TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Applied & Health Sciences

DEPARTMENT OF MATHEMATICS & PHYSICS

UNIVERSITY EXAMINATION FOR DEGREE OF:

BACHELOR OF SCIENCE IN MATHEMATICS & COMPUTER SCIENCE (BMCS 13S)

AMA 4214: CLASSICAL MECHANICS

SPECIAL/SUPPLEMENTARY EXAMINATION

SERIES: JUNE 2015

TIME ALLOWED: 2 HOURS

Instructions to Candidates:

You should have the following for this examination

- *Mathematical tables*
- *Scientific Calculator*

This paper consist of **FIVE** questions

Answer question **ONE (COMPULSORY)** and any other **TWO** questions

Maximum marks for each part of a question are as shown

This paper consists of **TWO** printed pages

Question One (Compulsory)

a) Define the terms:

(i) Displacement **(2 marks)**

(ii) Velocity **(1 mark)**

b) Illustrate on a distance-time graph and a velocity time for:

(i) A body moving with uniform velocity **(2 marks)**

(ii) Motion of a body thrown vertically upwards **(2 marks)**

c) Derive the THREE equations of linear motion **(6 marks)**

d) Find the Tension in a string when an object of mass 0.5kg is whirled in a horizontal circle of radius 2m with a constant speed of 10m/s **(4 marks)**

e) Show that Power = Force x Velocity **(5 marks)**

f) Find the kinetic energy of a particle of mass 20 units moving with a velocity v = 3i – 5j + 4k **(3 marks)**

g) A particle moves a long a curve whose parametric equations are $x = 3e^{-2t}$, $y = 4\sin 3t$ and $z = 5\cos^3 t$ where t is the time. Find the velocity and acceleration of the particle at any given time t **(5 marks)**

Question Two

a) A ball of mass 0.1kg is thrown vertically upwards with an initial velocity of 20m/s. Calculate:
   (i) The time taken to return to the thrower **(4 marks)**
   (ii) The maximum height attained **(3 marks)**
   (iii) The kinetic energy of the ball half way up **(4 marks)**
   (iv) The potential energy of the ball half way up **(2 marks)**

b) A body having mass 0.5kg at the end of a string is whirled in a horizontal circle radius 2m at a constant speed of 10m/s. Calculate the maximum and the minimum Tension experienced by the body **(7 marks)**

Question Three

a) Two particles have position vectors $r_1 = 2ti - t^2 j + (3t2 - 4t)k$ and $r_2 = (5t^2 - 12t + 4)i + t^3 j - 3tk$. Find:
   (i) Relative velocity **(6 marks)**
   (ii) Relative acceleration of the 2nd particle with respect to the first at the instant where t = 1 **(6 marks)**

b) Calculate the speed at which a plane must be flying when looping the loop of radius 0.80km so that the pilot feels no force from either his harness or his seat **(5 marks)**

c) A car of mass 1 x 10^3kg travelling at 72km/h on a horizontal road is brought to rest a distance of 40m by the action brakes and frictional forces. Find the average braking force **(3 marks)**

Question Four

A projectile is launched with an initial speed of um/s and at an angle θ to the horizontal. Determine:

a) Time it takes to reach the highest point **(4 marks)**
b) The highest point reached **(5 marks)**
c) Time of flight back to earth **(4 marks)**
d) Range **(5 marks)**
e) Prove that the Range of the projectile is maximum when $\theta = 45^o$ **(2 marks)**

Question Five

a) Show that the total linear momentum of a system of particles A and B, travelling in opposite directions is constant **(7 marks)**

b) A particle of constant mass m moves in space under the influence of a force field F. Assuming that at time t_1 and t_2, the velocities of the particle are v_1 and v_2 respectively. Show that the work done by the particle is equal to the change in kinetic energy i.e.

$$\int_{t_1}^{t_2} F.dr = \frac{1}{2}mv_2^2 - \frac{1}{2}mv_1^2$$

(8 marks)

c) Prove that if F is a force acting on a particle and v is the velocity of the particle then the power applied to the particle is given by P = F.V **(5 marks)**