Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2016 / 2017

COURSE NAME	:	SOLID MECHANICS I
COURCE CODE	:	BDA 10903
PROGRAMME	:	BDD
EXAMINATION DATE	:	DECEMBER 2016/ JANUARY 2017
DURATION	:	3 HOURS
INSTRUCTION :	:	PART A: ANSWER **ALL** QUESTIONS PART B: ANSWER **ONE (1)** QUESTION **ONLY**

THIS QUESTION PAPER CONSISTS OF **SEVEN (7)** PAGES

PART A (COMPULSORY):
Answer **ALL** questions.

Q1. A propeller shaft subjected to combined torsion and axial thrust is designed to resist a shear stress of 63 MPa and a compressive stress of 90 MPa as shown in **Figure Q1**.

(a) Explain what is principal stress

(2 marks)

(b) Describe how principal stress can be calculated

(2 marks)

(c) Determine the principal stresses and show them on a sketch of a properly oriented element

(8 marks)

(d) Determine the maximum shear stresses and associated normal stresses and show them on a sketch of a properly oriented element

(8 marks)

Q2. An internal pressure, P of 20 MPa is applied to a tank with hemispherical cylinder shape as shown in **Figure Q2**. Given that the length of cylinder is 180 mm and the internal diameter, d is 120 mm. Assuming that there shall be no distortion at the junction, and the tensile hoop stress will not exceed 150 MPa. Use E = 180 GPa and $v = 0.3$.

(a) Calculate the minimum allowable thickness of the tank

(6 marks)

(b) Calculate the hoop strain in the cylinder

(4 marks)

(c) Calculate the change in volume in the tank

(10 marks)

Q3. The assembly shown in **Figure Q3** consists of two sections of steel pipe connected together using a reducing coupling at B. The smaller pipe has an outer diameter of 18.75 mm and an inner diameter of 17 mm, whereas the larger pipe has an outer diameter of 25 mm and an inner diameter of 21.5 mm. If the couple shown is applied to the handle of the wrench with given distance of a = 150 mm and b = 200 mm.

(a) Determine the maximum shear stress developed in each section AB and BC of the pipe

(12 marks)

(b) Determine the shear stress developed at the inner and outer walls along the central portion of smaller pipe

(4 marks)

(c) Sketch the location of these shear stresses on the cross section of the smaller pipe. Indicate clearly the directions of the shear stresses

(4 marks)

Q4. The beam ABCD as illustrated in **Figure Q4** has overhangs that extend in both directions for a distance of 4.2 m from the supports at B and C, which are 1.2 m apart.

(a) Draw the free body diagram (FBD) of the beam

(3 marks)

(b) Calculate the vertical support forces

(5 marks)

(c) Draw the Shearing Force Diagram (SFD) and the Bending Moment Diagram (BMD) of the beam

(10 marks)

(d) Determine the maximum absolute value of the bending moment

(2 marks)

PART B (OPTIONAL) :
Answer **ONE (1)** question only.

Q5. A pin connected structure is loaded and supported as shown in **Figure Q5**. Bar *CDE* is to be considered rigid. Bar A is made of hardened carbon steel with a modulus of elasticity of 210 GPa, a cross sectional area of 1200 mm^2 and α=11.9x10^{-6}/°C. Member B is a structural aluminium alloy bar with a modulus elasticity of 70 GPa, a cross sectional area of 300 mm^2 and α=22.5 x10^{-6}/°C. When the system is unloaded at 40°C, bars A and B are unstressed. After the load P is applied, the temperature of both bars decreases to 15°C. Determine the normal stresses in bars A and B. Then calculate the vertical component of the displacement of pin *E*.

(20 marks)

Q6. A T-section beam is designed to support loadings as demonstrated in **Figure Q6**. Sketch the shearing and bending moment diagram for the beam. Then calculate the maximum tensile bending stress and maximum compressive bending stress in the beam.

