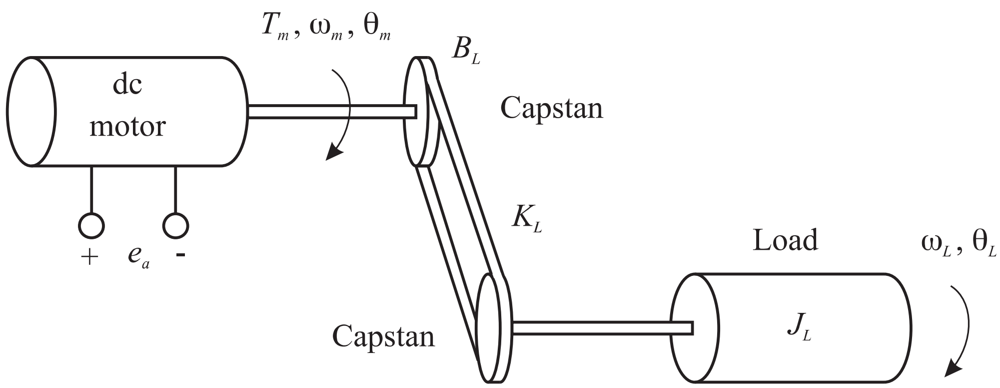
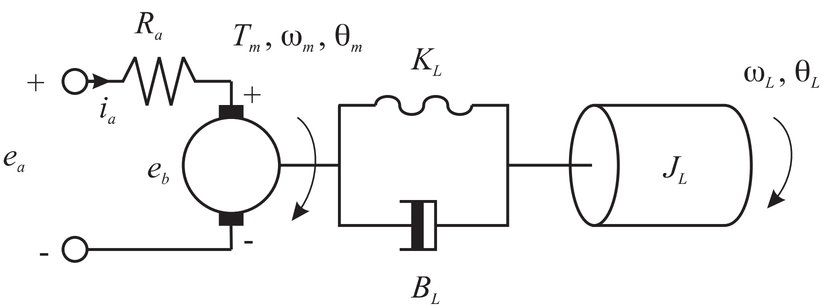
Tape Drive System

A tape drive system utilizing a permanent-magnet dc motor is shown below.



The system is modeled by the following diagram.



The system parameters are

$$
\begin{array}{ll}
K_a/R_a = 36 \text{ oz-in/volt} & J_m = 0.023 \text{ oz-in-sec}^2 \\
K_e = 6.92 \text{ oz-in/rad/sec} & K_L = 2857.6 \text{ oz-in/rad} \\
B_L = 10 \text{ oz-in-sec} & J_L = 7.24 \text{ oz-in-sec}^2
\end{array}
$$

The constant K_L represents the spring constant of the elastic tape, B_L denotes the viscous friction coefficient between the tape and the capstans, K_b is the back emf constant, $K_e=K_bK_a/R_a+B_m$, K_a is the torque constant, and B_m is the motor viscous friction constant.

The state equations can be written

$$
\dot{\mathbf{x}}(t) = \begin{bmatrix} 0 & 1 & 0 & 0 \\ -K_L/J_L & -B_L/J_L & K_L/J_L & B_L/J_L \\ 0 & 0 & 0 & 1 \\ K_L/J_m & B_L/J_m & -K_L/J_m & -(K_e+B_L)/J_m \end{bmatrix} \mathbf{x}(t) + \begin{bmatrix} 0 \\ 0 \\ 0 \\ K_a/(J_m R_a) \end{bmatrix} \mathbf{u}(t)
$$

$$\mathbf{y}(t) = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 \end{bmatrix} \mathbf{x}(t)$$

where

$$x_1(t) = \theta_L$$
$$x_2(t) = \omega_L = \dot{\theta}_L$$
$$x_3(t) = \theta_m$$
$$x_4(t) = \omega_m = \dot{\theta}_m$$

The input is

$$u(t) = \mathrm{e}_a$$

The objective of the control system is to accurately control the speed of the load.