



TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL & AUTOMOTIVE ENGINEERING

UNIVERSITY EXAMINATION FOR:

BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

EMG 2411 : SOLID AND STRUCTURAL MECHANICS IV

END OF SEMESTER EXAMINATION

SERIES: APRIL 2016

TIME: 2 HOURS

DATE: Pick Date May 2016

Instructions to Candidates

You should have the following for this examination

-Answer Booklet, examination pass and student ID

This paper consists of **FIVE** questions. Attempt any **THREE** questions.

Do not write on the question paper.

Question 1

Fig Q1 shows a two-celled tube with a cross-section whose dimensions are indicated in millimeters and $t_1 = 4mm$, $t_2 = 6.2mm$ and $t_3 = 2.8mm$.

If a torque of magnitude $11.6kN - m$ is applied, calculate

- the stresses in all the walls
 - the overall angle of twist per unit length
- Torsional Modulus of Rigidity $G = 80GN / m^2$

Question 2

Fig Q2 shows a beam of length l fixed at the left-hand end and propped at the right-hand end, while supporting a centre-point load P .

- Calculate the reactions at the supports

(ii) Derive expressions for the deflection at a distance $\frac{l}{4}$ and a distance $\frac{l}{2}$ from the fixed end of the beam

E = Modulus of Elasticity of the beam material

I = Second Moment of Area of beam cross-section about a horizontal axis through

Its centre of gravity.

Question 3

Fig Q3 shows the cross-section of a cantilever beam of length l made from a material of thickness t . The beam has a small slit along its whole length, the slit location being as shown in the figure. A vertical force P is applied at the free end of the beam. The line of action of force P is such that only bending (and no twisting) of the cross-section takes place.

Determine

- the Shear Stresses and sketch their distribution along the faces $AB, BC, CD,$ and DE of the cross-section.
- the position of the Shear Centre of the cross-section.

Question 4

- A strut of uniform cross-section is of length l and it is pinned at the ends. It carries an axial compressive load P as well as a laterally applied centre point load W .

Show that the maximum deflection is given by

$$\delta = \frac{W}{2nP} \tan \frac{nl}{2} - \frac{Wl}{4P}$$

Where $n = \sqrt{\frac{P}{EI}}$ and I is the Second Moment of Area of the cross-section

- (b) Derive an expression for the maximum compressive stress in the strut if one assumes the strut to be of solid cross-section with diameter a .

Question 5

A circular plate has diameter 600mm and it is made from a material of thickness 0.018mm . The plate is clamped around its periphery and it is subjected to a concentrated centre point load of magnitude 450N .

Calculate the magnitude of the radial stress at the fixed end.

Modulus of Elasticity $E = 200\text{GN} / \text{m}^2$

Poisson's ratio $\nu = 0.3$

Assume that at any radius r , the Bending Moment in the radial direction per unit length of arc is given by

$$M_r = -D \left[\frac{d^2w}{dr^2} + \frac{\nu}{r} \frac{dw}{dr} \right]$$

And the Bending Moment in the circumferential direction per unit length of radius is given by

$$M_\theta = -D \left[\frac{1}{r} \frac{dw}{dr} + \nu \frac{d^2w}{dr^2} \right]$$

Also

$$\frac{d}{dr} \left[\frac{1}{r} \frac{d}{dr} \left(r \frac{dw}{dr} \right) \right] = \frac{Q}{D}$$

