Bachelor of Science (B.Sc.) Fifth Semester

# B.Sc. 3529 / MAT-302 - Mathematics Paper-II (Optional)
# (Special Relativity-I)

P. Pages : 2 **GUG/W/18/1316**

Time : Three Hours * 1 0 2 9 * Max. Marks : 60

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Notes : 1. Solve all **five** questions.
2. All questions carry equal marks.

## UNIT – I

**1.** a) Define inertial system. Prove that in an inertial frame, a particle, not under the influence of any force moves in a straight line with constant speed. **6**

b) Show that Newton's Kinematical equations of motion are invariant under Galilean transformations. **6**

**OR**

c) Prove that Maxwell's equations do not obey the Newtonian principle of relativity. **6**

d) Explain Fitzgerald & Lorentz Contraction hypothesis. **6**

## UNIT – II

**2.** a) Assume that the Lorentz transformations are linear transformations of the form **6**
$x' = Ax + Bt \ \& t' = Dx + Et, E > 0,$
Considering $x^2 - c^2t^2 = x'^2 - c^2t'^2$ and the motion of the origin of $S'$, deduce the Lorentz transformations.

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) Explain time dilation. **6**

## UNIT – III

**3.** a) Obtain the transformation of Particle velocities. **6**

b) In the system $S'$, let $u'_x = c\cos\theta, u'_y = c\sin\theta$. If $S'$ moves with velocity V relative to the system S along the x-axis, then show that $u_x^2 + u_y^2 = c^2$ in S. **6**

**OR**

c) Let u & u' be the velocities of a particle in two inertial systems S and S' respectively where S' is moving with velocity V relative to S along the XX' axis. Show that **6**

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

d) Obtain the transformation of the Lorentz contraction factor **6**

$\left(1-\frac{u^2}{c^2}\right)^{1/2}$.

## UNIT – IV

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

b) Define timelike interval and 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 timelike. **6**

**OR**

c) Define a four tensor of the second order in Minkowskian geometry and obtain **6**

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

d) Show that moving clocks go slow than those at rest. **6**

**5.** Solve **any six.**

a) Define space and Time in classical mechanics. **2**

b) Write Maxwell's equations in vacuum. **2**

c) Write the principle of constancy of the speed of light. **2**

d) Write the Lorentz transformations. **2**

e) Write Relativistic addition law for velocities. **2**

f) Write the transformation equations for the acceleration of a particle. **2**

g) Define space like interval and light like interval. **2**

h) Define proper time for the body. **2**

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