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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2013/2014

COURSE NAME	:	SOLID MECHANICS 1
COURSE CODE	:	BDA 10903 / BDA 10402
PROGRAMME	:	1 BDD
EXAMINATION DATE	:	JUNE 2014
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FIVE (5)** QUESTIONS ONLY.

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

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Q1. a) Show the stress-strain diagram of a ductile material which has an offset yield stress , $\sigma_{YL} = 0.2\%$.

(3 marks)

b) Describe the differences between single shear and double shear.

(4 marks)

c) Links BC and DE are both made of steel with Young's Modulus, $E = 200$ GPa and are 12 mm wide and 6 mm thick as shown in **FIGURE Q1**. Determine

(i) The force in each link when a 2.4 kN force P is applied to the rigid member AF.

(ii) The corresponding deflection of point A.

(13 marks)

Q2. a) A cantilevered beam has a length L with a loading P applied at the end of the beam.

(i) Draw the diagram of the beam (2 marks)

(ii) Prove that the maximum bending moment, $M_{max} = -PL$

(5 marks)

b) A simply supported beam is loaded as shown in **FIGURE Q2**.

(i) Draw the shear and bending moment diagrams (8 marks)

(ii) Determine the maximum absolute values of the shear and the bending moment (5 marks)

Q3. a) Sketch two different examples for 'statically determinate beams' and 'statically indeterminate beams'.

(4 marks)

b) A beam CD is loaded and supported as shown in **FIGURE Q3**. Determine

(i) The reaction at point D and C.

(ii) The maximum and minimum of the shear force and bending moment.

(iii) The minimum required depth *h*.

(Given σ_{all} = 12 MPa and τ_{all} = 0.9 MPa).

(16 marks)

Q4. a) State the definition of torsion. (2 marks)

b) Describe the torsional failure mode of a beam surface for ductile and brittle materials. (4 marks)

c) Two solid steel shafts are connected by the gears as shown in **FIGURE Q4.** Knowing that the shear modulus, G = 77 GPa and the radius of gear B, r_B = 20 mm, determine the angle through which end A rotates when T_A = 75 Nm.

(14 marks)

Q5. a) Describe about thin wall cylinder. (3 marks)

b) State **FOUR (4)** example of thin wall cylinder. (4 marks)

c) The cylindrical pressure tank shown in **FIGURE Q5** has an inside diameter of 1.6 m and a wall thickness of 35 mm. The pressure in the tank is 1700 kPa. An additional axial load of 180 kN is applied to the top end of the tank through a rigid bearing plate. Determine

(i) The stresses σ_x, σ_y and τ_{xy} on a stress element at point A, which is on the outside surface of the tank.

(ii) The normal and shearing stresses on an inclined plane oriented at +30° from the x-axis.

(13 marks)

Q6. a) By using a plane stress diagram, derive stress-transformation equation as below

$$\sigma_n = \frac{\sigma_x + \sigma_y}{2} + \frac{\sigma_x + \sigma_y}{2}\cos 2\theta + \tau_{xy}\sin 2\theta$$

(10 marks)

b) **FIGURE Q6** shows a plane stress diagram with three different loading. By using a correct equation, calculate

(i) Principal planes

(ii) Principal stresses

(iii) Corresponding normal stress (10 marks)

- END OF QUESTION –

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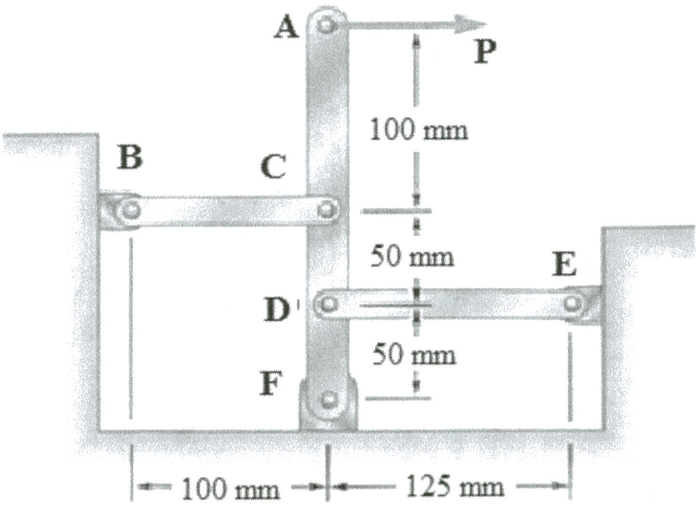

