Charles Darwin University

Final Examination

Family Name						
Given Name/s						
Student Number						
Teaching Period	Semester 2, 2018					

ENG212 – Mechanics of Solids	DURATION	
	Reading Time:	10 minutes
	Writing Time:	180 minutes

INSTRUCTIONS TO CANDIDATES

1. Read **ALL** questions carefully.
2. Show all your working. Note that marks will be given for correct processes as well as correct results.
3. Marks as indicated for each question **ARE NOT of equal value**, the total is 100.
4. This paper contains six questions. Answer **all six (6)** questions.

EXAM CONDITIONS

You may begin writing from the commencement of the examination session. The reading time indicated above is provided as a guide only.

This is a CLOSED BOOK examination

Any non-programmable calculator is permitted

No handwritten notes are permitted

No dictionaries are permitted

ADDITIONAL AUTHORISED MATERIALS	EXAMINATION MATERIALS TO BE SUPPLIED
No additional printed material is permitted	1 x 20 Page Book 1 x Scrap Paper Formula Sheet/s

THIS EXAMINATION IS PRINTED DOUBLE-SIDED.

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Answer ALL questions in the answer booklet provided.

Marks for each question are indicated.

Question 1 (18 marks)

The beam shown in figure 1 is constructed from two boards. The beam is subjected to the loading shown in figure 1.

a. Draw the shear and moment diagrams for the beam (Marks: 6)

b. Determine the shear stress at point *B* on the web of the beam at section *a-a.* (Marks: 6)

c. Determine the shear flow at point *B* in section *a-a.* (Marks: 6)

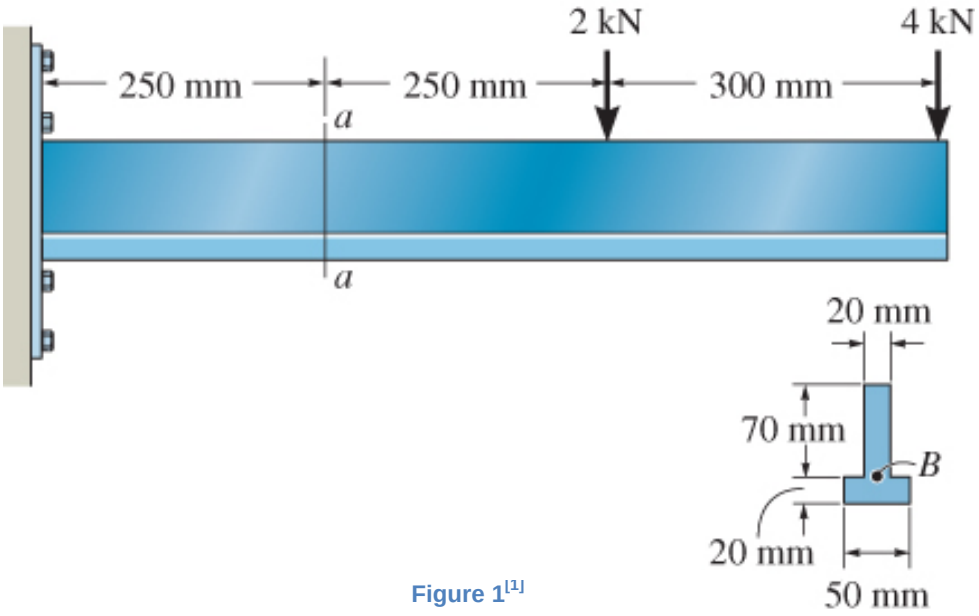

Figure 1[1]

Question 2 (13 marks)

The plate shown in figure 2 below has a maximum allowable stress of σ_{allow} = 220 MPa:

d. Determine the maximum allowable force *P* that can be applied to the plate. (Marks: 9)

e. What is the maximum stress if this force is applied and where does it occur? (Marks: 4)

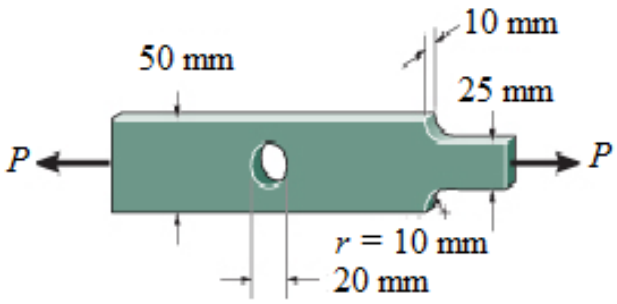

Figure 2[1]

Question 3 (14 marks)

The stainless steel shaft shown in figure 3 has a diameter of 120 mm. The shaft is fixed at *A* and *B*. For T_C = 800 Nm and T_D = 500 Nm, determine the absolute maximum and minimum values of shear stress in the shaft and indicate where they occur. Stainless steel has a modulus of rigidity of *G* = 75 GPa.

