SYLLABUS
For
Three Year B. A./B.Sc. (Honours) Courses
of studies in MATHEMATICS

(Effective from the academic session 2005 – 2006 and onwards)

****

THE UNIVERSITY OF BURDWAN
RAJBATI, BURDWAN
WEST BENGAL

3-YEAR HONOURS COURSES

PART – I

Paper				Marks	No. of Lectures
I	Group - A	:	Abstract Algebras	50	60
	Group – B	:	Linear Algebra	30	35
	Group - C	:	Number Theory	20	25
II	**Analysis – I**				
	Group - A	:	Differential Calculus	50	60
	Group – B	:	Integral Calculus	20	25
	Group - C	:	Vector Analysis	30	35

PART – II

III	Group - A	:	Classical Algebra	30	40
	Group – B	:	Geometry	50	60
	Group - C	:	Tensor Calculus	20	25
IV	Group - A	:	Differential Equations (Ordinary & Partial)	50	60
	Group – B	:	Dynamics of a Particle	50	60

PART – III

V	**Analysis-II**				
	Group - A	:	Metric Spaces	40	50
	Group – B	:	Real Analysis	40	50
	Group – C	:	Complex Analysis	20	20
VI			**Mechanics**		
	Group - A	:	Principles of Mechanics	70	85
	Group – B	:	Elements of Continuum Mechanics with Hydrostatics	30	35
VII	Group - A	:	Mathematical Probability	40	40
	Group – B	:	Statistics	20	25
	Group - C	:	Elements of Operations Research	40	40
VIII	Group - A	:	Numerical Analysis	35	40
	Group – B	:	Computer Programming	15	20
IX		:	Computer Aided Numerical Methods – Practical	50	50

Part – I

Paper – I

(Abstract Algebra, Linear Algebra and Number Theory)

Group – A ***Abstract Algebra*** ***(Marks - 50)***

Sets, relation, mappings – surjective, injective and bijective, Composition of two mappings, extension and restriction of a mapping ; Countable and uncountable sets, countability of rational numbers and uncountability of the reals. Equivalence relation and partition of a set, partial order relation. Maximal and minimal elements, infimum and suprimum of subsets, uniqueness, Hesse's diagram, Lattices as p.o. set, definition of lattice in terms of meet and join, equivalance of two definitions, linear order relation; Boolean algebra and its application to simple circuit.

Groups – definition, Dihederal group subgroups, generators of groups and subgroups, order of a group and order of an element, Abelian groups.

Permutation groups, cycles, length of a cycle, transpositions, even and odd permutation, alternating group, important examples such as S_3 and K_4 (Klein4 –group),

Cyclic subgroup of a group, cyclic groups and their subgroups, Cycic subgroups of prime order, Cayley's theorem.

Cosets, normal subgroup, quotient group, Lagranges theorem, homomorphism, isomorphism, kernel of homomorphism, First homomorphism theorem, isomorphism of cyclic groups.

Ring, subring, ideal of a ring, ring homomorphism elementary properties, Integral domain, Characteristic of a ring

Field, subfield, finite field, characteristics of a field, Every integral domain can be extended to a field.

Group – B ***Linear Algebra*** ***(Marks - 30)***

Matrices, addition and multiplication of matrices, row equivalence, row reduced echelon form, elementary matrices, nonsingular matrices, inverse, Hermitian, Skew Hermitian, orthogonal matrices.

Vector space, linearly dependent and independent vectors, subspaces, span of a subset, basis, dimensions of a finite dimensional vector space, change of coordinates. Row rank and column rank of a matrix, rank of a matrix. Determinants and its properties, Laplaces' expansions of determinants (proof not required), product of determinants (proof not required).

Linear transformation, algebra of linear transformation. existence of solution of homogeneous and non-homogeneous system of linear equations and determination of their solution.

Characteristic equation, statement of Caley-Hamilton theorem and its application like inverse and powers of a non-singular matrices, eigen values, eigen vectors, similar matrices, similarity transformation, diagonalization of matrices of order 2 and 3 with application to Geometry.

Group – C ***Number Theory*** ***(Marks - 20)***

Primes and composite numbers, Fundamental theorem of arithmetic, greatest common divisor, relatively prime numbers, Euclid's algorithm, least common multiple.

Congruences : properties and algebra of congruences, power of congruence, Fermat's congruence, Fermat's theorem, Wilson's theorem, Euler – Fermat's theorem, Chinese remainder theorem.

Number of divisors of a number and their sum, least number with given number of divisors.

Eulers ϕ function - ϕ (n). Mobius μ - function, relation between ϕ function and μ function. Diophantine equations of the form ax+by = c, a, b, c integers.

