UNIVERSITY OF KALYANI

REVISED SYLLABUS

FOR THREE YEARS B.Sc. DEGREE COURSE

(HONOURS AND GENERAL)

IN

MATHEMATICS

According to the New Examination Pattern
Part – I, Part- II & Part- III

WITH EFFECT FROM THE SESSION
2009 – 2010

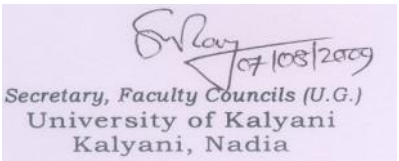
University of Kalyani

Complete Syllabus for B.Sc. (Honours) Course in

MATHEMATICS

(w.e.f. the session 2009-2010)

According to the New Examination Pattern
Part – I, Part – II & Part – III



University of Kalyani

Revised Syllabus of Mathematics
(w.e.f. the session 2009-2010)

Contents

HONOURS COURSE

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Paper wise subject and marks distribution

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	B	15	Linear Algebra – I
	C	20	Abstract Algebra – I
	D	40	Analytical Geometry of two & three dimensions
	E	10	Vector algebra
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	B	25	Integral Calculus
	C	40	Differential Equations – I

Part – II

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	C	20	Abstract Algebra – II
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Part – III

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Mathematics (Honours)
Paper wise subject and marks distribution

Part – III

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VIII	A	30	Numerical Analysis (Theoretical)
	B	20	Fundamentals of Computer Science & Computer Programming (in C)
	C	50	Practical: Computer Programming & Numerical analysis

For Practical: Three problems (Two from Computer Programming [20 marks] and one from Numerical analysis [15 marks]). Practical Note Book –05 marks, Viva- voce- 10 marks. Time allotted for examination = 04 hours.

PART – I

Paper – I

Full Marks - 100

Group - A
Classical Algebra – I (Marks – 15)

Complex Numbers: De Moivre's theorem and its applications. Direct and inverse circular and hyperbolic functions. Logarithm of a complex number. Expansion of trigonometrical functions. Gregory's series . **(5)**

Relation between the roots and coefficients of general polynomial equation of one variable. Fundamental theorem of Classical algebra (no proof required) and its consequences. Nature of roots of an equation (surds or complex roots occur in pairs) . Statements of Descartes' rule of signs and of Sturm's theorem and their applications. Transformations of equations. Multiple roots. Symmetric function of roots. Reciprocal equations. Special roots. Solutions of cubic equations (Cardan method) and biquadrate equations (Ferrari's method) . **(10)**

Group – B
Linear Algebra – I (Marks – 15)

Matrices of real and complex numbers : Definition of a matrix , Equality of matrices , Addition , Multiplication , Scalar multiplication. Transpose and conjugate transpose of a matrix, symmetric, Skew-symmetric, Hermitian and skew- Hermitian matrices, orthogonal matrix and their simple properties. **(6)**

Determination of square matrix of order n. Basic properties. Minors and cofactors . Lapace's method of expansion . Product of determinants. Symmetric and skew - symmetric determinants. Solutions of a system of equations by Cramer's rule. Adjugate / Adjoint of a determinant. Jacobi's theorem. **(7)**

Singular and non-singular matrics. Adjugate / Adjoint and inverse of a matrix. Elementary operation. Echelon matrix and rank of a matrix. Determinations of rank of a matrix-statements and applications of all relevant results and theorems (no proof required).

Normal forms. Elementary matrix. Statement and application of the results on elementary matrix. Normal form and equivalence of matrices. Congruence of matrices (statements of relevant theorems). **(8)**

Group – C
Abstract Algebra – I (Marks - 20)

Basic Concept : Sets, Subsets. Equality of sets. Operation of sets. Union intersection, complements, symmetric difference and properties of those operations. De Morgan's laws. Cartesian products. Binary relations. Equivalence relation. Partition. Relation of partial order. Congruence relation modulo n is an equivalence relation. Congruence classes. Mapping : Injection, surjection and bifection . Inverse and identity maping. Composition of mapping and its associativity . Binary operation in a finite set by construction of table. **(8)**

Introduction to Group theory : Groupoid , Semi group, Quasi group. Monoid and Group. Examples of each of these systems. Definitions of both sided identity and inverse with examples . Additive (resp. multiplicative) group of integers n (resp. a prime p). Klein's 4 - group. Properties deducible from the definition of group including solvability of ax =b and ya

= c . A finite semi group in which both cancellation laws hold is a group. Integral powers of an element and laws of indices in a group. Order of an element . Order of a group.

Subgroup: Definition of a subgroup. Invariance of the identity and inverse in a subsystem of a group. Characterization of a subgroup. Intersection and union of subgroups. Cosets and Lagrange's theorem . **(15)**

Reference Books (for Groups A, B & C)

1. Bernard and Child : Higher Algebra.
2. Burnside and Panton : Theory of Equations (Vol. I)
3. Ghosh and Khan : A Text book of Algebra.
4. Neal H. Mc Coy : Introduction to Modern Algebra
5. D.S. Malik, J.M.Mordeson and M.K.Sen : Fundamentals of Algebra.
6. K.B. Dutta : Matrix and Linear Algebra.
7. Hoffman and Kunze :Linear Algebra.
8. Shanti Narayan : A Text book of matrices .
9. V. Krishnamurthy, V.P.Arora : An Introduction to Linear Algebra.
10. L.Mirsky : An Introduction to Linear Algebra
11. J.B.Fraleigh : A First Courses in Abstract Algebra.
12. I.N. Herstein : Topics in Algebra.
13. V.Khanna and S.K.Bhambri : A Courses in Abstract Algebra
14. Surjeet singh and Q.Zameeruddin : Modern Algebra.
15. K.C.Roy and A.G.Das : Abstract and Linear Algebra

Group - D
Analytical Geometry (Marks - 40)

Two- dimensional Geometry (20): Transformation of rectangular axes. Invariants associated with the coefficients of general degree equation. Necessary and sufficient conditions for the general second degree equation to represent a pair of straig ht lines. Reduction of the general second degree equation to canonical form. Classification of conics. Pair of straight lines. Conjugate diameters of conics. Pole and polar with respect to a non -singular conic. Asymptotes , Coaxial systems of circles. Pola r equations of straight lines. Circle and conics (with a focus as pole) and tangent ,normal, chord of contact. **(16)**

Three- dimensional Geometry (20) : Rectangular Cartesian coordinates in space. Dire ction cosines and direction ratios of a directed line. Projection , angle between two lines. Equations to a plane in intercept ,normal and general forms. The sides of a plane. Bisectors of the angles between two planes. Parallelism and perpendicularity of two planes. Straight lines in the space. Skew lines. Sphere, cone, cylinder, surfaces of revolution , ruled surface. **(14)**

Transformation of rectangular axes in the space. Reduction of the general second degree equation in three variable s to canonical form. Classification of quadrics . Standard equations and shapes of ellipsoid, hyperboloid and paraboloid . Generating lines of hyperboloid of one sheet and hyperboloid parabolic. **(7)**

Reference Books

1. M.C.Chaki: A text book of Analytic
2. J.G.Chakraborty and P.R.Ghosh: Analytical Geometry and Vector Analysis.
3. V.A. llyin and E.G. Poznyak: Analytical Geometry
4. M. Postnikov: Lectures in Geometry
5. S.B. Sengupta: Coordinate Geometry and Vector Analysis.

Group - E
Vector Algebra (Marks – 10)

Basic notions .Addition of vectors. Scalar multiplication of a vec tor. Scalar and vector products of two vectors. Scalar and vector triple products. Application to geometry and mechanics **(8)**

Reference Books

1. J.G.Chakraborty and P.R.Ghosh : Analytical Geometry and Vector Analysis.
2. M.S. Speizel : Vector Analysis.
3. S.B. Sengupta : Coordinate Geometry and Vector Analysis.

