

B.Sc. - III (CBCS Pattern) Semester-V  
**USMT12 : Mathematics DSE Paper-IV - Special Relativity-I**

P. Pages : 2

Time : Three Hours



**GUG/S/25/13118**

Max. Marks : 60

- Notes : 1. Solve all **five** questions.  
2. Each question carries equal marks.

**UNIT – I**

1. a) Obtain Galilean transformation equation. 6  
b) Show that Newton's kinematical equations of motion are invariant under Galilean transformation. 6

**OR**

- c) Show that Maxwell's equations do not remain invariant under Galilean transformation. 6  
d) Explain Fitzgerald and Lorentz contraction hypothesis. 6

**UNIT – II**

2. a) Show that set of all Lorentz transformations form a group. 6  
b) Explain time dilation in special Lorentz transformation. 6

**OR**

- c) The space – time coordinate of two events as measured in an inertial frame S are  $(x_1, o, o, t_1)$  and  $(x_2, o, o, t_2)$ . Show that there exists an inertial frame moving with uniform velocity  $c^2(t_2 - t_1)/(x_2 - x_1)$  with respect to S and where these events occur at the same time. 6

$$\frac{x_2 t_1 - x_1 t_2}{\sqrt{(x_2 - x_1)^2 - c^2(t_2 - t_1)^2}}$$

- d) Show that  $x^2 + y^2 + z^2 - c^2 t^2$  is Lorentz invariant. 6

**UNIT – III**

3. a) Obtain transformation equations for the velocity of a particle. 6  
b) Obtain transformation of Lorentz contraction factor  $\left(1 - \frac{u^2}{c^2}\right)^{1/2}$  6

**OR**

- c) An observer moving along the X – axis of S with velocity V observes a body of proper volume  $V_0$  moving with velocity u along the x axis of S. Show that the observer measures the volume to be equal to 6

$$V_0 \sqrt{\frac{(c^2 - v^2)(c^2 - u^2)}{(c^2 - uv)^2}}$$

- d) Obtain transformation equations for the acceleration of the particle. 6

#### UNIT – IV

4. a) Prove that there exists an inertial system S' in which the two events occur at one and the same point if the interval between two events is time like 6
- b) Obtain Lorentz transformation in index form. 6

#### OR

- c) Prove that there exists an inertial system S' in which the two events occur at one and the same time if the interval between two events is spacelike. 6
- d) Deduce the transformation for the components of T " 6

5. Solve **any six**.

- a) Define Space and Time. 2
- b) Explain Event. 2
- c) Write two postulates of Einstein's special relativity theory. 2
- d) Show that four dimensional volume elements  $dx dy dz dt$  is lorentz invariant. 2
- e) Obtain the relativistic addition law for velocities. 2
- f) There are three galaxies  $G_1, G_2$  and  $G_3$ . Observations in  $G_1$  show that  $G_2$  and  $G_3$  are moving in opposite directions each with a speed of  $0.5c$ . 2
- g) Show that  $x^1 = -x_1, x^2 = -x_2, x^3 = -x_3, x^4 = x_4$ . 2
- h) Write definition of four tensor. 2

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