

USMT12 - Mathematics Paper-IV - DSE-IV : Special Relativity-I

P. Pages : 2

GUG/W/22/13118

Time : Three Hours



Max. Marks : 60

- Notes :
1. Solve **all five** questions.
 2. Question 1 to 4 has an alternative solve each question in full or its alternative in full.
 3. All questions carry equal marks.

UNIT – I

1. a) Show that the Maxwell's equations do not remain invariant under Galilean transformation. **6**
- b) Define an inertial system. Prove that in an inertial frame, a particle not under influence of any force particle moves in a straight line with constant speed. **6**

OR

- c) Explain Fitzgerald & Lorentz Contraction Hypothesis. **6**
- d) Obtain Galilean transformation in equations. **6**

UNIT – II

2. a) Show that the Lorentz Transformation form a group. **6**
- b) Show that simultaneity is relative in special theory of relatively. **6**

OR

- c) Explain Length Contraction in special relatively. **6**
- d) Prove that $\nabla^2 - \frac{1}{C^2} \frac{\partial^2}{\partial t^2}$ is invariant under Lorentz transformation. **6**

UNIT – III

3. a) Obtain transformation equations for components of acceleration of a particle. **6**
- b) 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 observe measures the volume to be equal to $V_0 \sqrt{\frac{(c^2 - v^2)(c^2 - u^2)}{(c^2 - uv)^2}}$ **6**

OR

- c) Obtain transformation of Lorentz contraction factor $\left(1 - \frac{u^2}{c^2}\right)^{1/2}$. **6**

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

UNIT – IV

4. a) Prove that there exists an inertial frame S' in which two events occur at one and the same time. If the interval between two events is space like. **6**

- b) Deduce distance formula in four dimensional geometry of space time. **6**

OR

- c) Show that $x^1 = -x_1, x^2 = -x_2, x^3 = -x_3, x^4 = x_4$ and then $x_i = (-\vec{r}, ct)$. **6**

- d) Define a four tensor of second order in Minkowskian geometry and obtain **6**

$$T'^{14} = \alpha^2 \left[-\frac{v}{c} T^{11} + T^{14} + \frac{v^2}{c^2} T^{41} - \frac{v}{c} T^{44} \right]$$

5. Attempt **any six**.

- i) Define space & time in classical mechanics. **2**

- ii) Write Newton 1st law of motion. **2**

- iii) Write the Lorentz Transformation equations. **2**

- iv) Show that the three dimensional volume element $dx dy dz$ is not Lorentz invariant. **2**

- v) Write relativistic addition law for velocities. **2**

- vi) Write the transformation equations for component of particle velocity. **2**

- vii) Define four tensor. **2**

- viii) Define proper time for the body. **2**
