Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2019/2020

COURSE NAME	:	SOLID MECHANICS 2
COURSE CODE	:	BDA 20903/ BDA 30303
PROGRAMME	:	2 BDD
EXAMINATION DATE	:	DECEMBER 2019/ JANUARY 2020
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FIVE (5)** QUESTIONS **ONLY**

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

Q1 A steel I beam structure is designed to withstand both normal and shear. In order to analyse the stress distribution at a point on the web of the I beam, strain gauges are used. Three gauges A, B and C are installed as shown in **Figure Q1**. The reading from these gauges are recorded as follows: $\epsilon a = 600\mu$, $\epsilon b = -300\mu$ and $\epsilon c = -150\mu$. Determine:-

(a) The strain components ϵx, ϵy and γxy. (6 marks)

(b) The principal strains and their locations measured from x-axis. (6 marks)

(c) The principal stresses and the maximum shear stress if modulus of elasticity for steel is 200 GPa and Poisson's ratio is 0.3 (8 marks)

Q2 A cantilever beam carries a couple of moment, M = 400 Nm at B and concentrated force, P at A as shown in **Figure Q2**. Find the value of force, P cause zero or no deflection at A assuming that EI is constant through the beam.

(20 marks)

Q3 The brass bar AB has a uniform rectangular cross section and is supported by pins and brackets as shown in **Figure Q3**. Each end of the bar can rotate freely about a horizontal axis through the pin, but rotation about a vertical axis is prevented by the brackets. Determine:

(a) The ratio b/d for which the factor of safety is the same about the horizontal and vertical axes. (10 marks)

(b) The factor of safety if P = 8 kN, L = 2 m, d = 38 mm and E = 105 GPa. (10 marks)

Q4 (a) Determine the total axial and bending strain energy in the A-36 structural steel as illustrated in **Figure Q4(a)** with W200x86 beam. The beam cross-sectional area, A is $11000(10^{-6})m^2$. Given E=210 GPa. (10 marks)

(b) The tubular shaft in **Figure Q4(b)** is fixed at the wall and subjected to two torques as shown. Determine the strain energy stored in the shaft due to this loading. Given G = 75 GPa. (10 marks)

Q5 (a) Based on **Figure Q5**, derive and prove that the Hoop Stress, σ_H and the Radial Stress, σ_R can be expressed as follows:

$$\sigma_R = \frac{a^2 P_a - b^2 P_b}{\left(b^2 - a^2\right)} - \frac{a^2 b^2 \left(P_a - P_b\right)}{r^2 \left(b^2 - a^2\right)}$$

$$\sigma_H = \frac{a^2 P_a - b^2 P_b}{\left(b^2 - a^2\right)} + \frac{a^2 b^2 \left(P_a - P_b\right)}{r^2 \left(b^2 - a^2\right)}$$

(14 marks)

(b) A thick cylindrical shell with inner radius 10 cm and outer radius 16 cm is subjected to an internal pressure of 70 MPa. Find the maximum and minimum hoop stresses.

(6 marks)

Q6 (a) Define the maximum shear stress theory and sketch its failure envelope.

(5 marks)

(b) Define the maximum shear strain energy theory and sketch its failure envelope.

(5 marks)

(c) A round solid cantilever bar is subjected to combined torsion, T = 100 Nm and force, P = 2000 N at the free end as shown in **Figure Q6**. The bar is made of a ductile material having the yield strength, σ_y = 30 MPa. Assuming that there is no transverse shear, determine the minimum diameter, D to avoid yielding using the maximum shear and the maximum shear strain energy theories. (10 marks)

-END OF QUESTION-

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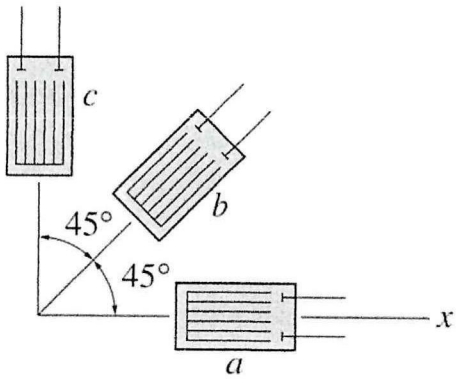

