



MAASAI MARA UNIVERSITY

**REGULAR UNIVERSITY EXAMINATION
2023/2024 ACADEMIC YEAR
SECOND YEAR FIRST SEMESTER**

**SCHOOL OF PURE APPLIED AND HEALTH
SCIENCES
BACHELOR OF SCIENCE**

**COURSE CODE:MAT 2213-1
COURSE TITLE: FUNDAMENTALS OF
MECHANICS**

DATE:16/4/2024

TIME: 1100-1300 HRS

INSTRUCTIONS TO CANDIDATES

- 1.** This paper contains **FOUR (4)** questions
- 2.** Answer question **ONE (1)** and any other **TWO (2)** questions
- 3.** Do not forget to write your Registration Number.

QUESTION ONE (20 MARKS)

- a. A particle moves in from rest in a circular path of a circle of radius 20 cm. If its tangential speed is 40 cm/sec, calculate its angular velocity, angular acceleration and normal acceleration .
[5mks]
- b. Find the work done in moving an object along a vector $\mathbf{r} = 3\mathbf{i} + 2\mathbf{j} - 5\mathbf{k}$ if the applied force is $\mathbf{F} = 2\mathbf{i} - \mathbf{j} - \mathbf{k}$. [3mks]
- c. A particle moving in a force field \mathbf{F} has its momentum given at any time t by $\mathbf{p} = 3e^{-t}\mathbf{i} - 2\cos t\mathbf{j} - 3\sin t\mathbf{k}$. Find \mathbf{F} . [3mks]
- d. The angular momentum of a particle is given as a function of time t by $\Omega = 6t^2\mathbf{i} - (2t + 1)\mathbf{j} + (12t^3 - 8t^2)\mathbf{k}$. Find the torque at time $t=1$. [3mks]
- e. Show that the equation $x = 3 + 4\cos 2t + 3\sin 2t$ executes simple harmonic motion. Hence find the Centre, Time, Period and the Phase angle. [6mks]

QUESTION TWO (15 MARKS)

- a) A projectile is launched with a muzzle velocity of 2900km/h at an angle of 60° with a horizontal and lands on the same plane. Find
- the time to reach maximum height
 - the, maximum height reached,
 - the total time of flight,
 - the range,
 - the speed after 1 minute of flight,
 - the speed at a height of 10,000m.

QUESTION THREE (15 MARKS)

- a) Prove that
- $\mathbf{F} = (2xy + z^3)\mathbf{i} + x^2\mathbf{j} + 3xz^2\mathbf{k}$ is a conservative force field. [3mks]

- ii. Find the potential corresponding to \mathbf{F} **[4mks]**
- iii. Find the work done in moving a particle in this field from $(1, -2, 1)$ to $(3, 1, 4)$ **[3mks]**

b) A particle of mass m moves along the x axis under the influence of a conservative force field having potential $V(x)$. If the particle is located at positions x_1 and x_2 at respective times t_1 and t_2 , prove that if E is the total energy

$$t_2 - t_1 = \sqrt{\frac{m}{2}} \int_{x_1}^{x_2} \frac{dx}{\sqrt{E - V(x)}}. \quad \text{[5mks]}$$

QUESTION FOUR (15 MARKS)

- a) A particle of mass 5g moves along the x axis under the influence of two forces ; (i) a force of attraction to origin 0 which in dynes is numerically equal to 40 times the instantaneous distance from 0, and (ii) a damping force proportional to the instantaneous speed such that when speed is 10m/s the damping force is 200 dynes. Assuming that the particle starts from rest at a distance 20 cm from 0.
- i) Set up the differential equation and conditions describing the motion **[6mks]**
 - ii) The position of the particle at any time. **[6mks]**
 - i. Determine the amplitude, period and frequency of the damped Oscillations. **[3mks]**

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