Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION

SEMESTER I

SESSION 2018 / 2019

COURSE NAME	:	SOLID MECHANICS I
COURCE CODE	:	BDA 10903
PROGRAMME	:	BDD
EXAMINATION DATE	:	DECEMBER 2018 / JANUARY 2019
DURATION	:	3 HOURS
INSTRUCTION :	:	PART A : ANSWER **THREE (3)** QUESTIONS **ONLY**
		PART B : ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **SEVEN (7)** PAGES

PART A (OPTIONAL):
Answer **THREE (3)** questions **ONLY**.

Q1 Bar B of the pin connected system as shown in **Figure Q1** is made of an aluminum alloy [E_a = 70 Gpa, A_a = 300 mm^2 and α_a = 22.5(10^{-6})/°C] and bar A is made of a hardened carbon steel [E_s = 210 Gpa, A_s = 1200 mm^2 and α_s = 11.9(10^{-6})/°C]. Bar CDE is to be considered rigid. When the system is unloaded at 40 °C, bar A and B are unstressed. After the load P is applied, the temperature of both bars decreases to 15 °C. Determine

(i) The normal stress in bar A.

(8 marks)

(ii) The normal stress in bar B.

(8 marks)

(iii) The vertical displacement of pin E.

(4 marks)

Q2 A simply supported beam is loaded with a distributed load of 25 kN/m and at the same time a concentrated load of 60 kN creating a moment, as illustrated in the **Figure Q2**.

(i) Draw the free body diagram.

(2 marks)

(ii) Calculate the vertical support forces at A and B.

(4 marks)

(iii) Draw the Shearing Force Diagram (SFD) and the Bending Moment Diagram (BMD).

(10 marks)

(vi) By considering the Bending Moment Diagram, draw the illustration of the beam deflection.

(4 marks)

Q3 A wood beam of dimensions 200 mm x 300 mm is reinforced on its sides by steel plate 12 mm thick as shown in **Figure Q3**. The moduli of elasticity for the steel and wood are E_s = 204 GPa and E_w = 8.5 GPa respectively. Also the corresponding allowable stresses are σ_s = 140 MPa and σ_w = 10 MPa. Determine

(i) The moment of inertia about the z axis.

(8 marks)

(ii) Bending moment of wood beam and steel plate.

(8 marks)

(iii) Maximum permissible bending moment, M_{max}.

(4 marks)

Q4 **Figure Q4** shows a composite shaft consists of a 5 mm thick brass jacket (G = 39 GPa) bonded to a 30 mm diameter steel core (G = 77 GPa). Knowing that the shaft is subjected to 565 Nm torques,

(i) Compute the total torque of the composite shaft.

(5 marks)

(ii) Determine the maximum shearing stress in the brass jacket.

(5 marks)

(iii) The maximum shearing stress in the steel core.

(5 marks)

(vi) The angle of twist of end B relative to end A.

(5 marks)

PART B (COMPULSORY):
Answer **ALL** questions.

Q5 (a) A spherical vessel as shown in **Figure Q5(a)** 3 meter diameter is subjected to an internal pressure of 1.5 N/mm^2. Find the thickness of the vessel required if the maximum stress is not to exceed 90 MPa.

(4 marks)

(b) A cylinder is 150 mm diameter and 750 mm long with a wall 2 mm thick. It has an internal pressure 0.8 MPa greater than the outside pressure. Determine

(i) The circumferential stress.

(3 marks)

(ii) The longitudinal stress.

(3 marks)

(iii) The circumferential strain.

(4 marks)

(iv) The change in cross sectional area.

(6 marks)

Q6 Due to an applied load an element as shown in **Figure Q6** is subjected to the state of plane stress as shown.

(i) Identify the principal planes.

(4 marks)

(ii) Calculate the principal stresses.

(6 marks)

(iii) Determine maximum shearing stress and the corresponding normal stress.

(10 marks)

- END OF QUESTION -

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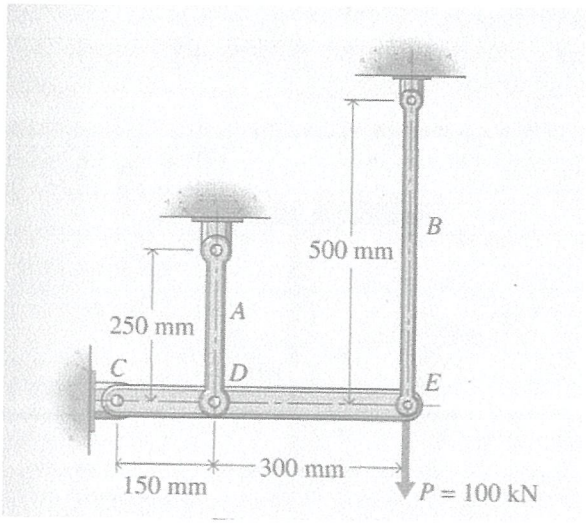

