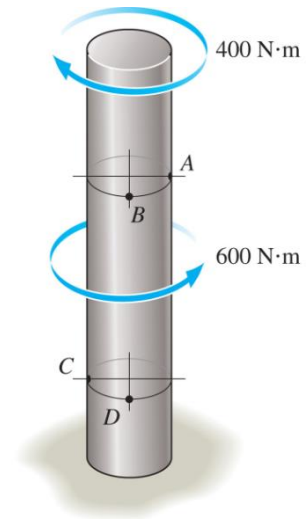
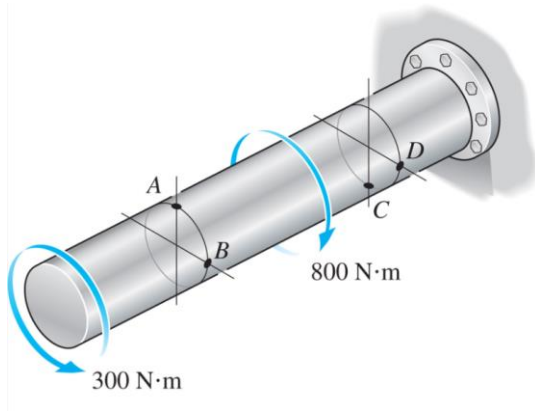


## Chapter 5 Lecture Problems

### Finding the Internal Resultant Torque

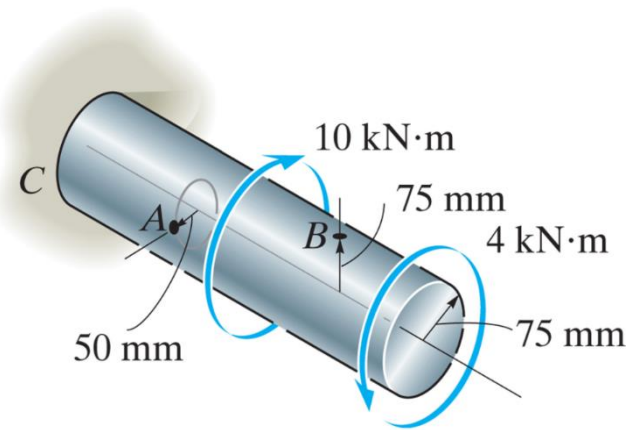
Determine the internal resultant torque at each section. Draw the resulting torque diagram.



## Chapter 5 Lecture Problems

### Problem 5-3

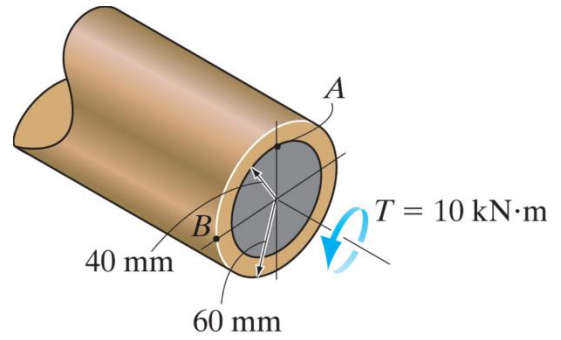
The solid shaft is fixed to the support at C and subjected to the torsional loadings shown. Determine the shear stress at points A and B and sketch the shear stress on the volume elements located at these points.



Chapter 5 Lecture Problems

Problem F5-2

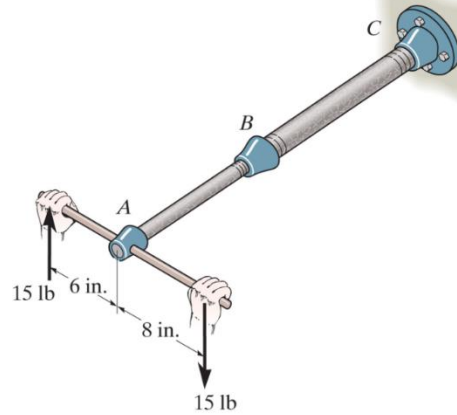
The hollow circular shaft is subjected to an internal torque of  $T=10 \text{ kNm}$ . Determine the shear stress developed at points A and B. Represent each state of stress on a volume element.



