ELEC 341

Project P7

10 Marks

Learning Objectives

- Lead (PD) Control
  - Root Locus
  - Dynamics
  - SS Error

So far, you only generated Pole-Zero plots which only shows the open-loop roots, not the closed loop roots for different gain values. That's what a Root Locus is for.

Proportional Root Locus

Generate a Root Locus plot of the control system.
Use rla() to see the asymptotes.

- Root Locus with Asymptotes

Identify the root(s) that cross the jω axis. These determine Ku.

Replace the controller you developed in P6 with a LEAD controller:

- *The derivative is computed without any additional filtering.*
- *The zero is placed half way between the controller pole and the jω axis.*

The zero MUST be closer to the jω axis than the pole or it's not a LEAD controller.

Controller Dynamics

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

- P7_D = unity gain controller dynamics
- P7_Ku = Ultimate Gain

Let's see if the LEAD controller improved performance.

LEAD Root Locus

Generate a Root Locus of DGH.

- Root Locus with Asymptotes

Was the Root Locus affected very much by the Lead Controller ???

Is it possible that the Root Locus doesn't tell the whole story ???

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
- Lead Controller with K = Ku/2 (degrees) black
- *Add a* ***legend()*** with descriptive labels.

You know that the Proportional and Lead controlled systems each have a different Ultimate Gain so don't misinterpret the variable "Ku". It is not a fixed number. It changes depending on which control system you are referring to.

Different Steady-State Errors make two curves difficult to compare. To see if this controller was a step in the right direction, make it an more apples-to-apples comparison.

Tuned Gain

Adjust K until the steady-state error of the Lead controlled system is equivalent to the steady-state error of the Proportional controlled system.

- P7_K = Tuned Gain

Tuned Response

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

- θd = 10° (degrees)
- Proportional Controller with Kp = Ku/2 (degrees) blue
- Lead Controller with K = Kopt (degrees) black

Was it worth it to implement a LEAD controller ???

It may be easy to implement in Matlab, but in a micro-controller you have to compute velocity in your ISR, which may require a lower control frequency.

Deliverables

Values

1. P7_D (2 marks)
2. P7_Ku (1 marks)
3. P7_K (1 marks)

Figures

1. Proportional RL (1 marks)
2. Lead RL (1 marks)
3. Step Response (2 marks)
4. Tuned Response (2 marks)