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: DECEMBER 2016
TIME: 2 HOURS
DATE: 5 Dec 2016

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 both ends and supporting a uniformly distributed load of magnitude wN/m over a distance a metres and a clockwise couple of magnitude $2wa^2N-m$ applied at the centre of the beam.

(i) Derive expressions for the reactions at the supports

(ii) Derive expressions for the slope and deflection at the centre 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 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 = Torsion modulus of rigidity of the material

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 acting Shear Force $'V'$.

(i) Derive an expression for the Maximum Shear Stress.

(ii) Determine the position of the Shear Centre

Question 4

A slender horizontal strut with pin-ends carries a horizontal compressive load $'P'$ and a vertical centre point load W. If the length of the strut is given by l

(a) show that the centre point deflection of the strut is given by:

$$\delta = \frac{W}{2P}\left[\frac{1}{n}\tan\frac{nl}{2} - \frac{l}{2}\right]$$

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

E being the Modulus of Elasticity of the material and I, the Second Moment of area of the cross-section.

(b) If this strut has a circular cross-section of diameter $40mm$; length $3m$ and an axial compressive load of magnitude $140kN$, calculate the acceptable value of the vertical load W if the maximum allowable compressive stress is $260MN/m^2$.

$$E = 210GN/m^2$$

Question 5

A steel circular plate is firmly clamped along the edges at a radius R_0 per unit area and a central point and carries a central point load N. If the thickness of the plate is $'t'$, the Modulus of Elasticity is E and the Poisson's ratio is $'\upsilon'$

(a) derive an expression for the deflection $'w'$ of the plate at a radius $r = 0$

(b) derive an expression for the radial stress (σ_r) per unit arc length at $r = R_0$

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

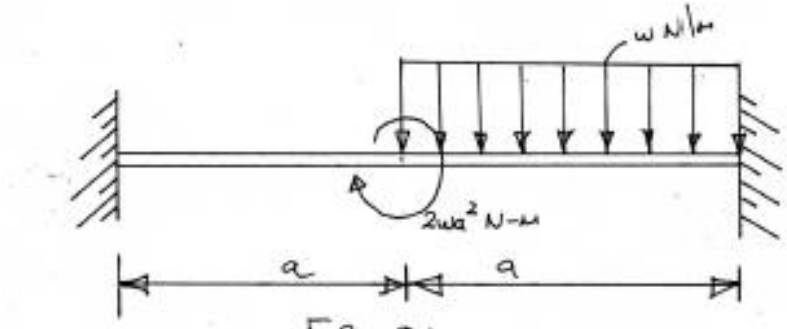

FIG Q1

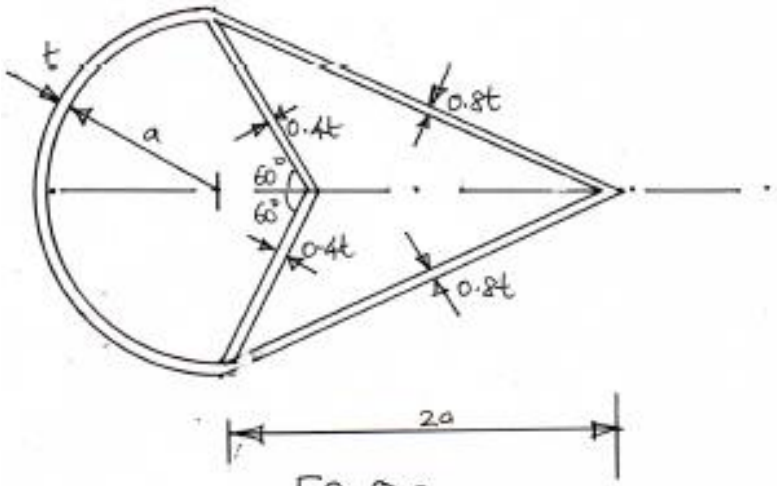

FIG Q2

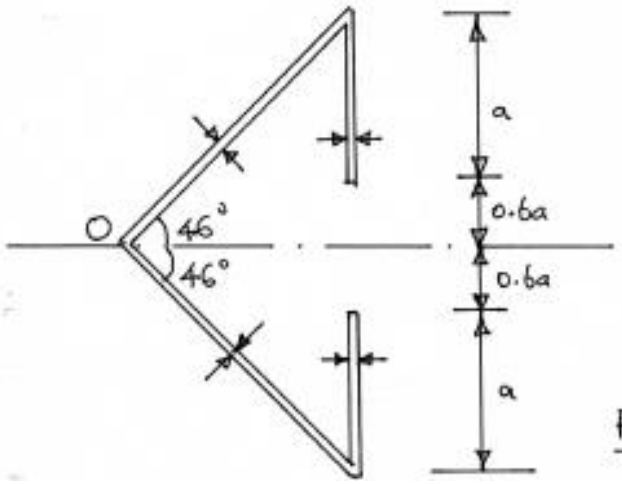

FIG Q3