Department of Mathematics

Semester Courses of M.A/M.Sc. (Mathematics)

The course of M.A/M.Sc. (Mathematics) will be spread in two years - Previous & Final. There will be two semester examinations and a viva-voce & project work examination every year.

M.A./ M.Sc. Previous (Mathematics)

(effective from session 2011-2012)

The M.A./ M.Sc. Previous (Mathematics) examination will consist of two semesters, called first and second semesters. Their examinations will be held in the months of December and April respectively. In each of these semester examinations there will be five compulsory papers and one optional paper. Each paper will be of three hours' duration and of 50 maximum marks, except where stated otherwise. Besides there will be a viva-voce & project work examination of 50 marks in the second semester.

Format of the Question Paper.

There will be one compulsory question consisting of 6 parts of short answer type question based on the whole course, out of which 5 parts will have to be answered. Besides, there will be 6 questions, ordinarily consisting of two parts (a) and (b), out of which 4 questions will have to be answered. Thus in all 5 questions will have to be attempted and 7 questions will have to be set. All questions will carry equal marks, except where stated otherwise.

First Semester

Compulsory Papers

Paper I	:	Groups and Canonical Forms
Paper II	:	Topology-I
Paper III	:	Differential and Integral Equations
Paper IV	:	Riemannian Geometry
Paper V	:	Hydrodynamics

Optional Papers

Any one of the following papers will have to be opted.

Paper VI (a)	:	Spherical Astronomy-I
Paper VI (b)	:	Operations Research-1
Paper VI (c)	:	Fuzzy Sets
Paper VI (d)	:	Programming in C (with ANSI features)
		(i) Theory : 30 marks
		(ii) Practical : 20 marks (2 hours' duration)
Paper VI (e)	:	History of Mathematics-I
Paper VI (f)	:	Dynamics of Real Gases-I

Second Semester

Compulsory Papers

Paper I	:	Fields and Modules
Paper II	:	Topology-II
Paper III	:	Partial Differential Equations
Paper IV	:	Differentiable Manifolds
Paper V	:	Fluid Dynamics

Optional Papers:

Any one of the following papers will have to be opted. Those who have offered Paper VI (a) in First Semester will offer Paper VI (a) in second semester, and similarly for other optional papers.

Paper VI (a)	:	Spherical Astronomy-II
Paper VI (b)	:	Operations Research-II
Paper VI (c)	:	Fuzzy Logic
Paper VI (d)	:	Numerical Methods
		(i) Theory : 30 marks
		(ii) Practical : 20 marks (2 hours'duration)
Paper VI (e)	:	History of Mathematics-II
Paper VI (f)	:	Dynamics of Real Gases-II

Viva –Voce and Project Work: **50 marks**

There will be a Viva-Voce and Project Work based on all the 12 papers of M.A./M.Sc. Previous (Mathematics). Under the project, the candidate will present a dissertation in his/her own handwriting. The dissertation will consist of one theorem/article with proof or one problem with solution, relevant definitions with examples and/or counter-examples, wherever necessary, from each paper of Mathematics studied in First and Second semesters. The dissertation will of 20 marks and the viva-voce will be of 30marks. For viva-voce examination and evaluation of project work there will be a board of examiners consisting of a coordinator, an external examiner and an internal examiner. The dissertation will be forwarded by the Head of Department at the university centre and by the Principal of the college at the college centre.

M.A./ M.Sc. First Semester
Mathematics
Paper I
Groups and Canonical forms

Groups : Conjugacy relation. Normaliser of an element. Class equation of a finite group. Center of a group. Fundamental theorems on isomorphism of groups. Automorphisms. Inner automorphism. Maximal subgroups. Composition series. Jordan-Holder theorem. Solvable groups. Nilpotent groups. Commutator subgroups. External and iternal direct product of groups. Cauchy's theorem for finite group. Sylow's theorem.

(6 questions)

Canonical forms : Similarity of linear transformations. Invariant subspaces. Reduction to triangular forms .Nilpotent transformations. Index of nilpotency. Invariants of a nilpotent transformation. The primary decomposition theorem. Jordan blocks and Jordan forms.

(2 questions)

Books recommended :

1. I.N. Herstein : Topics in Algebra, Wiley Eastern Ltd., New Delhi, 1975.
2. P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul : Basic Abstract Algebra (Second Edition), Cambridge University Press, Indian Edition , 1997.
3. Surjeet Singh and Qazi Zameeruddin: Modern Algebra, Vikas Publishing House. Pvt. Ltd., 2005.
4. K.B. Datta : Matrix and Linear Algebra, Prentice Hall of India Pvt. Ltd., New Delhi, 2000.
5. S. Kumaresan : Linear Algebra, A Geometric Approach, Prentice Hall of India, 2000.
6. S.K. Jain, A. Gunawardena and P.B. Bhattacharya : Basic Linear Algebra with MATLAB, Key College Publishing (Springer- Verlag), 2001.
7. A.R. Vasishtha & A.K. Vasishtha : Modern Algebra, Krishna Prakashan Media (P) Ltd., Meerut .

M.A./ M. Sc. First Semester
Mathematics
Paper –II

Topology –I

Topological space - Definition through open set axioms. Examples including usual topology, ray, lower limit and upper limit topologies on R, topology of metric spaces, cofinite and cocountable topologies, weak and strong topologies.

Closed sets, interior of a set, closure of a set. Characterization of topologies in terms o1 closed sets, interior operators, closure axioms.

Neighbourhoods, neighbourhood system and neighbourhood base. Topology through neighbourhood axioms.

Adherent points, limit points and derived set, dense set.

Base and subbase for a topology and characterization of topology in terms of base and subbase axioms. Topology generated by a family of subsets. (4 questions)

First countable and second countable spaces. Relative topology and subspaces, hereditary property. Lindeloff theorem and separable spaces.

Continuous functions and their properties. Continuity in terms of open sets ,closed sets, neighbourhoods, closures. Convergence of a sequence, sequential continuity, homeomorphisms. Topological invariant properties.

Compact sets and their properties. Finite intersection property, Bolzano Weierstrass property. Continuous functions and compactness, Sequential compactness, countable compactness and their comparison. One point compactification.

(4 questions)

Books recommended :

1. George F. Simmons : Introduction to Topology and Modern Analysis, Mc Graw-Hill Book Company 1963.
2. J.L. Kelley : General Topology, Van Nostrand, Reinhold Co., New York 1995.
3. K.D. Joshi : Introduction to General Topology, Wiley Eastern Ltd., 1983.
4. James R Munkres : Topology, Prentice Hall of India Pvt. Ltd., New Delhi, 2000.
5. S. Willard : General Topology Addison-Wesley, Reading, 1970.

M.A./ M. Sc. First Semester
Mathematics
Paper III
Differential and Integral Equations

Series Solution of Differential Equations : Solution in power series by Frobenius method. Legendre, Bessel and hypergeometric equations. A set of 24 particular solutions of hypergeometric differential equation. Legendre, Bessel and hypergeometric functions and their properties.

(3 questions)

Integral Equations : Volterra integral equations of first and second kind. L_2- kernels and functions. Solution by successive approximation and successive substitution to a Volterra integral equation. Fredholm integral equations. Solution by successive approximation. Neumann series. Pincherle- Goursat kernels (degenerate kernels). Hilbert- Schmidt theory for symmetric kernels.

(3 questions)

Books recommended :

1. Piaggo : An Elementary Treatise on Differential Equations.
2. A.R. Forsyth : A Treatise on Differential Equations.
3. F.G. Tricomi : Integral Equations.

M.A./ M. Sc. First Semester
Mathematics
Paper – IV
Riemannian Geometry

Tensor Algebra : Dual space. Tensor product of vector spaces. Tensors of type (r,s) .Tensor product of tensors. Algebraic operations .Contraction . Symmetric and skew-symmetric tensors.

Curvature of a curve . Principal normal .Geodesics .Geodesic and Riemannian coordinates .Geodesic form of the linear element . Parallelism of a vector of constant / variable magnitude.

(3 question)

Congruences and orthogonal ennuples . Ricci's coeficients of rotation. Curvature of a congruence . Geodesic congruence. Reason for the name " coefficient of rotation ". Narmal congruence. Irrotational congruence. Congruences canonical with respect to a given congruence.

Riemannian curvature tensor.Its contration . Covariant curvature tensor . Bianchi 's identity.Riemannian curvature of a V_n . Theorem of Schur . Mean curvature of a space for a given direction .

(3 question)

Projevtive and conformal transformations . Weyl's projective and conformal curvature tensors and their properties .

(2 questions)

Books recommended :

1. C.E. Weatherburn : An Introduction to Riemannian Geometry and the Tensor Calculus ,Cambridge University Press, 1966.
2. R.S. Mishra : A Course in Tensors with Applications to Riemannian Geometry , Pothishala (Pvt.) Ltd., 1965.
3. L.P. Eisenhart : Riemannian Geometry .
4. T.J. Willmore : An Introduction to Differential Geometry.

M.A./ M. Sc. First Semester
Mathematics
Paper – V
Hydrodynamics

Lagrangian and Eulerian methods. Equation of continuity. Boundary surfaces. Stream Lines. Path lines and streak lines. Velocity potential. Irrotational and rotational motions. Lagrange's and Euler's equations of motion. Pressure equation. Bernoulli's theorem. Impulsive actions. Flow and circulation. Permanence of irrotational motion. Stream function. Irrotational motion in two-dimensions. Complex velocity potential. Sources, sinks, doublets and their images.

