Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2015/2016

COURSE NAME	: SOLID MECHANICS
COURSE CODE	: BDU 20802
PROGRAMME	: 2 BDM
EXAMINATION DATE	: JUNE 2016/JULY 2016
DURATION	: 2 HOURS AND 30 MINUTES
INSTRUCTION	: ANSWER **FOUR (4)** QUESTIONS **ONLY**

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

Q1 (a) A square brass bar must not stretch more than 2.5 mm when it is subjected to a tensile load. Knowing that modulus of elasticity, E_{brass} is 105 GPa and that the allowable tensile strength, σ_{all} is 80 MPa, determine:

(i) The maximum allowable length of the bar.

(ii) The required dimensions of the cross section if the tensile load is 40 kN.

(10 marks)

(b) Part of a control linkage for an airplane consists of a rigid member CBD and a flexible cable AB as shown in **Figure Q1(b)**. Originally, the cable is unstrecthed for both cases.

(i) If a force is applied to the end D of the member and causes it to rotate by $\theta = 0.3°$, determine the normal strain in the cable.

(ii) If a force is applied to the end D of the member and causes a normal strain in the cable of 0.0035 mm/mm, determine the displacement of point D.

(15 marks)

Q2 (a) For the beam and loading shown in **Figure Q2(a)**, determine the maximum normal stress due to bending on a transverse section at C.

(10 marks)

(b) The dead-weight loading along the centerline of the airplane wing is shown in **Figure Q2(b)**. If the wing is fixed to the fuselage at A:

(i) Determine the reactions at A.

(ii) Derive the equations of the shear and bending-moment curves for the whole airplane wing.

(iii) Draw the shear and moment diagram for the airplane wing.

(15 marks)

Q3 (a) Briefly explain elastic and plastic behaviors of metallic materials and define the engineering stress and true stress.

(8 marks)

(b) Two vertical forces are applied to a beam of the cross section shown in **Figure Q3(b)**.

(i) Draw the free body diagram of the beam and determine the reactions at A and D.

(ii) Determine the location of neutral axis for cross-section of the beam.

(iii) Derive the equations of the bending - moment curves for section BC.

(iv) Determine the maximum tensile and compressive stresses in portion BC of the beam.

(17 marks)

Q4 (a) **Figure Q4(a)** shows solid rod AB which has a diameter d_{AB} = 60 mm and is made of a steel for which the allowable shearing stress is 85 Mpa. The pipe CD, which has an outer diameter of 90 mm and a wall thickness of 20 mm, is made of an aluminum for which the allowable shearing stress is 54 MPa. Both structures are welded together. Determine the largest torque T that can be applied at A and the twist angle at the end A when that torque is applied.

(10 marks)

(b) The cylindrical pressure tank shown in **Figure Q4(b)** has an inside diameter of 1.2 m and fabricated by butt welding 20 mm thick plate with a spiral seam. The pressure in the tank is 2800 kPa and axial load 130 kN, are applied to the end of the tank through a rigid bearing plate. Determine:

(i) The normal stress perpendicular to the weld

(5 marks)

(ii) The shearing stress parallel to the weld

(5 marks)

(iii) The maximum shearing stress at a point on the outside and inside surface of the vessel

(5 marks)

Q5 (a) Define the terms principle stresses and principle planes.

(4 marks)

(b) **Figure Q5(b)** shows a plane stress diagram with three different types of loading. Determine:

(i) The state of stress at the point on another element oriented 30° clockwise from the position shown.
(ii) The principal planes.
(iii) The principal stresses.
(iv) The maximum shearing stress and the corresponding average normal stress.

Show the results obtained in (i), (ii), (iii) and (iv) in Mohr's circle.

(21 marks)

- END OF QUESTION –

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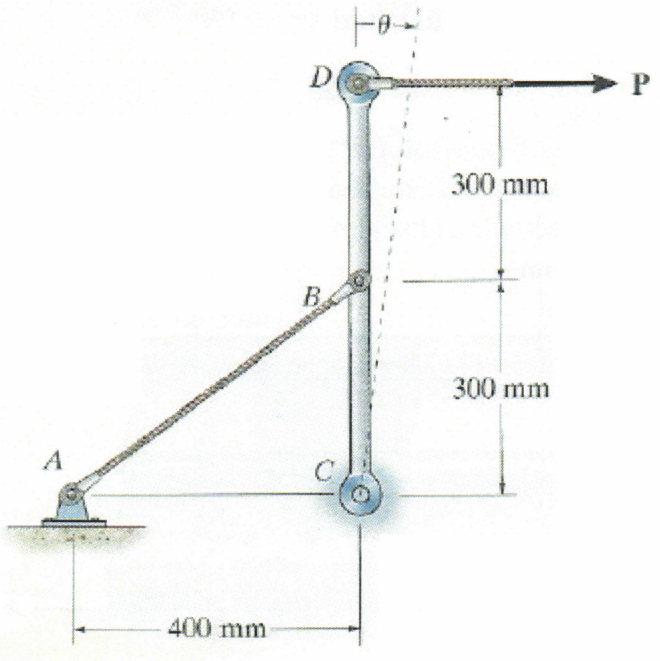

