

ENGINEERING SCIENCE C103  
EXAM SOLUTIONS 2005

Q 2 a) A hollow shaft with an outside diameter of 30 mm and inside diameter of 20 mm carries a torque of 170 Nm. Determine the maximum shear stress in the shaft.

b) If the shaft is 800 mm long and has a modulus of rigidity of 10 GPa, determine the angle of twist between the two ends.

For a hollow cylinder  $J = \frac{\pi(D^4 - d^4)}{32}$

$$J = \frac{\pi(D^4 - d^4)}{32} = \frac{\pi \times (30^4 - 20^4)}{32} = 63814 \text{ mm}^4$$

$$\tau_{\max} = \frac{TR}{J} = \frac{170 \times 0.015}{63814 \times 10^{-12}} = 39.96 \times 10^6 \text{ Pa or } 39.96 \text{ MPa}$$

$$\theta = \frac{TL}{GJ} = \frac{1700 \times 0.8}{10 \times 10^9 \times 63814 \times 10^{-12}} = 0.213 \text{ radian}$$

Converting to degrees  $\theta = 12.2^\circ$