UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER III
SESSION 2017/2018

COURSE NAME	:	MECHANICS OF MATERIALS
COURSE CODE	:	DAC 20703
PROGRAMME CODE	:	DAA
EXAMINATION DATE	:	AUGUST 2018
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **TWO (2)** QUESTIONS IN PART A AND **TWO (2)** QUESTIONS IN PART B

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THIS QUESTION PAPER CONSISTS OF **TEN (10)** PAGES

PART A

Q1 (a) **Figure Q1(a)** shows a stress-strain graphs for two hypothetical materials, labeled material A and material B. By reffering to that graphs, answer the following questions.

(i) Which material is stronger and explain why?

(3 marks)

(ii) Which material is stiffer and explain why?

(3 marks)

(iii) Which material is ductile and explain why?

(3 marks)

(iv) Determine the E-modulus of material B.

(3 marks)

(v) Consider a bar made of material A, with diameter of 10 mm and length 300 mm. Determine the elongation of the bar under tension of 10 kN.

(5 marks)

(b) Define Poisson's ratio.

(2 marks)

(c) A copper wire 3 m long and 1 mm^2 in cross-section is fixed at one end and a weight of 10 kg is attached at the free end. If Modulus Young, E for copper is 12.5 x 10^{10} N/m^2 and Poisson ratio, $\upsilon = 0.25$ calculate the extension and lateral strain produced in the wire.

(6 marks)

Q2 (a) (i) Give an explanation of principle planes and principle stresses.

(4 marks)

(ii) Name **TWO (2)** methods for plane stress analysis

(2 marks)

(b) Given normal stress are σ_x = 15MPa , σ_y = 5 MPa, and τ_{xy} = 4 MPa. Construct Mohr Circle method and determine:

(i) The principle planes

(6 marks)

(ii) The principle stresses

(6 marks)

(iii) The maximum shearing stress

(7 marks)

Q3 (a) Beams are usually described by the way they are supported. Name **TWO (2)** types of beams and explain with the aid of drawing.

(6 markah)

(b) **Figure Q3 (b)** shows a shaft with the bearings at A and D exert only vertical reactions. The loading is applied to the pulleys at B, C and E.

(i) Draw the shear and moment diagrams for the shaft

(4 marks)

(ii) Determine the maximum shear force and bending moment

(11 marks)

(iii) Determine the bending moment at x = 1 m from A.

(4 marks)

PART B

Q4 (a) Describe the following terms below:

(i) Normal Stress
(ii) Shear Stress
(iii) Strain
(iv) Bending moment
(v) Pure bending of beam

(5 Marks)

(b) List **FIVE (5)** assumptions in the theory of simple bending

(5 Marks)

(c) **Figure Q4 (c)** shows a beam and its cross section. Calculate and determine maximum bending stress (σ_{maks}) that happen in the beam.

(15 marks)

Q5 A beam with cross section 25mm x 15mm is subjected to the corresponding loads as shown in **Figure Q5**.

(a) Calculate the reaction at A and B

(4 marks)

(b) Construct the relevant boundary condition.

(5 marks)

(c) Determine the maximum deflection and slope at point A by using Macaulay method.

(16 marks)

Q6 (a) Define the Torsion theory.

(2 marks)

(b) A solid steel shaft shown in **Figure Q6 (b)** has a diameter of 20 mm. If it is subjected to the two torques, calculate the reactions at the fixed supports A and B.

(8 marks)

(c) Calculate the minimum diameter of a solid steel shaft that will not twist through more than 3° in a 6-m length when subjected to a torque of 12 kN·m and maximum shearing stress. Use G = 83 GPa.

(9 marks)

(d) A column has a length of 8 m having modulus of elasticity of 200 kN / mm^2, and a moment of inertia of 7519 x 10^4 mm^4. If the safety factor given is 2, evaluate the safe load of the column if

(i) Both at the end of the column is pinned.

(ii) Both at the end of the column is fixed.