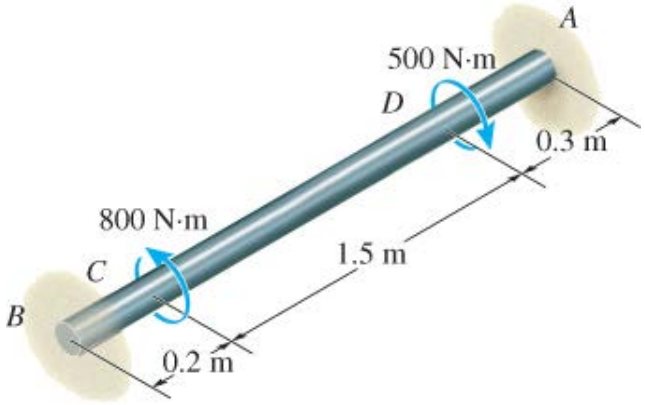

Figure 3[1]

Question 4 (18 marks)

A pressure vessel made of steel is shown in figure 4, it has an internal diameter of 60 cm and a wall thickness of 0.5 cm. A strain gauge is bonded to the surface of the vessel in the *x* direction. The original length of the strain gauge is 0.5 cm and it has been elongated by 0.2×10^{-3} cm. The modulus of elasticity of steel is E=200 GPa and the Poisson's ratio is ν=0.3.

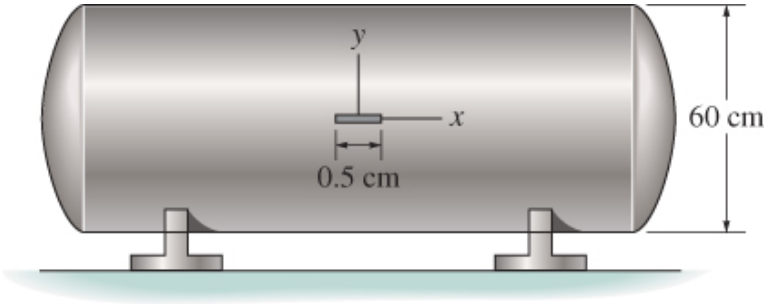

Figure 4[1]

a. Calculate the strain in the *x* direction, ε_x. (Mark: 1)

b. Determine the hoop stress, σ_h, and the longitudinal stress, σ_l in the vessel. (Marks: 6)

c. Express the strain in the *x* direction, ε_x, in terms of the hoop stress, σ_h, and the longitudinal stress, σ_l. (Marks: 3)

d. What is the value of the pressure *P*, which caused the strain you calculated in part a. (Marks: 3)

e. Calculate the value of the maximum shear strain in the *x*, *y* plane (Marks: 5)

Question 5 (17 marks)

The state of stress at a point in a member is shown on the element in figure 5. Determine the stress components acting on the inclined plane *AB*. Solve the problem using Mohr's circle.

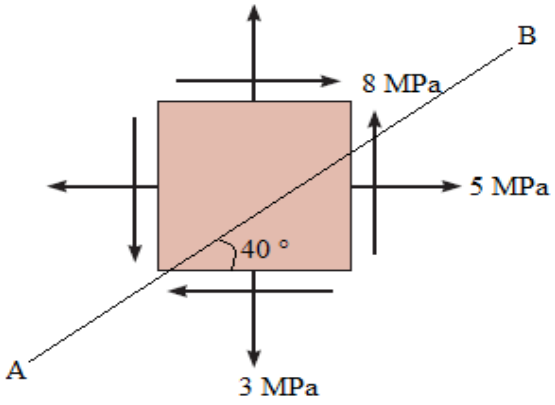

Figure 5[1]

Question 6 (20 marks)

An aluminium beam is used to support the load w= 10 kN/m as shown in figure 6. The solid beam is rectangular with a height of 200 mm and a width of 120 mm. The length of the beam L = 4 m. The modulus of elasticity for the beam is E = 70 GPa.

a. Express the bending moment along the length of the beam as a function of x in terms of the reaction force at B. (Marks: 3)

b. What is the deflection of the beam at A? (Mark: 1)

c. What is the slope of the beam at A? (Mark: 1)

d. Draw an exaggerated deflected shape for the beam. (Marks: 3)

e. Determine the value of the slope of the beam at B (Marks: 3)

f. Determine the reaction force at B (Marks: 3)

g. Determine the slope and the deflection of the beam halfway between A and B (2 m from A) (Marks: 3)

h. Is this the maximum deflection of the beam? Explain your answer (Marks: 3)

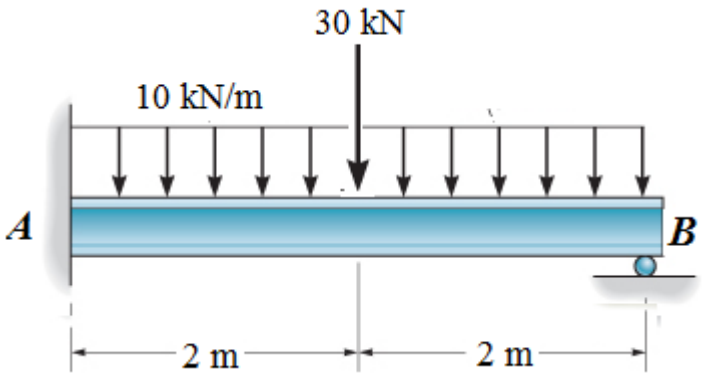

Figure 6[1]

[1] R. C. Hibbeler, *Mechanics of Materials*,10th Edition, Pearson, (2017).