2.44. A dc motor develops 55 N-m of torque at a speed of 600 rad/s when 12 volts are applied. It stalls out at this voltage with 100 N-m of torque. If the inertia and damping of the armature are 7 kg-m^2 and 3 N-m-s/rad, respectively, find the transfer function, $G(s) = \theta_L(s)/E_a(s)$, of this motor if it drives an inertia load of 105 kg-m^2 through a gear train, as shown in Figure P2.30. [Section: 2.8]

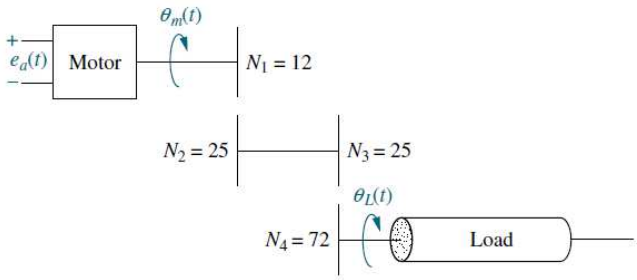
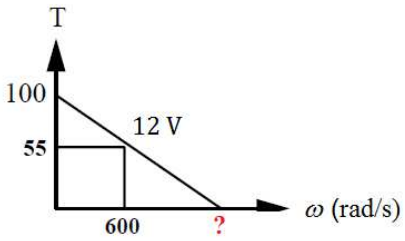


FIGURE P2.30



$$\frac{\theta_m(s)}{E_a(s)} = \frac{K_t/(R_a J_m)}{s\left[s + \frac{1}{J_m}(D_m + \frac{K_t K_b}{R_a})\right]}$$

$$\frac{R_a}{K_t} T_m(t) + K_b \omega_m(t) = e_a(t)$$

Çözüm: Motor armatür (rotor, döneç) eylemsizlik ve sönüm değerleri: J_a=7 kg-m^2, D_a=3 N-m-s/rad olarak veriliyor.

T_{max}=100 N-m veriliyor. Ayrıca 600 rad/s hızda tork 55 N-m olarak veriliyor.

ω_{max}=? hesaplamamız gerekiyor. Tork-Hız grafiğinde oluşan üçgen benzerliğini kullanarak

ω_{max}= 1333.3333 olarak hesaplanır.

Bu durumda:

$$\frac{K_t}{R_a} = \frac{T_{stall}}{E_a} = \frac{100}{12}; \qquad K_b = \frac{E_a}{\omega_{no-load}} = \frac{12}{1333.33}. \qquad J_m = 7 + 105\left(\frac{1}{6}\right)^2 = 9.92; \qquad D_m = 3.$$

hesaplanabilir. Bu değerleri formülde yerine yazarsak transfer fonksiyonu:

$$\frac{\theta_m(s)}{E_a(s)} = \frac{\left(\frac{100}{12}\right)\frac{1}{9.92}}{s(s + \frac{1}{9.92}(3.075))} = \frac{0.84}{s(s+0.31)}.$$

bulunur. Bizden istenen $\frac{\theta_L(s)}{E_a(s)}$ oranı ise:

$$\theta_L(s) = \frac{1}{6}\theta_m(s), \qquad \frac{\theta_L(s)}{E_a(s)} = \frac{0.14}{s(s+0.31)}.$$

olarak hesaplanabilir.