Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2016/2017

COURSE NAME	:	SOLID MECHANICS II
COURSE CODE	:	BDA20903
PROGRAMME	:	BDD
EXAMINATION DATE	:	JUNE 2017
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS IN **PART A** ANSWER ONE **(1)** QUESTION IN **PART B**

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

PART A

Q1 The steel ($E = 200$GPa, $\nu = 0.32$) vertical post is loaded to the forces as shown in **Figure Q1**. If the strain gauges a and b are firmly attached at point A give readings of $\varepsilon_a = 300\mu$ and $\varepsilon_b = 175\mu$. Determine the magnitudes of P_1 assuming that $P_1 = P_2$. There is no transverse force occurs at point A. Solve the following problems:

(a) Sketch the free body diagram at point A,

(5 marks)

(b) Find the moment of inertia of the cross section,

(5 marks)

(c) Find the normal strains at point A, and

(8 marks)

(d) Find force P_1.

(2 marks)

Q2 (a) Explain the importance of buckling of columns analysis in a building structure.

(4 marks)

(b) Steel bar AB in **Figure Q2** is pin connected at its ends for buckling in y-y axis. Given $w = 4\text{kN/m}$, $E_{st} = 210$ GPa and $\sigma_Y = 380$ MPa:

i) Construct the Free-Body Diagram (FBD) of the given frame ABC,

(4 marks)

ii) Determine the maximum load P can be supported by the frame,

(8 marks)

iii) Determine the factor of safety with respect to buckling about the y-y axis.

(4 marks)

Q3 (a) Define the main difference between thick and thin cylinders and give an example for each type of cylinder

(4 marks)

(b) Derive the expression of longitudinal stress, σ_L for a closed thick cylinder which has inner radius, R_1 and outer radius, R_2 and subjected to internal pressure only.

(6 marks)

(c) **Figure Q3** shows a cross section of composite cylinder that is made by shrinking a tube of 330 mm internal diameter and 50 mm thick over another tube of 330 mm external diameter and 50 mm thick. The radial pressure at the common surface, after shrinking is 180 MPa. Suppose the compound cylinder is subjected to an internal fluid pressure of 1200 MPa, determine;

i) the hoop stresses at inner radius and outer radius of inner cylinder,

(5 marks)

ii) the hoop stresses at inner radius and outer radius of outer cylinder.

(5 marks)

Q4 (a) Compare the differences between brittle and ductile materials. Give an example for each material with their corresponding mathematical expressions.

(8 marks)

(b) A horizontal shaft of 75 mm in diameter and 350 mm in length projects from a bearing as shown in **Figure Q4**. The vertical load of 10 kN, horizontal compression load of 12 kN and torque, T Nm are applied at the free end of the shaft. If the safe stress for the material is 145 MPa and assuming the Poisson's ratio is 0.3. Determine the torque, T to which the shaft may be subjected using the following theories:

i) The Tresca Theory, and

ii) The Von Mises Theory

(12 marks)

PART B

Q5 An overhanging beam is roller-supported at point *B* and pin-supported at point *D* is loaded as shown in **Figure Q5**. Using an Integration Method and assume that *EI* is constant, determine:

(a) the reactions at points B and D,

(7 marks)

(b) the equation of the elastic curve, and

(10 marks)

(c) the deflection at point C.

(3 marks)

Q6 (a) Derive the expression of Castigliano's 2nd theorem for linear displacement and slope

(6 marks)

(b) The bolt in **Figure Q6** has a diameter of 10 mm and the link AB has a rectangular cross section that is 12 mm wide by 7 mm thick. The bolt is tightened so that it has a tension of 500N. Both members are made of steel with elastic modulus of 200 GPa. By neglecting the hole in the link and with the help of free body diagram, determine the strain energy.

i) In the bolt due to axial force.

ii) In the link due to bending

(14 marks)

- END OF QUESTION -

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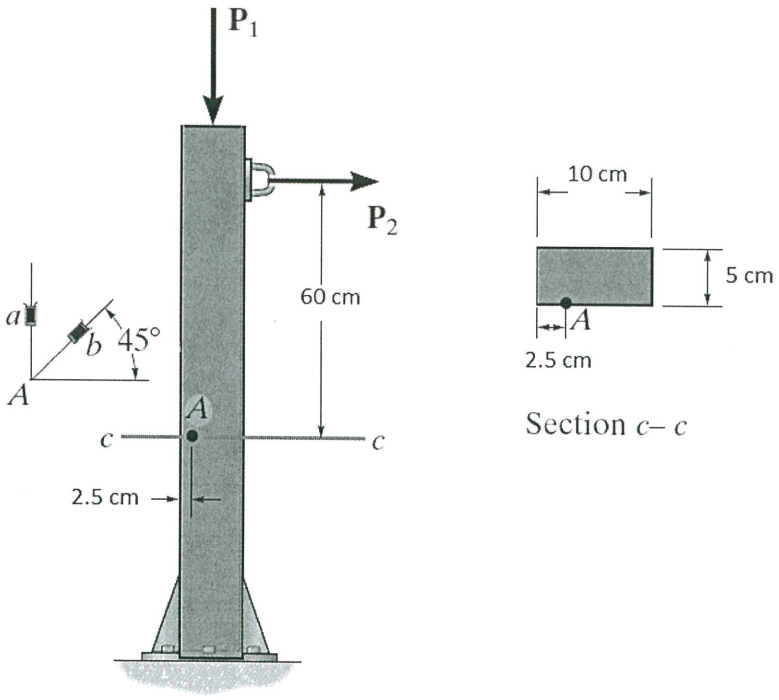

