Different Types of Approximation, Least Square Polynomial Approximation, Polynomial Approximation using Orthogonal Polynomials, Approximation with Trigonometric Functions, Exponential Functions, Chebychev Polynomials, Ratioal Functions.

MONTE CARLO METHODS 20 Marks

Random number generation, congruential generators, statistical tests of pseudo-random numbers.

Random variate generation, inverse transform method, compostion method,

acceptance-rejection method, generation of exponential, normal variates, binomial and Poisson variates.

Monte Carlo integration, hit or miss Monte Carlo integration, Monte Carlo integration for improper integrals, error analysis for Monte Carlo integration.

Recommended Text

1. C.E. Froberg. introduction to Numerical Analysis, (Second Edition), Addison-Wesley, 1979.

Other References

2. James B. Scarborough, Numerical Mathematical Anasysis, Oxford and IBH Publishing Co. Pvt. Ltd., 1966.
3. Melvin J. Maron, Numerical Analysis A Practical Approach, Macmillan Publishing Co., Inc. New York, 1982.
4. M.K. Jain, S.R.K. Lyengar, R.K. Jain, Numerical Methods Problems and Solutions, New Age International (P) Ltd., 1996.
5. M.K. Jain, S.R.K. Lyengar, R.K. Jain, Numerical Methods for Scientific and Engineering Computation, New Age International (P) Ltd., 1999.
6. R.Y. Rubistein, Simulation and the Monte Carlo Methods, John Wiley, 1981.
7. D.J. Yakowitz, Computational Probability an Simulation, Addison-Wesley, 1977.

B.A./B.SC MATHEMTICS PART III

PAPER III

OPTIONAL PAPERS

1- DIFFERENTIAL GEOMETRY

Local Theory of curves-space curves. Examples. Planner curves. Helices. Serret-Frenet apparatus. Existence of space curves. Involutes and evolutes of curves.

Global Curve Theory-Rotation index. Convex Curves. Isoperimetric inequality. Four vertex theorem. **(15 Marks)**

Local Theory of Surfaces-Parametric patches on surface. First Fundamental form and arc length. Normal curvature.Geodesic curvature and Gauss formulae. Shape operator Lp of a surface at a point. Vector field along a curve. Second and third fundamental forms of a surface. Weiengarten map. Principal Curvatures. Gaussian Curvature. Mean and normal curvatures. Gauss theorem egregium. Isometry groups and the fudamental existence theorem for surfaces. **(15 Marks)**

Global Therory of surfaces-Geodesic coordinate patches, Gauss-Bonnet formulae, Euler-characteristic of a surface. Index of a vector field. Spaces of constant curvature. **(10 Marks)**

Intrinsic Theory of Surfaces in Riemannian Geometry-Parallel translation and connections. Cartan's structural equations and curvature. Interpretation of curvature. Geodesic curvature and Gauss-Bonnet for a 2-dimensional Riemann surface. Geodesic coordinate systems. Isometries and spaces of constant curvature and the 3-types of geometry. **(10 Marks)**

Transic Extension Theroy of surfaces in R^3-Spherical image. Parallel translation for imbedded surfaces in R^3. Classisfication of compact connected oriented surfaces in R^3 relative to curvature. **(10 Marks)**

Elements of general Riemannian Geometry-Concepts of manifolds and examples. Riemannian metric. Tensor fields Covarient differentiation. Symmetry peoperties of curvature tensor. Concept of affine connection. Christoffel symbols. Curvature and torsion tensors. Riemannian metric and affine connection geodesic

and normal coordinates. Fundamental theorem of Riemannian geometry.

(15 Marks)

References

1. J.A. Thorpe, Introduction to Differential Geometry, Springer-verlag.
2. I.M. Singer and J.A. Thorpe, Lecture notes on Elementary Topology and Geometry, Springer-Verlag, 1967.
3. B. O. Neill, Elementary Differential Geometry, Academic Press, 1966.
4. S. Sternberg. Lectures on Differential Geometry, Prentice-Hall, 1964.
5. M. DoCarmo. Differential Geometry of Curves and surfaces, Prentice-Hall, 1976.
6. D.Laugwitz, Differential and Riemannian Geometry, Academic Press, 1965.
7. R.S. Millman and G.D. Parker, Elements of Differential Geometry, Prentice-Hall, 1977.
8. W. Kleingenberg, A course in Differential Geometry, Springer-Verlag.
9. T.J. Willmore, An Introduction to Differential and Riemannian Geometry, Oxford University Press, 1965.

B.A./B.SC MATHEMTICS PART III

PAPER III

OPTIONAL PAPERS

2. DISCRETE MATHEMATICS

Sets and Propositons- Cardinality Mathematical Induction. Principle of Inclusion and exclusion.

