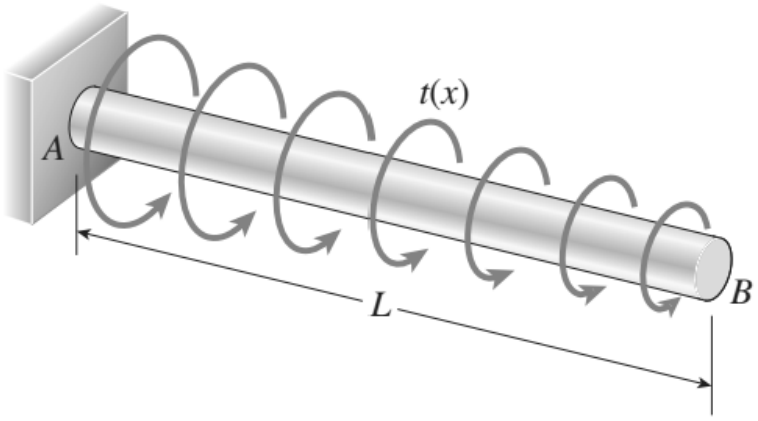
ME 323: Mechanics of Materials **Homework 4**

Spring 2026 **Due: February 13, 2026**

Problem 1 (10 points):

A solid prismatic bar AB of uniform circular cross section (diameter d) is loaded by a distributed torque (see figure). The intensity of the distributed torque, that is, the torque per unit distance, is denoted $t(x)$ (Nm/m) and varies linearly from a maximum value t_A at end A to zero at end B. Also, the length of the bar is L and the shear modulus of elasticity of the material is G.

(a) Determine the maximum shear stress τ_{max} in the bar.
(b) Determine the angle of twist ϕ between the ends of the bar.



Problem 2 (10 points):

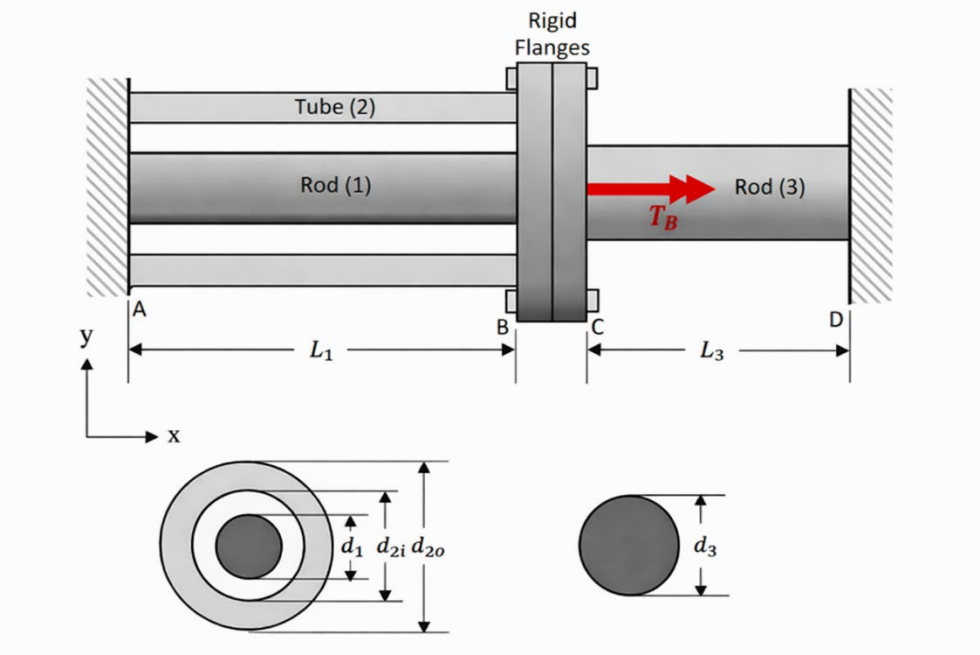
A solid rod (1) of diameter d_1 is enclosed by a concentric tube (2) of inner diameter d_{2i} and outer diameter d_{2o}, and both are attached to a rigid support at A and a rigid flat flange at B. A solid rod (3) of diameter d_3 is similarly attached to a rigid support at D and a rigid flat flange at C. The flanges are securely connected. Subsequently, an external torque T_B is applied at B.

