# 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.**

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**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

(a) the stresses in all the walls
(b) 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 $P$.

(i) Calculate the reactions at the supports

(ii) Derive expressions for the deflection at a distance $l/4$ and a distance $l/2$ 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

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

(b) the position of the Shear Centre of the cross-section.

**Question 4**

(a) 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 $E = 200GN/m^2$

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

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

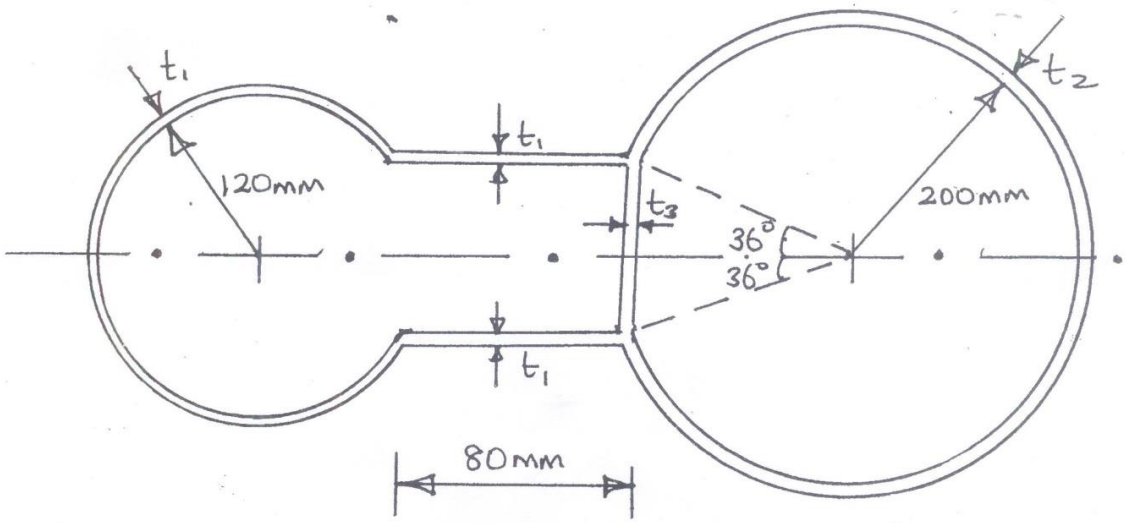


FIG Q1

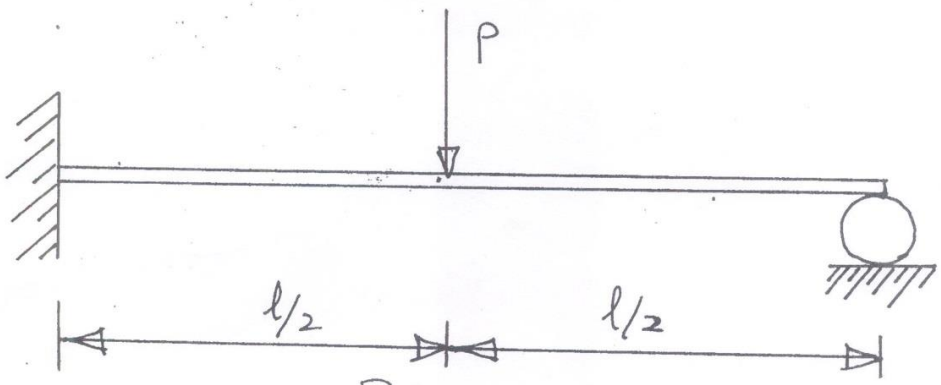


FIG Q2

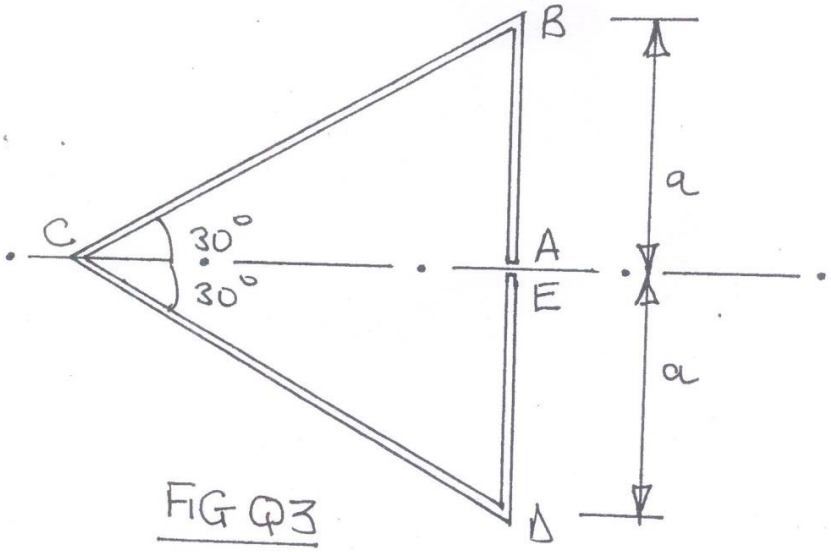


FIG Q3