# THE MOMBASA POLYTECHNIC UNIVERSITY COLLEGE

## FACULTY OF ENGINEERING &TEHNOLOGY

## Department of Mechanical & Automotive Engineering

Diploma in Mechanical Engineering (Plant DPL 3P)

Diploma in Mechanical Engineering (Production DPR 3)

Diploma in Automotive Engineering (DAE 3P)

## Second Year Semester One SUP Exam

## EME 2203

## MECHANICS OF MACHINES I

**OCTOBER SERIES**

**Time 2 Hours**

Instructions

You should have the following for this examination:

Answer booklet

Scientific calculator

SMP mathematical tables

This paper consists of **FIVE** Questions, answer Question **ONE** (Compulsory) and any other **TWO** Questions.

**Question ONE (Compulsory)**

(a) State the:

(I) Conservation of Momentum principle
(II) Conservation of Energy Principle.

**(2 Marks)**

(b) A plane weighing 100tonnes and cruising at a speed of 1.2km/h collides head on with a 40 tonne helicopter travelling at 4km/h in mid-air.

(I) Their velocities immediately after colliding
(II) The impulse developed in the collision.

**(7 Marks)**

(c) Define the following, stating their SI units:

(I) Impulse
(II) Momentum
(III) Mass moment of Inertia
(IV) Centripetal acceleration
(V) Velocity

(5 Marks)

(d) A stone in thrown vertically upwards from rest. It accelerates constantly at $11.5m/s^2$ for 5.8 seconds and the begins to decelerate due to the effect of gravitation acceleration. Calculate the maximum height it attains just when it stops and begins to fall down. (6 Marks)

**Question TWO**

(a) (I) Determine the second Moment of Area of the cross-sectional Area shown below by using the parallel axis theorem by using the parallel axis theorem (Dimensions in cm). (10 Marks)

(b) The figure below shows a piston cylinder arrangement:

If the crank is rotating with an angular velocity of 3600rpm anticlockwise, calculate:

(i) The linear velocity of the piston
(ii) The angular velocity of the connecting rod
(iii) The Linear velocity of the handle locating at the mid-point of the connecting rod.

**(10 Marks)**

**Question THREE**

(a) In a wind tunnel experiment, the total resistances to a plane model is given by the expression $(132 + 0.6V + 0.1V^2)$ Newtons, where V is the velocity of the wind in $m/s^2$. If the wind speed is set at 100km/h against a 1.2tonne model, calculate:

Calculate:

(i) The total resistance
(ii) The acceleration attained by the model.

**(8 Marks)**

(b) (I) From first principles, show that;

Impluse = Change of momentum **(4 Marks)**

(II) A mass of 0.5kg is whirled in a horizontal circle by a string of 1.5KN/m stiffness at a speed of 360rpm. If the original length of the string is 150mm, calculate:

(i) The radius of the rotation
(ii) The string extension

**(8 Marks)**

**Question FOUR**

(a) Determine the area moment of inertia of the cross-section below (Dimensions in mm).

**(12 Marks)**

(b) From first principles show that the second moment of area for:

$$J = \frac{\pi D^4}{32}$$

(I) A solid shaft;

$$J = \frac{\pi}{32}(D^4 - d^4)$$

(II) A Hollow shaft;

Where: D - Outside diameter
d - Inside diameter

**(8 Marks)**

**Question FIVE**

(a) A 0.32 tonne bomb launched at 5km/s explodes and separates into two parts. One part of 0.2 tonnes experiences a thrust of 1.5kN in the line of flight and it's speed reduces by 15m/s during the explosion. Calculate:

(I) The duration of the thrust period.
(II) The final speeds of the first and second parts.

**(8 Marks)**

(b) A stone is thrown over a wall as illustrated below:

If the intial acceleration is 32.2m/s and g=9.8m/s$^2$. Calculate:

(i) The iniat velocity, if the time from A – B is 20 secs.
(ii) The distance travelled from B-C in radians.
(iii) The total time for the whole motion.

**(12 Marks)**