SARDAR PATEL UNIVERSITY
M.Sc. (Semester-III) Examination
March-2019
Wednesday 27/03/2019
Time: 02:00 PM to 05:00 PM

Subject: Mathematics

Course No. PS03EMTH41 (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. In Lorentz transformation spacetime is _____
   (a) relative   (b) absolute   (c) not defined   (d) none of these
2. Newton's equations are invariant under _____ transformation.
   (a) General Galelian   (b) General Lorentz
   (c) Special Lorentz   (d) None of these
3. A frame rotating with constant speed relative to an inertial frame is _____
   (a) an inertial frame   (b) a Lorentzian frame
   (c) a non-inertial frame   (d) not a frame
4. In special relativity simultaneity is _____
   (a) absolute   (b) relativistic   (c) not defined   (d) non-relativistic
5. According to relativity, a moving clock appears to _____.
   (a) move faster   (b) move slower   (c) be stopped   (d) vanish
6. For the velocity 4-vector, which one of the following is correct?
   (a) It is Time-like   (b) It is space-like
   (c) It is a null vector   (d) None of these.
7. Which one of the following is correct?
   (a) Mass is equivalent to momentum
   (b) Mass increases with motion
   (c) Mass of a particle remains constant during the motion.
   (d) Mass of a moving particle is not defined.
8. The maximum number of independent components of Ricci tensor for a spacetime is _____.
   (a) 21   (b) 10   (c) 0   (d) 20

Q-2 Attempt any SEVEN
1. State Maxwell's equations in vacuum. (14)
2. State Special Lorentz transformations connecting two frames in relative motion along X–axis.
3. State postulates of special relativity.
4. State formula for length contraction.
5. Explain the meaning of aberration of light.
6. What is meant by a timelike spacetime separation? Give its interpretation also.
7. Show that gradient of a scalar is a covariant vector.
8. What is meant by Minkowski structure of spacetime.
9. Give an example of covariant tensor of rank-2.

(1)

(P.T.O)

Q-3

(a) Show that special Lorentz transformations form a group under usual composition. (06)

(b) Show that wave equation is not invariant under special Galelian transformation. (06)

OR

(b) A clock appears to lose one minute per hour, find its velocity.

Q-4

(a) Discuss Doppler's effect in the framework of relativity. (06)

(b) State the expression of spacetime interval and hence obtain the relation between proper time and usual time. (06)

OR

(b) Let w be resultant velocity of two velocities u and v, given by $\tanh^{-1}\frac{w}{c} = \tanh^{-1}\frac{u}{c} + \tanh^{-1}\frac{v}{c}$, then deduce the law of relativistic composition of velocities.

Q-5

(a) Describe Poincare structure of spacetime. Hence describe the special Lorentz transformation as rotation of axes. (06)

(b) Derive formula for relativistic kinetic energy. (06)

OR

(b) What is the increase in the relativistic mass of a particle of rest mass 1 gm when it is moving with 0.6c velocity? Also find its kinetic energy.

Q-6

(a) State the transformation of a contravariant vector. Show that transformation satisfies group property. (06)

(b) State geodesic equation in a Riemannian space, hence obtain geodesics in the two dimensional Euclidean space. (06)

OR

(b) Discuss principle of equivalence and principle of covariance. Also discuss their role.

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