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THE OPEN UNIVERSITY OF SRI LANKA

FACULTY OF ENGINEERING TECHNOLOGY

DIPLOMA IN TECHNOLOGY - LEVEL 05

FINAL EXAMINATION 2009/2010

MEX5232 Strength of Materials II

DATE : March 01, 2010

TIME : 930 - 1230hrs

DURATION : 3 hours

Read the following instructions carefully before answering the questions

1. This question paper consists of **eight** questions. Answer **any five** questions **only**.
2. All questions carry equal marks.
3. Time allocation for the paper is **03hrs.**
4. Do not spend more than **30 - 35** minutes for a question.

Q1. (a) Write down the differential equation for the elastic curve for bending of beams and name its terms.

(b) A Simply supported beam carries a distributed load as shown in figure Q1 below.

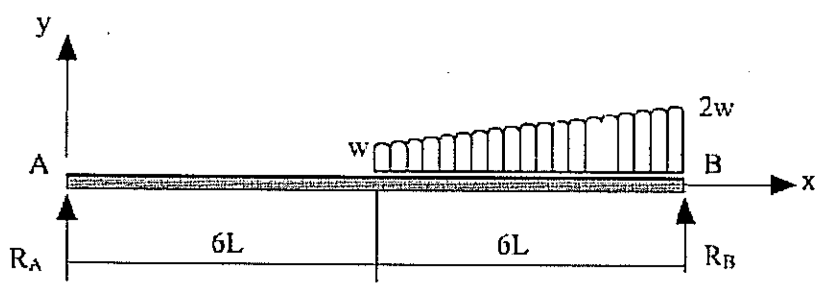

Figure Q1

(i) Find out the reactions at supports A and B.

(ii) Write an equation for the bending moment using Macaulay's Method

(iii) Derive the deflection equation for the elastic curve.

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Q2. (a) State Mohr's first and second theorems as applied to the deflection of built-in beams.

(b) A built-in beam carries two point loads as shown in figure Q1.

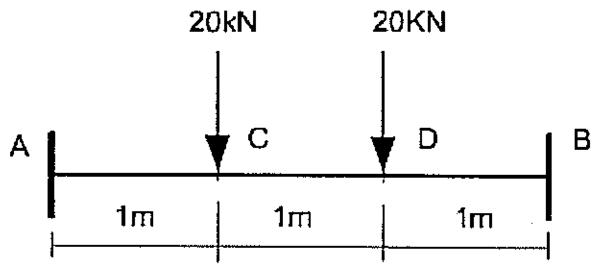

Figure Q2

(i) Sketch free body diagram, free moment diagram and fixing moment diagram for the beam.

(ii) Determine the values of fixing moments at the beam ends using Mohr's theorems.

Q3. (a) Define the following section properties of a beam.

(i) Second moment of area about two mutually perpendicular axes

(ii) Product second moment of area about the same axes

(b) Calculate the second moments of area and the product second moment of area of the beam section shown in figure Q3.

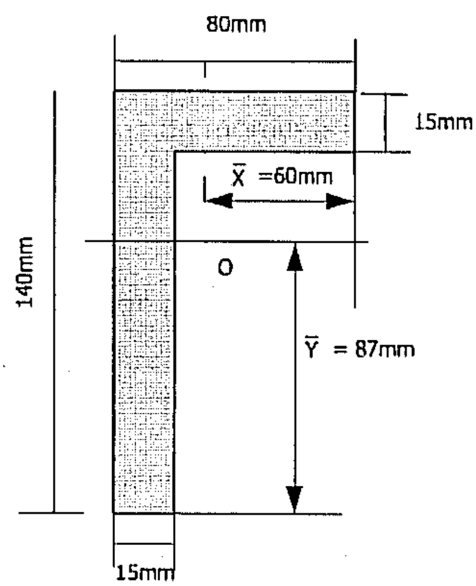

Figure Q3

Q4. Write down the Lame equations for radial and hoop stresses for thick cylinders.

