UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
(ONLINE)
SEMESTER II
SESSION 2020/2021

COURSE NAME	:	SOLID MECHANICS I
COURSE CODE	:	BDA 10903
PROGRAMME CODE	:	BDD
EXAMINATION DATE	:	JULY 2021
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWERS **TWO (2)** QUESTIONS IN **PART A** AND **ALL QUESTIONS** IN **PART B**

THIS QUESTION PAPER CONSISTS OF **EIGHT (8)** PAGES

PART A

Q1 (a) The rigid bar AB as shown in **Figure Q1(a)** is supported by a steel road AC having a diameter of 22 mm and an aluminum block having a cross-sectional area of 2000 mm^2. The 20-mm-diameter pins at A and C are subjected to single shear. If the failure stress for the steel and aluminum is $\sigma_{st}^{Fail} = 680$ MPa and $\sigma_{al}^{Fail} = 70$ MPa, respectively, and the failure shear stress for each pin is $\tau^{Fail} = 900$ MPa, determine the largest load P that can be applied to the bar. Apply a factor of safety of F.S = 2.

(10 marks)

(b) Draw the shear and moment diagrams for the beam shown in **Figure Q1(b).**

(10 marks)

Q2 A uniformly distributed force of C kN/m and a concentrated load of D kN are applied to a cantilever beam with a cross-section as shown in **Figure Q2**. By using the parameters listed in **Table Q2**.

(a) Determine the support reaction of the cantilever beam.

(2 marks)

(b) Draw the shear and moment diagrams of the beam.

(6 marks)

(c) Determine the maximum bending moment, M_{max} of the beam.

(3 marks)

(d) Determine the moment of inertia, I of the beam cross-section.

(5 marks)

(e) Calculate the maximum tensile and compressive stresses in the beam.

(4 marks)

Q3 (a) The A-36 steel bolt is tightened within a hole so that the reactive torque on the shank AB (with constant radius of 4 mm) as shown in **Figure Q3(a)** can be expressed by the equation $t = kx^2$ Nm/m, where x is in meters. If a torque of T = 50 Nm is applied to the bolt head and G_{st} = 75 GPa, calculate:

(i) the constant k

(5 marks)

(ii) the amount of twist in radian the 50-mm length of the shank.

(8 marks)

(b) The steel shaft has a diameter of 40 mm and is fixed at its ends A and B as shown in **Figure Q3(b)**. If it is subjected to the couple, determine the support reactions at fixed supports A and B of the shaft. Given G_{st} = 75 GPa.

(7 marks)

PART B

Q4 (a) A thin cylinder 95 mm internal diameter, 500 mm long with walls 4.5 mm thick is subjected to an internal of 9 MN/m^2. If E = 200 GPa and v = 0.25, and assuming rigid end plates. Calculate:

(i) The change in volume.

(2 marks)

(ii) The change of internal diameter and change in length.

(4 marks)

(iii) The value of hoop and longitudinal stresses.

(4 marks)

(b) A water tank consists of a cylinder section enclosed by hemispherical shell with the thickness of 15 mm as shown in **Figure Q4**. The pressure inside the tank is maintained at 10 MPa The circumferential strain at the junction of the cylinder and hemisphere assumed to be the same. Given E = 200 GPa and v = 0.3. Calculate:

(i) The circumferential strain of the cylindrical portion and the hemispherical ends.

(6 marks)

(ii) The change in volume of the tank.

(4 marks)

Q5 **Figure Q5** shows few loadings applied on bar ABD. Suppose the diameter of the bar is 120 mm, and knowing that P1, P2 and P2 are 10.a kN, 5.b kN and 15.c kN, respectively. Parameter a, b, and c are given by:

a = last digit of your matrix number
b = fifth digit of your matrix number
c – fourth digit of your matrix number

For example, a student with the matrix number CD200187 will have the values of 10.a = 10.7, 5.b = 5.8 and 15.c = 15.1.

(a) Calculate the state of stress at point H

(6 marks)

(b) Sketch the element of this state of stress

(3 marks)

(c) Determine the principal planes and the corresponding principal stresses at point H

(11 marks)

Q6 A pressure tank is supported by two cradles as shown in **Figure Q6**. One of the cradles is designed so that it does not exert any longitudinal forces on the tank. The cylindrical body of the tank has 5.a m outer diameter and is fabricated from a 12 mm steel plate by butt welding along a helix that forms an angle of 4b° with transverse plane. The end caps are spherical and have a uniform wall thickness of 10 mm. The gage pressure is 1.c MPa. Parameter a, b, and c are given by:

a = last digit of your matrix number
b = fifth digit of your matrix number
c = fourth digit of your matrix number

For example, a student with the matrix number CD170987 will have the values of 5.a = 5.7, 4b = 48 and 1.c = 18.

