KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS

2020/2021 ACADEMIC YEAR

SECOND YEAR SECOND SEMESTER

MAIN EXAMINATION

FOR THE DEGREE OF BACHELOR OF SCIENCE

COURSE CODE: MAA 212/MAT 223

COURSE TITLE: DYNAMICS 1

DATE: 25/07/2022   **TIME:** 11 AM -1 PM

INSTRUCTIONS TO CANDIDATES
Answer Question One and Any other TWO Questions

TIME: 2 Hours

QUESTION ONE (30 MKS)

a) The position of a particle is given by a vector $r = (t^2 + t)i + (t^3 + 2t + 1)j + t^4k$ relative to a fixed frame S , If the origin of S' is moving a long a vector $R(t)= (t^3 + 3t + 1)i + (t^4 + 2t)j + t^5k$ relative to S . Determine (5mks)
   i) r'
   ii) v'

b) A sphere makes a complete revolution about its own axis in 10mins. If the velocity of any point on its diametrical circle is 100m/min. find the radius of the sphere. (4mks)

c) 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 angular velocity vector of the body (5mks)

d) The motion of a body rotating about the axis is defined as $\theta = 3t^3 - 18t^2 + 26t + 8$ where θ is angular position expressed in rad and $t = T$ sec. Determine time (7mks)
   i) When the angular velocity is 0^0
   ii) The angular position and the total angular distance travelled when acceleration becomes 0.

e) A rifle is aimed horizontally at a target 30m away. The bullet heats the target 1.9 cm below the aiming point.
   i) What is the bullets time of flight (4mks)
   ii) What is the muzzle velocity (3mks)

f) Find the work done in moving an object along the vector $r = 3i + 2j - 5k$ if the applied force $F = 2i - j - k$ (2mks)

QUESTION TWO (20MKS)

a) A wheel starting from rest accelerates at the rate of 2 rad/s^2 for an interval of 10 sec. If it is then made to stop in the next 5 sec by applying brakes. Find
   i) The maximum angular velocity attained (4mks)
   ii) The total angle turned (4mks)

b) Load P is connected to a string wrapped over a pulley. The load is lifted u with the help of belt. Find a unit vector parallel to $3\vec{A} - 2\vec{B} + 4\vec{C}$. Given $\vec{A} = 3i - j - 4k$, $\vec{B} = -2i + 4j - 3k$, $\vec{C} = i + 2j - k$. (5mks)

c) The position vector of a particle P is given by $r = (2t^2 - 3)i + (4t + 4)j + (t^3 + 2t^2)k$. Find (7mks)
   i)   The distance OP when $t = 0$
   ii) The velocity of P when $t = 1$
   iii) The acceleration of P when $t = 2$

QUESTION THREE (20MKS)

a) Two ends P and Q of a rigid bar of length 5m slide along the y and x axis respectively. If the velocity of point P is 10m/s vertically downwards. Determine
   i)   The velocity of point Q
   ii) Angular velocity of the rigid bar
   iii) Velocity of point R when it makes an angle of 60^0 with the horizontal

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 $\cap$ 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 sec 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