

**330:148 (g) Machine Design  
Assignment 9 (Shaft design)**

**To be submitted by November 5, 2007**

1. A shaft of diameter 60 mm is subjected to a shear stress of 40 MPa and has an angle of twist equal to 0.01 radian. Determine the length of the shaft for  $G = 0.8 \times 10^5$  MPa. (Ans. 600 mm)
2. A 3 ft length of steel shaft is to transmit 50 hp at 3600 rpm. Determine the required shaft size, if the allowable shear stress is 6000 lb/in<sup>2</sup>. (Ans. 15/16 in)
3. A motor shaft is running at 900 rpm delivering 60 kW of power. Calculate the diameter of the motor shaft if the permissible shear stress in the shaft material is not to exceed 55 MPa. (Ans. 40 mm)
4. A 15 kW, 1400-rpm motor drives a centrifugal pump. Determine the diameter of the motor shaft, if the permissible torsional shear stress is limited to 50 MPa. (Ans. 25 mm)
5. The bar of a boring machine having a diameter of 60 mm is subjected to a shear stress of 40 MPa and has an angle of twist of 0.01 radian. Calculate the length of the bar when  $G = 84$  GPa. (Ans. 630 mm)
6. The shaft running at 120 rpm transmits 430 kW. The shaft is to be designed such that the shear stress should not exceed 56 MPa and the angle of twist must not be more than 1 deg on a length of 16 diameters. The modulus of rigidity,  $G$  is  $0.8 \times 10^5$  MPa. Calculate the shaft diameter. (Ans. 160 mm)
7. A hollow shaft of 1¼ in outside diameter and a 5/8 in inside diameter has an allowable stress of 5000 lb/in<sup>2</sup>, and an allowable angle of twist of 0.1 deg per foot of length.  $G = 12 \times 10^6$  lb/in<sup>2</sup>. Find the maximum value of torque that can be applied and how much horsepower can be delivered at 1700 rpm. (Ans. 392 lb in, 10.58 hp)
8. A commercial shaft, 5 ft long between bearings carries a 200 lb pulley at its mid point. The pulley is keyed to the shaft and receives 20 hp at 150 rpm. The belt drive is horizontal with a total belt tension of 1500 lb. Calculate the shaft diameter and angle of twist between the bearings. Take  $G = 12 \times 10^6$  lb/in<sup>2</sup>, allowable shear stress is 6,000 lb/in<sup>2</sup> and allowable normal stress is 12,000 lb/in<sup>2</sup>. (Ans. 2¾ in, 0.214 deg)
9. A line shaft supporting two pulleys A and B is shown in Fig. 1. The allowable stress may be taken as 85 MPa. Determine the shaft diameter. (Ans. 50 mm)