(4 questiuons)

Two-dimensional irrotational motion produced by motion of circular and elliptic cylinders in a liquid. Kinetic energy of liquid. Milne-Thomson circle theorem. Theorem of Blasius. Stoke's stream function. Motion of a sphere through a liquid. Vortex motion. Vortex lines. Kelvin's proof of permanence. Motion due to circular and rectilinear vortices.

(4 questiuons)

Books recommended :

1. B.G. Verma: Hydrodynamics, Pragati Prakashan, Meerut, 1995.
2. W.H. Besaint and A.S. Ramsey: A Treatise on Hydrodynamics, Part II, C.B.S. Publishers, Delhi, 1988.
3. F. Chorlton: Text Book of Fluid Dynamics, C.B.S. Publishers, Delhi, 1985.

M.A./ M. Sc. First Semester
Mathematics
Paper – VI (a)
Spherical Astronomy-I

Refraction, parallel plate formula, homogeneous shell, concentric layers of varying density, differential equation for refraction, refraction in right ascension and declination, effect of refraction on sun-rise and disc of the sun.

(1 question)

Precession and nutation, physical cause of precession and nutation. Precession and nutation in right decension and declination, independent day numbers.

(1 question)

Aberration in longitude and liatitude; right ascension and declination, aberrational ellipse, diurnal aberration and its effect in hour angle and declination, planetary aberration.

(2 questions)

Geocentric and heliocentric parallax, geocentric parallax in zenith distance, distance of the moon, lunar parallax in right ascension and declination, stellar parallax in longitude and latitude; right ascension and declination. parallactic ellipse.

(2 questions)

Books recommended :

1. Gorakh Prasad : Spherical Astronomy.
2. Ball : A Text book of Spherical Astronomy.

M.A./ M. Sc. First Semester
Mathematics
Paper – VI (b)
Operations Research-I

Origin and development of OR. Objective, nature, definition and scope of OR. Phases of OR Methods.

Network analysis: Basic concepts and definition. Network drawing and analysis Critical path method. Labelling method. Methods based on time estimates to find critical path. Concept of slack and float. Resource levelling and time-cost trade-off analysis. Time-cost optimization procedure. Project crashing. PERT. Requirements for application of PERT technique. Practical limitations in using PERT. Diffferences in PERT and CPM. Shortest path problem. Minimum spanning tree problem. Maximum flow problem. Minimum cost flow problem.

(4 questions)

Sequencing Problems : Assumptions for seqnencing problem. Processing n jobs on two mchines, n jobs on three machines, 2 jobs on m machines.

Non-Linear Programming: Introduction and defintions. Formulation of non-Linear programming problems, General non-linear programming problems. Constrained optimization with equality constraints. Constrained optimization with inequality constaints. Saddle point problems Saddle points and NLPP.

Goal Programming: Introduction and definition. Concept of goal programming. Difference between linear programming approach and goal programming approach. Goal programming model formulation. Methods of solution of goal programming problem. Graphical method and Simplex method.

(4 question)

Books recommended :

1. H.A. Taha: Operations Research – An Introduction, Macmillan Publishing Co., Inc., New York.
2. Kanti Swarup, P.K. Gupta, Man Mohan: Operations Research, Sultan Chand and Sons, New Delhi.
3. B.S. Goel, S.K. Mittal: Operations Research, Pragati Prakashan, Meerut.
4. P.K. Gupta, D.S. Hira: Operatons Research – An Introduction, S. Chand & Company Ltd., New Delhi.
5. S.S. Rao: Optimization Theory and Applications, Wiley Eastern Ltd., New Delhi.
6. J.K. Sharma: Operations Research – Theory and Applications, Macmillan India Ltd.
7. S.D. Sharma: Operations Research, Kedar Nath Ram Nath & Company.

M.A./ M. Sc. First Semester
Mathematics
Paper – VI (c)
Fuzzy Sets

Fuzzy Sets: Basic definitions, α-level sets. Convex fuzzy sets. Basic operations on fuzzy sets. Types of fuzzy sets. Cartesian products. Algebraic products. Bounded sum and difference, t-norms and t-conorms.

(2 questions)

The Extension Principle: The zadeh's extension principle. Image and inverse image of Fuzzy sets. Fuzzy numbers. Elements of Fuzzy arithmetic.

(2 questions)

Fuzzy Relations and Fuzzy Graphs: Fuzzy relations on fuzzy sets. Composition of Fuzzy relations. Min-Max composition and its properties. Fuzzy equivalance relations. Fuzzy compatibility relations. Fuzzy relation equations. Fuzzy Graphs. Similarity relation.

(2 questions)

Possibility Theory: Fuzzy measures, Evidence theory. Necessity measure. Possibility measure. Possibility distribution Possibility theory and Fuzzy sets. Possibility theory verses probability theory.

(2 questions)

Books recommended :

1. H.J.Zimmermann: Fuzzy set theory and its applications, Allied Publishers Ltd., New Delhi, 1991.
2. G. J. Klir and B. Yuan: Fuzzy sets and fuzzy logic, Prentice-Hall of India, New Delhi, 1995.

M.A./ M. Sc. First Semester
Mathematics
Paper – VI (d)
Programming in C (with ANSI features)

Theory : Max Marks : 30

Overview of C : History and importance of C. Sample Programms. Programming Style. Executing a 'C' Programme. Constants, Variables and Data Type.

Operators : Arithmetic, Relational, Logical, Assignment, Increment and Decrement, Conditional, Bitewise, Special.

Expressions : Arithmetic expressions, evaluation of expressions. Input and output operators.

(2 questions)

Decision Making and Branching: Decision making with if statement, simple if statement, the if ..... else statement. Nesting of if .....else statements. The else if Ladder. The Switch statement. The Goto statement.

Decision Making and Looping: The while statement. The do statement. The for statement. Jump in Loop.

Arrays : One and Two- Dimensional Arrays. Deceleration of One and Two-Dimensional

Arrays. Initializing of One and Two-Dimensional Arrays. Multi-dimensional Arrays. Dynamic Arrays. Character Arrays and Strings, (3questions)

User defined Functions : Need for user defined functions. A multi function program. Elements of user defined functions. Definition of functions. Functions Call . Functions Deceleration.Category of function. Nesting of functions.

Pointers: Understanding pointers. Declaring pointer variables. Initializing of pointer variables. Accessing a variable through its pointer. Chain of pointers. Pointers and arrays. Pointer as function argument. File management in C. (3 questions)

Book recommended :
1. E. Balagurusamy: Programming in ANSI C, TMH, New Delhi

Practical : Max. Marks : 20
Programming in C (with ANSI features)

1. To print the prime numbers between 1 and 100.
2. To print the odd prime numbers between 1 and 100.
3. To find the sum of first 10 natural numbers.
4. To find the average of n numbers.
5. To find the area of a triangle when coordinates of its vertices are given.
6. To find the area of a triangle when lengths of its sides are given.
7. To find the roots of a quadratic equation.
8. To add any two 3x3 matrices.
9. To multiply any two 3x3 matrices.
10. To sort all the elements of a 4x4 matrix.
11. To find the value of determinant of a 5x5 matrix.
12. To implement bisection method.
13. To implement false- position method.

M.A./ M. Sc. First Semester
Mathematics
Paper – VI (e)
History of Mathematics-I

Ancient Mathematics: The Babylorians. The Egyptians. The Greeks. The Romans. The Maya. The Chinese. The Japanese. The Hindus. The Arabs. Mathematics in Europe during the middle age. Mathematics in the sixteenth, seventeenth and eighteenth centuries. The renaissance Vieta and Descartes to Newton, Euler, Lagrange. and Laplace.

(8questions)

Book recommended :
1. F. Cajon: A History of Mathematics.

M.A./ M. Sc. First Semester
Mathematics
Paper – VI (f)
Dynamics of Real Gases-I

Chemical Thermodynamics: Thermodynamics system and kind of equilibrium. Conservation of mass. First and second laws of thermodynamics Gibbs equation. Entropy production.

Equilibrium flow: Steady shock waves, steady nozzle flow, Prandtl-Meyer flow, frozen flow.

(5 questions)

Flow with vibrational or chemical non-equilibrium. Basic equations. Equilibrium and frozen flow. Accoustic equations. Equilibrium and frozen velocities. Propagation of plane acoustic waves. Small departures from a uniform free system. Flow over a wavy wall.

(3 questions)

Book recommended :
1. W. G. and C.H.: Introduction to Physical Gas Dynamics.

M.A./ M. Sc. Second Semester
Mathematics
Paper I
Fields and Modules

Field theory : Extension fields. Algebraic and transcendental extensions. Splitting field. Separable and inseparable extensions. Normal extension. Perfect fields. Finite fields. Antomorphisms of extensions. Galois group. Fundamental theorem of Galois theory. Construction with ruler and compass. Solution of polynomial equations by radicals. Insolvability of the general equation of degree 5 by radicals.

(4 questions)

Modules : Cyclic modules. Simple modules . Semi-simple modules. Schuler's lemma. Free modules. Noetherian and artinian modules. Hilbert basis theorem.