Paper – II

Full Marks - 100

Group- A
Differential Calculus (Marks – 35)

Concept only and Examples : Function of a single variable : ϵ- δ definition of the limits of a function, basic properties of limits. Continuous functions (elementary properties). Derivative, its geometrical interpretation and meaning of its sign. Differential. The chain rule. **(7)**

Successive differentiation , Leibnitz's theorem. **(3)**

Partial derivatives of functions of two variables ,Euler's theorem on homogenous functions and its converse, rule of differentiation of implicit functions (problems up to three variables)**.** **(5)**

Plane curve: Derivative of arc length (Cartesian and polar).Angle between radius vector and tangent, perpendicular from pole to tangent ,pedal equations to curves (Cartesian and polar forms).Rectilinear asymptotes (Cartesian and polar).E nvelopes of one – parameter and two parameter family of curves . Curvature, radius of curvature, centre of curvature, evolutes. Test concavity and of convexity ,points of inflexion. Multiple points. Tracing of curves in Cartesian and polar coordinates **(22)**

Group- B
Integral Calculus (Marks - 25)

Concept only and Examples: Indefinite integrals .Definite integral as the limit of a sum ,statement of elementary properties , geometrical interpr etation. **(3)**

Fundamental theorem of Integral calculus (statement only). Reduction formulae for $x^n e^x$ $\sin^n x$, $\cos^n x$, $\sin^m x \cos^n x$, $\tan^n x$, $\cot^n x$, $\sec^n x$, $\text{cosec}^n x$, $1/(a + b\cos x)^n$, $1/(x^2 + a^2)^n$, $x^m/(a + bx^n)$ etc. (m, n being positive integers). **(15)**

Finite arc length , Quadrature , volume and surface of solids of revolution **.** Ideas of Centroid and Moment of inertia. **(10)**

Group- C
Differential Equations - I (Marks - 40)

Genesis of differential equations – formation and general solution with its meaning .First order differential equations of one degree. Homogeneous and Exact equations. Integrating factor .First order linear equations and equations reducible to it. Equations of First order but not of first degree. Clairaut's form. Singular solution . simple applica tions to geometry (e.g. orthogonal trajectories). **(12)**

Higher order linear equations with constant coefficients . Cauchy Euler equation. General solution of second order linear equations, linear independence ,notion of Wronskian . Normal form. Method of variation of parameters. Exact equations of second order. **(10)**

Simple eigen value problems. Simultaneous linear differential equations. Total differential equations with condition of integrability. **(6)**

Reference Books (for Groups A, B & C)

1. S.M.Nikolsky : A course of Mathematical Analysis , Vol – 1.
2. Das and Mukherjee : Differential Calculus.
3. Maiti and Ghosh : Differential Calculus, An Introduction to Analysis .
4. Shanti Narayan : Differential Calculus.
5. T.M.Apostol : Calculus – I
6. Shanti Narayan : Integral Calculus.
7. Das and Mukherjee : Integral Calculus.
8. Forsyth : Treatise on Differential Equations.
9. Murray : Differential Equations.
10. Piaggio : Differential Equations.
11. Chakraborty and Ghosh : Differential Equations.
12. D.Chatterjee : Integral Calculus and Differential Equations

PART – II

Paper – III **Full Marks - 100**

Group A
Classical Algebra – II (Marks – 15)

Cauchy – Schwartz inequality . Inequalities involving A.M. (including "weighted") , G.M., H.M. and their applications . m-th power theorem. **(5)**

Integers : Statements of well-ordering principals and principal of mathematical introduction Second principal of Mathematical Introd uction. Proof of some simple mathematical results by induction . Divisibility of integers. Division algorithm. The greatest common divisor (gcd) of integers a, b . Existence and uniqueness of (gcd) of two integers. Prime integers. Euclid's first and second theorems. Congruences. Euler's Φ function. Farmat's theorem . **(14)**

Group – B
Linear Algebra – II (Marks – 15)

Vector / Linear space over a field with special reference to space of n - tuples of real and complex numbers. Examples of vector spaces. Subspace. Union and inter section of subspaces. Sum of two subspaces.

Linear combination. Linear dependence and independence of a finite set of vectors. Linear span. Generators of a vector space. Finite dimensional vector spaces. Existence of basis. Replacement theorem. Extractio ns of a basis from given generators. Formation of basis from a linearly independence subset. Row space. Column space of a matrix. Row rank, Column rank and rank of matrix. Application of matrices of a system of linear (both homogenous and non- homogenous) equations. Theorems on consistency of a system of linear equations. **(12)**

Finite dimensional linear product space. Definition and examples. Norm, Euclidian vector space (EVS). Orthogonality of vectors, Orthonormal basis, Gr am Schmidt process of orthonormalisation . **(3)**

Linear Transformation . Definition and Examples. Matrix representation. Orthogonal transformation . Characteristic equation of a square matrix. Cayles -Hamilton theorem. Eigen values and vectors- their simple properties. Diagonalisation of matrices . **(6)**

Real quadratic form involving three variables . Positive and negative definite forms. **(2)**

Group – C
Abstract Algebra – II (Marks – 20)

Normal subgroups. Factor groups. Homomorphism , Kernel, Isomorphism, Fundamental theorem of homorphism . **(4)**

Cyclic group : Definition and examples. Subgroup of a cycle group. Generators. A finite group of prime order is cyclic. Any two cyclic groups of same order (>0) are isomorphic.

Permutations : Cycle, Transposition. Representation of a non -identity permutation as the product of disjoint cycles. Even and odd permutations. Symmetric group . Alternating group. Order of an alternating group. C ayley's theorem. **(18)**

Introduction to rings, Integral domain, skew field and fields. Examples of each of these system and their elementar y properties. Zero divisors. Characteristics of a ring. **(5)**

Reference Books (for Groups A, B & C)

1. Bernard and Child : Higher Algebra.
2. Burnside and Panton : theory and Equations (Vol. I)
3. Ghosh and Khan : A Text book of Algebra.
4. Neal H. Mc Coy : Introduction to Modern Algebra
5. D.S. Malik, J.M.Mordeson and M.K.Sen : Fundamentals of Algebra.
6. K.B. Dutta : Matrix and Linear Algebra.
7. Hoffman and Kunze :Linear Algebra.
8. Shanti Narayan : A Text book of matrices .
9. V. Krishnamurthy, V.P.Arora : An Introdu ction to Linear Algebra.
10. L.Mirsky : An Introduction to Linear Algebra
11. J.B.Fraleigh : A First Courses in Abstract Algebra.
12. I.N. Herstein : Topics in Algebra.
13. V.Khanna and S.K.Bhambri : A Courses in Abstract Algebra
14. Surjeet singh and Q.Zameeruddin : Modern Algebra.
15. K.C.Roy and A.G.Das : Abstract and Linear Algebra

Group – D
Analysis – I (Marks – 50)
(All the topics are in relation to IR)

Peano's axiom. Concept of a real number by Dedekind cut. Arithmetic and geometric continuum of real numbers. Bounded set. Least uppers bound axiom. Archimedean property.

Open sets in terms of interior points. Closed sets. Basic properties of open and closed sets. Limiting points of a set , Bolzano – Weierstrass theorem . Idea of open cover of a set . Heine – Borel theorem . Equivalence of Bolzano – Weierstrass theorem and Heine – Borel theorem . Relatively closed and open sets (examples only).

Sequences. Bounds, limits, convergence and divergence of a sequence , Cauchy's general principal of convergence. Sandwich theorem. Monotone sequences and their convergence . Cauchy's first and second theorems on limits. Applications to sequences such as $n^{1/n}$, $x^{1/n}$, x^n , $(1 + 1/n)^n$ etc .

Subsequences of a sequence . Every bounded sequences has a convergent subsequence. . Limsup and liminf of a sequence. Existence of subsequence of a sequence that converges to limsup (liminf) of the sequence. The subsequential limits of a bounded sequence form a closed set .

Denumerable and non-denumerable sets . The set of all rational numbers and the set of all algebraic numbers are denumerable .Non denumerability of the set of all irrational numbers and an interval.

Convergence and divergence of infinite series. Comparison test , D'Alembert's ratio test , Cauchy's root test , Cauchy's condensation test, Raabe's test, Logarithmic test , Gauss' test for series of positive terms . Applications .

Series of arbitrary terms . Leibnitz theorem for alternating series . Absolutely and conditionally (non- absolutely) convergent series. Idea of rearrangements of the terms of a series . Examples of series that changes the sum after a suitable rearrangement . Riemann's rearrangement theorem (statement only).

Real valued functions . Limits of a function at a point . Algebra of limits . Boubded functions, monotone functions . Calculation of limits for elementary functions . Continuous functions (definition by sequences of points and with open sets). Properties of continious functions such as boundedness , attainment of bounded , Darboux intermediate property etc. in a closed interval . Continuity of composite functions . Piecewise continuous functions . Continuity relative to a set (examples only).

Kinds of discontinuities of a function . Classification of discontinuities of a monotone function. Uniform continuity .

