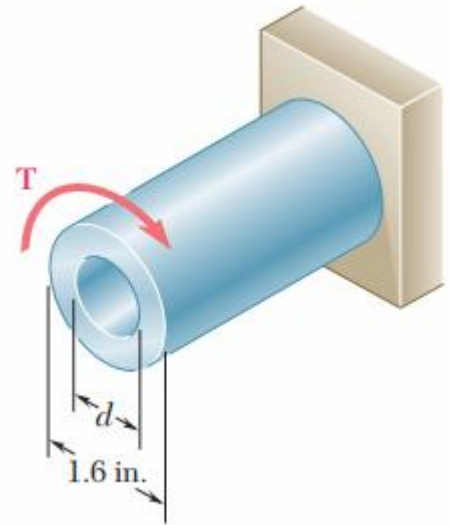


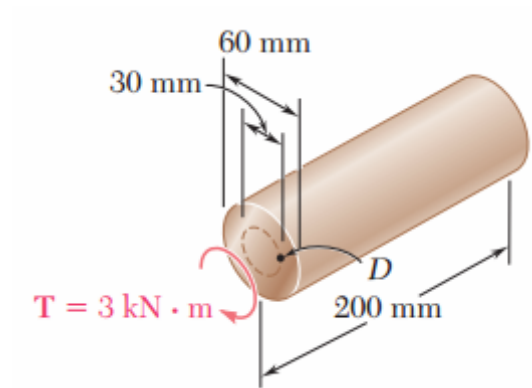


Chapter 3

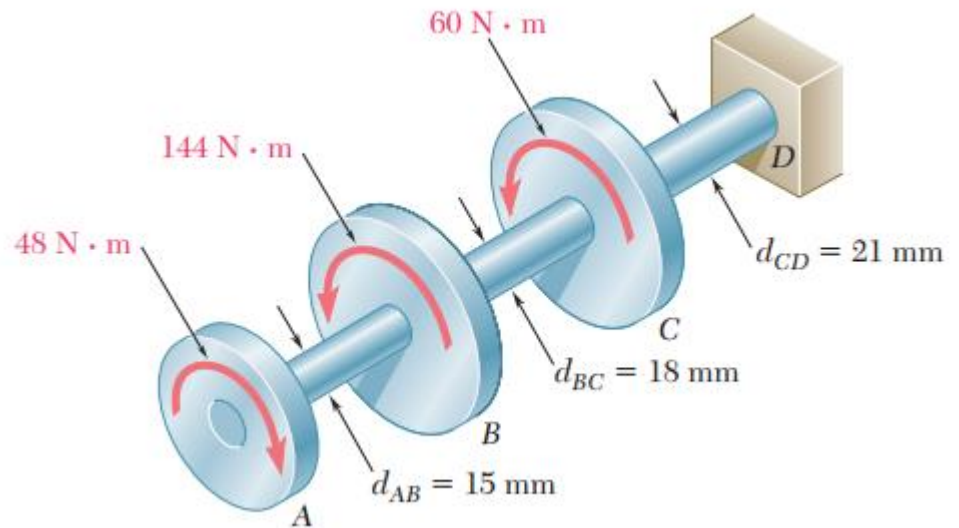
3.3 Knowing that $d = 1.2$ in., determine the torque $\mathbf{T}$ that causes a maximum shearing stress of 7.5 ksi in the hollow shaft shown.



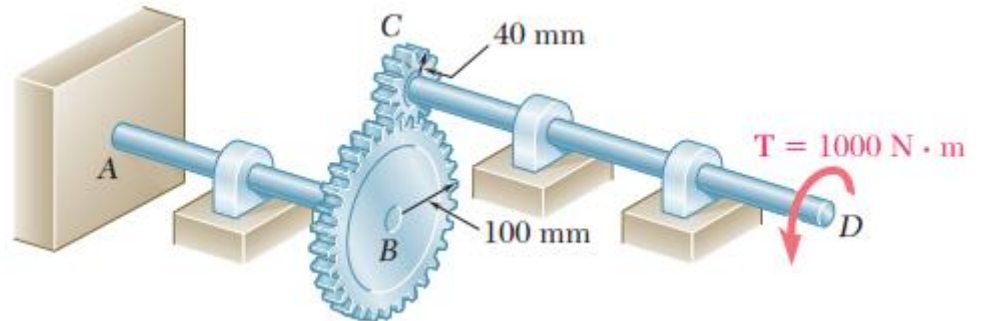
- 3.5** A torque $T = 3 \text{ kN} \cdot \text{m}$ is applied to the solid bronze cylinder shown. Determine (a) the maximum shearing stress, (b) the shearing stress at point D , which lies on a 15-mm-radius circle drawn on the end of the cylinder, (c) the percent of the torque carried by the portion of the cylinder within the 15-mm radius.



