



College of Engineering & Technology

Department: Mechanical Engineering Marks: 15
 Lecturer: Dr. Rola Afify Time: 1.00 - 2.00
 Course Code: ME356 Date: 11/11/2015

Name: Model Answer

R.N.:

Answer the following questions:

Question one (7 marks)

A hollow circular cross-sectional shaft 50 mm outer diameter and 30 mm inner diameter and 0.7 m long is subjected to a torque of 1200 N.m. Calculate the shear stress and the angle of twist. Take $G = 90 \text{ GPa}$.

(Hint: $\frac{T}{J} = \frac{G\theta}{L} = \frac{\tau}{r}$)

$d_o = 50 \text{ mm}$
 $d_i = 30 \text{ mm}$
 $l = 0.7 \text{ m}$
 $T = 1200 \text{ N.m}$
 $\tau = ??$
 $\theta = ??$

$$\tau = \frac{Tr}{J}$$

$$= \frac{1200 \times 10^3 \times 25}{\frac{\pi}{32} (50^4 - 30^4)}$$

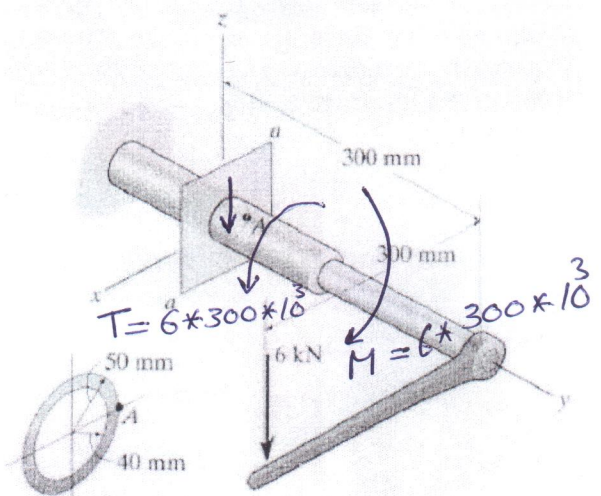
$$= 56.17 \text{ MPa}$$

$$\theta = \frac{T \cdot L}{GJ}$$

$$= \frac{1200 \times 10^3 \times 0.7 \times 10^3}{90 \times 10^3 \times \frac{\pi}{32} (50^4 - 30^4)}$$

$$= 0.0175 \text{ rad}$$

$$= 1^\circ$$



Question two (8 marks)

Determine the maximum stress at section a-a shown in Figure.

Section a-a

torsion

$$\tau = \frac{Tr}{J} = \frac{6 \times 10^3 \times 300 \times 50}{\frac{\pi}{32} [100^4 - 80^4]}$$
$$= 15.527 \text{ MPa}$$

Bending

$$\sigma_b = \frac{My}{I} = \frac{6 \times 10^3 \times 300 \times 50}{\frac{\pi}{64} [100^4 - 80^4]}$$
$$= 31.05$$

The stresses are from different kinds

$$\sigma_{\max} = \frac{\sigma_b}{2} + \sqrt{\left(\frac{\sigma_b}{2}\right)^2 + \tau^2}$$
$$= \frac{31.05}{2} + \sqrt{\left(\frac{31.05}{2}\right)^2 + (15.527)^2}$$
$$= 37.53 \text{ MPa}$$

$$\tau_{\max} = \sqrt{\left(\frac{\sigma_b}{2}\right)^2 + \tau^2}$$
$$= \sqrt{\left(\frac{31.05}{2}\right)^2 + (15.527)^2}$$
$$= 21.96 \text{ MPa}$$