(a) Calculate the normal stress and the maximum shearing stress in the spherical caps.
(6 marks)

(b) Draw the Mohr's circle, solve the stress in directions perpendicular and parallel to the helical weld.
(8 marks)

(c) If the right cradle suddenly crushed, determine the stress at point A (for student with odd matrix number) or point B (for student with even matrix number) which is located 0.25 m from the ground of the left cradle. Let's the weight of pressure tank acting on its centroid, CG equal to your matrix number. For example, a student with the matrix number CD170987 will have weight of pressure tank equal to 170987 N.
(6 marks)

-END OF QUESTIONS –

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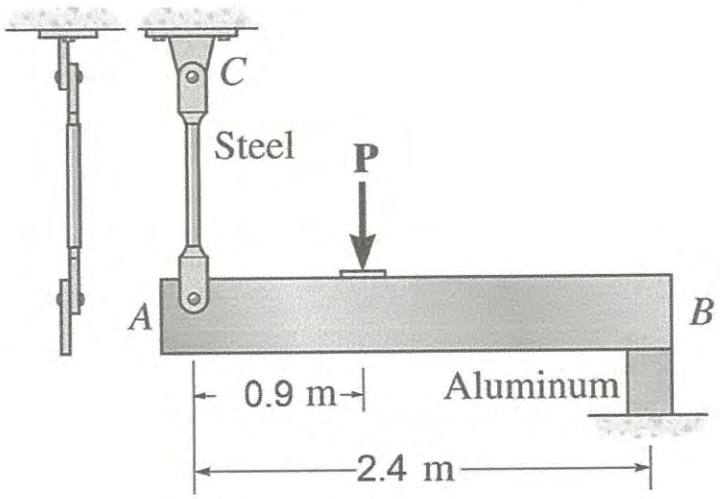

Figure Q1(a)

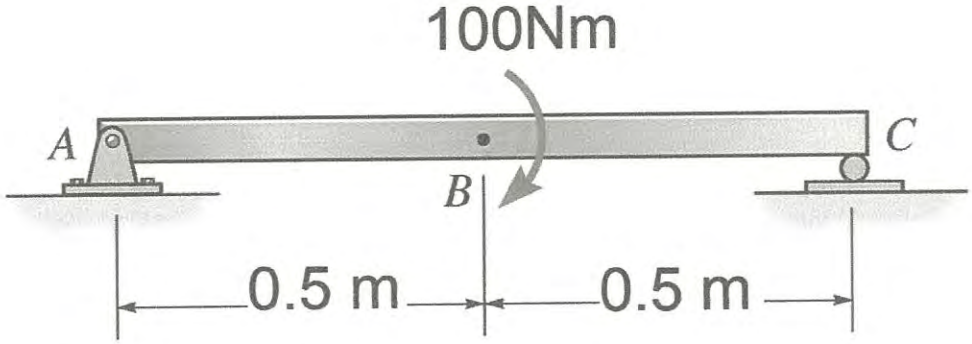

Figure Q1(b)

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Table Q2

Parameter	Student with **ODD** matric number (XD 20xx**A**) A = 1, 3, 5, 7, 9	Student with **EVEN** matric number (XD 20xx**B**) B = 0, 2, 4, 6, 8
C	8 kN/m	40 kN/m
D	20 kN	100 kN

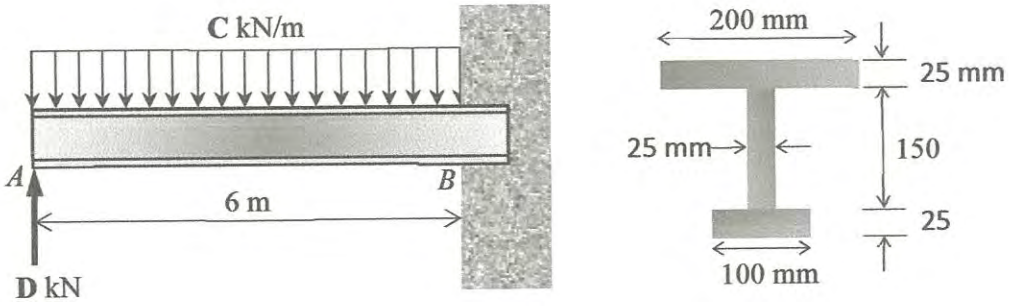

Figure Q2

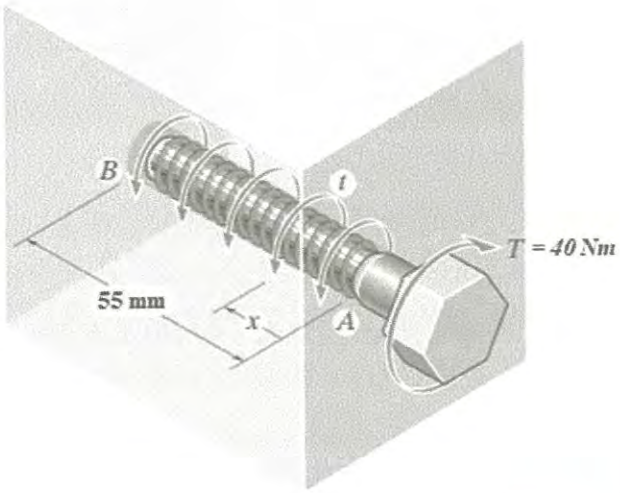

Figure Q3(a)

