Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2023/2024

COURSE NAME	:	SOLID MECHANICS
COURSE CODE	:	DAM23303
PROGRAMME CODE	:	DAM
EXAMINATION DATE	:	JULY 2024
DURATION	:	3 HOURS
INSTRUCTIONS	:	1. ANSWER **FIVE (5)** QUESTIONS ONLY 2. THIS FINAL EXAMINATION IS CONDUCTED VIA ☐ Open book ☒ Closed book 3. STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK

THIS QUESTION PAPER CONSISTS OF **SIX (6)** PAGES

PART A

Q1 This question is related to the chapter stress and strain. Answer all questions.

(a) A stress-strain diagram determines how a material behaves by showing the relationship between the strain and stress for a given material.With a sketched stress-strain diagram, explain every region in a typical stress-strain diagram.

(6 marks)

(b) A composite rod consists of segments *AB*, *BC* and *CD* with different lengths and cross-sectional areas as shown in **Figure Q1.1.** Axial loads are applied at the position indicated. Assume that the assembly is suitably braced to prevent buckling and let E_{st} = 200GPa, E_{br} = 83GPa and E_{al} = 70GPa.

(i) Draw the free body diagram for each of the segment *AB*, *BC*, and *CD* to indicate the force acting on each of them. State whether the force is tensile or compressive.

(5 marks)

(ii) Compute the total change in the length of the composite rod.

(3 marks)

(c) Two parallel walls 10 m apart are held together by a steel rod 30 mm diameter passing through metal plates and nuts at each end. The nuts are tightened home when the rod is at a temperature of 110 ℃ . Determine the stress in the rod when the temperature falls to 65℃ if :(Take E = 200GPa and $\alpha = 12 \times 10^{-6}/°C$).

(i) The ends do not yields.

(3 marks)

(ii) The ends yield by 2 mm.

(3 marks)

Q2 This question is related to the shear force and bending moment diagram. Answer all questions.

(a) In each case, the beam is subjected to the loading shown in **Figure Q2.1**. Sketch the general shape of the shear and moment diagram for each case.

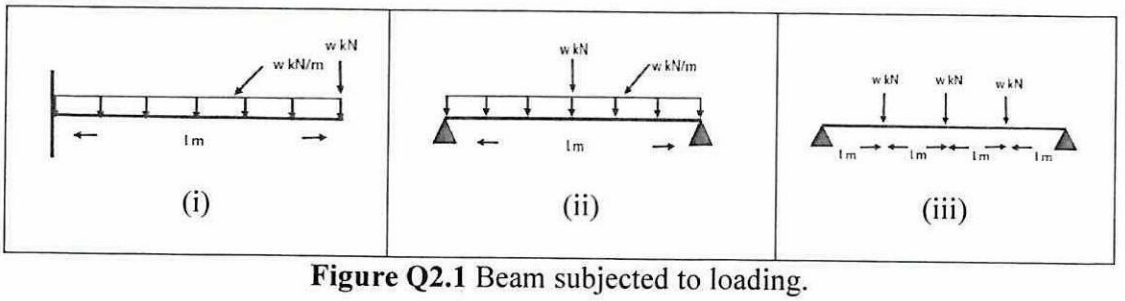

Figure Q2.1 Beam subjected to loading.

(6 marks)

(b) Beam *AB* is 2 meters long and carries a uniformly distributed load, as shown in **Figure Q2.2.**

(i) Draw shear force and bending moment diagrams.

(12 marks)

(ii) Determine the location and magnitude of the maximum value of the bending moment.

(2 marks)

Q3 This question is related to the chapter on bending stress. Answer all questions.

(a) Differentiate between Centre of Gravity and Centroid.

(2 marks)

(b) A cross sectional area of the beam is shown in **Figure Q3.1.** If the n-section is simply supported over a span of 6m. It carries a U.D.L (Uniform Distributed Load) of 3 kN/m run including its own weight over its entire span. Find the maximum tensile and compressive stress occurring in the beam section.

(13 marks)

(c) Calculate the centre of gravity of a channel section as shown in **Figure Q3.2**. State the location of its neutral axis location from the x-axis.

(5 marks)

Q4 This question is related to the chapter torsion. Answer all questions.

(a) Differentiate between torsion and torque.

(4 marks)

(b) The torques shown in **Figure Q4.1** are exerted on pulleys A and B. Knowing that both shaft are solid, determine the maximum shearing stress in shaft *AB* and shaft *BC*.

(6 marks)

(c) **Figure Q4.2** shows an electric motor (power, $P = 4$ kW and rotation, N = 200 rpm) turning a shaft with a diameter, *d*. If the maximum allowable shear stress is τ_{max}=200 MPa, determine the value of the shaft diameter, *d*.

(10 marks)

Q5 This question is related to the chapter thin cylinder. Answer all questions.

(a) Define Circumferential stress (hoop stress) and Longitudinal stress.

