UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER 2
SESSION 2009/2010

NAME OF THE SUBJECT	:	SOLID MECHANICS II
SUBJECT CODE	:	BDA 3033
COURSE	:	3 BDD / 3BDI
DATE OF EXAMINATION	:	APRIL / MAY 2010
TIME	:	3 HOURS

INSTRUCTIONS:

(1) Answer any *FIVE* (5) questions only from the given *SIX* (6)questions.
(2) Symbols used is as per common convention unless other wise stated
(3) This question paper contains 7 pages including the front page

S1 a) How many strain gauges are needed to determine the two dimensional strains in a component? Why?

(4 marks)

b) An axial force **P** and a horizontal force *Qx* are both applied to the rectangular bar as shown in **Rajah S1**. A 45° strain rosette on the surface of the bar at point *A* indicates the following strains:

$\varepsilon_1 = -75\ \mu$, $\varepsilon_2 = +300\ \mu$ and $\varepsilon_3 = +250\ \mu$.

Knowing that E = 200 GPa and ν = 0.30, determine the magnitudes of ***P*** and ***Qx***.

(16 marks)

S2 (a) What are statically indeterminate beams? How will you find the indeterminacy in them?

(4 marks)

(b) For the beam and loading shown in **Rajah S2**,

(i) Express the magnitude and location of the maximum deflection in terms of w_0, L, E, and I.

(ii) Calculate the value of the maximum deflection, assuming that beam *AB* is a *W*460 X 74 rolled beam and that w_0 = 68 kN/m, L = 5.5 m and E = 200 GPa   I= 333e-6 m^4

(16 marks)

S3 a) Prove that the critical load for the fixed-free column according to Euler's theory is given by $P_{cr} = \frac{\pi^2 EI}{4L^2}$

(8 marks)

b) A steel bar having square cross section as shown in **Rajah S3** is pin connected at its ends. Determine tne maximum allowable load than can be applied to the frame. Use a factor of safety of 2. Given E=200 GPa and σ_y= 250 MPa.

(12 marks)

S4 (a) Define Castigliano's theorem for determining the displacement of a beam.

(2 marks)

(b) Apply this to find the displacement at 'B' of the beam shown in **Rajah S4(a)**

(8 marks)

(b) The **Rajah 4(b)** shows a 700N weight diver jumps with a downward velocity of 1.2m/sec onto end C of a diving board of uniform cross section 40 mm X 500 mm. Assuming that the diver's legs remains rigid and using E = 12 GPa, determine the maximum normal stress in the board.

(12 marks)

S5 a) A steel beam of Yielding Strength of 250 MPa and Area of cross section b X d as 25 X 100 mm^2 is subjected to loading as shown in **Rajah S5**. Find the critical stress for failure using (i) Normal Stress Theory and (ii) Tresca Criterion.

(10 marks)

b) An Aluminium alloy (Yielding Strength 260 MPa) is to be used for a solid drive shaft such that it transmits 35 kW at 1800 rpm. Using a factor of safety of 2, determine the smallest diameter of the shaft that can be selected based on Von Mises theory .

(10 marks)

S6 (a) Mention any two assumptions made in Lame's theory for thick cylinders.

(4 marks)

(b) A Steel cylinder of 200 mm external diameter is to be shrunk to another steel cylinder of 100 mm internal diameter. After shrinking the diameter at the junction is 150 mm and the radial pressure at the junction is 12.5 N/mm^2. Find the original difference in radii at the junction. Take E =200 GPa.

(16 marks)

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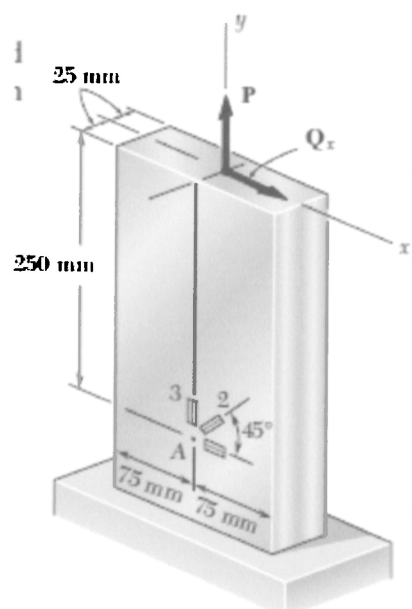
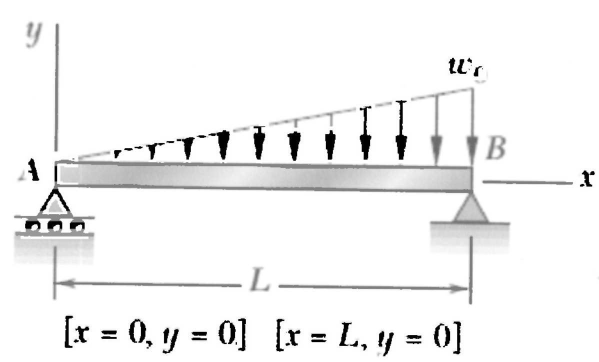


