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Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION

(ONLINE)

SEMESTER I

SESSION 2020 / 2021

COURSE NAME	:	SOLID MECHANICS
COURCE CODE	:	BDX 20303
PROGRAMME	:	BDX
EXAMINATION DATE	:	JANUARY / FEBRUARY 2021
DURATION	:	3 HOURS
INSTRUCTION :	:	PART A: ANSWER **THREE (3)** QUESTIONS **ONLY** PART B: ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF EIGHT (8) PAGES

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PART A (OPTIONAL):
Answer **THREE (3)** questions **ONLY.**

Q1. The hanger assembly as shown in **Figure Q1(a)** is used to support a distributed loading of w. If the allowable tensile stress of σ_{allow} = 150 MPa is not exceeded in the 15 mm diameter rod AB, and an allowable shear stress of τ_{allow} = 100 MPa is not exceeded in the 12 mm diameter bolts at A and B.

(a) Calculate the intensity of maximum distributed load w that can be supported by the hanger assembly

(5 marks)

(b) Illustrate bending moment diagram and specify where the maximum bending moment occurs in beam

(9 marks)

(c) if the inverted-T beam has dimension as shown in **Figure Q1(b),** evaluate the maximum tensile stress in beam due to bending

(6 marks)

Q2. (a) The simple beam AB shown in the **Figure Q2 (a)** is subjected to a concentrated load P and a couple $M_1 = {}^{PL}/_{4}$ acting at the position indicated. Illustrate the shear force and bending moment diagram for this beam

(12 marks)

(b) Two load P and $2P$ are separated by fix distance, d as shown in **Figure Q2 (b).** The load may be placed at any distance x from the left hand support of the beam. Deduce the distance x for maximum bending moment in the beam if P = 6 kN, d = 1.6 m and L = 8 m.

(8 marks)

Q3. The beam shown in **Figure Q3** is made of wood. If it is subjected to an internal moment of M = 3 kN/m,

(a) Calculate the location of C (centroid) of the cross section where the neutral axis passes through

(3 marks)

(b) Calculate the moment of inertia of the cross section

(5 marks)

(c) Calculate the maximum tensile and compressive stress in the beam

(10 marks)

(d) Generate the bending stress distribution on the cross section.

(2 marks)

Q4. The design of the gear and shaft system as shown in **Figure Q4** requires that steel shafts of the same diameter be used for both AB and CD. It is further required that τ_{max} $\leq$ 60 MPa and that the angle θ_D through which end D of shaft CD rotates not exceed 1.5°. Knowing that G = 77 GPa, calculate the required diameter of the shafts.

(20 Marks)

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

Q5. The steel pressure tank shown in **Figure Q5** has a 750 mm inner diameter and a 9 mm wall thickness. Knowing that the butt welded seams form an angle $\beta = 50°$ with the longitudinal axis of the tank and that the gage pressure in the tank is 1.4 MPa,

(a) evaluate the normal stress perpendicular to the weld

(10 marks)

(b) evaluate the shearing stress parallel to the weld

(10 marks)

Q6. Two forces $\boldsymbol{P_1}$ and $\boldsymbol{P_2}$, with a magnitude of $\boldsymbol{P_1}$ = 15 kN and $\boldsymbol{P_2}$ = 18 kN, are applied as shown in **Figure Q6 (a)** to the end *A* of bar *AB*, which is welded to a cylindrical member *BD* of radius c = 20 mm. Knowing that the distance from *A* to the axis of member *BD* is a = 50 mm and assuming that all stresses remain below the proportional limit of the material. Also, given the normal and shearing stresses at point *K* of the transverse section of member *BD* located at a distance b = 60 mm from end *B*, as shown in **Figure Q6 (b)**.

