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The Open University of Sri Lanka
Faculty of Engineering Technology
Department of Civil Engineering

Study Programme	: Bachelor of Technology Honours in Engineering
Name of the Examination	: Final Examination
Course Code and Title	**: CEX3234/CVX3534 Strength of Materials**
Academic Year	: 2017/18
Date	: 24th January 2019
Time	: 1330-1630hrs
Duration	: **3 hours**

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of Eight **(8)** questions in **Four (4)** pages.
3. Answer any **Five (5)** questions only. All questions carry equal marks.
4. Answer for each question should commence from a new page.
5. Relevant charts/ codes are provided.
6. This is a Closed Book Test (CBT).
7. Answers should be in clear hand written.
8. Do not use Red colour pen.

Q1. (a) How will you draw the Shear Force and Bending moment diagrams for a beam which is subjected to inclined loads?

(3 Marks)

(b) Explain 'point of contraflexure'. How many points of contraflexure you will have for simply supported beam overhanging at one end only.

(3 Marks)

(c) Draw the Shear Force and Bending Moment diagrams for the overhanging beam carrying uniformly distributed load of 2 kN/m over the entire length and a point load of 2 kN as shown in Fig. Q1.

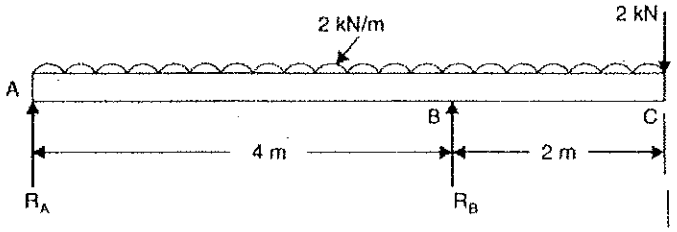

Fig. Q1

(14 Marks)

Q2. (a) What is Macaulay's method? Where is it used?

(2 Marks)

(b) A beam ABC of length 9m has one support of the left end and the other support at a distance of 6m from the left end. The beam carries a point load of 1 kN at right end also carries a uniformly distributed load of 4 kN/m over a length of 3m as shown in Fig. Q2. Determine the slope and deflection at point C. Take $E = 2 \times 10^5$ N/mm^2 and $I = 5 \times 10^8$ mm^4.

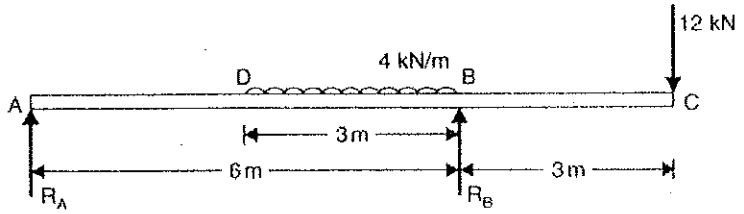

Fig. Q2

(18 Marks)

Q3. (a) Define;
i). Torsion
ii). Torsional rigidity
iii). Polar moment of inertia

(3 Marks)

(b) Torsion formula can be expressed as $\frac{T}{J} = \frac{\tau}{R} = \frac{G\theta}{L}$ State the meaning and units of each parameter.

(7 Marks)

(c) A hollow shaft, having an internal dimeter 40% of its external diameter, transmits 562.5 kw power at 100 r.p.m. Determine the external diameter of the shaft if the shear stress is not to exceed 60 N/mm^2 and the twist in a length of 2.5m should not exceed 1.3 degrees.
Assume maximum torque = 1.25 x Mean Torque
and Modulus of rigidify = 9×10^4 N/mm^2

(10 Marks)

Q4. (a) Define,
i). Slenderness ratio
ii). Radius of gyration

(4 Marks)

(b) Discuss Limitations of Euler's Theory.

(2 Marks)

(c) Explain how the failure of a short and of a long column takes place.

(2 Marks)

(d) What is 'equivalent length of a column'? Give the ratios of equivalent length and actual length of columns with various end conditions.

(4 Marks)

(e) Calculate the safe compressive load on a hollow cast iron column (one end rigidly fixed and other hinged.) of 15cm external diameter, 10cm internal diameter and 10m in length. Use Euler's formula with a factor of safety of 5 and E = 95 kN/mm^2 (Cripling load $P = \pi^2 EI/Le^2$).