References:

1. S. Barnard & J.M. Child – *Higher Algebra*(Mac Millan)
2. Burnside & Panton – *Theory of Equations* (S. Chand)
3. Neal H. Mckoy – *Theory of Numbers* (Macmillan)
4. Ivan Niven & N. S. Zuckerman – *An Introduction to Theory of Numbers* (John-Wiley)
5. Birkhoff & Maclane – *A Survey of Modern Algebra* (Mac Millan)
6. I. N. Herstein – *Topics in Algebra*
7. B. C. Chatterjee – *Abstract Algebra,* Vol. I (Das Gupta)
8. S. Mapa – *Higher Algebra,* Vol. I
9. Surjeet Singh – *Abstract Algebra* (Vikas)
10. Jain & Bhattacharyya – *Abstract Algebra*
11. Roy & Lahiri – *Higher Algebra*
12. T. M. Apostol – Number Theory
13. B. S. Vayas – *Discrete Mathematics*
14. Hall & Knight – *Algebra*
15. M. C. Chaki – *Co-ordinate Geometty*
16. Ghosh & Chakraborty – *Higher Algebra*
17. R. M. Khan - *Algebra*

Paper – II

(Analysis – I)

Group A ***Differential Calculus*** ***(Marks - 50)***

Order completeness of real numbers system is to be assumed.
Sequence of real numbers, Monotone Sequence, Notion of convergence, Upper and Lower Limits of a Sequence, Limits, Algebra of Limits. Subsequences and their convergence.

Series of nonnegative terms, Test for convergence, Ratio test, Comparison test, Cauchy's root test, Raabe's test, Gauss's test, Leibnitz test.

Series of arbitrary numerical terms, Alternating series, Absolutely and conditionally Convergent series, Riemann's rearrangement theorem (Proof not required).

ε-δ definition of limit of a function at a point, Algebra of limits, Bounded function, Monotone function, Continuous function, Local continuity, Properties of continuous function over a closed interval (without proof), Derivative, Successive differentiation, Leibnitz's theorem, Rolle's theorem, Mean value theorems, Intermediate value property of the derivatives, Taylor and Maclaurin's theorem with Cauchy and Langrange's form of remainder, Taylor series, Expansion of elementary function such as e^x, cosx, sinx, $(1+x)^n$, $\log_e(1+x)$ etc.

Tangent, Normal, Envelope, Asymptote, Curvature , Curve tracing; Astroid, Cycloid, Cardinal Folium of Descartes.

Maxima, Minima, Indeterminate form, L'Hospital's theorem.

Functions of Several variables, Continuity, differentiability, Partial derivative, Commutativity of the orders of partial derivatives [Schwartz's theorem only], Euler's theorem.

Group – B ***Integral Calculus*** ***(20 Marks)***

Indefinite integrals and statement of their properties, Method of partial fraction, Reduction formula.

Statement of properties of definite integral and its applications.

Double and triple integration, Rectification, Quadrature. Pappus theorem (proof not required). Calculation of volumes and surfaces of revolution, Evaluation of integrals for center of gravity of symmetric configuration including an arc, sector of a circle and hemisphere.

Group – C ***Vector Analysis*** ***(30 Marks)***

Vector Algebra ;Addition of vectors, Scalar and Vector products of two vectors, Scalar and vector triple products, Geometrical interpretations of different Products. Representation of a vector in E_3, Components and resolved parts of vectors.

Point of division of a line segment, Vector equation of a straight line & a plane.,

Continuity and differentiability of vector-valued function of one variable. Velocity and acceleration. Space curve, Arc length, Tangent, Normal. Integration of vector-valued function of one variable.

Vector-valued functions of two and three variables, Gradient of scalar function, Gradient vector as normal to a surface. Divergence and curl, their properties.

Evaluation of line integral of the type

$$\int_C \phi(x,y,z)\,d\vec{\gamma}, \qquad \int_C \vec{F}.d\vec{\gamma} \qquad \int_C \vec{F} \times d\vec{\gamma}$$

Green's theorem in the plane. Gauss and Stokes, theorems (Proof not required), Green's first and second identities. Evaluation of surface integrals of the type

$$\iint_S \phi\,d\vec{S}, \qquad \iint_S \vec{F}.d\vec{s} \qquad \iint_S \vec{n} \times \vec{F}\,dS$$

References:

1. Shantinarayan –*Differential and Integral Calculus*
2. Shantinarayan – *Mathematical Analysis*
3. Edwards – *Calculus*
4. Williamson – *Calculus*
5. E. W. Hobson – *A Treatise of Plane Trigonometry*
6. Bromwich – *Theory of Infinite Series*
7. Knopp – *Infinite Series*
8. Malik & Arora – Mathematical *Analysis*
9. Shantinarayan – *Theory of Vectors*
10. Spiegel – *Vector Analysis*(Schaum Series)
11. Weatherburn – *Vector Analysis,* Vol. II
12. D. E. Rutherford – *Vector Methods* (Oliver and Boyd)

Part – II

Paper - III
(Classical Algebra, Geometry and Tensor Calculus)

Group – A ***Classical Algebra*** ***(Marks - 30)***

Polynomial equation, Fundamental theorem of Algebra (Statement only), Multiple roots, Statement of Rolle's theorem only and its applications, Equation with real coefficients, Complex roots, Descarte's rule of sign, relation between roots and coefficients, transformation of equation, reciprocal equation, binomial equation – special roots of unity, solution of cubic equations – Cardan's method, solution of biquadratic equation – Ferrari's method.