(2 questions)

Books recommended :

1. I.N. Herstein : Topics in Algebra, Wiley Eastern Ltd., New Delhi, 1975.
2. P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul : Basic Abstract Algebra (Second Edition), Cambridge University Press, Indian Edition , 1997.
3. Surjeet Singh and Qazi Zameeruddin: Modern Algebra, Vikas Publishing House. Pvt. Ltd., 2005.
4. T.Y. Lam : Lectures on Modules and Rings, GTM, Vol. 189, Springer Verlag, 1999.
5. A.R. Vasishtha & A.K. Vasishtha : Modern Algebra, Krishna Prakashan Media (P) Ltd., Meerut .

M.A./ M. Sc. Second Semester
Mathematics
Paper –II
Topology –II

Separation axioms – T_o, T_1, T_2, regular, T_3, normal and T_4 spaces, their comparison and examples, hereditary and topological invariant characters. Urysohn's lemma and Tietze extension theorem.

Separated sets. Connectedness in terms of separated sets. Characterization of connected sets in terms of open sets and closed sets. Closure of a connected set. Union of connected sets. Connected sets in R. Continuity of a function and connectedness. Components and partition of space.

Inadequacy of sequential convergence. Directed sets, nets and subnets and their examples Convergence of a net, charaterisation of open sets, closed sets, closure, cluster point and limit pointof a set in terms of net convergence. Hausdorffness andcontinuity of a function in trems of nets. (4 questions)

Definition of filter and its examples. Neighborhood filter. Comparison of filters. Filter base and subbase. Convergence of a filter. Ultrafilters. Continuous functions and filters.

Net based on filter and filter based on net.

Quotient topology, quotient space, quoitient map, quotient space X/R,

Finite product space, projection mapping.

Tychonoff product topology in terms standard subbase and its characterizations in terms of projection maps, continuous functions, Product of T_0,T_1,T_2, spaces. Connectedness and compactness, first and second countability for product spaces.

(4 questions)

Books recommended :

1. George F. Simmons : Introduction to Topology and Modern Analysis, Mc Graw-Hill Book Company 1963.
2. J.L. Kelley : General Topology, Van Nostrand, Reinhold Co., New York 1995.
3. K.D. Joshi : Introduction to General Topology, Wiley Eastern Ltd., 1983.
4. James R Munkres : Topology, Prentice Hall of India Pvt. Ltd., New Delhi, 2000.
5. S. Willard : General Topology Addison-Wesley, Reading, 1970.

M.A./ M. Sc. Second Semester
Mathematics
Paper III
Partial Differential Equations

Partial Differential Equations of the First Order : Origin of first order partial differential equations. Lagrange's solution of first order linear partial differential equation. Non-linear partial differential equations of the first order. Cauchy's method of characteristics, Charpit's method and Jacobi's method.

(4 questions)

Partial Differential Equations of Second and Higher Orders : Origin of second order partial differential equations. Higher order partial differential equations with constant coefficients. Equations with variable coefficients. Classification of second order partial differential equations. Canonical forms. Solution of non-linear second order partial differential equations by Monge's method. Method of separation of variables for solving Laplace, wave and diffusion equations.

(4 questions)

Books recommended :

1. A.R. Forsyth : A Treatise on Differential Equations
2. I.N. Sneddon : Elements of Partial Differential Equations.

M.A./ M. Sc. Second Semester
Mathematics
Paper – IV
Differential Geometry of Manifolds

Difnition and examples of differentiable manifold. Differentiable functions. Differentiable curves .Tengent space .Vector fields.Lie bracket.

Invariant view point of connections . Covariant differentiation . Torsion. Curvature . Parallelism . Difference tensor of two connections. Lie derivative.

(4 questions)

Riemannian Manifold. Riemannian connection. Riemannian curvature tensor and Ricci tensor. Idenitities of Bianchi. Sectional curvature.

Exterior product of two vectors. Exterior algebra of order r .Exterior derivative .Cartans's structural equations.

Submanifolds. Normals. Induced connection. Gauss formulae. Weingarten formulae. Lines of curvature. Mean curvature. Equetions of Gauss and Codazzi.

(4 question)

Books recommended :

1. B.B. Sinha : An Introduction to Modern Differential Geometry, Kalyani Publishers, New Delhi, 1982.
2. N.J. Hickls : Notes on Differential Geometry.
3. K. Yano and M. Kon: Structure of Manifolds, World Scientific Publishing Co. Pvt. Ltd.,1984.

M.A./ M. Sc. Second Semester
Mathematics
Paper – V
Fluid Dynamics

Wave motion in a gas. Speed of Sound. Equation of motion of a gas. Subsonic, sonic and supersonic flows of a gas. Isentropic gas flows. Flow through nozzle. Shock formation. Elementary analysis of normal and oblique shock waves. Derivation of speed of shock formed by sudden movement of piston in a gas at rest. (4 Questiuons)

Stress components in a real fluid. Relations between Cartesian components of stress. Rate of strain quadric. Principal stresses. Relations between stress and rate of strain. Coefficient of viscosity. Navier-Stokes equations of motion. Steady viscous flow between parallel planes and through tubes of uniform circular cross-sections. Steady flow between concentric rotating cylinders. Diffusion of vorticity. Energy dissipation due to viscosity. Reynolds number.

(4Questiuons)

Book recommended :

1. F. Chorlton: Text Book of Fluid Dynamics, C.B.S. Publishers, Delhi, 1985

M.A./ M. Sc. Second Semester
Mathematics
Paper – VI (a)
Spherical Astronomy-II

Planetary phenomena, geocentric motion of a planet, elongation, stationary points, phases, brightness of the planet.

Lunar and solar eclipses, Earth's shadow at moon's distance, ecliptic limits, greatest and least number of eclipses in a year.

(4 questiuons)

Determination of longitude and latitude, sextant, dip of the horizon, Mercator's projection, great circle on Mercator's chart, position circle.

Proper motions and its effect in right ascension and declination, position angle, change in position angle due to star's motion and due to the motion of the pole, the motion of the sun, parallactic motion in right ascension and declination. Binaries.

(4 questiuon)

Books recommended :

1. Gorakh Prasad : Spherical Astronomy.
2. Ball : A Text book of Spherical Astronomy.

M.A./ M. Sc. Second Semester
Mathematics
Paper – VI (b)
Operations Research-II

Input-Output Analysis : Introduction, Meaning of input-output. Main features of analysis and assumptions. Leontief static model. Input-output table. Balance equation. Inter-industrial relation. Technological coefficient. Technology matrix. Problem based on changing demands.

(2 questions)

Inventory control: Introduction, Classification of inventory. Economic parameters associated with inventory problems. Deterministic models. Economic lot size model with uniform rate of demand. Sensitivity analysis of economic order quantity formula. Economic lot size with different rate of demand in different cycles. Economic lot size with finite rate of production. Limitation of EOQ formula. Deterministic model with shortage. Instantaneous production with back orders. Finite rate of replenishment of inventory. Fixed time model. Lost-sales shortages. Multi-item deterministic model with one linear constraint. Restriction on the number of stocked units, Restriction on the amount to be invested on inventory. Models with lead time.

(3 questions)

Problems of replacement: Introduction, Replacement models and their solutions. Concept of present value. Replacement of items whose efficiency deteriorates with time. Replacement of items whose maintenance cost increases with time and the value of money remains constant. Replacement of items when the value of money also changes. Criteria of present value for comparing replacement alternative. Staffing problem.

(2 questions)

Dynamic Programming : Formulation and solution of dynamic programming problem. Deterministic dynamic programming. Dynamic programming approach to problems of shortest route resource allocation and production.

(1 question)

Books recommended :

1. H.A. Taha: Operations Research – An Introduction, Macmillan Publishing Co., Inc., New York.
2. Kanti Swarup, P.K. Gupta, Man Mohan: Operations Research, Sultan Chand and Sons, New Delhi.
3. B.S. Goel, S.K. Mittal: Operations Research, Pragati Prakashan, Meerut.
4. P.K. Gupta, D.S.Hira: Operatons Research – An Introduction, S. Chand & Company Ltd., New Delhi.
5. S.S. Rao: Optimization Theory and Applications, Wiley Eastern Ltd., New Delhi.
6. J.K. Sharma: Operations Research – Theory and Applications, Macmillan India Ltd.
7. S.D. Sharma: Operations Research, Kedar Nath Ram Nath & Company.

M.A./ M. Sc. Second Semester
Mathematics
Paper – VI (c)
Fuzzy Logic

Fuzzy Logic: An overview of classical logic, Multivalued logics. Fuzzy propositions. Fuzzy quantifires. Linguistic variables and hedges. Inference from conditional fuzzy propositions, the compositional rule of inference.

(2 questions)

Approximate Reasoning: An overview of fuzzy expert system. Fuzzy implications and their selection. Multiconditional approximate reasoning. The role of fuzzy relation equation.

(2 questions)

An Introduction to Fuzzy Control: Fuzzy controllers. Fuzzy rule base. Fuzzy inference engine. Fuzzification and the various defuzzification methods (the center of area, the center of maxima, and the mean of maxima methods).

