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Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

**FINAL EXAMINATION
SEMESTER I
SESSION 2022/2023**

COURSE NAME : SOLID MECHANICS
COURSE CODE : DAM 23303
PROGRAMME CODE : DAM
EXAMINATION DATE : FEBRUARY 2023
DURATION : 3 HOURS
INSTRUCTIONS :
1. ANSWER **5 (FIVE)** 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 QUESTION PAPER CONSISTS OF **EIGHT (8)** PAGES

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- Q1** (a) Divide materials into **two (2)** broad categories. Differentiate the stress-strain diagram for both materials. (6 marks)
- (b) **Figure Q1(b)** shows the concrete post is reinforced axially with four symmetrically placed steel bars, each with a cross-sectional area of 900 mm^2 . The axial load, P with 1 MN is applied to the concrete. The modulus of elasticity is 14 GPa for concrete and 200 GPa for steel. Determine:
(i) the stress in each material
(ii) the maximum safe axial load P could be applied. The allowable stresses for steel bar are $= 120 \text{ MPa}$ and concrete $= 6 \text{ MPa}$. (14 marks)
- Q2** (a) A beam is a structural member resting on supports to carry vertical loads. State **four (4)** aspects that will affect the bending behaviors of the beam. (4 marks)
- (b) The overhanging beam in **Figure Q2(b)** carries two uniformly distributed loads and a concentrated load. Determine:
(i) the reactions force at points B and D
(ii) draw the shear force and bending moment diagrams for the beam (16 marks)
- Q3** (a) Draw a diagram explaining the stress variation across a beam section when subjected to a positive bending moment. (2 marks)
- (b) A 65 Nm couple is applied to the steel bar as illustrated in **Figure Q3(a)**. Assuming that the couple is applied about z-axis as shown and the value of $E = 200 \text{ GPa}$, determine the maximum stress in the steel bar. (3 marks)
- (c) A cantilever beam AB with a rectangular cross-section has a longitudinal hole drilled throughout its length as shown in **Figure Q3(b)**. The beam supports a load $P = 700 \text{ N}$. The cross-section is 30 mm wide and 60 mm high, and the hole has a diameter of 10 mm . Determine:
(i) the bending stress at the top of the beam
(ii) the bending stress at the top of the hole
(iii) the bending stress at the bottom of the hole (15 marks)

- Q4** (a) To obtain a simple theory in explaining the behaviour of shaft exerted with torque, a few assumptions have been made. List **four (4)** of the assumptions. (4 marks)
- (b) A hollow steel shaft with an outside diameter of 450 mm and inside diameter of 350 mm is subjected to a torque of 350 kNm as presented in **Figure Q4(a)**. The modulus of rigidity G (shear modulus) for the steel is 80 GPa. Calculate the maximum shearing stress in the shaft. (4 marks)
- (c) Four gears are attached to a circular shaft and transmit the torques as shown in **Figure Q4(b)**. The allowable shear stress in the shaft is 90 MPa. Determine:
(i) the required diameter d of the shaft if it has a solid cross-section
(ii) the required inside diameter d_i , if the shaft, is hollow with an outside diameter of 45 mm (12 marks)
- Q5** (a) State a correct definition of a thin wall cylinder. (2 marks)
- (b) List **four (4)** examples of thin wall pressure vessels and state whether they are spherical or cylindrical vessels. (4 marks)
- (c) A thin cylinder is attached with a set of strain gauges arrange in circumferential and longitudinal on its body to measure the strain value when the cylinder is subjected to internal pressure as shown in **Figure Q5(c)**. The cylinder is in closed-end conditions and the strain reading is shown in the figure. The cylinder is subjected to pressure by fluids inside the vessel. The internal diameter is 500 mm and thickness of the vessel is 12 mm.
(i) determine the value of gauge pressure indicates the fluid pressure inside the vessel when the $\nu = 0.3$
(ii) calculate the maximum pressure that can be sustained by a spherical vessel with the same stress experienced by the thin cylinder and with the same design parameters. Discuss your answer. (14 marks)

- Q6** (a) Names **two (2)** common methods that can be used to determine the transformation of stress in plane stress. (2 marks)
- (b) A steel rod is being loaded with forces as illustrated in **Figure Q6(b)**. The diameter of the rod is 12.5 mm, and its length is 600 mm. Considering the value of force K, B and N are 5 kNm, 10 kN and 35 kN respectively.
- (i) Determine the shearing and normal stress at the element located at point S.
 - (ii) Calculate the element's principal stress and principal plane at point S.
 - (iii) Sketch the principal plane for the element at S.
- (18 marks)

