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

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

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

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

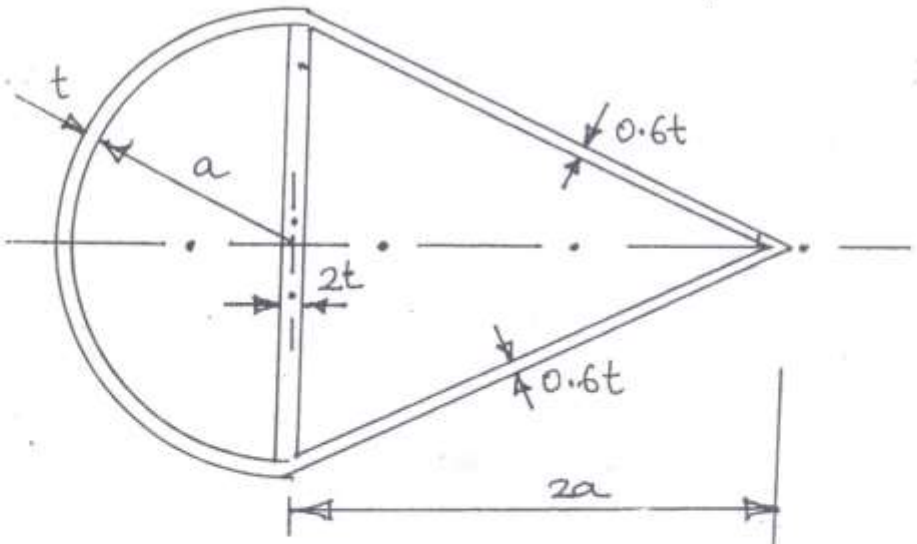

FIG Q1

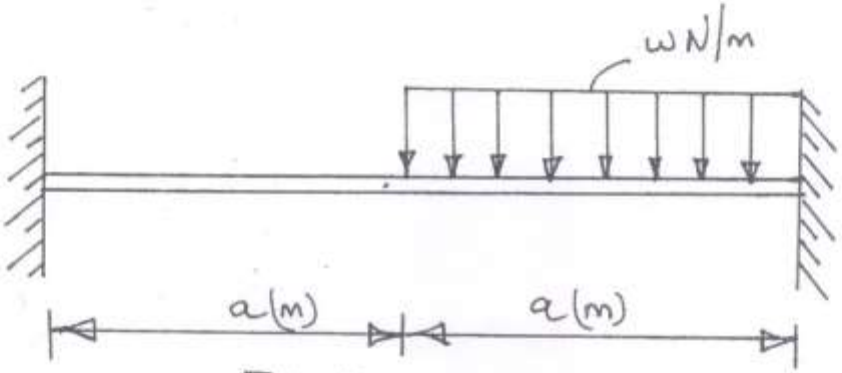

FIG Q2

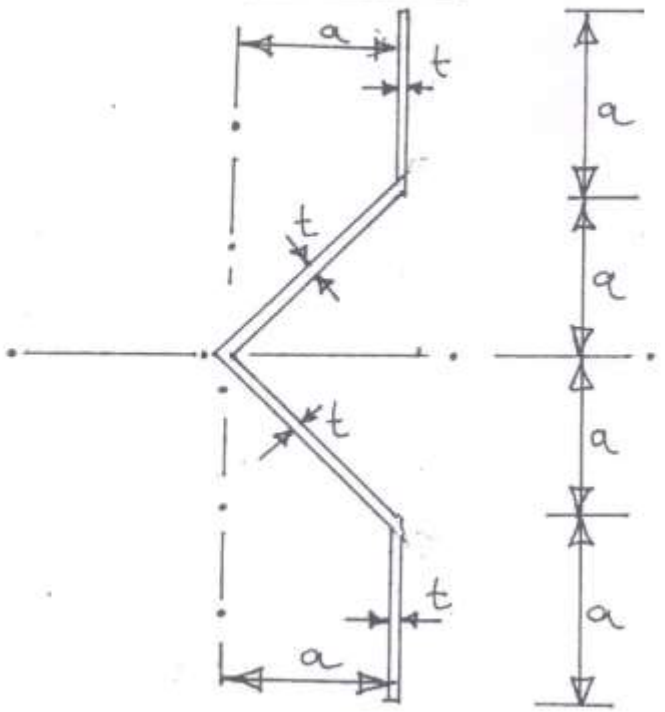

FIG Q3