(2 questions)

Decision Making in Fuzzy Environment: Individual decision making. Multiperson decision making. Multicriteria decision making. Multistage decision making. Fuzzy ranking methods. Fuzzy linear programming.

(2 questions)

Books recommended :

1. H.J.Zimmermann: Fuzzy set theory and its applications, Allied Publishers Ltd., New Delhi, 1991.
2. G. J. Klir and B. Yuan: Fuzzy sets and fuzzy logic, Prentice-Hall of India, New Delhi, 1995.

M.A./M.Sc. Second Semester
Mathematics
Paper VI(d)
Numerical Methods (with Programming in C)

Theory :

Max Marks: 30

Numerical Solution of Systems of Linear Equations :

Introduction. Gauss- Elimination Method. Gauss- Elimination Method with Pivoting. III-Conditioned Equations. Iterative Refinement of the Solution obtained by Gauss Elimination Method. Gauss-Jordan Method. Crout's Method. Jacobi's Iteration Method. Gauss-Seidel Iteration Method. Successive over Relaxation (SOR) Method. Development of programs in C. (4 questions)

Numerical Solution of Partial Differential Equations:

Introduction. Finite- Difference Approximations to Derivatives. Classification of Partial Differential Equations. Elliptic Partial Differential Equations. Laplace's Equation. Solution of Laplace's Equation by Jacobi's Method, Gauss- Seidel Method, Successive Over-Relaxation (SOR) Method. ADI Method. Poisson's Equation, Solution of Poisson's Equation. Parabolic Partial Differential Equations. Heat Equation, Solution of Heat Equation. Crank-Nicolson Method. Hyperbolic Partial Differential Equations. Solution of Hyperbolic Partial Differential Equations. Wave Equation and its Solution by Finite- Difference Method, Development of programs in C. (4 questions)

Books Recommended:

(1) E. Balagurusamy: Programming in ANSI C, TMH, New Delhi.
(2) Prahlad Tiwari, R.S. Chandel and A.K. Tripathi : Programming in C & Numerical Analysis, Ram Prasad & Sons, Agra.
(3) S.S. Sastry : Introductory Methods of Numerical Analysis, PHI, New Delhi.

Practical :

Max. Marks :20

Numerical Methods (with Programming in C)

1. To implement Newton-Raphson method.
2. To implement Newton's forward/backward interpolation formula.
3. To implement Lagrange's interpolation formula.
4. To implement Trapezoidal rule.
5. To implement Simpson's one third rule.
6. To implement Gauss- elimination method
7. To implement Gauss- Jordan method.
8. To implement Crout's method
9. To implement Jocobi's method
10. To implement Gauss-Seidel method
11. To implement SOR method

M.A./M.Sc. Second Semester
Mathematics
Paper VI(e)
History of Mathematics-II

Mathematics during nineteenth and twentieth centuries: Symthetic geometry**.** Analytic geometry. Algebra. Analysis. Theory of functions. Theory of numbers. Applied Mathematics.

(8 questions)

Book Recommended:

(1) F. Cajon: A History of Mathematics

M.A./ M. Sc. Second Semester
Mathematics
Paper – VI (f)
Dynamics of Real Gases-II

Linearized flow behind a normal shock wave. Quasi-one-dimensional flow. Dispersed shock wave, Nozzle flow.
(2 questions)

Flow with radiative non-equilibrium: Greyogas approximation. One dimensional equations. Differential approximation. Accoustic equation. Plane accoustic waves. Small departure from free stream. Linearized and non-linear flow through a normal shock.

(6 questions)

Book recommended :
1. W. G. and C.H.: Introduction to Physical Gas Dynamics.

M.A./ M.Sc. Final (Mathematics)

(effective from session 2011-2012)

The M.A./M.Sc. Final (Mathematics) will consist of two semesters, called third and fourth semesters. Their examinations will be held in the months of December and April respectively. In each of these semester examinations there will be four compulsory papers and two optional papers—each one being selected from two separate groups of optional papers, marked Group 1 and Group 2. Each paper will be of three hours' duration and of 50 maximum marks, except where stated otherwise. There will be a viva-voce and project work examination of 50 marks in the fourth semester.

Format of the Question Paper.

There will be one compulsory question consisting of 6 parts of short answer type questions based on the whole course, out of which 5 parts will have to be answered. Besides, there will be 6 questions, ordinarily consisting of two parts (a) and (b), out of which 4 questions will have to be answered. Thus in all 5 questions will have to be attempted and 7 questions will have to be set. All questions will carry equal marks, except where stated otherwise.

Third Semester

Compulsory Papers

Paper I	:	Advanced Real Analysis
Paper II	:	Banach Spaces
Paper III	:	Advanced Complex Analysis
Paper IV	:	Dynamics of Rigid Bodies

Optional Papers

Group 1: Any one of the following will have to be opted.

Paper V (a)	:	Advanced Riemannian Geometry
Paper V (b)	:	Theory of Summability
Paper V (c)	:	Structures on a Differentiable Manifold-I
Paper V (d)	:	Wavelet Theory-I
Paper V (e)	:	Special Functions-I

Group 2: Any one of the following will have to be opted.

Paper VI (a)	:	Mathematical Modelling
Paper VI (b)	:	General Relativity
Paper VI (c)	:	Magneto Fluid Dynamics-I
Paper VI (d)	:	Theory of Elasticity
Paper VI (e)	:	Application of Mathematics in Finance

Fourth Semester

Compulsory Papers

Paper I	:	Lebesgue Integration

Paper II	:	Hilbert Spaces
Paper III	:	Discrete Mathematics
Paper IV	:	Analytical Dynamics

Optional Papers

Group 1: One paper from the following will have to be opted. Those who have offered Paper V (a) in Third Semester will offer Paper V(a) Fourth Semester, and similarly for other optional papers.

Paper V (a)	:	Finsler Geometry
Paper V (b)	:	Fourier Series
Paper V (c)	:	Structures on a Differentiable Manifold-II
Paper V (d)	:	Wavelet Theory-II
Paper V (e)	:	Special Functions-II

Group 2: One paper from the following will have to be opted. Those who have offered Paper VI (a) in Third Semester will offer Paper VI(a) Fourth Semester, and similarly for other optional papers.

Paper VI (a)	:	Bio-Mathematics
Paper VI (b)	:	Cosmology
Paper VI (c)	:	Magneto Fluid Dynamics-II
Paper VI (d)	:	Viscous Flow
Paper VI (e)	:	Mathematics of Insurance.

Viva –Voce and Project Work: **50 marks**

There will be a Viva-Voce and Project Work examination based on all the 12 papers of M.A./M.Sc. Final (Mathematics). Under the project, the candidate will present a dissertation in his/her own handwriting. The dissertation will consist of one theorem/article with proof or one problem with solution, relevant definitions with examples and/or counter-examples, wherever necessary, from each paper of Mathematics studied in third and fourth semesters. The dissertation will of 20 marks and the viva-voce will be of 30marks. For viva-voce examination and evaluation of project work there will be a board of examiners consisting of a co-ordinator, an external examiner and an internal examiner. The dissertation will be forwarded by the Head of Department at the university centre and by the Principal of the college at the college centre.

M.A./ M. Sc. Third Semester
Mathematics
Paper – I
Advanced Real Analysis

Sequences and series of functions of real numbers. Pointwise convergence and uniform convergence. Cauchy Criterion of uniform convergence. Weierstrass test for uniform convergence. Uniform convergence and continuity. Uniform convergence and integration. Uniform convergence and differentiation. Example of a function which is continuous everywhere on the real line but nowhere differentiable.

Functions of bounded variation and their properties. Absolutely continuous functions and their properties. Relation between absolute continuity and function of bounded variation.

Riemann-Stieltjes integration w.r.t. arbitrary integrator. Existence of Riemann- Stieltjes integrals. Integration by parts theorem. Properties of R-S integrable functions. Interchange of integrand and integrator functions. Uniform convergence and R-S integration. Evaluation of R-S integrals. R-S integrals and sequence of integrator functions.

Inadequacy of Riemann integration. Lebesgue's outer measure λ and its properties. Length of an interval and Lebesgue outer measure. Lebesgue measurable sets in R and σ-algebra of Lebesgue measurable sets M_λ in R Lebesgue measurability of open sets, closed sets and Borel sets. Labesgue measure on R. Example of a Non-Lebesgue measurable set. Cantor's set and its Labesgue measure. (4 questions)

General outer measure μ. Caratheodory's definition of μ-measurable sets. σ-algebra of μ-measurable sets M_μ. Definition of a measure. Measurable space and a measure space.

Definition of a measurable function. Equivalent conditions for measurable function. Sum and product of measurable functions. Composition of a measurable and a continuous function. Sequences of measurable functions. Measurability of supremum function, infimun function, limit superior function, limit inferior function and limit function. Simple measurable functions and their properties. A non-negative measurable function as the limit of a sequence of non-negative simple measurable functions. Concept of almost everywhere (a.e.). Lebesgue theorem. Measurability of Riemann integrable functions.

Convergence in Measure and its properties. F. Riesz theorem and Egorov theorem. Convergence almost everywhere, almost uniform convergence and their inter-relations

(4 questions)

Books recommended :

1. Walter Rudin: Principles of Mathematical Analysis (3rd edition), McGraw-Hill, Kogakusha, 1976 International Student Edition.
2. H. L. Royden : Real Analysis, Macmillan Pub. Co. Inc. New York, 4th Edition, 1993.
3. Richard Johnson Baugh; Foundation of Mathematical Analysis.

