

A-0693

Total Pages : 3

Roll No.

MAT-609

Mathematics (MSCMAT/MAMT)

(Theory of Relativity)

Examination, June 2025

Time : 2:00 Hrs.

Max. Marks : 70

Note :- This paper is of Seventy (70) marks divided into Two (02) Sections 'A' and 'B'. Attempt the questions contained in these sections according to the detailed instructions given therein. *Candidates should limit their answers to the questions on the given answer sheet. No additional (B) answer sheet will be issued.*

Section-A

(Long Answer Type Questions) $2 \times 19 = 38$

Note :- Section 'A' contains Five (05) Long-answer type questions of Nineteen (19) marks each. Learners are required to answer any two (02) questions only.

1. If u and v are two velocities in the same direction and V their resultant velocity given by :

$$\tanh^{-1} \frac{V}{c} = \tanh^{-1} \frac{u}{c} + \tanh^{-1} \frac{v}{c}$$

then deduce the law of composition of velocities from this equation.

2. Show that Lorentz transformations form a group.
3. Show that $E = mc^2$.
4. If A^i and B^j are contravariant vectors and $C_{ij}A^iB^j$ is an invariant. Prove that C_{ij} is a tensor of the second order.
5. Prove the cyclic property :

$$R_{hijk} + R_{hjki} + R_{hkij} = 0$$

Section-B

(Short Answer Type Questions) 4×8=32

Note :- Section 'B' contains Eight (08) Short-answer type questions of Eight (08) marks each. Learners are required to answer any *four* (04) questions only.

1. The origin of two systems S and S' coincide initially. The system S' is moving with velocity $(3i + 4j + 6k)$ cm/sec. relative to S . After 2 sec if the co-ordinates of any point as observed by an observer at the origin of S are $(5, 6, -9)$ cm. Find the co-ordinates of the point relative to an observer at the origin of S' .

2. Define Special theory of Relativity and also explain its postulates.
3. A particle with rest mass 2×10^{-24} kg is moving with speed 2.1×10^8 m/sec. Calculate its moving mass.
4. Explains the following terms in detail; light cone, world line, space like vector, time like vector.
5. Show that :

$$\Gamma_{ij,k} + \Gamma_{jk,i} + \Gamma_{ki,j} = \frac{1}{2} \left(\frac{\partial g_{ij}}{\partial x^k} + \frac{\partial g_{jk}}{\partial x^i} + \frac{\partial g_{ik}}{\partial x^j} \right)$$

6. Write short note on Kronecker Delta.
7. Prove that the product of two tensors is also a tensor.
8. Define the following :
 - (a) Flat space time
 - (b) Simultaneity
 - (c) Principle of covariance
 - (d) Principle of equivalence