Derivatives . Definition and implication of the sign of the derivative. Rolle's theorem , Lagrange's and Cauchy's mean value theorem, Darboux theorem . Taylor's theorem with different forms of remainders . Maclaurin series expansion of elementary functions with their respective range of validity. **(50)**

Reference Books

1. T.M. Apostol : Mathematical Analysis.
2. Bartle and Sherbert : Introduction to Real Analysis .
3. Bromwich : Infinite Series .
4. S.C.Malik : Mathematical Analysis.
5. W.Rudin : Principel of Mathematical Analysis.
6. Saxena and Shah : Introduction to Real Variable Theory.
7. Shantinarayan : A course of Mathematical Analysis.
8. K.R.Ross : Elements of Real Analysis.
9. B.K.Lahiri and K.C.Roy : Real Analysis.

Paper – IV

Full Marks - 100

Group - A
Linear Programming and game Theory (Marks - 40)

Role of linear programming in decision problems. Formulation of linear programming models. Graphical solution. **(2)**

Basic solution (BS) and Basic Feasible Solution (BFS) with reference to LPP. Degenerate and non degenerate BFS. **(2)**

Convex set, convex hull, convex polyhedron, cone, extreme points, hyper plane, supporting hyper plane. **(2)**

The collection of all FS of a LPP is a convex set. Relationship between extreme points and BFS. The objective function has its optimum value at an extreme point of the convex polyhedron generated by the set of all feasible points (closed and bounded). If a LPP admits of an optimal solution then at least one of the BFS must be optimal. Reductions of FS to BFS. **(5)**

Standard form of LPP . Matrix representation of LPP. Variable unrestricted in sign. Simplex method. Charnes' Big – M method . Two phase method . Unbounded solutions and alternative optima. **(7)**

Duality theory. The dual of the dual is the primal. If any constant to the primal problem is equality in sign, then the corresponding dual variable is unrestricted in sign and conversely .

Relation between the objective value of the primal problem and dual problem. **(8)**
Complementary slackness theorem (statement only).Solution of LPP by dual method.
Transportation and assignment problem and their optimal solutions. **(5)**
Travelling Salesman problem **(4)**

Game theory: Two – person zero sum games . Players and their strategies. Rectangular games . Pure and mixed strategies . Maximin and Minimin criteria. Optimal strategy and the value of the game. Solution of a game for mixed strategies. Geometric method for resolving 2 x n and m x 2 games. Fundamental theorem. Relationship between game theory and LPP. **(7)**

Reference Books

1. G. Hadley: Linear Programming.
2. S.Gass: Linear Programming.
3. J.G.Chakraborty & P.R.Ghosh : Linear Programming & Game Theory.
4. P.K.Karak: Linear Programming.
5. H.A.Taha : Operations Research.
6. S.D.Sharma: Operations Research.
7. Kanti Swarup , Gupta and Monmohon: Operations Research.

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

Fundamental notions and Principles of dynamics : Kinematics and kinetics. Laws of motion . Relative velocity. **(1)**

Motion in a Straight line : Motion of a particle with uniform and variable acceleration. Motion under inverse square law. Simple harmonic motion (S.H.M.). Composition of two S.H.Ms having same period or slightly different periods. Elastic strings . Harmonic oscillator, effect of a disturbing force . damped oscillation and damped forced oscillation . Motion under gravity when the resistance varies as same integral power of velocity . **(8)**

Work, Power and Energy: Definitions.Work done in stretching an elastic string. Conservative forces. Conservation of energy. **(3)**

Impulse and impulsive forces: Impulse of a force. Impulsive forces. Conservation of linear momentum . **(2)**

Collision of elastic bodies : Elasticity . Impact of smooth bodies . Impact on fixed plane. Direct and oblique impact of two smooth spheres. Loss of kinetic energy . Angle of deflection . **(3)**

Motion in a Plane : Velocity and acceleration of a particle moving on a plane in Cartesian and polar coordinates . Motion of a particle moving on a plane referred to a set of rotating rectangular axes. Angular velocity and acceleration . Circular motion . Tangential and normal accelerations . (**10)**

Central orbit : Characteristics of central orbits . Areal velocity . Law of force for elliptic , parabolic and hyperbolic orbits . Velocity under central forces. Orbit under radial and transverse accelerations . Stability of nearly circular orbits. **(8)**

Planetary motion: Newtonian law . Orbit under inverse square law. Kepler's laws of planetary motion . Time of description of an arc of an elliptic , Parabolic and hyperbolic orbit. Effect of disturbing forces on the orbit. **(5)**

Artificial satellites: Orbit round the earth . Parking orbits . Escape velocity . **(2)**

Constrained motion: Motion of a particle on smooth and rough curves with special reference to circle and cycloid. **(3)**

Motion in a resisting medium: Vertical and curvilinear motion in a resisting medium . **(3)**

Motion of varying mass: Equations of motion. **(2)**

Reference Books

1. J.G.Chakraborty & P.R.Ghosh : Advanced Analytical Dynamics
2. N. Dutta & R.N. Jana : Dynamics of a Particle
3. N.L.Synge & S.A.Griffith : Principles of Mechanics
4. S.L.Loney : Dynamics of a Particle
5. A.S.Ramsey. : Dynamics (Part – I)
6. F. Charlton : A Text book of Dynamics

Group - C

Analysis – II (Marks –10)

L'Hospital rule (statement only) with applications. Points of local extrema (maximum , minimum , and saddle point) of a function in an interval . Sufficient conditions for the existence of a local maximum or a minimum of a function at a po int . Simple applications to geometry and to physical problems. **(10)**

Reference Books

1. T.M. Apostol: Mathematical Analysis.
2. Bartle and Sherbert: Introduction to Real Analysis.
3. Bromwich: Infinite Series .
4. S.C.Malik: Mathematical Analysis.
5. W.Rudin: Principel of Mathematical Analysis.
6. Saxena and Shah: Introduction to Real Variable Theory.
7. Shantinarayan: A course of Mathematical Analysis.
8. K.R.Ross: Elements of Real Analysis.
9. B.K.Lahiri and K.C.Roy: Real Analysis.

PART – III

Paper – V **Full Marks - 100**

Group – A
Analytical Statics (Marks – 40)

*** Preliminary concepts**: Parallelogram, triangle and polygon laws of forces. Equilibrium of a particle with a same smooth curve of surface. Like and unlike parallel forces. Moment and couple . **(2)**

(***** No broad question is to be set from this section)

Coplanar forces : Reduction of a system of coplanar forces . Moment about any point as base . Equation of the line of resultant . Necessary and sufficient conditions of equilibrium . Astatic equilibrium . Case of three forces . Action at joint in a frame work. **(5)**

Friction: Laws of statical friction. Coefficient, angle and cone of friction. Equilibrium on a rough inclined plane . Equilibrium of a particle to rest on a rough curve under any given forces . **(3)**

Centre of gravity : Centre of gravity of areas , surfaces and volumes (variation of gravity included). Pappus theorem (statement only). **(5)**

Strings : Equilibrium of a flexible inelastic string under gravity (variations of density and cross – section included). Light and heavy inextensible strings resting on a plane curve. (**3**)

Work and Energy : Work theorem . Principle of virtual work and its converse . Stable and unstable equilibrium . stability of equilibrium of two bodies other than spherical bodies . Energy test of stability . Condition of stability of equilibrium of a perfectly rough heavy body lying on fixed body . **(8)**

Forces in three dimensions : Moment of a force about a line . Reduction of a system of forces in space . Poinsot's central axis . Invariants of a system of forces. Equations of the central axis . Wrench and screw . Condition for a single resultant force . General conditions of equilibrium and their deduction from the principle of virtual work. **(14)**

Reference Books

1. S.L. Loney : An Elementary Treatise on Statics.
2. S.L. Loney: Statics
3. A.S.Ramsey: Statics
4. M.C.Ghosh: Analytical Statics.
5. S. Mondal: Advanced Analytical Statics
6. J.M.Kar: Analytical Statics

Group – B
Dynamics of a Rigid Body (Marks – 20)

Moments and products of inertia: Moment of inertia (M.I) and product of inertia (P.I.) of some simple cases . M.I. about a perpendicular axis . Routh's rule . M.I. about parallel axes . M.I. about any straight line. M.I. of a lamina about a straight line in its plane . Momental ellipsoid . Equi-momental systems. **(4) General equations of motion**: D'Alembert's principal and its application to deduce general equations of motion of a rigid body . Motion of the centre of inertia (C.I.) of a rigid body . M otion relative to C.I . **(3)**

