M.Sc. MATHEMATICS
THIRD SEMESTER
SPECIAL THEORY OF RELATIVITY
MSM – 305A
[USE OMR SHEET FOR OBJECTIVE PART]

SET

A

Duration : 3 hrs.

Full Marks : 70

[**Objective**]

Time: 30 min.

Marks: 20

Choose the correct answer from the following: *1X20=20*

1. A train is moving with an initial velocity 2km/hour. After some time its velocity gradually increases. Motion is
   a. Uniform   b. Absolute
   c. Non-Uniform   d. Relative

2. Great American Relativist R.C Tolman stated that
   a. All laws of physics must be same & speed of light is constant
   b. Einstein's Theory of Relativity may be regarded as based on the fundamental idea of Relativity of all motion.
   c. All laws of physics must be same & speed of light is variable
   d. Einstein's Theory of Relativity may be regarded as based on the Absolute motion of Relativity of all motion.

3. Relativistic Theorem is

   a. $u = \dfrac{u' - v}{1 - \dfrac{vu'}{c^2}}$ u, u' are respectively the velocity of particle according to S and S'

   and , v, c are velocities of moving frame and light

   b. $u = \dfrac{u' - v}{1 + \dfrac{vu'}{c^2}}$ u, u' are respectively the velocity of particle according to S and S'
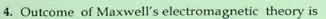
   and , v, c are velocity of moving frame and light

   c. $u = \dfrac{u' + v}{1 + \dfrac{vu'}{c^2}}$, u, u' are respectively the velocity of particle according to S and S'

   and , v, c are velocities of moving frame and light

   d. $u = \dfrac{u' + v}{1 - \dfrac{vu'}{c^2}}$ u, u' are respectively the velocities of particle according to S and S'

   and , v, c are velocity of moving frame and light

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4. Outcome of Maxwell's electromagnetic theory is
   a. Light is electromagnetic phenomenon
   b. It is wave propagating in vacuum
   c. Newton's law of Mechanics are same
   d. None of the above

5. For a material particle which is moving with velocity u

   a. $\dfrac{dx}{d(ct)} < 1$

   b. $\dfrac{dx}{d(ct)} > 1$

   c. $\dfrac{dx}{d(ct)} = 1$

   d. None of the above

6. The value of $\delta^{\mu}{}_{\alpha}$ in terms of fundamental metric tensor is

   a. $g^{\mu}{}_{\nu} g^{\nu}{}_{\alpha}$

   b. $g^{\nu}{}_{\alpha}$

   c. $g^{\mu}{}_{\alpha}$

   d. $g^{\mu\nu} g_{\nu\alpha}$

7. $m, m_0, m - m_0$ are respectively called for a moving particle with velocity u

   a. Rest mass, total mass and dynamic mass of the moving particle
   b. Dynamic mass, rest mass and total mass of the moving particle
   c. Total mass, rest mass and dynamic mass of the moving particle
   d. None of the above

8. Four-dimensional Euclidean flat space time is

   a. $dS^2 = dx^2 + dy^2 + dz^2 - c^2 dt^2$

   b. $dS^2 = dx^2 + dy^2 + dz^2 + c^2 dt^2$

   c. $-(dS^2 = dx^2 + dy^2 + dz^2) + c^2 dt^2$

   d. None of the above

9. In Minkowski's Geometry of space time, the condition for Space-like interval is

   a. $c^2 < \dfrac{|x_2 - x_1|^2}{(t_2 - t_1)^2}, i, eS^2{}_{12} < 0$

   b. $c^2 > \dfrac{|x_2 - x_1|^2}{(t_2 - t_1)^2}, i, eS^2{}_{12} > 0$

   c. $c^2 = \dfrac{|x_2 - x_1|^2}{(t_2 - t_1)^2} i, eS^2{}_{12} = 0$

   d. $c^2 \neq \dfrac{|x_2 - x_1|^2}{(t_2 - t_1)^2}, i, eS^2{}_{12} \neq 0$

10. $\left(1 - \dfrac{1}{n^2}\right)$ is known as

    a. Fresnel Drag constant
    b. Fresnel Drag coefficient
    c. Fresnel Drag variable
    d. None of the above

11. Result of Galilean Transformation is

    a. Both of classical physics and electromagnetic laws are invariant under Galilean transformation.
    b. All classical physics laws are not invariant but Maxwell's electromagnetic laws are invariant under Galilean Transformation.
    c. All classical physics laws are invariant but Maxwell's electromagnetic laws are not invariant under Galilean Transformation.
    d. None of the above

