

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



Study Programme : Bachelor of Science Honours in Engineering
Name of the Examination : Final Examination
Course Code and Title : DMX4205 Strength of Materials I
Academic Year : 2024/25
Date : 19th of February 2026
Time : 09.30-12.30h
Duration : 3 hours

General instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **five (5)** questions in **four (4)** pages.
3. Answer **all** questions.
4. All questions carry equal marks.
5. Answer to each question should commence on a new page.
6. This is a Closed Book Test (CBT).

- Q1 (a) State the torsion equation in standard engineering notation and clearly define every term, specifying the corresponding SI unit for each term. (03 marks)
- (b) Figure Q1 shows a stepped shaft fixed at A, with 40 kNm torque applied at C and 20 kNm at the free end B. Length AC has a recess with a 25 mm diameter. AC = 200 mm, CD = 200 mm, and DB = 300 mm. The diameters of AD and DB are 50 mm and 40 mm, respectively. The shaft made of aluminium has a modulus of Rigidity $G = 30 \text{ GPa}$.

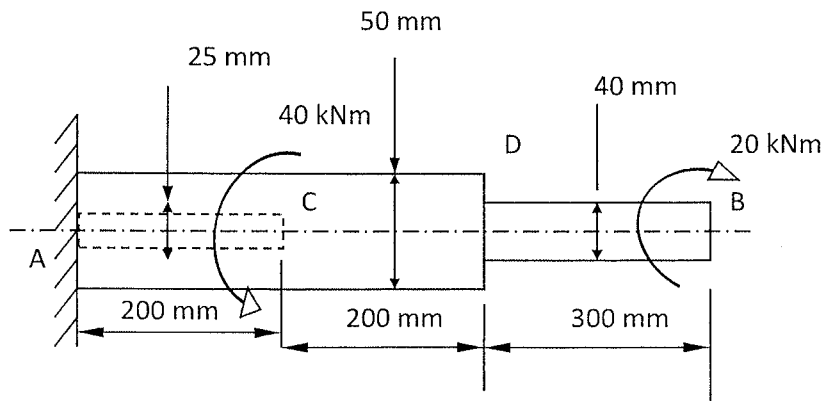


Figure Q1

Determine the following:

- i. Shear stress in the BD section. (03 marks)
- ii. Angular displacement of the free end. (03 marks)
- iii. Shear stresses and angular displacements in DC and AC sections. (08 marks)
- iv. Maximum shearing stress in the shaft AB. (03 marks)

Q2 The stresses acting on three mutually perpendicular planes at a point in an elastic material are shown in Fig.Q2 as follows:

72 N/mm² tensile and 28 N/mm² shear on plane AC, 14 N/mm² compressive and 28 N/mm² complementary shear on plane BC, and no stress on plane AB.

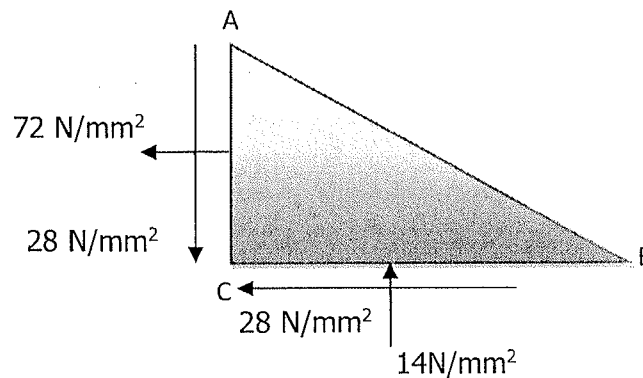


Figure Q2

- (a) Draw Mohr's stress circle for the stress element. (05 marks)
- (b) Calculate the following with the aid of Mohr's stress circle.
 - i. Principal stresses. (05 marks)
 - ii. Maximum shear stress. (03 marks)
 - iii. Position of the planes on which there is no normal stress. (03 marks)
 - iv. Principal strains. (04 marks)

Modulus of elasticity (E) = 200×10^6 N/mm², Poisson's ratio (ν) = 0.3.