(a) Calculate the principle planes and principle stresses at point *K* by using Mohr's Circle

(10 Marks)

(b) Calculate the maximum shearing stress at point *K* from diagram in 6(a), and

(4 marks)

(c) Sketch the orientation of the principle planes

(6 marks)

- END OF QUESTION -

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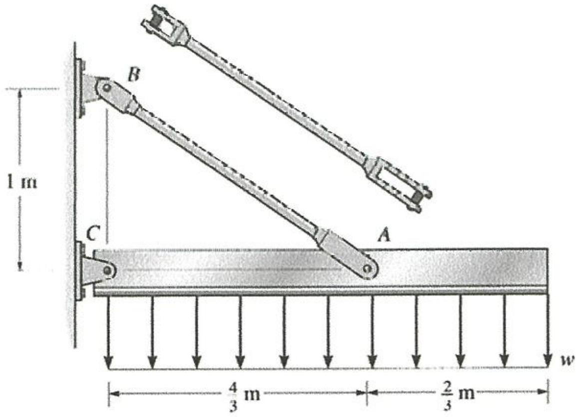

Figure Q1(a)

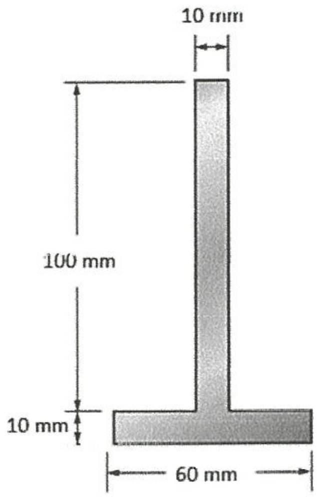

Figure Q1(b)

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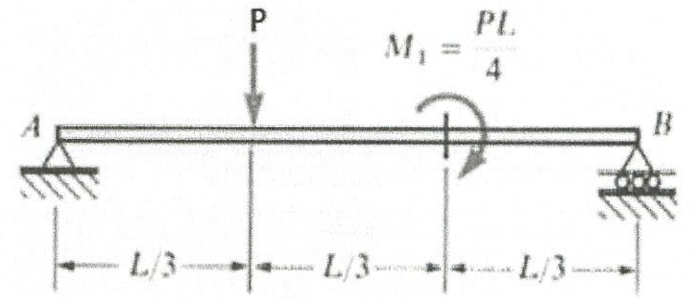

Figure Q2(a)

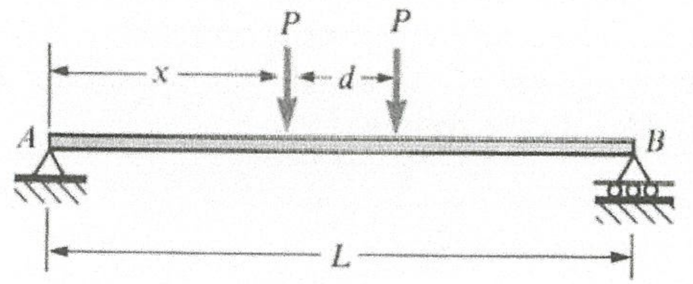

Figure Q2(b)

