UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAM
SEMESTER II
SESSION 2012/2013

COURSE NAME	:	SOLID MECHANICS II
COURSE CODE	:	BDA30303 / BDA3033 / BDA20903
PROGRAMME	:	BACHELOR IN MECHANICAL ENGINEERING WITH HONOURS
EXAMINATION DATE	:	JUNE 2013
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTION	:	PART A: ANSWER **TWO (2)** QUESTIONS ONLY. PART B: ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **NINE (9)** PAGES

PART A: ANSWER **TWO (2)** QUESTIONS ONLY.

Q1 (a) Referring to **FIGURES Q1(a)** and **(b)**, determine the corresponding state of strain at $\theta = 0°$ resulting from the two states of strain shown using Mohr's circle and element diagram.

(8 marks)

(b) The bracket in **FIGURE Q1(c)** is made of steel for which $E_{\text{steel}} = 200$ GPa and $\nu_{\text{steel}} = 0.3$. Due to the loadings, the readings from the gauges at point A which is on the surface of the bracket are given as

$$\varepsilon_a = 600\text{x}10^{-6}, \quad \varepsilon_b = 450\text{x}10^{-6}, \quad \varepsilon_c = -75\text{x}10^{-6}$$

Referring to the given measurements, determine:

(i) The principal strains at point A, and

(ii) The corresponding principal stresses at point A.

(17 marks)

Q2 (a) State **THREE (3)** different types of ends support and their boundary conditions involved.

(6 marks)

(b) Define the *Statically Indeterminate Beams*.

(4 marks)

(c) For the beam and loading shown in **FIGURE Q2**, determine:

(i) The reaction at A, and

(ii) The deflection at C.

(15 marks)

Q3 (a) Define the *effective-length*, L_e.

(2 marks)

(b) The effective-length factor, K is vary depends on the column end support. There are **FOUR** (4) different values of K. For each value of K, draw the diagram of the column with their different end supports.

(8 marks)

(c) The A-36 steel bar AB as shown in **FIGURE Q3** has a square cross section. If it is pin-connected at its ends, determine the maximum allowable load P that can be applied to the frame. Use a factor of safety with respect to buckling of 2. Use E = 210 GPa and σ_y = 250 MPa.

(15 marks)

Q4 (a) A beam with length L and cross-sectional area A is loaded with vertical load, P at the middle of its length. For the following of the beam types, derive the strain energy of the beam:

(i) Cantilever beam, and

(ii) Simply-supported beam.

Let your answer in terms of L, A, P, Young's modulus (E) and moment of inertia (I).

(12 marks)

(b) Determine the reaction forces for a beam under loading as shown in **FIGURE Q4** using strain energy method. The beam cross-sectional area, A is 1 x 10^5 mm^2. Given E = 200 GPa and I = 106 x 10^6 mm^2.

(13 marks)

PART B : ANSWER **ALL** QUESTIONS

Q5 (a) Based on **FIGURE Q5**, derive and prove that the Hoop Stress, σ_H and the Radial Stress, σ_R can be expressed follow

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

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

(17 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.

(8 marks)

Q6 (a) Define the following theories:

(i) The Tresca theory, and

(ii) The von Mises theory.

(8 marks)

(b) A horizontal shaft of 75 mm in diameter and 350 mm in length projects from a bearing as shown in **FIGURE Q6**. 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.

(17 marks)

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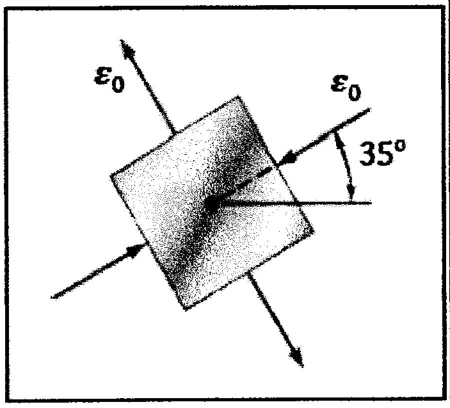
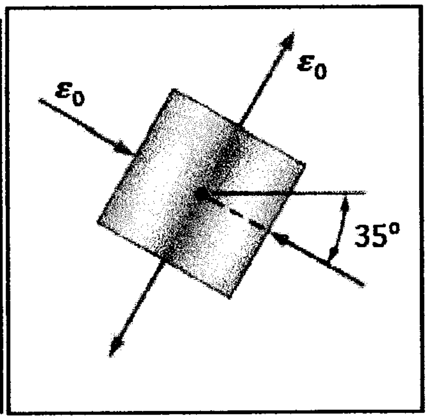


