UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2022/2023

COURSE NAME	:	SOLID MECHANICS II
COURSE CODE	:	BDA 20903
PROGRAMME CODE	:	BDD
EXAMINATION DATE	:	JULY/AUGUST 2023
DURATION	:	3 HOURS
INSTRUCTIONS	:	1. ANSWER **FIVE (5)** QUESTIONS **ONLY**
		2. THIS FINAL EXAMINATION IS CONDUCTED VIA **CLOSED BOOK**
		3.STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK

THIS QUESTIONS PAPER CONSISTS OF **EIGHT (8)** PAGES

Q1 (a) Explain what is Poisson ratio with sketches and state their formula.

(4 marks)

(b) An element of material subjected to plane strain as in **Figure Q1(b)** has strains as follows: $\varepsilon_x = 220\mu$, $\varepsilon_y = 480\mu$ and $\gamma_{xy} = 180\mu$.

(i) Calculate the strains for an element oriented at an angle $\theta = 50^\circ$ and show these strains on a sketch of a properly oriented element.

(8 marks)

(c) A delta rosette, as shown in **Figure Q1(c)**, measures micro-strains as follows:

$\varepsilon_A = -100\mu$, $\varepsilon_B = 700\mu$ and $\varepsilon_C = 600\mu$.

(i) Calculate the principal strains, if the modulus of elasticity is 200 GPa and Poisson's ratio is 0.3

(8 marks)

Q2 (a) For the cantilever beam and loading shown in **Figure Q2** using the double integral method:-.

(i) Determine the equation of the elastic curve for portion AB of the beam.

(14 marks)

(ii) Determine the deflection and slope at point B.

(6 marks)

Q3 (a) With the help of diagrams, explain:

(i) Slenderness ratio

(ii) Three types of boundary conditions

(iii) Critical load

(10marks)

(b) A cross-sectional and hollow pole made of cast iron with both ends firmly tied supports a 1000kN axial compression load. If the pole length is 6 meter and the outer diameter is 270mm, calculate the thickness of the pole wall to support this load with the safety factor is 4 to withstand failure. Take the value of E as 100GPa.

(10 marks)

Q4 (a) **Figure Q4(a)** (i) and (ii) show a straight and stepped bar, respectively.

(i) Calculate the strain energy developed in each bar.

(4 marks)

(ii) Give observation on the strain energy calculated above and discuss why there is a difference

(4 marks)

(b) **Figure Q4(b)** depicts an aluminum shaft that is fixed at C with a shear modulus of G=27 GPa. Solid segment AB has a radius of 20mm. Segment BC of the shaft has a hollow design, with an inner radius of 20mm and an outer radius of 40mm.

(i) Calculate the internal torsion T_{AB} and T_{BC} of each segment AB and BC

(4 marks)

(ii) Determine the total torsional energy stored in the shaft

(8 marks)

Q5 (a) Describe the difference between thin and thick cylinders.

(4 marks)

(b) A thick cylinder has an outside diameter of 400 mm and an inside diameter of D*i*. It is found that the internal pressure acting inside the cylinder is about 50 MPa. A strain rosette is attached at the external surface and recorded the surface strains as follows: $\varepsilon_a = 60\mu$ at angle 0°, $\varepsilon_b = 545\mu$ at angle 60° and $\varepsilon_c = 555\mu$ at angle 120°. Assuming that the modulus of elasticity and Poisson's ratio of the cylinder's material are 210 GPa and 0.3, respectively.

(i) Compute the stress distribution across the cylindrical wall.

(10 marks)

(ii) Determine the thickness of the cylinder.

(6 marks)

Q6 As the first task assigned to you as a mechanical engineer, you need to determine the loading capacity of the company's cantilever beam, which is illustrated **in Figure Q6**. The yield stress σ_y of the beam is specified as 300MPa.

(a) Calculate the stresses acting at the critical location.

(8 marks)

(b) Use Mohr's circle to define the principal stresses, σ_1 and σ_2

(4 marks)

(c) Define the maximum force P that can be applied before the beam fails using Tresca and Von Mises's criteria.

(8 marks)

-END OF QUESTION-

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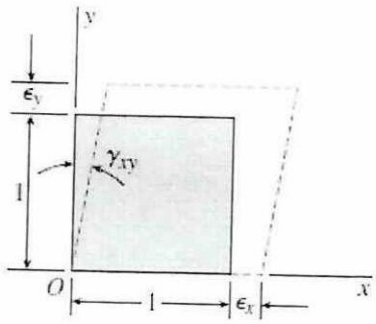

Figure Q1(b)

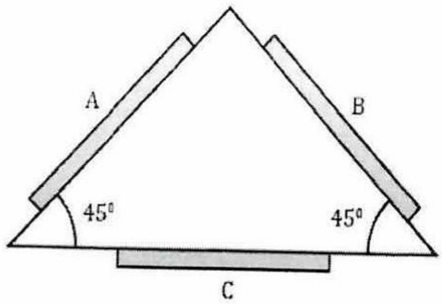

Figure Q1(c)

