# SARDAR PATEL UNIVERSITY
## M.Sc. (Semester-III) Examination
### October-2016
### Friday 21/10/2016
### Time: 02:00 PM to 05:00 PM

**Subject: Mathematics**          **Course No. PS03EMTH16 (Relativity-I)**

Note: 1. Answer to all questions to be given in the answer book only.
   2. Figures on the right indicate full marks.

Q-1  Choose appropriate answer from the options given.          (08)
1. Rotating frame cannot be taken as _____ frame.
     (a) inertial     (b) Galelian     (c) non-inertial     (d) Einstein
2. Length of a moving object appears to be _____.
     (a) unchanged   (b) decreased     (c) increased     (d) unpredictable
3. According to special relativity a moving clock appears _____.
     (a) to run slower   (b) to run faster   (c) stopped   (d) as a stationary clock.
4. Four dimensional volume element is _____ under SLT
     (a) Relativistic   (b) invariant     (c) absolute     (d) not defined
5. A spacetime interval for which $c^2 dt^2 - dx^2 - dy^2 - dz^2 < 0$ is _____.
     (a) Space-like   (b) time-like   (c) null   (d) not possible
6. The norm of velocity 4-vector is _____
     (a) positive     (b) negative     (c) zero     (d) unit
7. Which one of the following is incorrect?
     (a) Wavelength depends on the observer.
     (b) Transverse Doppler effect does not occur in Newtonian theory.
     (c) Transverse Doppler effect occurs in Newtonian theory.
     (d) None of these.
8. The field equations in empty space are given by_____.
     (a) $R_{hijk} = 0$   (b) $R_{ij} = 0$     (c) $\Gamma_{ij}^{h} = 0$     (d) None of these

Q-2  Attempt any **SEVEN**          (14)
1. State special Lorentz transformations connecting two frames in relative motion.
2. What is meant by length contraction?
3. State postulates of special relativity.
4. What is meant by aberration of light?
5. State the formula for transformation of mass.
6. Give an example of a covariant vector.
7. State the expression of Christoffel symbol of first type. Discuss its symmetry.
8. State principle of equivalence.
9. State Einstein's field equations.

Q-3
(a)  Show Maxwell's equations reduce to wave equations in vacuum.          (06)
(b)  What is meant by simultaneity? Show that it is not absolute.          (06)

## OR

(b)  An astronaut wants to go to a star 15 light years away. The rocket accelerates quickly and then moves with uniform velocity. Calculate with speed the rocket must move relative to the earth if the astronaut is to reach there in one year as measured by the clocks at rest on the rocket.

(P.T.O.)

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Q-4

(a) In usual notations derive $w = \frac{u+v}{1+\frac{uv}{c^2}}$. Also show that if $u < c, v < c$ then $w < c$. (06)

(b) Discuss the concept of Doppler effect using special relativity. (06)

**OR**

(b) A rod of length 10 meters is at rest in the XY-plane in S-frame and makes an angle $\sin^{-1}\left(\frac{3}{5}\right)$ with the X-axis. Find its length and angle of inclination as seen from a frame S' moving with a velocity 0.6c with respect to S along X-direction.

Q-5

(a) State the expression of spacetime interval and show that it is invariant under a Lorentz transformation. (06)

(b) Define velocity 4-vector. Find its magnitude. (06)

**OR**

(b) What is the increase in the mass of a particle of rest mass 1 gm when it is moving with 0.8c velocity? Also find the increase its kinetic energy.

Q-6

(a) Discuss algebraic properties of Riemann tensor; and also define Ricci tensor. (06)

(b) Compute all independent Christoffel symbols for the space described the metric $ds^2 = d\theta^2 + \sin^2\theta \, d\phi^2$. (06)

**OR**

(b) Show that for a weak field geodesic equation reduces to Poisson equation.

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