

M.Sc.(Maths.) Semester - 3 (CBCS) Examination**Oct/Nov-2025 (NEW COURSE)****Sp. Theory of Relativity and Tensor Analysis (Elective (New))****Time: 2:30 Hours****Marks: 70****Instructions:**

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

- Q- 1(A) Answer any two out of three (10)**
- (1) Derive special Lorentz transformation.
 - (2) Explain Michelson-Morley experiment.
 - (3) Explain negative results of Michelson-Morley experiment.
- Q - 1(B) Answer any one out of two (04)**
- (1) The length of a rocket ship is 100m on the ground when it is in flight, its length observed on the ground is 99m. Calculate its speed.
 - (2) Show that the set of all SGTs forms group under usual composition.
- Q - 2(A) Answer any two out of three (10)**
- (1) Discuss simultaneity of events in special relativity.
 - (2) In usual notations prove that $E = mc^2$.
 - (3) Derive the law of relativistic addition of velocities.
- Q- 2(B) Answer any one out of two (04)**
- (1) Explain the composition of two SLTs.
 - (2) Calculate the velocity at which mass of a particle becomes 8 times rest mass.
- Q - 3(A) Answer any two out of three (10)**
- (1) Define metric tensor and show that it is covariant tensor of rank 2.
 - (2) Define Contravariant vector and show that displacement vector is contravariant vector.
 - (3) Derive the transformation law of tensors.
- Q- 3(B) Answer any one out of two (04)**
- (1) Show that δ_{α}^{β} is a tensor of type (1,1).
 - (2) Define covariant vector and give an example.
- Q- 4(A) Answer any two out of three (10)**
- (1) Define Christoffel's symbol of second kind and show that they do not form tensors.
 - (2) Define Outer product of two tensors and discuss its type.
 - (3) Prove that covariant differentiation of a contravariant vector is a tensor.
- Q- 4(B) Answer any one out of two (04)**
- (1) Derive relation between 1st and 2nd kind Christoffel symbols.
 - (2) Check whether $\Gamma_{\alpha\beta}^{\delta} = \Gamma_{\beta\alpha}^{\delta}$.
- Q- 5(A) Answer any two out of three (10)**
- (1) Prove that Lorentzian matrices form a group under usual multiplication.
 - (2) If u & v are two velocities in the same direction and V is their resultant velocity given by $\tanh^{-1} \frac{V}{c} = \tanh^{-1} \frac{u}{c} + \tanh^{-1} \frac{v}{c}$.
 - (3) Show that wave equation is invariant under special Lorentz transformation.
- Q- 5(B) Answer any one out of two (04)**
- (1) A rod of proper length 100m is observed by an observer moving with speed $0.8c$ along the length of the rod, find the apparent length of the rod.
 - (2) A particle with a mean proper life of $1\mu\text{sec}$ moves through the laboratory at $2.7 \times 10^{10} \text{ cm/s}$. What will be its life as measured by an observer in the laboratory?
