

## MACHINE DESIGN/SHOP PRACTICE PROBLEMS WITH SOLUTIONS

### MULTIPLE CHOICE QUESTIONS

Select the best answer from each of the following questions. On the answer sheet provided, shade the box that corresponds to your choice. Strictly no erasures allowed.

1. If a solid shaft has a diameter of 4 inches. Determine the polar section modulus.  
 a) 25.13 in<sup>3</sup>                      b) 12.57 in<sup>3</sup>                      c) **12.57 in<sup>3</sup>**                      d) 25.13 in<sup>3</sup>

$$\text{Solution: } Z_p = \frac{J}{c} = \frac{2J}{D} = \frac{\pi}{16} D^3 = \frac{\pi}{16} (4)^3 = 12.57 \text{ in}^3$$

2. The transmitted torque of a hollow shaft is 3400 N-m at a shearing stress of 55 MPa. If the outside diameter is 1.25 times that of the inside diameter, what is the inside diameter, in mm?  
 a) **64.87**                      b) 46.87                      c) 84.67                      d) 74.64

$$\text{Solution: } \tau_s = \frac{16T}{\pi D^3 (1 - \beta^4)} \quad \text{where, } \beta = \frac{D_i}{D_o} = \frac{1}{1.25} = 0.8$$

$$D = \sqrt[3]{\frac{16T}{\pi \tau_s (1 - \beta^4)}} = \sqrt[3]{\frac{16(3.4)}{\pi (55000) [1 - (0.8)^4]}} = 81.092 \text{ mm}$$

$$D_i = \frac{D_o}{1.25} = \frac{81.092}{1.25} = 64.87 \text{ mm}$$

3. If the angular deformation of a solid shaft should not to exceed 1° in a length of 1.8 m and the allowable shearing stress is 83 Mpa, what is the diameter of the shaft? Assume that the shaft material has  $G = 77 \times 10^4$  kPa.  
 a) **222.34 mm**                      b) 234.22 mm                      c) 23.42 cm                      d) 24.22 cm

$$\text{Solution: } \theta = \frac{TL}{JG} = \frac{32TL}{\pi D^4 G} = \frac{32 \left( \frac{\pi D^3 \tau_s}{16} \right) L}{\pi D^4 G} = \frac{2 \tau_s L}{DG}$$

$$D = \frac{2 \tau_s L}{\theta G} = \frac{2(83000)(1.8)}{1^\circ \left( \frac{\pi}{180^\circ} \right) (77 \times 10^4)} = 222.34 \text{ mm}$$

4. What modulus of elasticity in tension is required to obtain a unit deformation of 0.00105 from a load producing a unit tensile stress of 3163.27 kg/cm<sup>2</sup>?  
 a)  $40 \times 10^4$  psi                      b)  **$43 \times 10^4$  psi**                      c)  $45 \times 10^4$  psi                      d)  $46 \times 10^4$  psi

# Machine Design Problems And Solutions

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