Section 3

Ans 2

Given

diameter ratio, $D_i : D_o = 3:4$

Power, $P = 80\ kW$

$N = 400\ rev/min$

~~$N = 400 \times 2\pi\ rpm = 800\pi\ rpm$~~

$\tau_{max} = 80\ MN/m^2$

$\theta = 4.8°$

$l = 4\ m$

$G = 80\ GPa$

Power is give by $P = \frac{2\pi NT}{60}$

$\Rightarrow 80 \times 10^3 = \frac{2\pi \times 400 \times T}{60}$

$T = 1909.09\ N\text{-}m$

Diameter of shaft when shear stress is not to exceed $70\ MN/m^2$

$$T = \frac{\pi}{16}\tau\left(\frac{D_o^4 - D_i^4}{D_o}\right)$$

$$\Rightarrow 1909.09 \times 10^3 = \frac{\pi}{16} \times 80 \times \frac{\left[D_o^4 - \left(\frac{3}{4}D_o\right)^4\right]}{D_o}$$

$$0.6836 D_o^3 = 121487$$

$$D_o = 56.22 \text{ mm}$$

$$D_i = \frac{3}{4} D_o$$

$$\Rightarrow D_i = \frac{3}{4} \times 56.22 = 42.165 \text{ mm}$$

Diameters of shaft when twist is not to exceed 3.8°

$$\frac{T}{J} = \frac{G\theta}{l}$$

$$\frac{1909.09 \times 10^3}{\frac{\pi}{32}(D_o^4 - D_i^4)} = \frac{80 \times 10^3 \times 4.8 \times \pi}{4000 \times 180}$$

$$\Rightarrow D_o^4 - D_i^4 = \frac{80 \times 10^3 \times 4.8 \times \pi \times \pi}{4000 \times 180 \times 1909.09 \times 32 \times 10^3}$$

$$D_o^4 - \left(\frac{3}{4} D_o\right)^4 = 1161.7104$$

$$D_o = 64.99 \text{ mm}$$

$$D_i = 0.75 \times 64.99 = 48.71 \text{ mm}$$