

Q1

1002276

$$\begin{aligned} i) \quad \epsilon_x &= 26 \times 10^{-6} \\ \epsilon_y &= -17 \times 10^{-6} \\ E &= 170 \times 10^9 \text{ Pa} \\ \nu &= 0.28 \end{aligned}$$

$$\frac{170 \times 10^9}{1 - 0.28^2} \left(26 \times 10^{-6} + \left(0.28 \times -17 \times 10^{-6} \right) \right) = 39.2 \text{ MPa}$$

$$\frac{170 \times 10^9}{1 - 0.28^2} \left(-17 \times 10^{-6} + \left(0.28 \times 26 \times 10^{-6} \right) \right) = -44.8 \text{ MPa}$$

$$\sigma_x = 87 \times 10^6$$

$$\sigma_y = 46 \times 10^6$$

$$ii) \quad \frac{1}{170 \times 10^9} \left(87 \times 10^6 - \left(0.28 \times 46 \times 10^6 \right) \right) = 436 \times 10^{-6}$$

$$\frac{1}{170 \times 10^9} \left(46 \times 10^6 - \left(0.28 \times 87 \times 10^6 \right) \right) = 127 \times 10^{-6}$$

Q2

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$$\sigma_x = 1.02E+08 \text{ Pa}$$

$$\sigma_y = 2.07E+08 \text{ Pa}$$

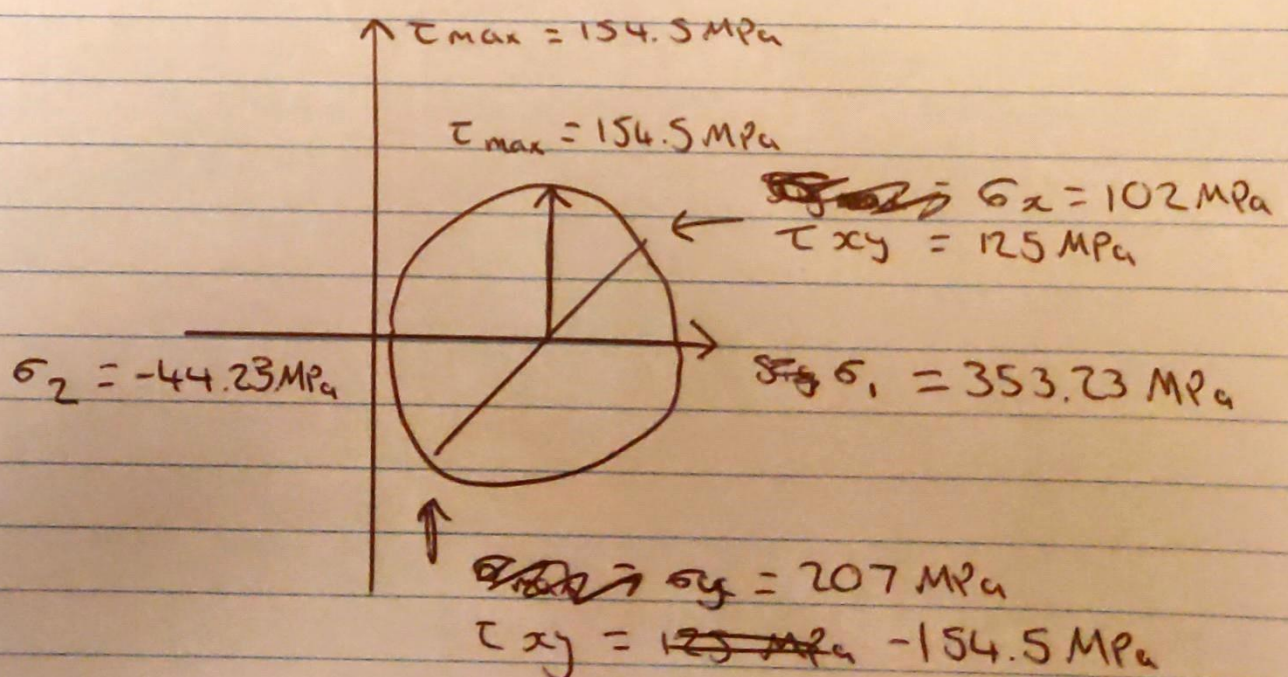
$$\tau_{xy} = 1.25E+08 \text{ Pa}$$

$$\left(\frac{\sigma_x + \sigma_y}{2} \right) + \frac{\sqrt{(\sigma_x - \sigma_y)^2 + 4\tau_{xy}^2}}{2} = 353.23 \text{ MPa}$$

$$\frac{(\sigma_x + \sigma_y)}{2} - \frac{\sqrt{(\sigma_x - \sigma_y)^2 + 4\tau_{xy}^2}}{2} = -44.23 \text{ MPa}$$

$$\tau_{\max} = \frac{\sqrt{(\sigma_x - \sigma_y)^2 + 4\tau_{xy}^2}}{2} = \frac{\sigma_1 - \sigma_2}{2} = 154.5 \text{ MPa}$$

$$\tau_{\min} = \left[\frac{\sigma_1 - \sigma_2}{2} \right] = -154.5 \text{ MPa}$$