Figure Q1

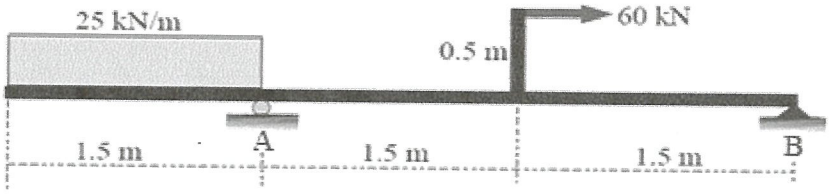

Figure Q2

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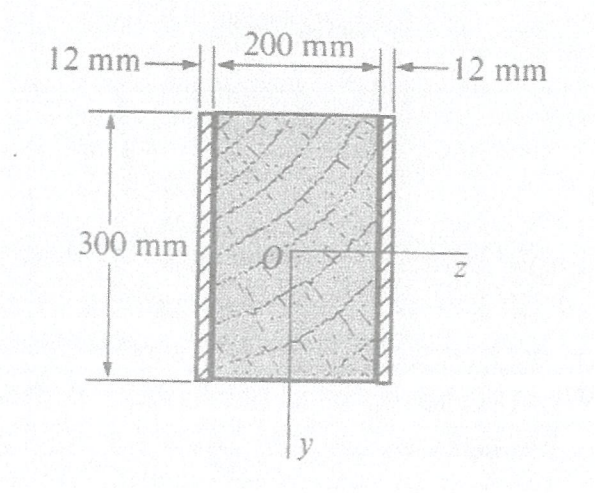

Figure Q3

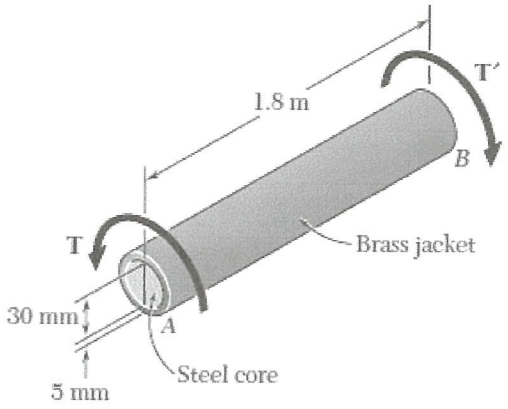

Figure Q4

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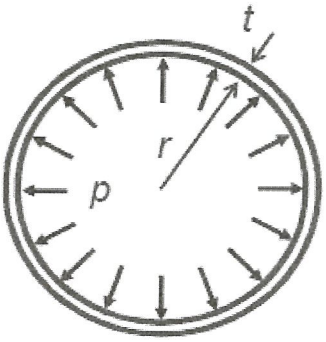

Figure Q5(a)

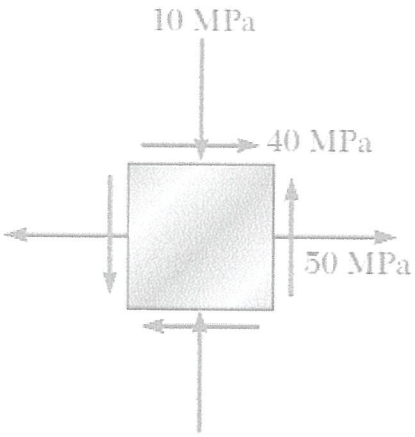

Figure Q6

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EQUATIONS

$$\sigma_{ave} = \frac{P}{A} \qquad \delta = \sum_i \frac{P_i L_i}{A_i E_i}$$

$$\delta_T = \alpha(\Delta T)L \qquad n = \frac{E_2}{E_1}$$

$$\sigma_{ave} = \frac{\sigma_x + \sigma_y}{2} \qquad R = \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

$$\sigma_{\max,\min} = \frac{\sigma_x + \sigma_y}{2} \pm \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

$$\tan 2\theta_p = \frac{2\tau_{xy}}{\sigma_x - \sigma_y}$$

$$\sigma_1 = \frac{pr}{t} \qquad \sigma_2 = \frac{pr}{2t}$$

$$\tau_{\max} = \frac{Tc}{J} \text{ and } \tau = \frac{T\rho}{J}$$

$$J = \tfrac{1}{2}\pi c^4 \qquad J = \tfrac{1}{2}\pi\left(c_2^4 - c_1^4\right)$$

$$\gamma_{\max} = \frac{\tau_{\max}}{G} = \frac{Tc}{JG} \qquad \phi = \sum_i \frac{T_i L_i}{J_i G_i}$$

$$T = \frac{P}{\omega} = \frac{P}{2\pi f} \qquad \tau_{\max} = \frac{T}{c_1 ab^2} \qquad \phi = \frac{TL}{c_2 ab^3 G}$$

$$\sigma_x = -\frac{My}{I} \qquad \frac{1}{\rho} = \frac{M}{EI}$$

$$\bar{Y} = \frac{\sum \bar{y}A}{\sum A} \qquad I_{x'} = \sum\left(\bar{I} + Ad^2\right)$$