Roll No. : .....

Total No. of Questions : **11**] [Total No. of Printed Pages : **3**

SPL–1020

M.Sc. (Previous) Special (Competition) 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

1. Attempt all questions :

(i) Determine if A is an orthogonal matrix :

$$A = \begin{bmatrix} -1 & 0 \\ 0 & 1 \end{bmatrix}$$

(ii) Define unitary matrix.

(iii) Write any *two* Recurrence relations of Laguerre Polynomials.

(iv) Write Rodrigue's formula for Hermite Polynomial.

(v) Find the Laplace transform of e^{Kt}.

(vi) Explain the principle of virtual work.

(vii) Write any *two* conditions for a transformation to be canonical.

(viii) Write the advantage of Hamiltonian approach when compared to Lagrangian approach.

(ix) Writing Rutherford's formula for the scattering cross-section, discuss important consequences.

(x) Explain any *one* phenomenon caused by effect of coriolis force.

Section–B

2. Prove 'Diagonalizing matrix of a Hermitian matrix is unitary.'

Or

Find the inverse of a matrix :

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

3. For Bessel's function prove that :

$$J_{n+3} + J_{n+5} = \frac{2}{x}(n+4)J_{n+4}$$

Or

For Hermite polynomial, show that :

$$H_n'' - 2x H_n' + 2n H_n = 0$$

4. Explain two shifting properties of Laplace transform.

Or

Use Lagrange's equation of motion to determine the motion of mass m, sliding without friction on an inclined plane of angle α.

5. Derive equation of motion of simple pendulum using Hamilton's equation of motion.

Or

Define Poisson Bracket and express equation of motion in Poisson Bracket form.

6. Discuss the condition for stability of orbits using :

$$V(r) = Kr^{n+1}$$

Or

Derive Kepler's second law of planetary motion.

Section–C

7. Find the eigenvalues of the matrix :

$$C = \begin{bmatrix} 1 & -1 & 1 \\ -1 & 1 & -1 \\ 1 & -1 & 1 \end{bmatrix}$$

8. Show that :

$$P_n(u) = \frac{1}{2^n n!} \frac{d^n}{d\mu^n} (\mu^2 - 1)^n$$

9. Obtain the general form of the Lagrange's equation from D'Alembert's principle.

10. Slate and discuss the principle of least action.

11. Obtain the expression of acceleration of a particle in rotating co-ordinate system. Explain the significance of each term of the formula.