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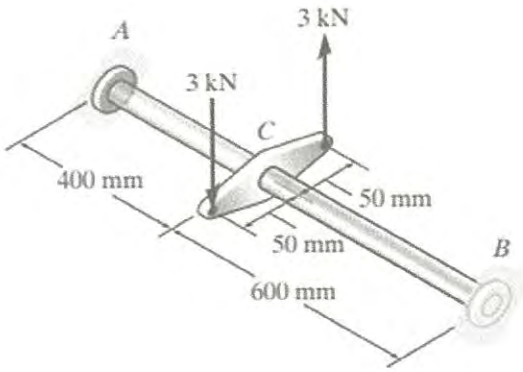

Figure Q3(b)

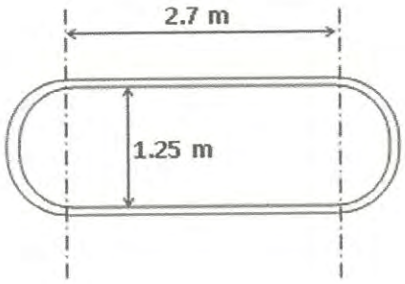

Figure Q4

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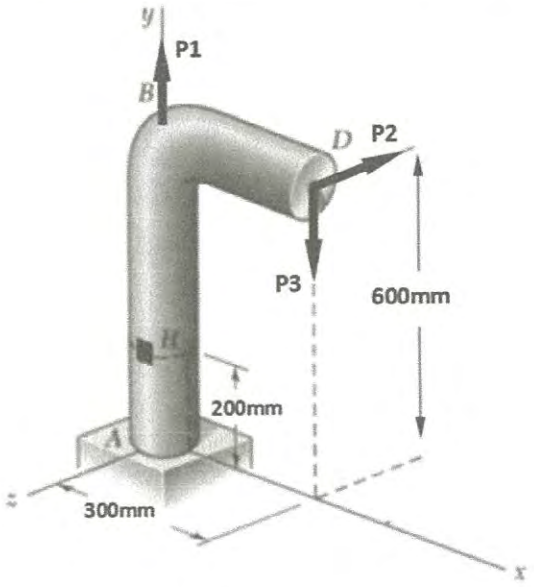

Figure Q5

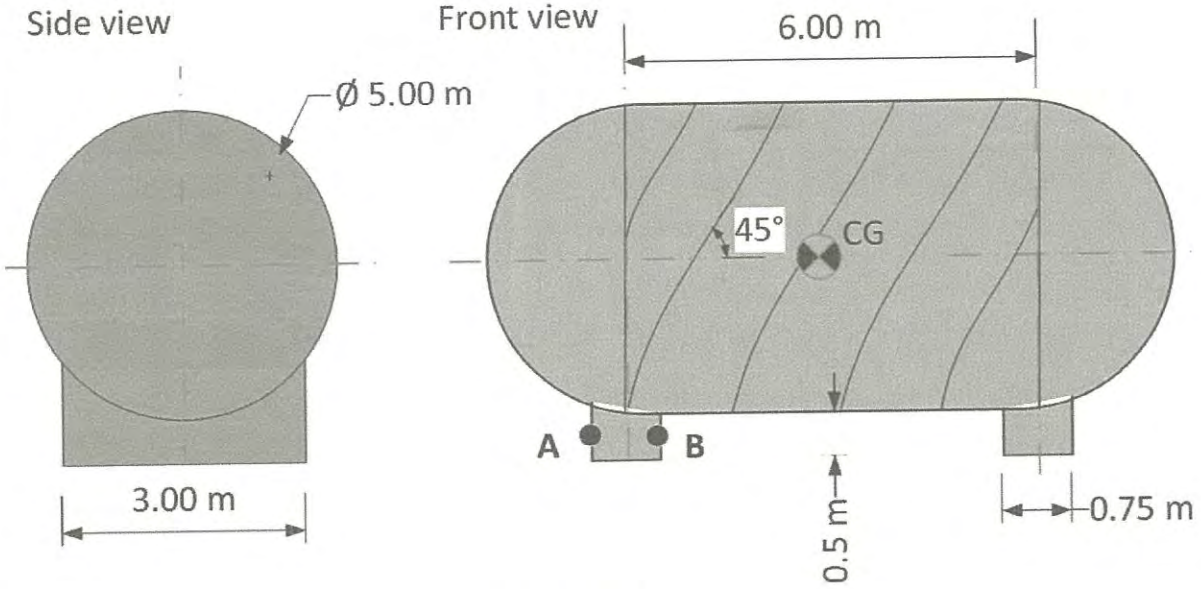

Figure Q6