UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
(ONLINE)
SEMESTER II
SESSION 2019/2020

COURSE NAME	:	SOLID MECHANICS 1
COURSE CODE	:	BDA 10903
PROGRAMME CODE	:	BDD
EXAMINATION DATE	:	JULY 2020
DURATION	:	3 HOURS
INSTRUCTION	:	PART A: ANSWER **THREE (3)** QUESTIONS **ONLY**
		PART B: ANSWER **ALL** QUESTIONS

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

PART A (OPTIONAL):

Answer **Three (3)** questions **ONLY.**

Q1 Two rods conneted system as shown in **Figure Q1** is made of a steel (E_{steel} = 200 Gpa and A_{steel} = 83 mm^2) and bronze (E_{bronze} = 600 Gpa and A_{bronze} = 300 mm^2). A rigid bar that is supported by a pin at A and neglecting the weight of the bar. If the load P = 50 kN is applied at the end of the bar, determine

(a) Draw the free body diagram (FBD) for equilibrium forces.

(3 marks)

(b) Draw the displacement diagram for compatibility conditon.

(3 marks)

(c) Stress in steel rod.

(7 marks)

(d) Stress in bronze rod.

(7 marks)

Q2 The beam shown in **Figure Q2** is used to support a uniform load along *CD* due to the 6-kN weight of the crate. A pin connected joint the concrete and the overhanging beam at point A. Solving each of the listed problem below:

(a) Construct free body diagram and determine the support reactions at point A and B.

(3 marks)

(b) If the reaction at bearing support B can be assumed uniformly distributed along its width, draw the shear and moment diagrams for the beam.

(14 marks)

(c) Based on diagrams obtained in (b), determine the maximum allowable internal moment, *M* that can be applied to the beam.

(3 marks)

Q3 A cast iron link shown in **Figure Q3 (a)** has the cross section view of **Figure Q3 (b)**. The allowable stresses are 30 MPa in tension and 120 MPa in compression.

(a) Calculate the central point of the section,

(4 marks)

(b) Determine the moment of inertia of the cross-section,

(4 marks)

(c) Determine the forces, P for individual point of A, B, C and D, and

(8 marks)

(d) Identify the maximum force of P and why you chose this value.

(4 marks)

Q4 (a) List five of the assumptions for derives a simple torsion theory.

(5 marks)

(b) Three shafts AB, CD and EF and four gears as shown in **Figure Q4 (b)** are used to form a gear train that will transmit power from the motor A to a machine tool at F. (Bearings for the shafts are omitted in the Figure). You as an assistant Engineer was asked by your supplier to solve the problem as listed below.

(i) Calculate the maximum power that can be transmitted if the frequency of the motor is 24 Hz and the allowable shearing stress for each shaft is 75 MPa. (Given: d_{AB}= 16 mm, d_{CD}= 20 mm and d_{EF}= 28 mm.)

(8 marks)

(ii) Determine the required diameter of each shaft if the frequency of the motor is 30 Hz and the allowable shearing stress for each shaft is 60 MPa. (Given: 7.5 kW power transmit from motor at A.)

(7 marks)

PART B (COMPULSORY):

Answer **ALL** questions.

Q5 (a) A thin-walled titanium alloy spherical shell has a 1 m inside diameter and is 7 mm thick. It is completely filled with an unpressurized, incompressible liquid. Through a small hole an additional 1000 cm^3 of the same liquid is pumped into the shell, thus increasing the shell radius. For this titanium allow E = 114 GPa and the tensile yield point of the material to be 830 MPa. Determine:

(i) The pressure after the additional liquid has been introduced and the hole closed.

(7 marks)

(ii) The normal stress in the titanium shell due to this pressure

(3 marks)

(b) The pressure tank shown in **Figure Q5 (b)** has a 10 mm wall thickness and butt welded seams forming an angle b = 20° with a transverse plane. For a gage pressure of 580 KPa. Determine;

(i) the normal stress perpendicular to the weld.

(7 marks)

(ii) the shearing stress parallel to the weld.

