

The Open University of Sri Lanka
Faculty of Engineering Technology



Study Programme : Bachelor of Science Honors in Engineering
Name of the Examination : Final Examination
Course Code and Title : **DMX4205 Strength of Materials I**
Academic Year : 2022/23
Date : 7th February 2024
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 (05) questions. Answer all questions.
3. All questions carry equal marks.

Question No.01:

a)

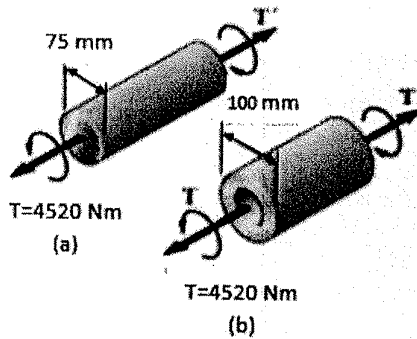


Fig.Q1A

Fig.Q1A (a) shows a solid cylinder of 75 mm diameter subjected to a torque $T = 4520 \text{ Nm}$ and Fig.Q1A (b) shows a hollow cylinder of 100 mm outer diameter subjected to the same torque $T = 4520 \text{ Nm}$.

Determine the following.

- (i) Maximum shear stress induced in the solid cylinder.

(02 marks)

- (ii) Inner diameter of the hollow cylinder that gives the same maximum shear stress found in part (i).

(03 marks)

b)

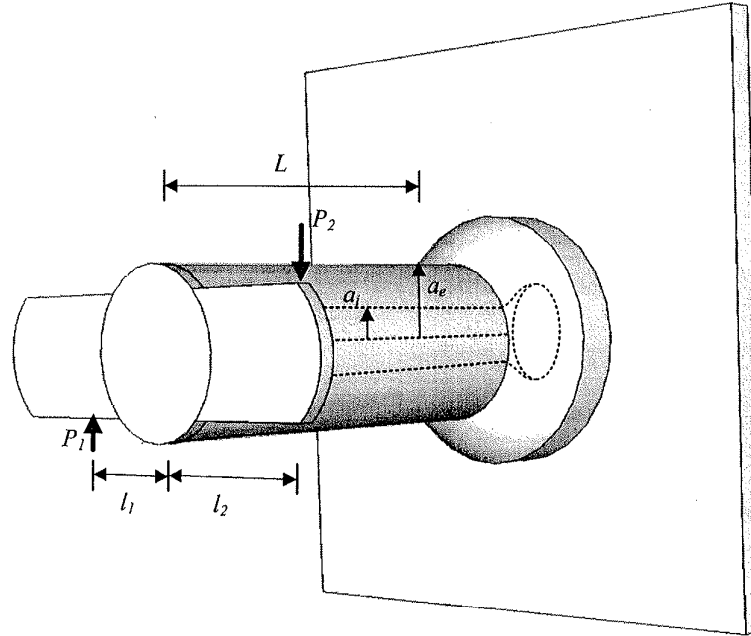


Fig.Q1B

A lug wrench made of an aluminum alloy has a tubular stem of length L , internal radius a_i , and external radius a_e . A turning torque is manually applied to the handle of the wrench through hand forces P_1 and P_2 at turning radii l_1 and l_2 as shown in Fig. Q1B. The modulus of rigidity (shear modulus) of the material of the wrench is G . Obtain expressions for:

- (i) the maximum shear stress
(ii) the angle of twist in the stem of the wrench.

(02 marks)

(03 marks)

We are given the numerical values, $L = 0.5$ m, $a_i = 1$ cm, $a_e = 2$ cm, $G = 30$ GPa, yield shear stress $\tau_y = 170$ MPa, and the maximum operating values for the applied torque: $l_1 = l_2 = 0.4$ m and $P_1 = P_2 = 150$ N. What is the corresponding factor of safety with respect to yielding under shear? What is the angle of twist of the wrench?

