Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2016/2017

COURSE NAME	:	SOLID MECHANICS
COURSE CODE	:	BDU 20802
PROGRAM	:	BACHELOR OF AERONAUTICAL ENGINEERING TECHNOLOGY (AIRCRAFT MAINTENANCE)
EXAMINATION DATE	:	JUNE 2017
DURATION	:	2 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS IN **PART A** AND **TWO (2)** QUESTIONS IN **PART B**

THIS PAPER CONTAINS **SEVEN (7)** PAGES

PART A: ANSWER ALL QUESTIONS

Q1 (a) A strain gauge is installed in the longitudinal direction on the surface of an aluminium beverage can, demonstrated in **FIGURE Q1**. The radius-to-thickness ratio of the can is 200. When the lid of the can is popped open, the strain changes by $\varepsilon_0 = 170 \times 10^{-6}$. Assuming that E = 70 GPa, and $\nu = 0.33$, determine the internal pressure, p in the can before it was opened.

(13 marks)

(b) A thin cylinder 75 mm internal diameter, 250 mm long with wall thick is subjected to an internal pressure of 7 MPa. Determine

(i) The change in internal diameter,

(ii) The change in length

(12 marks)

Q2 (a) For the given state of stress, determine the normal and shearing stresses after the element shown in **FIGURE Q2** has been rotated through

(i) 25° clockwise,

(ii) 10° counterclockwise

(13 marks)

(b) For the same state of stresses in **FIGURE Q2**, solve the problem using Mohr's circle.

(12 marks)

PART B: ANSWER TWO (2) QUESTIONS ONLY

Q3 (a) **FIGURE Q3** shows a solid circular rod AD. Determine

(i) The portion of the shaft in which the maximum shearing stress occurs,

(ii) The magnitude of that stress

(12 marks)

(b) If a 8 mm diameter hole is drilled through each portion of that shaft AD shown in **FIGURE Q3**, evaluate

(i) The portion of the shaft in which the maximum shearing stress occurs,

(ii) The magnitude of that stress

(13 marks)

Q4 **FIGURE Q4** shows at temperature 21°C, a 0.5 mm gap exists between the ends of the aluminium and stainless steel rods. The properties of the rods are given in **TABLE Q4**. At a later time when the temperature has reached 160°C, determine

TABLE Q4

	Aluminium	**Stainless steel**
Area, A (mm^2)	1806	774
Young Modulus (GPa)	72	190
Thermal Coefficient, α (/° C)	23.9×10^{-6}	17.3×10^{-6}

(a) The normal stress in the aluminium rod

(13 marks)

(b) The change in length of the aluminium rod

(12 marks)

Q5 Draw the shear and bending-moment diagrams for the beam and loading shown in **FIGURE Q5**. Determine

(a) The maximum absolute value of the shear

(12 marks)

(b) The maximum absolute value of the bending moment

(13 marks)

Q6 Two brass strips are securely bonded to an aluminium bar of 30 x 30 mm square cross section as shown in **FIGURE Q6**. Using the data given in **TABLE Q6**, determine

TABLE Q6

	Aluminium	**Brass**
Modulus of Elasticity (GPa)	70	105
Allowable stress (MPa)	100	160

(a) The largest permissible bending moment when the composite member is bent about horizontal axis.

(12 marks)

(b) If the materials change side, and using the same data given **TABLE Q6**, evaluate the change in largest permissible bending moment.

(13 marks)

