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
SUPPLIMENTARY EXAMINATION
SERIES: September 2018
TIME: 2 HOURS

Instruction to Candidates:

You should have the following for this examination

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

This paper consists of **FOUR** questions. Attempt any **THREE** questions.
Maximum marks for each part of a question are as shown.
Do not write on the question paper.

Question ONE

Fig Q1 shows a beam of length l, fixed at both ends and supporting a distributed load of magnitude $w\ N/m$ over a length $l/2$ and a point load P applied at a distance $l/4$ from the right-hand end.

(i) Calculate the reactions at the supports in terms of the indicated parameters

(ii) Show that the deflection at the centre of the beam is given by

$$\delta = -\frac{1}{EI}\left[\frac{wl^4}{768} + \frac{Pl^3}{384}\right]$$

Question TWO

Fig Q2 shows the cross-section of a steel beam, made from a plate of thickness t. If at a particular section along the length of this beam, a Shear Force V acts, locate the position of the Shear Centre.

Question THREE

Fig Q3 shows the cross-section of a two-celled tube with the thicknesses given as functions of t and the remaining dimensions given as functions of a. The tube has a length L and it is loaded by a twisting moment T. Taking the Modulus of Rigidity to be G, determine

(a) the Shear Stresses in all the walls
(b) the Angle of Twist per unit length

Question FOUR

A strut of length l is pin-jointed at the ends and it supports a compressive load P at the ends as well as a transverse load W applied at the centre.

(i) Derive an expression for the maximum deflection

(ii) If $P = 140kN$, the diameter of the strut $d = 40mm$, and the limiting stress in tension or compression is $260MN/m^2$, calculate the acceptable value of W.

Question FIVE

A circular plate of radius R and thickness t is fixed at the periphery and it supports a uniformly distributed pressure p /unit area on one surface.

(i) Show that the maximum deflection is given by $w = \frac{pR^4}{64D}$ and it occurs at the centre

(ii) Calculate the ratio $\frac{w_{\max}Plate}{w_{\max}Beam}$

where $w_{\max}Plate$ is the maximum deflection of the plate and $w_{\max}Beam$ is the maximum deflection of a beam of unit breadth and thickness t and length $2R$, simply supported at the ends and supporting a uniformly distributed load p /unit length.

Assume that for the plate, 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

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

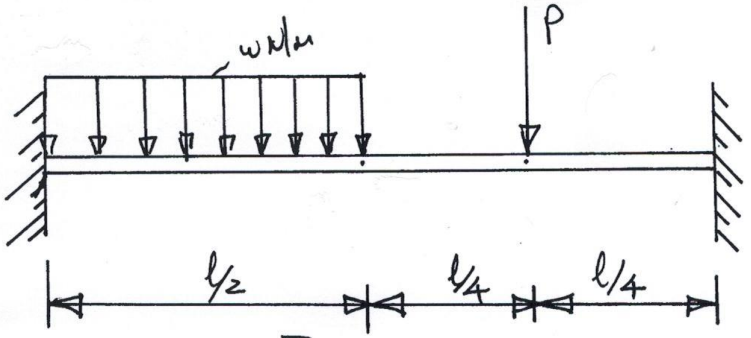

FIG Q1

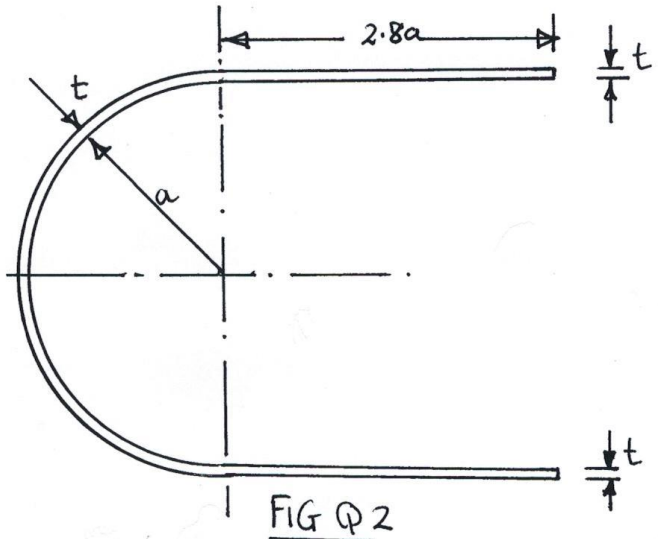

FIG Q2

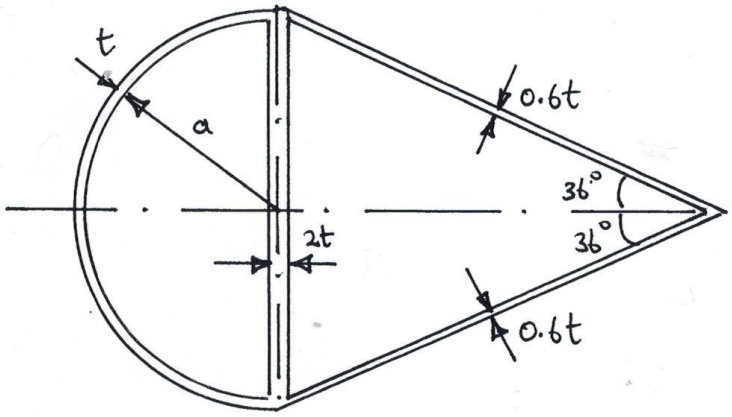

FIG Q3