Name: **Enrolment No:**	UPES UNIVERSITY WITH A PURPOSE

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination Dec 2021 and Jan 2022

Course: Classical Mechanics **Semester: I**
Program: MSc Physics **Time 03 hrs.**
Course code: PHYS7001 **Max. Marks: 100**

SECTION A

1. **Each Question will carry 4 Marks**
2. **Instruction: Complete the statement / Select the correct answer(s)**

S. No.	**Question**	**CO**
Q 1	Show that the transformation $$P = \frac{1}{2}(p^2 + q^2), \qquad Q = tan^{-1}\frac{q}{p}$$ is canonical	**CO2**
Q2	Write the Lagrangian and equation of motion for a mass m suspended to a spring of force constant k and allowed to swing vertically.	**CO3**
Q3	A clock keeps correct time. With what speed should it be moved relative to an observer so that it may seem to lose 2 minutes in 24 hrs.	**CO1**
Q4	A particle of unit mass moves in a potential $V(x) = ax^2 + \frac{b}{x^2}$, where a and b are positive constants. Determine the angular frequency of small oscillations about the minimum of potential.	**CO3**
Q5	Determine the value of the Poisson's bracket $[J_y, z]$	**CO2**

SECTION B

1. **Each question will carry 10marks**
2. **Instruction: Write short / brief notes**

Q 6	A particle of mass m moves under the action of central force whose potential is V(r) = Kmr^3 (K>0), then determine the value of kinetic energy and angular momentum for which the orbit will be a circle of radius R about origin. Also calculate the period of circular motion.	**CO2**
Q 7	Describe the scattering in a central force field and hence obtain the expression for scattering cross-section in Rutherford scattering.	**CO3**
Q 8	Discuss mass energy equivalence relation and obtain the relation $E = mc^2$.	**CO2**
Q.9	The Lagrangian of a system is given by $L = \frac{1}{2}m\dot{q}_1^2 + 2m\dot{q}_2^2 - K\left[\frac{5}{4}q_1^2 + 2q_2^2 - 2q_1q_2\right]$ m and K are constants. Determine the frequencies of the normal modes of the system	**CO3**

Section C

1. **Each Question carries 20Marks.**
2. **Instruction: Write long answer.**

Q10	Discuss the vibrations of a linear triatomic molecule of type AB_2. Obtain the frequencies of the normal modes. OR Obtain the Lagrange's equation of motion from variational principle	**CO3** **CO3**
Q.11	Show that for a particle, moving under central force f (r), the equation of orbit is given by $$\frac{d^2u}{d\theta^2} + u = -\frac{m^2u^2}{l^2} f\left(\frac{1}{u}\right)$$	**CO2**

List of important Constants

Planck's constant, h = 6.6 x 10^{-34} J.s
Boltzmann's constant, k = 1.38 x 10^{-23} J/K
Mass of electron, m_e = 9.1 x 10^{-31} Kg
Mass of proton, m_p = 1.67 x 10^{-27} Kg
Velocity of light, c = 3 x 10^8 m/s
Rydberg Constant, R = 1.097 x 107 m-1
Avogadro's number = 6.023 x 1023
Permeability of free space, $\mu_o = 4\pi$ x 10^{-7} Henry/m
Permittivity of free space, ε_o = 8.85 x 10^{-12} F/m