Figure Q1(b)

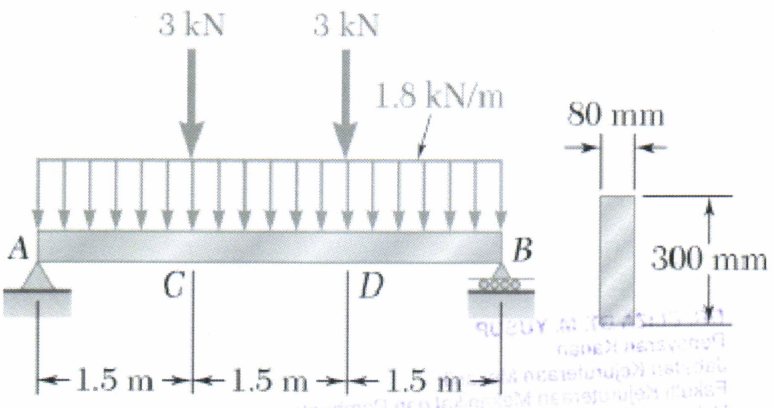

Figure Q2(a)

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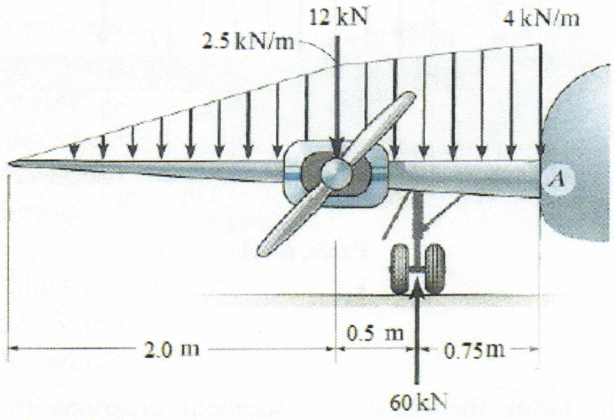
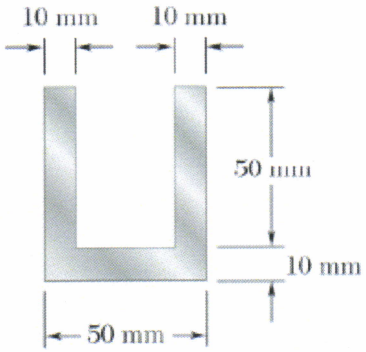


Figure Q2(b)



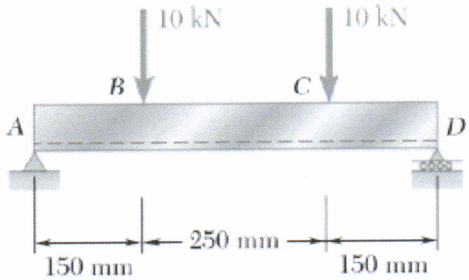


Figure Q3(b)

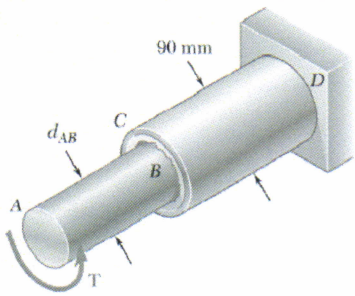


Figure Q4(a)

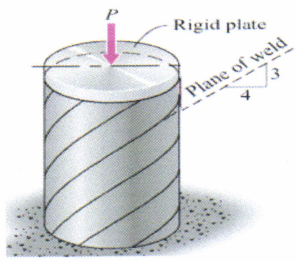


Figure Q4(b)

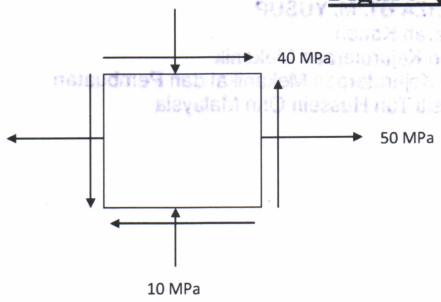


Figure Q5(b)