Name: **Enrolment No:**	UPES UNIVERSITY OF TOMORROW

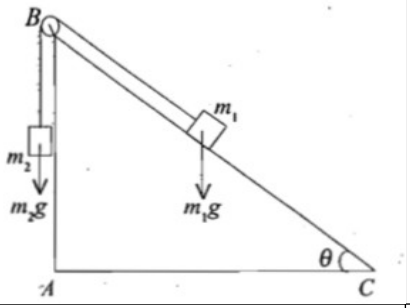
UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, May 2022

Course: Classical Dynamics
Semester: VI
Program: B.Sc [Physics] **Time : 03 hrs.**
Course Code: PHYS3010D **Max. Marks: 100**

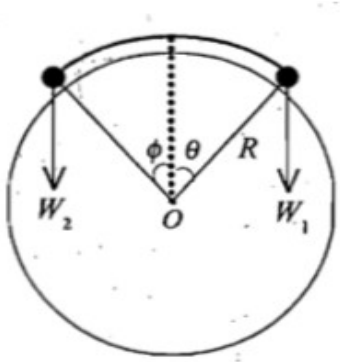
Instructions:

- All questions are compulsory (**Q9** and **Q10** have an internal choice).
- Scientific calculators can be used for calculations

SECTION A
(5Qx4M=20Marks)

S. No.		Marks	CO
Q 1	Determine the number of degrees of freedom in the following cases [i] The bob of a simple pendulum oscillating in a plane [ii] Dumbbell moving in a space	**4**	**CO1**
Q 2	Write the Lagrange's equation and Hamilton principle.	**4**	**CO1**
Q 3	An inextensible string of negligible mass hanging over a smooth pully B connects one mass m_1 on a frictionless inclined plane θ to another mass m_2. Using D'Alembert principle, prove that the masses will be in equilibrium, if $\sin\theta=\frac{m_2}{m_1}$ 	**4**	**CO1**
Q 4	Define generalized coordinates and their significance in classical dynamics.	**4**	**CO1**
Q 5	In the following cases, discuss whether the constraints are holonomic or non-holonomic. Specify the constraint force also I. The motion of a body on an inclined plane under gravity II. A bead on a circular wire	**4**	**CO1**

SECTION B
(4Qx10M= 40 Marks)

Q 6	Two heavy particles of weight W_1 and W_2 are connected by a light inextensible string and hang over a fixed smooth circular cylinder of radius R, the axis of which is horizontal [Fig]. Find the condition of equilibrium of the system by applying the principle of virtual work. 	**10**	**CO1**
Q 7	Define the retarded potential and retarded time. Derive the expression of Lienard- Wiechert potential.	**10**	**CO2**
Q 8	Define the power radiation by the accelerated charge and Derive the Larmor's formula to calculate the total power radiated in all directions	**10**	**CO3**
Q 9	Show that transformation defined by $q=\sqrt{2P}\sin Q$, $p=\sqrt{2P}\cos Q$ is canonical by using the Poisson bracket. **OR** What is the Doppler effect? Explain the Doppler effect from a four-vector perspective	**10**	**CO3**
SECTION-C (2Qx20M=40 Marks)			
Q 10	[a] In frame S, two events have the space-time coordinates $(0,0,0,0)$ and $(5c,0,0,3)$, where time coordinates in seconds. Find the space-time interval between them. Calculate the velocity of a frame in which [i] the two events are simultaneous, [ii] the first event occurs 1 sec earlier than the second, [iii] the second event occurs 1 sec earlier than the first What is the limit for the maximum time interval between these events? [b] An excited atom of total mass M, at rest concerning an inertial frame, goes over into a lower state with energy smaller energy. It emits a photon and thereby undergoes a recoil. The frequency of the photon will not be exactly $\nu=\Delta W/h$, but smaller. Compute this frequency. **OR** [a] Show that the relativistic form of Newton's second law, when F is	**20**	**CO2**

	parallel to v is $\vec{F}=\frac{md\bar{v}}{dt}\left(1-\frac{v^2}{c^2}\right)^{-3/2}$ [b] Show that the rest mass of a particle of momentum p and kinetic energy T is given by $m_0=\frac{p^2c^2-T^2}{2Tc^2}$		
Q. 11	[a] Explain Minkowski's four-dimensional formalism, highlighting the significance of the fourth component of momentum and the equation of motion. Explain the space and time like in four-vectors. [b] Calculate the length contraction of a rod moving with a velocity of 0.8c in a direction inclined at 45° to its length. Calculate the percentage contraction of a rod moving with a velocity of $0.9c$ in a direction inclined at 45° to its length.	**20**	**CO4**