Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2020/2021

COURSE NAME	: SOLID MECHANICS
COURSE CODE	: BDU 20802
PROGRAMME CODE	: BDM
EXAMINATION DATE	: JULY 2021
DURATION	: 2 HOURS
INSTRUCTION	: ANSWER **FOUR (4)** QUESTIONS **ONLY**

THIS QUESTION PAPER CONSISTS OF **FIVE (5)** PAGES

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Q1 (a) **Figure Q1(a)** shows two solid cylindrical roads *AB* and *BC* are welded together at B and loaded as shown. Knowing that d_1 = 30 mm and d_2 = 50 mm, find the average normal stress in the mid-section of:

(i) Rod AB
(ii) Rod BC

(10 marks)

(b) **Figure Q1(b)** shows aluminum rod (E = 70 GPa), which consists of two cylindrical portions, AB and BC. The designer intends to replace it with a cylindrical steel rod DE (E = 200 GPa) of the same overall length. Analyse the rod to determine the minimum required diameter, d of the steel rod. The steel rod vertical deformation is not to exceed the deformation of the aluminum rod under the same load and the allowable stress in the steel rod is not to exceed 165 MPa.

(10 marks)

Q2 (a) Briefly explain between elastic and plastic behaviors for ductile (steel) materials. Sketch σ-ε diagram and indicate between engineering σ-ε and true σ-ε, elastic and plastic regions.

(5 marks)

(b) The beam with rectangular cross sectional area is subjected to the loading as shown in **Figure Q2(b)**. The thickness of the beam is 20 mm. Given the moment of inertia, I for the beam is 2.98×10^6 mm^4, determine:

(i) The reactions at A and B. Draw free body diagram, and shear and bending moment diagrams for the beam.
(ii) The maximum normal stress due to bending.
(iii) The point at which the shear stress is zero.
(iv) The points at which the bending moment are zero.

(15 marks)

Q3 (a) Briefly explain between neutral plane and neutral axis.

(5 marks)

(b) The member having a rectangular cross section as shown in **Figure Q3(b1)**, is designed to resist a moment of 40 Nm. In order to increase its strength and rigidity, it is proposed that two small ribs be added at its bottom as shown in **Figure Q3(b2)**. Determine:

(i) The maximum normal stress in the member without rib.
(ii) The maximum normal stress in the member with ribs.

(15 marks)

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Q4 (a) Determine the torque exerted on the shaft at point E and draw the torque diagram for the gear-shaft system shown in **Figure Q4(a)**. (Use the right hand rule and assume the positive torque is directed to the left hand side).

(8 marks)

(b) One of two hollow drive shafts of an ocean liner is 38 m long, and its outer and inner diameters are 400 mm and 200 mm respectively. The shaft is made of a steel for which $\tau_{(all)}$ = 60 MPa and G = 77 GPa. Knowing that the maximum speed of rotation of the shaft is 2.75 Hz, Determine:

(i) The maximum power that can be transmitted by the one shaft to its propeller.
(ii) The corresponding angle of twist of the shaft.

(12 marks)

Q5 (a) Briefly explain the definition and the importance of factor of safety (FS).

(5 marks)

(b) A thin cylinder has an internal diameter of 230 mm, has wall 5mm thick and is 1 m long. It is found, to change in internal volume by 12.0×10^{-6} m^3 when it is filled with a liquid at a pressure P. If E = 200 GPa and v = 0.25, and assuming rigid end plates, determine:

(i) The values of hoop and longitudinal stresses.
(ii) The modification to these values if joint efficiency of 45 % (hoop) and 85 % (longitudinal) are assumed.
(iii) The necessary change in pressure P to produce a further increase in internal volume of 15 %. The liquid may be assumed incompressible.

(15 marks)

Q6 (a) Briefly explain the terms principle stresses and principle planes.

(5 marks)

(b) The state of plane at a point on a body is shown on the element in the **Figure Q6(b).** Represent this stress in terms of the:

(i) Principle stresses.
(ii) Maximum in-plane shear stress and associated average normal stress.

