Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER 1
SESSION 2016/2017

COURSE NAME	:	SOLID MECHANICS 2
COURSE CODE	:	BDA20903
PROGRAMME	:	BDD
EXAMINATION DATE	:	DECEMBER2016/JANUARY 2017
DURATION	:	3 HOURS
INSTRUCTION	:	1) ANSWER **ALL** QUESTIONS IN **PART A**. 2) ANSWER **ONE(1)** QUESTION **ONLY** IN **PART B**.

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

PART A

Q1. (a) **Figure Q1** shows rotation of line *dx'* and *dy'* subjected to strain component ε_x, ε_y and γ_{xy}. The rotational counterclockwise of line *dx'* will defined by angle, $\alpha = \delta y' / dx'$. Given that displacement $\delta y'$ can be determine by three displacement 'components' acting in y-direction and β is 90° from α. If α-β = γ_{xy} and with the help from information given in **Appendix**, prove that shear strain of an element is given as:

$$\gamma_{x'y'} = -(\varepsilon_x - \varepsilon_y)\sin 2\theta + \gamma_{xy}\cos 2\theta$$

(12 marks)

(b) A differential element of material at a point is subjected to a state of plane stress defined by $\sigma_x = 0$, σ_y = -200MPa and τ_{xy} = -150MPa.Knowing that E=200 GPa and G=77 GPa,:

(i) Find normal strains in x and y directions.

(4 marks)

(ii) Calculate average strain and shear strain.

(2marks)

(iii) Determine the orientation of the element act.

(2 marks)

Q2. (a) Describe the following terms.

(i) Buckling

(ii) Effective Length

(iii) Slenderness Ratio

(6 marks)

(b) An aluminum column built into the ground as shown in **Figure Q2** has length, L = 2.2 m, and is under axial compressive load P. The dimensions of the cross-section are b = 210 mm and d = 280 mm. The modulus of elasticity, E = 70 GPa.

(i) Determine the critical load to buckle the column.

(8 marks)

(ii) If the allowable compressive stress in the Aluminum is 240 MPa, is the column more likely to buckle or yield?

(3 marks)

(iii) If the factor of safety is F.S=1.95, what is the allowable buckling load.

(3 marks)

Q3. (a) Based on **Figure Q3**, derive and prove that the Hoop Stress, σ_H and the Radial Stress, σ_R can be expressed follow

$$\sigma_R = \frac{a^2P_a - b^2P_b}{(b^2 - a^2)} - \frac{a^2b^2(P_a - P_b)}{r^2(b^2 - a^2)}$$

$$\sigma_H = \frac{a^2P_a - b^2P_b}{(b^2 - a^2)} + \frac{a^2b^2(P_a - P_b)}{r^2(b^2 - a^2)}$$

(12 marks)

(b) A thick cylindrical shell with inner radius 10 cm and outer radius 16 cm is subjected to an internal pressure of 70 MPa. Find the maximum and minimum of hoop stresses.

(8 marks)

Q4. (a) Define the following theories:

(i) The Tresca theory, and

(ii) The von Mises theory.

(8 marks)

(b) A horizontal shaft of 75mm in diameter and 350 mm in length projects from a bearing as shown in **Figure Q4**. The vertical load of 10 kN, horizontal compression load of 12 kN and torque, T Nm are applied at the free end of the shaft. If the safe stress for the material is 145 MPa and assuming the Poisson's ratio is 0.3. Determine the torque, T to which the shaft may be subjected using the following theories:

(i) The Tresca theory, and

(ii) The von Mises theory.

(12 marks)

PART B

Q5. (a) Explain the definition of Statically Indeterminate Beams and discuss solution to determine support reactions for beams in such condition.

(6 marks)

(b) The beam in **Figure Q2** is subjected with distributed loading. Knowing the beam is fixed supported at one end and roller supported at the other end, determine:

(i) Reaction at point A.

(ii) Deflection at point C.