(6 marks)

-END OF QUESTIONS –

FINAL EXAMINATION

SEMESTER / SESSION : SEM III / 2017/2018
COURSES : MECHANICS OF MATERIALS
PROGRAMME : 1 DAA
COURSES CODE : DAC 20703

FORMULA

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

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

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

Second moment of inertia:

$$\Sigma I_{xx} = [I_x + Ad^2]_1 + [I_x + Ad^2]_2 + [I_x + Ad2]_3 + \ldots\ldots$$

$$\Sigma I_{yy} = [I_y + As^2]_1 + [I_y + As^2]_2 + [I_y + As^2]_3 + \ldots\ldots$$

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FINAL EXAMINATION

SEMESTER / SESSION : SEM III / 2017/2018 PROGRAMME : 1 DAA
COURSES : MECHANICS OF MATERIALS COURSES CODE : DAC 20703

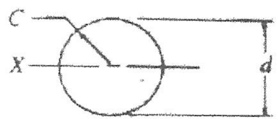
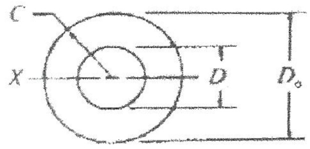
(1) $EI\dfrac{d^4y}{dx^4} = q(x)$ Force-deflection equation

(2) $EI\dfrac{d^3y}{dx^3} = V(x) = \int q(x)dx + C_1$ Shear-deflection equation

(3) $EI\dfrac{d^2y}{dx^2} = M(x) = \iint q(x)dx^2 + C_1x + C_2$ Bending moment-deflection equation

(4) $EI\dfrac{dy}{dx} = EI\theta(x) = \int M(x)dx + C_3$
$= \iiint q(x)dx^3 + C_1x^2 + C_2x + C_3$ Slope-deflection equation

(5) $EIy(x) = \int M(x)dx^2 + C_3x + C_4$
$= \iiint\int q(x)dx^4 + C_1x^3 + C_2x^2 + C_3x + C_4$ Deflection equation

Area Shape	*I*	*J*
Solid circle 	$\dfrac{\pi d^4}{64}$	$\dfrac{\pi d^4}{32}$
Hollow circle 	$\dfrac{\pi(D_o^4 - D_i^4)}{64}$	$\dfrac{\pi(D_o^4 - D_i^4)}{32}$

$\tau = \dfrac{Tr}{J}$ $\phi = \dfrac{TL}{JG}$ $P = T\omega$ $P = 2\pi fT$

FINAL EXAMINATION

SEMESTER / SESSION : SEM III / 2017/2018
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COURSES : MECHANICS OF MATERIALS
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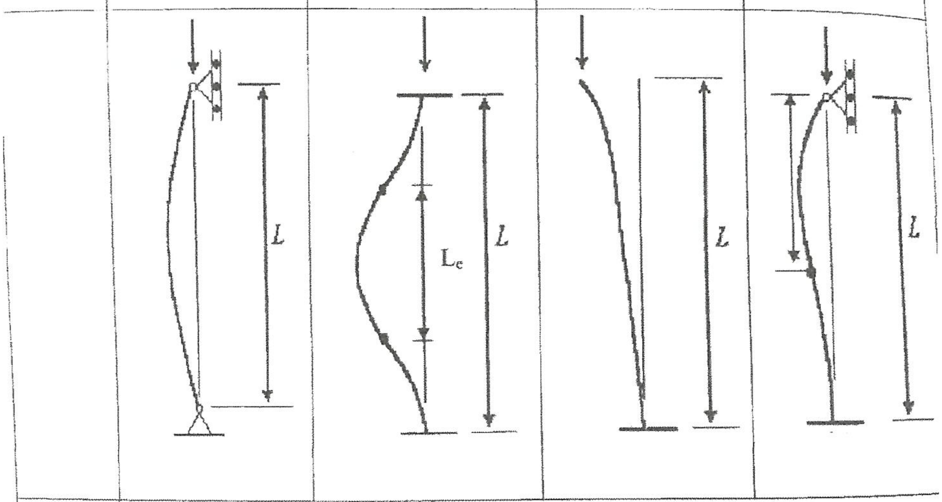

	Pinned-pinned	Fixed-fixed	Cantilever	Fixed-pinned
Basic Formula	$P_{cr}=\frac{\pi^2 EI}{L_e^2}$			
L_e	L	0.5L	2L	0.7L
P_{cr}	$P_{cr}=\frac{\pi^2 EI}{(L)^2}$	$P_{cr}=\frac{\pi^2 EI}{(0.5L)^2}$	$P_{cr}=\frac{\pi^2 EI}{(2L)^2}$	$P_{cr}=\frac{\pi^2 EI}{(0.7L)^2}$

