Roll No. : ....

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

BPG–1108

M.Sc. (Previous) Examination, 2021

PHYSICS

Paper - I

(Mathematical Physics and Classical Mechanics)

Time : 1½ 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 2 each

1. (i) What is inner product of a vector space ?

   (ii) Define the orthogonal and unitary matrices.

(iii) Explain the order of a differential equation.

(iv) Write the first *four* Legendre polynomials and draw their graphical representation.

(v) Define the Fourier transformation and inverse Fourier transformation.

(vi) Write all the comervation laws in mechanics.

(vii) Explain the assumptions of Hamilton-Jacobi method and write Hamilton-Jacobi equation.

(viii) Write the principle of least action.

(ix) What are Euler angles in a rotating frame ?

(x) Explain the stability condition of circular orbits.

Section–B 5 each

2\. (a) Determine the Eigen values and Eigen vectors of the following matrix :

$$A = \begin{bmatrix} 3 & 1 & 4 \\ 0 & 2 & 0 \\ 0 & 0 & 5 \end{bmatrix}$$

Or

(b) What do you mean by inverse of a matrix ? If A and B are two square matrices of $n \times n$ dimensions then prove that :

$$(AB)^{-1} = B^{-1}A^{-1}$$

3\. (a) Write the Hermite differential equation and obtain its solutions.

Or

(b) Prove the following orthogonality relation of Legendre polynomial :

$$\int_{-1}^{1} P_n(x)P_m(x)dx = \frac{2}{(2n+1)}\delta mn$$

4. (a) Describe method to find Laplace transform of periodic functions and evaluate Laplace transform of the following periodic function :

$$F(t) = \begin{cases} \sin t, & 0 < t < \pi \\ 0, & 0 < t < 2\pi \end{cases}$$

Or

(b) Define the generalized momenta and prove that if space is homogeneous then linear momentum of system is conserved.

5. (a) Using Hamilton-Jacobi method find solution of a linear harmonic oscillator.

Or

(b) Write all the four types of generating functions of canonical transformations, obtain their transformation relations.

6. (a) Derive expression for coriolis force.

Or

(b) A particle is moving under influence of force $f(r) = \frac{-k}{r^2}$ where $k > 0$. Obtain its equation of orbit and show that shape of orbit can be represented by conic sections.

Section–C 10 each

7. Define the Eigen value and Eigen vectors for a matrix and prove the Cayley-Hamilton theorem.

8. Deduce the solutions for Bessel's differential equation and prove the following recurrence relation :

$$x \frac{dJ_n(x)}{dx} = nJ_n(x) - xJ_{n+1}(x)$$

9. Derive Lagrangian equation of motion and prove that it remains invariant under Gallilion transformation.

10. Define the Poisson bracket. For two dynamical variables X and Y prove that for a canonical transformation the following identity is true :

$$[X, Y]_{Q,P} = [X, Y]_{q,p}$$

11. Derive the formula of cross-section in the Rutherford scattering.