

Mahindra University Hyderabad

École Centrale School of Engineering

Minor-1

Program: B. Tech. Branch: All Year: 2022 Semester: 2
Subject: Name (PH1201)

Date: 8-03-2023

Time Duration: 1 Hour 30 minutes

Start Time: 2.00 pm
Max. Marks: 60

Instructions:

- 1) All the questions are compulsory
- 2) Calculator is allowed

Q1.

(10+10)

(a) Find the length of a vector $A = (3\mathbf{i} + 1\mathbf{j} + 1\mathbf{k})$. Find a unit vector \mathbf{n} in XY plane which is perpendicular to vector A . Find the dot product of A and \mathbf{n} .

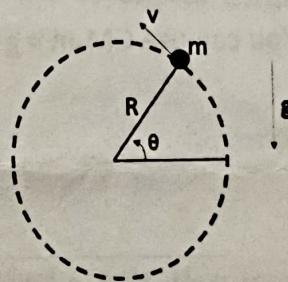
(b) Velocity of a particle in polar coordinates is given by $\mathbf{v} = \lambda r \hat{r} + \mu \theta \hat{\theta}$, where λ and μ are constants. Show that its radial component of acceleration is given by:

$$\lambda^2 r - \frac{(\mu \theta)^2}{r}$$

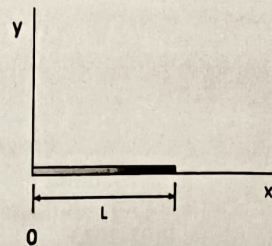
Q2.

(10+10)

(a) Mass m is whirled on the end of the string of length R . The motion is in a vertical plane in the gravitational field of the earth. The forces on m are the weight W down and string force T toward the center. The instantaneous speed is v and the string makes an angle θ with the horizontal. Using Newton's second law, find T at this instant.



- (b) A rod of length L has a nonuniform density λ , the mass per unit length of the rod varies as $\lambda = \lambda_0 (s/L)$ where λ_0 is a constant and s is the distance from the end marked 0. Find the center of mass.



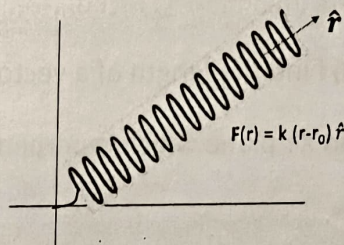
Q3

10+10

- (a) The spring force is given by $F(r) = k(r - r_0)\hat{r}$ where k is a spring constant, r_0 is unstretched length.

Is this a conservative force? explain your yes/no answer in one to two sentences.

Find the potential energy difference $U_b - U_a$ when spring is stretched from r_a to r_b .



- (b) A satellite of mass $m = 3000$ kg is in an elliptical orbit about the earth. At perigee (closest approach to earth) it has an altitude of 1100 km and at apogee (farthest distance from earth), its altitude is 4100 km.

What is the satellite energy E in Joule?

You can use $GM_em = g m R_e^2$, where $g = 10$ m/s², Radius of earth $R_e = 6400$ km