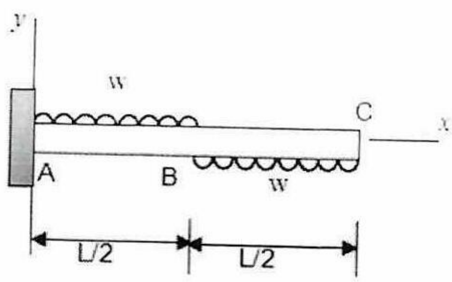

Figure Q2

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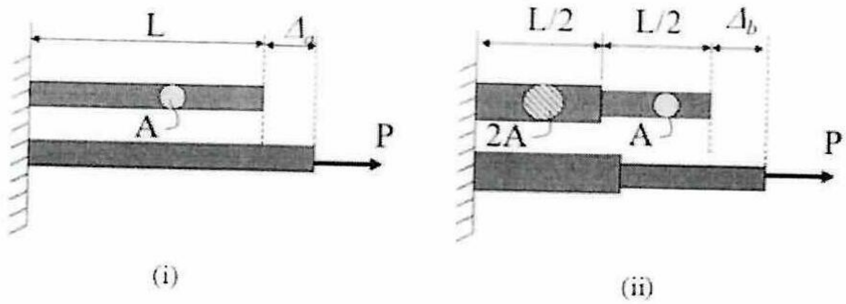

Figure Q4(a)

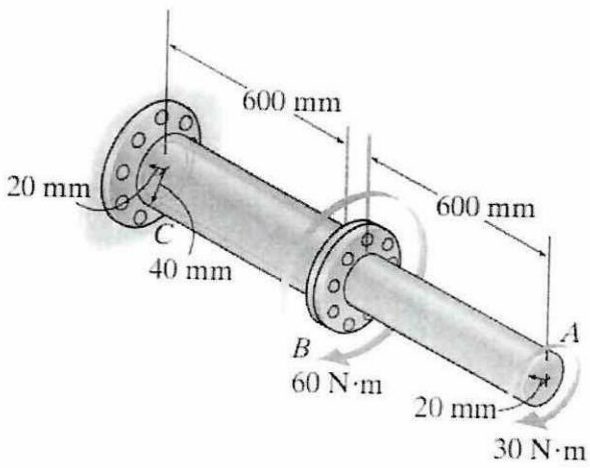

Figure Q4(b)

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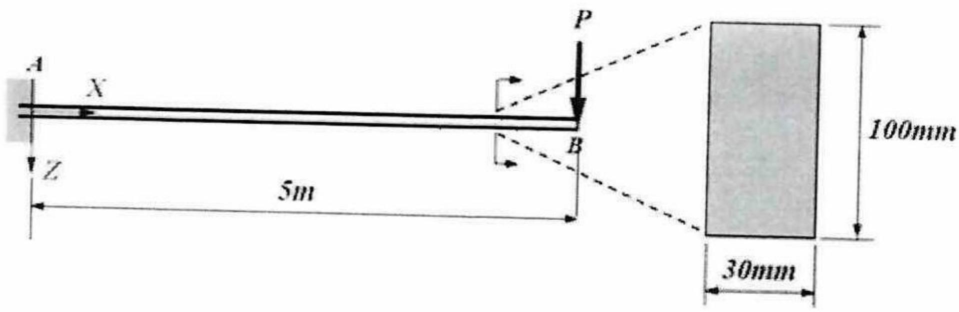

Figure Q6

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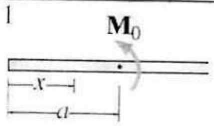
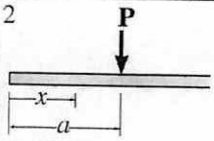
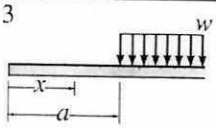
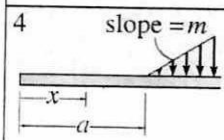
FORMULA

Loading	Loading Function $w=w(x)$
1 	$w = M_0\langle x-a\rangle^{-2}$
2 	$w = P\langle x-a\rangle^{-1}$
3 	$w = w_0\langle x-a\rangle^{0}$
4 	$w = m\langle x-a\rangle^{1}$

$$EI\frac{d^4y}{dx^4} = -w(x)$$

$$EI\frac{d^3y}{dx^3} = V(x)$$

$$EI\frac{d^2y}{dx^2} = M(x)$$

$$\tan 2\theta p = \frac{\gamma_{xy}/2}{(\epsilon_x - \epsilon_y)/2}$$

$$\tan 2\theta s = \frac{(\epsilon_x - \epsilon_y)/2}{-\gamma_{xy}/2}$$

$$\gamma_{xy} = \frac{1}{G}\tau_{xy}$$

$$\frac{\gamma_{max\ in\ plane}}{2} = \sqrt{\left(\frac{\epsilon_x - \epsilon_y}{2}\right)^2 + \left(\frac{\gamma_{xy}}{2}\right)^2}$$

$$\epsilon_x = \frac{1}{E}\left[\sigma_x - v(\sigma_y + \sigma_z)\right]$$

$$G = \frac{E}{2(1+v)}$$

$$\in_a = \in_x \cos^2\theta_a + \in_y \sin^2\theta_a + \gamma_{xy}\sin\theta_a\cos\theta_a$$

$$\in_b = \in_x \cos^2\theta_b + \in_y \sin^2\theta_b + \gamma_{xy}\sin\theta_b\cos\theta_b$$

$$\in_c = \in_x \cos^2\theta_c + \in_y \sin^2\theta_c + \gamma_{xy}\sin\theta_c\cos\theta_c$$