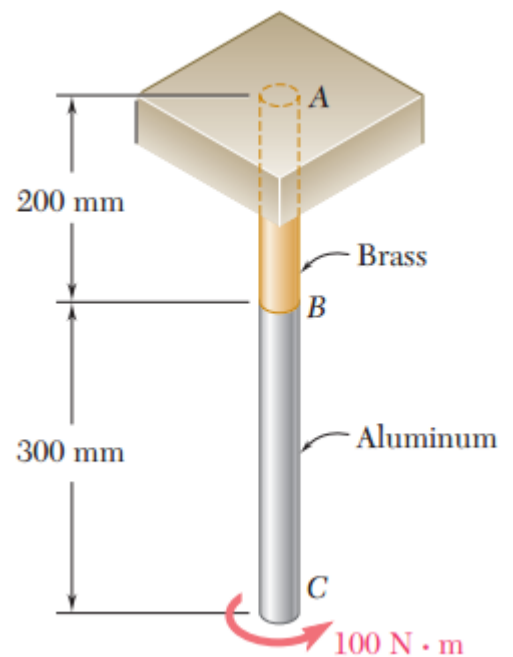
- 3.11** Knowing that each of the shafts AB , BC , and CD consists of a solid circular rod, determine (a) the shaft in which the maximum shearing stress occurs, (b) the magnitude of that stress.



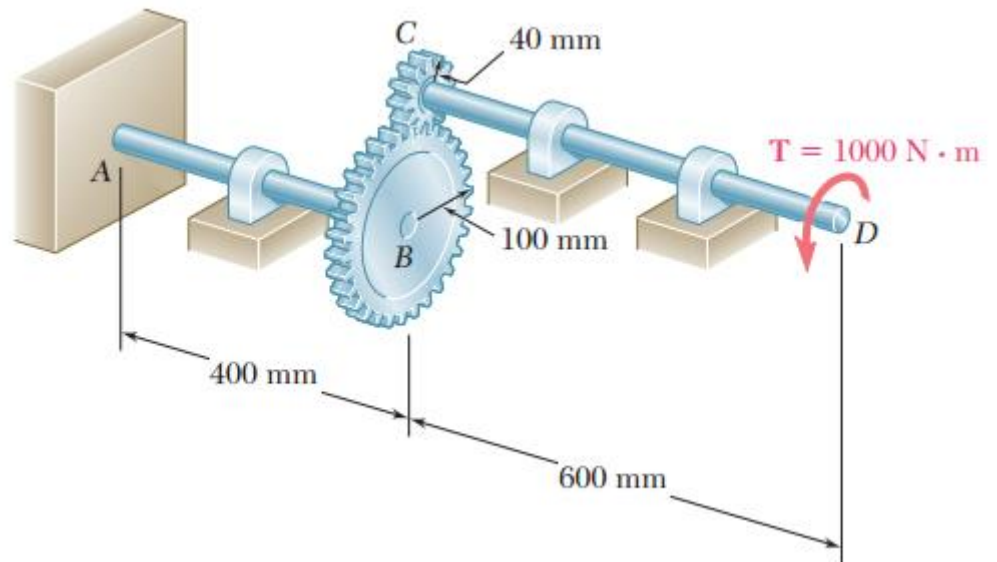
- 3.21** A torque of magnitude $T = 1000 \text{ N} \cdot \text{m}$ is applied at D as shown. Knowing that the diameter of shaft AB is 56 mm and that the diameter of shaft CD is 42 mm, determine the maximum shearing stress in (a) shaft AB , (b) shaft CD .



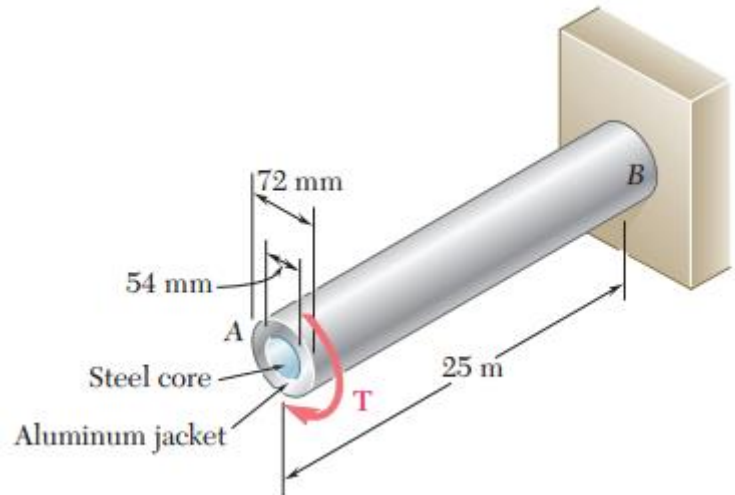
3.37 The aluminum rod BC ($G = 26 \text{ GPa}$) is bonded to the brass rod AB ($G = 39 \text{ GPa}$). Knowing that each rod is solid and has a diameter of 12 mm , determine the angle of twist (a) at B , (b) at C .