## Chapter 5 Lecture Problems

### Problem 5-11

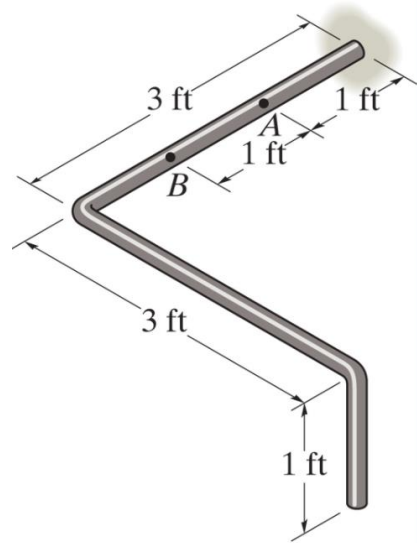
The assembly consists of two sections of galvanized steel pipe connected together using a reducing coupling at B. The smaller pipe has an outer diameter of 0.75 in and an inner diameter of 0.68 in, whereas the larger pipe has an outer diameter of 1 in and an inner diameter of 0.86 in. If the pipe is tightly secured into the wall at C, determine the maximum shear stress developed in each section of the pipe when the couple shown is applied to the handles of the wrench.



Chapter 5 Lecture Problems

Problem 5-44

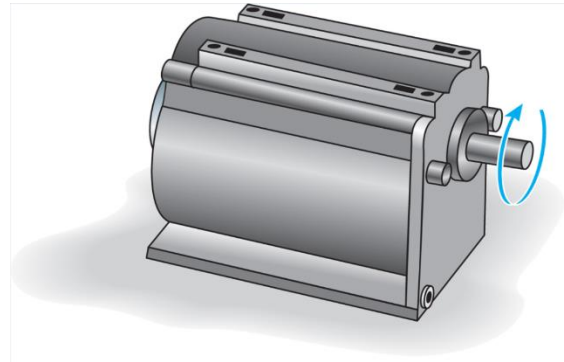
The rod has a diameter of 0.5 in and weight of 5 lb/ft. Determine the maximum torsional stress in the rod at a section at A due to the rod's weight.



## Chapter 5 Lecture Problems

### Problem F5-8

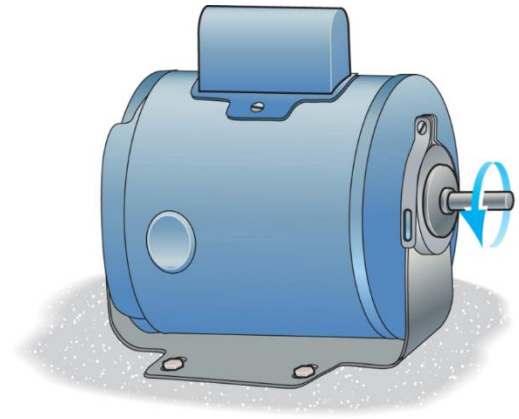
The gear motor can develop 3 hp when it turns at 150 rev/min. If the allowable shear stress for the shaft is  $\tau_{\text{allow}}=12$  ksi, determine the smallest diameter of the shaft to the nearest 1/8 in that can be used.



## Chapter 5 Lecture Problems

### Problem 5-35

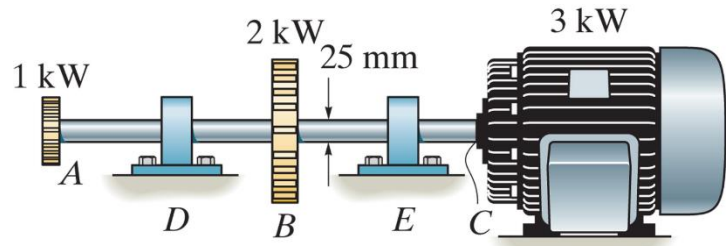
The 25 mm diameter shaft on the motor is made of a material having an allowable shear stress of  $\tau_{\text{allow}}=75$  MPa. If the motor is operating at its maximum power of 5 kW, determine the minimum allowable rotation of the shaft.



## Chapter 5 Lecture Problems

### Problem 5-31

The solid steel shaft AC has a diameter of 25 mm and is supported by smooth bearings at D and E. It is coupled to a motor at C, which delivers 3 kW of power to the shaft while it is turning at 50 rev/s. If gears A and B remove 1 kW and 2 kW, respectively, determine the maximum shear stress developed in the shaft within regions AB and BC. The shaft is free to turn in its support bearing D and E.