(8 Marks)

Q5. (a) Define the terms;
i). Principal plane
ii). Principal stress

(4 Marks)

(b) A rectangular bar is subjected to a direct stress (σ) in one plane only. Prove that the normal and shear stresses on an oblique plane are given by,

$$\sigma_n = \sigma \cos^2\theta \text{ and } \sigma_t = \frac{\sigma}{2} \sin 2\theta$$

Where θ = angle made by oblique plane with normal cross-section of the bar,
σ_n = Normal stress, and
σ_t = Tangential or shear stress.

(4 Marks)

(c) A point in a strained material is subjected to stresses shown in Fig. Q5. Using Mohr's circle method determine the normal and tangential stresses across the oblique plane. Check the answer analytically.

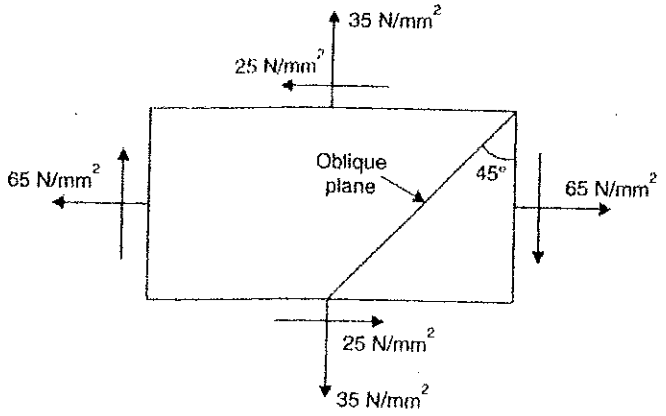

Fig. Q5

(14 Marks)

Q6. (a) What do you mean by,
i). Pure bending
ii). Neutral axis

(4 Marks)

(b) State the simple bending formular and briefly explain all the terms.

(4 Marks)

(c) A water main of 500mm internal diameter and 20mm thick is running full. The water main is of cast iron and is supported at two points 10m apart. Find the maximum stress in the metal. The cast iron and water weigh 7200 N/m^3 and 1000 N/m^3 respectively.

(12 Marks)

Q7. (a) Explain the terms,
i). Longitudinal strain
ii). Lateral strain
iii). Poisson's ratio

(3 Marks)

(b) Prove that the volumetric strain of a cylindrical rod which is subjected to an axial tensile load is equal to strain in the length minus twice the strain of diameter.

(5 Marks)

(c) Calculate the modulus of rigidity and bulk modulus of a cylindrical bar of diameter 30mm and length 1.5m if the longitudinal strain in a bar during a tensile stress is four times the lateral strain. Find the change in volume, when the bar is subjected to a hydrostatic pressure of 100N/mm^2. Take E = 1 x 10^5 N/mm^2.

(12 Marks)

Q8. (a) Define,
i). Young's Modulus
ii). Modulus of rigidity

(2 Marks)

(b) State the principle of Superposition.

(2 Marks)

(c) Prove that the total extension of a uniformly tapering rod of diameters D_1 and D_2, when the rod is subjected to an axial load P is given by,

$$dL = \frac{4PL}{\pi E D_1 D_2}$$

Where L = Total length of the rod
E = Young's Modulus

(4 Marks)

(c) The bar shown in Fig. Q8 is subjected to a tensile load of 160kN. If the stress in the middle portion is limited to 150 N/mm^2, determine the diameter of the middle portion. Find also the length of the middle portion if the total elongation of the bar is to be 0.2mm. Young's modulus is given as equal to 2.1 x 10^5 N/mm^2.

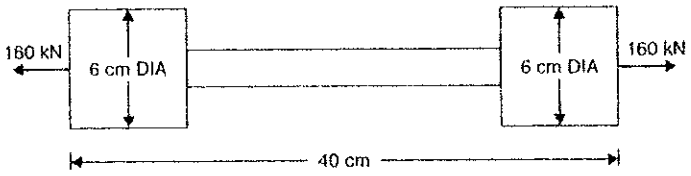

Fig. Q8

(12 Marks)