Mahindra University Hyderabad

École Centrale School of Engineering

Minor-I exam

Program: B. Tech. Branch: All Year: 1 Semester: 2

Subject: Physics 1 (PH1201)

Date: 29.02.24 Start Time: 10 am

Time Duration: 1.5 Hours Max. Marks: 60

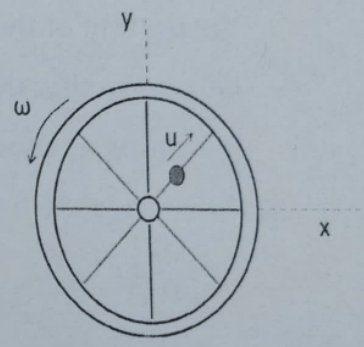
Instructions:

1) **All the questions are compulsory**

Q1 (10 +10)

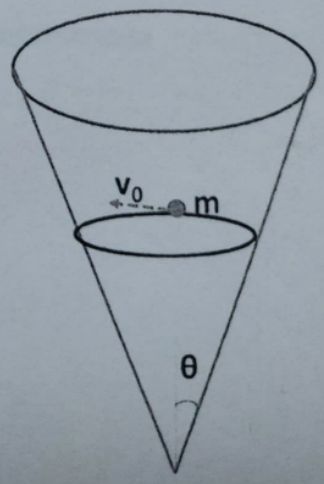
(a) Consider a particle moving in the x-y plane according to $\vec{r} = r(\cos \omega t\, \hat{\imath} + \sin \omega t\, \hat{\jmath})$, where r and ω are constants. Find the velocity and acceleration. Also, draw the trajectory.

(b) A bead moves outwards with constant speed 'u' along the spoke of a wheel and the wheel rotates about its axis with constant angular velocity $\dot{\theta} = \omega$. At t =0 spoke is along the x-axis and bead is at origin. Find the bead's velocity and acceleration at time t (in polar coordinates).



Q2 (10 +10)

(a) A particle of mass m slides without friction on the inside of a cone. The axis of the cone is vertical, and gravity is directed downward. The apex half-angle of the cone is θ, as shown. The path of the particle happens to be a circle in a horizontal plane. The speed of the particle is v_0.
Draw a force diagram and find the radius of the circular path in terms of v_0, g, and θ.



(b) A rubber ball of mass 0.1 kg falls to the floor. The ball hits with a speed of 10 m/s and rebounds with approximately the same speed. High-speed photographs show that the ball is in contact with the floor for $2*10^{-3}$ s. What is the average force exerted on the ball by the floor?

Q3 (10 +10)

(a) For what values of n are circular orbits stable with the potential energy

$U(r) = -\frac{A}{r^n}$ where A > 0? Note that $U_{eff}(r) = U(r) + \frac{L^2}{2\mu r^2}$

(b) A bead of mass m slides without friction on a vertical hoop of radius R. The bead moves under the combined influence of gravity and a spring of spring constant k attached to the bottom of the hoop. For simplicity assume, the equilibrium length of the spring to be zero so that the force due to the spring is -kr, where r is the instantaneous length of the spring as shown. The bead is released at the top of the hoop with negligible speed. How fast is the bead moving at the bottom of the hoop?