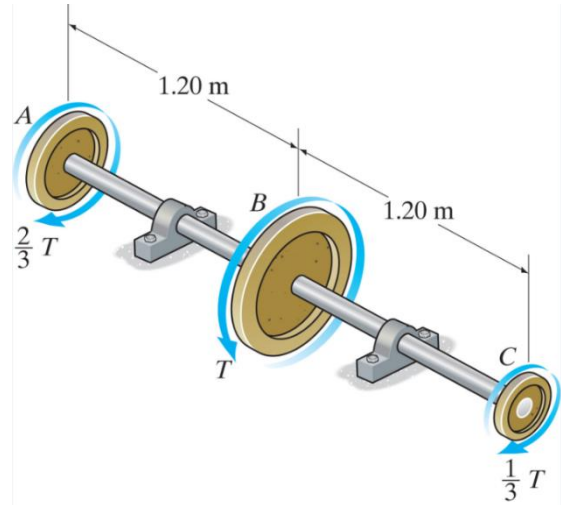




## Chapter 5 Lecture Problems

### Problem 5-51

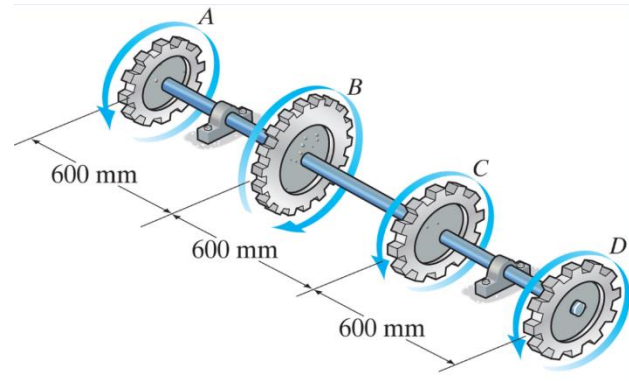
The 60 mm diameter shaft is made of 6061-T6 aluminum having an allowable shear stress of  $\tau_{\text{allow}}=80$  MPa. Determine the maximum allowable torque  $T$ . Also, find the corresponding angle of twist of disk A relative to disk C.



## Chapter 5 Lecture Problems

### Problem 5-54

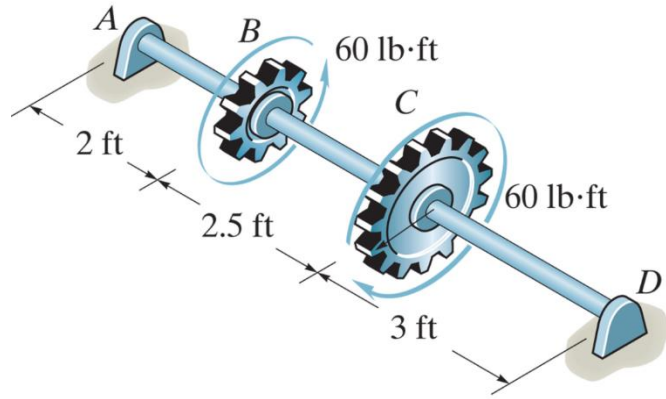
The shaft is made of A992 steel with the allowable shear stress of  $\tau_{\text{allow}}=75$  Mpa. If gear B supplies 15 kW of power, while gears A, C, and D withdraw 6 kW, 4 kW, and 5 kW, respectively, determine the required minimum diameter  $d$  of the shaft to the nearest millimeter. Also find the corresponding angle of twist of gear A relative to gear D. The shaft is rotating at 600 rpm.



Chapter 5 Lecture Problems

Problem 5-59

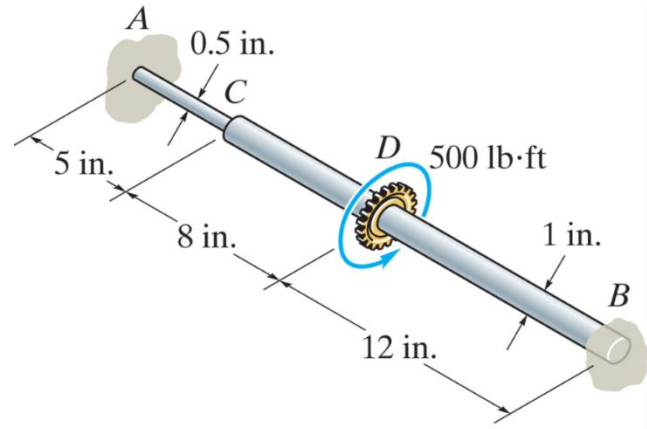
The shaft is made of A992 steel. It has a diameter of 1 in, and is supported by bearings at A and D, which allow free rotation. Determine the angle of twist of B with respect to D.