Inequalities involving arithmetic, geometric and harmonic means, Schwarz and Weierstrass's inequalities.

Simple Continued fraction and its convergents, representation of real numbers,

Complex numbers, De Moivre's theorem. Direct and inverse circular and hyperbolic functions, logarithm of a complex quantity.

Group – B ***Geometry*** ***(Marks-50)***

Two Dimensional Geometry: ***20***

Transformation of Co-ordinates, Invariants, General equation of second degree, Pair of St. lines, Classification of Conics, Pole, Polar, Polar Co-ordinates, Polar equation of st. lines, Circles, Conics, tangents, normals to Conics and their properties.

Three Dimensional Geometry: ***30***

Rectangular Cartesian Co-ordinates, Transformation of Co-ordinates, Invariants, Planes, St. lines, Shortest distance between two lines, Spheres, Cones, Cylinders, Ellipsoid, Paraboloid, hyperboloid. Tangent Planes and Normals and their properties, Central Quadrics, Ruled Surfaces, Generators, their properties, Classification of Quadrics.

Group – C ***Tensor Calculus*** ***(Marks - 20)***

Tensor as a generalized concept of a vector in E_3.Generalization of idea to an n-dimensional Eucledean space (E_n), Definition of an n-dimensional space, Transformation of Co-ordinates, Summation Convention, Kronecher delta, Invariant, Contravariant and Covariant vectors, Contravariant and Covariant tensors, Mixed tensors. Algebra of tensors, Symmetric and Skew-symmetric tensors, Contraction, Outer and inner products of tensors, Quotient law (Statement only).

Fundamental metric tensor of Riemannian space, Reciprocal metric tensor. A magnitude of a vector, angle between two vectors, Christoffel symbols, Covariant differentiation of vectors and tensors of rank 1 and 2. The identities $g_{ij,k} = g^{ij}{}_{,k} = 0$ and $S^{i}{}_{j,k} = 0$

References:

1. Finkbeiner – *Matrices and Linear Algebra* (Student Edition)
2. S. K. Mapa – *Higher Algebra*, Vol. II
3. T. Pati – *Theory of Matrices*
4. Santinarayan – *Theory of Matrices* (S. Chand)
5. A. R. Rao & P. Bhimsankaram – *Linear Algebra* (TMH).
6. J.T. Bell – *Solid Geometry*
7. Smith – *Co-ordinate Geomentry* (3 dim.)
8. M. C. Chaki – *Co-ordinate Geometry* (2 & 3 dim.)
9. S. L. Loney – *Co-ordinate Geometry* (2 dim.)
10. Askwith – *Co-ordinate Geometry* (2 dim.)
11. Barryspain – *Tensor Calculus*
12. I. S. Sokolnikoff – *Tensor Analysis*
13. M. C. Chakki - *Tensor Calculus*
14. R. M. Khan - *Geometry*

Paper – IV

(Differential Equation and Dynamics of a Particle)

Group – A **Differential Equation** ***(Marks - 50)***

Ordinary Differential Equations : ***(Marks - 40)***

Definition of ordinary differential equation-its order and degree, Formation of ordinary differential equations by elimination, Examples of differential equation from various fields of Sciences. First order linear equation, I.F., Exact differential Equations, condition ogf integrability. Solution of differential equation. Complete primitive and particular integral of ordinary differential equation. Linear differential equation-Linear property of its solutions. Picard's existence theorem (statement only) for $\frac{dy}{dx} = f(x,y)$ with $y = y_0$ at $x = x_0$. Equation of first order and first degree-exact equations and those convertible to exact form. Solution by separation of variables. Homogeneous equations. Linear equations of first order. Equations of first order but not of first degree-equations solvable for p = $\frac{dy}{dx}$, equations solvable for y, equation solvable for x, singular solutions, Clairart's form. Singular solution as envelope to family of general solution to the equation.

Linear differential equation of second and higher order. Two linearly independent solutions of a second order linear differential equations and Wronskian, general solution of second order linear differential equation, solution of linear differential equation of second order with constant coefficients. Solution when values of y and x are given at a point.