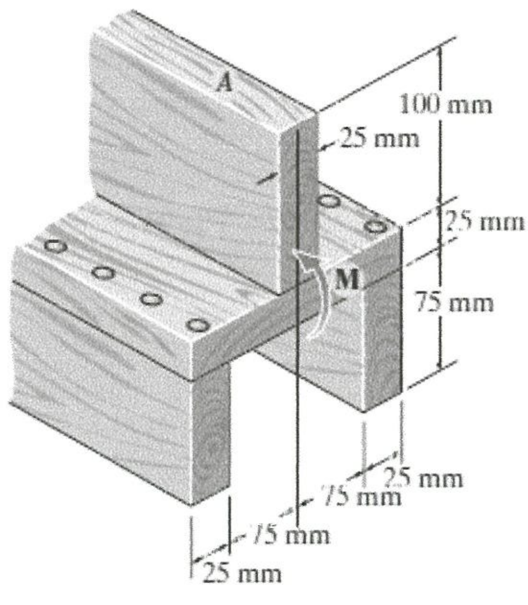

Figure Q3

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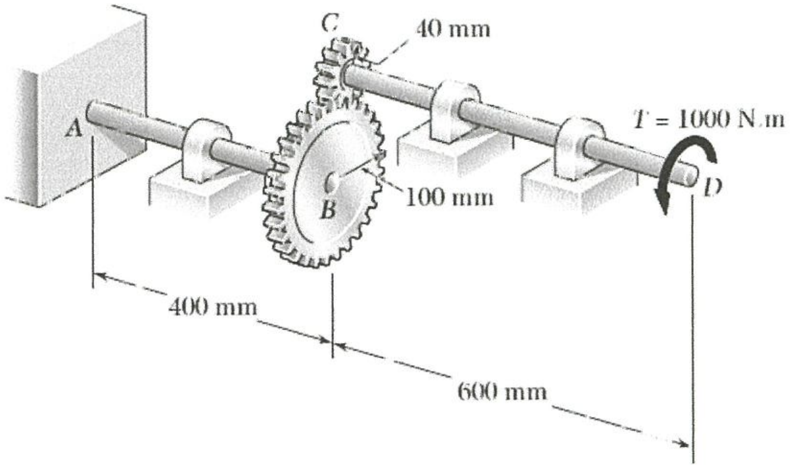

Figure Q4

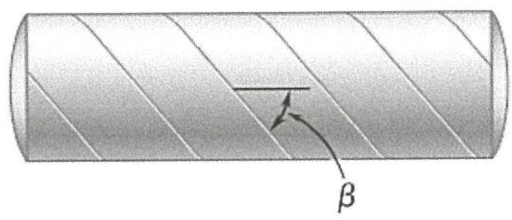

Figure Q5

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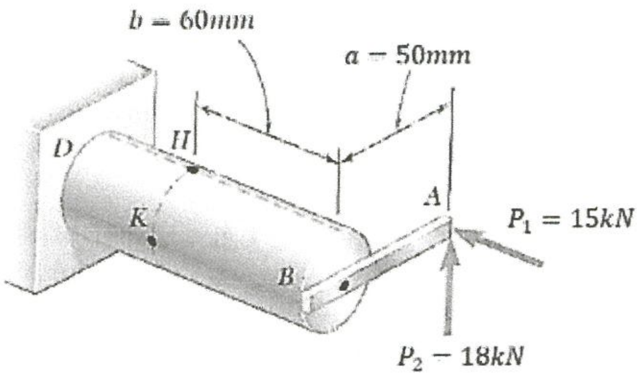

Figure Q6(a)

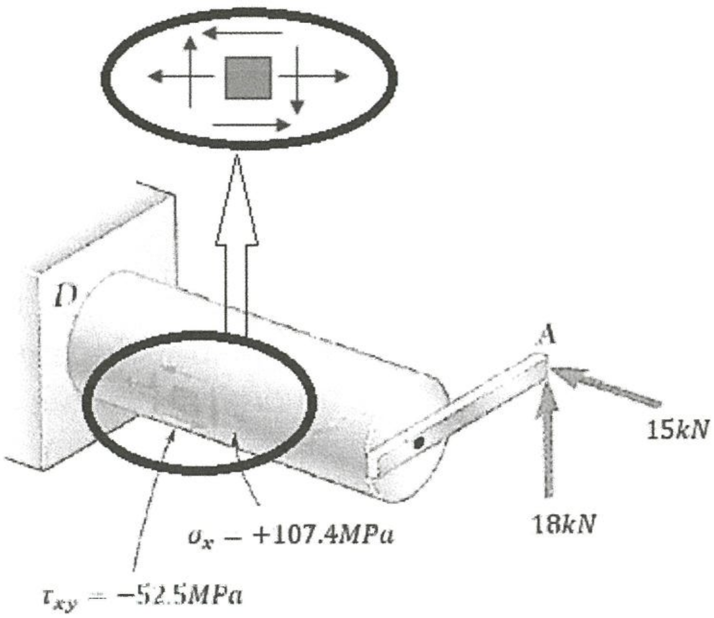

Figure Q6(b)

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EQUATIONS

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

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

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

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

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

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

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

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

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

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

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

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

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