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FIGURE Q1

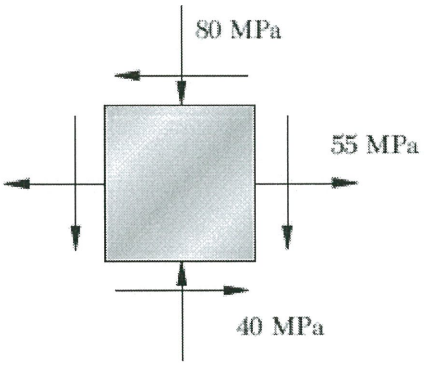

FIGURE Q2

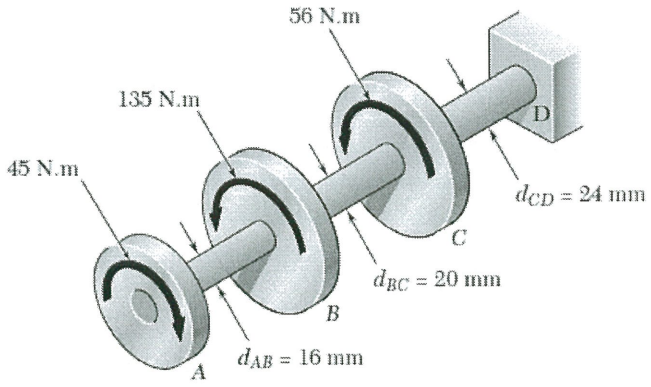

FIGURE Q3

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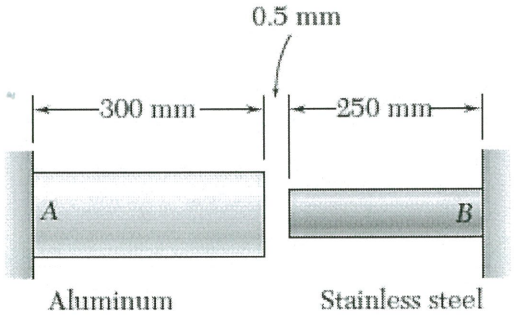

FIGURE Q4

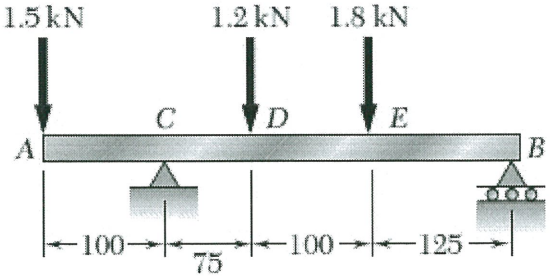

FIGURE Q5

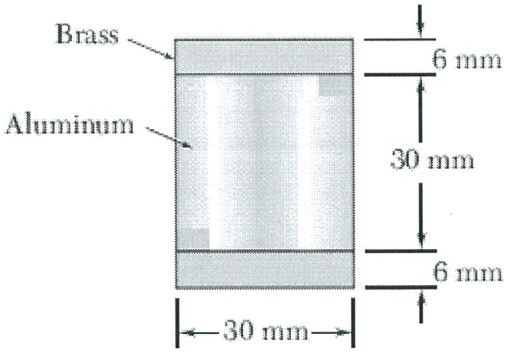

FIGURE Q6

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EQUATIONS

$$\sigma_{ave} = \frac{P}{A} \qquad \delta = \sum_i \frac{P_i L_i}{A_i E_i} \qquad \delta_T = \alpha(\Delta T)L$$

$$\sigma_{ave} = \frac{\sigma_x + \sigma_y}{2} \qquad R = \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

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

$$\tan 2\theta_p = \frac{2\tau_{xy}}{\sigma_x - \sigma_y}$$

$$\sigma_1 = \frac{pr}{t} \qquad \sigma_2 = \frac{pr}{2t} \qquad n = \frac{E_2}{E_1}$$

$$\varepsilon = \frac{1}{E}\pi(\sigma_L - \nu\sigma_H) \qquad \tau_{\max} = \frac{Tc}{J} \text{ and } \tau = \frac{T\rho}{J}$$

$$J = \tfrac{1}{2}\pi c^4 \qquad J = \tfrac{1}{2}\pi\left(c_2^4 - c_1^4\right)$$

$$\gamma_{\max} = \frac{\tau_{\max}}{G} = \frac{Tc}{JG} \qquad \phi = \sum_i \frac{T_i L_i}{J_i G_i}$$

$$T = \frac{P}{\omega} = \frac{P}{2\pi f} \qquad \tau_{\max} = \frac{T}{c_1 ab^2} \qquad \phi = \frac{TL}{c_2 ab^3 G}$$

$$\sigma_x = -\frac{My}{I} \qquad \frac{1}{\rho} = \frac{M}{EI}$$

$$\bar{Y} = \frac{\sum \bar{y}A}{\sum A} \qquad I_{x'} = \sum\left(\bar{I} + Ad^2\right)$$