UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2022/2023

COURSE NAME	:	MECHANICS OF MATERIALS
COURSE CODE	:	DAC 12503
PROGRAMME CODE	:	DAA
EXAMINATION DATE	:	FEBRUARY 2023
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTION	:	1. ANSWER **ALL** QUESTIONS 2. THIS FINAL EXAMINATION IS CONDUCTED VIA **CLOSED BOOK.** 3. STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK

THIS QUESTION PAPER CONSISTS OF **EIGHT (8)** PAGES

Q1 (a) Define the modulus of elasticity ***E***.

[3 marks]

(b) **Figure Q1(b)** a solid circular rod that is 600 mm long and 20 mm in diameter is subjected to an axial force of P equal to 50 kN. The elongation of the rod is 1.40 mm and its diameter becomes d'=19.9837 mm. Calculate the followings;

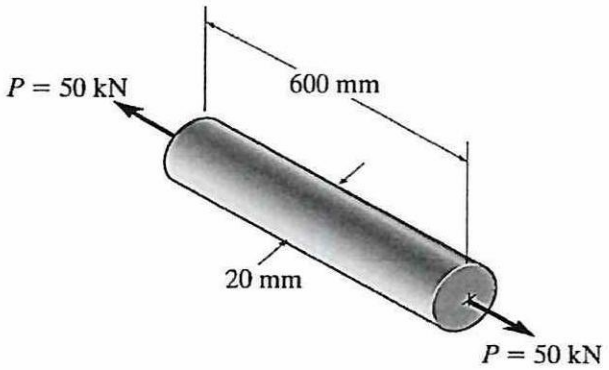

Figure Q1(b)

(i) The normal shear stress.

[4 marks]

(ii) Modulus of elasticity, ***E***.

[4 marks]

(iii) Modulus of rigidity, ***G***.

[4 marks]

(c) The acrylic rod is 200 mm long and 15 mm in diameter as shown in **Figure Q1(c)**. If an axial load of 300 N is applied to it, calculate the followings;

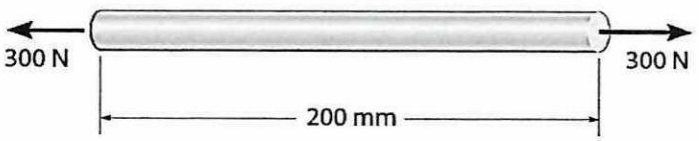

Figure Q1 (c)

(i) The changes in the rod length.

[4 marks]

(ii) The changes in the rod diameter.

[6 marks]

Q2 (a) **Figure Q2(a)** as shown below have two types of support for the steel beam.

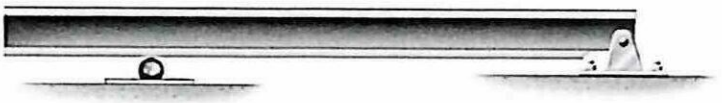

Figure Q2(a)

(i) Name the types of the beam.

[1 mark]

(ii) Name the types of each support.

[2 marks]

(b) A simply supported beam as shown in **Figure Q2(b)** carried distributed load with supports at point A and B.

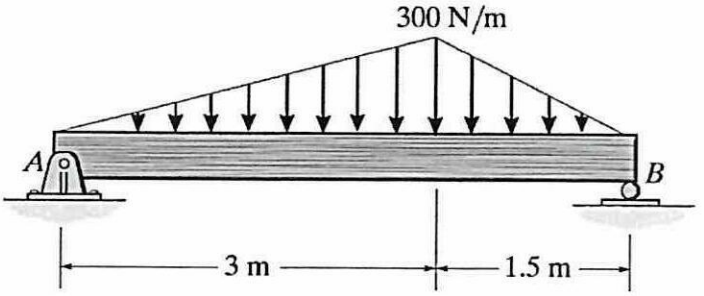

Figure Q2(b)

(i) Calculate the reaction force at each support.

[3 marks]

(ii) Express the shear and moment equations in terms of x for $0 < x < 3$ m and 3 m $< x < 4.5$ m.

[8 marks]

(iii) Calculate the shear force at 2 m from support A.

[2 marks]

(iv) Calculate the bending moment at 2 m from support A.

[2 marks]

(c) Wooden beam with corresponding loads as shown in **Figure Q2(c)**.

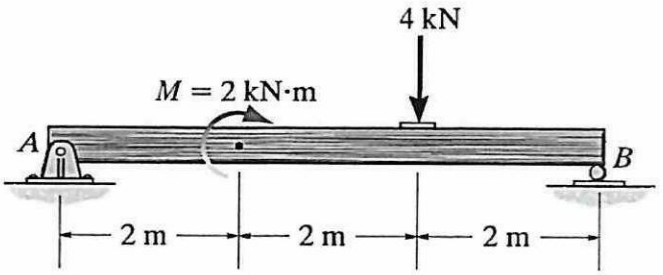

Figure Q2(c)

(i) Calculate the reaction force at each support.

[3 marks]

(ii) Draw the shear force diagram.

[2 marsk]

(iii) Draw the bending moment diagram.