(4 marks)

(b) A mild steel pipe diameter of 1.5 m and thickness of 15 mm is subjected to an internal fluid pressure of 1.5 N/mm^2. Calculate the hook stress and longitudinal stress develop in the pipe wall.

(6 marks)

(c) A cylindrical shell 3 m long has 1 m internal diameter and 15 mm metal thickness. Calculate the circumferential and longitudinal stress, if the shell is subjected to an internal pressure of 1.5 MPa. Also calculate the changes in diameter and length of the shell. (Modulus Young, $E = 200$ GPa and Poisson's ratio, $\gamma = 0.3$).

(10 marks)

Q6 This question is related to the chapter complex stress. Answer all questions.

(a) Define the meaning of:

(i) Principal Stress, $\sigma^{1/2}$

(ii) Principal Plane

(2 marks)

(b) A For the state of plane stress shown in **Figure Q6.1.** Determine;

(i) orientation for the principal stresses

(ii) the principal stresses,

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

(18 marks)

- END OF QUESTIONS -

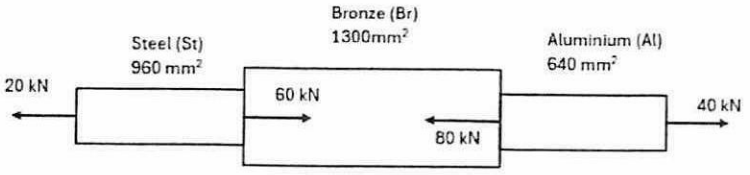

Figure Q1.1

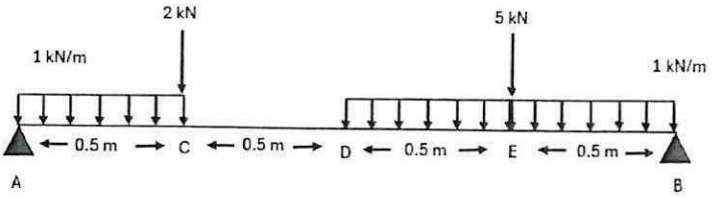

Figure Q2.2

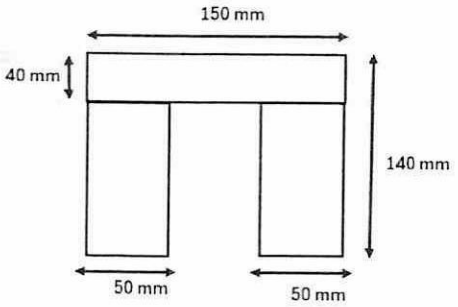

Figure Q3.1

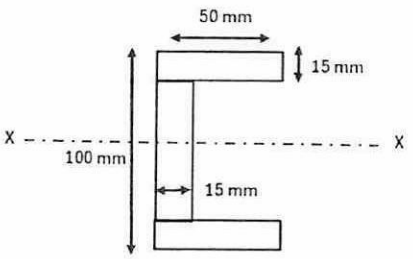

Figure Q3.2

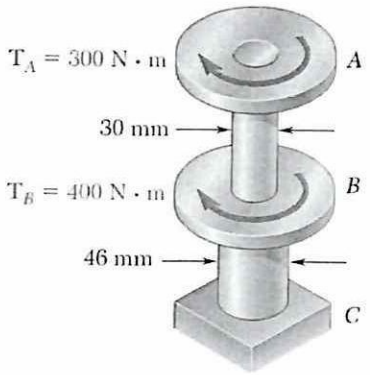

Figure Q4.1

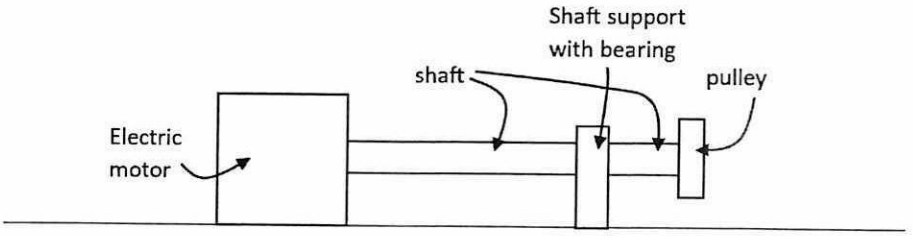

Figure Q4.2

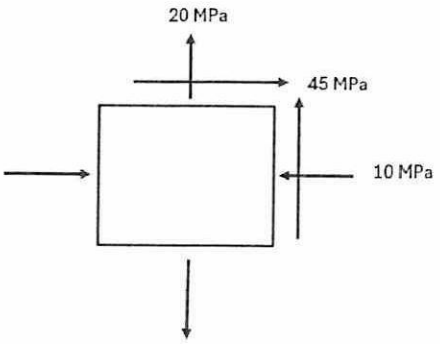

Figure Q6.1