THE MOMBASA POLYTECHNIC UNIVERSITY COLLEGE

(A Constituent College of Jkuat)

Faculty of Applied & Health Sciences

DEPARTMENT OF MATHEMATICS & PHYSICS

INSTITUTIONAL BASED PROGRAMME

UNIVERSITY EXAMINATIONS FOR DEGREE IN
BACHELOR OF ENGINEERING IN ELECTRICAL & ELECTRONIC ENG/
YR II, SEM II

SMA 2273: APPLIED MATHEMATICS

SPECIAL/SUPPLEMENTARY EXAMINATION

SERIES: FEBRUARY/MARCH 2012
TIME: 2 HOURS

<u>**Instructions to Candidates:**</u>
You should have the following for this examination
- *Answer booklet*

This paper consists of **FIVE** questions
Answer question **ONE (COMPULSORY)** and any other two questions
This paper consist of **THREE** printed pages

Take g to be 9.8m/s^2 where applicable

<u>SECTION A (COMPULSORY)</u>

QUESTION ONE (30 Marks)

a) A body of mass 5 kg is placed on a smooth table and is connected by a spring over a smooth pulley to another body of mass 3 kg, which hangs freely. The system is now released. Find the acceleration of the two bodies and the tension in the string. [5 Marks]

b) A stone is thrown vertically upwards from the ground at a velocity of 30m/s. How long will it take to reach 8.75m above the ground on its way downwards? [5 Marks]

c) Calculate the power supplied to a lift of total mass 500 kg which travels upwards at 1.5 m/s [5 Marks]

d) A lorry of mass 3 tonnes is towing a trailer of mass 2 tonnes up a hill inclined to the horizontal at $\sin^{-1}\left(\frac{1}{5}\right)$. The forward thrust of the lorry is 20,000N and resistances may be ignored. What is the tension in the tow-bar? [5 Marks]

e) A box of mass 8 kg, standing on rough horizontal ground is pulled by a string inclined at 30^0 to the horizontal. If the body is about to slide and $\mu = 0,5$, find the tension in the string. [5 Marks]

f) In the gas equation $\left(P + \dfrac{a}{v^2}\right)(v - b) = RT$, what are the dimensions of the constants a and b. [5 Marks]

SECTION B (ANSWER ANY TWO QUESTIONS FROM THIS SECTION)

QUESTION TWO (20 Marks)

a) A non uniform plank AB of mass 30 kg and length 4m has its centre of gravity at G. The plank is kept horizontal by parallel bars at E and F, 1 metre apart so that AE=0.5m as shown below.

If the forces of the bars on the plank are vertical and the ratio of the sizes of these forces is 5:3, find the forces on the bars and the position of G. [7 Marks]

b) The mass of a bicycle and rider together is 70 kg. The cyclist produces a driving force of 40N at the wheel, the total resistance of motion being 12N. In what distance will the cyclist increase his speed from 3m/s to 7m/s? [5 Marks]

c) A particle of mass 400g is attached to the end of a light string of length 1 metre. The string hangs vertically with its upper end, A, fixed. The particle is given a horizontal velocity of 2 m/s. Find the height to which it rises and the angle between the string and the vertical when it reaches this height. [8 Marks]

QUESTION THREE (20 Marks)

a) State the three Newton's laws of motion [3 Marks]

b) Sand is allowed to fall vertically at a steady rate of 100 grammes per second onto a horizontal conveyor belt moving at a steady velocity of 5cm/s. Calculate the force on the belt. [4 Marks]

c) Rain drops are falling through air with a velocity of 3m/s. If a north wind blows at 18km/h, find;

   i.   The direction in which the drops appear to fall to a person walking north at 6km/h
   ii. The velocity with which the drops would hit his umbrella. [7 Marks]

d) A balloon of total mass 200kg is floating at rest in the air. If a 10 kg sand bag is thrown out, with what acceleration will the balloon begin to ascend? [6 Marks]

QUESTION FOUR (20 Marks)

a) If a particle is projected inside a tunnel which is 5m high with a velocity of 60 metres per second, find the greatest possible angle of projection and the greatest possible range. [5 Marks]

b) Two equal weights of mass 10 kg are attached to the ends of a thin string which passes over three smooth pegs in a wall arranged in the form of an equilateral triangle with one side horizontal. Find the thrust on each peg. [6 Marks]

c) An effort of 150N is required to just move a certain body up an inclined plane of angle 12^0 with the horizontal, the force acting parallel to the plane. If the angle of inclination was 15^0, the effort required would be 172N. Find the weight of the body and the coefficient of fiction. [9 Marks]

QUESTION FIVE (20 Marks)

A rod AB of weight 12N and length 30cm has its centre of gravity at a point G where AG is 10cm. The end B lies on a smooth slope of inclination 30^0 to the horizontal. The rod is maintained in a horizontal position by a string attached at A. Find the direction of the string and the tension in it. [12 Marks]

Show that the forces of magnitude 40N acting at the vertices of the equilateral triangle ABC and parallel to the opposite sides (as shown in the figure below) form a couple.
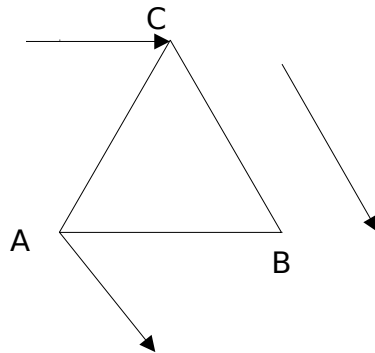
Find the magnitude of the couple if each side of the triangle is 50cm long. [8 Marks]