Figure Q1

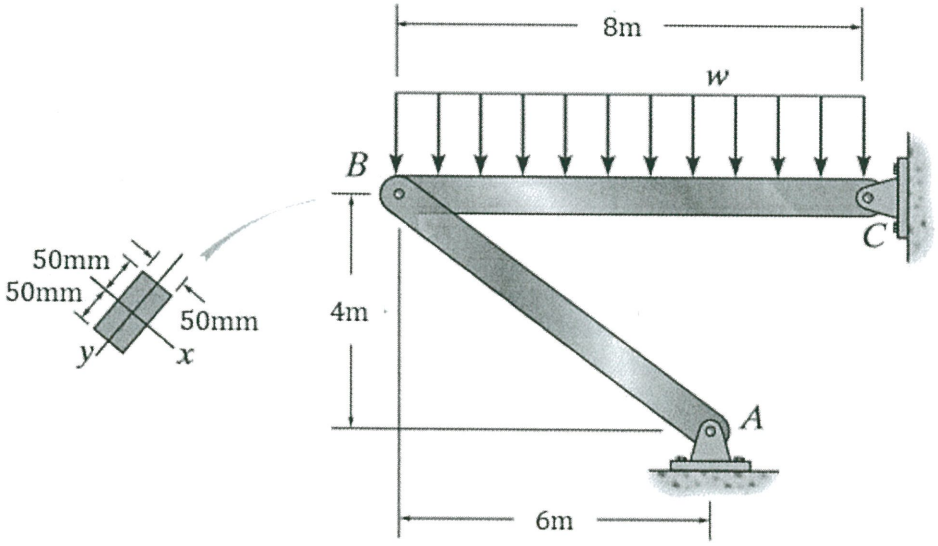

Figure Q2

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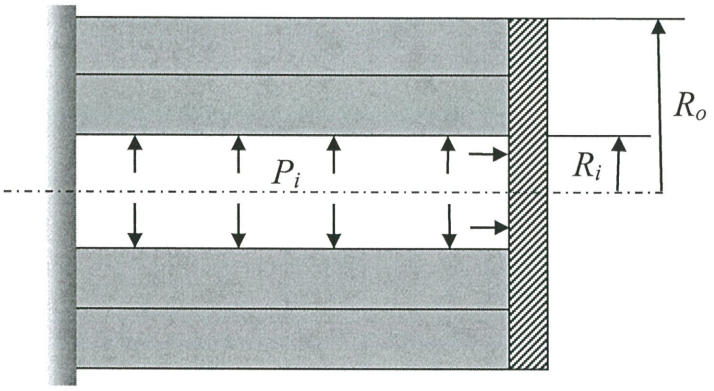

