(Knowledge for Development)

KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS

2021/2022 ACADEMIC YEAR

SECOND YEAR FIRST SEMESTER

EXAMINATION

FOR THE DEGREE OF BACHELOR OF SCIENCE

COURSE CODE: MAA 212 / MAT 223

COURSE TITLE: DYNAMICS 1

DATE: 04/02/2022 **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) Definition (3mks)
   i) A vector
   ii) A unit vector

b) Given $r_1 = 3i + 2j - k, r_2 = 2i - 4j - 3k$ *and* $r_3 = -i + 2j + 2k$.
   Find; (5mks)
   i) $|r_2|$
   ii) $|r_1 + r_2 + r_3|$

c) If $r_1 = 2i - j + k, r_2 = i + 3j - 2k, r_3 = -2i + j - 3k$ *and* $r_4 = 3i + 2j + 5k$.
   Find scalars a, b and c such that $r_4 = ar_1 + br_2 + cr_3$ (6mks)

d) Find the angle between $\vec{A} = 2i + 2j - k$ *and* $\vec{B} = 6i - 3j + 2k$ (5mks)

e) If $\vec{A} = 2i - j + 2k$ *and* $\vec{B} = -i - 3k$. Find the unit vector perpendicular to both $\vec{A}$ and $\vec{B}$ (4mks)

f) Given $a = 2i - j - 2k, b = 3i - 4k, c = i - 5j + 3k$.
   Verify that $a.(b \times c) = (a \times b).c$ (7mks)

QUESTION TWO (20 MKS)

a) A particle moving with initial velocity $v = 50j$ undergoes an acceleration $a = (35 + 2t^3)i + (4 - t^2)j$. What are the particles position and velocity after 3 seconds assuming that it starts at the origin? (8mks)

b) A fish swimming in a horizontal plane has a velocity $v_0 = 4i + j$ at apoint in the ocean whose position vector is $r_0 = 10i - 4j$ relative to a stationary rock at the shore. After the fish swims with constant acceleration for 20 secs, its velocity $v = 20i - 5j$.
   i) What are the components of acceleration? (5mks)
   ii) What is the direction of the acceleration with respect to the fixed x axis? (3mks)
   iii) Where is the fish at $t = 25$ secs, what is its speed and in what direction is it moving (4mks)

QUESTION THREE (20MKS)

a) A ball is thrown with a speed of 25m/s at an angle of 40^0 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 (4mks)
   ii) How far above the release point does the ball heat the wall (4mks
   iii) What are the horizontal and vertical components of its velocity as it heats the wall (4mks)
   iv) When it heats, has it passed the highest point on its trajectory. Explain (4mks)

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 velocityω_0. Write equations for the

i) Angular velocity (4mks)

ii) The angle turned as a function of time (4mks)

QUESTION FOUR (20mks)

a) A particle sliding a long a radial groove in a turn table has polar co- ordinates at time t , $r = ct,\ and\ \theta = \cap\, t$ where c and ∩ are positive constants . Find the velocity and acceleration vectors of the particle at time t and find the speed of the particle at time t. Deduce that$t > 0$, the angle between the velocity and acceleration vectors are always acute. (12mks)

b) The angular acceleration of a body rotating about an axis is directly proportional to the time when $t = 0$, the angular velocity of the body is -15rad/sec given that $\omega = 0\ and\ \theta = 16$ rad when $t = 5$ sec. Determine the equation of the motion of the body (8mks)

QUESTION FIVE (20MKS)

a) A rigid body is rotating with a constant angular speed 7 rads/sec about a fixed axis through the points A (2 ,3 ,-1) and B (-4, 0, 1) distances being measured in centimeters. The rotation is left handed relative to $\overrightarrow{AB}$. Find the instantaneous velocity, speed and acceleration of the particle P of the body at the point (-3,3 5) (12mks)

b) A grinding wheel is attached to a shaft of an electrical motor of rated speed 1500rpm, when the power is switched on, the units attains the rated speed in 5 secs and when the power is switched off the unit comes to rest in 90 secs. Assuming uniform accelerated motion, determine the number of revolutions the unit turns. (8mks)

i) To attain the rated speed

ii) To come to rest