Name: Enrolment No:	UPES UNIVERSITY WITH A PURPOSE

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
Online End Semester Examination, Dec 2020

Course: Classical Dynamics — Semester: V
Program: B.Sc [Physics Hons.] — Time: 03 hrs.
Course Code: PHYS 3010 — Max. Marks: 100

SECTION A

1. Section A is consist of six questions and each question is of five marks.
2. All the questions are compulsory.

S. No.		Marks	COs
Q.1	Determine the frequencies of a harmonic oscillators of mass m, for which the Hamiltonian is given by $H = \frac{1}{2}\left[\frac{p^2}{m} + \mu q^2\right]$ [a] $v = \frac{1}{2\pi}\sqrt{\frac{\mu}{m}}$ [b] $v = \frac{1}{\pi}\sqrt{\frac{\mu}{m}}$ [c] $v = \frac{1}{2\pi}\sqrt{\frac{2\mu}{m}}$ [d] $v = \frac{1}{2\pi}\sqrt{\frac{\mu}{2m}}$	5	CO1
Q.2	If the generating function has the form $F = F\,(q_k, P_k, t)$, then [a] $p_k = \frac{\partial F}{\partial q_k},\ Q_k = \frac{\partial F}{\partial P_k}$ [b] $p_k = -\frac{\partial F}{\partial q_k},\ Q_k = \frac{\partial F}{\partial P_k}$ [c] $p_k = \frac{\partial F}{\partial q_k},\ Q_k = -\frac{\partial F}{\partial P_k}$ [d] $p_k = -\frac{\partial F}{\partial q_k},\ Q_k = -\frac{\partial F}{\partial P_k}$	5	CO1
Q.3	A space ship moving away from the earth with velocity 0.6c fires a rocket (whose velocity relative to the spaceship is 0.7c away from the earth [a] .92c [b] 9.2c [c] 92c [d] 0.092c	5	CO2
Q.4	The proper life of π+ meson is 2.5 x 10^{-8} s. If a beam of these mesons of velocity 0.8c is produced, calculate the distance the beam can travel before the flux of the meson, beam is reduced to $\frac{1}{e}$ [a] 4.166X10^{-8}s [b] 4.166X10^{-6}s [c] 4.166X10^{-7}s [d] 4.166X10^{-5}s	5	CO2
Q.5	The velocity at which electron mass is $\sqrt{3}$ times the rest mass is [a] 2.448 X 10^8 m/s [b] 3.448 X 10^8 m/s [c] 2.448 X 10^7 m/s [d] 3.448 X 10^7 m/s	5	CO3

Q.6	An experimenter measures the length of a rod. Initially, the experimenter and the rod are at rest with respect to the lab. Consider the following statements. (A) If the rod starts moving parallel to its length but the observer stays at rest, the measured length will be reduced. (B) If the rod stays at rest but the observer starts moving parallel to the measured length of the rod, the length will be reduced (a) A is true but B is false (b) B is true but A is false (c) Both A and B are true (d) Both A and B are false	5	CO3
SECTION B 1. Section B containing five questions and each of ten marks. 2. All the questions are compulsory.			
Q.7	[a] Determine the number of degree of freedom in the following cases [i] A particle moving on the conference of a circle [ii] Two particles connected by a rigid rod moving freely in a plane [iii] The bob of a simple pendulum oscillating in a plane [iv] Dumbbell moving in a space [b] Write the Lagrange's equation and Hamilton principle with its significance.	5+5	CO1
Q.8	[a] Derive Newton's second law of motion from Lagrange's equations. [b] Derive the Lagrange's equation of motion for an electrical circuit comprising an inductance L and capacitance C. The capacitor is charged to q coulombs and the current flowing in the circuit is I amperes.	5+5	CO1
Q.9	[a] How much younger an astronaut will appear to earth observer if he returns after one year having moved with a velocity 0.5c? [b] What is the Doppler effect? Explain the Doppler effect from a four-vector perspective.	5+5	CO3
Q.10	Define the retarded potential and retarded time. Derive the expression of Lienard-Wiechert potential.	10	CO4
Q. 11	Define the power radiation by the accelerated charge and Derive the Larmor's formula to calculate the total power radiated in all directions.	10	CO4
	SECTION-C 1. Section C is consists of one question of 20 marks 2. The choice is also given in this section.		

Q. 12	[a] Explain Minkowski's four-dimensional formalism bringing out the significance of the fourth component of momentum and the equation of motion. Explain the space like and time like in four-vectors. [b] Calculate the percentage contraction of a rod moving with a velocity of 0.8c in a direction inclined at 60° to its own length. Calculate the percentage contraction of a rod moving with a velocity of $0.8c$ in a direction inclined at 60° to its own length. [c] Show that the rest mass of a particle of momentum p and kinetic energy T is given by $$m_0 = \frac{p^2c^2 - T^2}{2Tc^2}$$ **OR** [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] Show that four-dimensional volume $dx\,dy\,dz\,dt$ is invariant under Lorentz transformations. [c] Show that the momentum of a particle of rest mass m_0 and kinetic energy K_E is given by the expression. $$p = \sqrt{\left(\frac{K_E^2}{c^2} + 2m_0K_E\right)}$$	10+5+ 5= 20	CO3