$\sigma_{cr} = P_{cr}/A$

$P_{allow} = P_{cr}/\text{F.O.S}$

FINAL EXAMINATION

SEMESTER / SESSION : SEM III / 2017/2018 PROGRAMME : 1 DAA
COURSES : MECHANICS OF MATERIALS COURSES CODE : DAC 20703

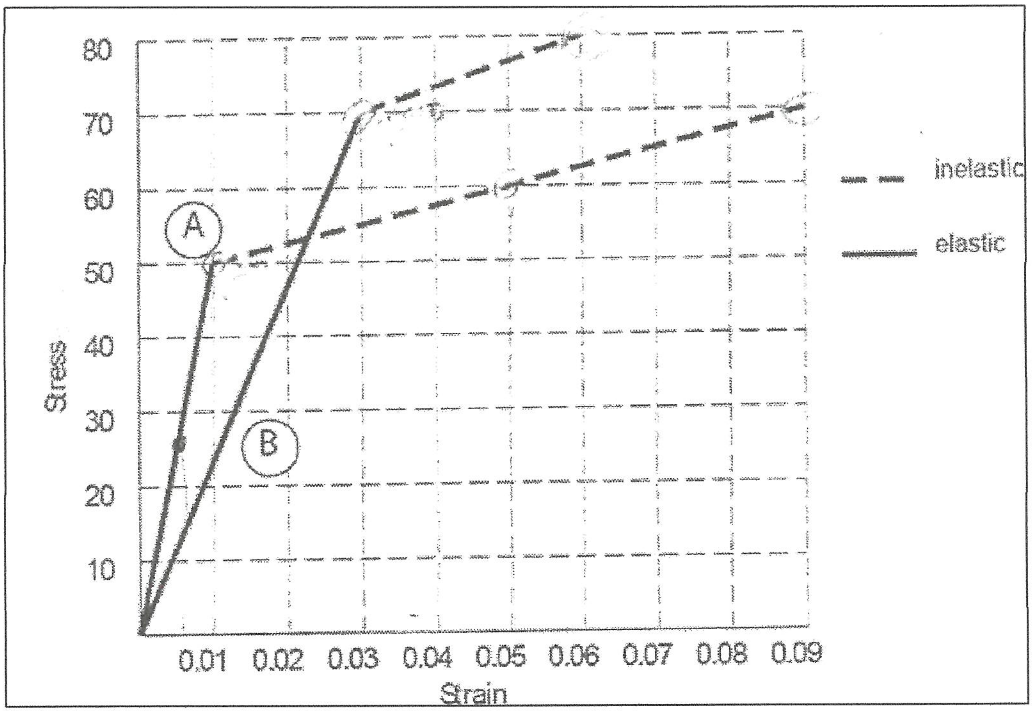

Figure Q1 (a)

FINAL EXAMINATION

SEMESTER / SESSION : SEM III / 2017/2018 PROGRAMME : 1 DAA
COURSES : MECHANICS OF MATERIALS COURSES CODE : DAC 20703

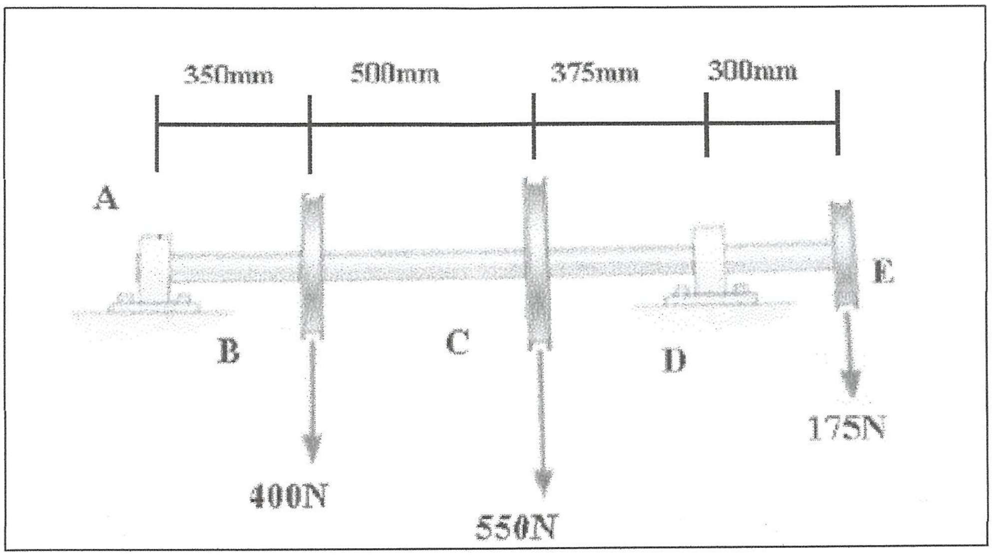

Figure Q3 (b)