A thick cylinder having inner and outer radii of 50mm and 150mm respectively is subjected to an internal pressure of $15MN/m^2$.

(a) Sketch hoop and radial stresses as a function of $1/r^2$, and indicate clearly the maximum hoop stress in the cylinder.

(b) Determine;
(i) Hoop and radial stresses at radius 100mm
(ii) Maximum Shear stress at radius 100mm

(c) If external pressure of $5MN/m^2$ is applied in addition to the internal pressure, sketch new stresses on the same coordinate axes in (a).

Q5. (a) What is meant by plastic bending of beams?

(b) Show that total bending moment carried by a beam section, when it is plastically yielded to a depth of d/2 (see figure Q5) is given by the following equation.

$$M = \frac{B\sigma_y}{12}(3D^2 - d^2)$$

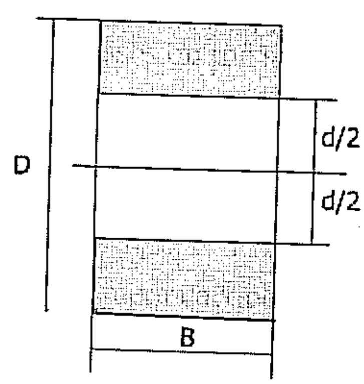

Figure Q5

Q6. (a) State (i) Rankine and (ii) Maximum shear stress theories for failure.

(b) A steel tube has a mean diameter of 100mm and a thickness of 3mm. Calculate the torque that can be transmitted by the tube with a factor of safety of 3, based on the above two failure criteria.

(c) If the above tube is subjected a constant compressive load of 10KN, determine the maximum torque that could be transmitted under the above two failure criteria.

Yield stress of steel can be assumed as $200MN/m^2$.

Q7. (a) The following equations apply when a thin walled tube of closed section is subjected an external toque.

$$T = 2\tau t A$$

$$\frac{\theta}{L} = \frac{\tau s}{2AG}$$

Name the different terms with their SI unit of measurement given in these relationships.

(b) A thin walled tube of 5mm wall thickness consisting of two cells as shown in figure Q7 is subjected a torque of 300Nm.

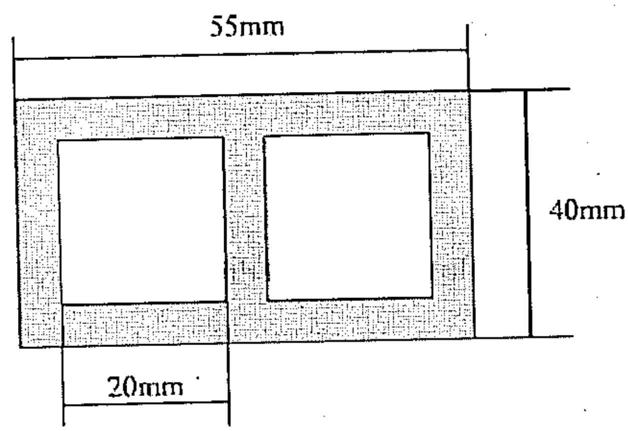

Figure Q7

Find

(i) Shear stresses at different locations of the section
(ii) Angle of twist of the tube.

Q8. (a) What are the types of stresses set up in a rotating solid disc?

(b) A steel ring of 300mm outer diameter and 200mm inner diameter has been shrunk onto a solid shaft a with tight fit. When the shaft rotates at 5000rpm the interface pressure was found to be 15MN/m^2.

a. Determine the circumferential stress at the interface at 5000rpm
b. What would be the speed that reduces the interface pressure to 5MN/m^2?

You may use the following formulae.

$$\sigma_r = A - \frac{B}{r^2} - K_1 r^2 \omega^2$$
$$\sigma_\theta = A + \frac{B}{r^2} - K_2 r^2 \omega^2$$

K_1 and K_2 are constants whose values can be taken as 3000kg/m^3 and 1700kg/m^3 respectively.