Q3

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

Simply supported

ii) $\frac{dy}{dx}$

iii) y

$F_1 = 2.3 \text{ kN}$

$F_2 = 1.0 \text{ kN}$

$w_1 = 450 \text{ N/m}$

$w_2 = 800 \text{ N/m}$

$R_A =$

$R_B =$

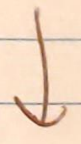
$a = 0.5 \text{ m}$

$b = 1.5 \text{ m}$

$c = 2.5 \text{ m}$

$d = 3.1 \text{ m}$

$M = EI \frac{d^2 y}{dx^2} = R_A [x] - F_1 [x-a]$



$= R_A [x] - w_1 [x-a] \frac{[x-a]^2}{2} - F_1 [x-b] - w_2 [x-b] \frac{[x-b]^2}{2}$
 $- w_1 \frac{[x-a]^2}{2} + w_1 \frac{[x-b]^2}{2} - w_2 \frac{[x-c]^2}{2} + w_2 \frac{[x-d]^2}{2}$

$EI \frac{dy}{dx} = \frac{R_A [x]^2}{2} - \frac{w_1 [x-a]^3}{6} + \frac{w_1 [x-b]^3}{6} - \frac{F_1 [x-b]^2}{2} - //$

$// \frac{w_2 [x-b]^3}{6} + \frac{w_2 [x-c]^3}{6} - \frac{F_2 [x-c]^2}{2} - \frac{R_B [x-d]^2}{2} + A$

iii) $M(x) = \frac{M(x)}{EI} = \frac{d^2 y}{dx^2}$

w) $EI \frac{d^2 y}{dx^2} = 1969.4 [x]^2$

$EI \frac{d^2 y}{dx^2} = 1969.4 [x] - 450 [x-0.5] \frac{[x-0.5]}{2} - 2300 [x-1.5] - 800$
 $[x-1.5] \frac{[x-1.5]}{2} - 1000 [x-2.5] - 2580.6 [x-3.1]$

Q4

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$$d = 0.28 \text{ m}$$

$$n_L = 0.57$$

$$\sigma_{\max} = 150 \times 10^5 \text{ N/m}^2$$

$$L = 0.60 \text{ m}$$

$$n_c = 0.66$$

$$P = 14.2 \times 10^5 \text{ N/m}^2$$

~~then~~

$$\sigma_c = \frac{Pd}{2\epsilon n_L}$$

$$\sigma_L = \frac{Pd}{4\epsilon n_c}$$

$$\epsilon = \frac{Pd}{2\sigma_c n_L}$$

$$\epsilon = \frac{Pd}{4\sigma_L n_c}$$

$$\frac{(14.2 \times 10^5) \times 0.28}{2 \times (150 \times 10^5) \times 0.57} = \epsilon$$

$$\epsilon = \frac{(14.2 \times 10^5) \times 0.28}{4 \times 0.66 \times (150 \times 10^5)}$$

$$\epsilon = 2.36 \text{ mm}$$

$$\epsilon = 2.00 \text{ mm}$$

$$\therefore \epsilon_{\min} = 2.36 \text{ mm}$$

Q5

102216

$$\begin{aligned} \text{ii) } E &= 200 \text{ E+11 Pa} & D_o &= 0.01905 \text{ m} & n &= 1 \\ L &= 1.37 \text{ m} & D_i &= 0.01785 \text{ m} \end{aligned}$$

$$\text{i) } A = \frac{\pi}{4} (d_o^2 - d_i^2) = 3.48 \times 10^{-5} \text{ m}^2$$

$$I_{xx} = I_{yy} = \frac{\pi}{64} (d_o^4 - d_i^4) = 5.89 \times 10^{-5} \text{ m}^4$$

$$I_c = \frac{\pi}{32} (d_o^4 - d_i^4) = 1.18 \times 10^{-4} \text{ m}^4$$

$$I_{xx} \times I_c = 6.94 \times 10^{-9} = I$$

$$K = \frac{I}{A} = 1.99 \times 10^{-4}$$

$$\text{iv) } SR = \frac{L}{K} = \frac{1.37}{1.99 \times 10^{-4}} = 6884.42$$

$$P_{cr} = \frac{\pi^2 EI}{(KL)^2} = \frac{\pi^2 \times 2.0 \times 10^{11} \times 6.94 \times 10^{-9}}{(1.99 \times 10^{-4} \times 1.37)^2} = 1.84 \times 10^{11}$$

$$F_{cr} = \frac{n \pi^2 EI}{L^2} = 7298.7431$$

$$\text{iii) } P_{cr} = 7298.7431 \text{ N}$$