Rajah S1



Rajah S2

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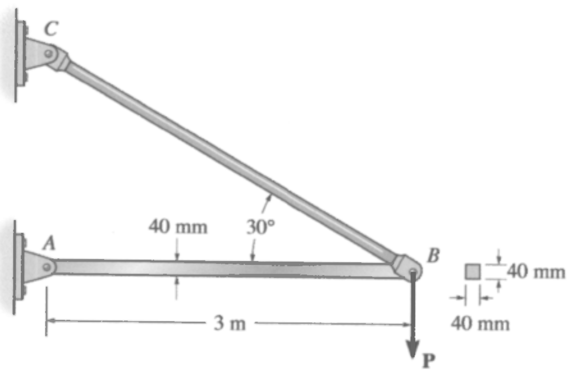
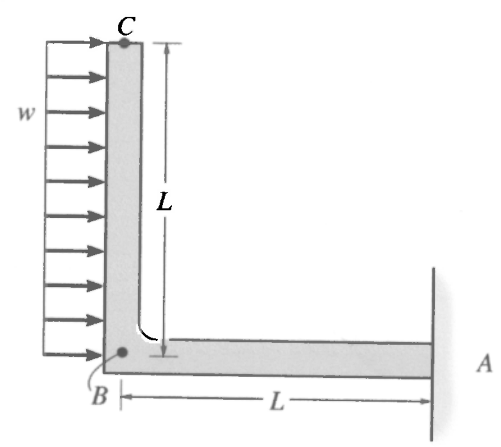


Rajah S3



Rajah S4(a)

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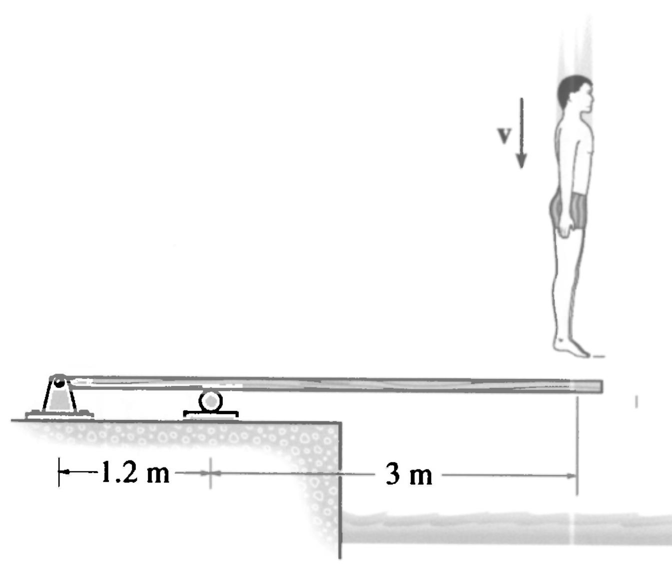
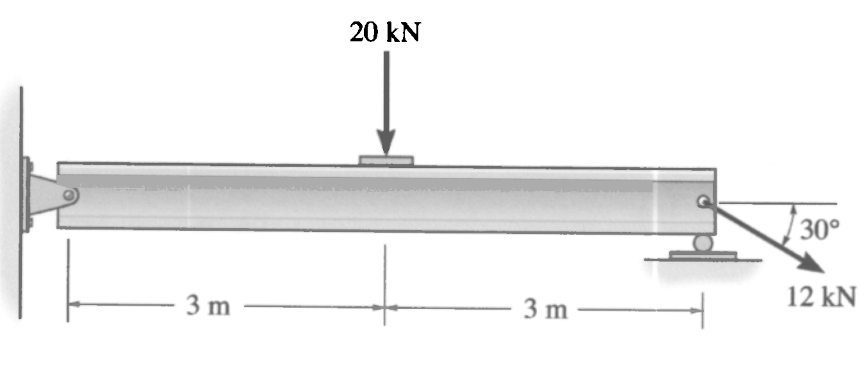


Rajah S4(b)



Rajah S5

APPENDIX

$$\epsilon_\theta = \epsilon_x \cos^2\theta + \epsilon_y \sin^2\theta + \gamma_{xy} \sin\theta.\cos\theta$$

$$\epsilon_{1,2} = \frac{\epsilon_x + \epsilon_y}{2} \pm \sqrt{\left(\frac{\epsilon_x - \epsilon_y}{2}\right)^2 + \left(\frac{\gamma_{xy}}{2}\right)^2}$$

$$\frac{\gamma_{max}}{2} = \pm\sqrt{\left(\frac{\epsilon_x - \epsilon_y}{2}\right)^2 + \left(\frac{\gamma_{xy}}{2}\right)^2}$$

$$\gamma_{xy} = \frac{\tau_{xy}}{G} \qquad \sigma_x = \frac{E}{1-\nu^2}(\varepsilon_x + \nu\varepsilon_y)$$

$$\tau_{xy} = \frac{Tr}{J} \qquad \sigma_y = \frac{E}{1-\nu^2}(\varepsilon_y + \nu\varepsilon_x)$$

$$J = \frac{\pi}{32}d^4 \qquad G = \frac{E}{2(1+\nu)}$$

$$Q = A\bar{y}$$

$$\tau_{xy} = \frac{VQ}{It} \qquad P_{cr} = \frac{\pi^2 EI}{(KL)^2}$$

$$\sigma_r = A - \frac{B}{r^2} \qquad \sigma_\theta = A + \frac{B}{r^2}$$

$$M = EI\frac{d^2y}{dx^2}$$

$$\frac{1}{2}P_m y_m = U_m = W(h + y_m)$$

$$U_i = \int_0^L \frac{N^2 dx}{2EA} = \frac{N^2 L}{2EA}$$

$$(U_b)_i = \int_0^L \frac{M^2 dx}{2EI}$$

$$|\sigma_1 - \sigma_2| \le \sigma_y$$

$$\sigma_1^2 - \sigma_1\sigma_2 + \sigma_2^2 \le \sigma_y^2$$

$$\Delta r = \frac{2r_2}{E}(A_2 - A_1)$$