TD 2 : (Review 2) Feedback Control System

Oct,25,2021 - It Chivorn

Problem 1.1 The block diagram of a system is shown in Figure 1. Determine the transfer function $T(s) = \dfrac{E(s)}{E_o(s)}$

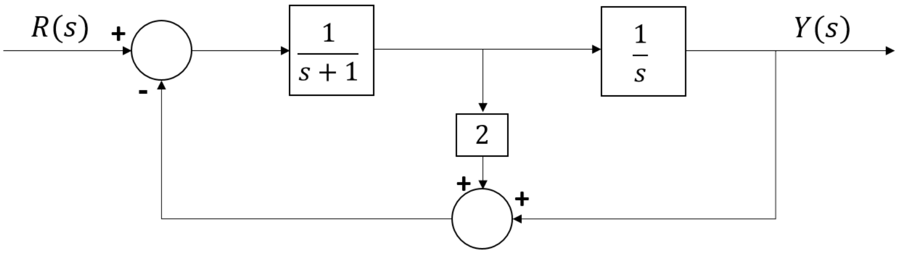

Figure 1: Multiloop feedback system

Problem 1.2 Consider a series LRC circuit:

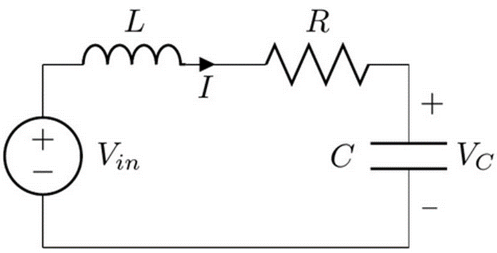

Figure 2: LRC circuit

1. Express the transfer function of LRC circuit $H(s) = \dfrac{V_c(s)}{V_{in}(s)}$.
2. Sketch pole-zero plan.
3. Find damping factor ζ and nature frequency ω_n of the second order system.

Problem 1.3 Determine the transfer function $H(s) = \dfrac{E_o(s)}{E_i(s)}$ for the op-amp circuit shown in Figure 3. Assume an ideal op-amp.

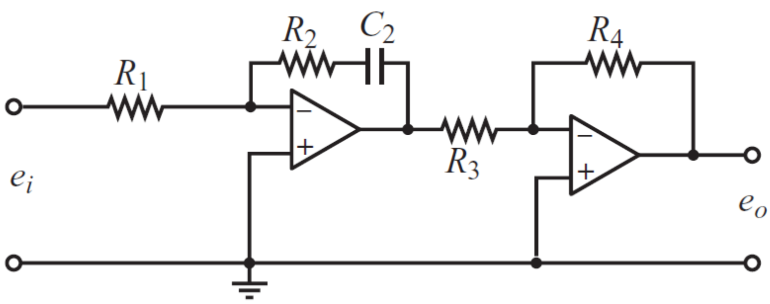

Figure 3: op-amp circuit

Problem 1.4 Consider transfer function G(s) and determine gain margin, phase margin, gain crossover, and phase crossover frequency $[PM, GM, \omega_{gc}, \omega_{pc}]$. Verify with MatLab.

$$G(s) = \frac{1000}{s(s+5)(s+20)}$$

Problem 1.5 A PMDC motor is a Permanent Magnet DC Motor with equivalent circuit as shown in Figure 5.

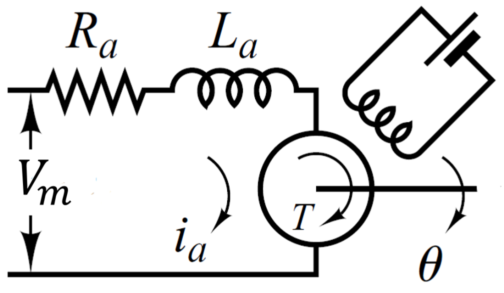

Figure 4: Equivalent circuit of Permanent Magnet DC Motor

1. Determine the transfer function $H(s) = \dfrac{\omega(s)}{V_m(s)}$.
2. Sketch the block diagram.
3. Obtain the first order system of DC motor modeling.
4. Calculate the steady state error with P Controller and PI Controller in the closed loop of DC motor.
   P controller : $C(s) = K_p$
   PI controller : $C(s) = K_p + \dfrac{K_i}{s}$

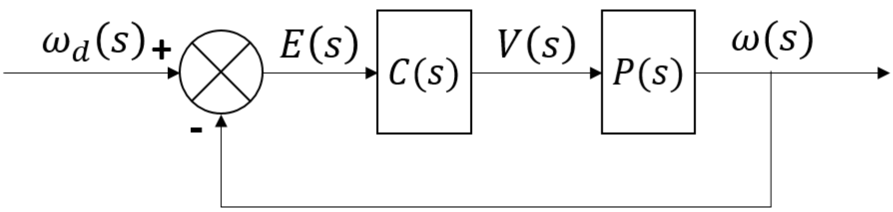

Figure 5: Closed loop block diagram

Problem 1.6 (Cruise control design). Consider the problem of maintaining the speed of a car as it goes up a hill as shown in the Figure 6. A cruise control problem :

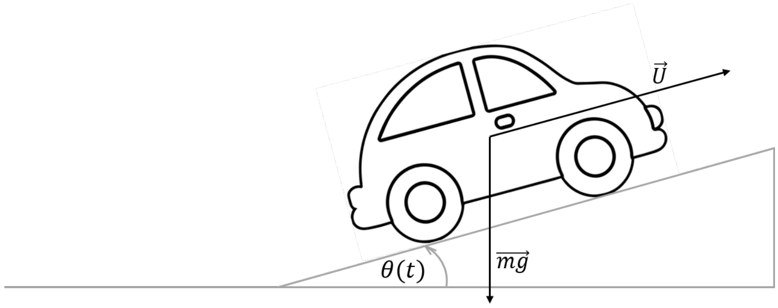

Figure 6: Cruise control problem

- Process input : gas pedal $u(t)$
- Process output : velocity $v(t)$
- Reference : desired velocity $v_d(t)$
- Disturbance : slop $\theta(t)$. Assuming θ to be small, then $sin(\theta) \cong \theta$

1. Construct a closed loop block diagram of the systems.
2. Write the process equations.
3. The cruise controller is PI controller is described by

$$u(t) = k_p e(t) + k_i \int_0^t e(\tau) d\tau$$

Compute the error dynamics and express PI controller gain. Since it is desirable that a cruise control system should respond to changes smoothly without oscillations.