UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 2 Examination in Engineering: March 2014

Module Number: CE2302 **Module Name: Mechanics of Materials**

[Three Hours]

[Answer **all questions**, each question carries 12 marks]

Q1. a) Briefly discuss the advantage of using composite material in a beam element.

[2 Marks]

b) A composite beam having the cross section as shown in Fig. Q1 is formed by securely bonding two rectangular aluminium sections to a square brass section. The modulus of elasticity and the allowable bending stresses of the two materials are as follows.

	Aluminium	Brass
Modulus of elasticity	70 GPa	105 GPa
Allowable bending stress	100 MPa	160 MPa

Determine maximum possible bending moment that can be carried by the composite beam when the beam is subjected to bending about its horizontal axis.

[10 Marks]

Q2. A steel wide-flange beam has the dimensions as shown in Fig Q2. If it is subjected to a vertical shear force of 60 kN,

a) Calculate the vertical shear stress at just above (point B) and below (point C) the intersection of web and flange. [4 Marks]

b) Determine the maximum vertical shear stress. [2 Marks]

c) Plot the shear stress distribution acting over the beam's cross-section. [2 Marks]

d) Determine the shear force resisted by the web. [4 Marks]

Q3. In-plane normal and shear stresses at a point in a structural body are shown in Fig. Q3.

a) Construct Mohr's circle to represent normal and shear stresses at any plane at this stress point. [4 Marks]

b) Using the Mohr's circle drawn in Part (a), determine the magnitude and direction of principal stresses. [3 Marks]

c) What is the maximum in-plane shear stress at the point? [2 Marks]

d) Determine normal and shear stresses on plane AB. [3 Marks]

Q4. a) Using usual notations and relevant assumptions derive torsion formula for a circular hollow tube. [2 Marks]

b) A shaft used in a machine is required to transmit 100 kW power at a frequency of 1200 r.p.m. The shaft needs to be made in steel having outer diameter of 50mm. Assume that the allowable shear stress in steel is 60 MPa.

i) Determine required wall thickness of the shaft. [5 Marks]

ii) If the hollow shaft is replaced with a steel solid shaft having the same weight, can it transfer the same power at the same frequency? [5 Marks]

Polar moment of area for solid bar $J = \frac{\pi}{2} r^4$, and for hollow cylinder $J = \frac{\pi}{2}(r_1^4 - r_2^4)$

Where r, r_1 and r_2 are the radius of solid bar, outer radius and inner radius of cylinder respectively.

Q5 Consider a cantilever beam ABC shown in FigQ5. The beam is 1 m long and carrying a point load of 10 kN at free end, and 50 kN/m distributed load up to 0.6 m from the fix end. The beam AB is of greater depth than it is beyond, having $I_{AB} = 5\times10^6$ mm^4 and beam BC having $I_{BC} = 2.5\times10^6$ mm^4. Neglect the weight of the beam. Young modulus of the beam material is 200 GPa.

a) Draw the bending moment diagram for beam ABC. [3 Marks]

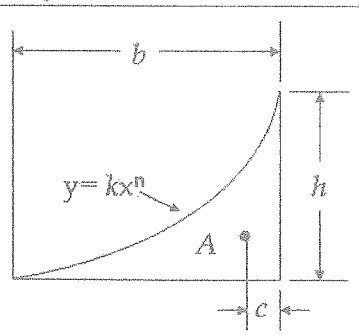
b) Using moment area method for deflection, determine [9 Marks]

(i) angular rotation at points B and C.

(ii) deflection at point C.

Hint: Area 'A' encircled by a parabolic curve and distance to centroid 'c' of such area are shown in Table 5.

Table Q5

	Area (A)	c
	$bh/(n+1)$	b/(n+2)

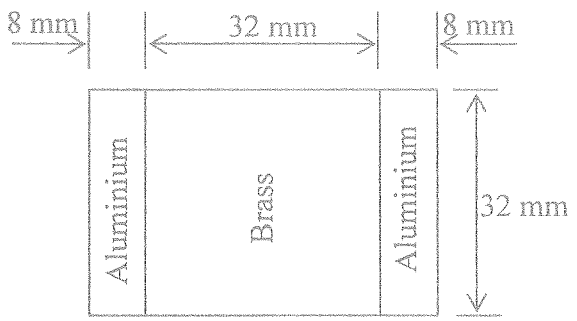


Fig.Q1

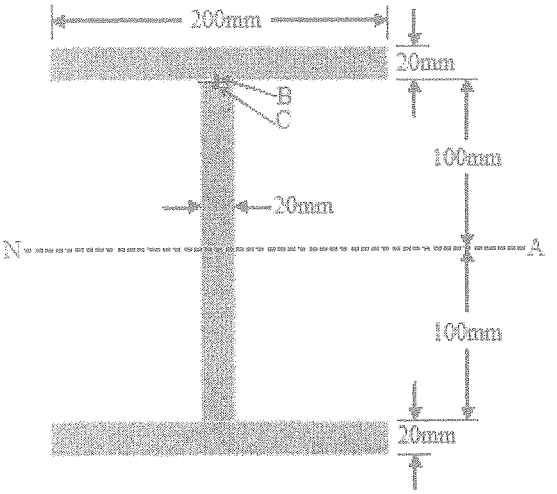


Fig.Q2

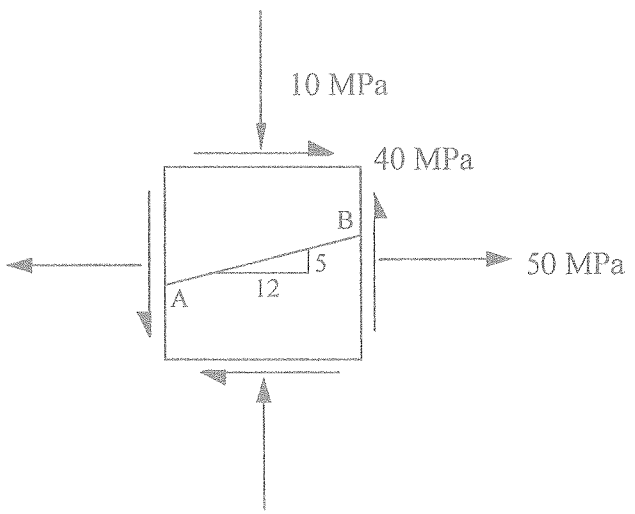


Fig.Q3

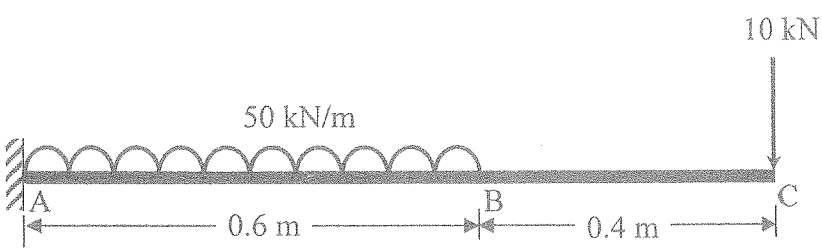


Fig. Q5.