- Q3 (a) What are the limitations of the Euler formula for buckling struts? (04 marks)
- (b) A long strut with both ends clamped is subjected to a compressive load P as shown in Figure Q3. (08 marks)

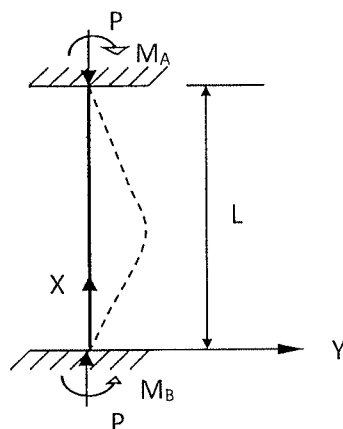


Figure Q3

Show that the critical buckling load P_{cr} is given by

$$P_{cr} = \frac{4\pi^2 EI}{L^2}$$

where L is the length of the strut, and EI is the flexural stiffness.

- (c) A steel bar with both ends pin-jointed is compressed longitudinally until it buckles. The length of the bar is 2.0 m, and the cross-section is 20 mm x 5 mm. Using Euler's formula, estimate the maximum central deflection before the yield point is reached. (08 marks)

Take Modulus of elasticity, $E = 210$ GPa and yield stress = 330 MPa

- Q4 (a) State the bending formula and write down the assumptions used to derive this formula. (04 marks)
- (b) Two vertical forces are applied to a beam of the cross-section shown in Figure Q4.

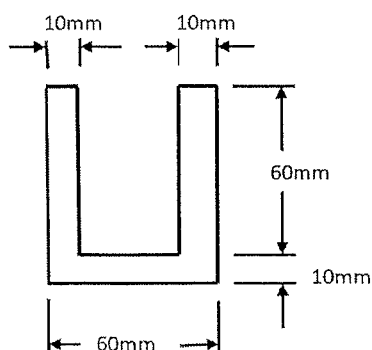
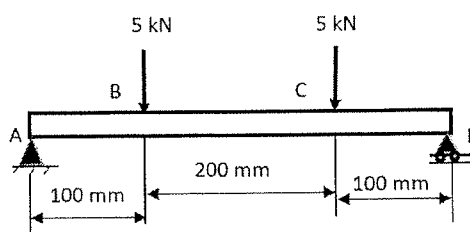


Figure Q4

Determine the following.

- i. Position of the neutral axis. (04 marks)
- ii. Second moment of area about the neutral axis. (06 marks)
- iii. Maximum tensile and compressive stresses in portion BC of the beam. (06 marks)

Q5 Figure Q5 shows a simple beam AB loaded by a couple M_0 at the support A.

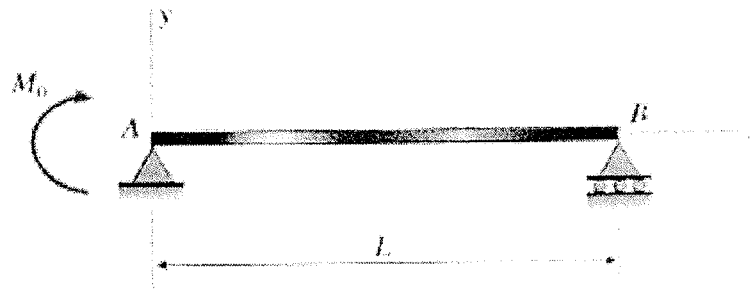


Figure Q5

- i. Write down the equation for the moment of a section x-length from support A. (04 marks)
- ii. Explain the boundary conditions for the beam shown in Figure Q5. (04 marks)
- iii. Derive the equation of the deflection curve for the beam AB loaded by a couple M_0 at the support A as shown in Figure Q5. (04 marks)
- iv. Find the distance to the maximum deflection from supports A and B. (04 marks)
- v. Hence, show that the maximum deflection ($\delta_{\max}$) of the beam is given by the following formula. (04 marks)

$$\delta_{\max} = \frac{M_0 L^2}{9\sqrt{3}EI}$$