Computability and Formal Lnaguages- Ordered Sets . Languages, Phrase Structure Grammars. Types of Grammars and Languages. **(15 Marks)**

Permutations, Combinations and Discrete Probability.

Relations and Functions-Binary Relations. Equivalence Relations and Partitions. Partial Order Relations and Lattices. Chains and Antichains. Pigeon Hole Principle. **(15 Marks)**

Graphs and planar Graphs-Basic Terminology Multigraphs. Weighted Graphs. Paths and circuits. Shortest Paths. Eulerian Paths and Circuits. Travelling Salesman Problem. Planar Graphs. Trees. **(15 Marks)**

Finite State Machines-Equivalent Machines. Finite State Machines as Language Recognizers.

Analysis of Algorithms- Time Complexity, Complexity of problems.

Discrete Numeric Functions and Generating Functions

Recurrence Relations and Recursive Algorithns - Linear Recurrence Relations with constant coefficients. Homogeneous Solutions. Particular Solution. Total Solution. Solution by the Method of Generating Functions. **(15 Marks)**

Brief review of Groups and Rings.

Boolean Algebras-Lattices and Algebraic Structures. Duality. Distributive and Complemented Lattices. Boolean Lattices and Boolean Algebras. Boolean Functions and Expressions. Propositional Calculus. Design and Implementation of Digital Networks. Switching Circuits. **(15 Marks)**

Recommended Text

C.L.Liu, Elements of Discrete Mathematics, (Second Edition), McGraw Hill, International Edition, Computer Science Series, 1986.

B.A./B.SC MATHEMTICS PART III

PAPER III

OPTIONAL PAPERS

3. MECHANICS

DYNAMICS OF RIGID BODIES : 40 Marks

Moments and Products of inertia. The Momental Ellipsoid. Equimomental Systems. Principal axes.

D' Alembert's principle. The general equations of motion of a rigid body. Motion of the Centre of inertia and motion relative to the Centre of Inertia.

Motion about a fixed axis. The compound pendulum. Centre of percussion.

Motion of a rigid body in two dimensions under finite and impulsive forces.

Conservation of Momentum and Energy Lagrange's equations. Initial Motions.

HYDROSTATICS : 35 Marks

Pressure equation, Condition of equilibrium. Lines of force. Homogeneous and heterogeneous fluids. Elastic fluids. Surface of Equal pressure. Fluid at rest under action of gravity. Rotating fluides.

Fluid pressure on plane surfaces. Centre of pressure. Resultant pressure on curved surfaces.

Equilibrium of floating bodies. Curves of buoyancy. Surface of buoyancy. Stability of equilibrium of floating bodies. Meta centre. Work done in producing a displacement. Vessel containing liquid.

Gas laws. Mixture of gases. Internal Energy. Adiabatic expansion. Work done in compressing a gas. Isothermal Atmosphere. Connective equilibrium.

References

1. S.L. Loney, An Elementary Treatise on the Dynamics of a Particle and of Rigid bodies, Cambridge University Press, 1956.
2. A.S. Ramsey, Dynamics, Part I, Cambridge Uniersity Press, 1973.
3. W.H. Besant and A.S. Ramsey, A Treatise on Hydromechanics, Part I Hydrostatics, ELBS and G. Bell and Sons Ltd. London.

B.A./B.SC MATHEMTICS PART III

PAPER III

OPTIONAL PAPERS

4. MATHEMATICAL MODELLING

The Process of Applied Mathematics.

Setting up first-order differential equations-Qualitative Solution sketching.

Difference and differential equation growth models-single-species population models.

Population growth- An age structure model. The Spread of Technological innovation. **(15 Marks)**

Higher-order linear models-A model for the detection of diabetes. Combat modes. **(12 Marks)**

Traffic models-Car-following models. Equilibrium speed distributions. **(12 Marks)**

Nonlinear population growth models. Prey-Predator models. Epidemic growth models. **(12 Marks)**

Models from political science-Proportional representation-cumulative voting, comparison voting. **(12 Marks)**

Application in Ecological and Environmental subject areas-Urban waste water management planning. **(12 Marks)**

References

Vol. 1. Differential equation models, Eds. Martin Braun, C.S. Coleman, D.A. Drew.

Vol. 2 Political and Related Models. Steven. J. Brams. W.F. Lucas, P.D. Straffin (Eds.)

Vol.3 Discrete and System models, W.F. Lucas, F.S. Roberts, R.M. Thrall.

Vol.4 Life Science Models, H.M. Roberts & M. Thompson.

All Volumes published as modules in Applied Mathematics, Springer-Verlag, 1982.

B.A./B.SC MATHEMTICS PART III

PAPER III

OPTIONAL PAPERS

5. APPLICATION OF MATHEMATICS IN FINANCE AND INSURANCE

APPLICATION OF MATHEMATICS IN FINANCE : **40 Marks**

Financial Management- An overview. Nature and Scope of Financial Management. Goals of Financial Management and main decisions of financial management. Difference between risk, speculation and gambling.