Reference books :

1. G. de Barra : Measure theory and Integration, Wiley Eastern Limited, 1981.
2. E. Hewitt & K. Strumberg: Real and Abstract Analysis, Springer – Verlag, New York, 1969.

M.A./ M. Sc. Third Semester
Mathematics
Paper – II
Banach Spaces

Normed linear spaces, Banach spaces, their examples including R^n,C^n, $l_p(n)$, $1\leq p <\infty$, c_0,c, l_p , $1\leq p <\infty$, P [a,b], C[a,b]. Joint continuity of addition and scalar multiplication. Summable sequences and completeness. Subsapaces, Quotient spaces of normed linear space and its completeness.

Continuous and bounded linear operators and their basic properties. Normed linear space of bounded linear operators and its completeness. Various forms of and operator norm.

(4 questions)

Isometric isomorphism, Topological isomorphism. Equivalent norms. Finite dimensional normed spaces and compactness. Riesz Theorem, Bounded linear functionals Dual spaces. Form of dual spaces $(R^n)^*$, $(C^n)^*$,c_o^*, l_1^* , l_p^*, $1<p <\infty$.

Hahn- Banach theorem for real and complex normed linear spaces and its simple consequences. Open mapping theorem and its simple consequences. Product normed space. Closed graph theorem. Uniform boundedness. Banach-Steinhaus theorem. Embedding and Reflexivity

(4 questions)

Book recommended :

P.K. Jain, O.P. Ahuja and K. Ahmad: Functional Analysis, New Age International (P) Ltd. and Wiley Eastern Ltd., New Delhi, 1997.

Reference books :

1. B. Choudhary.& S. Nanda: Functional Analysis with Applications, Wiley Eastern Ltd., 1989.
2. I.J Maddox: Functional Analysis, Cambridge University Press (1970).
3. G.F. Simmons: Introduction to Topology and Modern Analysis, McGraw-Hill Book Company, New York, 1963.
4. K. Chandrashekhara Rao. Functional Analysis, Narosa Publishing House, New Delhi

M.A./ M. Sc. Third Semester
Mathematics
Paper – III
Advanced Complex Analysis

Analytic continuation. Uniqueness of analytic continuation. Power series method of analytic continuation. Branches of many-valued function. Singularities of an analytic function. Riemann surfaces. Gamma function. Zeta Function. Principle of reflection. Hadamard's multiplication theorem. Functions with natural boundaries.

(3 questions)

Maximum-modulus theorem. Schwarz's lemma. Vitali's convergence theorem. Hadamard's three-circles theorem. Mean values of $|f(z)|$. Borel-Cartheodory theorem. Pharagmen- Lindel of theorem.

Conformal representation. Linear (bilinear) transformations involving circles and half-planes. Transformations $w=z^2$, $w=(z+1/z)/2$, $w = \log z$, $w = \tan^2(z/2)$ Simple function and its properties. The "1/4 theorem".

Radius of convergence of the power series. Analyticity of sum of power series. Position of the singularities.

(5 questions)

Books recommended :

1. E.C. Titchmarsh: Theory of Functions, Oxford University Press, London.
2. Mark J. Ablowitz and A.S. Fokas: Complex Variables: Introduction and Applications, Cambridge University Press, South Asian Edition, 1998.
3. R.V. Churchill & J.W. Brown. Complex Variables and Applications, 5th Edition McGraw-Hill, New York, 1990.
4. Shanti Narayan: Theory of Functions of a Complex Variable, S. Chand & Co., New Delhi.

M.A./ M. Sc. Third Semester
Mathematics
Paper – IV
Dynamics of Rigid Bodies

Harmonic oscillators. Effect of disturbing force. Damped and forced oscillations. Motion of a rigid body in two dimensions under finite and impulsive forces. Kinetic energy and moment of momentum in two dimensions. Rolling spheres and cylinders. Conservation of energy and momentum.

(4 questions)

Motion of a billiard ball. Equations of motion and their applications in three dimensions. Motion of a system of particles. Moving axes. Equations of motion in most general form. Momentum of a rigid body. Euler's equations of motion. Moment of momentum about instantaneous axis. Kinetic energy of a rigid body. Motion relation to earth's surface.

(4 questions)

Books recommended :

1. S.L. Loney: An Elementary Treatise on the Dynamics of a Particle and of Rigid Bodies, Macmillan India Ltd., 1982.
2. A.S. Ramsey: Dynamics Part-II, The English Language Book Society and Cambridge University Press, 1972.
3.J.L. Synge and B.A. Griffith: Principles of Mechanics, McGraw Hill International Book Company, 1982.

M.A./ M. Sc. Third Semester
Mathematics
Paper – V (a)
Advanced Riemannian Geometry

Hypersurfaces : Unit normal. Generalised convariant differentiation. Gauss's formulae. Curvature of a curve in a hypersurface. Normal curvature. Mean curvature. Principal normal curvature. Lines of curvature. Conjugate and asymptotic directions. Tensor derivative of the unit normal. Gauss characteristic equation and Mainardi-Codazzi equations. Totally geodesic hypersurfaces.

Subspaces: Unit normals. Gauss's formulae. Change from one set of normals to another. Curvature of a curve in subspace. Conjugate and asymptotic directions. Generalisation of Dupin's theorem. Derived vector of a unit normal. Lines of curvature for a given normal.

(4 question)

Lie derivative: Infinitesimal transformation. The notion of Lie derivative. Lie derivative of metric tensor and connection. Motion and affine motion in Riemannian spaces.

Hypersufaces in Euclidean space: Hyperplanes. Hyperspheres. Central quadric hypersurfaces. Reciprocal quadric hypersurfaces. Conjugate radii. Any hypersurface in Euclidean spaces. Riemannian curvature of a hypershpere. Geodesics in a space of positive constant curvature.

(4 questions)

Books recommended :

1. C.E. Weatherburn: An Introduction to Riemannian Geometry and the Tensor Calculus, Cambridge University Press, 1966.
2. K. Yano: The Theory of Lie Derivatives an its Applications, North Holland Publishing Company, Amsterdam,1957.
3 R. S. Mishra: A Course in Tensors with Applications to Riemannian Geometry, Pothishala (Pvt.) Ltd., 1965.

M.A./ M. Sc. Third Semester
Mathematics
Paper – V (b)
Theory of Summability

Special method of summation. Norlund means. Regularity and consistency of Norlund means. Inclusion. Equivalence. Arithmetic means. Holder's means. Simple theorems concerning Holder's means. Cesaro means. Means of non-integral orders.

Simple theorems concerning Cesaro summability. Equivalence theorem.Cesero an Abel summability (theorems 63, 64, 65 and 66 from Hardy's 'Divergent series').

(4 questions)

Matrix summability: Ordinary summability of sequences by infinite matrices (Treatment of the above to followed from Maddox's book).

Multiplication of series: Multiplication of (C,K) summable series.

(4 questions)

Books recommended :

1. G.H. Hardy: Divergent series, Oxford, 1949.
2. E.C. Titchmarsh: Theory of Functions (relevant portion of chapter XIII).
3. A. Zygmud:Trigonometric series Vol. 1, Cambridge, 1959 (relevant portion of chapter XIII).
4. I.J. Maddox: Elements of Functional Analysis, Cambridge University Press, 1970(relevant portion of chapter 7).

M.A./ M. Sc. Third Semester
Mathematics
Paper – V (c)
Structures on a Differentiable Manifold –I

Almost Complex Manifolds : Elementary notions, Nijenhuis tensor Eigen values of F, Integrability conditions, Contravariant and covariant analytic vectors, F-connection.

Almost Hermit Manifolds: Definition, Almost analytic vector fields. Curvature tensor. Linear connections.

(4 questions)

Kaehler Manifolds: Definition. Curvature tensor. Affine connection. Properties of projective, conformal, concircular and conharmonic curvature tensors. Contravariant almost analytic vector.

Nearly Kaehler Manifolds: Introduction, Curvature identities, Almost analytic vectors.

(4 questions)

Books recommended :

1. R.S. Mishra: Structure on differentiable manifold and their application, Chandrama Prakashan, Allahabad, 1984.
2. K. Yano and M. Kon: Structures of Manifolds, World Scientific Publishing Co. Pvt. Ltd., 1984.

M.A./ M. Sc. Third Semester
Mathematics
Paper – V (d)
Wavelet Theory-I

Wavelet Transform and its Basic Properties : Introduction. Continuous wavelet transform and examples. Basic properties of wavelet transform. Discrete wavelet transform. Orthonormal wavelets.

(4 questions)

Different Ways of Constructing Wavelets: Orthonormal bases generated by a single function. Balaon-Low theorem. Smooth projections on $L^2(R)$. Local sine and cosine bases and the construction of some wavelets.

(4 questions)

Book recommended :

Eugenio Hernandez and Guido Weiss: A First Course of Wavelets, CRC Press, New York, 1996.

