The Open University of Sri Lanka
Faculty of Engineering Technology

Study Programme	:	Bachelor of Technology Honours in Engineering
Name of the Examination	:	Final Examination
Course Code and Title	:	**MEX4275 Strength of Materials I**
Academic Year	:	2016/17
Date	:	6th December 2017
Time	:	0930hrs – 1230hrs
Duration	:	3 hours

General instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of 8 questions.
3. Answer any 5 questions. All questions carry equal marks.

Question No.1

(a) List the various types of loads to which a beam can be subjected.

(04 Marks)

(b) Draw the shear force and bending moment diagrammes for the beam loaded and supported as shown in Fig.Q1.

Hence determine the maximum bending moment of and the location where it acts on the beam.

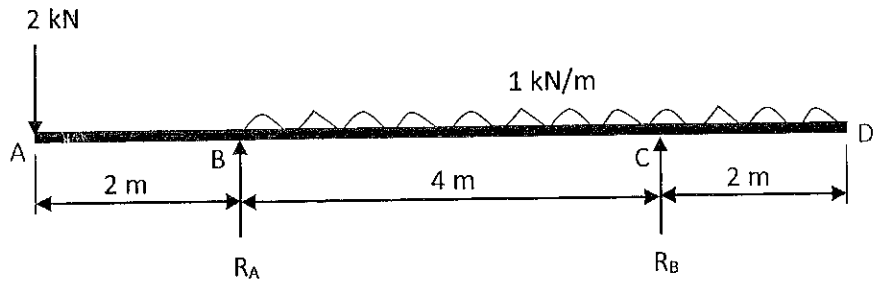


Fig.Q1

(16 Marks)

Question No.2

(a) Define and explain the terms.

i) Longitudinal strain ii) Lateral strain iii) Poisson's ratio

(06 Marks)

(b) A mild steel tube of external diameter 80 mm and internal diameter 60 mm is enclosed centrally inside a brass tube of same length and having external diameter 100 mm and internal diameter 80 mm. The ends of the tubes are brazed together and the composite arrangement is subjected to an axial pull of 25 kN as shown in Fig.Q2.

If modulus of elasticity for steel and brass are 200 GPa and 100 GPa respectively and compound tube length is 300 mm, determine the load carried by and shortening length or extension of each tube.

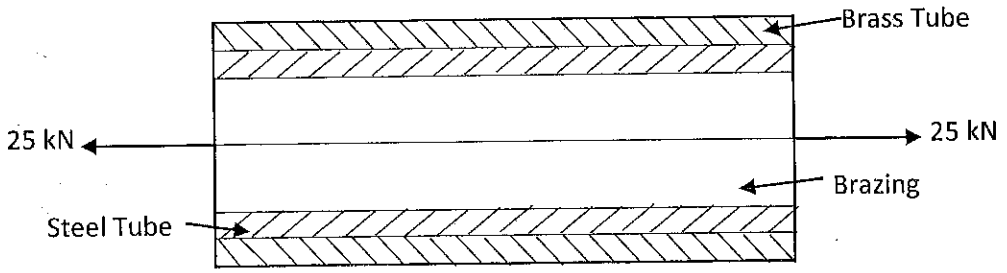


Fig.Q2

(14 Marks)

Question No.3

(a) Explain how Mohr's circle can be constructed for a rectangular stress element subjected to normal stresses σ_x and σ_y, and shear stress τ ? Identify the important stresses that the Mohr's circle provides.

(05 Marks)

(b) At a point in a rectangular block of an elastic material under strain, there is a tensile stress of 50 MPa on one plane and a compressive stress of 30 MPa on a plane at right angle to the former. These stresses are accompanied by a shearing stress of 30 MPa. The shear stress acts on the plane carrying tensile stress in such a way that it tends to rotate the block anti-clockwise.

(i) Sketch the block with system of stresses.

(ii) Determine analytically or graphically the following.

1. the magnitude of the principal stresses
2. the direction of the principal planes
3. the magnitude of the maximum shear stress

(15 Marks)

Question No.4

(a) State the bending formula and write down the assumptions made when deriving this formula.

(04 Marks)

(b) A composite beam is fabricated from steel and timber. The bending moment acting on a given cross section of the beam is "M". Derive an equation to find out the flexural rigidity of the composite beam in terms of Young's modulus and second moment of area.

