MAY 2014 **P/ID 37456/PMAG**

Time : Three hours Maximum : 100 marks

PART A — (10 × 2 = 20 marks)

Answer ALL questions.

1. What is an English gravitational system and write down its fundamental units?
2. Define generalized coordinates and give an example.
3. What is Kepler problem?
4. Define Routhian function.
5. Write down the necessary and sufficient condition for the stationary value of the integral $\int_{x_0}^{x_1} f\left(y(x),\ y'(x), x\right)\, dx$.
6. State the brachistochrone problem.
7. What is orthogonal transformation?
8. Define contact transformation.
9. Write down the equation of Galilean transformation.
10. State the Einstein's principle of relativity.

PART B — ($5 \times 6 = 30$ marks)

Answer ALL questions.

11. (a) State and prove the principle of virtual work.

Or

(b) Define generalized force and prove that the necessary and sufficient condition for static equilibrium is that all the generalized forces due to the applied forces be zero.

12. (a) Two particles, each of mass m are connected by a rigid mass less rod of length l. The particles are supported by knife edges placed perpendicular to the rod. Assuming that all motion is confined to the horizontal xy plane, find the Jocobi integral.

Or

(b) Derive the equation of motion of a particle of unit mass which is attracted by an inverse square gravitational force to a fixed point O.

13. (a) Derive the Hamilton's canonical equation of motion.

Or

(b) Find the stationary values of the function $f = 2$, subject to the constraints

$\phi_1 = x^2 + y^2 + z^2 - 4 = 0$

$\phi_2 = xy - 1 = 0$.

14. (a) Show that the transformation $Q = \sqrt{2q}\ e^{t} \cos p$, $p = \sqrt{2q}\ e^{-t} \sin p$ is a canonical transformation.

Or

(b) Find the $K - H$ functions for the transformation

$$Q = q - tp + \frac{1}{2} g t^2$$

$$P = p - gt.$$

15. (a) Describe the michelson-morley experiment.

Or

(b) Give an classification of interval between events.

PART C — ($5 \times 10 = 50$ marks)

Answer ALL questions.

16. (a) State and prove the De Alemberts principle.

Or

(b) State and prove the Konig's theorem.

17. (a) Derive the Lagrange's equation of motion in terms of Routhian functions.

Or

(b) Using the method of Ignoration of coordinate obtain the integrals of motion of a spherical pendulum of length l.

18. (a) State and prove the principle of least action.

Or

(b) State and prove the Jacobi's theorem.

19. (a) Consider the transformation $Q = \sqrt{q}\cos p,\ P = \sqrt{q}\sin p$. Show that it represents a canonical transformation with $\mu \neq 1$. Solve for the new Hamiltonian function for a system having $T = \frac{1}{2}m\dot{q}^2,\ V = \frac{1}{2}kq^2$.

Or

(b) Define Lagrange bracket and give an example. Show that the Lagrange bracket is invariant under a canonical transformation.

20. (a) Discuss the Lagrangian and Hamiltonian formulation in relativity.

Or

(b) Discuss the motion of Rocket with
(i) Constant acceleration and
(ii) Constant thrust.

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