where Q is the Shear Force per unit length and

$$D = \frac{Et^3}{12(1-\nu^2)}$$

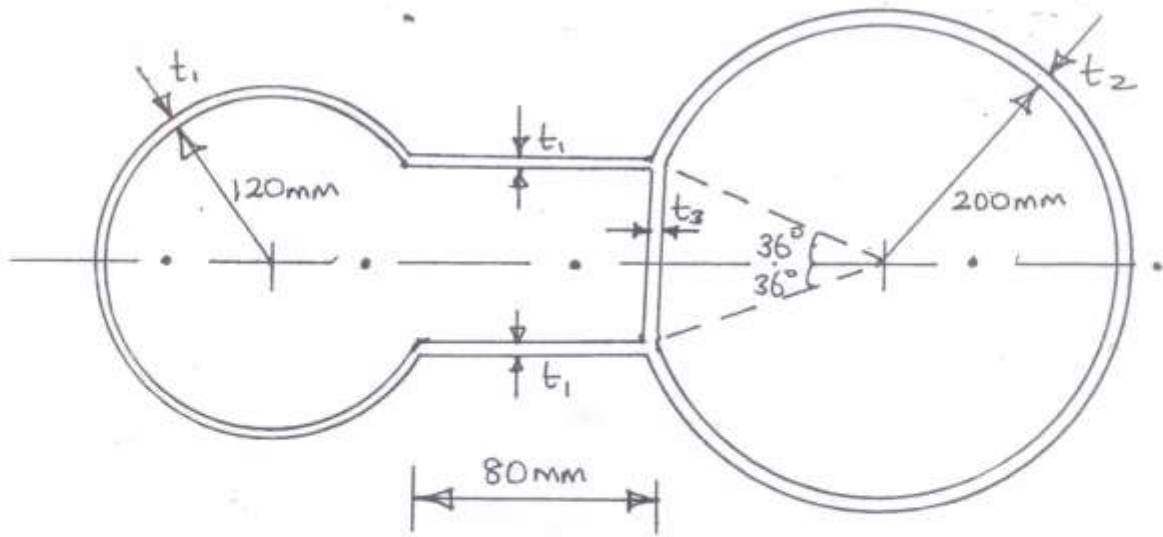


FIG Q1

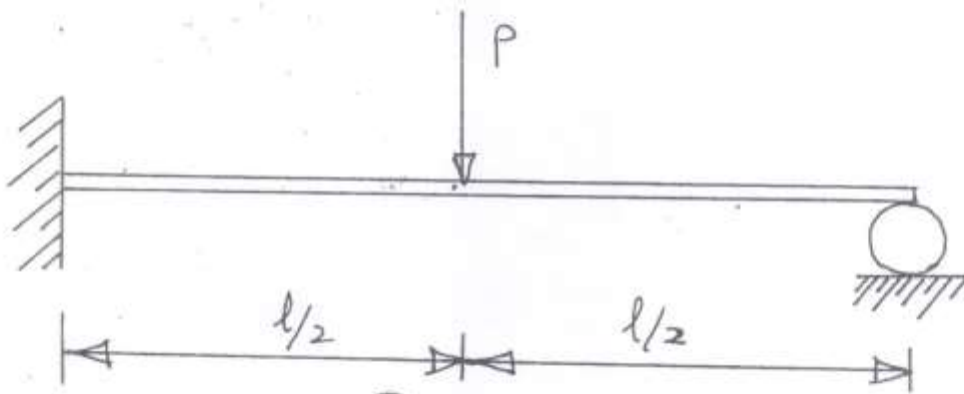


FIG Q2

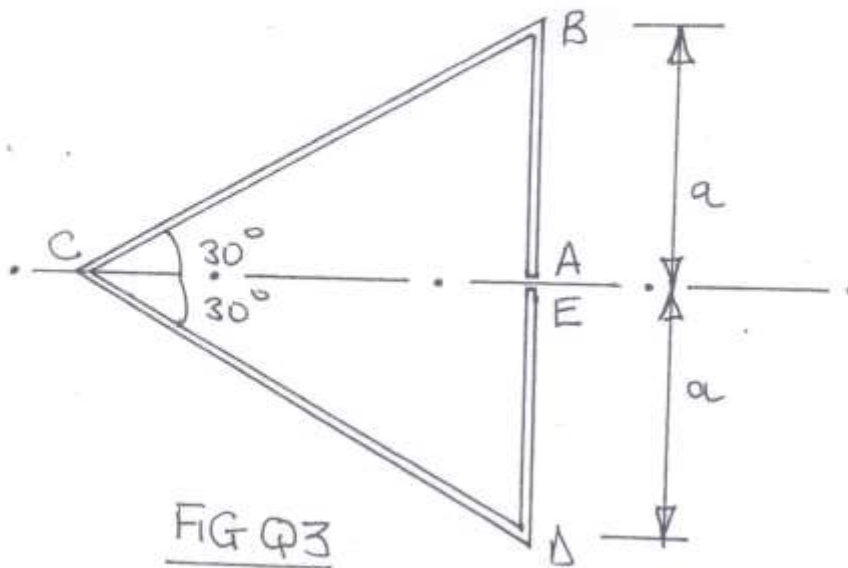


FIG Q3