ELEC 341 – Graded Assignments

Assignment A8
Lag & Lead-Lag Control

10 Marks

Learning Objectives

Lag (PI) Control
Lead-Lag (PID) Control
Heuristic Tuning

Matlab
nyqlog()

Replace the Lead controller (KD) from the previous assignment with the Lag Controller (KD).

Controller pole at 0.
Use controller zero to cancel the most dominant real system pole.
You already computed the open-loop transfer function GH. Re-use it.

Q1 1 mark(s) Lag Dynamics

Compute the Derivative Gain Kp.
Compute the controller Dynamics D.
Compute the Ultimate Gain of DGH (Ku).
Look up the settle time (Ts) of the closed-loop transfer function when K = Ku x 50%.

- Q1.Kp (pure) Scalar
- Q1.D (pure) LTI

***COW**: Did you cancel the pole you intended to cancel ???*

Do you have a single-pole @ -2CF ???

*Now for some **DESIGN** work.*

A LAG controller has 2 free design parameters.

Kp** (proportional gain) moves the **zero
***K** (master gain) moves the **poles** along the Root Locus*

Compute the ultimate gain Ku to use as a starting point.

*Tune the gain K and zero Z to meet the following RCGs for a **Unit Step** input.*

REQUIREMENTS:

Overshoot <= 10%

GOALS:

Ts as small as possible

Q2 2 mark(s) Tuned PI Control

Specify your tuned master gain K, zero Z, and transfer function X.

- Q2.K (Vs/m) Scalar
- Q2.Z (rad/s) Scalar
- Q2.X (pure) LTI

Replace the Lag controller (KD) with a Lead-Lag controller (KD).

Pole at 0.
Derivative pole at -2CF (finite difference derivative with no additional filtering)
Use zeros to cancel the two most dominant real system poles.

Q3 1 mark(s) PID Dynamics

Compute the Proportional Gain Kp & Derivative Gain Kd.
Compute the controller Dynamics D.

- Q3.Kp (pure) Scalar
- Q3.Kd (s) Scalar
- Q3.D (pure) LTI

Q4 2 mark(s) Real Zeros

Compute the ultimate gain of DGH (Ku).
Calculate the closed-loop transfer function (X) when K = Ku x 50%.

- Q4.Ku (Vs/m) Scalar
- Q4.X (pure) LTI

***COW**: Did you cancel the poles you intended to cancel ???*

Do you have a pole @ 0 and a double-pole @ -2CF ???

Plot the step response of Q4.X.

Modify the Lead-Lag controller (KD).

Pole at 0.
Derivative pole at -2CF (finite difference derivative with no additional filtering)
*Use zeros to cancel the two **complex** system poles.*

Q5 2 mark(s) Complex Zeros

Compute the ultimate gain of DGH (Ku).
Calculate the closed-loop transfer function (X) when K = Ku x 50%.

- Q5.Ku (Vs/m) Scalar
- Q5.X (pure) LTI

***COW**:*

Plot the step response of Q5.X.

Is it an improvement over Q4.X ???

A LEAD-LAG controller has 3 free design parameters.

__Kp__ & __Kd__ (proportional & derivative gains) move the two __zeros__

__K__ (master gain) moves the __poles__ along the Root Locus

Tune the gain K and zeros Z to meet the following RCGs for a __Unit Step__ input.

REQUIREMENTS:

Overshoot <= 10%

GOALS:

Ts as small as possible

Q6 2 mark(s) Tuned PID Control

Specify your tuned master gain K, zeros Z, and transfer function X.

- Q6.K (Vs/m) Scalar
- Q6.Z (rad/s) Vector 1x2
- Q6.X (pure) LTI

COW:

Were you able to improve upon LAG Control ???

If not, maybe you should try again.

Plot both step responses on the same figure.

Extra Practice:

Repeat this assignment using position control.

Repeat this assignment using different RCGs.

Change the Overshoot specification.

Minimize Tp or Tr rather than Ts

Since you've learned how to **COW**, you don't need your work marked any more.

Or use your friend's student number and compare results.

Use **nyqlog()** to check your gain and phase margins.