(18)

(Knowledge for Development)

KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS

2020/2021 ACADEMIC YEAR

END OF SEMESTER EXAMINATIONS

THIRD YEAR SECOND SEMESTER

SPECIAL/ SUPPLEMENTARY EXAMINATION

FOR THE DEGREE OF BACHELOR OF SCIENCE

MATHEMATICS

COURSE CODE: **MAA 324**

COURSE TITLE: **DYANAMICS 2**

DATE: 18/01/2022 **TIME:** 2:00 – 4:00 PM

INSTRUCTIONS

Answer **Questions ONE a**nd Any other **TWO**

QUESTION ONE [30MKS]

a. The position of an electron is given by $\vec{r} = 3ti - 4t^2 j + 2k$. (5mks)

   i. What is $\vec{v}$ at t=2s in vector notation

   ii. What are the magnitude and direction of $\vec{v}$ just then

b. A satellite moves at constant speed in a circular orbit about the center of earth and near the surface of earth. If the magnitude of its acceleration is g=9.81m/s^2, find its speed and the time for one complete revolution. (4mks)

c. A system of particles consists of three masses $m_1 = 0.5kg$, $m_2 = 2kg$, $m_3 = 5kg$ located at P_1(-3, 1, 2), P_2(0, 1, 2) and P_3(-1, 3, 0) respectively. Find the position vectors of the center of mass of the system. (4mks)

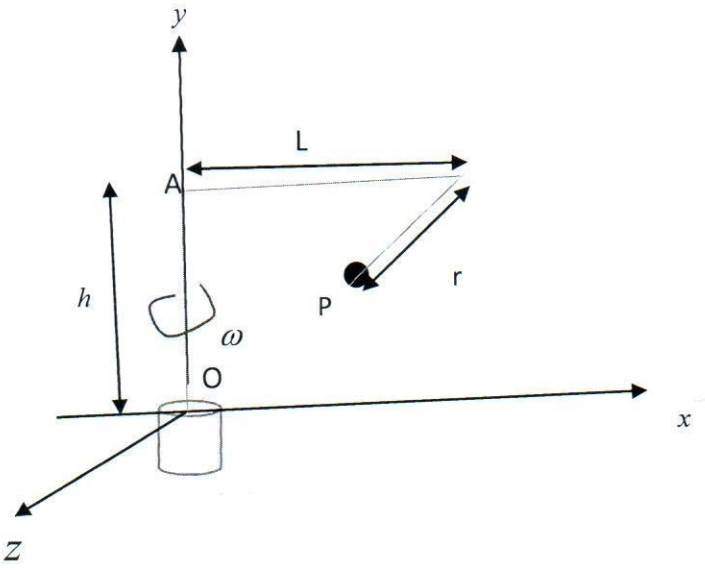
d. A spacecraft S' is at rest, eventually heading toward alpha when spacecraft S passed it at a relative speed c/2. The captain of S' sends a radio signal that lasts 1.2s according to that ship clock. Use the Lorentz transformation to find the time interval of the signal by the communications officer of spaceship S. (5mks)

e. An airplane propeller is rotating with uniform angular speed of 1800rpm. The blades of the propeller are 6ft long. Determine the linear speed of a point 2ft from the axis and 6ft from the axis. (5mks)

f. The rod shown rotates about the y-axis at angular speed 10rad/s and accelerates at the rate of 2rad/s^2. The dimension L=h=2m and r=1m. There is a small mass P glued to the rod at its free end. At the instant shown, the three segments of the rod parallel to the three axes. (7mks)

   i. Find the velocity of point P at the instant shown

   ii. Find the acceleration of point P at the instant shown



QUESTION TWO [20MKS]

a. A riffle is aimed horizontally at a target 30m away. The bullet hits the target 1.9cm below the aiming point. (6mks)

g. What is the bullets time of flight?

ii. What is the muzzle velocity?

b. Two particles of masses m1=1kg and m2=2kg have position vectors given by $\vec{r}_1 = (2t\hat{i} - 4\hat{j})m$ and $\vec{r}_2 = (5t\hat{i} - 2t\hat{j})m$ respectively where t is time. Determine the velocity and linear momentum of the center of mass of the two-particle system at any time and at t=1s (4mks)

c. In a particle accelerator, when electrons accelerated to 0.999c collide with a target, the collision produces a muon which moves in the direction of the electron with a speed of 0.95c. What is the muon's momentum in the lab frame and in the frame of the electron beam? ($c = 3.0\times10^8 m/s,\ mass\ of\ muon = 1.9\times10^{-28} kg$) (6mks)

d. A stationery person observes that rain is falling vertically down at 30km/h. a cyclist is moving on the level road at 10km/h. in which direction should the cyclist hold his umbrella to protect himself from rain? (4mks)

QUESTION THREE [20MKS]

a. A fly wheel of diameter 2ft spins about the axis through its center and perpendicular to the plane of the wheel at 1000rpm. The wheel weighs 20lbf (pound-force). Assuming to be a thin, uniform disk. Find its kinetic energy. (6mks)

b. A pendulum arm has a negligible mass and length D. a mass M is attached to one end of the arm and the other is attached to a support that allows the pendulum to pivot freely in the x-z plane. The angle between the pendulum arm and the vertical is ϕ.find the oscillator of the pendulum by Lagrange equation. (8mks)

c. The angular speed of a motor wheel is increased from 1200rpm to 3120rpm in 16 s. determine the angular acceleration and number of revolutions the engine makes during this time. (6mks)

QUESTION FOUR [20MKS]

a. Derive the Lagrange equation (10mks)

b. An electron velocity has velocity v=0.990c. (6mks)

i. Calculate the kinetic energy of the electron

ii. Compare the result with the classical value for kinetic energy at this velocity (mass of electron is $9.11\times10^{-31} kg$, $c = 3.0\times10^8 m/s$)

c. Determine the virtual work δW done by the force $\vec{F} = 4\hat{i} + 3\hat{j}$ where I and j are the unit vectors in the x and y directions over a virtual displacement δq with the constants; $x = r\cos\theta$, $y = r\,sin\theta$. Use the generalized coordinates $q_1 = r$ and $q_2 = \theta$ (4mks)

QUESTION FIVE [20 MKS]

a. Suppose an object is dropped from a tower of height h at the equator, when will it land relative to the 'plumb line' at the release point? (8mks)

b. A delighted math's graduate throws her cap into the air with an initial velocity of 24.5m/s at 36.9^0 above the horizontal. The cap is later caught by another student. Find (7mks)

   i. The total time the cap is in the air

   ii. The total horizontal distance travelled (ignore air resistance)

c. A car drives north at 2.5m/s for 6s, then turns east and drives at 3m/s for 12s. What is the magnitude and direction of the average velocity for the trip? (5mks)