12. Lorentz Transformation Equations are

a.
$$x' = \frac{x - vt}{\sqrt{1 + \frac{v^2}{c^2}}}$$

$$y' = y$$
$$z' = z$$

$$t' = \frac{t - \frac{vx}{c^2}}{\sqrt{1 - \frac{v^2}{c^2}}}$$

b.
$$x' = \frac{x - vt}{\sqrt{1 - \frac{v^2}{c^2}}}$$

$$y' = y$$
$$z' = z$$

$$t' = \frac{t - \frac{vx}{c^2}}{\sqrt{1 - \frac{v^2}{c^2}}}$$

c.
$$x' = \frac{x + vt}{\sqrt{1 - \frac{v^2}{c^2}}}$$

$$y' = y$$
$$z' = z$$

$$t' = \frac{t - \frac{vx}{c^2}}{\sqrt{1 - \frac{v^2}{c^2}}}$$

d. None of the above

13. The Condition for Lorentz transformation transform to Galilean Transformation is

a. Velocity of moving frame is very very greater than the velocity of light

b. Velocity of moving frame is very very less than the velocity of light

c. Both A& B

d. None of the above

14. Postulates of Special Theory of Relativity are

a. Principle of Relativity & Universal Constancy of light

b. All laws of physics must be same in all inertial frame of reference & light is absolute

c. Newton's law & Maxwell's law

d. None of the above

15. Which of the following option is correct, where l is the length of the rode measured from observer S and l' is the length of the rode measured from observer S'

a. $l' > l$, where l, l' are the length measured from S, S'

b. $l' < l$, where l, l' are the length measured from S, S'

c. $l' = l$, where l, l' are the length measured from S, S'

d. $l' < l$, where l, l' are the length measured from S', S

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16. Result of Michelson-Morley Experiment is
    a. Earth velocity relative to Ether is constant
    b. Earth velocity relative to Ether is variable
    c. Earth velocity relative to Ether is negligible
    d. Earth velocity relative to Ether is zero

17. Relation between charge density and current density is
    a. $\sigma = ju$, where j is the current density, σ is the charge density and u velocity of moving electron
    b. $j = \sigma u$, where j is the current density, σ is the charge density and u velocity of moving electron
    c. $j = -\sigma u$, where j is the current density, σ is the charge density and u velocity of moving electron
    d. None of the above

18. One of the consequence of Lorentz Transformation is
    a. Relativity of Simulteniety   b. Galilean Equation
    c. Doppler's effect   d. Relativistic Equation

19. Which of the following is correct
    a. $\sigma = \left(\dfrac{\sigma_0}{m_0} \right) p$, where j is the current density, σ_0, m_0 is the charge density and mass at rest position of the electon,, p is the momentum

    b. $j = \left(\dfrac{\sigma_0}{m_0} \right) p$, where j is the current density, σ_0, m_0 is the charge density and mass at rest position of the electon,, p is the momentum

    c. $j = \left(\dfrac{\sigma_0}{m_0} \right) q$, where j is the current density, σ_0, m_0 is the charge density and mass at rest position of the electon,, p is the momentum

    d. $j = -\left(\dfrac{\sigma_0}{m_0} \right) p$, where j is the current density, σ_0, m_0 is the charge density and mass at rest position of the electon,, p is the momentum

20. The material particle travelling slower than light and having real mass is called
    a. Tachyons   b. Luxons
    c. Tardyons   d. None of the above

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[4]

Descriptive

Time : 2 hrs. 30 mins.   Marks : 50

[Answer question no.1 & any four (4) from the rest]

1. What is the principle of Relativity? Prove the statement   2+8=10
    "Einstein boldly rejected the existence of Ether"by any experiment.

2. What do you mean by Euclidean Space time? Find the four-   2+8=10
    dimensional invariant length element?

3. What are the four Maxwell's electromagnetic equations. Prove that   4+6=10
    they are invariant.

4. Is Maxwell's Electromagnetic equations are invariant under Galilean   1+9=10
    Transformation? Explain about the invariancy of Electromagnetic
    equation

5. What do you mean by charge density and current density? Prove that   3+7=10

    $j = \left(\dfrac{\sigma_0}{m_0} \right) p$ if it is correct and give special meaning of each symbol.

6. In Minkowski Geometry write the definition of three particles   3+2+5
        a. Tachyons   =10
        b. Tardyons
        c. Luxions
    Write the condition of time-like interval and space-like interval?
    Draw the diagram of world line of different type of particles?

7. Write four differences of Galilean transformation and Lorentz   4+6=10
    transformation? What is the importance of Lorentz transformation?

8. What are the real life example of consequence of Lorentz   3+3+4
    Transformation? Explain any two consequences of Lorentz   =10
    transformation.

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[5]