(05 marks)

Question No.02:

A handle of a drum is subjected to a distributed load as shown in Fig. Q2(a). An infinitesimal rectangular element at point O close to the distributed load of the handle experiences the state of plane stress shown in Fig. Q2(b), with respect to the Cartesian coordinate frame xOy , where $\sigma_x = 10 \text{ MPa}$, $\sigma_y = -50 \text{ MPa}$, and $\tau_{xy} = -20 \text{ MPa}$.

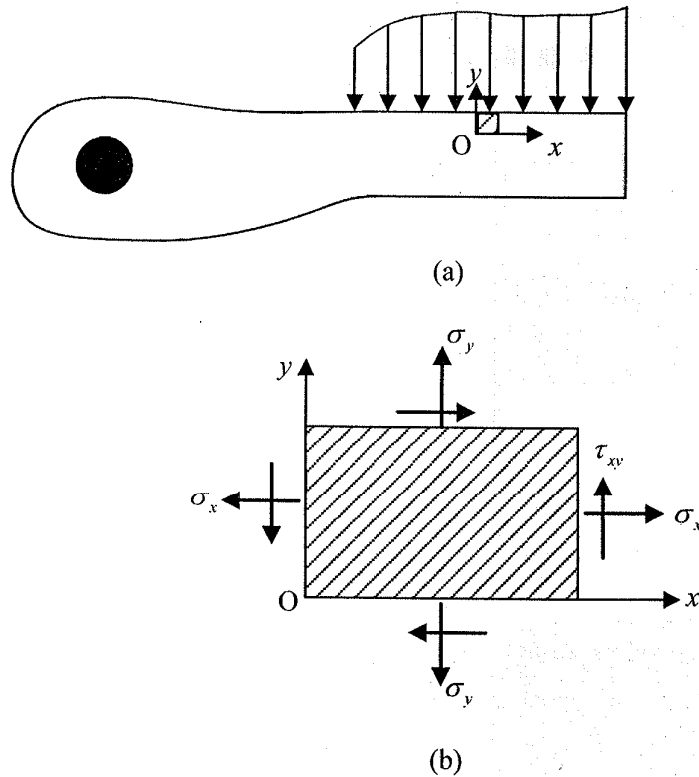


Fig.Q2: (a) A handle subjected to a distributed force; (b) State of plane stress on an infinitesimal element at O.

By direct calculation, or using Mohr's stress circle, determine the state of stress at O (answering to the question (i), (ii) and (iii)) on an infinitesimal rectangle which is in the first quadrant of the coordinate frame $x'Oy'$ where the x' -axis is at 30° from the original x -axis, in the negative direction.

- (i) Find the normal stress ($\sigma_{x'}$) in direction x' -axis (05 marks)
- (ii) Find the shear stress ($\tau_{x'y'}$) (05 marks)
- (iii) Find the normal stress ($\sigma_{y'}$) in direction y' -axis (05 marks)
- (iv) Draw the state of stress on the rotated element. (05 marks)

Question No.03:

An overhanging beam AC of constant flexural rigidity EI , length $L+a$, is simply supported at A and B as shown in Fig.Q3. The beam is subjected to a concentrated load P at the end C.