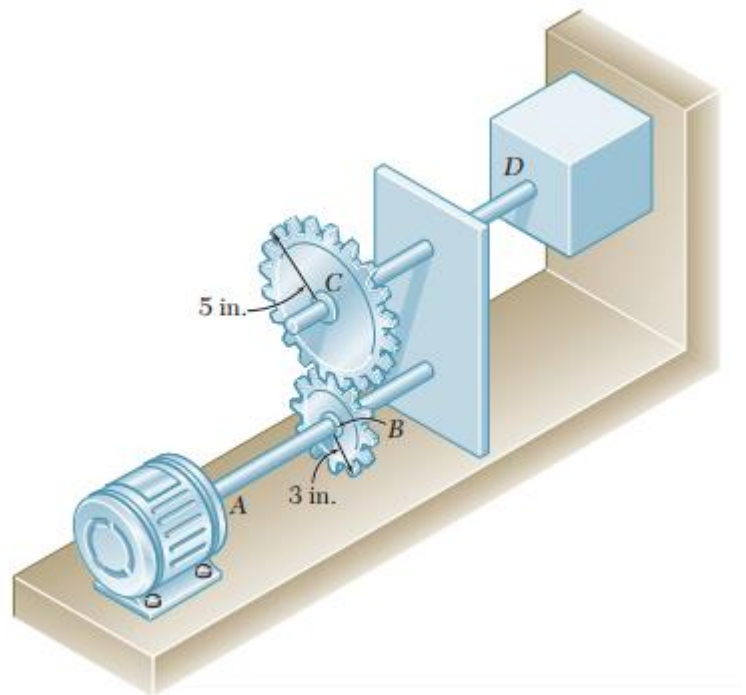
3.45 The design of the gear-and-shaft system shown requires that steel shafts of the same diameter be used for both AB and CD . It is further required that $\tau_{\max} \leq 60$ MPa and that the angle ϕ_D through which end D of shaft CD rotates not exceed 1.5° . Knowing that $G = 77$ GPa, determine the required diameter of the shafts.



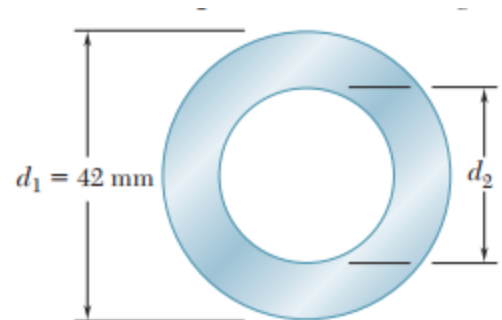
- 3.51** A torque of magnitude $T = 4 \text{ kN} \cdot \text{m}$ is applied at end A of the composite shaft shown. Knowing that the modulus of rigidity is 77 GPa for the steel and 27 GPa for the aluminum, determine (a) the maximum shearing stress in the steel core, (b) the maximum shearing stress in the aluminum jacket, (c) the angle of twist at A.



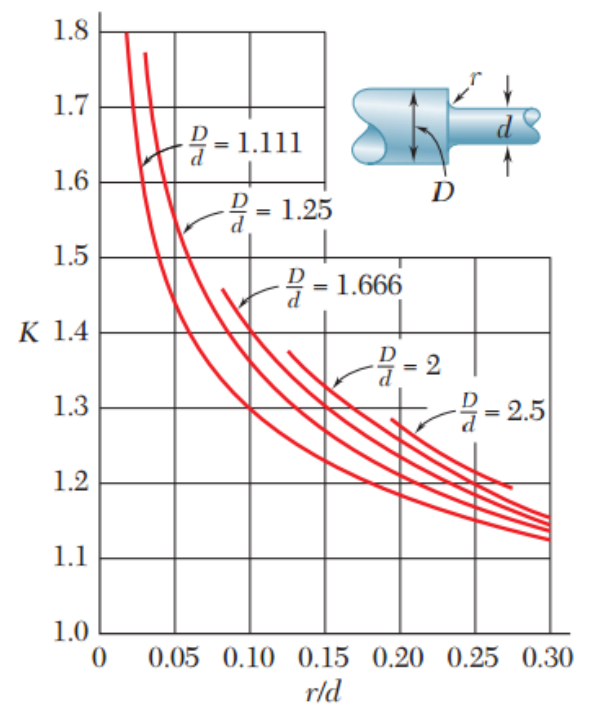
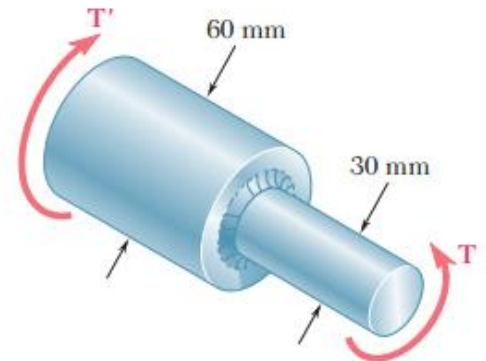
- 3.74** The two solid shafts and gears shown are used to transmit 16 hp from the motor at *A* operating at a speed of 1260 rpm to a machine tool at *D*. Knowing that the maximum allowable shearing stress is 8 ksi, determine the required diameter (*a*) of shaft *AB*, (*b*) of shaft *CD*.