(3 marks)

Q6 (a) **Figure Q6 (a)** shows the normal and shear stress components in terms of σ_x, σ_y, τ_{xy}. Derive the plane stress transformation of $\sigma_{x'}$, $\sigma_{y'}$ and $\tau_{x'y'}$ about the *a-a* axis.

$$\sigma_{x'} = \frac{\sigma_x + \sigma_y}{2} + \frac{\sigma_x - \sigma_y}{2}\cos 2\theta + \tau_{xy}\sin 2\theta$$

$$\tau_{x'y'} = -\frac{\sigma_x - \sigma_y}{2}\sin 2\theta + \tau_{xy}\cos 2\theta$$

$$\sigma_{y'} = \frac{\sigma_x + \sigma_y}{2} - \frac{\sigma_x - \sigma_y}{2}\cos 2\theta - \tau_{xy}\sin 2\theta$$

(14 marks)

(b) For the state of plane stress as shown in **Figure Q6(b)**, determine

(i) The orientation of principal planes.

(3 marks)

(ii) The orientation of principal stresses.

(3 marks)

- END OF QUESTIONS -

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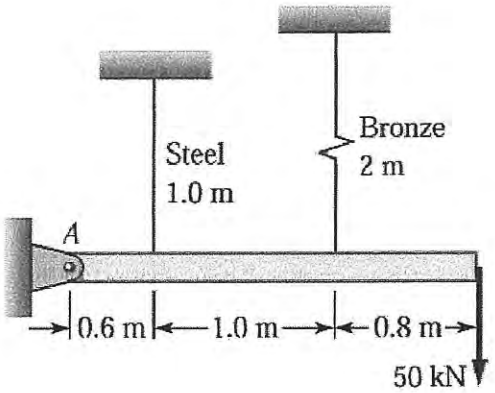

Figure Q1

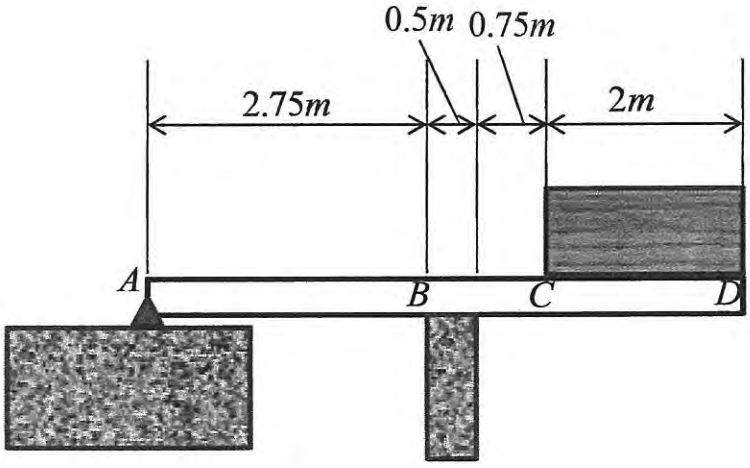

Figure Q2

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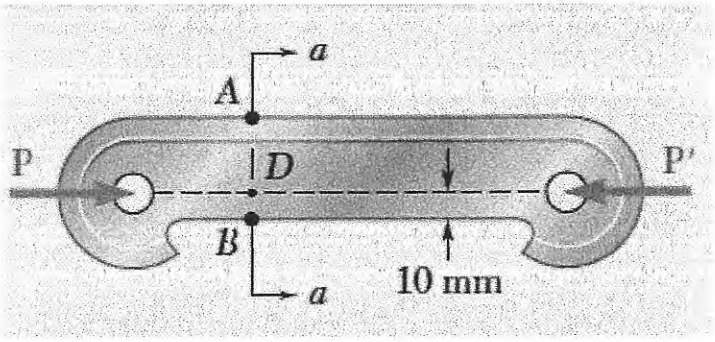

Figure Q3(a)

