

M.Sc.(Maths.) Semester - 3 (CBCS) Examination**Oct/Nov-2022 (NEW COURSE)****Sp. Theory of Relativity and Tensor Analysis (Elective (New))****Time: 2:30 Hours****Marks: 70****Instructions:**

1. All questions are compulsory.
2. Figures to the right indicate marks.

- Q.1 (a) Answer the following questions. [04]**
 (1) Derive the formula for time dilation.
- Q.1 (b) Answer any two questions out of three. [10]**
 (1) Prove that the laws of electrodynamics do not obey Galilean mechanics.
 (2) Explain negative results of Michelson–Morley experiments.
 (3) Show that the set of all Special Lorentz Transformations forms a group under composition.
- Q.2 (a) Answer the following questions. [04]**
 (1) Writing the formula of proper time, explain its meaning.
 (2) What do you mean by length contraction?
- Q.2 (b) Answer any two questions out of three. [10]**
 (1) In usual notation derive the total energy (E) of a particle.
 (2) Show that the mass of a moving particle is relative.
 (3) Prove that no physical signal can travel with speed greater than fundamental speed (speed of light).
- Q.3 (a) Answer the following questions. [04]**
 (1) State all the properties of Riemann Curvature Tensor.
 (2) Giving an example, define contravariant vector.
- Q.3 (b) Answer any two questions out of three. [10]**
 (1) Show that the Christoffel symbols are not tensors.
 (2) Prove that metric tensor is symmetric covariant tensor of rank 2.
 (3) Transform $ds^2 = dx^2 + dy^2 + dz^2$ into spherical coordinates using the transformation law.
- Q.4 (a) Answer the following questions. [04]**
 (1) What is Einstein's Summation Convention?
 (2) In usual notation prove that $\Gamma_{ijk} + \Gamma_{jki} = \frac{\partial g_{ik}}{\partial x^j}$.
- Q.4 (b) Answer any two questions out of three. [10]**
 (1) Find the number of algebraically independent components of the covariant Riemann curvature tensor.
 (2) Find all the Christoffel symbols of 2nd kind for the line element $ds^2 = dr^2 + r^2 d\theta^2 + r^2 \sin^2 \theta d\phi^2$.
 (3) Define outer product of tensors and discuss its rank.
- Q.5 (a) Answer the following questions. [04]**
 (1) Decompose mixed tensor of rank three $T_{\sigma}^{\mu\nu}$ in a four dimensional space.
 (2) Prove that the covariant derivative of an invariant is same as its ordinary derivative.
- Q.5 (b) Answer any two questions out of three. [10]**
 (1) Show that the set of covariant vectors forms a vector space.
 (2) Calculate the velocity at which mass of a particle becomes 8-times rest mass.
 (3) Let two events P and Q occur simultaneously in S-frame. Are they simultaneous in S'-frame?
