DO NOT WRITE ANYTHING ON QUESTION PAPER EXCEPT YOUR NAME, DEPARTMENT AND ENROLMENT No.

POSSESSION OF MOBILE, SMART WATCH ETC, IN EXAMINATION IS A UFM PRACTICE

Name of Student MADHAV GUPTA Enrolment No. E22CSEU0827

Department /School SCSET

BENNETT UNIVERSITY, GREATER NOIDA

End Term Examination, EVEN SEMESTER 2022-23

COURSE CODE: **EPHY108L** MAX. DURATION: **TWO HOURS**

COURSE NAME: **Mechanics** Weightage: **40**

COURSE CREDIT: **3** MAX. MARKS: **40**

Note

- Programable calculator is not allowed.
- All questions are compulsory.

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1. Write short answers:
   a. If the unit vectors in a spherical coordinate system are $\hat{r}, \hat{\theta}, \hat{\phi}$, then determine $\hat{\phi} \times \hat{r}$. 1
   b. If velocity of a particle is described as $\vec{v}(t) = e^t(t^2 - 2t)\hat{r}$, then determine the acceleration at $t = 1$. 2
   c. A particle of mass m is following a circular trajectory such that the angular velocity is $\omega\hat{j}$. The radial vector is $r\hat{i}$ then determine the centrifugal force. 2
   d. If the angular velocity of a particle of mass m is defined as $\omega\hat{k}$ and linear velocity in the non-inertial frame is $\vec{v}_{rot} = v\hat{j}$, then determine the Coriolis force. 2
   e. A particle is rotating in the xy-plane, along a circular path in counter-clockwise direction, with angular speed ω, about z-axis. What is the position vector $\vec{r}(t)$? Given $\vec{r}(0) = a\hat{i}$. 2
   f. Some general vector $\vec{A}$ precessing with constant angular velocity $\vec{\omega}$ about the axis in direction $\hat{n}$, then what will be $\frac{d\vec{A}}{dt}$? 2
   g. The relation between inertial and a rotating frame is noted as $\left(\frac{d}{dt}\right)_{in} = \left(\frac{d}{dt}\right)_{rot} + \vec{\Omega}\times$, where $\vec{\Omega}$ is the rotation velocity. Determine the inertial velocity ($\vec{v}_{in}$) in this case. 2

2. Answer the following questions:
   a) A planet moves around the Sun. Show that the radius vector joining the planet to Sun sweeps out equal area in equal interval of time. 4

b) A planet of mass M is moving under the influence of central force $\vec{F}(r) = -\frac{A}{r^3}\hat{r}$, where A is positive constant. Determine the non-zero values of angular momentum L for which the planet will move in circular orbit. 5

c) Assuming a right-handed coordinate system, f and g are given as $f = xyz$ and $g = x + y + z$. Find the value of $\vec{\nabla} \cdot (\vec{\nabla}(fg))$ at point P (2,0,1). 4

3. Answer the following questions:

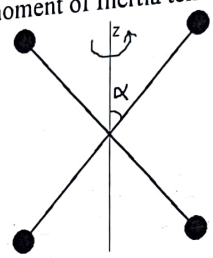
a) Calculate moment of inertia for a uniform thin ring of mass M and radius R, around the following axis

(i) Symmetry axis of the ring

(ii) Tangent to the ring and lying in the plane of the ring.

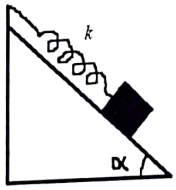
(iii) Diameter of the ring. 6

b) The figure below shows four identical masses m connected through massless rods. The rods make an angle α with respect to z axis. Distance of each mass from the intersection point of the rods is l. Find the moment of Inertia tensor of the system.



4

c) In the figure below, a block weighing 14.0 N, which can slide without friction on an incline at angle $\alpha = 40.0°$, is connected to the top of the incline by a massless spring of unstretched length 0.450 m and spring constant 120 N/m.



(i) How far from the top of the incline is the block's equilibrium point?

(ii) If the block is pulled slightly down the incline and released, what is the period of the resulting oscillations? 4

Best of Luck