

STELLA MARIS COLLEGE (AUTONOMOUS) CHENNAI 600 086
(For candidates admitted from the academic year 2011-12 & thereafter)

SUBJECT CODE : 11MT/PE/TS24

M. Sc. DEGREE EXAMINATION, APRIL 2013
BRANCH I – MATHEMATICS
SECOND SEMESTER

COURSE : ELECTIVE
PAPER : TENSOR ANALYSIS AND SPECIAL THEORY OF RELATIVITY
TIME : 3 HOURS MAX. MARKS : 100

SECTION –A

Answer all the questions: 5×2=10

1. Define a tensor of rank greater than two.
2. Define covariant derivative.
3. Define stress.
4. State Einstein's principle of relativity.
5. Define proper time interval.

SECTION –B

Answer any five questions: 5×6=30

6. Show that $\frac{\partial A_p}{\partial x^q}$ is not a tensor even though A_p is a covariant tensor of rank one.
7. If $\varphi = a_{jk}A^jA^k$ show that we can always write $\varphi = b_{jk}A^jA^k$ where b_{jk} is symmetric.
8. Express the divergence of a vector A^p in terms of its physical components for spherical coordinates.
9. Prove that \sqrt{g} is a relative tensor of weight one.
10. If the covariant force acting on a particle is given by $F_k = \frac{-\partial V}{\partial x^k}$ where $V(x^1, \dots, x^N)$ is the potential energy, show that $\frac{d}{dt} \left[\frac{\partial L}{\partial x^k} \right] - \frac{\partial L}{\partial x^k} = 0$ where $L = T - V$.
11. Describe a Galilean transformation.
12. Explain law of the addition of velocities.

SECTION –C

Answer any three questions:

3×20=60

13. a) Determine the conjugate metric tensor in (a) cylindrical and (b) spherical coordinates.
- b) Show that any inner product of the tensors A_r^p and B_t^{qs} is a tensor of rank three.
14. a) Derive transformation laws for the Christoffel symbols of the first and second kind.
- b) Define Geodesics in Riemannic space and prove that $\frac{d^2x^r}{ds^2} + \left\{ \begin{matrix} r \\ pq \end{matrix} \right\} \frac{dx^p}{ds} \frac{dx^q}{ds} = 0$.
15. a) Define work and energy in tensor form.
- b) Derive the Lagrange's Equation for a force system to be conservative.
16. a) Explain Newtonian Principle.
- b) Define Frame of reference, coordinate transformation and explain force law and its transformation properties.
17. a) Derive Lorentz Transformation equations and obtain its inverse.
- b) Explain Einstein's clock paradox.

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