Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2016/2017

COURSE NAME	:	SOLID MECHANICS
COURSE CODE	:	BNJ 20903
PROGRAMME CODE	:	BNL / BNG / BNK / BNM / BNH
EXAMINATION DATE	:	DECEMBER 2016 / JANUARY 2017
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWERS **FIVE (5)** QUESTIONS ONLY

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

Q1 (a) Describe the following terms:

(i) Normal Stress (σ).

(2 marks)

(ii) Shear Stress (τ).

(2 marks)

(iii) Normal Strain (ε).

(2 marks)

(b) **Figure Q1(b)** shows a rod consisting of two cylindrical portions AB and BC. Portion AB is made of Brass (E_B = 105 GPa, α_B = 20.9 x 10^{-6} /°C) and portion BC is made of Aluminium (E_A = 72 GPa, α_A = 23.9 x 10^{-6} /°C). Knowing that the rod is initially in unstressed condition,

(i) Determine the thermal expansion of the rod when induced by a temperature rise of 42°C.

(2 marks)

(ii) Analyze portions AB and BC to show that the rod is experiencing a compressive normal stress (σ) when induced by a temperature rise of 42°C.

(12 marks)

Q2 (a) List **One (1)** type of:

(i) Statically determinate beams

(2 marks)

(ii) Statically indeterminate beams

(2 marks)

(b) **Figure Q2(b)** shows a beam AB with loaded and supported by fixed support at A and B. Given distributed load AC is 30 kN/m and point load at D is 60 kN

(i) Calculate the support reaction at A and B

(4 marks)

(ii) Sketch the shear and bending moment diagram

(10 marks)

(iii) Determine maximum absolute value shear force and bending moment for beam AB

(2 marks)

Q3 (a) Describe about the following terms:

(i) Plain Stress

(2 marks)

(ii) Plain Strain

(2 marks)

(b) Determine the equivalent state of stress on an element at the same point in **Figure Q3(b)** which represents

(i) the Principal Stresses

(3 marks)

(ii) the Orientation of Principle Plane

(3 marks)

(iii) the Maximum In-Plane Shear Stress

(3 marks)

(iv) Orientation of the Plane of Maximum In-Plane Shear Stress

(4 marks)

(v) Average Normal Stress

(3 marks)

Q4 (a) Define the term

(i) Columns

(2 marks)

(ii) Critical Load

(2 marks)

(b) Given **Two (2)** types of struct which is round struct AB and square struct CD show in **Figure Q4(b)**. Given E = 200 GPa

(i) Calculate the radius of the round strut so that the round and square struts have the same cross-sectional area

(12 marks)

(ii) Compute the critical load for each round struct and square struct

(4 marks)

Q5 (a) A solid steel shaft (G = 77.2 GPa) must transmit 150 kW at a speed of 360 rpm. Given a specification that the maximum shearing stress will not exceed 50 MPa and the angle of twist in a 2.5 m length must not exceed 3°, determine appropriate diameter for the shaft design. Justify your answer.

(10 marks)

(b) A 2.5 m long solid steel shaft (G = 77.2 GPa) of 30 mm diameter rotates at a frequency of 30 Hz. Knowing that the allowable shearing stress is 50 MPa and that the angle of twist must not exceed 7.5°, determine the maximum power that the designed shaft can transmit. Justify your answer.

(10 marks)

Q6 (a) A pressure vessel is having a wall thickness (t), inner radius (r), and subjected to a gauge pressure (p) that developed within the vessel by a contained gas. By referring to **Figure Q6(a)**, derive the Hoop Stress (σ_1) and Longitudinal Stress (σ_2) applied for Cylindrical and Spherical pressure vessels.

(15 marks)

(b) A cylindrical pressure vessel has an inner radius of 600 mm and a wall thickness of 12 mm. Determine the maximum internal pressure it can sustain so that it's Hoop Stress (σ_1) will not exceed 140 MPa.

(5 marks)

-END OF QUESTIONS –

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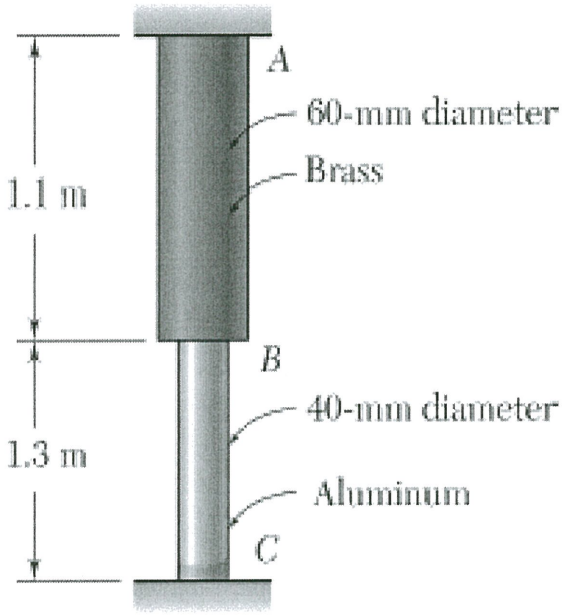