Particular integrals for second order linear differential equation with constant coefficients for polynomial, sine, cosine, exponential function and for function as combination of them or involving them. Method of variation of parameters for P.I. of linear differential equation of second order. Homogeneous linear equation of n-th order with constant coefficients. Reduction of order of linear differential equation of second order when one solution is known.

Simultaneous linear ordinary differential equation in two dependent variables. Solution of simultaneous equations of the form dx/P = dy/Q = dz/R. Equation of the form (Paffian form) Pdx +Qdy+Rdz = 0. Necessary and sufficient condition for existence of integrals of the above. Total differential equation.

Partial Differential Equations : ***(Marks - 10)***

Their formations, Lagrange's Linear equation. General integral and complete integral. Integral surface passing through a given curve.

References:

1. Murray – *Ordinary Differential Equation*
2. Piaggio –*Ordinary Differential Equation*
3. Sneddon – *Elements of Partial Differential Equations* (McGraw Hill)
4. Miller – *Partial Differential Equation –I*
5. *Differential Equation* (Schaum Series Publication)
6. Ince – *Differential Equation*
7. Nelson - *Differential Equation*
8. Ghosh & Chakraborty – *Differential Equations*
9. Maity & Ghosh – *Differential Equations*

Group – B ***Dynamics of a Particle*** ***(Marks- 50)***

Kinematics

Expressions for velocity & acceleration for

(i) Motion in a straight line;

(ii) Motion in a plane;

(iii) Motion in three dimension in rectangular cartesion co-ordinates.

Expressions for velocity & acceleration for motion in a plane

(i) referred to rotating axes in the plane,

(ii) in plane polar co-ordinates,

(iii) in tangential and normal direction of the path of the particle.

Kinetics

Momentum and Angular momentum of a moving particle, Newton's laws of motion. Equation of motion of a particle moving under the action of given external forces. Forces of friction. Rolling and Sliding friction. Nature of force in light inextensible string and in a light elastic string. Work and Power. Conservative force field. Potential energy and Kinetic energy of a particle. Principles of conservation

(i) of linear momentum, (ii) of angular momentum, (iii) of energy of a particle

Impulse of force. Ipulsive forces, change of momentum under impulsive forces. Examples. Collision of two smooth elastic bodies. Newton's experimental law of impact. Direct and blique impacts of (i) Sphere on a fixed horizontal plane, (ii) Two smooth spheres, Energy loss.

Motion of a particle in a straight line in the following cases :

For forces of the forms

(a) μx^n, n = 0, $\pm$ 1, n = -2 (μ >0 or < 0) with physical interpretation.

(b) S.H.M. of a particle attached to one end of an elastic string, the other end being fixed.

(c) Linearly damped harmonic motion.

(d) Forced oscillation with and without damping.

(e) Vertical motion under gravity when resistance varies as the velocity or the square of the velocity.

(f) Motion with constant power under resistance proportional to velocity under gravity.

(g) Vertical motion of a particle when its mass changes at a constant rate

(h) Motion of a heavy particle along a smoothl or rough inclined plane.

Motion in two dimensions :

(i) Motion of a projectile under gravity with air resistance neglected ;

(ii) Motion of a projectile under gravity with air resistance proportional to velocity, square of the velocity ;

(iii) Motion of a simple pendulum ;

(iv) Central Orbit – Motion under a central force:basic properties and differential equation of the path under given forces and velocity of projection. Apses. Time to describe a given arc of an orbit.

Law of force when the center of force and the central orbit are known. Special study of the following problems :

To find the central force for the following orbits –

(a) A central conic with the force directed towards the focus ;

(b) Equiangular spiral under a force to the pole ;

(c) Circular orbit under a force towards a point on the circumference.

To determine the nature of the orbit and of motion for different velocity of projection under a force per unit mass equal to –

(a) μ / $(\text{dist})^2$ towards a fixed point ;

(b) under a repulsive force μ / $(\text{dist})^2$ away from a fixed point

Circular orbit under any law of force μ f (r) with the centre of the circle as the centre of force.

Question of stability of a circular orbit under a force μ f (r) towards the center. Particular case of μ f (r) $=1/r^n$, Kepler's laws of planetary motion from the equation of motion of a central orbit under inverse square law. Modification of Kepler's third law from consideration of motion of a system of two particles under mutual attractions according to Newton's law of gravitational attraction. Escape velocity.

Motion of a particle along a smooth curve. Examples of motion under gravity along a smooth vertical circular curve, smooth vertical cycloidal arc (cycloidal pendulum), parabolic curve. Motion of a particle along a rough curve (circle, cycloid) & in a resisting medium.