Motion about an axis: Rotation of a rigid body about a fixed body . Equation of motion . K.E. of the body rotating about an axis . Compound pendulum and its minimum time of oscillation. **(3)**

Motion in two dimension under finite forces: Equations of motion . K.E. and angular momentum about the origin of a rigid body moving in two dimensions. Two – dimensional of a solid of revolution down a rough inclined plane. Necessary and sufficient condition for pure rolling. **(4)**

Motion under impulsive force: General equations of motion . Motion about a fixed axis . Centre of percussion . Motion in two dimensions . **(3)**

Conservation of momentum and energy: Principle of conservation of momentum under finite and impulsive forces. Principle of energy. Conservation of energy. K.E. of a moving body . **(3)**

Reference Books

1. J.G.Chakraborty & P.R.Ghosh : Advance Analytical Dynamics
2. N.L.Synge & S.A.Griffith : Principles of Mechanics
3. S.Ramsey. : Dynamics (Part – I)
4. F. Chorlton : A Text book of Dynamics

Group – C
Hydrostatics (Marks – 40)

* **Fundamental concept**: Real and ideal fluids. Pressure of fluid. Transmission of fluid pressure . Elasticity . Specific gravity. **(2)**

(* No broad question is to be set from this section)

Pressure of heavy fluids: Magnitude of pressure at a point in a liquid . Pressure at all points at the same horizontal level in a liquid at rest under gravity . For a liquid in equilibrium under gravity , the difference of pressure between any two points is proportional to their depths. Free surface of a homogeneous in equilibrium under gravity is ho rizontal . Horizontal planes in a liquid in equilibrium under gravity are surfaces of equal density . Pressure at any point in the lower of two immiscible liquids in equilibrium under gravity ; Surface of separation is a horizontal plane. Thrust of homoge neous liquids on plane surface. Hydrostatic paradox . Resultant thrust on one side of a vessel with plane base and plane vertical sides containing two immiscible liquids. Whole pressure. **(8)**

Condition of equilibrium of fluids: Pressure derivative in terms of force . Pressure equation and the conditions of equilibrium . Surfaces of equal pressure. Fluid of equilibrium under gravity . Fluid in relative equilibrium . Rotating fluid . **(8)**

Centre of pressure : Definition . Position of the centre of pressure (C.P.) of a plane area. C.P. of a plane area immersed in a heavy liquid under gravity. Positions of centres of pressure of some simple areas , e.g. triangular area , paral lelogram , circular area , composite plane area. C.P.of a plane area immersed in a number of liquids with different densities . Locus of the C.P. C.P. of a plane area referred to t he axes through its centroid. **(6)**

Thrusts on curved surfaces : Resultant thrust on a curved surface of a heavy homogeneous fluid at rest . Resultant thrust on a solid body wholly or partially immersed in a heavy fluid at rest . Resultant vertical thrust on a surface exposed to the pressure of a heavy fluid at rest . Resultant horizontal thrust in a given direction on a given surface . Resultant thrust on any surface of a liquid at rest under given forces. Resultant thrust on the curved surface of a solid bounded by a plane curve. **(6)**

Equilibrium of floating bodies: Conditions of equilibrium. Bodies floating under constraint. Potential energy of a liquid. **(2)**

Stability of floating bodies : Plane and surface of floatation . Buoyancy . Meta centre and meta centric height . Conditions of stability of equilibrium . Properties of surface of buoyancy. Equilibrium of a vessel containing liquid . Some elementary curves of buoyancy, e.g., triangle , rectangle . Oscillation of floating bodies. **(5) Gases**: Relation between pressure , volume and temperat ure of a gas . Mixture of gases. Pressure and density in an isothermal atmosphere when the gravity is constant and is variable . Convective equilibrium . Atmosphere in convective equilibrium . Work done in compressing a gas. **(3)**

Reference Books

1. D.C.Sanyal & K.Das :Hydrostatics
2. J.M.Kar. : Hydrostatics
3. S.L. Loney : Hydrostatics
4. A.S.Ramsey : Hydrostatics
5. W.H.Besant & A.S.Ramsay : A Treatise on Hydromechanics (part – I)

Paper – VI

Full Marks - 100

Group – A

Analysis – III (Marks – 40)

Defination of the Riemann integral ,boundedness of the integrand ,Cauchy's Criterion . Basic properties. The upper and lower Darboux sums ,the upper and lower Riemann integrals. Criterion for Riemann integrability in terms of osci llatory sums. Riemann integrability of monotone functions and continuous functions. Definition of the Darboux integral and its equivalence with the Riemann integral. Indefinite Riemann integral, its continuity and differentiability. Fundamental theorem.Com position theorem, absolute integrability, integration by parts formula . First Mean value theorem . Second Mean value theorem (Bonnet's and Weierstrass forms).

Convergence of a sequence of functions and series of functions. Uniform convergence . Weierstrass M – test . Theorem on sum function of a uniformly convergent series of continuous functions , term by term differentiation and integration .

Power series . Radius of convergence . Uniqueness of power series . Tests for estimation of radius of converge nce . Cauchy – Hadamard formula . Properties of power series , their term by term differentiation and integration .

Improper integrals ; their convergence for unbounded functions and unbounded range of integration . Abel's test , Dirichlet's test . Evalua tion of improper integrals

$\int_0^\infty (\sin x)/x \, dx$, $\int_0^\infty e^{-ax} (\sin bx)/x \, dx$ $(a > 0)$ and integrals depending on them .

Gamma functions.

Trigonometrically periodic functions . Fourier series associa ted with a function . Fourier series of odd and even functions . Dirichlet condition on Fourier series (no proof) .

(**40)**

Reference Books

1. Shantinarayan: Mathematical Analysis.
2. Burkill and Burkill: Second course of Mathematical Analysis.
3. W.Rudin : Mathematical Analysis.
4. Malik and Arora: Mathematical Analysis.
5. T.M. Apostol: Mathematical Analysis.
6. Goldberg: Method of Real Analysis.
7. Bartle and Sherbert: Introduction to Real Analysis.
8. A.G.Das: Generalized Riemann Integral.
9. B.K.Lahiri and K.C.Roy: Real Analysis.

Group – B
Calculus of Several Variables (Marks – 25)

Interior point of a subset, open subsets, neighborhood of a point ,c losed subsets in R^2 and R^3.

Limit and continuity of functions from R^2 to R . Double and repeated limits of such functions . Basic properties of continuous function $f : R^2 \to R$.

Partial derivatives . Theorems of Young and Schwarz on the commutativity of p artial derivatives .

Differentiability . Necessary and sufficient conditions for differentiability .

Taylor's theorem for functions of two variables with remainder after n terms . Maxima and minima for functions of two variables . Extreme values . Lagrange 's method of multipliers for extrema of a function of three variables .

Implicit functions : existence theorem , continuity and differentiability of implicit functions.

Jacobean and functional dependence in terms of Jacobeans . Partial derivative as a rati o of two Jacobians for functions of two variables . Idea of directional derivatives . Mappings from R^m to R^n where m and n are positive integers (examples only).

Double and repeated integrals and their equivalence . **(25)**

Reference Books

1. Shantinarayan : Mathematical Analysis.
2. W.Rudin : Mathematical Analysis.
3. Malik and Arora : Mathematical Analysis.
4. Goldberg : Method of Real Analysis.
5. T.M. Apostol : Mathematical Analysis.
6. Robert .G. Bartle : The element of Real Analysis.

Group – C
Differential Equations - II (Marks - 15)

Partial differential equations – formation and solution by Lagrange's method and Char pit's method. Geometrical Interpretation. **(6)**

Lapalce transform and its application to the solution of ordinary differential equations of second order with constant coefficients. **(6)**

Power series solution of ordinary differential equations at an ordinary point. **(3)**

Reference Book

1. Forsyth: Treatise on Differential Equations.
2. Murray: Differential Equations.
3. Piaggio: Differential Equations.
4. Chakraborty and Ghosh: Differential Equations.
5. D.Chatterjee: Integral Calculus and Differential Equations.

Group – D

Metric Space (Marks – 20)

Definition and examples of metric spaces such as R^n ($n\geq1$), C[a,b], a<b, and l_p ($p\geq1$). Open and closed balls and neighborhood of a point. Open and closed sets and their relations . Union and intersection of open and closed sets. Limit point of a set. Interior and closure of set w ith elementary properties. Bounded sets.

Cauchy sequences. Every convergent sequence is a Cauchy sequence but the converse is not true. Complete and incomplete metric spaces. Completeness of R^n ($n\geq1$),C[a,b], a<b, Cantor's intersection theorem : necessary a nd sufficient conditions (no proof).

