TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Engineering and Technology
Department of Mechanical & Automotive Engineering
UNIVERSITY EXAMINATION FOR:
BSc. Mechanical Engineering
EMG 2411 : SOLIDS & STRUCTURAL MECHANICS IV
END OF SEMESTER EXAMINATION
SERIES: sept. 2017
TIME: 2 HOURS
DATE: sept. 2017

Instruction to Candidates:

You should have the following for this examination

- *Answer booklet*
- *Non-Programmable scientific calculator*

This paper consists of **FIVE** questions. Attempt any **THREE** questions. All Questions carry equal marks.

Maximum marks for each part of a question are as shown.

Do not write on the question paper.

Question 1

Fig Q1 shows a beam of length $'2a'$ metres fixed at the left-hand end and propped at the centre. The beam supports a uniformly distributed load of magnitude wN/m over a span of $'a'$ metres as well as a point load of magnitude $'2wa'$ Newtons and a clockwise couple of magnitude $'2wa^2'N-m$ at the free end.

(i) Derive expressions for the reactions at the supports

(ii) Derive expressions for the slope and the deflection at the free end of the beam.

E - Modulus of elasticity of the beam

I - Second Moment of area of the beam cross-section

Question 2

Fig Q2 shows the cross-section of a 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 given 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 3

Fig Q3 shows a cross-section of a beam made from a material of thickness 't' and the rest of the dimensions are indicated as functions of 'a'.

(i) Calculate the magnitude of the maximum Shear stress

(ii) Determine the position of the Shear centre

Question 4

Fig Q4 shows a strut fixed at the left-hand end and supporting a compressive load P as well as a bending moment M at the free end.

Show that :

$$M = \frac{PaCosnl}{(1 - Cosnl)}$$

where l is the length of the strut and 'a' the deflection at the free end

Question 5

A circular plate of radius R and thickness 't' is fixed at the periphery and the plate supports a uniformly applied pressure 'p' per unit area.

(i) Show that the maximum radial stress per unit arc $(\sigma_r \max)$ is given by

$$\sigma_r \max = \frac{3pR^2}{4Et^2}$$

And the maximum circumferential stress per unit radius $(\sigma_\theta \max)$ is given by

$$\sigma_\theta \max = \frac{3pR^2(1+\upsilon)}{8t^2}$$

(iii) show that at $r = 0$ the bending moment in the circumferential direction per unit length of radius is given by

$$M_\theta = \frac{pR^2(1+\upsilon)}{16}$$

And (at $r = 0$) the bending moment in the radial direction per unit length of circumference is given by

$$M_r = \frac{pR^2(1+\upsilon)}{16}$$

Assume that at any radius 'r' the bending moment in the radial direction per unit length of arc is given by

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

And the bending moment in the circumferential direction per unit length of radius is given by

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

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

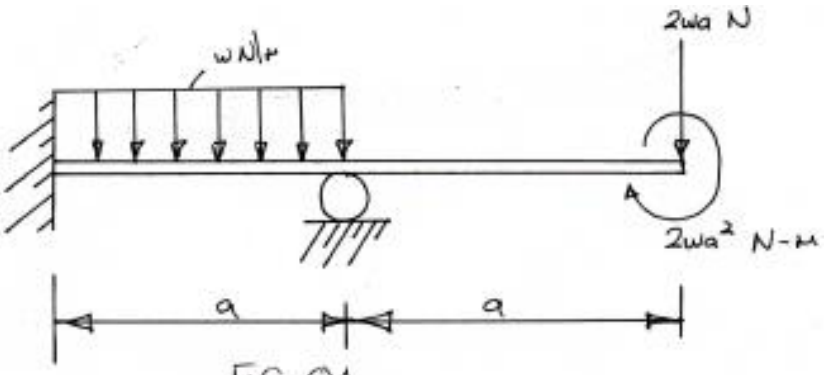

FIG Q1

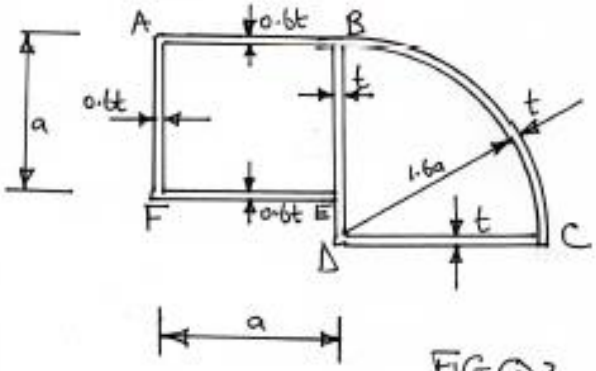

FIG Q2

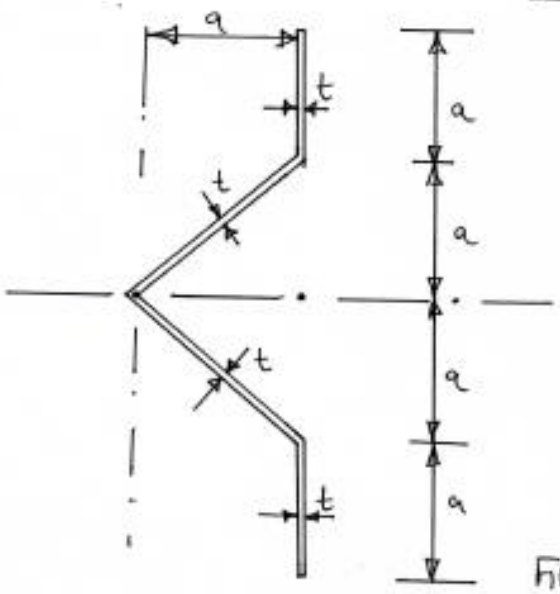

FIG Q3

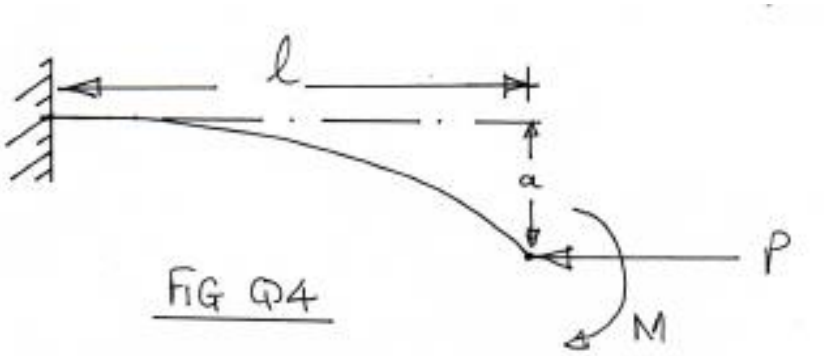

FIG Q4