TOBB EKONOMİ VE TEKNOLOJİ ÜNİVERSİTESİ

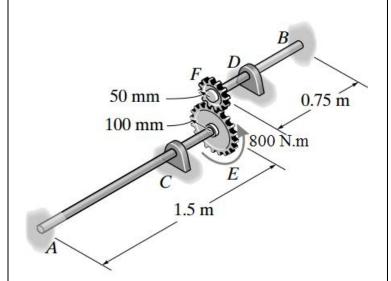MAK 206 Strength of Materials – 2015 Spring
QUIZ 4
13 February 2015   Ad, Soyad: **SOLUTION**
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Problem: The two shafts are made of A-36 steel. Each has a diameter of 30 mm and they are connected using the gears fixed to their ends. Their other ends 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 800 N.m is applied to the gear at E as shown,

   a) Determine the reactions at A and B.
   b) Determine the rotation of the gear at E.

Given: G_{st}= 75 GPa

a)
Equilibrium:

$$T_A + F(0.1) - 800 = 0 \quad\quad [1]$$
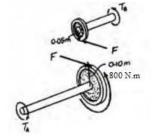
$$T_B - F(0.05) = 0 \quad\quad [2]$$

From Eqs. [1] and [2]

$$T_A + 2T_B - 800 = 0 \quad\quad [3]$$

Compatibility:

$$0.1\phi_E = 0.05\phi_F$$

$$\phi_E = 0.5\phi_F$$

$$\frac{T_A(1.5)}{JG} = 0.5\left[\frac{T_B(0.75)}{JG}\right]$$

$$T_A = 0.250T_B \quad\quad [4]$$

Solving Eqs. [3] and [4] yields:

$$T_B = 355.55 \text{ N} \cdot \text{m} \quad\quad \text{Ans.}$$

$$T_A = 88.88 \text{ N} \cdot \text{m} \quad\quad \text{Ans.}$$

b)
Angle of Twist:

$$\phi_E = \frac{T_A L}{JG} = \frac{88.88(1.5)}{\frac{\pi}{2}(0.0150^4)(75.0)(10^9)}$$

$$= 0.02235 \text{ rad} = 1.28° \quad\quad \text{Ans.}$$