FIGURE Q1

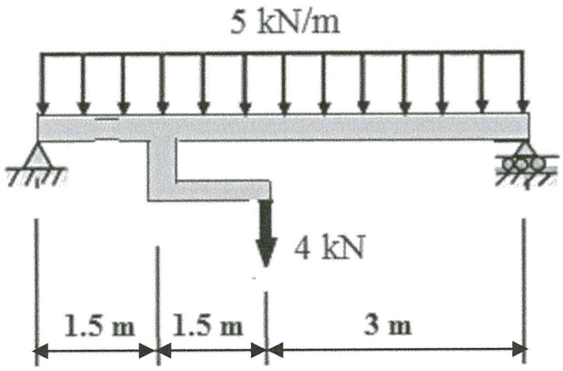

FIGURE Q2

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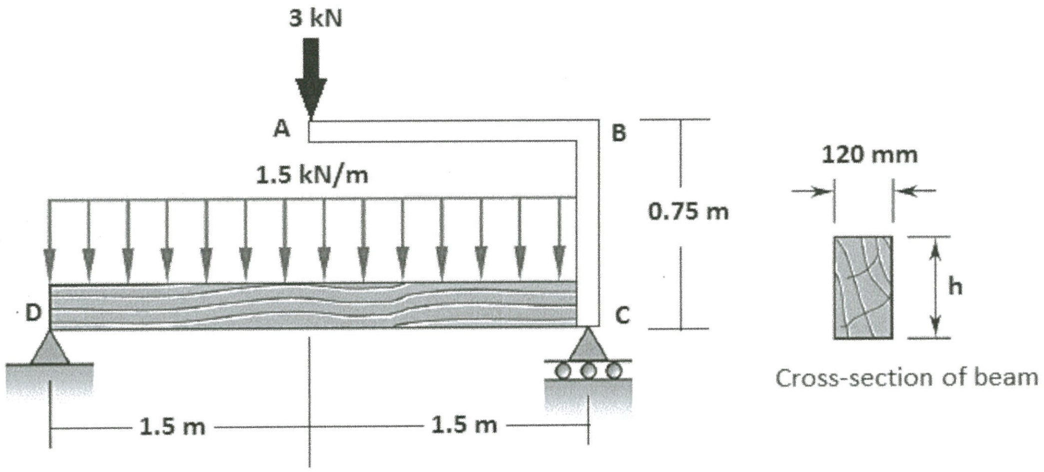

FIGURE Q3

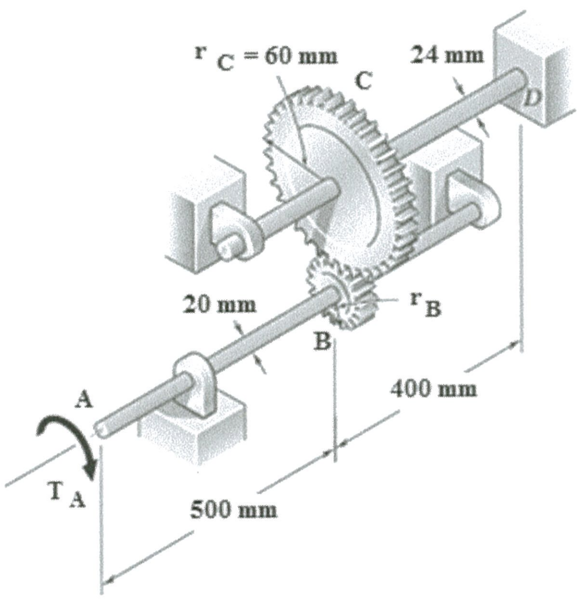

FIGURE Q4

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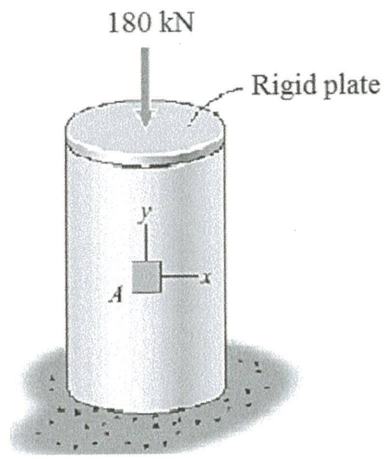

FIGURE Q5

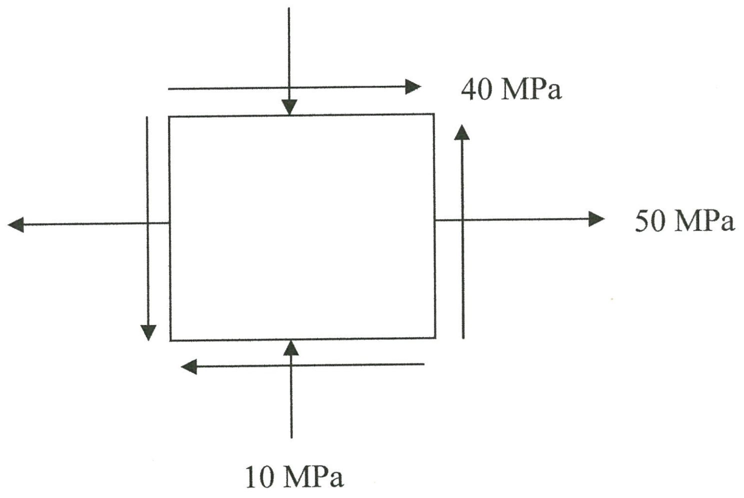

FIGURE Q6

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Stress Transformation Equations

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

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

Principal Stress

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

$$\sigma_{1,2} = \frac{\sigma_x + \sigma_y}{2} \pm \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

Maximum in-plane shear stress

$$\tan 2\theta_s = -\frac{(\sigma_x - \sigma_y)/2}{\tau_{xy}}$$

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

$$\sigma_{avg} = \frac{\sigma_x + \sigma_y}{2}$$

Absolute maximum shear stress

$$\tau_{\substack{abs\\max}} = \frac{\sigma_{\max} - \sigma_{\min}}{2}$$

$$\sigma_{avg} = \frac{\sigma_{\max} + \sigma_{\min}}{2}$$