ELEC 341

Project P8

10 Marks

Learning Objectives

- Lag (PI) Controller Design
- Zero selection
- Master Gain

- Matlab
  - margin()
  - rla()
  - nyqlog()

- Simulink
  - n/a

Your LEAD controller didn't improve Steady-State error much at all, and that is one of your biggest problems. Let's try LAG control.

You already have a Root-Locus for your Proportional controller so there's no need to repeat that. Just refer to it.

The zero of your LAG controller can be anywhere in the LHP since its pole is at 0. So start simple. You know your micro-controller put a pole at 2CF, so put your zero there to cancel it out. See what happens.

Controller Dynamics

Compute the dynamics of your LAG controller and the Ultimate Gain of DGH.

- P8_Dcf = unity gain controller dynamics with zero at 2CF
- P8_Ku = Ultimate Gain

LAG Root Locus

Generate a Root Locus of DGH.

- Root Locus with Asymptotes

Are the Open-Loop poles & zeros from your controller where you expect them ???

Zoom in if you can't see them clearly.

Let's see if the LAG controller did any better.

Step Response

Compute the **CLOSED-LOOP** Transfer Function of your **CONTROL SYSTEM**.
Plot the following step responses using **THE SAME TIME VECTOR**.

- θd = 10° (degrees)
- Proportional Controller with Kp = Ku/2 (degrees) blue
- Lag Controller with K = Ku/2 (degrees) black
- *Add a **legend()*** with descriptive labels.

Did Steady-State error get any better ???

Did it come at any cost ??? Like overshoot, for example ???

Stable Zero

Use **margin()** to find the Phase X-Over Frequency when a P-Controller is used.
Place the zero one decade before the Phase X-Over Frequency.
Iterate using the Lead Controller dynamics until the zero stabilizes.

- P8_z (rad/s) = Zero Location
- P8_D = unity gain controller dynamics with zero at new zero location

The new zero location was designed to have a very large phase margin. A very stable system allows you to be more aggressive with the master gain K.

If you implemented it right, you should see a large PM on your Nyquist Plot.

Nyquist Plot

Use nyqlog() to generate a Nyquist Plot of DGH. Note that GM = Ku.

- Nyquist Plot

Tuned Gain

Increase K as much as possible without introducing any overshoot.

- P8_K = maximum Master Gain

Tuned Response

Plot the following step responses using **THE SAME TIME VECTOR**.

- θd = 10° (degrees)
- Original Lag Controller with K = Ku/2 (degrees) black
- Lag Controller with K = Tuned Gain (degrees) red

Was one method better than the other ??? Will it always be better ???

When is one method better than the other ???

Deliverables

Values

1. P8_Dcf (1 marks)
2. P8_Ku (1 marks)
3. P8_z (1 marks)
4. P8_D (1 marks)
5. P8_K (1 marks)

Figures

1. Lag RL (1 marks)
2. Step Response (1 marks)
3. Nyquist Plot (1 marks)
4. Tuned Response (2 marks)