# TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF APPLIED &HEALTH SCIENCES

MATHEMATICS & PHYSICS DEPARTMENT

## UNIVERSITY EXAMINATION FOR:

**BACHELOR OF TECHNOLOGY IN APPLIED PHYSICS AND BACHELOR OF TECHNOLOGY IN ENVIRONMENTAL PHYSICS & RENEWABLE ENERGY**

APS 4304: CLASSICAL MECHANICS

END OF SEMESTER EXAMINATION

**SERIES: MAY 2016**

**TIME: 2** HOURS

**DATE: MAY 2016**

**Instructions to Candidates**

You should have the following for this examination

*-Answer Booklet, examination pass and student ID*

This paper consists of 4 questions.

**Do not write on the question paper. Answer question ONE (compulsory) and any other two questions.**

SECTION A (30POINTS)

QUESTION 1

(a) (i)Give the expression for angular momentum in terms of **r** and **p** where **r** is the displacement and **p** is the linear momentum of a particle moving in a circle of radius l**r**l. [3points]

(ii) The torque of on an object is given by N =rXF where F is the force creating the torque. Show that $\frac{d}{dt}$ **L** =**N**and explain what it means when **N** = 0. [4points]

(b) A bat of mass m perches on the outside of edge of a freely turning ceiling fan of rotational inertia I and radius r. By what ration does the angular momentum of the fan

change? [5points]

(c) Consider a one dimensional potential,

$$U(x) = -\frac{wl^2\left(x^2 + l^2\right)}{x^4 + 8l^4}$$

(i) Sketch the potential. [5points]

(ii) Is the motion bounded or unbounded? [3points

(iii) Where are the equilibrium values and are they stable or unstable? [5points]

(d) The total energy of some particle is given by the equation

$E = T + U$ . Assuming that $\mathbf{F}.\mathbf{dr} = d\left(\frac{1}{2}mv^2\right) = dT$ , show that

$\frac{dE}{dt} = (\mathbf{F}.\nabla U)\mathbf{.r} + \mathbf{p}$, where $\mathbf{p} = \frac{\partial U}{\partial t}$ [5points]

SECTION B

QUESTION 2

(a) In the figure above, a block slides down an inclined plane without friction.

(i) Compute its acceleration [3points]

(ii) Compute its velocity after it has moved a distance $x_0$ down the plane from rest. [5points]

(iii) If the coefficient of friction between the block and plane is $\mu_s = 0.4$, at what angle

$\theta$ will the block start sliding if it is initially at rest? [6points]

(b) Find the displacement of a particle undergoing vertical motion in a medium having a retarding force proportional to the velocity. [6points]

QUESTION 3

(a) A system consists of a spring whose one end is fixed to an immovable wall while the other end is a mass m kg attached to it. The spring which has a spring constant k is stretched a distance x and released.

(i) Write down the equation of motion of the mass. [3points]

(ii) Solve the equation in a general form and decide which part of the equation satisfies the physical condition of the system. [7points]

(iii) What are the frequency and period of the oscillation mass? [4points]

(iv) Compute the maximum potential energy and maximum kinetic energy of the mass. [6points]

QUESTION 4

(a) Consider a projectile motion in two dimensions. Find the equation of motion in both Cartesian and polar coordinates. [8points]

(b) (i)A particle is constrained to move on the inside surface of a smooth cone of half angle $\alpha$ .The particle is subject to a gravitational force. Determine a set of generalized coordinates and find the constraints. [7points]

(ii) Find the Lagrange's equations of motion [5points]