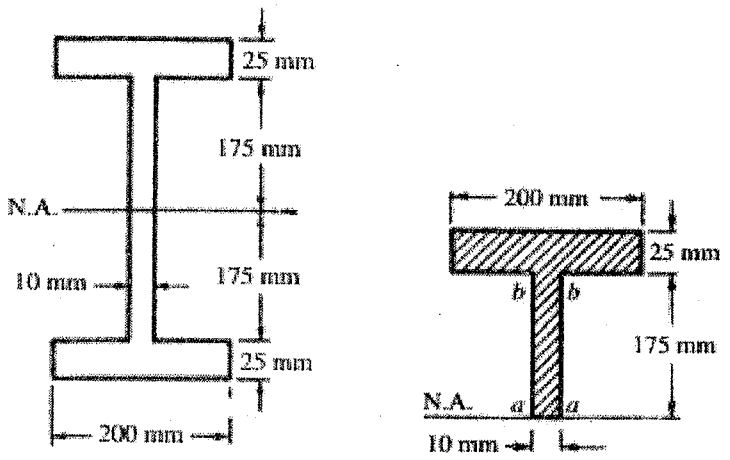
The Open University of Sri Lanka
Faculty of Engineering Technology

Study Programme	:	Bachelor of Technology Honours in Engineering
Name of the Examination	:	Final Examination
Course Code and Title	:	**DMX4205 Strength of Materials I**
Academic Year	:	2021/22
Date	:	7th February 2023
Time	:	0930:00hrs – 12:30hrs
Duration	:	3 hours

General instructions

1. Read instructions given below carefully before answering the questions.
2. This question paper consists of six (06) questions. Answer any five (05) questions.
3. All questions carry equal marks.

Question No.01:



(a) (b)

Fig.Q1

Fig.Q1(a) shows an I-type cross section of a beam, subjected to a shearing force 'V' of 150kN, over the section. Determine the following.

a) Second moment of area about the neutral axis of the section shown in Fig.Q1(a).

(04 marks)

b) First moment of area about the neutral axis of the shaded area of Fig.Q1(b).

(04 marks)

c) Maximum shearing stress at the neutral axis of the section $a - a$.

(04 marks)

d) Minimum shearing stress in the web section $b - b$.

(04 marks)

e) Average stress in the web of the beam in Fig.Q1(a).

(04 marks)

Question No.02:

a) Explain the terms ***principal stress*** and ***principal plane*** in a two dimensional stress system.

(04 marks)

b)

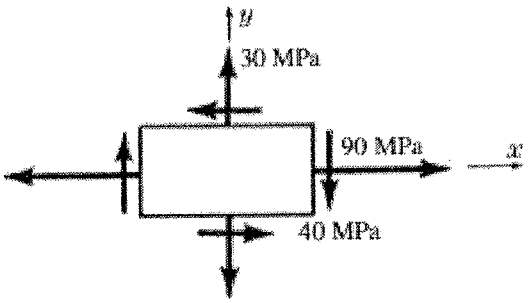


Fig.Q2

The stresses acting on three mutually perpendicular planes at a point in an elastic material are 90 MPa and 30 MPa tensile stresses and 40 MPa shear stresses as shown in Fig.Q2.

I) Construct Mohr's circle of stress for this(Fig.Q2) stress system. **(06 marks)**

II) Hence determine the following.

i. Maximum and minimum principal stresses **(04 marks)**

ii. Position of principal planes **(02 marks)**

iii Maximum shear stress **(02 marks)**

iv Corresponding normal stress for the maximum shear stress **(02 marks)**

Question No.03:

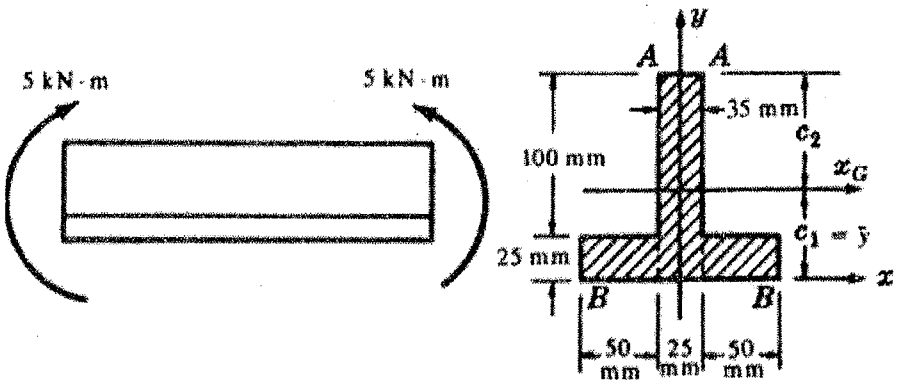


Fig.Q3

A steel beam is loaded by a couple at each of its ends, the magnitude of each couple being 5kNm. The beam has an inverted T – type cross section as shown in Fig.Q3. Determine the following.

a) Centroid of the cross-sectional area. **(04 marks)**

b) Second moment of area about the x- axis as shown in Fig.Q3. **(04 marks)**

c) Second moment of area about the neutral axis of the section. **(04 marks)**

d) Maximum tensile stress in the beam and its location. **(04 marks)**

e) Maximum compressive stress in the beam and its location. **(04 marks)**

Question No.04:

A beam of constant flexural rigidity **EI** and length **L** is simply supported as shown in Fig.Q4. The beam is subjected to uniformly distributed load w/m.

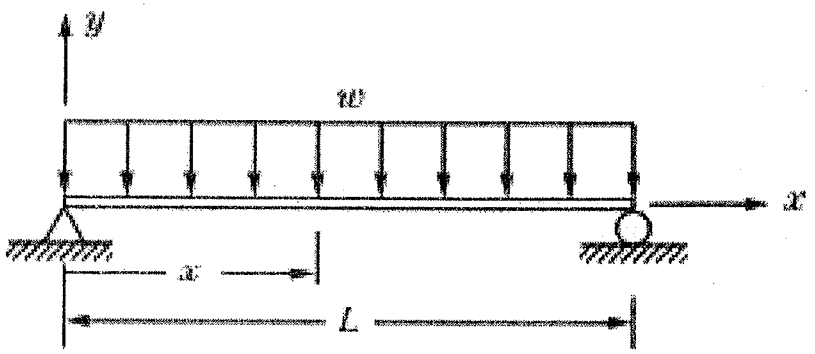


Fig.Q4

a) Find the reaction forces at the two ends of the beam **(02 marks)**

b) Write the differential equation for the elastic curve **(04 marks)**

c) Derive the equation for the elastic curve **(10 marks)**

d) Determine the maximum deflection of the beam. **(04 marks)**

Question No.05:

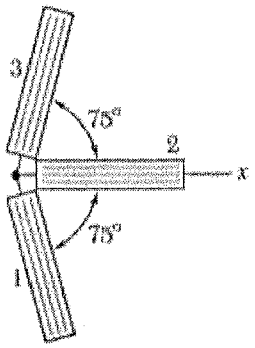


Fig.Q5

A strain gauge rosette has been attached on a surface of a certain machine element as shown in Fig. Q5. The measured strains are:

$$\epsilon_1 = -93.1x10^{-6}\ mm/mm$$

$$\epsilon_2 = +385x10^{-6}\ mm/mm$$

$$\epsilon_3 = +210x10^{-6}\ mm/mm$$

a) Write the three equations for ϵ_1, ϵ_2, and ϵ_3 for the above system shown in Fig.Q5 in terms of strains in the direction of x and y (ϵ_x, and ϵ_y).

(06 marks)

b) Determine the strains in x and y directions ϵ_x, ϵ_y

(04 marks)

c) The orientation and magnitude of the principal strains in the plane of the rosette

(06 marks)

d) The maximum in-plane shearing stress

(04 marks)

Question No.06:

a) Write the simple torsion formula with usual notations. Explain the meaning of each symbol in the formula with their relevant SI units of measurement.

(06 marks)

b) A solid shaft of diameter 76 mm carries an axial torque of 4.6 kNm. Determine the maximum shearing stress subjected by the shaft.

(06 marks)

c) Solve Part (b), assuming that the solid shaft has been replaced by a hollow shaft of the same outer diameter and of 24 mm inner diameter.

(08 marks)

END