(a)



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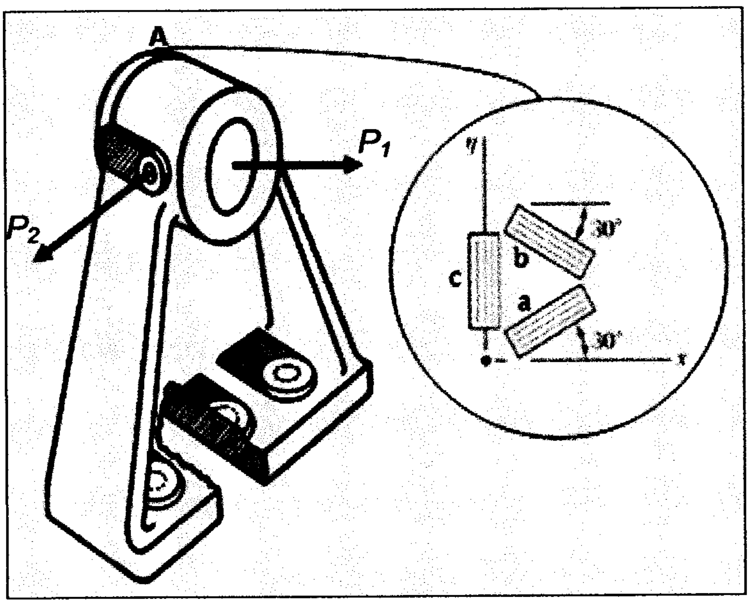

(c)

FIGURE Q1

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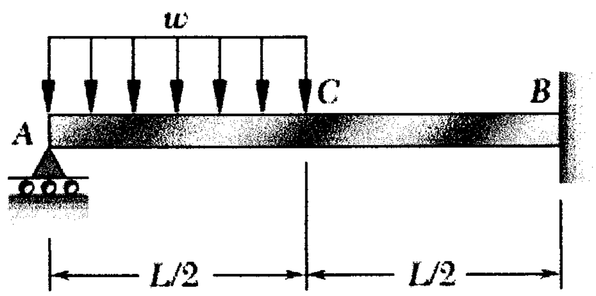

FIGURE Q2

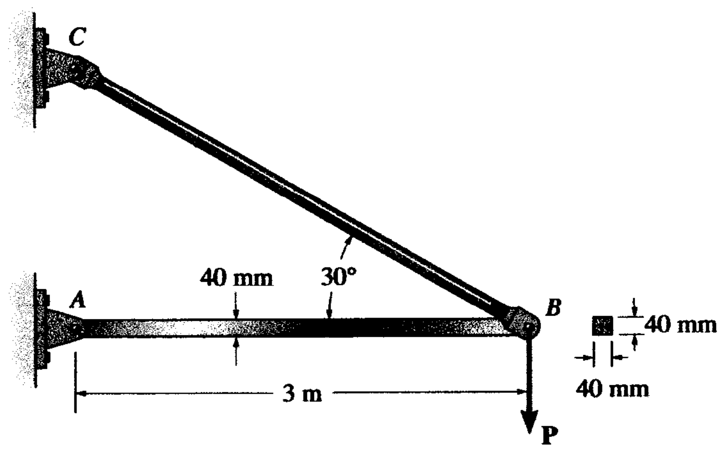

FIGURE Q3

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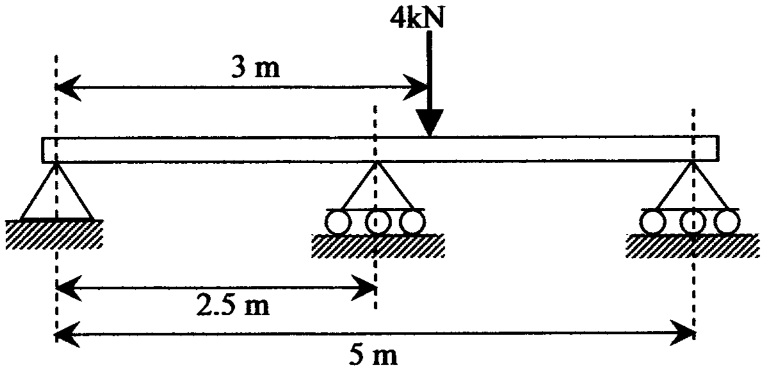

