TECHNICAL UNIVERSITY OF MOMBASA

UNIVERSITY EXAMINATIONS 2015/2016

AMA 4214 CLASSICAL MECHANICS

SECOND YEAR SECOND SEMESTER EXAMINATIONS FOR THE BACHELOR OF SCIENCE DEGREE IN MATHS AND COMPUTER SCIENCE.

INSTRUCTIONS: *Answer question one and any other two questions*

QUESTION ONE

a) The power applied to a particle by a force field is given as a function of time by $p(t) = 3t^2 - 4t + 2$. Find the work done in moving a particle from $t = 2$ to $t = 4$ (4mks)

b) A particle moves so that the position vector is given by $\vec{r} = a\cos\mu t\hat{i} + a\sin\mu t\hat{j}$ where μ is a constant. Show that the velocity $\vec{v}$ of the particle is perpendicular to $\vec{r}$ (5mks)

c) Show that the force field $\vec{F} = \left(2xy + z^3\right)\hat{i} + x^2\hat{j} + 3xz^2\hat{k}$ is conservative. (5mks)

d) A particle moves on a circle of radius 20cm. If it's tangential speed is 40cm/s, Find :

i. It's angular speed (1mks)

ii. Angular and normal acceleration (2mks)

iii. Arc length covered in time t=5 seconds (3mks)

e) Show that the equation $x = 3 + 4\cos 2t + 3\sin 2t$ executes simple harmonic motion (SHM), hence find the centre, time period and phase angle. (5mks)

f) A particle is projected with a velocity of $50ms^{-1}$ at an elevation of 35^0. Find the greatest height reached, the time of flight and the horizontal range (take $g = 9.8m^{-2}$) (5mks)

QUESTION TWO

a)

i. State Newton's first and second law of motion. (4mks)

ii. Find the constant force needed to accelerate a mass of 40kg from the velocity $\left(4\hat{i} - 5\hat{j} + 3\hat{k}\right)m/s$ to the velocity $\left(8\hat{i} + 3\hat{j} - 5\hat{k}\right)m/s$ in 20 seconds. (4mks)

iii. What is the magnitude of the force in (ii)

iv. Find the work done on the particle in motion of 20sec (2mks)

b) A mass of 2kg oscillating on a spring with a spring's constant 4N/m passes through its equilibrium point with velocity 8m/s. Determine:

i. the energy of the system at this point (2mks)

ii. the maximum displacement of the mass (4mks)

c) A fly wheel of diameter 1.1m, rotating at 1200 rev/min slows down at a constant rate to 900rev/min in 30s. Find:

i. angular acceleration (3mks)

ii. the initial speed of a point on the rim of the fly wheel. (1mk)

QUESTION THREE

a) A car of mass 100kg moves uphill along a street inclined at 30^0 to the horizontal. Determine the force which the car must produce to move with

i. Uniform motion (5mks)

ii. An acceleration of $0.4m/s^2$ (3mks)

b) A particle moves on a space curve defined by the parametric equation $x = t, y = \frac{1}{2}t^2, z = t$ Find :

i. the velocity (2mks)

ii. the acceleration (2mks)

iii. tangential acceleration (2mks)

iv. normal acceleration (4mks)

v. the principal normal (2mks)

QUESTION FOUR

a)

i. Define a uniform force field (1mk)

ii. Prove that a uniform force field is always conservative. (3mks)

iii. Find the potential of a uniform force field (3mks)

b) A parachutist falls from rest under gravity and the air resistance is mkv^2, where v is the velocity, k is a positive constant and m is the mass of the parachutist and the parachute. Find v in terms of the distance fallen x and also in terms of time t (13mks)

QUESTION FIVE (20mks)

a) A particle of unit mass moves along a space curve defined by $\vec{r} = a\cos\mu t\hat{i} + b\sin\mu t\hat{j}$ where a, b, μ are constants. Find:

i. Torque (5mks)

ii. Angular momentum about the origin. (5mks)

iii. Impulse developed by the force field between $t = 0$ to $t = {}^{\circledR}\!/_{2\mu}$ (5mks)

iv. Show that the impulse in © is equal to change in momentum. (5mks)