Roll No. : ....

Total No. of Questions : **11**] [Total No. of Printed Pages : **4**

BPP–1096

M.Sc. (Previous) Examination, 2022

PHYSICS

Paper - I

(Mathematical Physics and Classical Mechanics)

Time : 3 Hours] [*Maximum Marks : 75*

Section–A **(Marks : 2 × 10 = 20)**

Note :– Answer all *ten* questions (Answer limit **50** words). Each question carries **2** marks.

Section–B **(Marks : 5 × 5 = 25)**

Note :– Answer all *five* questions. Each question has internal choice (Answer limit **200** words). Each question carries **5** marks.

Section–C **(Marks : 10 × 3 = 30)**

Note :– Answer any *three* questions out of five (Answer limit **500** words). Each question carries **10** marks.

Section–A

1. (i) What does linear independence mean in vector space ? How dimensionality of vector space related to it ?

   (ii) Define Hermitian and Skew-Hermitian matrices.

   (iii) Write Bessel's differential equation. Write the conditions to get cylindrical and spherical Bessel functions.

(iv) Write Rodrigues' formula for generating Legendre polynomials.

(v) Define holonomic and non-holonomic constraints.

(vi) Define generalized coordinates and generalized momentum.

(vii) Define Action and write the statement of Hamilton's principle.

(viii) Write the all four forms of generating functions used in canonical transformations.

(ix) Define interial and non-inertial frames. Explain the term pseudo force also.

(x) Write the conditions for stability and closure of orbits.

Section–B

2. Diagonalize the following matrix :

$$\begin{bmatrix} 1 & 0 & 1 \\ 0 & 1 & 2 \\ 2 & 0 & 1 \end{bmatrix}$$

Or

Find the eigenvalues and eigenvectors for the following matrix :

$$\begin{bmatrix} 1 & -1 & 0 \\ 0 & 0 & 0 \\ 0 & -3 & 3 \end{bmatrix}$$

3. Write Legendre differential equation and obtain its solution.

Or

Show that :

(i) $J_{1/2}(x) = \sqrt{\frac{2}{\pi x}} \sin x$ (ii) $J_{-1/2}(x) = \sqrt{\frac{2}{\pi x}} \cos x$

4. Evaluate :

(i) $L^{-1}\left(\frac{e^{-s}}{s^2 + w^2}\right)$ (ii) $L^{-1}\left[\ln \frac{(s^2+1)}{(s-1)^2}\right]$

Here : L^{-1} means inverse Laplace transformation

Or

Define the term cyclic co-ordinate. Prove that if space is isotropic then angular momentum of system is conserved.

5. A solid homogeneous cylinder of radius r, rolls without slipping on the inside of a stationary large cylinder of radius R.

(i) Find the equation of motion using Langrange equation.

(ii) Determine the time period of small oscillation about the stable equilibrium position.

Or

Prove that the transformation :

$$P = q \cot p$$

$$Q = \log\left(\frac{\sin p}{q}\right)$$

is canonical and find the generating function.

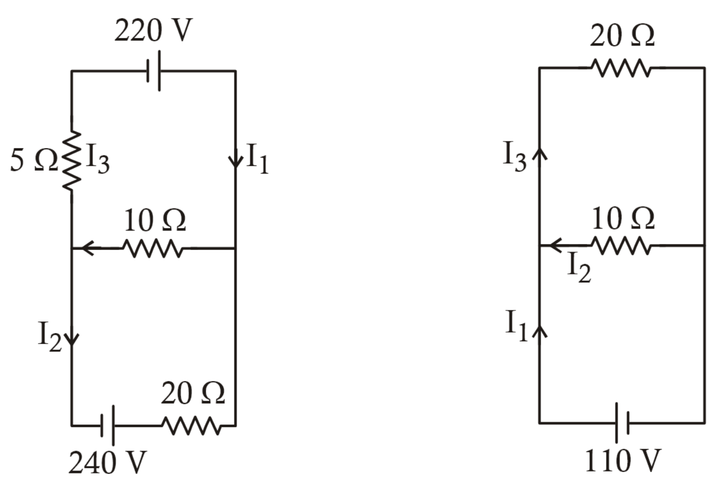
6. Define Coriolis Force. Let an object is thrown in vertical upward direction from earth surface with initial velocity 'u'. Find the horizontal deflection due to Coriolis force if projection of object is from equator.

Or

Define Central Force. Using Langrage equation of motion prove that angular momentum and energy are conserved for the motion of particle under the action of central force.

Section–C

7. How set of linear equations can be expressed in form of matrix ? Explain with example. Write Cramer's rule for linear system of three equations. Find the currents in the following networks using Cramer's rule : 2+3+5



8. Use power series method to solve the following equations :

(i) $y'' + y = 0$

(ii) $x^2 y'' + xy' + \left(x^2 - \frac{1}{9}\right) y = 0$

The solution of equation (ii) represent which type of special function ? Derive the following relation :

$$2J_n'(x) = J_{n-1}(x) - J_{n+1}(x)$$ 2+4+1+3

9. Explain the term virtual work. Write D'Alembert principle. Using D'Alembert principle derive Lagrangian equation of motion. Find the period of compound pendulum using Lagrangian equation. 2+2+4+2

10. Define the Poisson bracket. Prove that :

(i) [X, Y + Z] = [X, Y] + [X, Z]

(ii) [X, YZ] = Y[X, Z] + [X, Y]Z

(iii) $[J_x, J_y] = J_z$

Here J_x, J_y and J_z are angular momentum in X, Y and Z direction respectively

(iv) $[J_y, P_x] = -P_z$

(v) $[J_z, P_x] = P_y$

Here P_z and P_y are momentum in z and y directions. 1+1½+1½+2+2+2

11. Define differential scattering cross-section. Explain the term impact parameter also. Find relation between these two quantities. For the central force f that is inversely proportional to square of the distance calculate scattering cross-section. 1½+1½+2+5