Name: **Enrolment No:**	

UPES

End Semester Examination, December 2023

Course: Classical Mechanics — **Semester: VII**

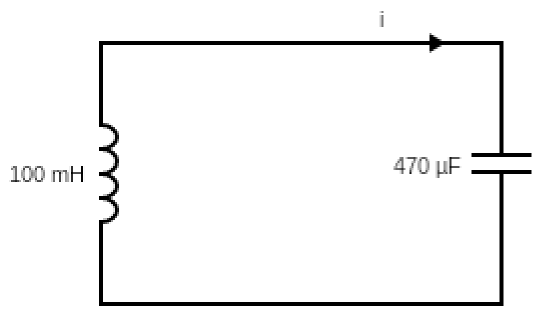
Program: BSc Physics by research — **Time : 03 hrs.**

Course Code: PHYS3030 — **Max. Marks: 100**

Instructions: All questions are compulsory and there is internal choices in question no 9 and 11.

SECTION A

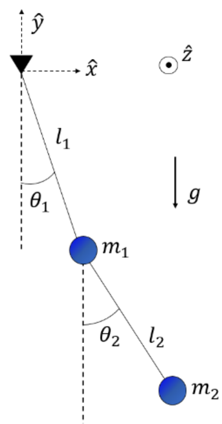
(5Qx4M=20Marks)

S. No.		Marks	CO
Q 1	State the Variational Principle and obtain the condition for extremum path.	**04**	**CO1**
Q.2	Obtain the Lagrangian equation of motion for the LC circuit shown below.  	**04**	**CO3**
Q.3	Determine the frequency of a Harmonic oscillator by Hamilton's equations of motion.	**04**	**CO3**
Q.4	Determine the velocity with which a body moves for its mass to become twice its rest mass.	**04**	**CO2**
Q.5	The potential of a diatomic molecule as a function of the distance (r) between the atoms is given by $V(r) = -\frac{a}{r^6} + \frac{b}{r^{12}}$. Determine the value of the potential at equilibrium separation between the atoms.	**04**	**CO1**

SECTION B

(4Qx10M= 40 Marks)

S. No.		Marks	CO
Q 6.	State the Hamilton's principle and use it to obtain Hamilton's equation of motion.	**10**	**CO3**
Q.7.	A particle of mass 'm' moves inside a bowl. If the surface of the bowl is given by the equation $z = \frac{1}{2}a(x^2 + y^2)$ determine the Lagrangian of the system.	**10**	**CO3**
Q.8.	Define the Virial theorem and show that for particle moving in a central force field $\overline{T} = -\frac{1}{2}\overline{V}$.	**10**	**CO1**

Q.9.	A particle of mass 'm' and coordinate 'q' has the Lagrangian $L = \frac{1}{2} m\dot{q}^2 - \frac{\lambda}{2} q\dot{q}^2$. Calculate the Hamiltonian of the system. OR Lagrangian of a system is given by $$L = \frac{1}{2}m\dot{q}_1^2 + 2m\dot{q}_2^2 - 5k\left(\frac{5}{4}q_1^2 + 2q_2^2 - 2q_1q_2\right)$$ Where 'm' and 'k' are positive constants. Determine the frequencies of its normal modes.	**10**	**CO3**
SECTION-C **(2Qx20M=40 Marks)**			
Q.10	Discuss the scattering in central force filed through Lagrangian formulation and thus obtain expression for total scattering cross-section of alpha particle scattering through nucleus.	**20**	**CO2**
Q.11	Apply the theory of small oscillations to obtain the secular equation for a double pendulum as shown below and hence determine its normalized frequencies.  OR Discuss the general theory of small oscillations and thus interpret the secular equation and the eigen value equation, hence deduce the method to obtain the resonating frequencies.	**20**	**CO3**