Figure Q1

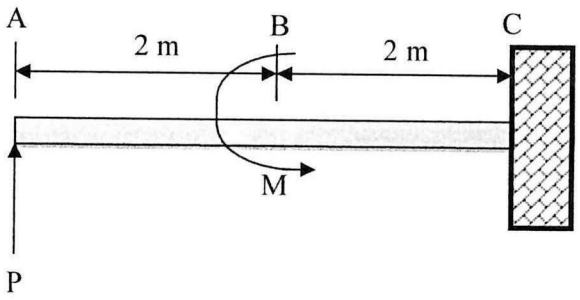

Figure Q2

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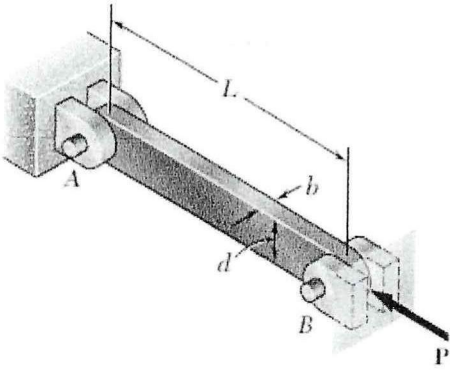

Figure Q3

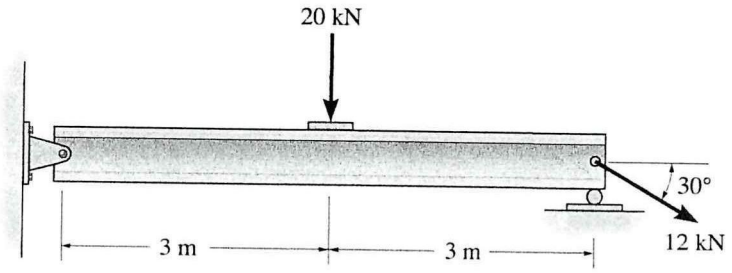

Figure Q4 (a)

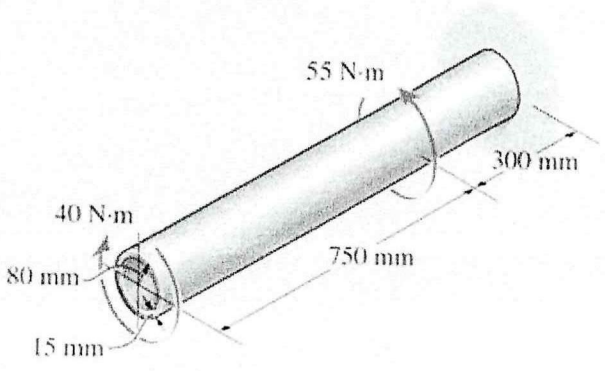

Figure Q4 (b)

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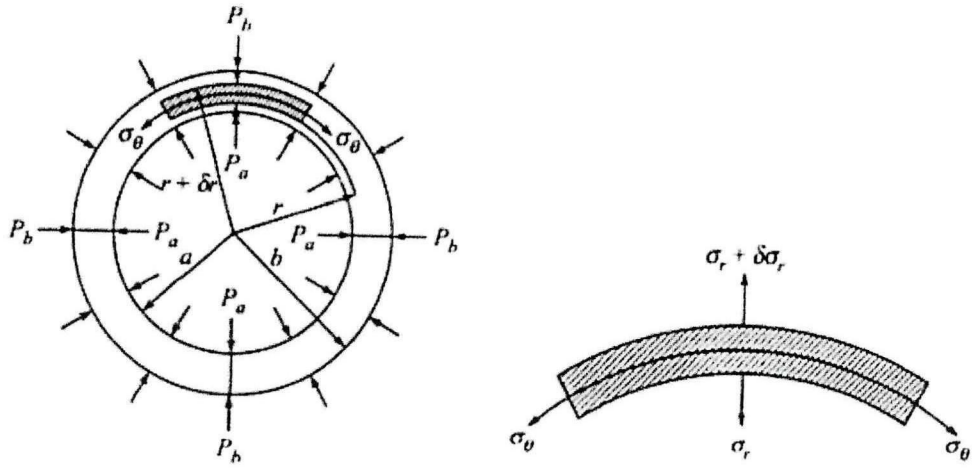

Figure Q5

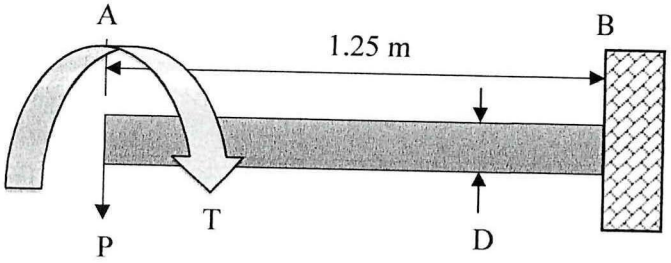

Figure Q6