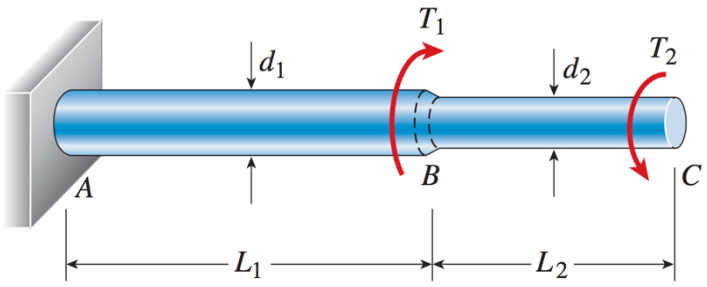
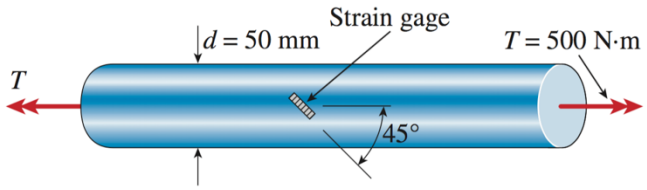
ME 202 Strength of Materials Spring 2023
Tutorial 1 12 Jan 2023

1. A stepped shaft ABC consisting of two solid circular segments is subjected to torques T_1 and T_2 acting in opposite directions, as shown in the figure. First, sketch the free body diagram of the entire shaft and of each segment AB and BC. Then, using the torsion formulas, calculate the following quantities: (a) the maximum shear stress in each segment of the shaft, and (b) the angle of twist at end C. Hint: first solve the problem with T_1, T_2 pointing in the same direction for simplicity. Then solve the problem with the given directions as shown in the figure.



2. A solid circular bar of diameter $d = 50$ mm is twisted in a testing machine until the applied torque reaches $T = 500$ Nm. At this value of the torque, a strain gage oriented at 45 deg to the axis of the bar gives a reading of 339×10^{-6}. Find the shear modulus of the material.



3. A rigid flywheel of mass M = 10 kg and radius of gyration K = 200 mm is rigidly attached at the end of a massless elastic shaft of length L=1 m, cross-sectional diameter d = 50 mm, and shear modulus G=75 GPa. The shaft-flywheel assembly is rotating with a constant angular speed n = 2500 rpm. All of a sudden, the bearing at A jams/locks/freezes. Calculate (1) the maximum angle of twist in the shaft (2) the maximum shear stress in the shaft. Ignore the effect of gravity, and friction in bearings B, C. Hint: use the principle of conservation of energy. Try solving the equivalent problem involving axial deformations before tackling the torsion problem.