(Knowledge for Development)

KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS

2021/2022 ACADEMIC YEAR

THIRD YEAR SECOND SEMESTER

SPECIAL/SUPPLEMENTARY EXAMINATION

FOR THE DEGREE OF BACHELOR OF EDUCATION AND BACHELOR OF SCIENCE

COURSE CODE: **MAA 324**

COURSE TITLE: **DYNAMICS II**

DATE: 21/11/2022 **TIME: 8:00 AM – 10:00 AM**

INSTRUCTIONS TO CANDIDATES

Answer Question One and Any other TWO Questions

This Paper Consists of 3 Printed Pages. Please Turn Over.

QUESTION ONE (20 MARKS)

a) Define the following terms as used in dynamics. (4 Marks)
   i) Scalar Quantity
   ii) Dynamics
   iii) Velocity
   iv) Rigid body

b) Find (i) $\vec{C} \times \vec{D}$ and (ii) $\vec{C} - \vec{D}$ provided that $\vec{C} = 8\hat{i} - 2\hat{j} + 3\hat{k}$ and $\vec{D} = 10\hat{i} + 5\hat{j} - \hat{k}$ (6 Marks)

c) A body of mass m_0 moving at a speed of V, collides with and sticks to an identical body at rest. What is the mass and momentum of the final clump? (6 Marks)

d) A particle starting 23m from the origin has moved to 43 m in 5 seconds. Find the average velocity of the particle. (4 Marks)

e) State quantum fluid theory. (2 Marks)

f) State Lagrange's Theorem. (2 Marks)

g) A 2kg particle has a velocity $V_1 = (2\hat{i} - 3\hat{j}) +$ m/s and a 3kg particle has a velocity $V_2 = (\hat{i} + 6\hat{j})$ m/s. Find velocity of the Centre of mass and total momentum of the system. (6 marks)

QUESTION TWO (20 MARKS)

a) Solve the problem of the simple pendulum of mass m and length L by first using the Cartesian coordinates to express the Lagrangian and then transform into a system of cylindrical coordinates. (10 Marks)

b) The distance mean distance of Centre of earth to the Centre of the sun is $r_{es} = 1.49 \times 10^{11} m$. The mass of the earth is $M_e = 5.9 \times 10^{24} kg$ and the mass of the Sun is $M_s = 1.99 \times 10^{30} kg$. The mean radius of the Sun is $r_s = 6.96 \times 10^8 m$. Where is the location of Centre of mass of the sun earth system? (4 Marks)

c) A model can move around a circular track of radius 0.4m at 2 rev/sec. What is its:
   (i) Period, T. (2 Marks)
   (ii) Angular Velocity ω. (4 Marks)

QUESTION THREE (20 MARKS)

a) From the equation of acceleration in terms of both initial and final velocities derive the three main linear vertical motion equations. (10 Marks)

b) A stone is projected vertically upwards with a velocity of 30m/s from the ground. Calculate:

(i) The time it takes to reach the maximum height. (2 Marks)

(ii) Time of flight. (2 marks)

(iii) Maximum height reached (3 Marks)

(iv) Velocity of return (3 Marks)

QUESTION FOUR (20 MARKS)

a) A particle moving with an initial velocity $V = 50\hat{j}$ undergoes acceleration $\vec{a} = (35 + 2t^3)\hat{i} + (4 - t^2)\hat{j}$. What are the particles position and velocity after 3 seconds assuming that it starts at the origin. (10 marks)

b) Calculate angular momentum at t=1 second for two particles A and B of mass 2kg and 3kg if their position vectors are $\vec{r}_A = (2t^2 + t + 1)\hat{i} + (3t + 4)\hat{j} - 8\hat{k}$ and $\vec{r}_B = (4t^2 + 4t)\hat{i} + (t^4 + 3t)\hat{j} + (3t - 4t^2)\hat{k}$ respectively. (10 marks)

QUESTION FIVE (20 MARKS)

A fish is swimming in a horizontal plane whose velocity $V_0 = 4\hat{i} + \hat{j}$ m/s at appoint in the ocean whose position vector $\vec{r}_0 = 10\hat{i} - 4\hat{j}$ m relative to a stationary rock at the shore. After the fish swims with constant acceleration for 20 seconds, its velocity is $\vec{V} = (20\hat{i} - 5\hat{j})$ m/s.

a) What are the components of acceleration? (6 marks)

b) What is the direction of acceleration with respect to the fixed x axis. (3 marks)

c) Where is the fish at t=25 seconds. (5 marks)

d) What is the velocity of the fish at t = 25 seconds and what is the direction of the direction of its velocity. (6 marks)