-END OF QUESTIONS -

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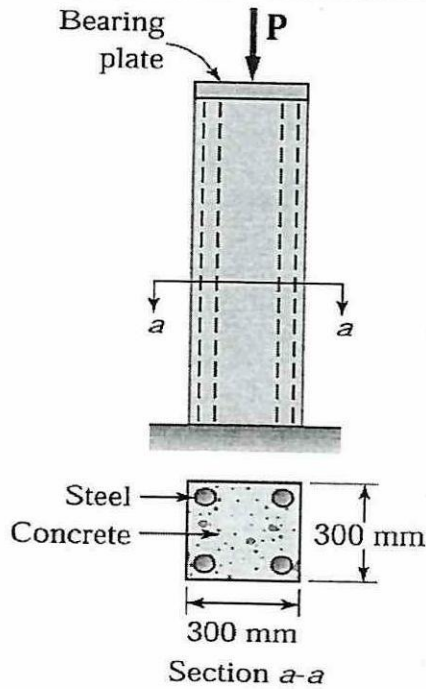


Figure Q1(b)

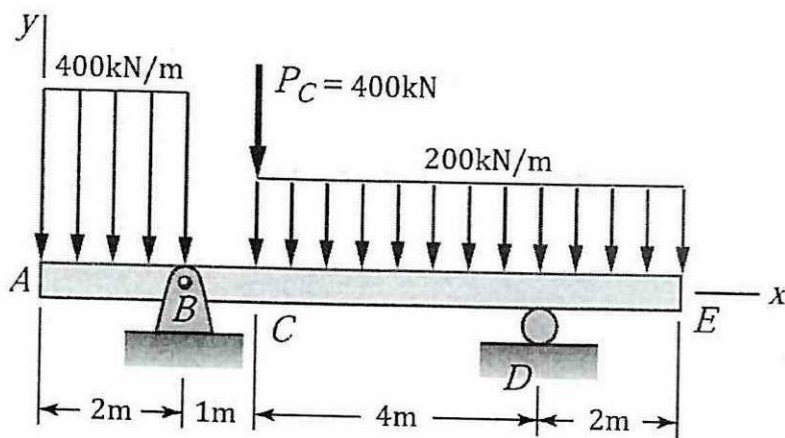


Figure Q2(b)

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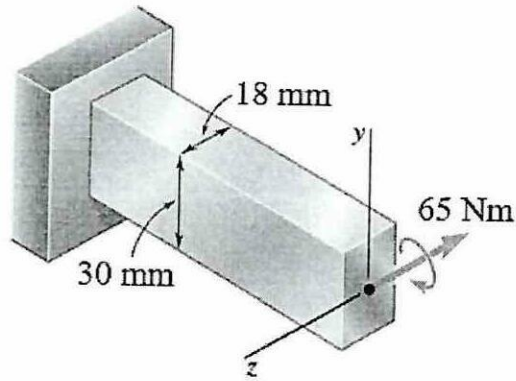


Figure Q3(a)

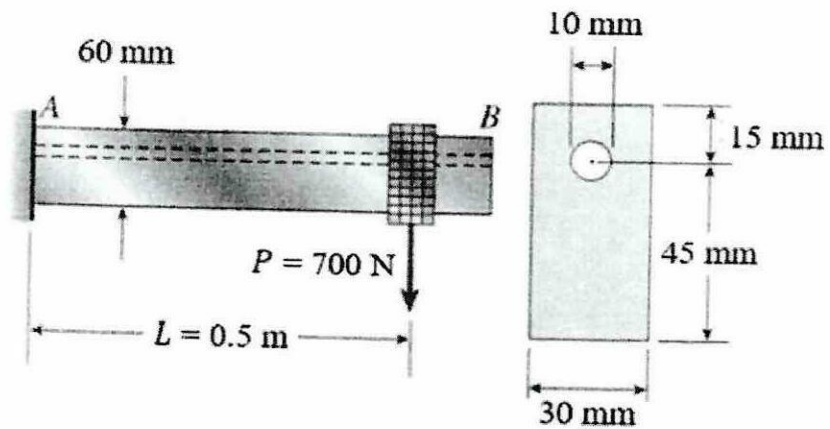


Figure Q3(b)

