TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Applied & Health Sciences

DEPARTMENT OF MATHEMATICS & PHYSICS

UNIVERSITY EXAMINATION FOR THE BACHELOR OF SCIENCE IN ELECTRICAL ENGINEERING

SMA 2273: APPLIED MATHEMATICS

SPECIAL/SUPPLEMENTARY EXAMINATION

SERIES: MARCH 2014

TIME: 2 HOURS

Instructions to Candidates:

You should have the following for this examination

- *Answer Booklet*

This paper consist of **FIVE** questions in **TWO** sections **A** & **B**

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

Maximum marks for each part of a question are as shown

This paper consists of **THREE** printed pages

SECTION A (COMPULSORY)

Question One

a) Distinguish between the following terms:

(i) Force and power **(2 marks)**

(ii) Coplanar and concurrent forces **(marks)**

b) (i) Express force as a function of velocity and as a function of displacement **(6 marks)**

(ii) A particle of unit mass moving on a straight line is acted upon by a force given by -4xN, where x is the displacement of a 1kg particle. The particle is at rest when x = 3m. Find the velocity when x = 1m. **(7 marks)**

c) A Golf ball of mass 0.06kg resting on a toe is given a horizontal impulse of 18NS. Calculate velocity with the ball takes off. **(3 marks)**

d) A force of magnitude 4N and 3N acts along sides AB and AD of a square ABCD respectively with sides 2m. Find the perpendicular distance of the line of action of their resultant R from 0 which is the midpoint of DC. **(4 marks)**

e) A particle is projected vertically upwards with a velocity of $14ms^{-1}$ calculate:

(i) The time it takes to return to its point of projection **(2 marks)**

(ii) The height to which it rises **(2 marks)**

(iii) The time after its projection when its speed is $7ms^{-1}$ **(2 marks)**

SECTION B (Answer any TWO questions from this section)

Question Two

a) A particle of 1 unit mass moves along a curve in a force field, F given by $\vec{F} = (6t-8)i - 60t^3 j + (20t3 + 36t2)\vec{K}$ where t is the time. If the initial position and velocity are:

$\vec{V} = 2i - 3k$

$\vec{V}_i = 5i + 4j$

Find:

(i) Acceleration and magnitude of its acceleration at t = 2 **(4 marks)**

(ii) Velocity and magnitude of velocity at t = 2 **(5 marks)**

(iii) Momentum at t = 2 seconds **(2 marks)**

b) A crate is to be moved up an inclined plane 10m long and 6m high. If the crate weigh 100N and it is to be pulled up at a uniform speed. Compute:

(i) The work done (assumed plane is frictionless) **(4 marks)**

(ii) How much work would be done by lifting the crate through a height of 6m **(2 marks)**

Question Three

a) Stat the Newton's second law of motion **(2 marks)**

b) Two particles have position vectors given by:

$\vec{V} = 4ti - 2t^2 j - 5tk$ and $\vec{V_i} = (2t^2 - t)\hat{i} + t^3 j - 4t\overset{n}{k}$

(i) The relative velocity of the 2nd particle with respect to 1st particle when t = 3 secs. **(5 marks)**

(ii) The relative acceleration of the 2nd particle with respect to 1st particle at the same time. **(5 marks)**

c) A bullet of mass 30g is fired horizontally into a small block of 8kg which is suspended by string 2m long. The bullet remains embedded in the wood and the block resists until the string makes an angle of 30^o on the vertical. Find the velocity of the bullet. **(8 marks)**

Question Four

a) Two forces p and q which are inclined at 120^o have a resistant of magnitude of $P\sqrt{7}$. Calculate the magnitude of q in terms of p. **(8 marks)**

b) A particle of mass 2kg rests on the surface of a rough plane which is inclined at 30^o to the horizontal. It is connected by a light inelastic string passing over a light smooth pulley at the top of the plane, to a particle of mass 3kg which is hanging freely. If the coefficient of friction between the 2kg mass and the plane is 1/3

- **(i)** Show all the forces acting on the particle **(2 marks)**
- **(ii)** Find the acceleration of the system when it is released from rest **(4 marks)**
- **(iii)** Find the tension in the string **(2 marks)**
- **(iv)** Find the force exerted by the string on the pulley **(2 marks)**

c) Define the term equilibrium as relating to forces **(2 marks)**

Question Five

a) A particle moves in a circle of radius 20m of its tangential speed is 40m/s. Determine:

- **(i)** The angular speed
- **(ii)** Angular acceleration and normal acceleration
- **(iii)** The arc length covered in time t = 5 secs
- **(iv)** The angle subtended in time t = 5 secs **(10 marks)**

b) Determine the work done in moving a particle once around a circle C is (x, y) plane; if the particle has the centre at the origin and radius 3 units, and if the force is given by $F = (2x - y + z)i + (x + y - z^2)j + (3x - 2y + 4z)\overset{n}{k}$

(10 marks)