(14 marks)

Q6. A simply supported beam ADB with a length of L as shown in **Figure Q4** is loaded with a uniformly distributed force, w along the length of b. Considering the Castigliano's theorem:

(a) Draw a related free body diagram and determine the reaction at point A and B.

(6 marks)

(b) Prove that the deflection at point D is:

$$\delta_D = \frac{wab^3}{24L}(4a + b)$$

(14 marks)

-END OF QUESTION-

FINAL EXAMINATION

SEMESTER / SESSION : SEM I / 2016/2017
COURSE NAME: SOLID MECHANICS 2

PROGRAMME CODE : BDD
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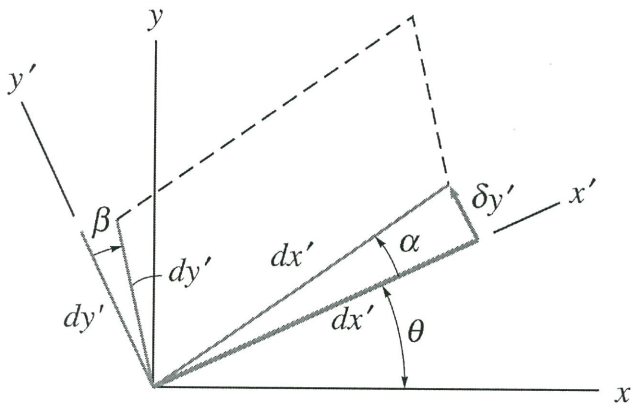
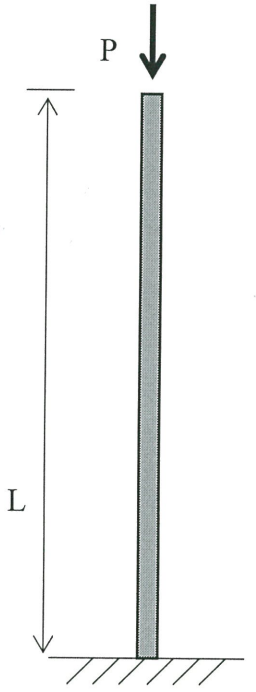


Figure Q1



Cross section

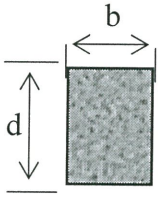


Figure Q2

FINAL EXAMINATION

SEMESTER / SESSION : SEM I / 2016/2017
COURSE NAME: SOLID MECHANICS 2

PROGRAMME CODE : BDD
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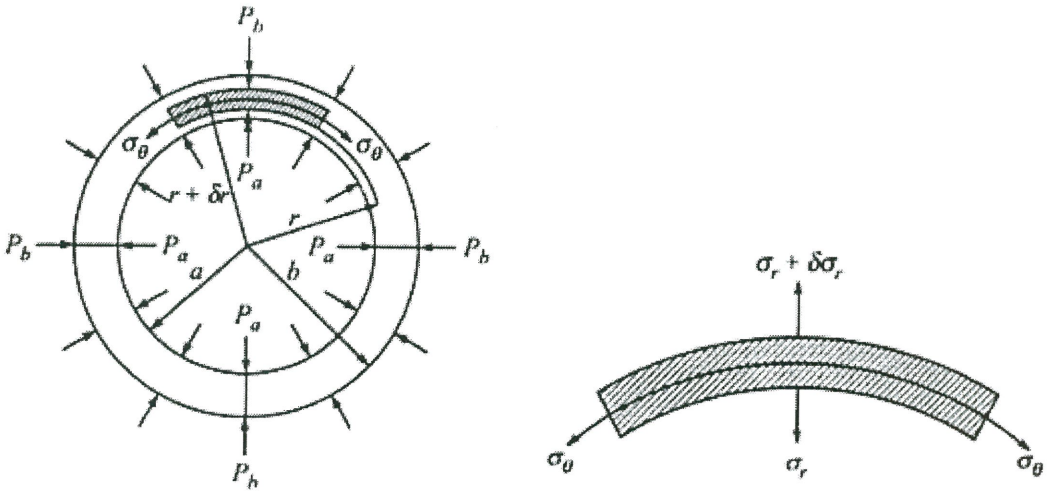

