

M.Sc.(Maths.) Semester - 3 (CBCS) Examination**Oct/Nov-2021 (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) State Einstein's postulates of relativity.
- (2) State special Lorentz transformation connecting frames in relative motions along Y-axis.

Q.1 (b) Answer any two questions out of three. [10]

- (1) Explain negative results of Michelson–Morley experiments.
- (2) Show that the wave equation is invariant under special Lorentz transformation.
- (3) Prove that Newton's equations of motion obey Galilean's relativity.

Q.2 (a) Answer the following questions. [04]

- (1) Show that special Galilean transformation is a special case of special Lorentz transformation.

Q.2 (b) Answer any two questions out of three. [10]

- (1) Prove that relativistic composition of two velocities less than velocity of light is also less than the velocity of light. Justify its meaning.
- (2) Show that the composition of two special Lorentz transformations is again a Lorentz transformation.
- (3) Derive the formula of time dilation.

Q.3 (a) Answer the following questions. [04]

- (1) Giving an example, define contravariant vector.
- (2) Show that δ^α_β is a tensor of rank two.

Q.3 (b) Answer any two questions out of three. [10]

- (1) Define metric tensor and show that it is covariant and symmetric tensor of rank two.
- (2) Show that the second order covariant derivatives of a covariant vector do not commute.
- (3) Define Christoffel symbols of first kind and show that they do not form a tensor.

Q.4 (a) Answer the following questions. [04]

- (1) In usual notation prove that $\Gamma_{ijk} + \Gamma_{jki} = \frac{\partial g_{ik}}{\partial x^j}$.
- (2) Define covariant derivative of a mixed tensor of rank $p + q$.

Q.4 (b) Answer any two questions out of three. [10]

- (1) State and prove The Quotient Theorem.
- (2) Simplify $g_{ha} R^a_{ijk}$.
- (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^μ_σ in a four dimensional space.
- (2) Let A_α be a covariant vector. Then show that λA_α is also a covariant vector, where λ is an arbitrary constant.

Q.5 (b) Answer any two questions out of three. [10]

- (1) Show that the set of all special Galilean transformations forms a group under usual composition.
- (2) Find all Christoffel symbols of first kind for the line element $ds^2 = dr^2 + r^2 d\theta^2 + r^2 \sin^2 \theta d\phi^2$.
- (3) Let two events P and Q occur simultaneously in S-frame. Are they simultaneous in S'-frame?
