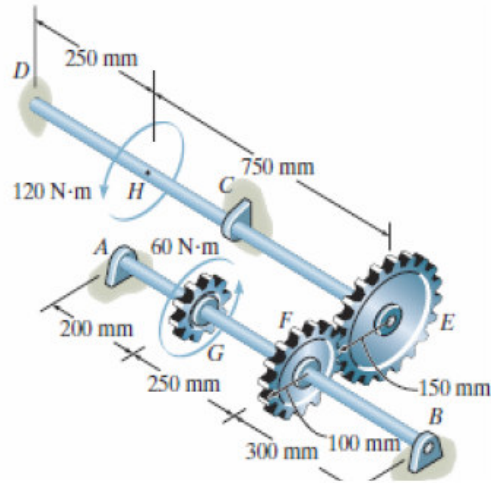


Problem 5-59

The two shafts are made of A-36 steel. Each has a diameter of 25 mm, and they are supported by bearings at *A*, *B*, and *C*, which allow free rotation. If the support at *D* is fixed, determine the angle of twist of end *A* when the torques are applied to the assembly as shown.

- Given:** $L_{DH} := 250\text{mm}$ $L_{HE} := 750\text{mm}$
 $L_{AG} := 200\text{mm}$ $L_{GF} := 250\text{mm}$
 $L_{FB} := 300\text{mm}$ $d := 25\text{mm}$
 $r_E := 150\text{mm}$ $r_F := 100\text{mm}$
 $T_H := 120\text{N}\cdot\text{m}$ $T_G := 60\text{N}\cdot\text{m}$
 $G := 75\text{GPa}$



Solution:

Internal Torque : AS shown on FBD

At F: $T_F = T_G$ $P := \frac{T_G}{r_F}$ $P = 600\text{ N}$

At E: $T_E := -P \cdot (r_E)$ $T_E = -90\text{N}\cdot\text{m}$

Angle of Twist :

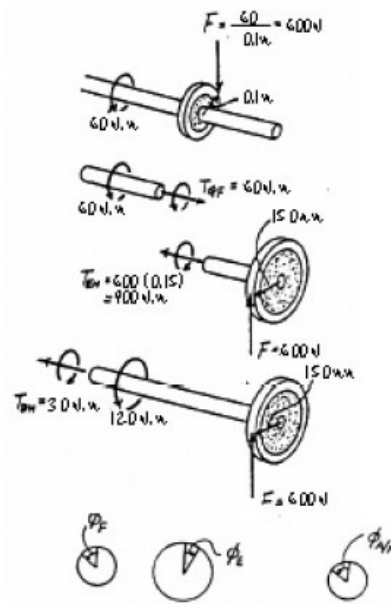
$$J := \frac{\pi}{2} \cdot \left(\frac{d}{2}\right)^4$$

$$\phi_E := \frac{T_H \cdot L_{DH}}{G \cdot J} + \frac{T_E \cdot (L_{DH} + L_{HE})}{G \cdot J}$$

$$\phi_E = -0.020861\text{ rad}$$

$$\phi_E \cdot (r_E) = -\phi_F \cdot (r_F) \quad \phi_F := -\frac{r_E}{r_F} \cdot \phi_E$$

$$\phi_F = 0.031291\text{ rad}$$



Since there is no torque applied between *A* and *G*,

$$\phi_{A_F} := \frac{T_G \cdot L_{GF}}{G \cdot J} \quad \phi_{A_F} = 0.005215\text{ rad}$$

$$\phi_A := \phi_{A_F} + \phi_F \quad \phi_A = 0.036506\text{ rad}$$

$\phi_A = 2.092\text{ deg}$ **Ans**