- 3.83** A 1.6-m-long tubular steel shaft ($G = 77.2$ GPa) of 42-mm outer diameter d_1 and 30-mm inner diameter d_2 is to transmit 120 kW between a turbine and a generator. Knowing that the allowable shear stress is 65 MPa and that the angle of twist must not exceed 3° , determine the minimum frequency at which the shaft can rotate.



- 3.87** The stepped shaft shown must transmit 45 kW. Knowing that the allowable shearing stress in the shaft is 40 MPa and that the radius of the fillet is $r = 6$ mm, determine the smallest permissible speed of the shaft.



- 3.125** Determine the largest allowable square cross section of a steel shaft of length 20 ft if the maximum shearing stress is not to exceed 10 ksi when the shaft is twisted through one complete revolution. Use $G = 11.2 \times 10^6$ psi.

TABLE 3.1. Coefficients for Rectangular Bars in Torsion

a/b	c_1	c_2
1.0	0.208	0.1406
1.2	0.219	0.1661
1.5	0.231	0.1958
2.0	0.246	0.229
2.5	0.258	0.249
3.0	0.267	0.263
4.0	0.282	0.281
5.0	0.291	0.291
10.0	0.312	0.312
∞	0.333	0.333

- 3.128** The torque $\mathbf{T}$ causes a rotation of 0.6° at end B of the aluminum bar shown. Knowing that $b = 15$ mm and $G = 26$ GPa, determine the maximum shearing stress in the bar.

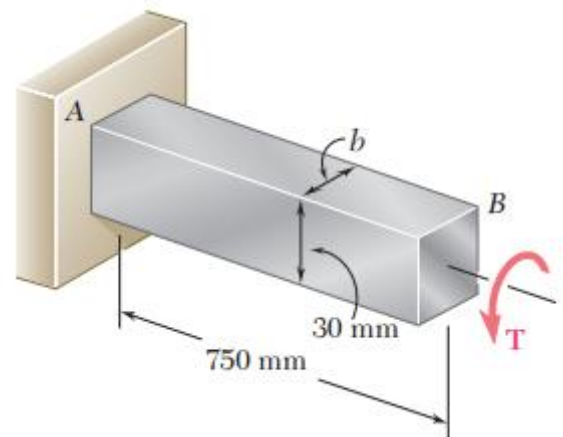
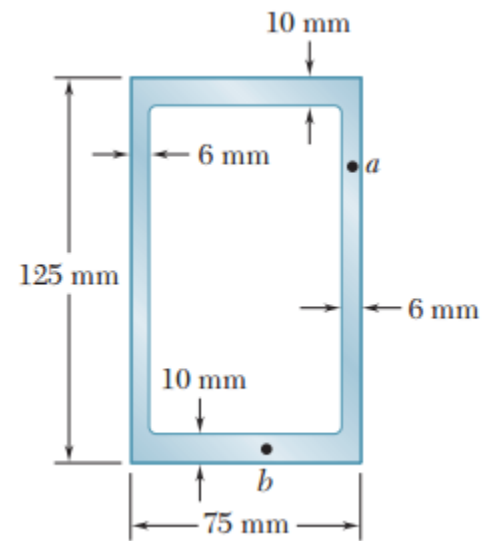


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10.0	0.312	0.312
∞	0.333	0.333

3.140 A torque $T = 5 \text{ kN} \cdot \text{m}$ is applied to a hollow shaft having the cross section shown. Neglecting the effect of stress concentrations, determine the shearing stress at points a and b .



- 3.141** A $90\text{-N} \cdot \text{m}$ torque is applied to a hollow shaft having the cross section shown. Neglecting the effect of stress concentrations, determine the shearing stress at points a and b .