Reference books:

1. C.K. Chui: An Introduction to Wavelets, Academic Press,1992.
2. I. Daubechies: Ten Lectures on Wavelets, CB5-NSF Regional Conference in Applied Mathematics, 61, SIAM 1992.
3. Y. Mayer: Wavelets, algorithms and applications (Translated by R.D. Rayan, SIAM, 1993).
4. M. V. Wikerhauser: Adopted wavelet analysis from theory of software, Wellesley, MA, A,K. Peters, 1994.

M.A./ M. Sc. Third Semester
Mathematics
Paper – V (e)
Special Functions-I

The Gamma Function: Analytical characters. Euler's limit formula. Duplication formula. Eulerian integral of first kind, Canonical product. Asymptotic expansion. Hankel contour integral.

Hypergeometric Functions: Solution of homogeneous linear differential equation of order two. Second order differential equation with three regular singularities. Hypergeometric equation and its properties. Confluent hypergeometric equation.

(5 questions)

Legendre functions: Complete solution of Legendre's differential equation. Integral representations and recurrence formulae for $P_n(z)$, $Q_n(z)$. Legendre polynomials of large degree. Neumann's expansion theorem. Associated Legendre's function.

(3 questions)

Book recommended :

1. E.T. Copson: Theory of Functions of a Complex Variable (Chapters IX an XIV).

M.A./ M. Sc. Third Semester
Mathematics
Paper – VI (a)
Mathematical Modelling

Mathematical Modelling: Need, techniques, classification and simple illustrations of mathematical modelling. Limitations of mathematical modelling.

Mathematical Modelling Through Ordinary Differential Equations of First Order:
Linear and Non-linear Growth and Decay models. Compartment models. Mathematical modelling of geometrical problems through ordinary differential equations of first order.

Mathematical Modelling Through System of Ordinary Differential Equations of First Order: Mathematical modelling in Population Dynamics. Mathematical modelling of epidemics. Compartment models. Mathematical modelling in Economics. Mathematical models in Medicine. Arm Race, Battles and International Trade in terms of system of ordinary differential equations.

(4 questions)

Mathematical Modelling Through Ordinary Differential Equations of Second Order: Mathematical modelling of planetary motions. circular motion and motion of satellites, Mathematical modelling through linear differential equations of second order,Application of Differential Equation in Cardiography.
Mathematical Modelling Through Partial Differential Equations: Situations giving rise to partial differential equation models.The Transmission Line, Application of Partial Differential Equation in Nuclear Reactors.

(4questions)

Book recommended:

1. J.N. Kapur: Mathematical Modelling, New Age International (P) Limited, New Delhi.
2. Zafar Ahsan : Differential Equations and Their Applications, PH I learning Private Limited, New Delhi.

M.A./ M. Sc. Third Semester
Mathematics
Paper – VI (b)
General Relativity

Transformation of coordinates, transformation law of tensor, Product of two tensor, Contraction, Trace of a tensor, quotient law, Metric tensor and Riemannian space, Conjugate tensor, symmetric and anti-tensor, Tensor density, Levi-Civita tensor, Christoffel symbol, Covariant derivative, Riemannian metric, Geodesic, Null geodesic, Tensor form of gradient, divergence, Laplacian and Curl, Riemannian and normal null coordinate, Gaussian coordinate, Parallel transport, Riemannian curvature tensor, Parallel propagation and Riemannian curvature tensor, Ricci tensor, Bianchi identities, Conformal curvature tensor, Conformal Invariance, Geodesic deviation, Lie derivatives in curved space time, Symmetry, Integrability condition of killing's equations, examples of symmetric space time.

(4 Questions)

Introduction to General Relativity, Principal of Equivalence, Principal of General covariance, Mach's Principle, Non-Euclidean character of rotating disc, geodesic postulate, Newtonian approximation of equation of motion, Search for Einstein's field equation, Einstein's field equation reduces to Poisson's equations, Gravitational field in empty space, Clock Paradox, Schwarzschild exterior solution, Singularities in Schwarzschild line element, Isotropic form of Schwarzschild exterior line element, Planetary orbits, Three Crucial tests in General Relativity, Radar Echo Delay (Fourth test), Analogous to Kepler's Law, Energy momentum tensor, Formula for energy momentum tensor for perfect fluid, Schwarzschild internal solution, Boundary conditions, Action Principle, Derivation of Einstein's field equation from variational principle, Energy momentum pseudo tensor, Gravitational waves weak field equations, Gravitational waves in empty space, Birkhoff's theorem, Vaidya metric, The Vaidya metric in Null Co-ordinates.

(4 Questions)

Recommended books-

1. K. D. Krori : Fundamentals of Special and General Relativity; PHI Publication, 2010.
2. S. R. Roy and Raj Bali : Theory of Relativity; Jaipur Publishing House, 2008.
3. Steven Weinberg : Gravitation and Cosmology : Principles and applications of General Relativity; Wiley Publ.,2005.
4. J. V. Narlikar : An Introductions to Relativity; Cambridge University Press, 2010.
5. I.B. Khriplovich : General Relativity; Springer Science + business media, 2005.

M.A./ M. Sc. Third Semester
Mathematics
Paper – VI (c)
Magneto Fluid Dynamics – I

Maxwell equations. Electromagnetic field in a conductor. MHD approximations. Rate of flow of charge. Important MHD parameters. Diffusion of magnetic field. Frozen-in-fields. Integral of magnetic field equation. Analogy of magnetic field with vorticity. Alfven theorem. Lorentz force and its transformations. Magnetic energy. Poynting vector theorems. Basic equations of inviscid and viscous magnetohydrodynamics. Energy conservation law.

(4 questions)

Alfven waves. MHD waves in a compressible fluid. Equi-partition of energy of Alfven waves. MHD boundary conditions. Equations of incompressible MHD flow. Parallel steady flow. Steady parallel flow in a conservative field of force. One-dimensional steady viscous MHD flow. Hartmann flow. Couette flow.

(4 questions)

Books recommended :

1. Alan Jeffery, Magnetohydrodynamics, Oliver and Boyd Ltd., Edinburgh, 1966.
2. F. Chorlton, Text Book on Fluid Dynamics, C.B.S. Publishers, Delhi,1985.
3. S.I. Pai, Magnetohydrodynamics and Plasma Dynamics, Springer-Verlag,1962.

M.A./ M. Sc. Third Semester
Mathematics
Paper – VI (d)
Theory of Elasticity

Shear. Displacement. Strain and its varieties. Transformation of the components of strain. Relation connecting the dilatation, the rotation and the displacement. Resolution of any strain into dilatation and shearing strain.

Traction across a plane at a point. Surface tractions and body forces. Law of equilibrium of surface tractions on small volumes. Stress at point and its transformation. Stress quadric. Types of stress. Stress-equations of motion and of equilibrium.

(4 questions)

Strain energy function. Hooke's Law. Elastic constant. Determination of stress in a body. Strain energy function for isotropic solids of elasticity. Stress-strain relations.

(4 questions)

Book recommended :

1. I. Love: Mathematical Theory of Elasticity.

M.A./ M. Sc. Third Semester
Mathematics
Paper – VI (e)
Application of Mathematics in Finance

Financial Management: An overview. Nature and scope of financial management. Goals of financial management and main decision 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 returns: Return as Internal Rate of Return (IRR). Numerical methods like Newton-Rapshon method to calculate IRR. Measurement of returns under uncertainity situations.

Meaning of risk: Difference between risk and uncertainty. Types of risks. Measurement of risk. Calculation of security and Portfolio Risk and Return-Morkowitz Omdel. Sharpe's Single Index Model-Systematic risk and Unsystematic Risk. Taylor Series and Bond Valuation. Valuation. Calculation of Duration and Convexity of Bonds.

(5 questions)

Financial Derivative: Futures. Forwards. Swaps and Options. Call and Put Option. Call and Put Parity theorem. Pricing of contingent claims through Arbitrage and Arbitrage theorem.

Pricing by Arbitrage: A Single Period Option Pricing Model. Multi Period Pricing Model-Cox-Ross-Rubinstein Model. Bounds on Option Prices.

(3 questions)

Books recommended :

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 Pvt. Limited.
3. Sheldom M. Ross: An Introduction to Mathematical Finance, Cambridge University Press.
4. Salih N. Neftci: An Introduction to Mathematics of Financial Derivatives, Academic Press Inc.
5. Robert J. Elliott and P. Ekkehard Kopp: Mathematics of Financial Markets, Springer-Verlag, New York Inc.

M.A./ M. Sc. Fourth Semester
Mathematics
Paper – I
Lebesgue Integration

Lebesgue Integration of a simple measurable function on R and its properties. Lebesgue Integration of a bounded measurable function on a set E with finite Lebesgue measure, i.e. $\lambda(E) < \infty$, and its properties. Bounded convergence theorem, Lebesgue integration and Riemann integration.

Integration on a measure space. Integration of a non-negative measurable function on a measure space. Lebesgue integral of general measurable function and its properties. Space of Lebesgue integrable functions.

Integral as a measure. Lebesgue's monotone convergence theorem. Integral of sum of two non-negative measurable functions. Integral as a countably additive set function. Integral of a non-negative function on a set of small measure. Integral of sum of two measurable functions. Term by term integration of a series of non-negative measurable function. Fatou's lemma, Lebesgue's dominated convergence theorem.