References:

1. Chorlton - *A Text Book of Dynamics*
2. Synge & Griffith – *Principles of Mechanics*
3. Smart – *Dynamics*
4. Simmons – *Dynamics*
5. Loney – *Tr. on Analytical Dynamics*
6. Ramsey – *Dynamics, Pt. I, Pt. II*
7. Lamb – *Dynamics*
8. Gate Wood - *A Text Book of Dynamics*
9. Ghosh & Chakraborty – *Advanced Analytical Dynamics*
10. Ganguly & Saha – *Dynamics*
11. Dutta & Jana - *Dynamics*

Part – III

Paper –V

(Analysis – II)

Group – A ***Metric Spaces*** ***(Marks - 40)***

Metric, examples of standard metric spaces including Eucleadean and Discrete metrics; open ball, closed ball, open sets; metric topology; closed sets, limit points. and their fundamental properties; interior, closure and boundary of subsets and their interrelation; denseness; separable and second countable metric spaces and their relationship.

Continuity : Definition of continuous functions, algebra of real/complex valued continuous functions, distance between a point and a subset, distance between two subsets.

Connectedness: Connected subsets of the real line R, open connected subsets in R^2, components; components of open sets in R and R^2; Structure of open set in R, continuity and connectedness; intermediate value theorem.

Sequence and completeness: Sequence, subsequence and their convergence; Cauchy sequence and completeness, completeness of R^n; Cantor's theorem concerning completeness. Definition of completion of a metric space, construction of the reals as the completion of the incomplete metric space of the rationals with usual distance (proof not required). Continuity preserves convergence.

Compactness: Definitions (by means of open covering), Compact metric spaces and finite intersection property (FIP) of closed sets; Compact subsets, continuity and compactness; sequential compactness, Equivalence between compactness and sequential compactness, relation between compactness, completeness and total boundedness.

Heine-Borel theorem concerning characterization of compact subsets of R^n.

Uniform continuity and continuity on compact sets; distance between two non empty disjoint closed set one of which is compact is a positive real.

Group – B ***Real Analysis*** ***(Marks - 40)***

Definition of Riemann integration, Uniqueness, Cachy's criterion, Linear property, Darboux theory of Riemann integration, equivalence, Darboux theorem(proof not required), Riemann integral as the limit of a sum, equivalence. Fundamental theorem of integral calculus, Properties of the Riemann integral; Riemann integrability of continuous and monotone functions, discontinuous function. First and second Mean value theorems of Integral Calculus. Functions defined by integrals, their continuity and differentiability.

Convergence of sequence and series of functions, uniform convergence, Cauchy's Criterion of uniform convergence, continuity of sum function of a uniformly convergent series of continuous functions, term by term differentiation and integration for proper integrals.

Functions of several variables, theory of extrema, maxima, minima, Lagranges' method of miltipliers, Jacobian, Implicit function theorem (proof not required).

Integral as a function of parameter. Differentiation and integration under the sign of integration, change of order of integration for repeated integrals.

Inproper integrals, their convergance (for unbounded functions and unbounded range of integration) Abel's and Dirchlets' test, Beta and Gamma function, Evaluation of improper integrals

$$\int_0^{\pi/2} \log \sin x \, dx \,, \qquad \int_0^{\infty} \frac{\sin x}{x}\, dx \,, \qquad \int_0^{\infty} e^{-\alpha x} \frac{\sin \beta x}{x}\, dx \,, \qquad \alpha > 0$$

and integrals dependent on them.

Fourier series associated with a function, Series of odd and even functions, Main theorem concerning Fourier series expansion of piece wise monotone functions (proof not required).

Group – C ***Complex Analysis*** ***(Marks - 20)***

Introduction of complex number as ordered pair of reals, geometric interpretation, metric structure of the complex plane **C**, regions in **C.** Stereographic projection and extended complex plane $\mathbf{C}_\infty$ and circles in $\mathbf{C}_\infty$

Continuity and differentiability of a complex function. Analytic functions and Cauchy Riemann equation, harmonic functions.

Power series, radius of convergence, sum function and its analytic behaviour within the circle of convergence, Cauchy-Hadamard Theorem.

Introduction of exp(z), sinz, cosz, tanz and the branches of logz and their analytic behaviour.

Transformation (mapping), Concept of Conformal mapping, Bilinear (Mobius) transformation and its geometrical meaning, fixed points and circle preserving character of Mobius transformation.

