KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS

2021/2022 ACADEMIC YEAR

THIRD YEAR SECOND SEMESTER

MAIN EXAMINATION

FOR THE DEGREE OF BACHELOR OF SCIENCE

COURSE CODE: **MAA 324**

COURSE TITLE: DYNAMICS II

DATE: 30/08/2022   **TIME:** 2:00 PM – 4:00 PM

INSTRUCTIONS TO CANDIDATES
Answer Question One and Any other TWO Questions

TIME: 2 Hours

QUESTION ONE (30 MARKS)

a) Define the following terms as used in dynamics.   (4 Marks)
   i)   Dynamics
   ii)   System of Particles
   iii) Center of Mass
   iv)   Torque

b) Find $\vec{A} - \vec{B}$ provided that $\vec{A} = 4\hat{i} - 6\hat{j} + 2\hat{k}$ and $\vec{B} = 13\hat{i} + 7\hat{j} - \hat{k}$ (2 marks)

c) A particle moves so that its position as a function of time is $\vec{r} = \hat{i} + 4t^2\hat{j} + t\hat{k}$. Write the expression of its velocity and acceleration as a function of time.   (4 marks)

d) A particle starting at the origin moved $18km$ in $30\sec onds$. Find its average velocity   (4 Marks)

e) A rifle is aimed horizontally at a target 30m away. The bullet hits the target 1.5 cm below the aiming point. Determine the bullets time of flight and the Nozzle velocity. (Take $g = 9.8m/s^2$)   (6 marks)

f) State Hamiltonian Principle.   (2 Marks)

g) A wheel rotates with angular acceleration given by $\alpha(t) = 4t^3 + 3t^2$. If the wheel has initial angular velocity of w_0, Write the equation for the Angular velocity and Angular displacement as a function of time. (8 marks)

QUESTION TWO (20 MARKS)

A body moves across a surface that has axes coordinates drawn. The coordinates (metres) of the position of the body as a function of time t (seconds) are given by

$$x = -0.4t^2 + 8t + 32$$
$$y = 0.3t^2 - 9t + 25$$

a). at t = 10 seconds, Determine the body's position vector $\vec{r}$ in unit vector notation and in magnitude angle notation. (6 marks)

b). at t = 10 seconds, determine the body's velocity in vector notation and magnitude angle notation. (8 marks)

c). at t = 10 seconds, determine the body's acceleration in vector notation and magnitude angle notation (6 marks)

QUESTION THREE (20 MARKS)

Two masses M and m are connected by a rigid rod of length L and negligible mass as shown below
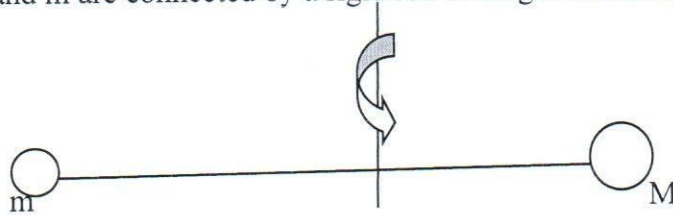
For an axis perpendicular to the rod, show that the system has minimum moment of inertia when axis passes through centre of mass. Also show that moment of inertia is $I = \dfrac{mM}{(m+M)} L^2$.(20 marks)

QUESTION FOUR (20 MARKS)

Two particles A and B of mass 2.5 kg and 4 kg are at position vectors
$\vec{r}_A = (2t^2 + t + 1)\hat{i} + (3t + 4)\hat{j} - 8\hat{k}$ and $\vec{r}_B = (4t^2 + 4t)\hat{i} + (t^4 + 3t)\hat{j} + (3t - 4t^2)\hat{k}$. Calculate at t = 2 second:

a). Centre of mass of the system   (5 marks)

b). Total momentum of the system (5 marks)

c). Kinetic energy of the system.   (10 marks)

QUESTION FIVE (20 MARKS)

a). Particle of mass 2 kg has a position vector $\vec{r} = (t^2 + t)\hat{i} + (t^3 + 2t + 1)\hat{j} + t^4 \hat{k}$ relative to a fixed frame S. If the origin of S' is moving along the vector $\vec{R} = (t^3 + 3t + 1)\hat{i} + (t^4 + 2t)\hat{j} + t^4 \hat{k}$ relative to S. Calculate :

i. $\vec{r}'$ (4 marks) ii. $\vec{V}'$ (4 marks) iii. $\vec{F}'$ as value for friction force. (5 marks)

b). Two rockets of length L_0 are approaching the earth from opposite directions at velocities of $\pm 3m/s$. How long does one of them appear to the other?   (7 Marks)