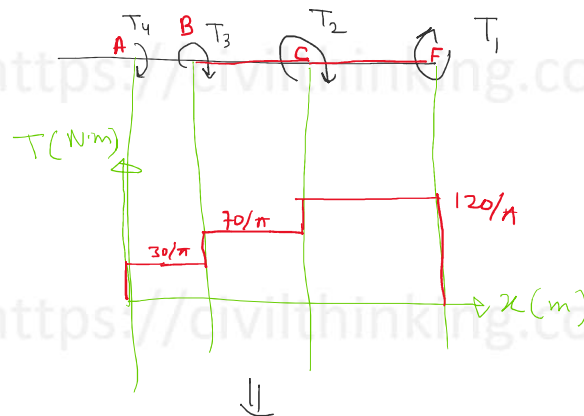
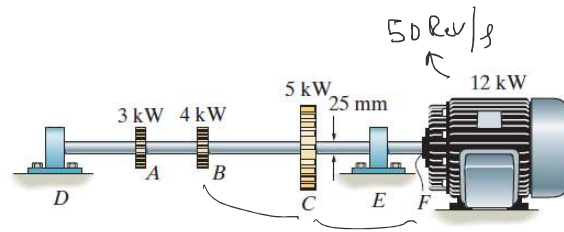


Torsion in Shafts. Question 5-39 Solution

Monday, 10 March, 2025 04:11 PM

5-39. The solid steel shaft DF has a diameter of 25 mm and is supported by smooth bearings at D and E . It is coupled to a motor at F , which delivers 12 kW of power to the shaft while it is turning at 50 rev/s. If gears A , B , and C remove 3 kW, 4 kW, and 5 kW respectively, determine the maximum shear stress developed in the shaft within regions CF and BC . The shaft is free to turn in its support bearings D and E .

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$$T_{\max, BC} = 70/\pi \text{ N.m}; T_{\max, CF} = 120/\pi$$

To find: $\tau_{\max, BC}, \tau_{\max, CF}$

Let's apply Torsion equations to BC & CF:

$$\frac{\tau}{R} = \frac{T}{J}$$

In BC:

$$\frac{\tau_{BC}}{R_{BC}} = \frac{T}{J_{BC}} \Rightarrow \frac{\tau_{BC}}{\frac{0.0250}{2}} = \frac{70/\pi}{\frac{\pi}{2} \left(\frac{0.025}{2} \right)^4} \quad \left[\because R = \frac{\text{diameter}}{2} = \frac{25\text{mm}}{2} = \frac{0.0250}{2} \text{ m} \right]$$

$$\Rightarrow \tau_{BC} = \frac{71680000}{\pi^2} \text{ N/m}^2 = 7.26 \text{ MPa}$$

In CF:

$$\frac{\tau_{cf}}{\frac{0.0250}{2}} = \frac{120/\pi}{\frac{\pi}{2} \left(\frac{0.025}{2}\right)^4} \Rightarrow \tau_{cf} = \frac{122880000}{\pi^2} \text{ N/m}^2 \approx 12.45 \text{ MPa}$$

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