References:

1. Goldberg – *Method of Real Analysis*
2. Burkil & Burkil – *Second course of Mathematical Analysis*
3. Santinarayan – *Mathematical Analysis*
4. Conway – *Functions of One Complex Variable*
5. Carslaw – *Fourier Series*
6. Churchil – *Theory of Function of Complex Variable*
7. Malik & Arora – *Mathematical Analysis*
8. R. G. Burth and D. H. Sherert – *Introduction to Analysis*
9. R. G. Burtle – *Elements of Real Alalysis*
10. W. Rudin – *Mathematical Analysis*
11. Apostol – *Mathematical Analysis*
12. Copson – *Complex Variable*
13. Shah & Saxena – *Theory of Function of Real Variable*
14. G. F. Simmons – *Introduction to Topology and Modern Analysis*
15. E. G. Philips – *Functions of a Complex variable with applications*
16. Maity & Ghosh – *Analysis – I & II*

Paper –VI

(Mechanics)

Group – A ***Principles of Mechanics*** ***(Marks - 70)***

I. Physical Foundations of Classical Dynamics : ***(Marks - 10)***

Inertial frames, Newton’s laws of motion, Galilean transformation. Form-invariance of Newton’s laws of motion under Galilean transformation. Fundamental forces in classical physics (gravitation). Electric and Magnetic forces, action-at-a-distance. Body forces; contact forces: Friction, Viscosity.

II. Dynamics of a system of particles and of a rigid body (Vector treatment): (Marks - 40)

System of particles :

Fundamental concepts, centre of mass, momentum, angular momentum, kinetic energy, work done by a field of force, conservative system of forces – potential and potential energy, internal potential energy, total energy.

Following important results to be deduced :

(i) Centre of mass moves as if the total external force were acting on the entire mass of the system concentrated at the centre of mass (examples of exploding shell, jet and rocket propulsion).

(ii) The total angular momentum of the system about a point is the angular momentum of the system concentrated at the centre of mass, plus the angular momentum for motion about the center.

(iii) Similar theorem as in (ii) for kinetic energy.

Conservation laws : conservation of linear momentum, angular momentum and total energy for conservative system of forces.

An idea of constraints that may limit the motion of the system, definition of rigid bodies.

D'Alembert's principle, principle of virtual work for equilibrium of a connected system.

Rigid Body :

Moments and products of inertia (in three-dimensional rectangular co-ordinates). Inertia matrix. Principal values and principal axes of inertia matrix. Principal moments and principal axes of inertia for (i) a rod, (ii) a rectangular plate, (iii) a circular plate, (iv) an elliptic plate, (v) a sphere, (vi) a right circular cone, (vii) a rectangular parallelepiped and (viii) a circular cylinder.

Two-dimensional motion of a rigid body. Following examples of the two-dimensional motion of a rigid body to be studied :

(i) Motion of a uniform heavy sphere (solid and hollow) along a perfectly rough inclined plane;

(ii) Motion of a uniform heavy circular cylinder (solid and hollow) along a perfectly rough inclined plane:

(iii) Motion of a rod when released from a vertical position with one end resting upon a perfectly rough table or smooth table.

(iv) Motion of a uniform heavy solid sphere along an imperfectly rough inclined plane ;

(v) Motion of a uniform circular disc, projected with its plane vertical along an imperfectly rough horizontal plane with a velocity of translation and angular velocity about the centre.

III. Analytical Statics : ***(Marks -20)***

Forces, concurrent forces, Parallel forces. Moment of a force, Couple. Resultant of a force and a couple (Fundamental concept only).

Reduction of forces in three-dimensions, Pointsot's central axis, conditions of equilibrium. Virtual work, Principle of Virtual work.

Simple examples of finding tension or thrust in a two-dimensional structure in equilibrium by the principle of virtual work.

Stable and unstable equilibrium- Energy test of stability, stability of a heavy body resting on a fixed body with smooth surfaces- simple examples.

General equations of equilibrium of a uniform heavy inextensible string under the action of given coplanar forces, common catenary, catenary of uniform strength.

Group – B Elements of Continuum Mechanics with Hydrostatics (Marks - 30)

1. Elements of Continuum Mechanics:

Deformable body. Idea of a continuum (continuous medium). Surface forces or contact forces. Stress at point in a continuous medium, stress vector, components of stress (normal stress and shear stress) in rectangular Cartesian co-ordinate system; stress matrix. Definition of ideal fluid and viscous fluid.

II. ***Hydrostatics :***

Pressure (pressure at a point in a fluid in equilibrium is same in every direction). Incompressible and compressible fluid, Homogeneous and non-homogeneous fluids.

Equilibrium of fluids in a given field of force; pressure gradient. Equipressure surfaces, equilibrium of a mass of liquid rotating uniformly like a rigid body about an axis. Simple applications.

Pressure in a heavy homogeneous liquid. Trust on plane surfaces: center of pressure, effect of increasing the depth without rotation. Centre of pressure of a triangular & rectangular area and of a circular area immersed in any manner in a heavy homogeneous liquid. Simple problems.

Thrust on curved surfaces :Archemedes' principle. Equilibrium of freely floating bodies under constraints. (Consideration of stability not required).

Equation of state of a 'perfect gas', Isothermal and adiabatic processes in an isothermal atmosphere. Pressure and temperature in atmosphere in convective equilibrium.