Mappings. Definition of a continous mapping with the help of open sets and sequences of points . Application of completeness to Banach's fixed point theorem .

Definition of compact sets with the help of sequences of poi nts. Compact metric spaces . Every compact set is complete but the converse is not true . Relations between compact sets , bounded sets, and closed sets (statement with examples only). Every closed subset of a compact metric space is compact. Continuous i mage of a compact set is compact. **(20)**

Reference Books

1. E.T. Copson : Metric Spaces .
2. G. F. Simmons : Introduction to Topology and Analysis.
3. K.K.Jha : Functional Analysis .
4. J.B. Conway : A course in Functional analysis .
5. B.K.Lahiri : Metric Spaces.

Paper – VII

Full Marks - 100

Group – A

Vector Analysis (Marks – 20)

Vector Analysis: Scalar and vector functions of a single variable ; magnitude of a vector function, limit and continuity of vector functions and their properties. Differentiation of a vector function. Geometrical interpretation and properties of the derivatives . **(5)**

Scalar field: Directional derivative and gradient, vector field; curl and divergence, del operator and their elementary properties. **(5)**

Curvilinear coordinates and curves in E_3 , tangent , principal normal, binormal, curvature , torsion, Serret – Frenet formulae . Fundamental planes . **(5)**

Connected and simply connected regions. Riemann integral ,l ine integral, multiple integral, Line integrals as integrals of vectors. Circulation , irrotational vector. Work done, conservative force, potential . Orientation. Statement of Stokes, Green's and Divergence theorems and simple problems related to these th eorems. **(5)**

Reference Books

1. M.C.Chaki: Vector Analysis.
2. B.Spain: Vector Analysis.
3. C.E. Weatherburn: Advance Vector Analysis.
4. H.Lass: Vector and Tensor Analysis.
5. I.S. Sokolnikoff: Vector Analysis, Theory and Applications.
6. Maiti and Ghosh: Vector Analysis.
7. Ghosh and Chakraborty: Vector Analysis.

Group - B
Tensor Algebra (Marks – 10)

A tensor as a generalized concept of a vector in E_3 and its generalization in E_n. Space of n – dimension. Transformation of coordinates. Summation convention. Definition of scalar or invariant. Contravariant, covariant vectors and tensors , mixed tensors of arbitrary order. Equality of tensors, addition, subtraction of two tensors. Outer product of tensors, Contaction and inner product of tensors. Symmetric and skewsymmetric tensors. Quotient law, reciprocal tensor of a tensor. **(12)**

Reference Books

1. H. Lass: Vector and tensor Analysis.
2. I.S. Sokolnikoff: Vector Analysis, Theory and Applications.
3. M.C.Chaki: A text book of Tensor Analysis.
4. F. Goreux: Differential Geometry .
5. Ghosh & Chakraborty: Vector Analysis.
6. U.C.De, A.A.Shaikh and Joydeep Sengupta: Tensor Calculus, Narosa Publishers, New Delhi .

Group – C
Complex Analysis (Marks – 15)

Complex numbers as ordered pairs of real numbers . Geometrical representation of complex numbers , the complex plane (Argand diagram). Complex conjugates , absolute values and amplitudes . Domains.

Complex functions , Limits and continuity . Continuity in terms of real and imaginary parts .

Differentiability of complex functions. Cauchy – Riemann equations in Cartesian and polar forms , Sufficient conditions for differentiability (statement only).

Analytic functions .Difference between analytic and differentiable functions. Determination of analytic function from real or imaginary part.

Harmonic functions. Exponential , trigonometric and logarithmic functions and their analyticity . Hyperbolic functions.

Bilinear transformations. Cross ratio. Fixed points of a bilinear transformation. **(14)**

Reference Books

1. J.B. Conway : Functions of one complex var iable.
2. R.V. Churchil : Theory of Functions of complex variable.
3. W.Rudin : Mathematical Analysis.
4. E.T. Copson : Theory of Functions of a complex variable.
5. E.G. Philips : Functions of a complex variable with applications .
6. B.K.Lahiri : Complex Analysis .

Group – D
Probability Theory (Marks – 30)

Probability theory : Random experiment . Simple , compound , exhaustive and exclusive events ,event , space . Classical and frequency definitions of probability and their limitations . Axiomatic definition of probability . Addition and multiplication rules of probabilites. Baye's theorem . Independent and dependant trials . Bernoulli trials , binomial law . Poisson trials. Multinomial law . **(6)**

Random variables and probability distributions : Definitions . Discrete and continuous distribution function . Binomial, Poisson and normal distributions. Transformation of random variables . Two – dimensional probability distribution – Discrete and continuous . Uniform distribution and two – dimensional normal distribution . Conditional distributions. Transformation of random variables in two – dimensions. **(10**)

Mathematical expectation : Expectation . Mean , variance , moment . Measure of location , dispersion , skewness , kurtosis , median , mode , quartiles . Moment generating function. Characteristic function . Two-dimensional expectation . Covariance , correlation coefficient , joint characteristic function . Regression coefficient . Regression curve . Least square regression lines and parabolas. **(12)**

Some discrete and continuous distribution : Chi – square , t – and F – distributions and their properties (statement only) **(2)**

Generating and characteristics functions and limit theorems : Tchebycheff's inequality . Convergence in probability and its simple properties . Bernoulli's and central limit theorems (Statement only). Law of large numbers (Statement only). Normal approximation to binomial distribution (Statement only). **(5)**

Group – E
Mathematical Statistics (Marks – 25)

Elements of statistics: Random sample . Population and samples . Collection , tabulation and graphical representation. Frequency distribution. **(4**)

Sample characteristics- mean, variance, skewness, kurtosis, excess, mode, median, semi - interquartile range.

Bivariate samples- correlation coefficient, regression lines, parabolic curve fitting , goodness of fit. **(5)**

Sampling distributions: Sampling distribution of stati stics . Sampling distribution of the sample mean and variance. Sampling distributi on for the normal population . **(2**)

Theory of estimation: Estimation and estimate – consistent and biased . Maximum likelihood estimation. Applications to binomi al , Poisson and normal populations. Confidence interval . Interval estimation for parameters of normal population.

Confidence intervals for mean and standard deviation of a normal population. Approximate confidence limits for the parameter of a binomial population. **(7)**

Statistical hypothesis: Simple and composite hypotheses . Best critical region of a test . Neyman – Pearson theorem (Statement only) and its application to normal population. Likelihood ratio testing and its application to normal population.

Tests of hypothesis - Test on mean and standard deviation of normal population. Comparison of means and standard deviations of two normal populations. **(7)**

Reference Books (for Groups D & E)

1. A.P.Baisnab & M.Jas: Elements of Probability and Statisti cs
2. A.Gupta: Mathematical Probability and Statistics
A. Banerjee , S.K. De & S. Sen: Mathematical Probability
3. S.K.De & S.Sen: Mathematical Statistics
4. H. Cramer: The Elements of probability theory and some of its Applications
5. H. Cramer: Mathematical Method of Statistics
6. W.Fellar: An Introduction to Probability Theory and its Applications
7. S.Goldberg: Probability (an Introduction)
8. Goon , Gupta & Dasgupta: Fundamental of Statistics (Vol – 1 & 2)

Paper-VIII

Full Marks –100

Group- A

Numerical Analysis (Marks - 30)

(Theoretical)

Errors in Numerical Computation: Exact and approximate numbers. Round off error. Inherent and Truncation error. Significant figures. Absolute, relative and percentage errors. **(2)**

Operators: Δ , ∇, E, μ, δ, (definitions and relations among them). **(1)**

Interpolation: Polynomial interpolation, Weierstrass' approximation theorem (only statement). Finite difference table. Propagation of errors in a difference table. Equispaced arguments. Newton's forward and backward, Stirling and Bessel interpolation formulae. Unequally spaced interpolating points. Lagrange's formula. Divided difference. Newton's divided difference interpolation formula. Inverse interpolation. Use o f Lagrange's interpolation formula and Newton's divided difference formula for inverse interpolation. Hermite interpolation formula (only the basic concepts). Errors in different interpolation formulae, convergence. **(13)**

Numerical Differentiation: Numerical Differentiation based on Newton's forward, backward and Lagrange's formulae. **(2)**

Numerical Integration: Integration of Newton's interpolation formula. Newton -Cote's formula. Trapezoidal and Simpson's 1/3 rd formulae. Their compos ite forms. Weddle's rule. Error formulae in all cases in terms of ordinates. Degree of precision of a quadrature formula. **(4)**

Solutions of non-linear equations: Method of tabulation, bisection, Regula -Falsi method. Fixed point iteration. Newton -Raphson method. Geometrical significance and convergence. Graffe's root squaring method for polynomial equations for real roots. **(5)**

System of linear algebraic equations: Gauss elimination method, Gauss -Jacobi, Gauss-Seidel iterative method. Gauss -Jordan matrix inversion method. **(3)**

Eigen-value problems: Power method for numerically extreme eigen -values. **(1)**

Reference Books

1. Introduction to Numerical Analysis: D.C.Sanyal and K.Das
2. Numerical Analysis: J. Scarborough.
3. Introduction to numerical analysis: F .B.Hilderbrand (TMH Edition).
4. Numerical Methods for Scientific and Engineering Computation: M.K.Jain, S.R.K.Iyengar, R.K.Jain.
5. Introduction to Numerical Analysis: Amritava Gupta and Subhas Ch.Bose.
6. Introductory Methods of Numerical Analysis: S.S.Sastry.
7. Numerical Analysis and Computational Procedures: S.A.Mollah
8. Numerical Methods: E.Balagurusamy (TMH Publishing Co.)

