Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
(ONLINE)
SEMESTER II
SESSION 2020/2021

COURSE NAME	:	SOLID MECHANICS 2
COURSE CODE	:	BDA 20903
PROGRAMME	:	BDD
DATE	:	JULY 2021
DURATION	:	3 HOURS
INSTRUCTION	:	PART A: ANSWER **THREE** QUESTIONS ONLY PART B: ANSWER **ALL** QUESTIONS

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

PART A (OPTION):
Answer any **three** questions.

Q1 The 45° strain rosette is mounted on a steel robotic arm as shown in **Figure Q1**. The robotic arm is made from steel with E_{steel} = 200 GPa and poison ratio, ν = 0.3. The following readings are obtained for each gauge:

$$\varepsilon_a = [Y+Z](10^{-6})$$
$$\varepsilon_b = -250(10^{-6})$$
$$\varepsilon_c = -200(10^{-6})$$

Here the value of Y and Z depends on the 5th digit and 6th digit of your matric number as shown in **Table 1**. For example, if your matrix number is DD 0701**12** gives the value of Y=300 and Z=60 :

Table 1

5th digit of matric number	Y	6th digit of matric number	Z
0	250	0	0
1	300	1	30
2	350	2	60
3	400	3	90
4	450	4	120
5	500	5	150
6	550	6	180
7	600	7	210
8	650	8	240
9	700	9	270

(a) Prove that $\varepsilon_x = \varepsilon_a$ and $\varepsilon_y = \varepsilon_c$.

(3 marks)

(b) Determine the shear strain, γ_{xy} and the normal strain, ε_x and ε_y.

(3 marks)

(c) Estimate the in-plane principal strains and the angle associated with the principal strains, and

(9 marks)

(d) Calculate the principal stress associated with the principal strains in (c).

(5 marks)

Q2 (a) A beam of uniform flexural stiffness EI and span L is simply-supported at its ends as shown in **Figure Q2(a)**; it carries a uniformly distributed vertical load of w per unit length, which induces bending in the yz plane only. Then the reactions at the ends are each equal to 0.5 (wL); if z is measured from the end C, the bending moment at a distance z from C is

$$M = \frac{1}{2}wLz - \frac{1}{2}wz^2$$

Find the maximum deflection, v_{max}

(7 marks)

(b) A simple beam BCD of span length 5m has overhang AB of length 3m as shown in **Figure Q2(b).** The beam is roller-supported at point *B* and pin-supported at point *D*. Determine the maximum deflection of the beam if *EI* is constant.

(13 marks)

Q3 The A-36 steel rod *BC* as shown in **Figure Q3** has a diameter of 5**X** mm (**X** is a last digit of your matrix number) and is used as a strut to support the beam. The yield strength of material is $\sigma_Y = 250$ MPa. Take modulus of elasticity, $E_s = 200$ GPa.

(a) Determine the maximum intensity w of the uniform distributed load that can be applied to the beam without causing the strut to buckle. Take factor of safety = 2 against buckling. Check whether Euler's equation is appropriate or not.

(13 marks)

(b) Then, calculate the new maximum intensity w if end condition for strut both fixed.

(7 marks)

Q4 The L2 steel bolt as shown in **Figure Q4** has a diameter of 5 mm, and the link *AB* which is made from stainless steel 304 has a rectangular cross section that is 1**X** mm wide (**X** is a last digit of your matrix number) by 4 mm thick. The bolt is tightened so that it has a tension of 1750 N. Neglect the hole in the link. The modulus of elasticity are, $E_{L2} = 200$ GPa and $E_{304} = 193$ GPa for both material.

(a) Determine the strain energy in the link *AB* due to bending. (12 marks)

(b) Determine the strain energy in the bolt due to axial load. (8 marks)

PART B (COMPULSORY):
Answer **all** questions.

Q5 **Figure Q5** shows a thick cylinder of **[A]** mm internal radius and **[B]** mm external radius is subjected to an internal pressure of 60 MN/m^2 and an external pressure of 30 MN/m^2. Determine the hoop and radial stresses at the inside and outside of the cylinder together with the longitudinal stress if the cylinder is assumed to have closed ends using analytical and graphical approaches.

(20 marks)

Use your last matrix number to get value of **[A]** and **[B]** as an example below:

*Example: If your matrix number is AD18030**8**; Thus, the last number is '**8**'*

Last matrix number	**0 - 3**	**4 - 6**	**7 - 9**
Value of **[A]**	60	80	100
Value of **[B]**	100	120	150

So, value **[A]** = 100, *and value* **[B]** = 150

Q6 A solid circular shaft has a diameter of *d* mm and is made from steel, which fail when tested in simple tension test at a stress of 150 MPa. The shaft was subjected by bending moment and torque which are 22.2 kNm and 44.4 kNm respectively. Calculate the minimum allowable shaft diameter, *d* according to:-

(a) Tresca failure criterion (10 marks)

(b) Von Mises theory of elastic failure (10 marks)

