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Reg. No. :

Code No. : 7121

Sub. Code : PMAM 23

M.Sc. (CBCS) DEGREE EXAMINATION, APRIL 2018.

Second Semester

Mathematics

CLASSICAL MECHANICS

(For those who joined in July 2017 onwards)

Time : Three hours

Maximum : 75 marks

SECTION A — (10 × 1 = 10 marks)

Answer ALL questions.

Choose the correct answer :

1. The differential equation of motion of the particle is

(a) $\vec{F} = \frac{d\vec{V}}{dt}$ (b) $\vec{F} = \vec{a}$
(c) $\vec{F} = \frac{-1}{a}$ (d) $\vec{F} = \frac{d\vec{p}}{dt}$

2. A system of N particles free from constraints has _____ degrees of freedom.

(a) $3N$ (b) $\frac{N}{2}$
(c) $4N$ (d) $\frac{N}{3}$

3. The Lagrangian $L =$

(a) $T + V$ (b) $T - V$
(c) TV (d) $\frac{T}{V}$

4. In Gaussian units $\nabla \cdot \vec{D} =$

(a) 0 (b) $\frac{4\pi J}{C}$
(c) $4\pi\rho$ (d) $\nabla \cdot \vec{B}$

5. The geodesics of a spherical surface are _____.

(a) sphere (b) cones
(c) great circles (d) straight lines

6. The shortest distance between any two points of a plane is

(a) circle (b) cylinder
(c) sphere (d) straight line

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7. The reduced mass $\mu =$

(a) $m_1 - m_2$ (b) $m_1 + m_2$

(c) $\frac{m_1 + m_2}{m_1 m_2}$ (d) $\frac{m_1 m_2}{m_1 + m_2}$

8. $\frac{1}{2} m r^{-2} + \frac{1}{2} \frac{l^2}{m n^2} + v = \text{_____}$.

(a) 0 (b) $\frac{1}{2}$

(c) $\frac{3}{2}$ (d) constant

9. If the orbit is a circle then $e =$

(a) 0 (b) 1

(c) 2 (d) $\frac{1}{2}$

10. The polar angle can be expressed by $1 + e \cos \theta =$

(a) $\frac{\cos \psi - e}{1 - e \cos \psi}$ (b) $\frac{1 - e^2}{1 - e \cos \psi}$

(c) $\frac{e^2 - 1}{1 - e \cos \psi}$ (d) $\frac{e - \cos \psi}{1 - e \cos \psi}$

SECTION B — (5 × 5 = 25 marks)

Answer ALL questions, choosing either (a) or (b).

11. (a) State and prove the conservation theorem for the angular momentum of a particle.

Or

- (b) Define the holonomic constraints and the nonholonomic constraints. Give examples.

12. (a) State and explain the principle of virtual work.

Or

- (b) Discuss the motion of one particle using plane polar coordinates.

13. (a) State and prove Hamilton's principle.

Or

- (b) Find the minimum surface of revolution.

14. (a) Prove that the central force motion of two bodies about their center of mass can be reduced an equivalent one-body problem.

Or

- (b) State and prove the virial theorem.



15. (a) Derive Kepler's equation.

Or

- (b) Using usual rotation prove that

$$\bar{A} = P \times \bar{L} - mk \frac{\bar{r}}{r}.$$

SECTION C — (5 × 8 = 40 marks)

Answer ALL questions, choosing either (a) or (b).

16. (a) Show that the K.E. of the system can be expressed as the sum of the K.E. of motion of the centre of mass and the K.E. motion.

Or

- (b) State and prove the conservation theorem for the total energy of the system.

17. (a) Derive Lagrange's equation from D'Alemberts principle.

Or

- (b) Obtain the Lagrange equations of motion for a spherical pendulum.

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18. (a) Derive Lagrangian equations from Hamilton's principle.

Or

- (b) A heavy particle is placed at the top of a vertical hoop. Calculate the reaction of the hoop on the particle by means of the Lagrange's undetermined multipliers. Find the height at which the particle falls off.

19. (a) Show that the central force motion is always planar and that in a motion, the time derivative of a areal velocity vanishes.

Or

- (b) Using virial theorem, derive Boyle's Law for perfect gases.

20. (a) State and prove Kepler's third law of planetary motion.

Or

- (b) Obtain the relation $\tan \frac{\theta}{2} = \sqrt{\frac{1+e}{1-e}} \tan \frac{\psi}{2}$.

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