

## Questions for practice in Machine Design

### PART III

Q.1. Determine the inside diameter and outside diameter of a hollow shaft which will replace a solid shaft made of the same material. The hollow shaft should be equally strong in torsion, yet weigh half as much per meter length.

Q.2. A solid shaft and a hollow shaft are to be of equal strength. The hollow shaft is to be 10% larger than the solid shaft. What will be the ratio of the weight of the hollow shaft to that of the solid shaft? Both the shafts are to be made of the same material.

Q.3. A Hollow shaft, 500mm outside diameter and 300mm inside diameter, is supported in two bearings 6m apart. The shaft is driven by a flexible coupling at one end and drives a ship's propeller at 100rpm. The maximum thrust on the propeller is 500kN when the shaft is transmitting 6000kW. Determine the factor of safety. Give your comment on the result obtained by you.

Use the following data:

Material = 40C8

Combined shock and fatigue factor for bending = 1.5

Combined shock and fatigue factor for torsion = 1.0

Acceleration due to gravity =  $9.8\text{m/sec}^2$ .

Density of material =  $8.1\text{ gms/cc}$ .

Calculation of average torque  $T_{av}$  from rated power [kW] of motor with rpm n:

$$(2\pi n \times T_{av})/60 = 1000 \times [\text{kW}];$$

$$T_{av} = (60 \times 1000) / (2\pi n) \times [\text{kW}] \text{ N-m} = (9549.296586/n) \text{ N-m} \approx (9550/n) \times [\text{kW}] \text{ N-m}$$

$$T_{av} = (9550/n) \times 10^3 \times [\text{kW}] \text{ N-mm.}$$

$$\text{Design Torque } T_d = T_{av} \times C_s.$$