THE OPEN UNIVERSITY OF SRI LANKA
FACULTY OF ENGINEERING TECHNOLOGY
DIPLOMA IN TECHNOLOGY – LEVEL 03
FINAL EXAMINATION 2011/2012
MEX3231 – STRENGTH OF MATERIALS 1
DATE :24TH MARCH 2012
TIME :0930 HRS - 1230 HRS
DURATION :03 HOURS

Answer any FIVE (05). All questions carry equal marks.

Question 01:

(a) For a strut of length L, and uniform section modulus EI and hinged at both ends show that the critical load is approximately $\frac{\pi^2 EI}{L^2}$.

(b) Briefly describe the concept of 'equivalent length' or 'effective length' as applied to buckling of struts under different end conditions.

(c) A 2 m long pin ended column of square cross section is to be made of wood. Assuming modulus of elasticity, E = 13 GPa, allowable stress σ_{all} = 12 Mpa and using a factor of safety of 2.5 in computing Euler's critical load for buckling, determine the size of the cross section if the column is to safely support a 100 kN load.

Question 02:

A gun metal sleeve is securely fixed to a steel shaft and the compound shaft is subjected to a torque. If the torque on the sleeve is twice the torque on the shaft,

(a) determine the ratio of the external diameter of the sleeve to the diameter of the shaft.

(b) If the maximum allowable shear stresses of the gun metal and steel are 40 MPa and 70MPa respectively, determine the torques that may be transmitted by the compound tube when the shaft diameter is 60 mm.
G_{steel} is 80 GPa and $G_{gun\ metal}$ is 30 GPa.

Question 03:

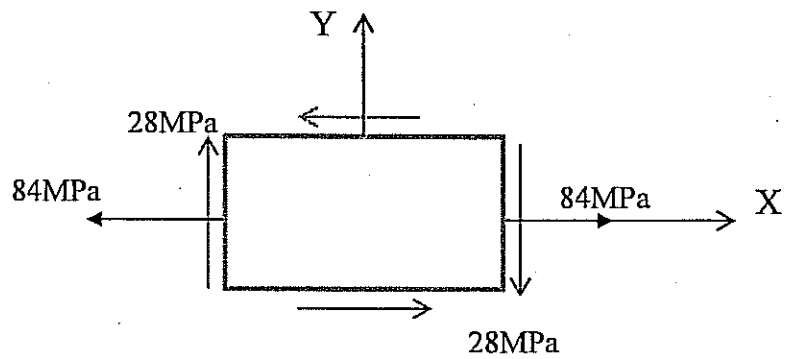


Fig.Q3

A plane element is subjected to the stresses as shown in Fig.Q3. Using Mohr's circle determine:

(a) The principal stresses and their directions.
(b) The maximum shearing stresses, the directions of the planes on which they occur, and the normal stresses on these planes.
The directions of the planes should be shown clearly by suitable sketches.

Question 04:

(a) Derive the equation $\frac{M}{I} = \frac{E}{R} = \frac{\sigma}{y}$ for the simple bending of a beam. List the assumptions made therein.

(b)

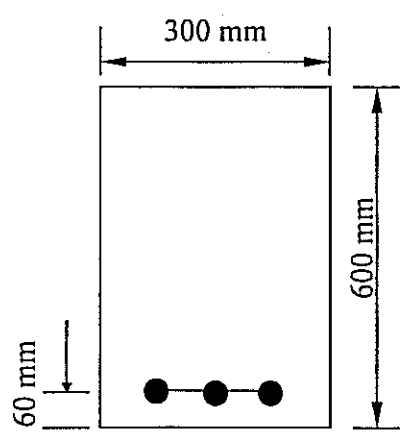


Fig.Q4

A reinforced concrete beam is 300 mm wide and 600 mm deep. The allowable stresses in steel and concrete are 150 MPa and 5 MPa respectively.

(i) Calculate the area of steel reinforcement if the steel rods are placed at a height of 60 mm from the bottom of the beam as shown in Fig.Q4. Assume $Es = 15E_c$.
(ii) If the span of the beam is 6m and density of concrete is 2200 kg/m^3, calculate the uniformly distributed load the beam can carry safely.

Question 05:

