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**63/1 (SEM-6) DSE3/PHYHE6036**

**2024**

**PHYSICS**

Paper : PHYHE6036

**(Classical Dynamics)**

*Full Marks : 80*

*Pass Marks : 32*

Time : Three hours

***The figures in the margin indicate full marks for the questions.***

1. Choose the correct answer (**any six**): 1×6=6
- (a) The law of conservation of linear momentum is derived from
- (i) First law
  - (ii) Second law
  - (iii) Third law
  - (iv) It has no concern with Newton's law

(b) The rate of change of angular momentum is called

- (i) kinetic energy
- (ii) linear momentum
- (iii) force
- (iv) torque

(c) Constraint in a rigid body is

- (i) holonomic
- (ii) nonholonomic
- (iii) scleronomic
- (iv) None of the above

(d) Generalised co-ordinates are

- (i) dependent of each other
- (ii) independent of each other
- (iii) necessarily be spherical co-ordinates
- (iv) surely be Cartesian co-ordinates

(e) The Lagrangian of a system describes the motion of

- (i) a harmonic oscillator
- (ii) an anharmonic oscillator
- (iii) a damped harmonic oscillator
- (iv) a system with unbound motion

(f) If for a harmonic oscillator

$T \rightarrow$  Kinetic energy

$V \rightarrow$  Potential energy

$L \rightarrow$  Lagrangian

$H \rightarrow$  Hamiltonian,

then choose the correct relation :

(i)  $L = V - T, H = V + T$

(ii)  $L = T - V, H = T + V$

(iii)  $L = T + V, H = T - V$

(iv)  $L = VT, H = V - T$

(g) A force, directed always away or towards a fixed point and is a function of the distance from the fixed point is called

- (i) Coriolis force
- (ii) Central force
- (iii) Centripetal force
- (iv) Centrifugal force

(h) The areal velocity of a planet in terms of angular momentum  $L$  and reduced mass  $\mu$  is given by

- (i)  $L/\mu$
- (ii)  $L/2\mu$
- (iii)  $2L/\mu$
- (iv)  $\sqrt{2\mu L}$

(i) An example of stable equilibrium is

- (i) a book placed flat anywhere on the table
- (ii) an egg standing on one end

(iii) a pendulum in the rest position

(iv) None of the above

(j) A particle is moving under a central force. Which of the following physical quantities remains constant?

- (i) Linear momentum
- (ii) Kinetic energy
- (iii) Angular momentum
- (iv) Work

2. Answer the following questions : **(any five)**  
2×5=10

- (a) What are constraints ? Explain.
- (b) Define gyroradius and gyrofrequency.
- (c) What is the Hamiltonian function ?
- (d) What are coupled Oscillators ?
- (e) What are inertial and non-inertial frames of reference ?
- (f) What is time dilation ?
- (g) What is Reynold's number ?

3. Answer the following questions : **(any six)**  
5×6=30

- (a) Derive Navier-Stokes equations.
- (b) What are generalised co-ordinates? Describe the advantage of using generalised co-ordinates in solving mechanical problems.
- (c) Deduce general form of Lagrange's equation.
- (d) Deduce Hamilton's equation for simple harmonic oscillations.
- (e) Briefly discuss the Lagrangian formulation of small oscillation.
- (f) What is a rigid body? Obtain Euler's equation of motion for a rigid body.
- (g) Discuss the principle of relativity and the invariance of speed of light.
- (h) Derive the expressions for the Lorentz space-time transformation.
- (i) Deduce continuity equation for a flow of liquid.
- (j) Establish Navier-Stokes equation.

4. Answer the following questions : **(any two)**  
10×2=20

- (a) Show that Lagrange's equation is invariant under Galilian transformation.
- (b) Derive the Euler-Lagrange equations of motion using the calculus of variations and hence obtain Lagrange's equation of motion for a system of particles.
- (c) Discuss one experiment in support of time dilation in special relativity.
- (d) Deduce Poiseuille's equation for a flow of a liquid through a pipe.

5. Answer the following question : **(any one)**  
14×1=14

- (a) Write short notes on—
  - (i) four momentum and energy-momentum relation
  - (ii) Lorentz transformations

- (b) Obtain the Lagrangian equation of motion for a free particle in cylindrical and spherical polar co-ordinates.
- (c) What is D'Alembert's principle? Derive Lagrange's equations of motion from it for conservative system.
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