



CVX3442 - Strength of Materials

FINAL EXAMINATION - 2022/2023

Time Allowed: Three (03) Hours

Date: 06-02-2024 (Tuesday)

Time: 13:30 – 16:30 hrs.

Answer any five (5) questions. All questions carry equal marks.

Q1.

Different engineering materials deform differently when subjected to the same loads.

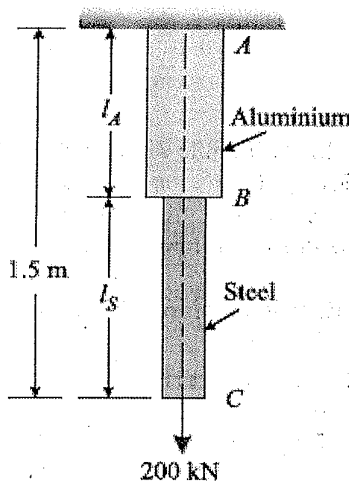


Figure Q1

- (a). Explain why “strain”, not “elongation”, is used as a measure to evaluate the deformability of a material.

[04 Marks]

- (b). A compound bar ABC (Figure Q1) 1.5m long is made up of two parts of aluminium and steel and the cross-sectional area of the aluminium bar is twice that of the steel bar. The rod is subjected to an axial tensile load of 200 kN. If the elongation of the aluminium and steel parts are equal, find the lengths of the two parts of the compound bar. Take E for steel as 200 GPa and E for aluminium as one-third of E for steel.

[16 Marks]

Q2.

When bodies deform in one direction, movement of material in this direction brings about deformations in directions perpendicular to this direction.

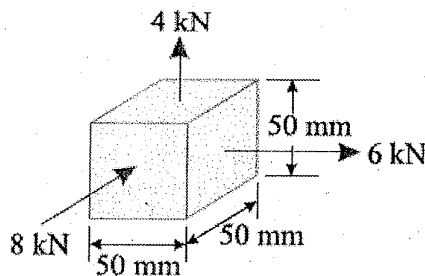


Figure Q2

- (a). Define “Poisson’s ratio”.

[02 Marks]

- (b). Write down the general expressions for principal strains ϵ_1 , ϵ_2 and ϵ_3 and prove that volumetric strain can be approximated to $(\epsilon_1 + \epsilon_2 + \epsilon_3)$.

[04 Marks]

- (c). A steel cube block of 50 mm side is subjected to a force of 6 kN (tension), 8 kN (compression) and 4 kN (tension) along x, y and z directions respectively as shown in Figure Q2. Determine the change in the volume of the block. Take E as 200 GPa and Poisson’s ratio as 0.30.

[14 Marks]

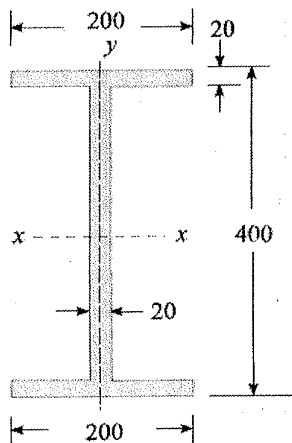
Q3.

A plane element in a boiler is subjected to tensile stresses of 400 MPa on one plane and 150 MPa on the other at a right angle to the former. Each of the above stresses is accompanied by a shear stress of 100 MPa such that when associated with the major tensile stress tends to rotate the element in an anticlockwise direction. Determine,

- (a). Principal stresses and their directions. [10 Marks]
- (b). Maximum shear stresses and directions of the plane on which they act. [10 Marks]

Q4.

Universal columns, with an I-shaped cross-section, are structural steel columns used in a vertical position.



- (a). Explain how the failure of a short column and a long column takes place. [04 Marks]
- (b). Explain the following terms,
- i) Radius of Gyration [02 Marks]
 - ii) Slenderness Ratio [02 Marks]
- (c). An I section joist 400 mm x 200 mm x 20 mm and 6.0 m long, shown in Figure Q4, is used as a strut with both ends fixed. What is Euler's crippling load for the strut? Take Young's modulus for the strut as 200 GPa. [12 Marks]

Figure Q4

Q5.

A beam of I section 30 cm x 12 cm, has flanges 2 cm thick and web 1 cm thick. Another rectangular beam is made out of the same material so that the weight per meter length of both beams is equal. The depth of the rectangular beam is twice its width.

- (a). Compare the flexural strength of the I beam to that of the rectangular beam. [10 Marks]
- (b). What will be the maximum stress developed in the I section for a bending moment of 30 kNm. [10 Marks]

Q6.

Macaulay's method (the double integration method) is a technique used in structural analysis to determine the deflection of beams

- (a). What is Macaulay's method? Where it is used? [04 Marks]
- (b). Find the maximum deflection and its location for the beam shown in Figure Q6. [16 Marks]

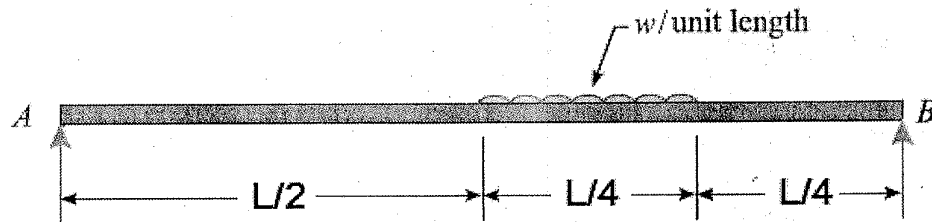


Figure Q6

Q7.

A strain gauge is a sensor whose resistance varies with changes in strain and hence can be used to measure strain.

- Draw a neat sketch of a typical strain gauge and name important parts. [04 Marks]
- Draw a neat sketch to show how strain gauges are placed in a rectangular or 45° strain rosette. [04 Marks]
- Explain with a sketch how the Mohr circle is constructed for a rectangular or 45° strain rosette. [12 Marks]

Q8.

A simply supported beam is shown in Figure Q8.

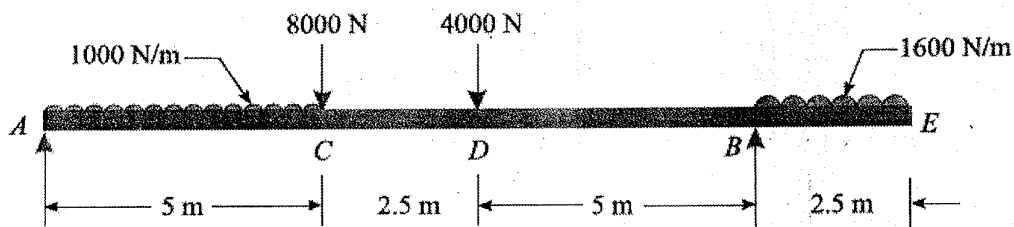


Figure Q8

- Find the support reactions at A and B. [04 Marks]
- Draw the bending moment and shear force diagrams indicating all important values. [16 Marks]

