

MAY 2012

P/ID 4526/XDD

Time : Three hours

Maximum : 100 marks

SECTION A — ($4 \times 20 = 80$ marks)

Answer ALL questions.

Each question carries 20 marks.

1. (a) (i) State and prove the principle of virtual work.
- (ii) State and prove the D'Alembert's principle. (10 + 10)

Or

- (b) (i) Derive the Lagrange's equation of motion for a holonomic system.
- (ii) Derive the equation of motion of Atwood's machine. (10 + 10)
2. (a) (i) State and prove the multiplier rule.
- (ii) Prove that every conservative system, holonomic or non-holonomic, has a constant Hamiltonian function.

Or

- (b) (i) State and prove the principle of least action.
- (ii) State Kepler's problem and use the Jacobi form of the principle of least action to obtain the orbit for the Kepler's problem. (10+ 10)
3. (a) (i) Derive the equation of Lorentz transformation.
- (ii) Discuss any two consequences of Lorentz transformation. (10 + 10)
- Or
- (b) (i) Derive the relativistic equations of motion and energy.
- (ii) Find the mass equivalent to the energy required to convert 1 Kg of water into ice at 0°C. (12 + 8)
4. (a) Derive the transformation laws for the Christoffel symbols of the first and second kind.

Or

- (b) (i) Prove that the covariant derivative of the metric tensors g_{jk} and g^{jk} vanish.
- (ii) Prove that a necessary condition that $I = \int_{t_1}^{t_2} F(t, x, \dot{x}) dt$ be an extremum is that $\frac{\partial F}{\partial x} - \frac{d}{dt} \left(\frac{\partial F}{\partial \dot{x}} \right) = 0$.

SECTION B — (10 × 2 = 20 marks)

Answer any TEN questions.

Each question carries 2 marks.

5. Define the term degrees of freedom.
6. What do you mean by non-holonomic constraint?
Give an example.
7. State Konig's theorem.
8. Define Routh's function.
9. What is conservative system?
10. Write down the Eulers Lagrange equation.
11. State the geodesic problem.
12. State Hamilton's principle.
13. Explain the meaning of absolute quantities with examples.
14. What is length contraction?
15. Write down the expression for Minkowski force.
16. What is the rest mass of a light photon?
17. Define a covariant tensor of rank two.

18. Prove that the contraction of the tensor A_q^p is invariant.
 19. Define symmetric and skew-symmetric tensors.
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