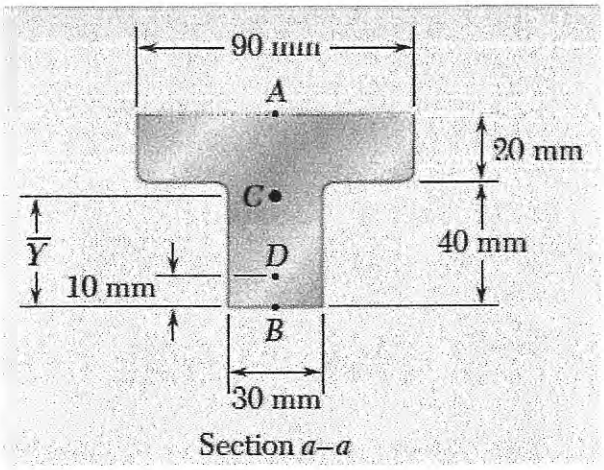

Figure Q3(b)

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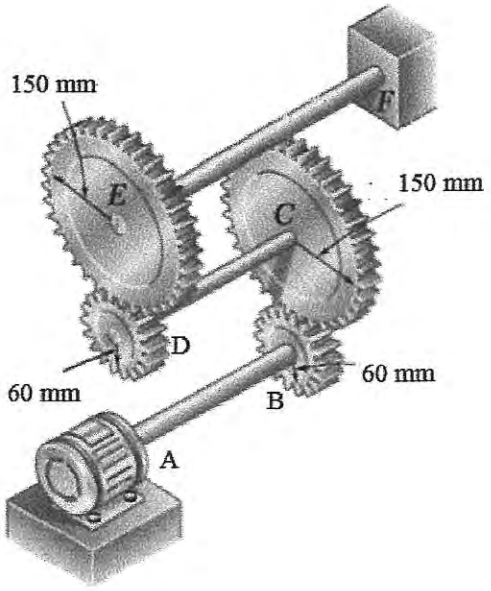

Figure Q4

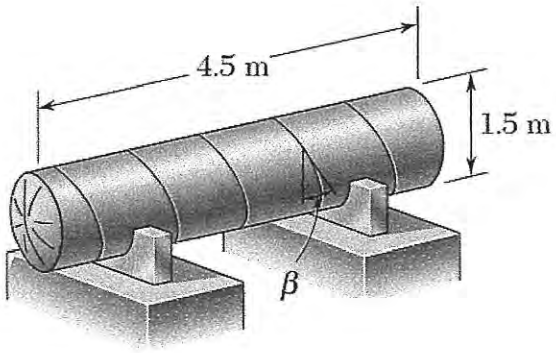

Figure Q5(b)

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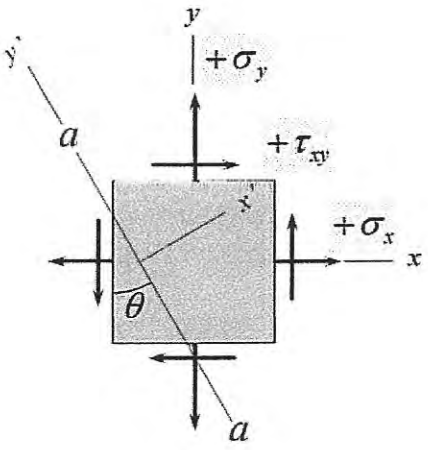

Figure Q6 (a)

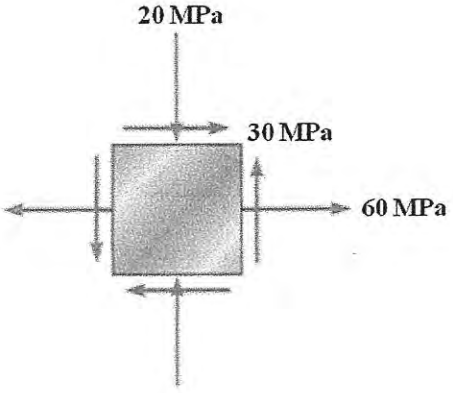

Figure Q6 (b)