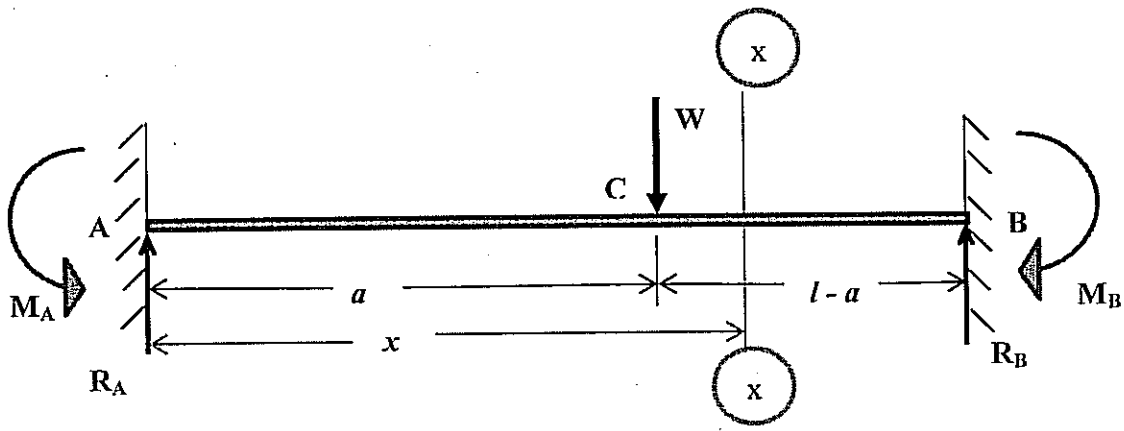


Fig.Q5

A beam **AB** having a length of l is fixed at its ends and subjected to a load W at **C** and two moments M_A and M_B at ends **A** and **B** respectively as shown in Fig.Q5.
Show that

(a) the maximum deflection of beam AB, $y_{max} = \frac{Wl^3}{192EI}$

(b) the distance 'x' from end A, to the point where the maximum deflection (y_{max}) occurs is given by, $x = \frac{2al}{l+2a}$

Question 06:

A beam **AB** having a total length of 9.6 m rest on supports **C** and **D** 7.5 m apart. Support **C** is 1.2m from '**A**' and the other support **D** is 0.9 m from **B**. The beam carries a uniformly distributed load of intensity 20 kN/ m for a length of 6 m, measured from the end **A** and a point load of 10 kN at the end **B**.

(a) Draw the shearing force and bending moment diagrams due to the given loading.

(b) Hence find the magnitude of maximum bending moment.

Question 07:

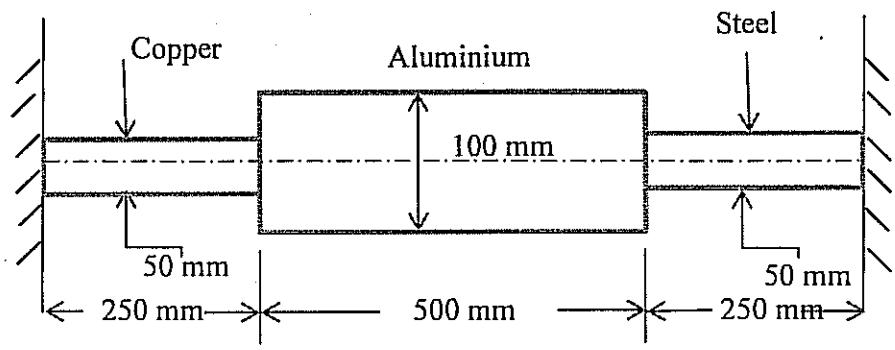


Fig.Q7

A composite bar shown in Fig.Q7 is rigidly attached to the end supports. The temperature of the composite system is raised by 60^0C. Determine the stresses in three portions of the bar if

(a) the supports are rigid
(b) the supports yield by 0.5 mm

Modulus of elasticity (E) and Coefficient of temperature (α) of each material are

For steel	$E_s = 200$GPa, $\alpha_s = 12 \times 10^{-6}/^0$C
For aluminium	$E_a = 90$GPa, $\alpha_s = 20 \times 10^{-6}/^0$C
For copper	$E_c = 100$GPa, $\alpha_c = 16 \times 10^{-6}/^0$C

Question 08:

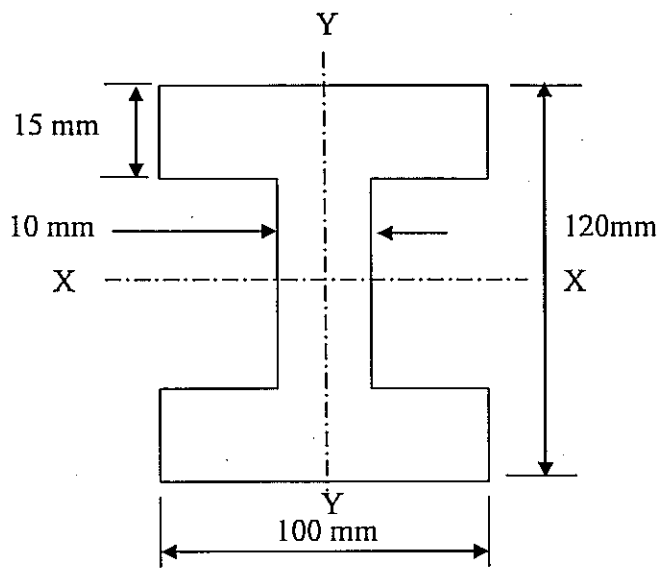


Fig.Q8

(a) Find the second moment of area of the beam section shown in Fig.Q8 about the axes X-X and Y-Y.

(b) Calculate the ratio of the moment of resistance to bending in the Y-Y plane to that for bending in the X-X plane if the maximum allowable stress due to bending is the same in both cases.

(c) The beam with above section is simply supported at its ends to allow bending in the Y-Y plane under the action of a uniformly distributed load of 15 kN/m. What should be the maximum distance between the two symmetrically placed supports if the allowable stress is limited to 40 N/mm^2.

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