

M.Sc. (Mathematics) 2nd Semester

TENSORS AND DIFFERENTIAL GEOMETRY

Paper—MATH-562

Time Allowed—Three Hours] [Maximum Marks—100

Note :— Attempt TWO questions from each unit. All questions carry equal marks.

UNIT—I

1. Define Cartesian Tensor of order 4. Also define contraction and state and prove contraction theorem.
2. Show that δ_{ij} is a tensor of order two.
3. Show that the transformation of a mixed tensor possess the transitive property.
4. Show that Christoffel symbols do not behave like tensor.

UNIT—II

5. Define principal normal and binormal. Find the equations of the principal normal and binormal.
6. State and prove Serret-Frenet formulae.

7. Find the curvature and torsion of the curve

$$x = a(u - \sin u), y = a(1 - \cos u), z = bu.$$

8. Find the centre and radius of spherical curvature.

UNIT—III

9. Investigate the spherical indicatrices of the circular helix $x = a \cos \theta, y = a \sin \theta, z = c\theta, c \neq 0$.
10. Find the envelop of the plane $lx + my + nz = 0$ where $al^2 + bm^2 + cn^2 = 0$.
11. Find the condition that the surface given by $z = f(x, y)$ may be developable.

12. Calculate the fundamental magnitudes to the surface $2z = ax^2 + 2hxy + by^2$ taking x, y as parameter.

UNIT—IV

13. Define conjugate direction. Find an analytic expression for two directions to be conjugate.
14. Show that the necessary and sufficient condition that the parametric curves be lines of curvature are $F = 0, M = 0$.
15. Find the asymptotic lines on the surface $z = x \sin y$.
16. State and prove theorem of Beltrami and Enneper.

UNIT—V

17. Show that the curves $u + v = \text{constant}$ are geodesics on the surface with metric

$$(1 + u^2) du^2 - 2uv du dv + (1 + v^2) dv^2.$$

18. Show that geodesic curvature vector of any curve is orthogonal to the curve.

19. State and prove Gauss – Bonnet theorem.

20. Find the condition that surface s may be mapped conformally onto surface s' .

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