- END OF QUESTION -

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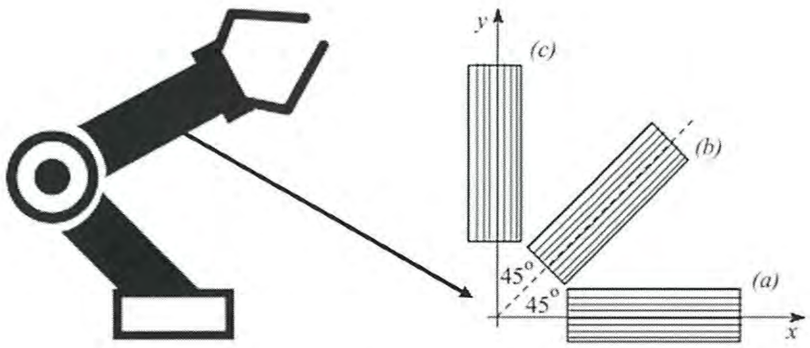

Figure Q1

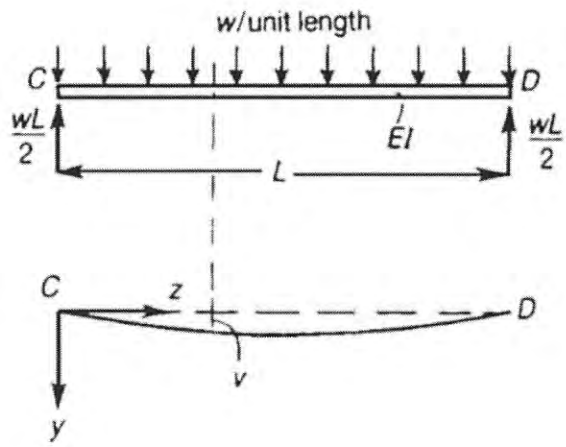

Figure Q2 (a)

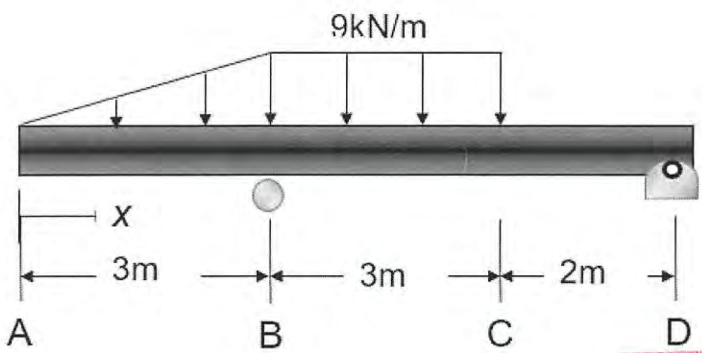

Figure Q2 (b)

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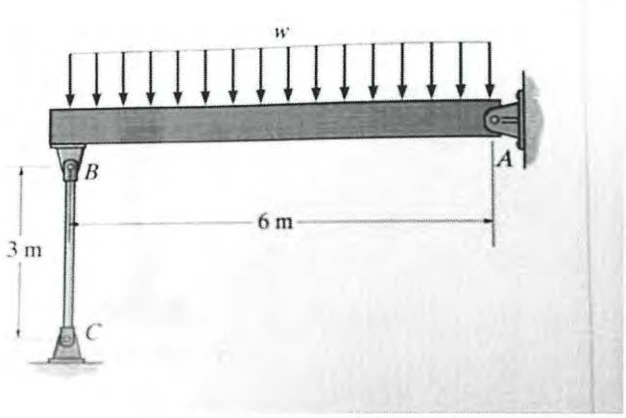

Figure Q3

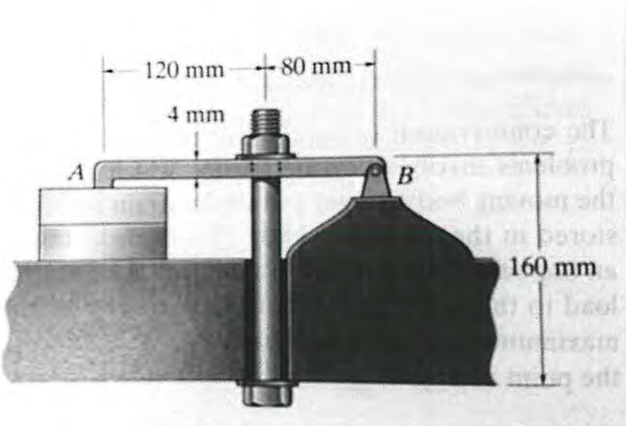

Figure Q4

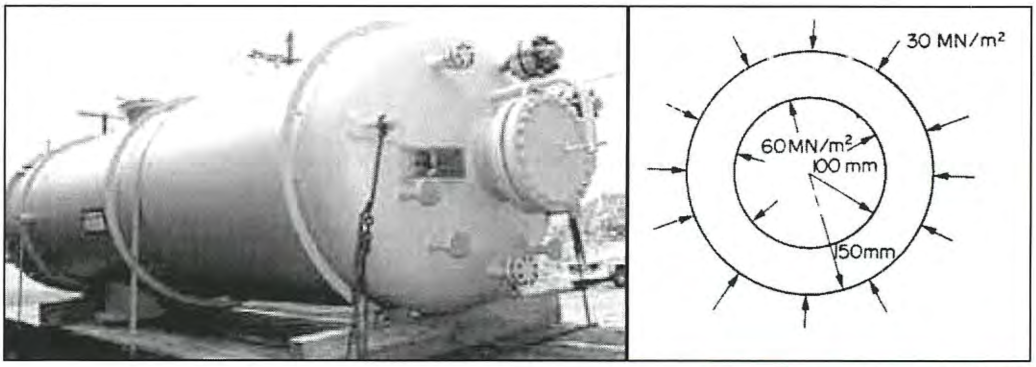

Figure Q5