Chapter 5 Lecture Problems

Problem 5-79

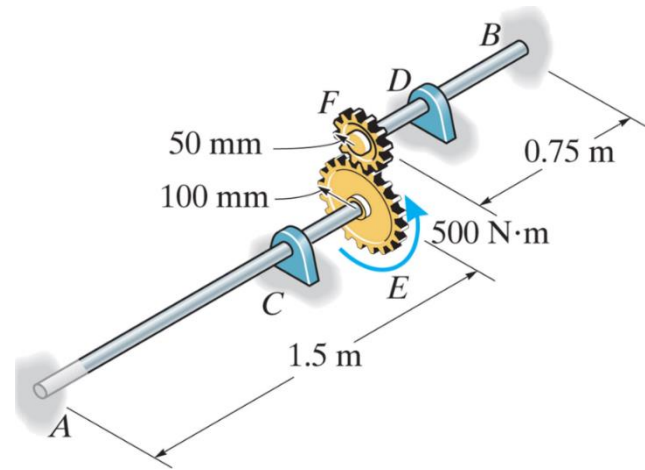
The steel shaft is made from two segments: AC has a diameter of 0.5 in and CB has a diameter of 1 in. If the shaft is fixed at its ends A and B and subjected to a torque of 500 lbft, determine the maximum shear stress in the shaft.  $G_{st}=10.8\text{Msi}$ .



## Chapter 5 Lecture Problems

### Problem 5-86/87

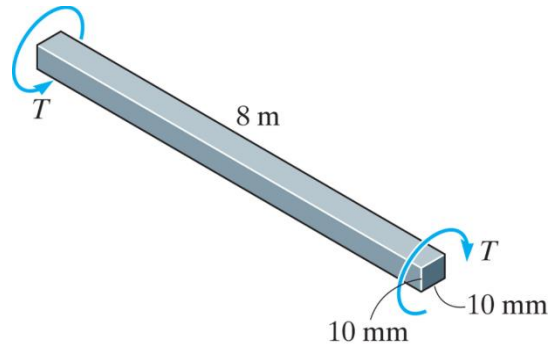
The two shafts are made of A-36 steel. Each has a diameter of 25 mm and they are connected using the gears fixed to their ends. Their other ends are attached to fixed supports at A and B. They are also supported by journal bearings at C and D, which allow free rotation of the shafts along their axes. If a torque of 500 N·m is applied to the gear at E as shown, determine the reactions at A and B. Determine the rotation of the gear at E.



## Chapter 5 Lecture Problems

### Problem 5-95

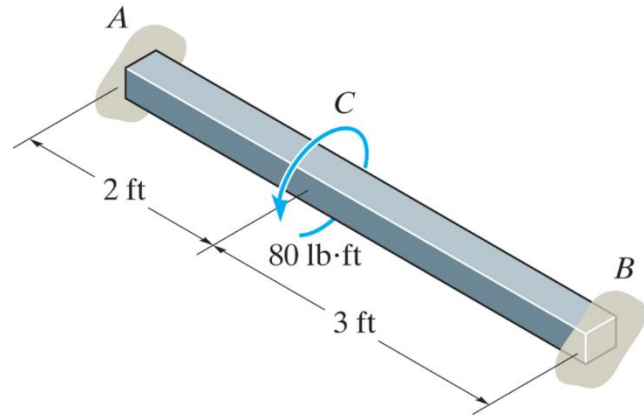
The aluminum rod has a square cross section of 10 mm by 10 mm. If it is 8 m long, determine the torque  $T$  that is required to rotate one end relative to the other end by  $90^\circ$ . ( $G_{al} = 28 \text{ GPa}$ ,  $\tau_{allow} = 240 \text{ MPa}$ )



## Chapter 5 Lecture Problems

### Problem 5-102

The aluminum strut is fixed between the two walls at A and B. If it has a 2 in by 2 in cross section, and it is subjected to the torque of 80 ft·lb at C, determine the reactions at the fixed supports. Also, what is the angle of twist at C?  $G_{al} = 3.8 \text{ Msi}$



## Chapter 5 Lecture Problems

### Problem 5-121

The step shaft is to be designed to rotate at 720 rpm while transmitting 30 kW of power. Is this possible? The allowable shear stress is  $\tau_{\text{allow}}=12$  MPa and the radius at the transition on the shaft is 7.5 mm.