Figure Q1(b)

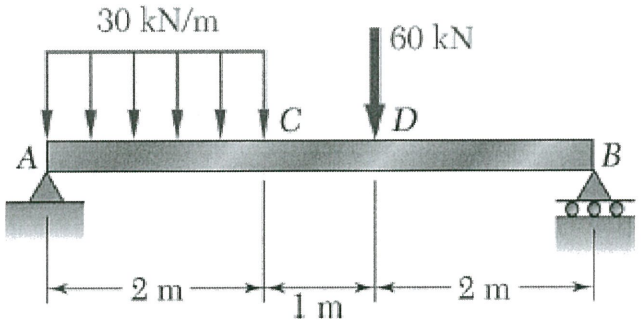

Figure Q2(b)

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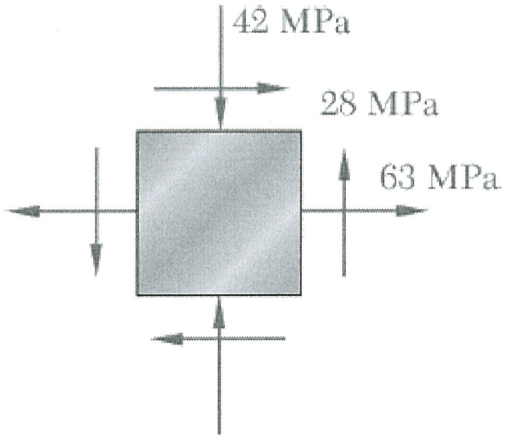

Figure Q3(b)

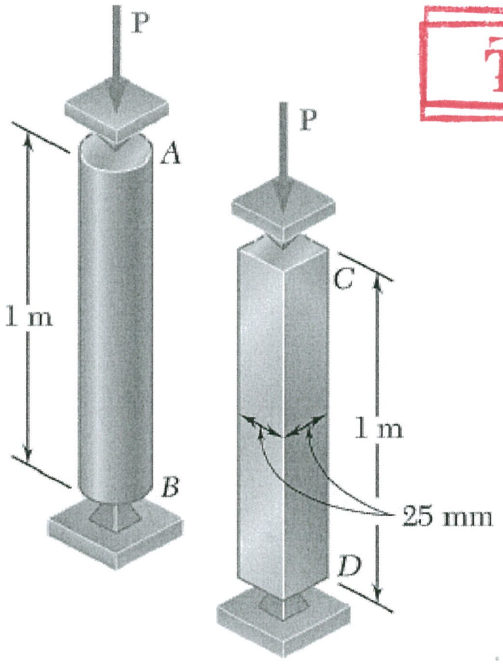

Figure Q4(b)

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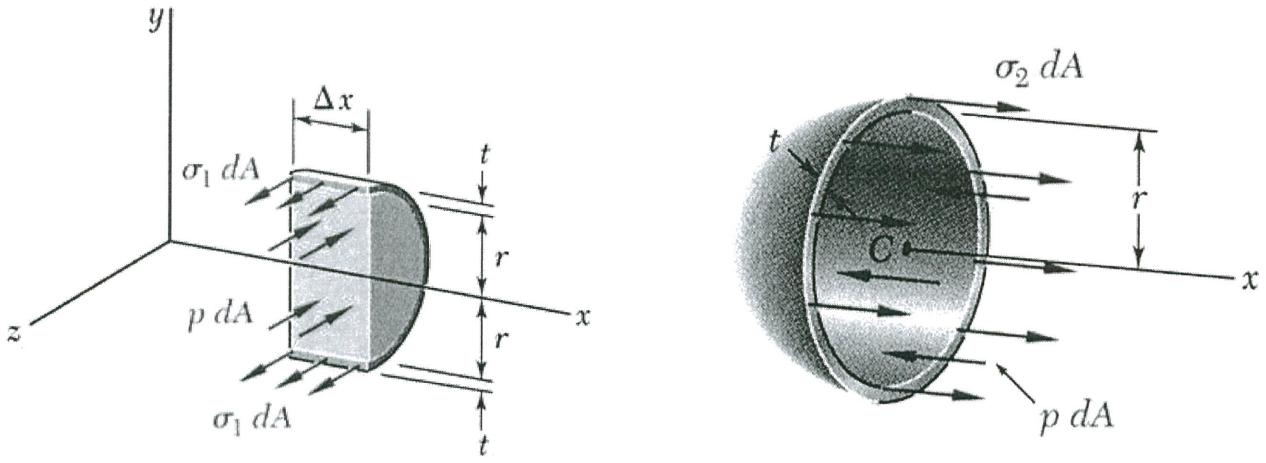

Figure Q6(a)