Figure Q3

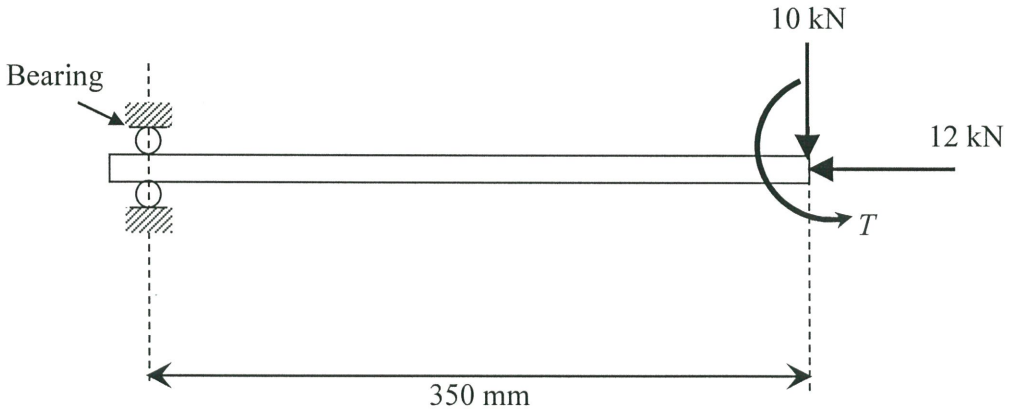

Figure Q4

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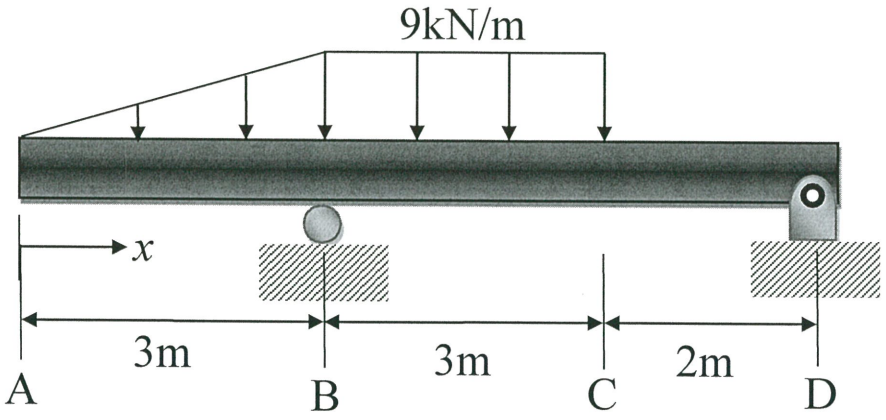

Figure Q5

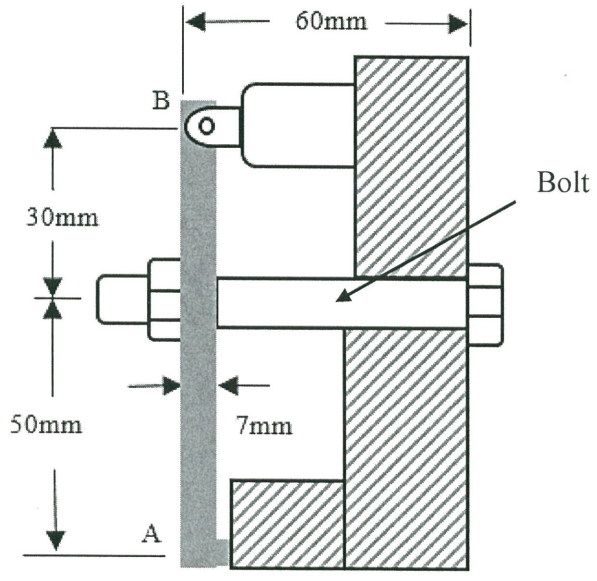

Figure Q6

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Formula:

$$\varepsilon(\theta) = \varepsilon_x \cos^2\theta + \varepsilon_y \sin^2\theta + \gamma_{xy} \sin\theta\cos\theta$$

$$\varepsilon_{x'} = \frac{\varepsilon_x + \varepsilon_y}{2} + \frac{\varepsilon_x - \varepsilon_y}{2}\cos 2\theta + \frac{\gamma_{xy}}{2}\sin 2\theta$$

$$\varepsilon_{y'} = \frac{\varepsilon_x + \varepsilon_y}{2} - \frac{\varepsilon_x - \varepsilon_y}{2}\cos 2\theta - \frac{\gamma_{xy}}{2}\sin 2\theta$$

$$\frac{\gamma_{x'y'}}{2} = -\frac{\varepsilon_x - \varepsilon_y}{2}\sin 2\theta + \frac{\gamma_{xy}}{2}\cos 2\theta$$

$$\tan 2\theta_p = \frac{\gamma_{xy}}{\varepsilon_x - \varepsilon_y}$$

$$\frac{d^2y}{dx^2} = \frac{M(x)}{EI}$$

$$\frac{dV}{dx} = -w$$

$$\frac{dM}{dx} = V$$

$$U_m = \frac{1}{2}mv_0^2$$

$$U = \frac{1}{2}Px$$

$$U = \sum \frac{F_i^2 L_i}{2A_i E_i}$$

$$U = \int \frac{M^2}{EI}dx$$

$$y_j = \frac{\partial U}{\partial P_j} = \int \frac{M}{EI}\frac{\partial M}{\partial P_j}dx$$

$$|\sigma_a| < \sigma_Y ; |\sigma_b| < \sigma_Y$$

$$|\sigma_a - \sigma_b| < \sigma_y$$

$$|\sigma_a| < \sigma_U ; |\sigma_b| < \sigma_U$$

$$|\varepsilon_a| < \varepsilon_U ; |\varepsilon_b| < \varepsilon_U$$

$$\tau_{\max} = \frac{1}{2}\sigma_Y$$

$$\tau_{\max} = \frac{1}{2}(\sigma_a - \sigma_b)$$

$$\sigma_a^2 - \sigma_a\sigma_b + \sigma_b^2 \le \sigma_Y^2$$

$$U = \int \frac{M^2}{EI}dx$$

$$y_j = \frac{\partial U}{\partial P_j} = \int \frac{M}{EI}\frac{\partial M}{\partial P_j}dx$$

$$\varepsilon_1 = \frac{\sigma_1}{E} - \frac{\nu}{E}\sigma_2$$

$$\varepsilon_2 = \frac{\sigma_2}{E} - \frac{\nu}{E}\sigma_1$$

$$\varepsilon_x = \frac{\sigma_x}{E} - \frac{\nu}{E}\sigma_y$$

$$\varepsilon_y = \frac{\sigma_y}{E} - \frac{\nu}{E}\sigma_x$$