(20 marks)

- END OF QUESTION –

FINAL EXAMINATION

SEMESTER/SESSION	: SEM I /2016/2017	PROGRAMME	: BDD
COURSE NAME	: SOLID MECHANICS I	COURSE CODE	: BDA10903

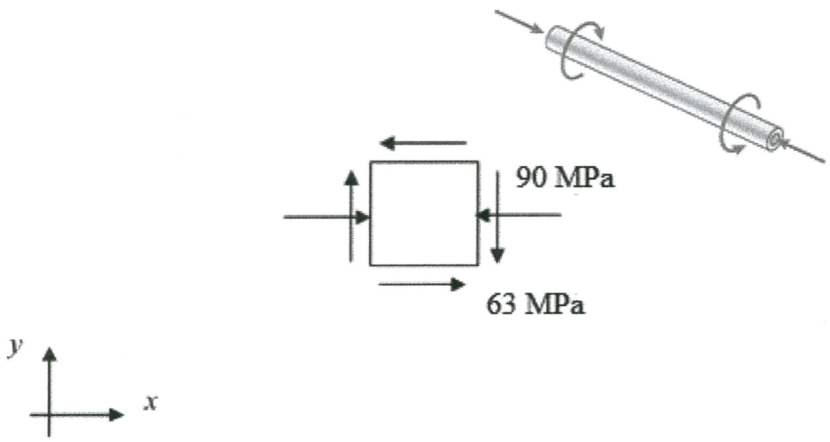

Figure Q1

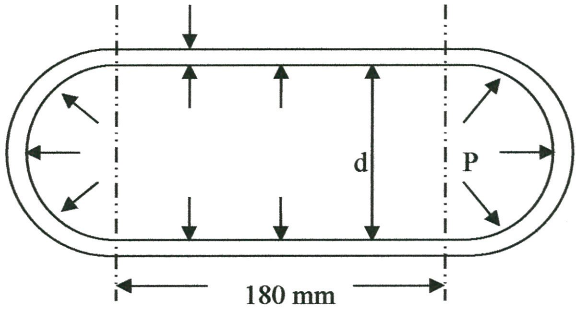

Figure Q2

FINAL EXAMINATION

SEMESTER/SESSION	: SEM I /2016/2017	PROGRAMME	: BDD
COURSE NAME	: SOLID MECHANICS I	COURSE CODE	: BDA10903

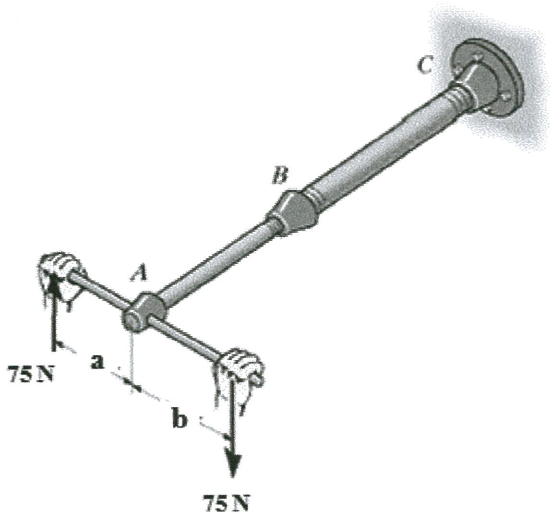

Figure Q3

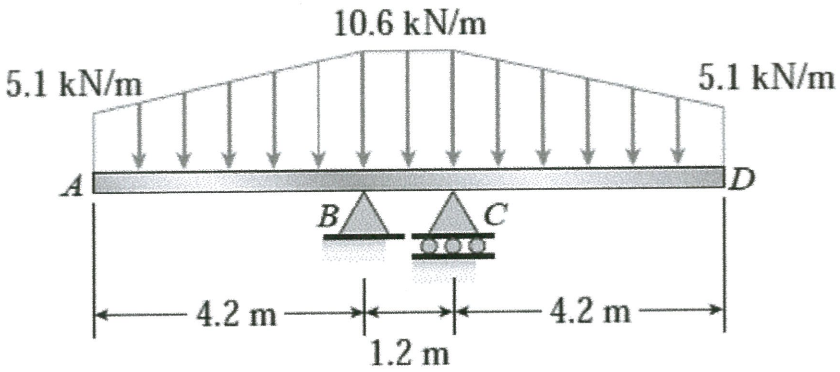

Figure Q4

FINAL EXAMINATION

SEMESTER/SESSION	: SEM I /2016/2017	PROGRAMME	: BDD
COURSE NAME	: SOLID MECHANICS I	COURSE CODE	: BDA10903

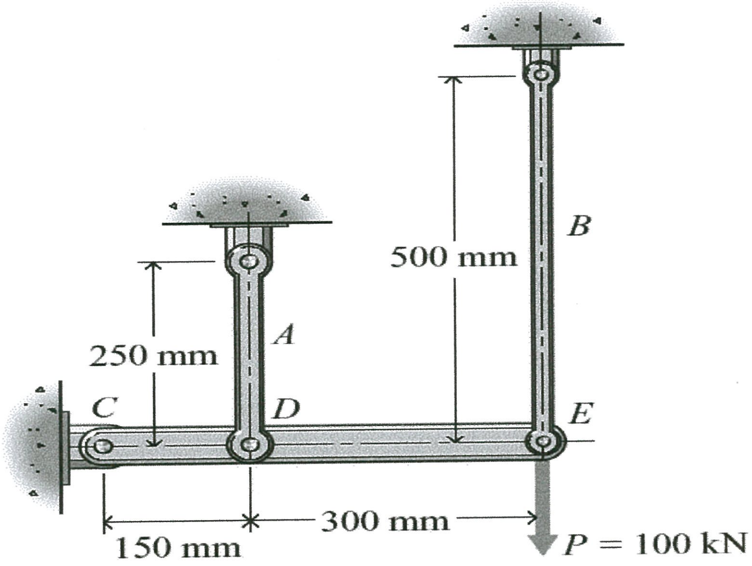

Figure Q5

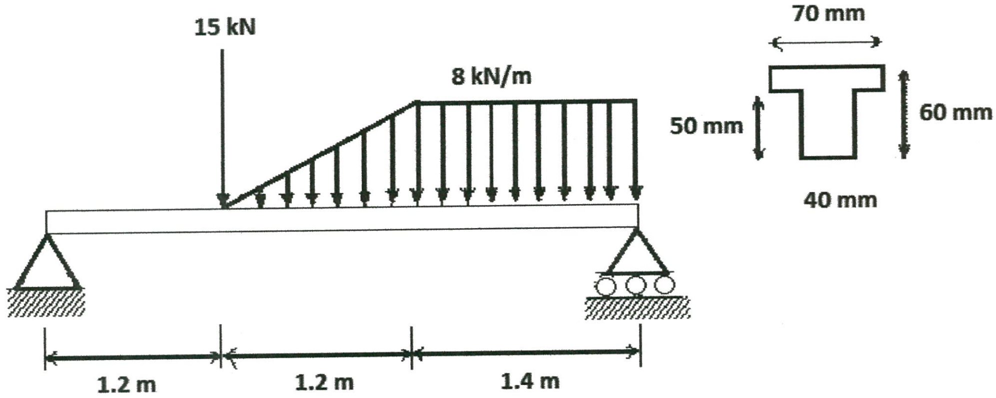

Figure Q6

FINAL EXAMINATION

PROGRAMME	: SEM I /2016/2017	PROGRAMME	: BDD
COURSE CODE	: SOLID MECHANICS I	COURSE CODE	: BDA10903

EQUATIONS

$$\sigma_{ave} = \frac{P}{A} \qquad \delta = \sum_i \frac{P_i L_i}{A_i E_i}$$

$$\delta_T = \alpha(\Delta T)L \qquad n = \frac{E_2}{E_1}$$

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

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

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

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

$$\tau_{\max} = \frac{Tc}{J} \text{ and } \tau = \frac{T\rho}{J}$$

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

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

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

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

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