THE MOMBASA POLYTECHNIC UNIVERSITY COLLEGE

(A CONSTITUENT COLLEGE OF JKUAT)

Faculty of Engineering and Technology

DEPARTMENT OF MECHANICAL AND AUTOMOTIVE ENGINEERING
DIPLOMA IN MECHANICAL ENGINEERING (PRODUCTION OPTION)
DIPLOMA IN MECHANICAL ENGINEERING (PLANT OPTION)
DIPLOMA IN MECHANICAL ENGINEERING (AUTOMOTIVE OPTION)

EME 2209
STRENGTH OF MATERIALS II

YEAR 2 SEMESTER II

SPECIAL/SUPPLEMENTARY EXAMINATIONS

SERIES: MARCH, 2012

TIME: 2 HOURS

INSTRUCTIONS TO CANDIDATES:

1. You should have the following for this examination
   - Answer booklet
   - Scientific calculator
   - Drawing instruments

2. This paper consists of **FIVE** questions
3. Question **ONE** is compulsory
4. Answer any other **TWO** questions.
5. Maximum marks per each question are shown.
6. This paper consists of *THREE printed pages.*

QUESTION ONE (COMPULSARY)

a) i) A horizontal beam simply supported at its ends, carries a total load **wl** uniformly distributed over its strength *l*. Show the total work done by the load in deflecting the beam is given by;

$$\frac{w^2 l^5}{240\, EI}$$

   Where I is the second moment of area of the cross section.

   ii) Find the total strain energy in the rolled steel joist, 0.6m long carrying a uniformly distributed load of 35kN/m run

   Take: E= 200GN/m² and I=5.66 x 10⁻⁶mm⁴

(12 marks)

b) With reference to **Castigiliano's** theorem prove the following relationship:

$$U = \int \frac{M^2}{2\,EI}\, dx$$

   Note: the variables maintain their usual meaning. (12 marks)

c) Deduce an expression for the strain energy U stored in a solid shaft of modulus of rigidity G under maximum shear stress τ.

(6 marks)

QUESTION 2

A solid steel shaft of **60mm** diameter is to be coupled in series with a hollow alloy shaft of the same external diameter Determine.

   i) The internal diameter of the alloy shaft if the angle of the twist per unit length is to be **55%** of that of the steel shaft.

   ii) The speed at which the shaft is to be driven to transmit **250kW** if the limit of shearing stress are to be **55** and **80MN/m²** in the alloy and steel respectively.

Take: (G_{steel} = 2.2 x G_{alloy})

QUESTION 4

a) A composite shaft consists of a steel rod 85mm diameter surrounded by a tightly fitting brass tube firmly fixed to it. Determine the outside diameter of the tube such that when a torque is applied to the composite shaft, it will be equally shaped by the two materials.

b) If the torque in the composite shaft above is 20kNm. Determine;

   I.   The maximum shearing stress in each material
   II.   The angle of then twist on a length of 1.2m

Take :(G $_{steel}$ = 200GN/M² and G $_{brass}$ = 100GN/M²).
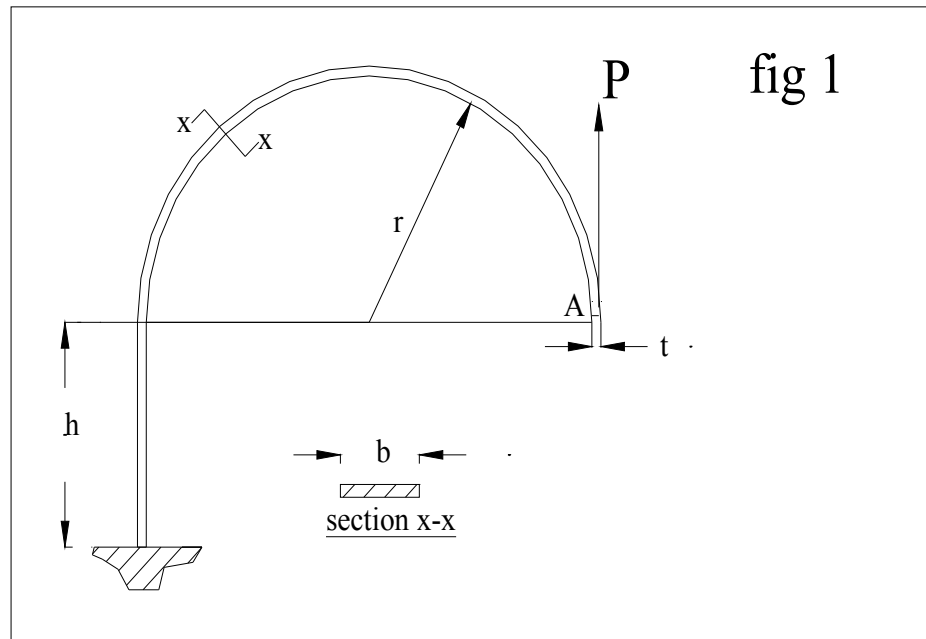
QUESTION 3

Obtain an expression for the horizontal displacement of point A in the bent cantilever shown in figure 1 which is of breadth *b*.

If r =50mm, t= 6mm, b=25mm, h= 90mm and the beam is of steel. Find the horizontal displacement of A for W = 20 N

TAKE:E=200GN/m²   (20 marks)

fig 1

section x-x

QUESTION 5

Obtain an expression in terms of *w,W* and *l* for the deflection under the load for the beam shown below using *Castigiliano's* theorem   (20 marks)

fig 2

w N/M

l