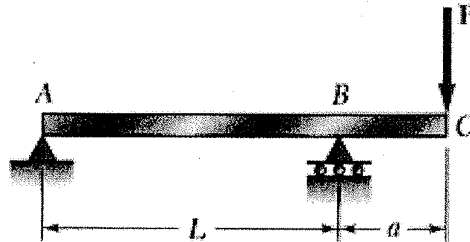


Fig.Q3

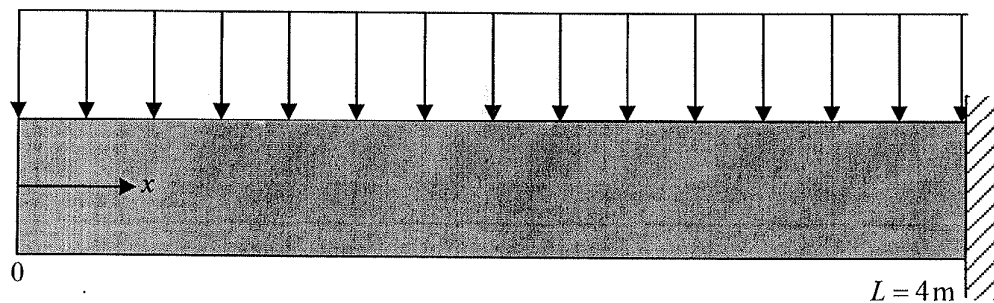
- (i) Find the reaction forces at A and B (02 marks)

For portion AB of the overhanging beam,

- (ii) Write the differential equation for the elastic curve (03 marks)
(iii) Derive the equation for the elastic curve (08 marks)
(iv) Locate the point of the maximum deflection (for portion AB) of the beam (04 marks)
(v) Evaluate corresponding maximum deflection. (03 marks)

Question No.04:

$w_o = 100 \text{ N/m}$



(a)

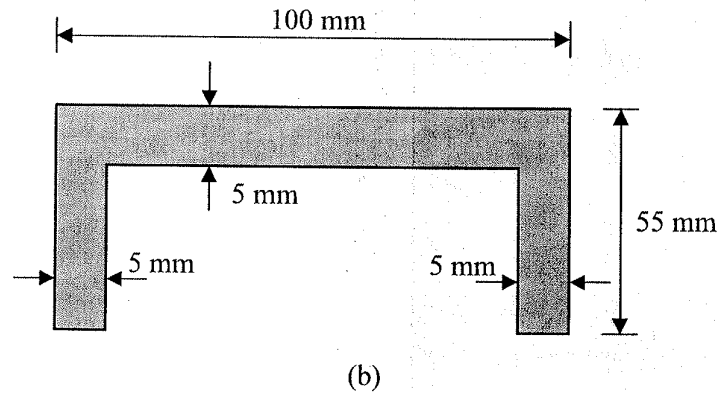


Fig. Q4

A cantilever beam of length 4 m as shown in Figure Q4(a) is made of a channel section with dimensions as given in Figure Q4(b). A uniformly distributed load of 100 N/m is applied on the beam.

(a) Determine the following.

- (i) Maximum (absolute) bending moment (03 marks)
- (ii) Centroid of the section from the bottom of the section (04 marks)
- (iii) Second moment of area of the section (05 marks)
- (iv) Maximum bending stress and its location in the beam. (03 marks)
- (b) Sketch the bending stress distribution on the channel section (05 marks)

Question No.05:

- a) Write down the five (5) assumptions made to develop in Euler's Column theory. (05 marks)
- b)

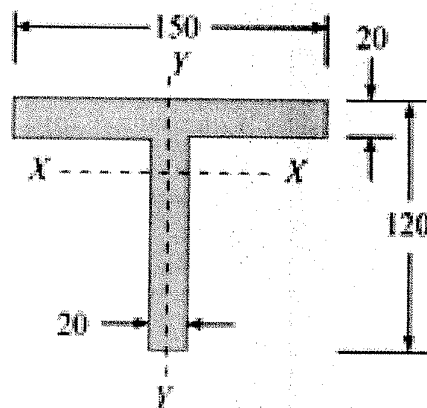


Fig. Q5

(i) Find the centre of gravity of the section from the bottom of the web.

(05 marks)

(ii) Find the second moment of area about XX and YY axes.

(05 marks)

(iii) A strut of 4 m long with hinged at its both ends. The cross section of the strut is a T-section with dimensions 150 mm x 120 mm x 20 mm. Calculate the crippling load. The modulus of elasticity for the material is 200 GPa.

(05 marks)

END OF QUESTION PAPER