Time value of Money- Interest rate and discount rate. Present value and future value-discrete case as well as continuous compounding case. Annuities and its Kinds.

Meaning of return. Return as internal rate of Return (IRR). Numerical Methods like Newton Raphson Method to calculate IRR. Measurement of returns under Uncertainty situations. Meaning of risk. Difference between risk and uncertainty. Types of risks. Measurements of risk. Calculation of security and Portfolio Risk and Return-Markowitz Model. Sharpe's Single Index Model-Systematic Risk and Unsystematic Risk.

Taylor series and Bond Valuation. Calculation of Duration and Convexity of bonds.

Financial Derivatives-Futures, Forward, Swaps and Options. Call and put Option. Call and Put Parity Theorem. Pricing of contingent claims through Arbitrage and Arbitrage Theorem.

APPLICATION OF MATHEMATICS IN INSURANCE 35 Marks

Insurance Fundamentals- Insurance defined. Meaning of loss. Chances of loss, peril, hazard, and proximate cause in insurance. Costs and benefits of insurance to the society and branches of insurance-life insurance and various types of general insurance. Insurable loss exposures feature of a loss that is ideal for insurance.

Life Insurance Mathematics-Construction of Mortality Tables. Computation of Premium of Life Insurance for a fixed duration and for the whole life.

Determination of claims for General Insurance-Using Poisson Distribution and Negative Binomial Distribution-the Polya Case.

Determination of the amount of Claims in General Insurance-Compound Aggregate claim model and its properties, and claims of reinsurance. Calculation of a compound claim density function. F-recursive and approximate formulae for F.

References

1. Aswath Damodaran, Corporate Finance-Theory and Practice, John Wiley & Sons, Inc.
2. John C. Hull, Options, Futures, and other Derivatives, Prentice-Hall of India Private Limited.
3. Sheldon M. Ross, An Introduction to Mathematical Finance, Cambridge University Press.
4. Mark S. Dorfman, Introduction to Risk Management and Insurance, Prentice Hall, Englwood Cliffs, New Jersey.
5. C.D. Daykin,T. Pentikainen and M. Pesonen, Practical Risk Theory for Actuaries, Chapman & Hall.

B.A./B.SC MATHEMTICS PART III

PAPER III

OPTIONAL PAPERS

6. SPECIAL THEORY OF RELATIVITY

Review of Newtonian mechanics-Inertial frames, Speed of light and Galilean relativity . Michelson-Morley experiment. Lorentz-Fitzgerold contraction hypothesis. Relative character of space and time. Postulates of special theory of relativity. Lorentz transformation equations and its geometrical interpretation, Group properties of Lorentz transformations. **(15 Marks)**

Relativistic kinematics-Composition of parallel velocites. Length contraction. Time dilation. Transformation equations for components of velocity and acceleration of a particle and Lorentz contraction factor. **(15 Marks)**

Geometrical representation of space-time-four dimensional Minkowskian space-time of special relativity. Time-like, light-like and space-like intervals. Null cone, Proper time. World line of a particle. Four vectors and tensors in Minkowskian space-time. **(15 Marks)**

Relativistic mechanics-Variation of mass with velocity. Equivalence of mass and energy. Transformation equations for mass momentum and energy. Energy-momentum four vector. Relativistic force and Transformation equations for its components. Relativistic Lagrangian and Hamiltonian. Relativistic equations of motion of a particle. Energy momentum tensor of a continuous material distribution. **(15 Marks)**

Electromagnetism-Maxwell's equations in vacuo. Transformation equations for the densities of electric charge and current. Propagation of electric and magnetic field strengths. Transformation equations for electromagnetic four potential vector. Transformation equations for electric and magnetic field strengths. Gauge transformation. Lorentz invariance of Maxwell's equations. Maxwell's equations in tensor form. Lorentz force on a charged particle. Energy momentum tensor of an electromagnetic field. **(15 Marks)**

References

1. C. Moller, The Theory of Relativity, Oxford Clarendon Press, 1952.
2. P.G. Bergmann, Introduction to the Theory of Relativity, Prentice Hall of India, Pvt. Ltd., 1969.
3. J.L. Anderson, Principles of Relativity Physics, Academic Press, 1967.
4. W. Rindler, Essential Relativity, Van Nostrand Reinhold Company, 1969.
5. V.A. Ugarov, Special Theory of Relativity, Mir Publishers, 1979.
6. R. Resnick, Introduction to Special Relativity, Wiley Eastern Pvt. Ltd., 1972.
7. J.L. Synge, Relativity : The Special Theroy, North-Holland Publishing Company, 1956.
8. W.G. Dixon, Special relativity: The Foundation of Macroscopic Physics, Cambridge University Press, 1982.