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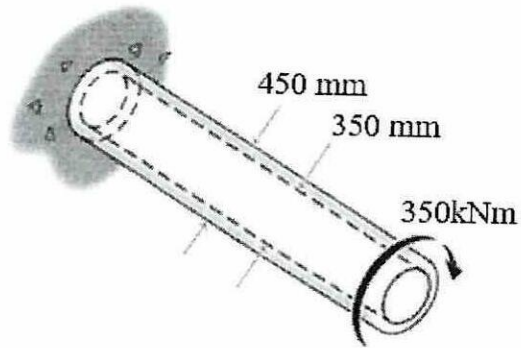


Figure Q4(a)

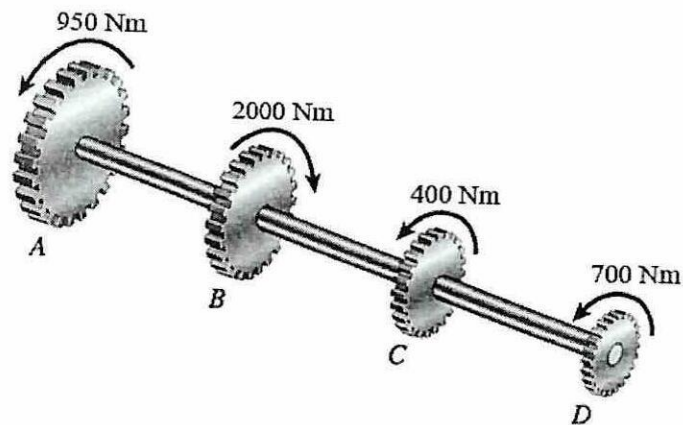


Figure Q4(b)

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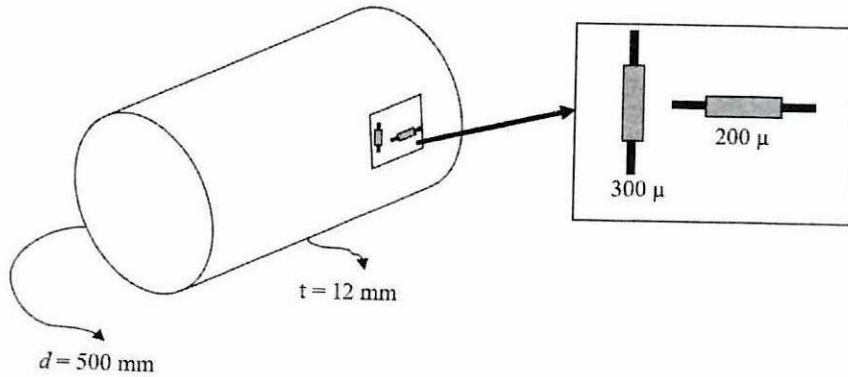


Figure Q5(c)

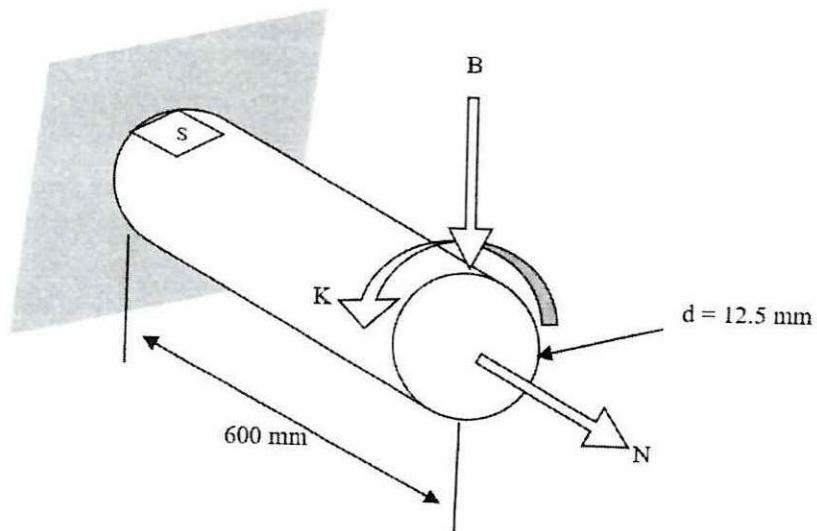


Figure Q6(b)