Figure Q3

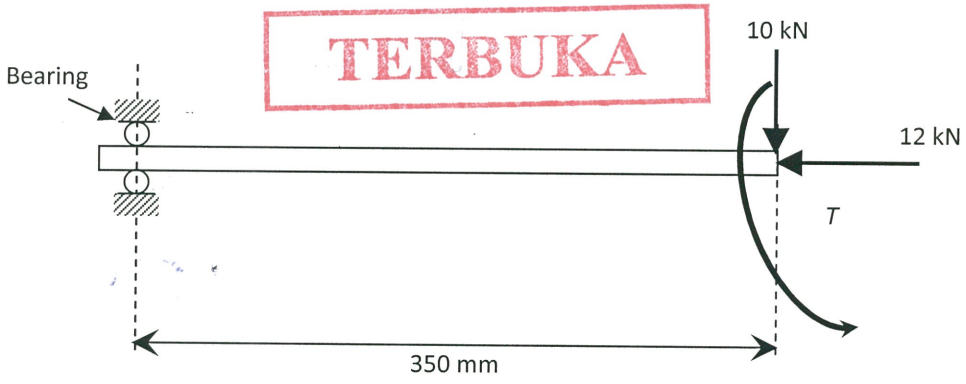

Figure Q4

FINAL EXAMINATION

SEMESTER / SESSION : SEM I / 2016/2017
COURSE NAME: SOLID MECHANICS 2

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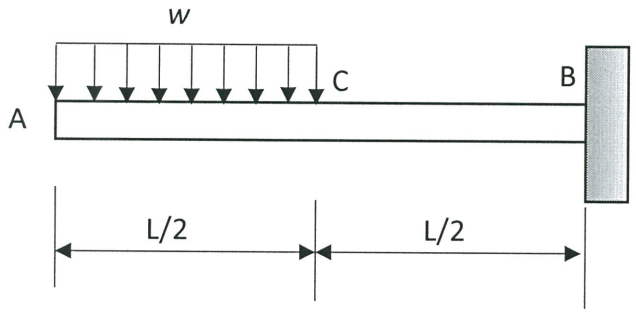

Figure Q5

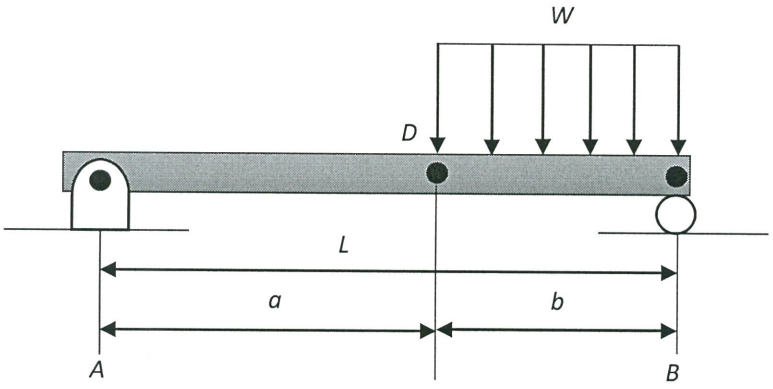

Figure Q6

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APPENDIX

$$dx = dx' \cos\theta$$

$$dy = dx' \sin\theta$$

$$\sin(\theta + 90°) = \cos\theta$$

$$\cos(\theta + 90°) = -\sin\theta$$

$$\sin\theta \cos\theta = \frac{\sin 2\theta}{2}$$

$$\cos^2\theta = \frac{1 + \cos 2\theta}{2}$$

$$\cos^2\theta + \sin^2\theta = 1$$