(4 questions)

Extension of a measure on an algebra to an outer measure, Product Measure. Measurable rectangles. Semi algebra of measurable rectangles, Product measure and product measure space. Measurability of a section of a set in $R_{\sigma\delta}$. Measurability of a section of measurable set with finite product measure. Fubini's theorem.

L_p Spaces : $\mathcal{L}_p(X, M, \mu)$ and $L_p(X, M, \mu)$ spaces as vector spaces. Norm on $L_p(X, M, \mu)$ spaces. Holder's and Minkowski's inequalities. $L_p(X, M, \mu)$ as a Banach space.

Essentially bounded functions and their properties, L_∞ spaces and its completeness.

Differentiations : Dini's four derivatives. Differentiation of monotonic functions, Integral of the derivative of monotonic increasing functions. Indefinite integral as a continuous function of bounded variation. Indefinite integral as an absolutely continuous function. Derivative of an integral. Fundamental theorem of the Integral Calculus for the Lebesgue integration.

(4 question)

Books recommended :

1. Walter Rudin: Principles of Mathematical Analysis (3rd edition), McGraw-Hill, Kogakusha, 1976 International Student edition.
2. H. L. Royden : Real Analysis, Macmillan Pub. Co. Inc. New York, 4th Edition, 1993.
3. Richard Johnson Baugh; Foundation of Mathematical Analysis.

Reference books :

1. G. de Barra : Measure theory and Integration, Wiley Eastern Limited, 1981.
2. E. Hewitt & K. Stromberg : Real and Abstract Analysis, Springer – Verlag, New York, 1969.

M.A./ M. Sc. Forth Semester
Mathematics
Paper – II
Hilbert Spaces

Inner product spaces, their basic properties and examples, Schwartz inequality. Norm induced by inner product, Continuity of inner product, Hilbert spaces and their examples. Parallelogram equality, polarization identity. Characterization of inner product in terms of norm. Separable Hilbert spaces and their examples

Orthogonal vectors. Orthogonal complement. Projection theorem. Projection operators. Orthogonal sets and their advantage over its linearly independent sets. Complete orthonormal sets. Bessel's generalized inequality. Parseval's Relation. Grahm-Schmidt orthogonalization process. Fourier series representation

Bounded linear functionals on Hilbert spaces. Riesz-Frechet representation theorem.Dual spaces.Inner product structure of dual spaces. Reflexivity of Hilbert spaces.

Hilbert adjoint operators. Shift operators. Special cases of Hilbert adjoint operoters self adjoint operators, positive operator, normal operators, unitary operators. Orthogonal projection operators.

(8 questions)

Book recommended :

P.K. Jain, O.P. Ahuja and K. Ahmad: Functional Analysis, New Age International (P) Ltd. and Wiley Eastern Ltd., New Delhi, 1997.

Reference books :

1. B. Choudhary.& S. Nanda: Functional Analysis with Applications, Wiley Eastern Ltd., 1989.
2. I.J Maddox: Functional Analysis, Cambridge University Press (1970).
3. G.F. Simmons: Introduction to Topology and Modern Analysis, McGraw-Hill Book Company, New York, 1963.
4. K. Chandrashekhara Rao. Functional Analysis, Narosa Publishing House, New Delhi

M.A./ M. Sc. Fourth Semester
Mathematics
Paper – III
Discrete Mathematics

Semigroups & Monoids: Definition and examples of Semigroups and Monoids. Homomorphism of Semigroups and Monoids. Congruence relation and Quotient Semigroups. Subsemigroup and Submonoids. Direct products. Basic homomorphism theorem.

Lattices: Lattices as partially ordered sets. Their properties. Lattices as Algebraic Systems. Sublattices. Direct products and Homomorphisms. Some Special Lattices e.g., Complete, Complemented and Distributive Lattices.

(4 questions)

Boolean Algebras: Boolean Algebras as Lattices, Various Boolean Identities. The Switching Algebra example. Subalgebras. Direct Products and Homomorphisms. Join-irreducible elements, Atoms and Minterms. Boolean Forms and their Euivalence.

Graph Theory: Definition of Graphs, Paths, Circuits, Cycles & Subgraphs. Induced Subgraphs. Degree of a vertex. Connectivity. Planar graphs and their properties. Trees. Euler's Formula for connected planar graphs.

(4questions)

Books recommended :

1. C.L. Liu: Elements of Discrete Mathematics (Second Edition), McGraw Hill, International Edition, Computer Science Series, 1986.
2. J.P. Tremblay & R. Mnohar: Discrete Mathematical Structures with Applications to Computer Science, McGraw-Hill Book Co., 1997.
3. N. Dew. Graph Theory with Application to Engineering and Computer Sciences, Prentice Hall of India.

M.A./ M. Sc. Fourth Semester
Mathematics
Paper – IV
Analytical Dynamics

Classification of dynamical systems. Generalized coordinates. Holonomic and non-holonomic systems, Kinetic energy. Generalized components of momentum. Generalized Components of the effective and applied forces. Lagrange's equations. Examples, Energy equation from Lagrange's equation. Reciprocal relations. Lagrange's equation for impulsive motion. Ignoration of coordinates. The Routhian functin. Euler's equation from Lagrange's equation.

(4 questions)

Hamilton's equations of motion. Application of Hamiltonian methods. Natural motions. The space of events. Action. Hamilton's principle. Principle of least action. Hamilton-Jocobi equation. Hamilton characteristic function. Generating function. Canonical transformations. Phase space. Bilinear invariants. Poisson brackets, Lagrange brackets. Invariance of Lagrange brackets and Poisson brackets under canonical transformations. Small oscillations. Langrange's equation of small oscillations. Lagrange's determinants. Normal modes and normal coordinates and their stationary properties.

(4 questions)

Books recommended :

1. S.L. Loney: An Elementary Treatise on the Dynamics of a Particle and a Rigid Body, Macmillan India Ltd., 1982.
2. A.S. Ramsey: Dynamics part-II, The English Language Book Society and Cambridge University Press, 1972.
3.J.L. Synge and B.A. Griffith: Principles of Mechanics, McGraw Hill International Book Company, 1982

M.A./ M. Sc. Fourth Semester
Mathematics
Paper – V (a)
Finsler Geometry

Finsler metric function. Its properties. Tangent space. Indicatrix. Metric tensor and C-tensor Homogeneity properties of g_{ij} and C_{ijk}. Dual tangent space. Geodesics. δ-differentiation. Partial δ-differentiation. Properties of partial δ-differentiation.

(2 questions)

Fundamental postulates of Cartan. Cartan's covariant derivatives and their properties. Geometry of paths. Berwald's covariant derivative and its properties.

(2 questions)

Commutation formula resulting from partial δ-differentiation. Other commutation formulae. Three curvature tensors of Cartan. Identities satisfied by curvature tensors including Bianchi identities.

(2 questions)

Books recommended :

1. H. Rund: The Differential Geometry of Finsler Spaces, Springer-Verlag, 1959.
2. M. Matsumoto: Foundations of Finsler Geometry and special Finsler spaces, Kaiseisha Press, Saikawa, Otsu, 520 Japan, 1986.

M.A./ M. Sc. Fourth Semester
Mathematics
Paper – V (b)
Fourier Series

Convergence problems Dirichlet's integral. Riemann-Lebesgue theorem.
Convergence tests. Dini's test. Jordan's test. Dela Valle's Poussin's test. Relations between the tests of Dini, Jorden and Dela Valle's Poussin. A continuous function with a divergent Fourier series.

(4 questions)

Functions of the class L^2: Bssel's inequality. Parseval's theorem for continuous functions. Riesz-Fischer theorem. Properties of Fourier coefficients. Uniqueness of trigonometrical series (Treatment of the above to be followed from Titchmarsh's book). Summability of Fourier series. Summability of S[f] and $\hat{S}$[f] by the method of first arithmetic mean. Abel summability of S [f] and $\hat{S}$ [f]

(4 questions)

Books recommended :

1. G.H. Hardy: Divergent series, Oxford 1949.
2. E.C. Titchmarsh: Theory of functions (relevant portion of chapter XIII).
3. A. Zygmud: Trigonometric Series Vol. 1, Cambridge 1959.
4. I.J. Maddox: Elements of Functional Analysis, Cambridge University Press, 1970.

M.A./ M. Sc. Fourth Semester
Mathematics
Paper – V (c)
Structures on a Differentiable Manifold –II

Almost Contact Manifolds : Definition. Eigen values of F. Intergrability conditions of $\pi_{m,}\pi_{m}$ and π_1. Lie derivative. Normal contact structure. Affinily almost cosymplectic manifold.
(3 questions)

Almost Grayan Manifolds: Introduction. D-conformal transformation. Particular affine connections. Almost Sasakian manifold. Quasi-Sasakian manifold. (2 questions)

Sasakian Manifolds: K-contact Riemannian manifold and its properties, Sasakian manifold and its properties. Properties of projective, conformal, concircular and con- harmonic curvatures in Sasakian manifold. Cosymplectic structure. (3 questions)

Books recommended :

1. R.S. Mishra: Structures on differentiable manifold and their applications, Chandrama Prakashan, Allahabad, 1984.
2. K. Yano and M. Kon: Structure of Manifolds, World Scientific Publishing Co. Pvt. Ltd., 1984.