References:

1. P. G. Bergmann – *Introduction to the Theory of Relativity* (Introduction & first chapter only).

2. H. Goldstein – *Classical Mechanics*
3. J. L. Synge and B. A. Griffith – *Principles of Mechanics*
4. A. Sommerfeld – *Mechanics,* Vol. I of *Theoretical Physics* (Chapter II)
5. S. L. Loney – *An Elementary Treatise on the Dynamics of a Particles and of Rigid Bodies.*
6. S. L. Loney – *Elementary Treatise on Statics*
7. A. S. Ramsey – *Statics*
8. H. Lamb – *Statics and Hydrostatics*
9. I. S. Sokolikoff – *Mathematical Theory of Elasticity* (Ch. 2 pages 36-39) (McGraw –Hill)
10. William Pragger –*Introduction to Mechanics of Continuous Media* (Ch. II Pp. 43-45) (Ginn & Company)
11. A K. Roy Chaudhury – *Classical Mechanics* (Clarendon Press, Oxford)
12. Gatewood – *Classical Mechanics*
13. S. L. Green – *Dynamics*
14. Shantinarayan – *Vector Calculus*
15. Takwale – *Classical Mechanics*
16. M. Rahaman – *Hydrostatics*
17. J. M Kar – *Hydrostatics*
18. M. Rahaman - *Statics*

Paper – VII

(Mathematical Probability, Statistics and Elements of Operations Research)

Group – A ***Mathematical Probability*** ***(Marks - 40)***

Concept of mathematical probability, classical statistical and axiomatic definition of probability, addition and multiplication rule of probability. Conditional probability, Baye’s theorem. Independent events. Bernoulli’s trial, Binomial and Multinomial Law. Random Variables. Distribution function. Discrete and continuous distributions. Binomial, Poisson, Uniform, Normal, Cauchy, Gamma, distribution and Beta distribution of the first and second kind. Transformation of random variables. Discrete and continuous distributions in two dimensions. Mathematical expectation. Theorems on the expectation of sum and product of random variables. Two dimensional expectation, covariance, Correlation co-efficient. Momentgenerating function. Characteristic function, conditional expectations, Regression curve, χ^2 and t distributions and their interrelations, convergence in probability Chebyshev's inequality. Bernoulli's limit theorem, Convergence inprobability. Concept of asymptotically normal distribution, central limit theorem in case of equal components.

Group – B ***Statistics*** ***(Marks - 20)***

Description of statistical data, simple measures of central tendency-mean, mode, median, measures of dispersion – standard deviation, quartile deviation. Moments and measures of Skewness and Kurtosis.

Bivariate frequency distribution. Scatter diagram, Correlation co-efficients, regression lines and their properties.

Concept of statistical population and random sample. Sampling distribution of sample mean and related χ^2, t and F distribution.

Estimation – Unbiasedness and minimum variance, consistency and efficiency, method of maximum likelihood, interval estimation for mean or variance of normal populations.

Group – C ***Elements of Operations Research*** ***(Marks - 40)***

General introduction to optimization problem, Definition of L.P.P., Mathematical formulation of the problem, Canonical & Standard form of L.P.P., Basic solutions, feasible, basic feasible & optimal solutions, Reduction of a feasible solution to basic feasible solution.

Hyperplanes and Hyperspheres, Convex sets and their properties, Convex functions, Extreme points, Convex feasible region, Convex polyhedron, Polytope. Graphical solution. of L. P.P.

Fundamental theorems of L.P.P., Replacement of a basis vector, Improved basic feasible solutions, Unbounded solution, Condition of optimality, Simplex method, Simplex algorithm, Artificial variable technique (Big M method, Two phase method), Inversion of a matrix by Simplex method.

Duality in L.P.P. : Concept of duality, Fundamental properties of duality, Fundamental theorem of duality, Duality & Simplex method, Dual simplex method and algorithm.

Transportation Problem (T.P.) : Matrix form of T.P., the transportation table, Initial basic feasible solutions (different methods like North West corner, Row minima, Column minima, Matrix minima & Vogel's Approximation method), Loops in T.P. table and their properties, Optimal solutions, Degeneracy in T.P., Unbalanced T.P.

Theory of Games : Introduction, Two person zero-sum games, Minimax and Maximin priciples, Minimax and Saddle point theorems, Mixed Strategies games without saddle points, Minimax (Maximin) criterion, The rules of Dominance. Solution methods of games without Saddle point : Algebraic method, Matrix method, Graphical method and Linear Programming method.