[2 marks]

Q3 (a) Sketch the possible deflection for both beam A and beam B as shown in **Figure Q3(a).**

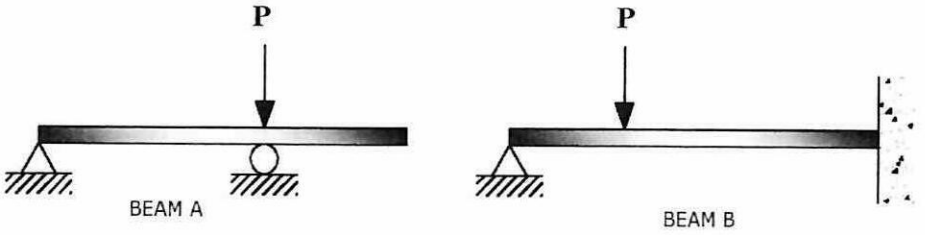

Figure Q3(a)

[2 marks]

(b) A simply supported beam as shown in **Figure Q3(b)** is subjected to axial load of 18kN at point B. Determine the slope and deflection at the middle of the beam span by using Macaulay's Method. *(Start analyze from A support)*

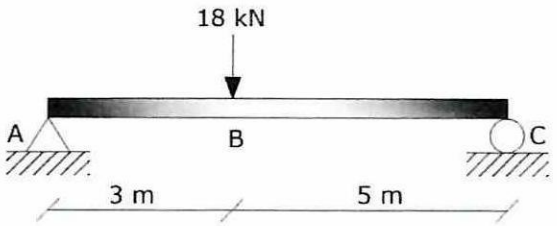

Figure Q3(b)

(i) Calculate the support reaction at A and C.

[3 marks]

(ii) Calculate the maximum deflection of the beam.

[4 marks]

(iii) Calculate the boundary condition for the Macaulay method.

[4 marks]

(iv) Calculate the equation for slope and deflection.

[8 marks]

(v) Calculate the slope and deflection at the middle of the beam span.

[4 marks]

Q4 (a) The general state of plane stress at a point, is shown in **Figure Q4(a)**. Label the arrow signage and name the component of each signage.

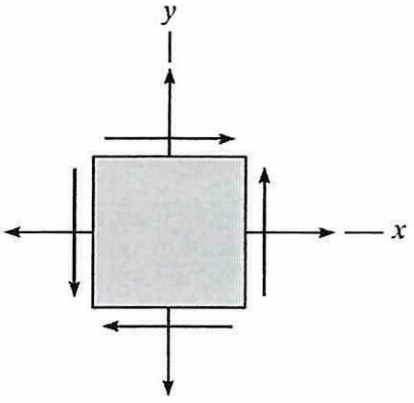

Figure Q4 (a)

[5 marks]

(b) The state of plane stress at a point is shown on the element in **Figure Q4(b)**. Represent this state of stress on an element oriented 20° counterclockwise from the position shown using Mohr's Circle.

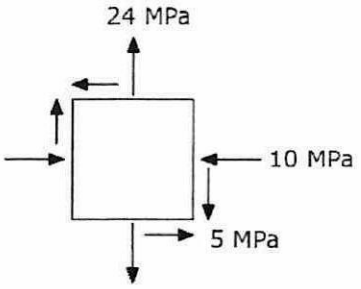

Figure Q4(b)

(i) Sketch state of stress of the element as a Mohr circle.

[4 marks]

(ii) Calculate the value the of average normal stress and radius of the circle.

[6 marks]

(iii) Plot and label the value of principles stresses ,the corresponding angle of rotation and the corresponding value of shear stress.

[4 marks]

(iv) Identify the value of maximum in plane shear stress, the corresponding angle

of rotation and the corresponding value of normal stress.

[4 marks]

(v) Calculate the stress on an element oriented 20° counterclockwise.

[6 marks]

-END OF QUESTIONS-

FINAL EXAMINATION

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$$\sigma = \frac{P}{A} \qquad \tau = \frac{P}{A} \qquad \delta = \frac{PL}{AE}$$

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

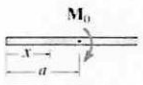
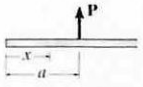
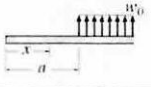
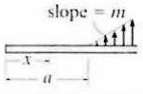
$$\sigma_{x'} = \left(\frac{\sigma_x + \sigma_y}{2}\right) + \left(\frac{\sigma_x - \sigma_y}{2}\right)\cos 2\theta + \tau_{xy}\sin 2\theta$$

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

$$\sigma_{\max} = \sigma_1 = \left(\frac{\sigma_x + \sigma_y}{2}\right) + R \qquad \sigma_{\min} = \sigma_2 = \left(\frac{\sigma_x + \sigma_y}{2}\right) - R$$

$$R = \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^{\ 2}} \qquad \theta_p = \frac{1}{2}\tan^{-1}\left(\frac{2\tau_{xy}}{\sigma_x - \sigma_y}\right)$$

$$\theta_s = \frac{1}{2}\tan^{-1}\left(-\frac{\sigma_x - \sigma_y}{2\tau_{xy}}\right) \qquad \sigma' = \frac{\sigma_x + \sigma_y}{2}$$

Loading	Loading Function $w = w(x)$	Shear $V = \int w(x)dx$	Moment $M = \int V dx$
	$w = M_0\langle x-a\rangle^{-2}$	$V = M_0\langle x-a\rangle^{-1}$	$M = M_0\langle x-a\rangle^{0}$
	$w = P\langle x-a\rangle^{-1}$	$V = P\langle x-a\rangle^{0}$	$M = P\langle x-a\rangle^{1}$
	$w = w_0\langle x-a\rangle^{0}$	$V = w_0\langle x-a\rangle^{1}$	$M = \frac{w_0}{2}\langle x-a\rangle^{2}$
	$w = m\langle x-a\rangle^{1}$	$V = \frac{m}{2}\langle x-a\rangle^{2}$	$M = \frac{m}{6}\langle x-a\rangle^{3}$