

M.Sc. (Maths) Semester - 3 (CBCS) Examination**DEC/JAN. - 2020****Sp. Theory of Relativity and Tensor Analysis (Elective)****Time: 1:30 Hours****Marks: 42****Instructions:**

1. Figure to the right indicate marks.
2. There are five questions in the question paper.
3. Answer any three of the following questions.

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|---------------|---|-----------|
| Q-1(a) | State special Galilean transformation. Show that composition of two Galilean transformations give a Galilean transformation. | 04 |
| Q-1(b) | Answer any TWO (5 marks each) | 10 |
| (1) | Discuss simultaneity of events in special relativity. | |
| (2) | Discuss possible explanations of negative results of Michelson-Morley experiment? | |
| (3) | State the postulates of special relativity. | |
| Q-2(a) | A rod of proper length 100m is observed by an observer moving with speed $0.8c$ along the length of the rod, find the apparent length of the rod. | 04 |
| Q-2(b) | Answer any TWO (5 marks each) | 10 |
| (1) | Derive law of relativistic addition of velocities. | |
| (2) | Obtain the expression of relativistic kinetic energy of a particle of rest mass m_0 moving with speed v . | |
| (3) | At what speed a particle should move so that its apparent mass is 10 times its proper mass? | |
| Q-3(a) | Define a covariant vector. Show that gradient of a scalar is a covariant vector. | 04 |
| Q-3(b) | Answer any TWO (5 marks each) | 10 |
| (1) | Discuss inner product of two vector fields in a Riemannian space and hence show that it is an invariant. | |
| (2) | Define metric tensor and show that it is covariant tensor. | |
| (3) | Giving an example define an affine space. | |
| Q-4(a) | Define Ricci tensor. Show that it is symmetric. | 04 |
| Q-4(b) | Answer any TWO (5 marks each) | 10 |
| (1) | Define Christoffel symbols of second kind. Show that they do not form a tensor. | |
| (2) | Show that second order covariant derivatives of a covariant vector do not commute. | |
| (3) | Derive the formula for finding maximum number of independent components of Riemann curvature tensor. | |
| Q-5 | Answer any TWO (7 marks each) | 14 |
| (1) | Describe the Michelson-Morley experiment. | |
| (2) | In usual notations prove $E = mc^2$. | |
| (3) | Define outer product of two tensors and discuss its tensor type. | |
| (4) | Compute Christoffel symbols of second kind for the line element | |

$$ds^2 = dr^2 + r^2 d\theta^2 + \sin^2 \theta d\phi^2$$