References:

1. Goldberg – *Probability – Introduction to Probability (PH)*
2. B. Gnedenko – *Theory of Probability [MIR Pub.]*
3. W. Feller – *Introduction to Probability, I & II, Wiley-Eastern Ltd.*
4. Croxton, F. E. – *Applied General Statistics [PHI]*
5. A.P. Baisnab & M. Jas – *Elements of Probability and Statistics [TMH]*
6. A. Gupta – *Probability & Statistics, Academic Publishers*
7. *Goon, Gupta & Dasgupta – An* outline of Statistical Theory, Vol. I, World Press
8. B. R. Bhat – *Modern Probability Theory, Wiley Eastern*
9. K.L. Chong – *Elementary Probability Theory and Stochastic Process, Narosa*
10. N. G. Das – *Statistical Methods, Vol. I & II*
11. Hadley – *Linear Programming*
12. Gauss – *Linear Programming*
13. J. K. Sharma – *Operations Research – Theory and Applications*
14. Taha – *Operations Research*
15. Schaum's Outline Series – *Operations Research*
16. Ghosh & Chakraborty – *An Introduction to Linear Programming*
17. Swarup, Gupta & Man Mohan – *Operations Research*

Paper – VIII

(Numerical Analysis and Computer Programming)

Group – A ***Numerical Analysis*** ***(Marks - 35)***

Approximation of numbers, decimal places, significant figures. Round off. errors in numerical calculations. addition, subtraction, multiplication and division. Loss of significant figures, Inherent errors in numerical methods. Ordinary and divided differences, Proagation of error in difference table. Problems of interpolation, remainder in interpolation. Newton's forward and backward interpolation formulae. Newton's divided difference formula. Central interpolation formulae: Gauss, Stirling and Bessel's formulae (Deduction not necessary).

Lagranges interpolation formula. Inverse interpolation formula.

Numerical integration : Newton-Cotes' formula (error term may be stated). Trapezoidal rule, Simpson's one-third rule, Inherent errors, degree of precision.

Numerical methods for finding the real roots of algebraic and transcendental equations :Location of roots by Tabulation and Graphical method. Finding the roots by the method of (i) Regula-Falsi (ii) Fixed point iteration and (iii) Newton Raphson & their convergences.

Solution of a system of linear equation : Gauss' elimination method and Gauss-Seidel method; statement of convergence criteria.

Solution of first order ordinary differential equations: Picard's method, Euler's method (modified), Taylor's method and Runge-Kutta's method of second and fourth order (derivation of 2^{nd} order formula only).

Group – B ***Computer Programming*** ***(Marks – 15)***

Anatomy of a computer: Basic structure, Input unit, Output unit, Memory unit, Control unit, Arithmetic logical unit. Computer generation and classification; Machine language, Assembly language, computer-high level languages. Compiler, Interpreter, Operating system.. Source programs and objects programs. Binary number system, Conversions and arithmetic operation.

Representation for Integers and Real numbers, Fixed and floating point.

Programming in FORTRAN-77 Language : Fortran Characters. Basic data types; Numeric Constant & Variables; Arithmetic Expressions, Assignment statements, I/O –statements(Format-free) ; STOP & END statement; Control statement: Unconditional GOTO, Computed GOTO, Assigned GOTO, Logical IF and Arithmetic IF.

Repetitive operations : DO statement; CONTINUE statement, Arithmetic statement functions; Library functions in FORTRAN.

References:

1. F. B. Hildebrand – *Numerical Analysis*
2. J. B. Scarborough – *Numerical Mathematical Analysis*
3. A. Gupta and S. C. Bose – *Introduction to Numerical Analysis*
4. V. Rajaraman – *Computer Primer*
5. Hunt and Shelly – *Computer and Common Sense*
6. V. Rajaraman – *Computer Programming In Fortran – 77*
7. Lips Stu – *Fortran* (Schaum's Publication)
8. Rajaraman – *Computer Oriented Numerical Methods.*
9. C. Xavier – *Fortran 77 and Numerical Methods.*

10. G. C. Layek, A. Samad and S. Pramanik - Computers Fundamentals, Fortran – 77 & Numerical Programs.

Paper - IX

(Computer Aided Numerical Methods -Practical)

Computer Aided Numerical Methods - Practical ***(Marks- 50)***

Sessional (Algorithm, Flowchart and Program with output) : 15 marks
Viva-voce : 5 marks
Problem : 30 marks (Algorithm – 5, Flowchart –5, Program – 10, Result – 10)

Prerequisites : PC – operating system and DOS commands, Concepts of Algorithms, Flowchart and Subscripted variables

1. Finding a real Root of an equation by
   (a) Fixed point iteration and
   (b) Newton-Rapson's method.
2. Finding the solution of linear equations by Gauss-Seidel method
3. Interpolation (Taking at least six points) by Lagrange's formula
4. Integration by
   (i) Trapezoidal rule
   (ii) Simpson's 1/3rd rule (taking at least 10 sub-intervals)
   5. Solution of a 1st order ordinary differential equation by fourth-order R. K. Method, taking at least four steps.