



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 the cross-section of a thin-walled two-celled tube subjected to a torque T . The dimensions of the sections are given as functions of ' a ' and the thicknesses of the various sections are indicated as functions of ' t '

Derive in terms of the indicated parameters

- (i) the Shear Stresses in all the walls
- (ii) the expression for the angle of twist per unit length

G = Torsional Modulus of Rigidity of the material

Question 2

Fig Q2 shows a beam of length ' $2a$ ' metres, fixed at both ends and supporting a uniformly distributed load of magnitude w N/m over a span length of ' a ' metres

- (i) Calculate the reactions at the supports
- (ii) Derive expressions for the deflection and the slope at the centre of the beam

E - Modulus of Elasticity of the beam material

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

through its centre of gravity

Question 3

Fig Q3 shows the cross-section of a beam made from a material of thickness ' t '

and the other dimensions are indicated as functions of ' a '. If the beam supports a vertical force ' V '

- (i) derive an expression for the maximum Shear Stress
- (ii) determine the position of the Shear Centre.

Question 4

- (a) Show that for a horizontal pin-ended strut compressed by a load ' P ' and supporting a uniformly distributed load of magnitude w N/m along its complete length, the maximum deflection is given by

$$\delta_{\max} = \frac{w}{P} \left[\frac{1}{n^2} \left(\sec \frac{nl}{2} - 1 \right) - \frac{l^2}{8} \right]$$

$$\text{Where } n = \sqrt{\frac{P}{EI}}$$

- (b) A horizontal strut $4.2m$ long has a hollow circular section of outside diameter $100mm$ and inside diameter $82mm$. The strut supports an axial compressive load of magnitude $140kN$ together with a uniformly distributed load of magnitude $3.6kN/m$ over its entire length. Calculate the magnitude of the maximum stress set up in the strut.

$$E = 208GN/m^2$$

Question 5

A plate of uniform thickness is of diameter $126mm$. The plate is constrained at its edges and it is loaded on one face with a uniform pressure ' p '. The thickness of the plate is $0.9mm$. If the maximum stress in the plate is limited to $120MN/m^2$ calculate

- (a) the magnitude of the pressure ' p ' applied
- (b) the magnitude of the maximum deflection produced

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

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

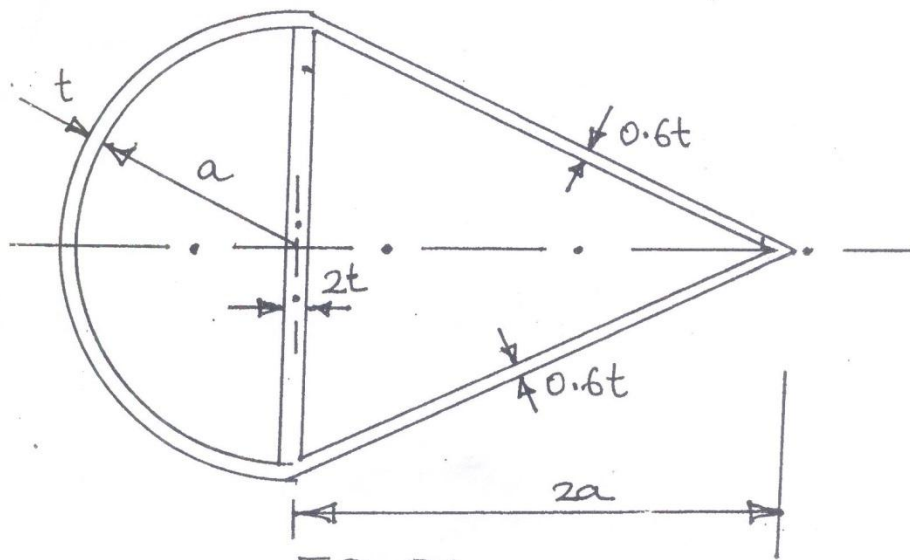


FIG Q1

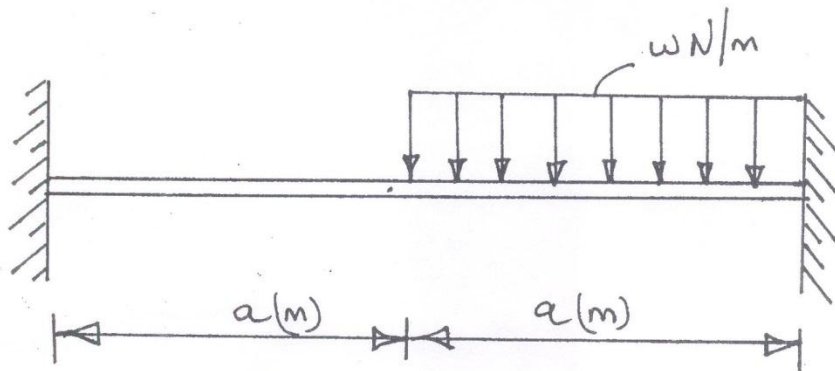


FIG Q2

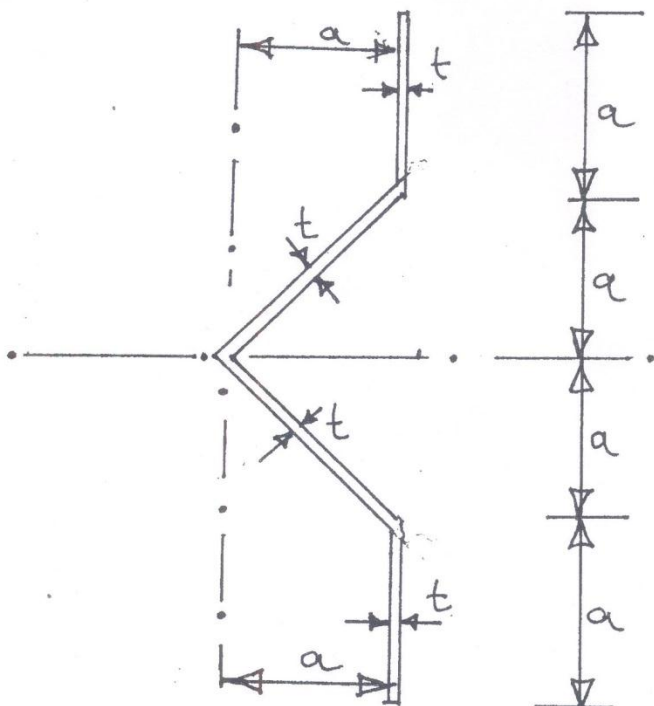


FIG Q3