M.A./ M. Sc. Fourth Semester
Mathematics
Paper – V (d)
Wavelet Theory-II

Multiresolution Analysis for Wavelets: The unitary folding operators and the smooth projections. Multiresolution analysis and construction of wavelets. Construction of compactly supported wavelets and estimates for its smoothness. Band limited wavelets. Characterization of Lemarie-Meyer wavelets and some other characterizations.

(4questions)

Spline Wavelets: Franklin wavelets and Spline wavelets on the real line. Orthonormal bases of piece-wise linear continuous functions for L^2 (T). Orthonormal bases of periodic splines. Periodization of wavelets defined on the real line. The basic equations and some of its applications. Characterization of MRA wavelets, low-pass filters and scaling functions. (4questions)

Book recommended :

Eugenio Hernandez and Guido Veiss: A First Course of Wavelets, CRC Press, New York, 1996.

Reference books:

1. C.K. Chui: An Introduction to Wavelets, Academic Press, 1992.
2. I. Daubechies: Ten Lectures on Wavelets, CB5-NSF Regional Conference in Applied Mathematics, 61, SIAM, 1992.
3.Y. Mayer: Wavelets, algorithms and applications (translated by R.D. Rayan, SIAM, 1993).
4. M.V. Wckerhauser: Aadopted wavelet analysis from theory of software, Wellesley, MA, A,K. Peters, 1994.

M.A./ M. Sc. Fourth Semester
Mathematics
Paper – V (e)
Special Functions-II

Bassel's differential equation and its series solution. Recurrence formula for $J_v(z)$. Schlaffi's contour integral for $J_v(z)$, Bessel function for integral order. Generating function for $J_v(z)$. Solution of Bessel's equation by complex integral. Hankel's functions.

Connection between Bessel and Hankel functions. The complete solution of Bessel's equation. Neumann''s polynomials and Neumann's expansion theorem. (4questions)

The elliptic functions of Weierstrass: Periodic functions. Lower bound of the period of an analytic function. Definition of an elliptic function. The irreducible poles and zeros of an elliptic function and properties. Weierstrass's sigma functions. Zeta function. Weierstrass's elliptic functions and their properties.

(4questions)

Book recommended :

1. E.T. Copson: Theory of Functions of a Complex Variable (Chapter IX and XIV).

M.A./ M. Sc. Fourth Semester
Mathematics
Paper – VI (a)
Bio-Mathematics

Introduction, Definition and Scope of Bio-Mathematics, Role of Mathematics in Biosciences.

Basic concepts of Fluid Dynamics, Bio-Fluid Dynamics, Basic concepts about blood, Cardiovascular system and blood flows, Blood flow through artery with mild stenosis, Two-layered flow in a tube with mild stenosis, Pulsatile Flow of Blood.

Peristaltic flow in tubes and channels.

(4 questions)

Gas exchange and air flow in lungs. Consumption and transport of Oxygen. Weibel's model for flows in lung airways. Comparison between flows of blood and flows in lung airways.

Diffusion. Fick's laws of diffusion. Diffusion equation. Modification of the diffusion equation. Diffusion in artificial kidney. Hemodialyser. Types of Hemodialyser.

(4 questions)

Books recommended :

1. J.N. Kapur: Mathematical Models in Biology and Medicine, Affiliated East-West Press Pvt. Ltd., New Delhi, 1985.
2. Y.C. Fung: Bio-Mechanics, Springer-Verlag New York Inc., 1990.
3. Stanley E. Charm and George S. Kurland: Blood Flow and Microcirculation, John Wiley & Sons, 1974.
4. S.A. Levin: Frontiers in Mathematical Biology, Springer-Verlag, 1994.
5. S.K. Pundir & R. Pundir : Biomathematics, Pragati Prakashan, 2010.

M.A./ M. Sc. Fourth Semester
Mathematics
Paper – VI (b)
Cosmology

Conservation of electric charge, Transformation formula for the densities of electric charge and electric current, Maxwell's equation in vacuo, Propagation of electric and magnetic densities, Transformation equation for differential operator, Lorentz invariance of Maxwell's equations, Maxwell's equation in tensor form, Lorentz force on a charged particle, Lorentz force density, energy momentum tensor for electromagnetic field, Electromagnetism in General Relativity, Derivation of Einstein-Maxwell's Equations from action principle, Reissner- Nordstrom Solution, The Tolman Metric.

Static cosmological models, Properties of Einstein Universe, Properties of de-Sitter Universe, Difference between Einstein and de-sitter Universe, Non-Static cosmological models, Derivation of Robertson-Walker metric, Geometrical features of R-W metric, Observable parameters in Robertson-Walker metric, Friedmann-Robertson-Walker cosmological models, Particles Horizon, Event Horizon, Einstein's field equation and dynamics of the universe, Cosmologies with a non zero Λ.

(4 Questions)

Origin and Evolution of Universe, Creation of matter, C-field Theory (Hoyle-Narlikar theory), The action principle, Cosmological equations, explosive Creation, The large number hypothesis, Observable parameters of the Steady State Theory.

Differential form, Connection 1-form and Ricci Rotation Coefficient, Cartan's equations of structure, Bianchi identities and symmetry properties of the Riemann-Christoffel Tensor, Calculation of Riemann Christoffel Tensor.

Gravitational Collapse, Gravitational Collapse of a Homogeneous Dust ball, Black Holes (Strong Gravitational fields), Non-spherical Gravitational Collapse, Price theorem and its implications, The Kerr metric or the Rotating black Holes, Ker-Newmann metric, The laws of Black Hole Thermodynamics.

(4 Questions)

Recommended books-

1. K. D. Krori : Fundamentals of Special and General Relativity; PHI Publication, 2010.
2. S. R. Roy and Raj Bali : Theory of Relativity; Jaipur Publishing House, 2008.
3. Steven Weinberg : Gravitation and Cosmology : Principles and applications of General Relativity; Wiley Publ.,2005.
4. J. V. Narlikar : An Introductions to Relativity; Cambridge University Press, 2010.

I.B. Khriplovich : General Relativity; Springer Science + business media, 2005.

M.A./ M. Sc. Fourth Semester
Mathematics
Paper – VI (c)
Magneto Fluid Dynamics – II

Bernoulli's equation in MHD. Kelvin's theorem in MHD. Ferraro's law of isorotation. Force-free magnetic fields. Pinch confinement of a plasma. Compatibility condition across a general discontinuity surface. Jump conditions across MHD shocks. Generalised Hugoniot condition. Compressible nature of MHD shocks. Stationary normal MHD shocks. Jump condition across MHD shock propagating in a gas at rest.

(4 questions)

Gasdynamic characteristic equations and characteristic curves. MHD characteristic equations. Fast and slow MHD waves. Transverse waves. Entropy waves. MHD simple waves. Contact surfaces and transverse simple waves. Fast and slow simple waves. Ordinary gasdynamic Characteristics in steady flow. Discontinuities in static case. Ordinary and Generalised Riemann invariants.

(4questions)

Books recommended :

1. Alan Jeffery, Magnetohydrodynamics, Oliver and Boyd Ltd., Edinburgh, 1966.
2. F. Chorlton, Text Book on Fluid Dynamics, C.B.S. Publishers, Delhi,1985.
3. S.I. Pai, Magnetohydrodynamics and Plasma Dynamics, Springer-Verlag,1962.

M.A./ M. Sc. Fourth Semester
Mathematics
Paper – VI (d)
Viscous Flow

Fundamental equation of fluid dynamics of viscous compressible fluid. Equation of state. Equation of continuity. Equation of motion. Equations of energy.

Exact solution of Navier-Stoke's equetion. Laminar flow between parallel walls (Couette and Poiseuille flow). Flow between concentric rotating cylinders-Couette flow. Hagen-Poiseuille flow in circular pipe. Convergent and divergent channels. Flow in the vicinity of stagnation point. Unsteady motioon of plate. One dimensional steady flow of vescous compressible fluid, Flow with uniform condition at + infinity. Shock wave thickness. Potential flow and Navier-Stoke's eqations. Vertically transport equation. Heat conduction equation. Linearized Navier-Stoke's equation. Limiting cases of every small and large Reynolds number.

(8 questions)

Book recommended :

1. S.I. Pai: Viscous Flow Theory : Laminar Flow.

M.A./ M. Sc. Fourth Semester
Mathematics
Paper – VI (e)
Mathematics of Insurance

Insurance Fundamentals: Insurance definition. 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. Insurable loss exposures-feature of 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.

(3 questions)

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.

(2 questions)

The claim number process. The claim size process. Solvability of the Portfolio. Reinsurance and Ruin Problem. Premium and Ordering of Risks-Premium. Calculation Principles and Ordering Distributions. Ordering Distributions. Distribution of Aggregate Claim Amount-Individual and Collective Model. Compound Distributions.

(3 questions)

Books recommended :

1. Robert. J. Elliott and P. Ekkehard Kopp 'Mathematics of Financial Markests,' Springer-Verlag, New York Inc.
2.C.D. Daykin, T Pentikainen and M. Pesonen: Practical Risk Theory for Actuaries, Champman and Hall.
3. Tomasz Rolski, Hanspter Shmidli, Volker Schmidt and Jozef Teugels: Stochastic Processes for Insurance and Finance, John Wiley & Sons Limited.

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