(15 marks)

- END OF QUESTIONS -

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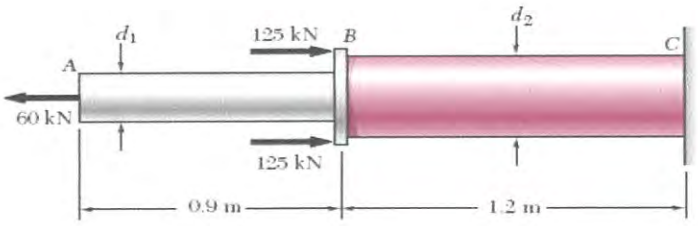

Figure Q1(a)

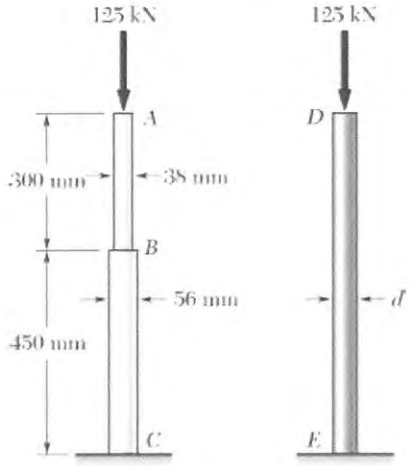

Figure Q1(b)

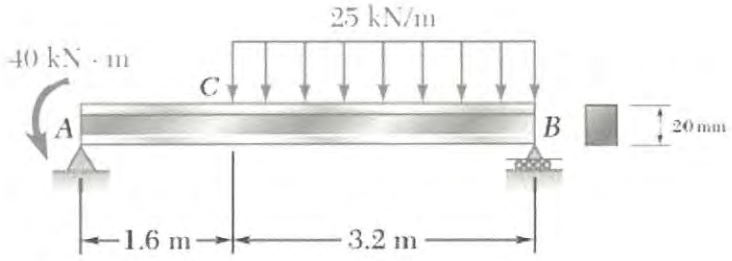

Figure Q2(b)

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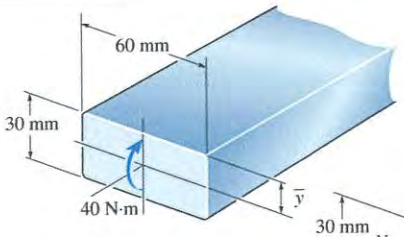

Figure Q3(b1)

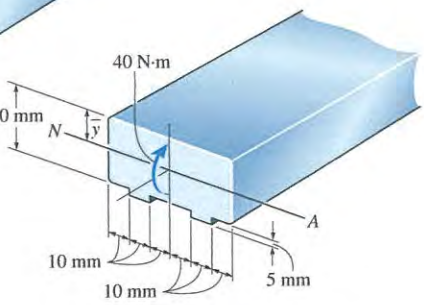

Figure Q3(b2)

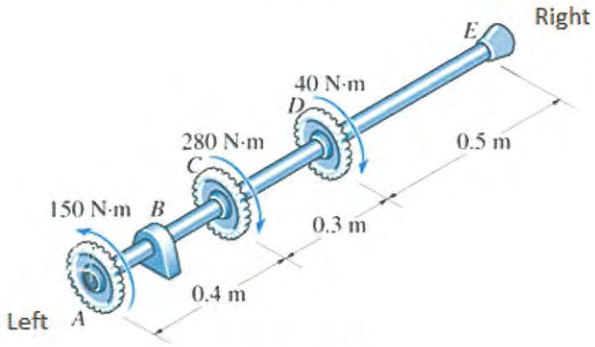

Figure Q4(a)

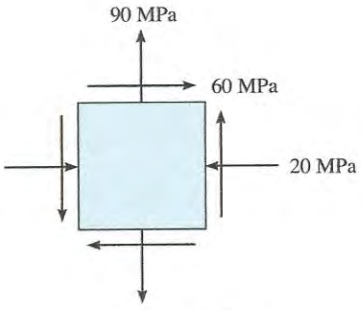

Figure Q6(b)

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