Group- B
Fundamentals of Computer Science and Computer Programming (Marks – 20)

Computer fundamentals: Idea of Boolean algebra (definitions and examples). Brief historical development. Computer generation. Basic structure and elementary ideas of computer system, operating systems, hardware and software. **(2)**

Positional number systems: binary, octal, decimal, hexadecimal systems. Binary arithmetic. **(2)**

Data storage: BIT, BYTE, WORD. Coding of data-ASCII, EBCDIC, etc. **(1)**

Algorithms and Flow chart: Important features, Ideas about complexities of algorithm. Application in simple problems. **(3)**

Programming Languages: General concepts, Machine language, Assembly language, High level language, Compiler and Interpreter. Object and Source Program. **(2)**

Introduction to ANSI C:

Historical development of C language. Structure of a C program. Various steps involved from writing to execution of C Program.

Character set in ANSI C. Key words: if, while, do, for, int, char, float etc.

Data type: character, integer, floating point, etc.. Variables, operators.

Basic I/O statement.

C operators: arithmetic, assignment, relational, logical, increment, and conditional.

Control instruction: if…else, for, do…while, switch, continue, etc..

Function: Definition and use of a function, library function and user defined function.

Array: One dimensional and two dimensional.

Running simple C Programs. **(10)**

Application to simple problems: Evaluation of functional values, solution of quadratic equations with real coefficients, approximate sum of convergent infinite series, sorting of real numbers, addition and multiplication of two matrices. Finding the real root of an equation by method of bisection, iteration and Newton-Raphson method. Numerical Integration. Numerical solution of ordinary differential equations. **(4)**

Reference Books

1. Introduction to Computer Fundamentals and Programming: Sen, Sarkar, Sarkar.
2. Let us C: Yashvant Kanetkar (BPB Publications).
3. Programming in C: V.Krishnamoorthy and K.R.Radhakrishnan (Tata McGr aw Hill).
4. C by example: Noel Kalicharan (Cambridge Low price edition).
5. Programming in ANSI C: E.Balagurusamy (Tata McGraw Hill).

Group - C
Practical - Computer Programming & Numerical Analysis (Marks - 50)

Computer Programming: (Marks- 20)

The following problems are to be done using C compiler:

General Computation: Area of a triangle, Evaluation of functional values, solution of quadratic equations with real coefficients, sum of N numbers, approximate sum of convergent infinite series, sorting of real numbers, addition and multiplication of two matrices, inverse of a matrix.

Numerical Computation: Numerical integration by Trapezoidal rule and Simpson's one third rule. Numerical solution of non-linear equation by Newton-Raphson method. Gauss elimination method for solution of a system of linear equation. Numerical solu tion of Ordinary Differential Equation by Runge-Kutta (4^{th} order) method.

Numerical Analysis: (Marks- 15)

Newton's forward and backward, Stirling and Bessel, Lagrange's and divided difference interpolation formulae. Inverse interpolation.

Numerical Differentiation based on Newton's forward and backward formulae.

Numerical Integration: Trapezoidal, Simpson's 1/3 rd and Weddle's rule.

Solution of non-linear equations: Tabulation, bisection, Regula-Falsi, Fixed-point iteration and Newton-Raphson method.

System of linear algebraic equations: Gauss elimination method, Gauss-Seidel iterative method. Gauss-Jordan matrix inversion method.

Eigen-value problems: Power method for numerically extreme eigen-values (3^{rd} order matrix).

For Practical: Three problems (Two from Computer Programming [20 Marks] & one from Numerical analysis [15 Marks]). Practical Note Book – 05 marks, Viva – voce – 10 marks. Time allotted for examination = 04 hours.

Reference Books

1. Introduction to Computer Fundamentals and Programming: Sen, S arkar, Sarkar.
2. Let us C: Yashvant Kanetkar (BPB Publications).
3. Programming in C: V.Krishnamoorthy and K.R.Radhakrishnan (Tata McGraw Hill).
4. C by example: Noel Kalicharan (Cambridge Low price edition).
5. Programming in ANSI C: E.Balagurusamy (Tata McGraw Hill).
6. Introduction to Numerical Analysis: D.C.Sanyal and K.Das
7. Numerical Analysis: J. Scarborough.
8. Introduction to numerical analysis: F.B.Hilderbrand (TMH Edition).
9. Numerical Methods for Scientific and Engineering Computation: M.K.Jain, S.R.K.Iyengar, R.K.Jain.
10. Introduction to Numerical Analysis: Amritava Gupta and Subhas Ch.Bose.
11. Numerical Analysis and Computational Procedures: S.A.Mollah
12. Numerical Methods: E.Balagurusamy (TMH Publishing Co.)

University of Kalyani

Revised Syllabus for B.Sc. (GENERAL) Course in

MATHEMATICS

(w.e.f. the session 2009-2010)

According to the New Examination Pattern
Part – I, Part – II & Part – III

University of Kalyani

Revised Syllabus of Mathematics
(w.e.f. the session 2009-2010)

Contents

GENERAL COURSE

Mathematics (General)

Paper wise subject and marks distribution

Part – I

Paper – I (Marks – 100)

Group	Marks	Subject
A	50	Differential Calculus
B	30	Integral Calculus
C	20	Differential Equations

Part – II

Marks – 200

Paper – II (Marks – 100)

Group	Marks	Subject
A	20	Classical Algebra
A	30	Abstract & Linear Algebra
B	40	Analytical Geometry
B	10	Vector Algebra

Paper – III (Marks – 100)

Group	Marks	Subject
A	40	Linear Programming
A	10	Game Theory
B	30	Probability Theory
B	20	Mathematical Statistics

Part – III

Marks – 100

Paper – IV (Marks – 100)

Group	Marks	Subject
A	25	Numerical Methods
A	15	Fundamentals of Computer Science & Computer Programming (in Fortran)
B	20	Statics
B	40	Dynamics of a Particle

PART – I

Paper - I

Full Marks - 100

Group -A

Differential Calculus (Marks - 50)

Real sequences ,bounds, finite and infinite and limits. Statements of algebra of limits and monotone sequences and their limits . Squeeze Theorem : If $U_n \leq x_n \leq V_n$ and limit $U_n = L = \lim V_n$, then $\lim x_n = L$. If $\lim (U_{n+1}/ U_n) = L < 1$,then $\lim U_n = 0$. Limits of $n^{1/n}$, $x^{1/n}$, $(x^n)/n!$, $(1+^{1/n})^n$ (definition of e) **(4)**

Series of real numbers , Convergence of series and of their linear sums. The geometric series. Series of positive terms : introduction, Comparison test, D'Alembert's ratio test. The series n^{-p} .Leibnitz theorem on alternating series . Notion of absolute convergence and its consequences (statement only). **(7)**

Real–valued functions on intervals . Limit, continuity ,algebra on limits and of continuous functions (statements only).Continuity of x^n (n = positive integer) sin x, cos x and of rational and other trigonometric functions. Continuity of composite functions and of e^x, log x, a^x and properties of continuous functions on closed intervals (statements only)Limits of monotone functions (statements only). Limit of $(^{\sin x}/x)$ as $x \to 0$. **(10)**

