1. Write out and describe the similarities and differences between the equations for deformation in axial members and angle of twist for torsional members.

2. A solid steel shaft has a diameter of 5 inches and is 3 feet long. The shaft is fixed at one end and free at the other. A counter-clockwise torque of 15 k-in is applied at the free end. If a second torque is applied at the midpoint of the shaft of 25 k-in. Determine the angle of twist at the free end.

3. A series of four gears are mounted on a 5 inch diameter steel shaft that is 8 feet long. Gear A is at 0 ft, Gear B at 2 ft, Gear C at 4 ft, and Gear D at 8 ft along the length. The torque on Gears A and C is 20 k-ft clockwise. The torque on Gear B is 10 k-ft counterclockwise and Gear D is 30 k-ft counterclockwise.

    a. Determine the angle of twist of gear D relative to A.
    b. Determine the angle of twist of gear C relative to A.
    c. Determine the angle of twist of gear C relative to B.

4. A motor delivers 500 hp to a tubular shaft with an outer diameter of 2 in. If the shaft is rotating at 200 rad/s, determine the required inner diameter if the allowable shear stress is 8 ksi. What is the angle of twist of the shaft when the engine is operating?