



(Knowledge for Development)

KIBABII UNIVERSITY
UNIVERSITY EXAMINATIONS
2022/2023 ACADEMIC YEAR
SECOND YEAR MAIN
EXAMINATION

FOR THE DEGREE OF BACHELOR OF EDUCATION AND
BACHELOR OF SCIENCE
MATHEMATICS

COURSE CODE: MAA 212

COURSE TITLE: DYNAMICS I

DATE: 14/12/2022

TIME: 9:00 AM – 11:00 AM

INSTRUCTIONS TO CANDIDATES

Answer Question One and Any other TWO Questions

TIME: 2 Hours

This Paper Consists of 4 Printed Pages. Please Turn Over.

QUESTION ONE (30 MARKS)

- a) Define the terms:
- (i) Work (1 mark)
 - (ii) Acceleration (1 mark)
 - (iii) Velocity (1 mark)
- b) A sphere makes a complete revolution about its own axis in 10 minutes. If the velocity at any point is 100m/min , find the radius of the sphere. (3 marks)
- c) A pitcher tosses a baseball straight up with the initial speed of 25m/s . How
- (i) Long does it take for the ball to reach its highest point (2 marks)
 - (ii) High does the ball rise above the release point (2 marks)
 - (iii) Long will it take for the ball to reach 25m above its release point (3 marks)
- d) Find the work done in moving an object along the vector $\vec{r} = 7\hat{i} + \hat{j} + 3\hat{k}$ if the force applied is $\vec{F} = \hat{i} - 2\hat{j} + 5\hat{k}$ (2 marks)
- e) A rigid body rotates about an axis and its equation $\theta = t^4 - 14t^2 - 50$ where θ is expressed in *rad* and t is in seconds. When $t = 3\text{s}$, determine its
- (i) Velocity (3 marks)
 - (ii) Acceleration (2 marks)
 - (iii) Position (2 marks)
- f) A particle moves along a curve whose parametric equations are $x = e^{-t}$, $y = 2 \cos 3t$, $z = 2 \sin 3t$, where t the time is. Determine the
- (i) Velocity at time t (2 marks)
 - (ii) Acceleration at time t (2 marks)
 - (iii) Magnitude of the velocity at $t = 0$ (2 marks)
 - (iv) Magnitude of the acceleration at $t = 0$ (2 marks)

QUESTION TWO (20 MARKS)

- a) Find the work done in moving an object along the vector $\vec{r} = 3\hat{i} + 2\hat{j} - 5\hat{k}$ if the force applied is $\vec{F} = 2\hat{i} - \hat{j} - \hat{k}$. (3 marks)
- b) A wheel rotates with angular acceleration given by $\alpha(t) = 4at^3 - 3bt^2$ where t is the time and a and b are constants. If the wheel has an initial angular velocity ω_0 write down the equations for the
- (i) Angular velocity (3 marks)
 - (ii) Angle turned as the function of time (4 marks)

- c) A particle is moving with an initial velocity $\vec{V} = 50 \underline{j}$. Vector \underline{j} undergoes an acceleration $\vec{a} = (35 + 2t^3)\underline{i} + (4 - t^2)\underline{j}$. Assuming that it starts from the origin and after 3 seconds, what is the particle's
- (i) Velocity (4 marks)
- (ii) Position (4 marks)
- d) The position vector of a particle P at time t is given by:
- $$\vec{r} = (2t^2 - 3)\underline{i} + (4t + 4)\underline{j} + (t^3 + 2t^2)\underline{k}$$
- Find the distance OP when $t = 0$ (2 marks)

QUESTION THREE (20 MARKS)

- a) A pulley of radius 1.1m is rotating with a speed of 800r.p.m. Calculate the angular velocity and linear velocity. (4 marks)
- b) A particle moves so that its position vector is given by $\vec{r} = \cos \omega t \underline{i} + \sin \omega t \underline{j}$ where ω is a constant. Show that the:
- (i) Velocity \vec{V} of the particle is perpendicular to \vec{r} . (3 marks)
- (ii) Acceleration \vec{a} is directed towards the origin and has a magnitude proportional to the distance from the origin. (3 marks)
- c) A fish swimming in a horizontal plane has a velocity of $V_0 = 4 \underline{i} + \underline{j}$ at a point in the ocean where the position vector is $\vec{r}_0 = 10 \underline{i} - 4 \underline{j}$ relative to a stationary rock at the shore. After the fish swims with a constant acceleration in 20 seconds, its velocity $\vec{V} = 20 \underline{i} - 5 \underline{j}$.
- (i) Where is the fish at $t = 25\text{seconds}$? (5 marks)
- (ii) What is its speed and in what direction is it moving? (5 marks)

QUESTION FOUR (20 MARKS)

- a) A rigid body is rotating with constant angular speed 7rad/s about a fixed axis through the points $A(2,3,-1)$ and $B(-4,0,1)$ whose distances are measured in cm . The rotation is in the left handed screw relative to vector \vec{AB} . Find the instantaneous velocity of the particle P of the body at a point $P(-3,3,5)$ (6 marks)
- b) Find the work done in moving an object along a straight line from $(3,2,-1)$ to $(2,-1,4)$ in a force field given by $\vec{F} = 4 \underline{i} - 3 \underline{j} + 2 \underline{k}$ (3 marks)
- c) A driving wheel is attached to a shaft of an electric motor of rated speed of 1500r.p.m. When the power is switched on the unit attains the rated speed in 5s and when the power is

switched off, the unit comes to rest in 90s. Assuming it is uniformly accelerated motion, determine the number of revolutions the unit turns to

- (i) Attain the rated speed (6 marks)
- (ii) Come to rest (5 marks)

QUESTION FIVE (20 MARKS)

- a) A rifle is aimed horizontally at a target 30 m away. The bullet hits the target 1.9 cm below the aiming point.
- (i) What is the bullet's time of flight? (4 marks)
 - (ii) What is the muzzle's velocity of the rifle? (3 marks)
- b) A ball is thrown with a speed of 25m/s at an angle of 40° above the horizontal directly towards a wall. The wall is 22m from the release point of the ball.
- (i) How long does the ball take to reach the wall? (4 marks)
 - (ii) How far above the release point does the ball hit the wall? (3 marks)
 - (iii) What are the horizontal and vertical components of its velocity as it hits the wall? (3 marks)
- c) The motion of a body rotating about an axis is defined by the notation $\theta = 3t^3 - 18t^2 + 26t + 8$, where θ is the angular position expressed in *radians* and t is time in seconds. Determine when angular velocity is zero (3 marks)

THE END