Derivative, differential, chain rule, Leibnitz theorem on successive derivatives. Meaning of the sign of a derivative at a points, geometrical interpretation .Rolle's theorem, .Mean value theorems of Lagrange and Cauchy (de nominator function having non-zero derivative) ,L.Hospital's rules (statement only)and related problems. **(8)**

Taylor's theorem with Lagrange's and Cauchy's from of remainder. Maclaurin's series expansion of cos x, sin x, e^x,$(1+x)^m$ and log (1+x). Local maxima and minima. **(5)**

Functions of several variables. Notions of partial derivatives of implicit functions, chain rules, total differentials and derivatives of implicit functions. Simple counter example to $f_{xy} = f_{yx}$, Schwarz's theorem on the equality (statement only). Euler's theorem on homogeneous functions of two variables (problems upto three variables).Lagrange's method of multipliers for extreme (working rules only). **(7)**

Applications on plane curves. Tangent, norm al, sub tangent and subnormal. Angle between radius vector and tangent. Derivative of arc length .Pedal equation to a curve (from

castesan and polar forms). Curvature for $y = f(x)$, $r = f(\theta)$, $p = f(r)$,$p = f(\Psi)$.Asymptotes for $f(x,y) = 0$, working rules only upto two equal roots of $\theta_n(m) = 0$. Envelopes. **(7)**

Reference Books :

1. S.M.Kikolsky :A Course of Mathematical Analysis , Vol. 1
2. Maiti & Ghosh : Differential calculus.
3. Das & Mukherjee : Differential calculus.
4. Shanti Narayan : Differential calculus.

Group -B

Integral Calculus (Marks - 30)

Indefinite integral ; trigonometry substitution and partial fraction methods. **(4)**

Reimann's definition of definite integral as the limit of a sum , elementary properties . Integrability of continuous functions (statement only) , geometrical interpretation .The fundamental theorem of integral calculus . **(5)**

Reduction formulae for $\int_0^{\pi/2} \sin^n x\,dx$, $\int_0^{\pi/2} \cos^n x\,dx$, $\int_0^{\pi/2} \sin^m x \cos^n x\,dx$, $\int_0^{\pi/2} \tan^n x\,dx$ **(3)**

Notions of improper integrals .Beta and Gamma functions(convergence assumed) their mutual relation(without proof)and elementary properties . Working rules for double and triple integrals. **(6)**

Evaluation of simple plane areas, arc lengths ,volumes and surface of solids of revolution . **(4)**

Reference Books:

1. Das & Mukherjee : Intergal Calculus .
2. Maity & bagchi : Intergal Calculus.
3. Shanti Narayan : Intergal Calculus.
4. D.K.Chatterjee : Intergal Calculus and Differential Equations.

Group- C

Differential Equations (Marks - 20)

Genesis of ordinary differential equations .First order linear and nonli near equations . Exact equations , use of integrating factors. First order and higher degree equations . Clairaut's form, singular solution. Second and higher order linear equations with constant coefficients. Euler's homogenous equations. Simultaneous lin ear equation of first and second order . Simple applications to geometry and mechanics. **(15)**

Reference Books:

1. Das & Mukherjee : Intergal Calculus.
2. J.G.Chakraborty & P.R.Ghosh : Differential Equations.
3. D.K.Chatterjee : Intergal Calculus and Differential Equations.

PART – II

Paper II **Full Marks - 100**

Group- A

Classical , Abstract & Linear Algebra (Marks – 50)

Classical Algebra (20) : Algebra of complex numbers. Argand plane. Modulus and argument of complex numbers . Principal value of argument . Complex conjugate. De Morvie's theorem (for integers and rational index) and its applications. Exponential ,sine, cosine , logarithmic , inverse circular and hyperbolic functions of a complex variable. **(4)**

Polynomials . Division algorithm (no proof). Remainder theorem. Cases when surd and imaginary roots occur in conjugate pairs in an equation. Fundamental theorem of classical algebra(without proof) and its consequences .Multiple roots. Statement and applications of Descartes' rule of signs. **(6)**

Relations between roots and coefficients. Symmetric functions of roots. Transformations of polynomial equations. Cardan's solution of the cubic equation. **(4)**

Determinants and their properties , multiplication of determinants. Minors and cofactors . Adjugate of a determinant . Solutions of systems of linear equations by carmer's rule. **(4)**

Abstract and Linear Algebra (30) : Sets , Finite and infinite sets .Subsets and power sets of a set. Equality . Union, intersection, compliment , difference and symmetri c difference of sets. Basic laws for union and intersection of sets. Demorgan's laws. Ordered pair. Cartesian product of two sets . **(3)**

Binary relation in a set. Equivalence relation, partition, injective, surjective and bijective mapping, identity mapping, inverse of a mapping. Composition of mappings. **(3)**

Groups. Definitions of semi-groups. Abelian and non- abelian groups, examples. In any group $a^m.a^n = a^{m+n}$ and $(a^m)^n = a^{m\,n}$ where m,n are integers. Uniqueness of identity and inverse of an element in a group. Solutions of ax = b and ya = b in a group, calcellation laws. Subgroup and their characterization. Invariance of identity and inverse of an element in subgroups. Finite groups, composition table , order of a group, order of an clement in a group. Notion of cyclic groups. **(5)**

Definition and example of rings, zero divisions, integral domains and fields, vector space over a field.

Vector space of ordered n-tuples of real and complex numbers. Linear dependence of vector and independence. Basis of a vector space ,subspace ,dimension . **(3)**

Matrices . Equality of matrices, transpose, conjugate and conjugate transpose of a matrix. Square, null, diagonal, scalar, identity, symmetric, skew -symmetric, Hermitian and skew-Hermitian matrices. **(3)**

Addition and multiplications of matrices : commutative, associative, distributive laws. Adjugate and inverse of a matrix. Singular and non -singular matrices. Orthogonal matrices. **(3)**

Elementary row operations on a matrix. Row space and column space of a matrix. Equality of row rank and column rank (no proof) . Rank of a matrix, solutions of systems of linear homogeneous and non-homogeneous equations in three unknowns by matrix method . **(4)**

Characteristic equation of a matrix , eigen values and eigen vectors (definitions and examples) . Caley- Hamilton's theorem (statement and verification only). **(1)**

Reference Books:

1. S.K.Mapa : Higher Algebra (Classical)
2. S.K.Mapa : Higher Algebra (Abstract and linear)
3. B.K. Lahiri and K.C.Roy :Higher Algebra
4. K.C.Roy and A.G.Das : Abstract and Linear Algebra
5. Shanti Narayan : A Text books of Matrices
6. F.Ayres : Theory and Problems of Matrices
7. G.Hadley : Linear Algebra
8. J.G.Chakraborty and P.R. Ghosh : Higher Algebra.

Group B

Analytical Geometry (Marks - 40)

Two-dimensional Geometry : Transformation of rectangular axes. Invariants associated with the coefficients of general second degree equation. Pair of straight lines. Reduction of general second degree equation to canonical forms, classifications. Coaxial system of circles, limiting points. Tangents and normals to conics. Polar equations of straight lines ,circles and conics (with a focus as pole) . **(16)**

Three - dimensional geometry : Rectangular Cartesian coordinates in space. Direction cosine and direction ratios of a directed line. Projection angle between two lines. Equations to a plane in intercept ,normal and general form. Angle between two planes. Necessary and sufficient condition for co planarity of four points. Plane through the line of inters ections of two planes. Perpendicular distance of a point from a plane. Volume of a tetrahedron. Equations to a straight line in different forms . Condition of coplanarity of two lines. Perpendicular distance of a point from a line. The shortest distance be tween two lines. Equations to a pair of skew lines. **(15)**

Equation of a sphere, Section of a sphere by a plane. Tangent planes to a sphere . Equation of a cone. Condition for a cone to have three mutually perpendicu lar generators. Right circular cone. Cylinder , Right circular cylinder. **(9)**

Vector Algebra (Marks - 10)

Vector Algebra : Position vectors in the plane and the space. Addition of vectors, scalar multiplication of a vector . Rectangular resolution of the vector. Scalar & vector products. Their geometrical interpretations, scalar and vector triple products. Angle between two vectors. Vectors equations of straight lines and planes. Application of vectors to geometry and mechanics . **(10)**

Reference Books:

1. M.C.Chaki - A text book of Analytic Geometry.
2. S.B. Sengupta - Coordinate Geometry and vector Analysis
3. J.G.Chakraborty and P.G. Ghosh - Analytical Geometry and vector Analysis
4. S.I.Loney - The Elements of Coordinate Geometry
5. Shanti Narayan - Vector Algebra

Paper – III

Full Marks - 100

Group – A (Marks- 50)

Linear Programming (Marks - 40)

Linear Programming : Formulation of linear programming problems (LPP). Slack and surplus variables. L.P.P. in matrix from . Convex set. Hyper plane. Extreme points. Convex polyhedron. Basic solution (B.S.) and basic feasible solution (B.F.S.). Degenerate and non- degenerate B.F.S.