(a) Determine the internal torques T_1, T_2, T_3 in three elements resulting from the load T_B
(b) Determine the maximum shear stresses $\tau_{max\,(1)}, \tau_{max\,(2)}, \tau_{max\,(3)}$ in the three elements.
(c) Determine the angle of twist at the rigid flanges (B or C)

Given : $d_1 = 3$ cm, $d_{2i} = 4$ cm, $d_{2o} = 5$ cm, $d_3 = 3.5$ cm,

$G_1 = 20$ GPa, $G_2 = 10$ GPa, $G_3 = 30$ GPa,

$L_1 = 200$ cm, $L_3 = 100$ cm, $T_B = 100$ N m



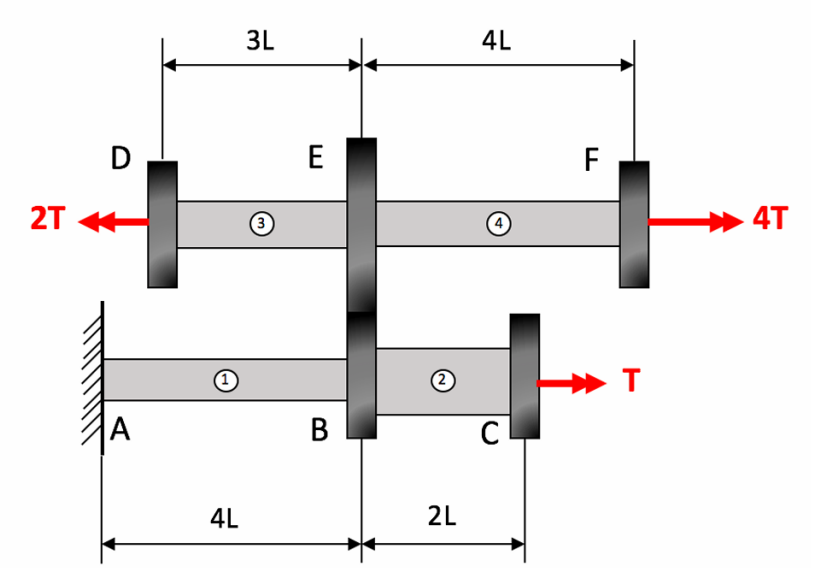
Problem 3 (10 points):

The gear shaft system consists of two parallel shafts, ABC and DEF. The shafts are interconnected by gears at B and E. The diameters of members 1, 2, 3, and 4 are d_1, d_2, d_3 and d_4, respectively. Both shafts have the same shear modulus G. Determine the angle of twist at C and F

Given : $d_1 = D, d_2 = 2D, d_3 = 1.5D, d_4 = 1.5D,$

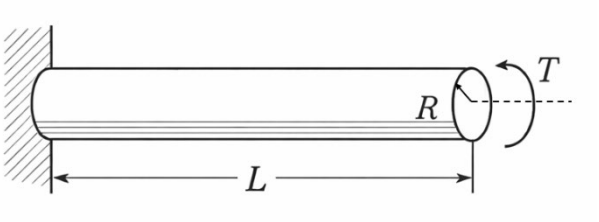
$d_B = 4D, d_E = 6D;\ \ D = 20$ mm,

$L = 500$ mm, $G = 100$ GPa, $T = 1500$ N m



Problem 4 (5 points):

Consider a circular shaft of radius R, length L, and shear modulus G, subjected to torque T at the free end, as shown in the figure. Determine the effect the following changes would have:



4.1 Increasing the shaft radius, R, would _____ the maximum shear stress

(a) Increase

(b) Decrease

(c) Not change

4.2 Increasing the shaft length, L, would _____ the maximum shear stress

(a) Increase

(b) Decrease

(c) Not change

4.3 Increasing the shaft shear modulus, G, would _____ the maximum shear stress

(a) Increase

(b) Decrease

(c) Not change

4.4 Increasing the shaft radius, R, would _____ the angle of rotation at the free end

(a) Increase

(b) Decrease

(c) Not change

4.5 Increasing the shaft length, L, would _____ the angle of rotation at the free end

(a) Increase

(b) Decrease

(c) Not change