EEENG307: Controlling DC Motors[1]

Lecture 21

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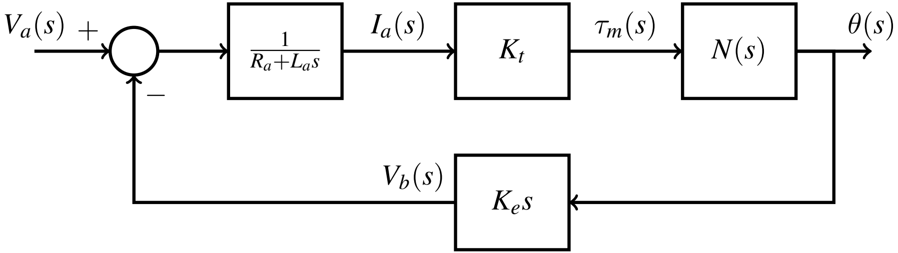
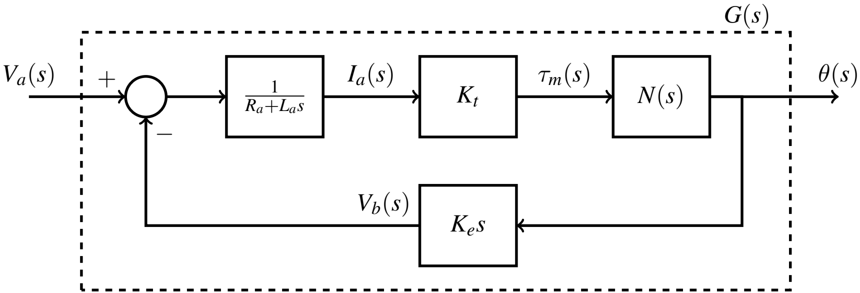
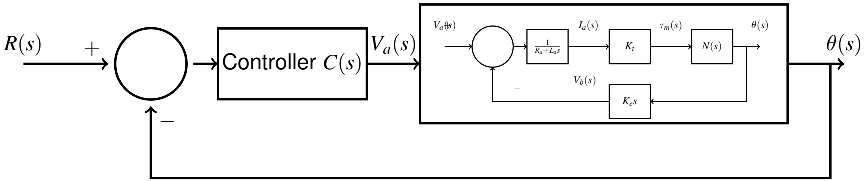
DC motor block diagram with arbitrary load



DC motor block diagram is the open loop plant



Feedback control of DC motor with plant shown



DC Motor Control Video Example

Consider the DC motor control problem shown in the video
https://www.youtube.com/watch?v=dTGITLnYAY0.

DC Motor Control Prompts

- What hardware is needed? Consider plant (DC motor), sensor, actuator and controller.
- What two physical components are considered as part of the “plant” in the video?
- What is the reference input signal called in the video?
- What kind of controller is used in the video?
- How are the integral and derivative terms estimated in this discrete-time control algorithm?
- What is the performance of the feedback controller at the first test? Consider both steady-state and transient (rise time, settling time, and percent overshoot) response.
- What control term is tuned to solve the problem identified in the previous step?
- What reference input signals are used?
- What types of disturbances are expected to impact the DC motor system?

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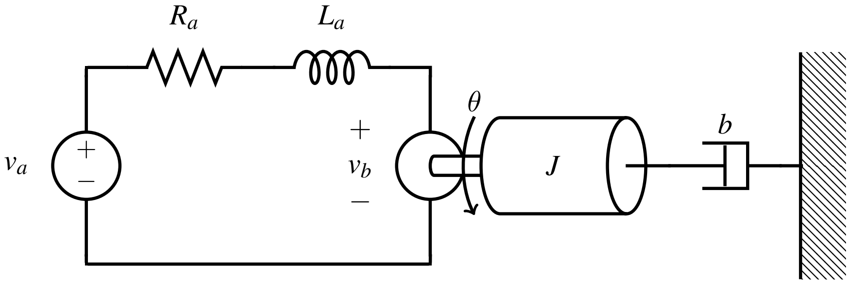
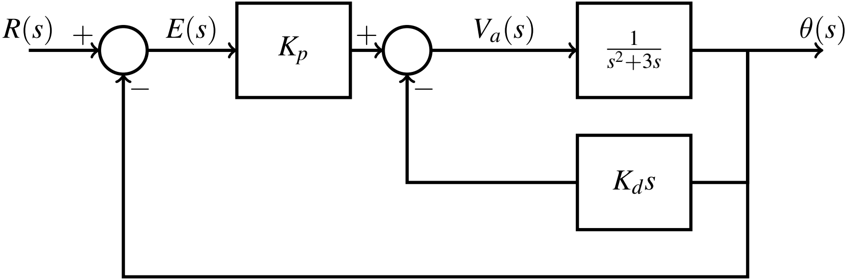


$$R_a = 1,\ L_a = 0,\ J = 1,\ b = 2,\ K_e = K_t = 1$$

- rise time, $t_r = .1$ s
- overshoot, $\%OS = 10\%$.



$$\frac{\theta(s)}{R(s)} = \frac{K_p}{s^2 + (3 + K_d)s + K_p}$$

$\omega_n^2 = K_p$, $2\zeta\omega_n = 3 + K_d$ and $K = 1$

- $t_r = \frac{2.2}{\omega_n} = .1$ implies $\omega_n = 22$
- $\%OS$ =10% implies $\zeta = \frac{-\ln\left(\frac{10\%}{100\%}\right)}{\sqrt{\ln\left(\frac{10\%}{100\%}\right)^2 + \pi^2}} = .59$

$$K_p = \omega_n^2 = 22^2 = 484$$
$$K_d = 2\zeta\omega_n - 3 = 2(.59)(22) - 3 = 22.96$$