

The Open University of Sri Lanka  
Faculty of Engineering Technology



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 : 2023/24  
Date : 25 February 2025  
Time : 9.30 am – 12.30 pm  
Duration : 3 hours

**General instructions**

1. Read the instructions given below carefully before answering the questions.
2. This question paper consists of five (05) questions. Answer all the questions.
3. All questions carry equal marks.

**Q1** A machine component is subjected to plane stress. The induced stresses at a point are as shown in Figure Q1:

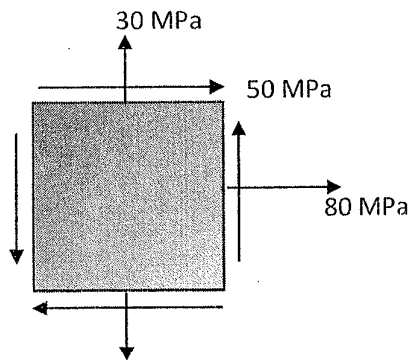


Figure Q1

- (a) Construct Mohr's Circle for the state of stress shown in Fig. Q1. (06 marks)
- (b) With the aid of the Mohr's Circle determine the following.
  - i) Principal stresses (04 marks)
  - ii) Orientation of the principal planes (03 marks)
  - iii) Maximum shear stress (03 marks)
- (c) Find the stress components on a plane rotated  $30^\circ$  counterclockwise from the original plane. (04 marks)

- Q2** A solid circular shaft with a diameter of 80 mm is subjected to a torque of 5000 Nm. In addition, there is a hollow circular shaft with an outer diameter of 120 mm, which is also subjected to the same torque. The shear modulus ( $G$ ) is 80 GPa.
- Calculate the maximum shear stress in the solid shaft. (04 marks)
  - Calculate the inner diameter of the hollow shaft so that the maximum shear stress matches that of the solid shaft. (05 marks)
  - Calculate the angle of twist for the solid shaft over a length of 3 meters. (03 marks)
  - Compare the stiffness of both shafts by analyzing their polar moments of inertia. (08 marks)
- Q3** (a) Write the flexure formula with usual notations and units. (05 marks)
- (b) A simply supported steel beam of 5 meters length is subjected to a central point load of 20kN. The beam has a rectangular cross-section with a width of 200 mm and a height of 400 mm. The yield strength of the steel is 250MPa.
- Determine the maximum bending stress in the beam. (05 marks)
  - Calculate the allowable stress If the factor of safety is 3.0. (05 marks)
  - Determine the maximum allowable point load that can be applied to the beam based on the factor of safety. (05 marks)
- Q4** Two columns of the same material and length, one with a circular cross-section of radius  $R$  and the other with a square cross-section of side length 50 mm, are subjected to the same compressive load as shown in Figure Q4. Given the modulus of elasticity  $E=210$  GPa and the length of the columns  $L=2$  m,

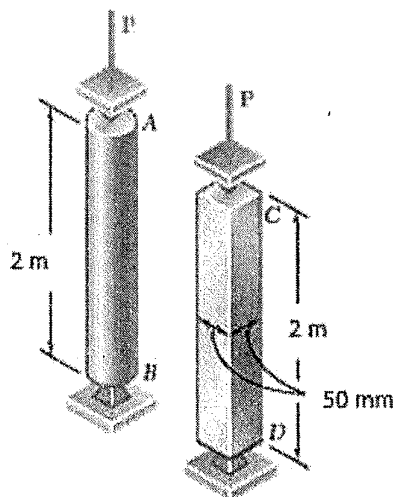


Figure Q4

Determine the following:

- (a) The radius  $R$  of the circular column is such that both columns have the same cross-sectional area. (04 marks)
- (b) The second moment of area for both square and circular columns. (05 marks)
- (c) The critical load for each column using Euler's formula. (06 marks)
- (d) Discuss why one column may be more susceptible to buckling than the other. (05 marks)

**Q5** A T-section beam has a flange width of 150 mm, flange thickness of 20 mm, web height of 200 mm, and web thickness of 10 mm as shown in Figure Q5. The beam is subjected to a shear force of 50 kN.

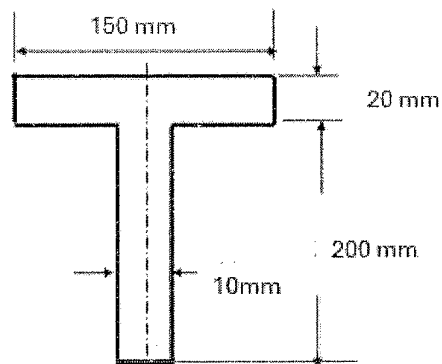


Figure Q5

Determine the following.

- (a) The location of the neutral axis. (05 marks)
- (b) The second moment of area about the neutral axis. (05 marks)
- (c) The shear stress at the neutral axis (05 marks)
- (d) The shear stress at a point 100 mm from the bottom of the web. (05 marks)