FIGURE Q4

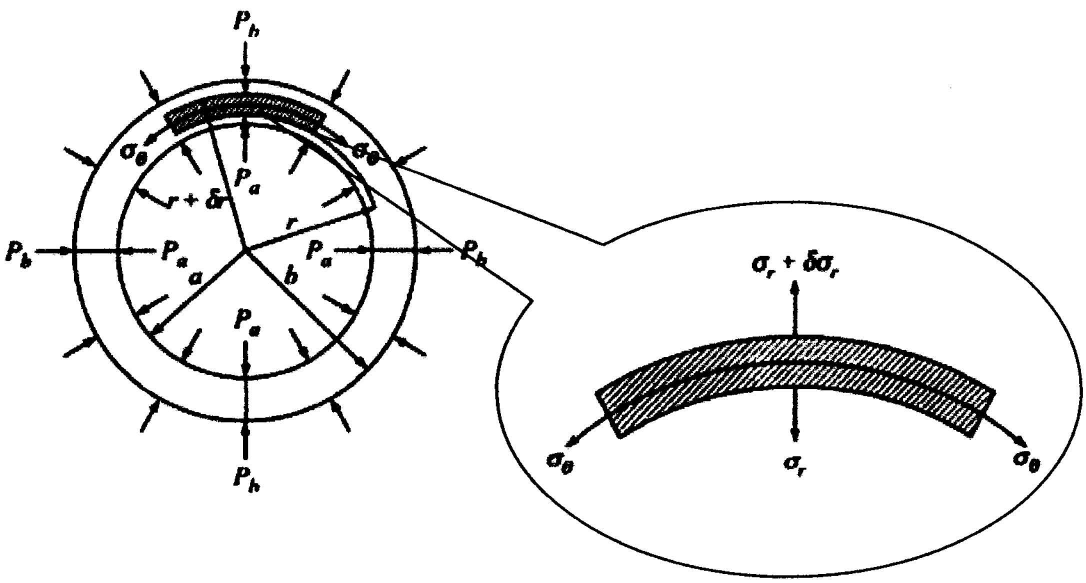

FIGURE Q5

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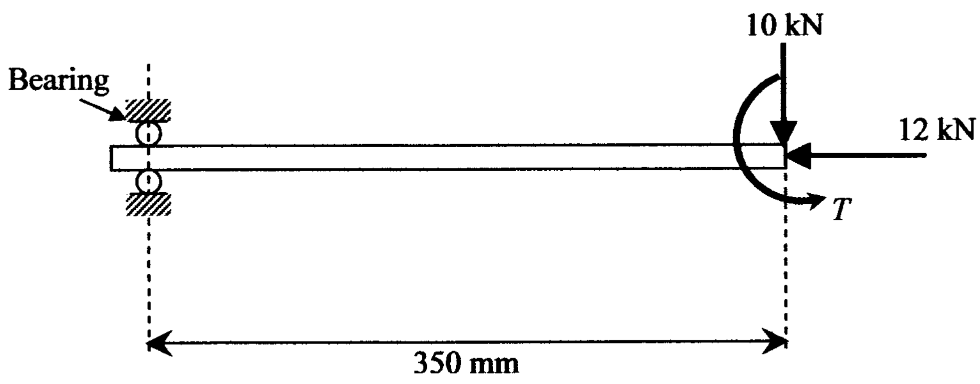

FIGURE Q6

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Formula:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$\tau_{\max}=\frac{Tc}{J}$$

$$J=\frac{\pi}{2}c^4$$

$$I=\frac{\pi}{4}c^4$$

$$\sigma_{\max,\min}=\frac{\sigma_x+\sigma_y}{2}\pm\sqrt{\left(\frac{\sigma_x-\sigma_y}{2}\right)^2+\tau_{xy}^2}$$

$$\sigma_{\max}=\frac{Mc}{I}$$

- END OF QUESTION -