Excercise1: DC motor simulation

演習1: DCモータの制御

Simulate and plot a rotation speed the following motor from 0 to 1 [sec] with 1 [msec] interval when applying Em = {1.5, 3.0, 4.5, 6.0} [v]. Submit a Matlab source code

次のモータの回転速度を数値計算しプロットせよ.時間は0から1秒まで1ミリ秒刻みで,Emは{1.5, 3.0, 4.5, 6.0}[V]. Matlabのソースコードを提出せよ

- Rm = 37.5 [Ohm]
- Lm = 0.29 [mH] = $0.29 * 10^{-3}$ [H]
- Jm = 0.015[gcm^2] = $0.015 *10^{-7}$ [kgm^2]
- Kt = 2.63 [mNm/A] = $2.63 * 10^{-3}$ [Nm/A]
- Ke = 3840[rpm/V] = 0.002488 [V/ (rad/s)]

DC motor equation (4/4)

Generated torque accelerates a rotar

$$\tau(t) = J_M \ddot{\theta}(t) + \tau_L$$

J_M: rotar intertia moment [Nm/rad.^2]
τ_L: load torque [Nm]

If τ_L=0, from the above equations, eliminating τ and I_M,

$$E_M(t) = \left(\frac{L_M J_M}{K_E K_T} \dddot{\theta}(t) + \frac{R_M J_M}{K_E K_T} \ddot{\theta}(t) + \dot{\theta}(t) \right) K_e$$

$$= \left(T_m T_e \dddot{\theta}(t) + T_m \ddot{\theta}(t) + \dot{\theta}(t) \right) K_e$$

$$T_m = \frac{R_M J_M}{K_e K_T} \quad T_e = \frac{L_M}{R_M}$$

T_m: mechanical time const.
T_e: electrical time const.

Example of Laplace transform

Motor equation

$$E_M(t) = \left(T_m T_e \dddot{\theta}(t) + T_m \ddot{\theta}(t) + \dot{\theta}(t)\right) K_e$$

$E_M(t)$: Applied Voltage [V] $E_M(s)$: Laplace transformed
$\theta(t)$: Rotar angle [rad] $\theta(s)$: Laplace transformed

$$E_M(s) = \left(T_m T_e s^3 \theta(s) + T_m s^2 \theta(s) + s\theta(s)\right) K_e$$

$$E_M(s) = s\theta(s) K_e \left(T_m T_e s^2 + T_m s + 1\right)$$

$$\approx s\theta(s) K_e \left(T_m s + 1\right)\left(T_e s + 1\right) \qquad T_m >> T_e$$

$$\frac{E_m(s)}{s\Theta(s)} = \frac{E_m(s)}{\Omega(s)} = \frac{1}{K_e\left(T_m s + 1\right)\left(T_e s + 1\right)}$$