

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

P. Pages : 2

Time : Three Hours



GUG/W/24/13118

Max. Marks : 60

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

UNIT – I

1. a) Define inertial system Prove that in such a reference frame a body, not under the influence of any force moves in straight line. **6**
- b) Show that Newton's kinematical equations of motion are invariant under Galilean transformation. **6**

OR

- c) Obtain the general and simple Galilean transformation. **6**
- d) Show that the Maxwell's equation do not remain invariant under the Galilean transformation. **6**

UNIT – II

2. a) Explain the length contraction by using special Lorentz transformation. **6**
- b) Prove that $\nabla^2 - \frac{1}{C^2} \frac{\partial^2}{\partial t^2}$ is invariant under special Lorentz transformation. **6**

OR

- c) Show that simultaneity is relative in special relativity. **6**
- d) Show that the set of all special Lorentz transformation forms a group. **6**

UNIT – III

3. a) Obtain the transformation equations for components of velocity. **6**
- b) Obtain the transformation equation for components of acceleration of a particle. **6**

OR

- c) Show that in nature no signal can move with a velocity greater than the velocity of light relative to any inertial system. **6**

- d) Let \bar{u} and \bar{u}' be the velocities of a particle in two inertial system S and S' respectively where S' is moving with velocity v relative to S along the XX' axis. Show that 6

$$\tan \theta' = \frac{\sin \theta \left(1 - \frac{v^2}{c^2}\right)^{1/2}}{\cos \theta - \frac{v}{u}}$$

$$\text{and } u'^2 = u^2 \frac{\left[1 - 2 \frac{v}{u} \cos \theta + \left(\frac{v}{u}\right)^2 - \left(\frac{v}{c}\right)^2 \sin^2 \theta\right]}{\left(1 - \frac{uv}{c^2} \cos \theta\right)^2}$$

Where θ and θ' are the angles between the x-axis and the vectors \bar{u} and \bar{u}' respectively.

UNIT – IV

4. a) Obtain the Lorentz transformation in index form. 6
- b) Prove that there exist on 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

OR

- c) Show that the proper time of a moving object is always less than the corresponding interval in the rest system. 6
- d) Show that 6
- $$x^1 = -x_1, x^2 = -x_2, x^3 = -x_3 \text{ and } x^4 = x_4 \text{ then } x_i = (-\vec{r}, ct)$$

5. Solve **any six**.

- a) Write Newton's first law of motion. 2
- b) Define space and time. 2
- c) Show that the three dimensional volume element $dx dy dz$ is not Lorentz invariant. 2
- d) Write the two postulate of special theory of relativity. 2
- e) Obtain the Einstein's velocity addition law. 2
- f) There are three galaxies G_1, G_2 and G_3 . Observation in G_1 show that G_2 and G_3 are moving in opposite direction each with a speed of $0.5c$. 2
- g) Define 2
- i) Space like ii) Light like
- h) Define four tensor. 2