Young's modulus - For timber E_t , for steel E_s ,

Second moment of area of the section - For timber I_t , for steel I_s

(08 Marks)

(c) A timber beam 72mm wide and 144 mm deep is to be reinforced by bonding strips of steel 72mm wide on to the top and bottom faces, over the whole length of the beam. If the moment of resistance of the composite beam is to be 4 times that of the timber alone with the same value of maximum stress in the timber, determine the thickness of steel strip and the ratio of maximum stresses in steel and timber. $E_s = 7.15\ E_t$

(08 Marks)

Question No.5

(a) Derive the following expression for the ratio of torques transmitted by a hollow and a solid circular shafts of same material, length and mass.

$$\frac{T_h}{T_s} = \frac{n^2 + 1}{n\sqrt{n^2 - 1}}$$

Where T_h and T_s are the torque relevant to hollow and solid shafts respectively, and 'n' is the ratio of outer and inner radii of the hollow shaft.

Hint: Allowable shear strength is equal for the both conditions.

(10 Marks)

(b) A hollow shaft with an external diameter'd' and internal diameter 'd/2' is replaced by a solid shaft of diameter 'd'. Find the following.

(i) Ratio of torques transmitted by hollow and solid shafts if equal stresses are induced in the two shafts.

(ii) Maximum shear stress induced in each of the hollow and solid shaft if the two shafts transmit equal torques.

(10 Marks)

Question No.6

(a) State Castigliano's first and second theorems for strain energy.

(04 Marks)

(b)

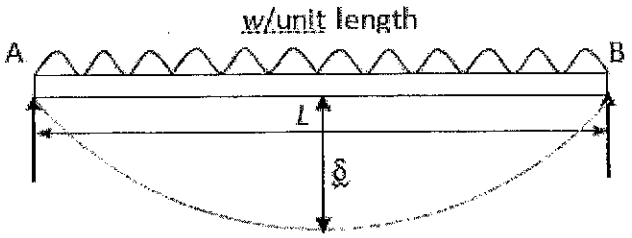


Fig.Q6

A simply supported beam carries a uniformly distributed load of intensity ***w*** over its length ***L*** as shown in Fig.Q6. If the flexural rigidity ***EI*** of the beam is constant, using the Castigliano's theorems show that the deflection (δ) at its mid span $= \frac{5wl^4}{384EI}$

(16 Marks)

Question No.7

Briefly explain the followings.

(a) Hardness of a material

(05 Marks)

(b) Fatigue failure

(05 Marks)

(c) Difference between the ductility and brittleness

(05 Marks)

(d) 'Elastic limit of a material' and its influence in engineering design.

(05 Marks)

Question No.8

(a) State the parallel axis theorem.

(04 Marks)

(b) Prove the relation

$$\frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R}$$

Where M = Bending Moment, I = Second Moment of Area, E = Young's modulus, σ = Bending stress in a fiber, at a distance y from the neutral axis, R = Radius of curvature.

(06 Marks)

(c) Find the moments of inertia about the centroidal axes XX and YY of the section shown in Fig. Q8.

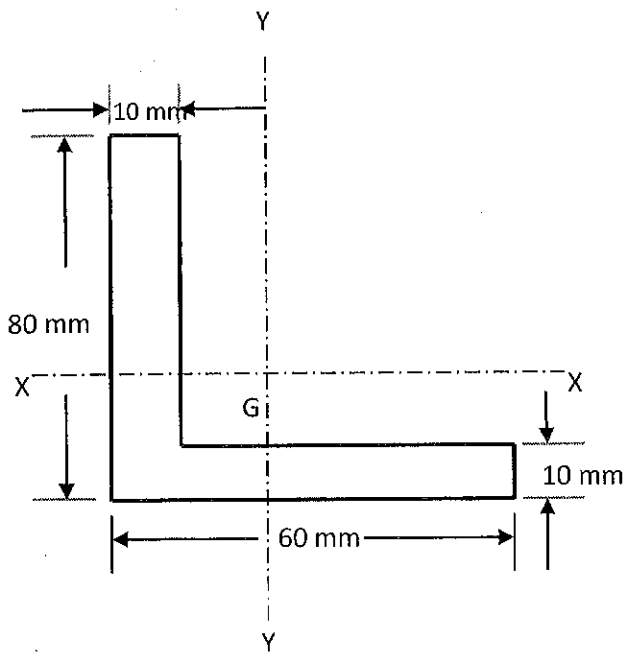


Fig. Q8

(10 marks)