The set of all feasible solutions of an L.P.P.is a convex set. The objective function of an L.P.P. assumes its optimal value at an extreme point of the convex set of F.S. A.B.F.S. of an L.P.P. corresponds to an extreme point of the convex set of feasible solutions.

Fundamental theorem of an L.P.P. (statement only) .Reduction of a F.S. to a B.F. S. standard form of an L.P.P. Solution by graphical method (for two variables). Simplex method, Charnes' big – M method . Two phase method .

Concept of duality. Duality theory. The dual of the duals is primal. Relation between the objective value of the duel and the primal problems . Dual problems with at most one unrestricted variable, one constraint of equality.

Transportation and Assignment problems and their optimal solutions.

Game Theory (Marks - 10)

Game Theory: Introduction, Two person zero- sum games. Minimax and Maximin principles. Minimax and saddle poin t theorems . Mixed strategies games with saddle points.

Reference Book :

1. G. Hadley : Linear Programming.
2. S.Gass : Linear Programming.
3. J.G.Chakraborty and P.R.Ghosh : Linear Programming and Game Theory .
4. P.M. Karak : Linear Programming & Game Theory.
5. H.A.Taha : Operations Research .
6. S.D.Sharma : Operations Research .
7. Kantiswarup , Gupta & Manmohan : Operations Research .

Group – B (Marks- 50)

Probability Theory (Marks – 30)

Events , probability of an event , classical and axiomatic definition of pro bability. Addition and multiplication theory of probability . Disjo int events . Independent events. Conditional probability . Bayes theorem . Random variables . Distribution function of random variable and its properties . Independence of random variables . Mathematical expectation. Expectation of two – dimensional random variables . Relation between expectation and moments . Principle of least squares. Variance . Binomial , Poisson and normal distributions . **(30)**

Mathematical Statistics (Marks – 20)

Random sample . Population and samples . C ollection , tabulation and graphical representation . Frequency distribution . Pie diagram . Frequency pol ygon , frequency curve , measure of central tendency . A.M., Median , Mode. Measures of dispersion . Moments and measures of skew ness and kurtosis . Scatter diagram . Lines of regressions , regression coefficients . Correlation coefficients . **(20)**

Reference Books:

1.	A.P. Baisnab & M. Jas	: Elements of Probability and Statistics
2.	A.Gupta	: Mathematical Probability and Statistics
3.	A.Banerjee , S.K. De & S. Sen	: Mathematical Probability
4.	S.K. De & S. Sen	: Mathematical Statistics
5.	H. Cramer	: Mathematical Method of Statistics
6.	S. Goldberg	: Probability (an Introduction)

PART – III

Paper-IV **Full Marks – 100**

Group- A (Marks - 40)

Numerical Methods (Marks - 25)

1. Approximate numbers, significant figures, computat ional errors, round-off errors, and truncation error. Error-Absolute, relative and percentage. **(2)**

2. Operators: Δ, ∇, E, μ, δ, (definitions and relations among them). **(1)**

3. Interpolation: Polynomial interpolation, remainder, difference table. Equi spaced arguments. Newton's forward and backward, Stirling and Bessel interpolation formulae. Unequally spaced interpolating points. Lagrange's formula. Divided difference. Newton's divided difference interpolation formula. Inverse interpolation. Use of Lagrange's interpolation formula for inverse interpolation. **(9)**

4. Numerical Differentiation: Numerical Differentiation based on Newton's forward, backward formulae. **(2)**
5. Numerical Integration: Trapezoidal and Simpson's 1/3 rd formulae. Their composite forms. Problems on numerical integration. **(2)**

6. Solution of non-linear equations: Method of tabulation, bisection, R egula-Falsi method. Fixed point iteration. Newton-Raphson method. Geometrical significance and convergence. **(4)**

7. System of linear algebraic equations: Gauss elimination method with pivoting and with condition of convergence (statement only). **(1)**

Reference Books:

1. A text book of Numerical Analysis: D.C.Sa nyal and K.Das.
2. Introductory Methods of Numerical Analysis: S.S.Sastry.
3. Numerical Analysis and Computational Procedures: S.A.Mollah.
4. Numerical Methods for Scientific and Engineering Computation: M.K.Jain, S.R.K.Iyengar, R.K.Jain.
5. Introduction to Numerical Analysis: Amritava Gupta and Subhas Ch.Bose.

Fundamentals of Computer Science and Computer Programming (Marks - 15)

Computer fundamentals: Brief historical development. Computer generation. Basic structure and elementary ideas of computer system, operati ng systems, hardware and software. **(2)**

Positional number systems: binary, octal, decimal, hexadecimal systems. Binary arithmetic. **(2)**

Programming Languages: General concepts, Machine language, Assembly language, High level language, Compiler and Inter preter. Object and Source Program. **(1)**

Algorithms and Flow chart: Important features. Application to simple problems. **(1)**

Programming with FORTRAN 77/90:
Introduction, Constants and variables -their classifications. Fortran expressions. I/O statements-formatted and unformatted. Control Statements - Unconditional GO TO, Computed GO TO, Logical IF, IF -THEN-ELSE. Arrays-Dimension statement. Repetitive computations-Do loops. Sub programs: Function sub program and Subroutine sub program.

Application to simple problems: Evaluation of functional values, solution of quadratic equations with real coefficients, approximate sum of convergent infinite series, sorting of real numbers. **(10)**

Reference Books :

1. FORTRAN 77 and numerical methods: C. Xavier (New Age International Ltd.).
2. Introduction to Computer Fundamentals and Programming: Sen, Sarkar, Sarkar.
3. Programming with FORTRAN 77- A structured approach: R.S.Dhaliwal, S.K.Agarwal, S.K.Gupta (Wiley Eastern Limited/New Age International Ltd.).
4. Programming and computing with FORTRAN 77/90: P.S.Grover (Allied Publishers).
5. Programming in BASIC: E. Balaguruswamy
6. Programming with BASIC: B.S.Gottfried
7. Programming with BASIC: V.Rajaraman

Group – B (Marks – 60)

Statics (Marks – 20)

*[Preliminary concepts : Parallelogram , triangle and polygon law s of forces. Like and unlike parallel forces . Moment and couple .]

Coplanar forces and their reduction . G eneral conditions of equilibrium of a system of coplanar forces . **(4)**

Friction . Laws of friction . Equilibrium of a particle on a rough inclined plane . Problems of friction – sliding , tumbling and rolling . Equilibrium of a flexible inelastic string under gravity . **(8)**

Centre of gravity and its determination for simple bodies , e.g. uniform rod , plane lamina , solid and hollow right circular cylinder and cone , sphere , hemisphere , thin uniform circular arc , sector of a circle . **(8)**

* No broad question is to be set from this part .

Reference Books:

1. B.C.Das & B.N. Mukherjee : Statics
2. K.Basu & M.C.Ghosh : Statics
3. S.L.Loney. : Statics

Dynamics of a Particle (Marks – 40)

Fundamental notions and principles . Laws of motion . Motion of a particle in a straight line with uniform and variable acceleration . Simple harmonic motion (S.H.M.) . Composition of two S.H.Ms of same period or slightly different periods. Elastic strings . Damped oscillation . Forced oscillation . Damped forced oscillation . Motion in a resisting medium . Projectile in a resisting medium . **(12)**

Work power , Energy . Work done in stretching an elastic string . Conservative force. Conservation of energy . **(4)**

Impulse and impulsive forces . Conservation of linear momentum . **(4)**

Motion in a plane . Velocity and acceleration in Cartesian and polar coordinates . Angular velocity and angular acceleration . Circular motion . Tangential and normal accelerations . **(8)**

Central forces and central orbits . Areal velocity . Characteristics of central orbits . Orbit under inverse square law . Planetary motion . Kepler's laws. Time of description of an arc of a central orbit . **(14)**

Reference Books:

1. J.G.Chakraborty & P.R.Ghosh : Analytical Dynamics
2. N. Dutta & R.N. Jana : Dynamics of a Particle
3. S.L.Loney : Dynamics of a Particle
4. B.C.Das & B.N.Mukherjee : Analytical Dynamics