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 Date/Time: 30<sup>th</sup> April 2020  
 Module Code: M4X02192  
 Module : Engineering Science

|    |    |    |
|----|----|----|
| Q1 | 3  | 9  |
| Q2 | 11 | 11 |
| Q3 | 9  | 11 |
| Q4 | 10 | 17 |
|    | 32 | 48 |

69%

Question 1:

$$AK = 1.7 \text{ W/mk}$$

$$D = 5 \text{ m}$$

$$H = 8 \text{ m}$$

$$h = 12 \text{ W/m}^2\text{k}$$

$$T_1 = 15^\circ + 273 = \cancel{348}^\circ\text{K} \quad 288^\circ\text{K}$$

$$T_2 = 68 + 273 = 341^\circ\text{K}$$

$$r = 200 \text{ mm} = 0.2 \text{ m}$$

$$A = \pi (2.5^2 - 2.4^2) \quad \times$$

$$A = 1.54 \text{ m}^2$$

$$Q = -kA(T_2 - T_1)$$

$$= (-1.7)(1.54)(341 - 288) \quad \textcircled{1}$$

$$Q_1 = -693.77 \text{ kW} \quad \textcircled{1}$$

$$Q =$$

$$Q = -kA(T_2 - T_1)$$

Chimney not Cylinder  
 Surface Area  
 $= \pi d h$

$$Q = hA(T_2 - T_1)$$

$$Q = (12)(1.54)(341 - 288)$$

$$Q = 979.44 \text{ kW} \quad \textcircled{1}$$

$$\text{heat transfer } Q =$$

$$= Q_2 - Q_1$$

$$= 979.44 - 693.77 \quad \times$$

$$\text{heat transfer is } 285.67$$

$$= 28567 \text{ W} \quad \text{kw}$$

Add them.

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### Question 2:

Belt diameter = 12 mm = 0.012 m (1)  
 $\tau = 304 \text{ MPa} = 3.04 \times 10^8 \text{ N/m}^2$  (1)  
 $F = 165 \text{ kN} = 165 \times 10^3 \text{ N}$  (1)

Area of the belt =  $\frac{\pi d^2}{4}$  (1)  $\bigg/$   $= \frac{\pi (0.012)^2}{4} = 1.13 \times 10^{-4} \text{ m}^2$  (1) ✓

$\tau = \frac{F}{A}$   $\bigg/$   $A = \frac{F}{\tau}$  (1)  
 $A = \frac{165 \times 10^3}{3.04 \times 10^8}$  (1)  
 $A = 542.76 \times 10^{-6} \text{ m}^2$  (1)

Area needed for load is  $542.76 \times 10^{-6} \text{ m}^2$

Number of bolts needed:

$= \frac{542.76 \times 10^{-6}}{1.13 \times 10^{-4}}$

$= 4.8$  (1) ✓

yay!

5 bolts are needed to support the lap joint.

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### Question 3:

$$G = 78 \text{ GPa} = 78 \times 10^9 \text{ N/m}^2 \quad (1)$$

$$T = 10 \text{ Nm}$$

$$S = 5 \text{ mm} = 0.005 \text{ m} \quad (1)$$

$$l = 140 \text{ mm} = 0.14 \text{ m} \quad (1)$$

$$J = \frac{S\sqrt{3}}{8} \cdot S^4$$

$$J = \frac{S\sqrt{3}}{8} (0.005^4)$$

$$J = 6.76 \times 10^{-10} \text{ m}^4 \quad \checkmark (2)$$

$$\frac{T}{J} = \frac{\cancel{x}}{\cancel{x}} = \frac{60?}{l} \quad / \quad \frac{T}{J} = \frac{60}{l} \quad / \quad \boxed{\frac{Tl}{JG} = \theta}$$

$$\theta = \frac{Tl}{JG} \quad (1)$$

$$\theta = \frac{(10)(0.14)}{6.76 \times 10^{-10} \times 78 \times 10^9} \quad (1)$$

$$\theta = 0.03 \text{ radians} \quad \checkmark \text{ in degrees?} \quad (1)$$

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My bad, text box hid  
the mm.

Question 4:

$D = 110 \text{ mm} = 110 \text{ mm}$

$d = 80 \text{ mm} = 0.08 \text{ m}$

$B = 65 \text{ mm} = 0.065 \text{ m}$

$b = 40 \text{ mm} = 0.04 \text{ m}$

$M = 6200 \text{ Nm}$

$E = 210 \text{ G N/m}^2 = 210 \times 10^9 \text{ N/m}^2$

$\sigma = ?$

$R = ?$

$y_1 = \frac{D}{2} = \frac{110 \text{ mm}}{2} = 55 \text{ mm}$

$$I = \frac{BD^3}{12} - \frac{bd^3}{12}$$

$$I = \frac{(0.065 \times 110^3)}{12} - \frac{(0.04 \times 80^3)}{12}$$

$I = 30.46 \text{ m}^4$

1)  $\frac{M}{I} = \frac{\sigma}{y} = \frac{\sigma}{R} \quad / \quad \frac{M}{I} = \frac{\sigma}{y} \quad / \quad \frac{My}{I} = \sigma$

$\sigma = \frac{6200 \times 55}{30.46}$  ① Carried errors

$\sigma = 11195 \text{ N/m}^2$

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Question 4 next

$$b) \quad \frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R} \quad \bigg/ \quad \frac{M}{I} = \frac{E}{R} \quad \bigg/ \quad \frac{R}{I} = \frac{E}{M} \quad \bigg/$$

$$R = \frac{EI}{M}$$

(2).

$$R = \frac{\left( \frac{M}{210 \times 10^9} \right) (30.46)}{6200}$$

(1)

$$R = 1.03 \times 10^9 \text{ m}$$

x

Carried errors.

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Question 4 with D as 110 mm.

$$\begin{aligned} M &= 6200 \text{ Nm} \\ E &= 210 \text{ GN/m}^2 \\ \sigma &= ? \\ R &= ? \\ y &= \frac{D}{2} = \frac{0.11}{2} = 0.055 \text{ m} \end{aligned}$$

$$\begin{aligned} D &= 110 \text{ mm} = 0.11 \text{ m} \\ d &= 80 \text{ mm} = 0.08 \text{ m} \\ B &= 65 \text{ mm} = 0.065 \text{ m} \\ b &= 40 \text{ mm} = 0.04 \text{ m} \end{aligned}$$

$$I = \frac{BD^3}{12} - \frac{bd^3}{12}$$

$$I = \frac{(0.065 \times 0.11)^3}{12} - \frac{(0.04 \times 0.08)^3}{12}$$

$$I = 2.77 \times 10^{-8} \text{ m}^4$$

$$\frac{M}{I} = \frac{\sigma}{y} \quad / \quad \frac{My}{I} = \sigma$$

$$\sigma = \frac{6200 \times 0.055}{2.77 \times 10^{-8}}$$

$$\boxed{\sigma = 1.23 \times 10^{10} \text{ N/m}^2}$$

$$\frac{M}{I} = \frac{E}{R} \quad / \quad R = \frac{EI}{M}$$

$$R = \frac{(210 \times 10^9)(2.77 \times 10^{-8})}{6200}$$

$$R = 938.225 \times 10^{-3}$$

$$\boxed{R = 0.94 \text{ m}}$$