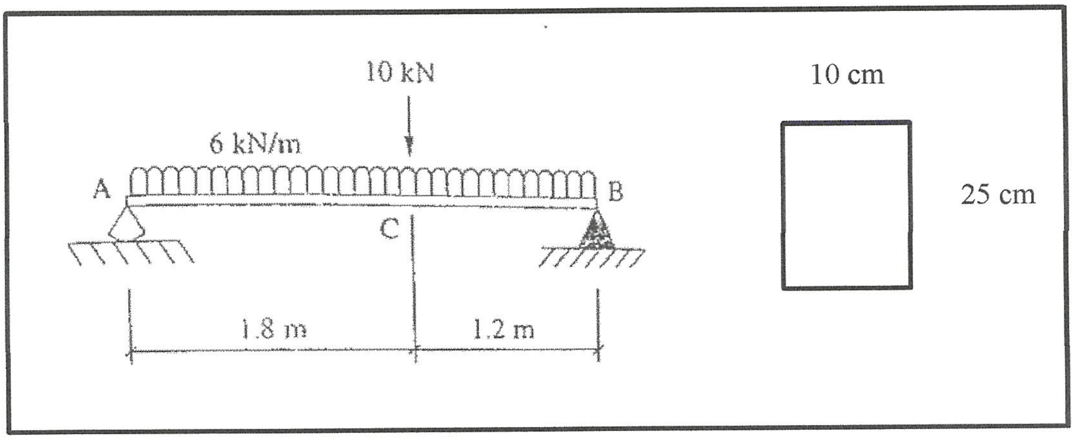

Figure Q4 (c)

FINAL EXAMINATION

SEMESTER / SESSION : SEM III / 2017/2018
COURSES : MECHANICS OF MATERIALS

PROGRAMME : 1 DAA
COURSES CODE : DAC 20703

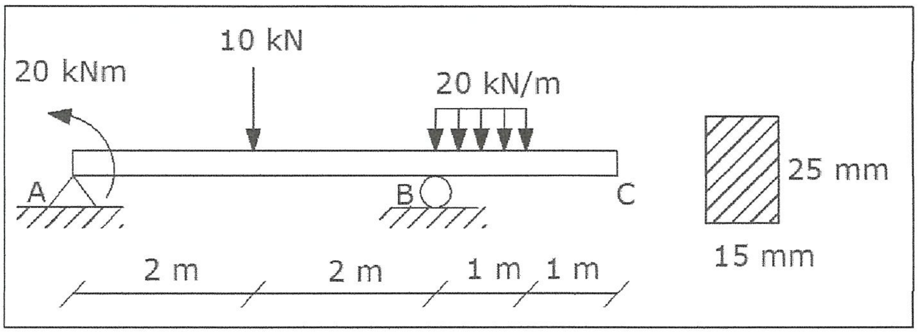

Figure Q5

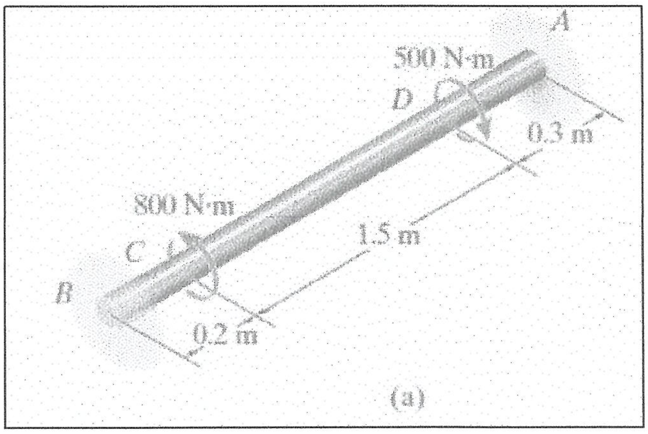

Figure Q6 (b)