

Paper- IV: Differential Geometry and Tensors

- Unit 1: Space curves, Tangent, Contact of curve and surface, Osculating plane.
- Unit 2: Principal normal and Binormal, Curvature, Torsion, Serret-Frenet's formulae, Osculating circle and Osculating sphere.
- Unit 3: Existence and Uniqueness theorems, Bertrand curves, Involute, Evolutes, Conoids, Inflexional tangents, Singular points, Indicatrix.
- Unit 4: Envelope, Edge of regression, Ruled surface, Developable surface, Tangent plane to a ruled surface.
- Unit 5: Necessary and sufficient condition that a surface $\zeta = f(\xi, \eta)$ should represent a developable surface, Metric of a surface.
- Unit 6: First, second and third fundamental forms, Fundamental magnitudes of some important surfaces, Orthogonal trajectories, Normal curvature.
- Unit 7: Meunier's theorem, Principal directions and Principal curvatures, First curvature, Mean curvature, Gaussian curvature, Umbilics. Radius of curvature of any normal section at an umbilic on $z = f(x, y)$, Radius of curvature of a given section through any point on $z = f(x, y)$, Lines of curvature.
- Unit 8: Principal radii, Relation between fundamental forms, Asymptotic lines, Differential equation of an asymptotic line, Curvature and Torsion of an asymptotic line.
- Unit 9: Geodesics, Differential equation of a geodesic, Single differential equation of a geodesic, Geodesic on a surface of revolution, Geodesic Curvature and Torsion, Gauss-Bonnet Theorem.
- Unit 10: Gauss's formulae, Gauss's characteristic equation, Weingarten equations, Mainardi-Codazzi equations. Fundamental existence theorem for surfaces, Parallel surfaces, Gaussian and mean curvature for a parallel surface, Bonnet's theorem on parallel surfaces.
- Unit 11: Tensor Analysis. Kronecker delta, Contravariant and Covariant tensors, Symmetric tensors, Quotient law of tensors, Relative tensor.
- Unit 12: Riemannian space. Metric tensor, Indicator, Permutation symbols and Permutation tensors, Christoffel symbols and their properties.
- Unit 13: Covariant differentiation of tensors, Ricci's theorem, Intrinsic derivative.
- Unit 14: Geodesics, Differential equation of geodesic, Geodesic coordinates, Field of parallel vectors.
- Unit 15: Riemann-Christoffel tensor and its properties, Covariant curvature tensor, Einstein space, Bianchi's identity, Einstein tensor, Flat space, Isotropic point, Schur's theorem.

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