

Paper II
MATHEMATICS
(Subjective)

MATHEMATICS.

PAPER- II

Time- 3 Hours

Full Marks- 100

This paper will be divided into two groups. Group A shall contain questions from General papers of M.A./ M.Sc. carrying 50 marks and group B shall contain questions from special papers carrying 50 marks. The questions shall be short answer type, each carrying 5 marks. Group A shall comprise 14 topics and one question shall be set from each topic. The candidate shall be required to answer 10 questions from Group A. Group B shall comprise 5 topics. Five questions shall be set from each of these five topics. The candidate shall be required to choose any two topics and answer 10 questions. The questions are to be so selected that they can be easily answered within the allotted time.

Group –A

1. **Real Analysis:** Differentiability of functions from R_n to R_m , partial derivatives, directional derivatives, continuously differentiable functions, Mean value theorem for functions of several variables, partial derivatives and differentiability of higher, Implicit function theorem.
2. **Complex Analysis:** Algebra of complex nos Analytic functions, Cauchy's theorem and Integral for, Taylor's and Laurent's series, Residues, Contour Integration.
3. **Linear Algebra:** Vector spaces, subspaces, quotient spaces, Linear dependence and independence, bases, dimension. The algebra of linear transformations, Kernel, range, isomorphism, Matrix representation of a linear transformation, change of bases, linear functionals, dual space, eigen values and eigen vectors, Cayley – Hamilton theorem.
4. **Abstract Algebra:** Groups, subgroups, Normal subgroups, Quotient groups, Homomorphisms, Cyclic groups, Permutation groups, Cayley's theorem, Rings, Ideals, Integral Domains, Fields, Polynomial Rings.


5. **Differential Equations:** First order ODE, singular solutions Initial value problems of first order ODE, Homogeneous and non-homogeneous linear ODE, Variation of parameters, Lagrange's and Charpit's methods of solving first order PDE. PDE's of higher order with constant co-efficients.
6. **Differential Geometry:** Space curves, their curvature and torsion, Serret-Frenet formula, Fundamental theorem of space curves curves of surfaces, First and second Fundamental form, Gaussian curvature, Principal directions and principal curvatures.
7. **Topology:** Elements of topological space, continuity, convergence, Homeomorphism, compactness, connectedness, separation axioms, First and second countability, product spaces, Quotient spaces.
8. **Functional Analysis:** Banach space, Hahn-Banach theorem, open mapping and closed graph theorems, Principle of uniform boundedness, Boundedness and continuity of linear transformations, Dual space, Hilbert space, Projection, Orthonormal bases, self-adjoint and normal operators.
9. **Mechanics:** Generalized co-ordinates, Lagrange's equation, Hamilton's canonical equation, variational principles, Hamilton's principle and principle of least action, Euler's dynamical equation of motion of rigid body.
10. **Fluid Dynamics:** Equation of continuity in fluid motion, Euler's equations of motion for perfect fluids. Two dimensional motion, complex potential, Motion of sphere in perfect liquid, vorticity.
11. **Integral Transforms:** Laplace Transform, Transform of elementary functions, Transform of derivatives, Inverse Transform, Convolution theorem, Fourier transform.

12. **Discrete mathematics:** Partially ordered sets, Lattices, Complete Lattices, Distributive lattices, Complements, Boolean Algebra, Boolean expressions, Application to switching circuits.
13. **Tensor Calculus:** Vector spaces and their dual, Bases and dual bases, Transformation of bases, covariant and contravariant vectors, Tensor of the type (r,s) , Tensor product of vectors, Fundamental algebraic operations of tensors, Inner product of vectors, contraction, Fundamental tensors, Christoffel symbols and their elementary properties, covariant differentiation of covariant vector, contravariant vector and tensor, Transformation formula of Christoffel symbols.
14. **Fuzzy Set Theory:** Fuzzy sets versus Crisp sets. Basic definitions, types properties and representation of Fuzzy sets. Convex Fuzzy sets. Basic operation on Fuzzy set. \mathcal{L} cuts. Decompositions theorem. Complements f-norm and f-conorms. Extension principles and simple applications of Fuzzy sets.

Group –B

1. **General Topology:-** Nets and filters, T_3 , T_4 , and completely regular space, Urysohn's lemma, Metrization theorem, Extension theorem, Stone- cech compactification, Local finiteness, Nagata- Smirnov metrization theorem, Paracompact spaces, Weierstrass approximation theorem, The stone- Weierstrass theorem, Extended Stone- Weierstrass theorem, Uniform space.
2. **Functional Analysis:-** Construction of a topology for a linear space, convex sets, Minkowski functional, seminorms and topology defined by a family of semi norms. The conjugate space of a Hilbert space, Adjoint and self-adjoint operators, normal operators, completely continuous operators, Projuction operators, Banach algebra.

- 3. Differential Geometry:-** Gauss's formulae for r_{11} , r_{12} , r_{22} , Gauss characteristic equation, Mainardi- Codazzi relation, spherical representation of a surface, Minimal surface and its properties, Nature of asymptotic lines, null lines and lines of curvature on a minimal surface, Ruled surface and its fundamental magnitudes, Line of striction, Nature of tangent plane at a point, Bonnet's theorem, asymptotic lines on a ruled surface.
- 4. Modern Algebra:-** Group complexes and subgroups, Iso- orphism theorems, Product theorem, decomposition of a group relative to two such groups, Frobenius theorem and simple properties, composition series and J-H theorem, Ideals, quotient rings, Isomorphism theorems. Principal Ideal domain. Unique Factorization domain, Field extensions, Galois theory.
- 5. Theory of Relativity:-** Classical theory of Relativity, Lorentz Transformations Notion of mass, momentum, energy and their transformation formulae, Equivalence of mass and energy, Minkowski space, Phenomenon of aberration, Drag coefficient and Doppler effect, General theory of Relativity, Energy momentum Tensor, Field equations, Motion of a free particle in a static field, Electromagnetic theory, Behaviour of Maxwell's equation under Lorentz Transformation, Einstein's law in gravitational field of an isolated particle, Schwarzschild solutions of Einstein's equation, Planetary orbit, Red shift, Deflection of light.


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