ELEC 341 – Graded Assignments

Assignment A7
Lead Control

10 Marks

Learning Objectives

Lead (PD) Control
Root Locus
Controller Dynamics
Master Gain
Ultimate Proportional Gain (K_u)

Matlab
- pzmap()
- rla()

Replace the proportional controller (K) from the previous assignment with the Lead Controller (KD) shown in Fig 1 (speed control).

FDD pole at -2CF (finite difference derivative with no weighted sum filter)
Use the controller zero to cancel the most dominant (closest to jω axis) real system pole.
You already computed the open-loop transfer function GH. Re-use it.

Q1 1 mark(s) Lead Dynamics

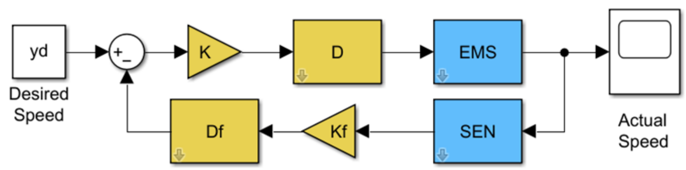
Compute the Derivative Gain Kd and controller Dynamics D.

- Q1.Kd (s) Scalar
- Q1.D (pure) LTI

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

Do you have one pole @ -CF from the DAQ and one @ -2CF from the FDD ???

Figure 1



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

A LEAD controller has 2 free design parameters.

Kd *(derivative gain) moves the* ***zero***
K *(master gain) moves the* ***poles*** *along the Root Locus*

Q2 2 mark(s) Steady State Error

Compute the ultimate gain of DGH (Ku).
Calculate the steady-state error (Ess) of the closed-loop transfer function when K = Ku x 50%.
Calculate the steady-state error (Ess99) of the closed-loop transfer function when K = Ku x 99%.

- Q2.Ku (Vs/m) Scalar
- Q2.Ess (%) Scalar
- Q2.Ess99 (%) Scalar

Is Ess @ K=Ku/2 an acceptable value ??? Generally a system is considered to have settled when it is within 2% of FV.

Is it possible to get an acceptable Ess with a LEAD controller for this system ??? You can't increase K beyond 99% of Ku. Even that is barely stable, by definition.

Did the LEAD controller stabilize (Ku > K) or de-stabilize (Ku < K) the system ???

You computed K in the previous assignment. Use it.

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

REQUIREMENTS:

Peak Value < 1.2
Ess < Q2.Ess50

GOALS:

Ess as small as possible

Q3 3 mark(s) Tuned Rate Control

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

- Q3.K (Vs/m) Scalar
- Q3.Z (rad/s) Scalar
- Q3.X (pure) LTI

To tune multiple parameters:

Adjust one parameter until RCGs are satisfied as well as possible.
Then do the next parameter.
Continue until all parameters have been done.
Start all over again.
Repeat until the results don't improve, no matter what you do.

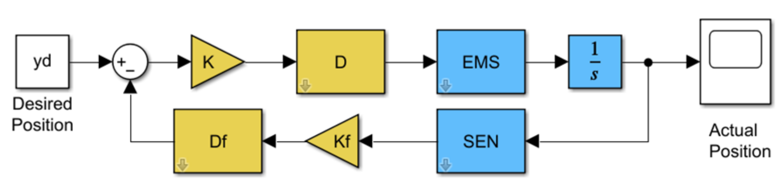
Just like before, you replaced the speed sensor with a position sensor.
Now the plant G is as shown in Fig 2. Do everything all over again.
Of course, you don't need to re-compute the controller dynamics.
And there is no need to re-compute Ess either. Remember why ???

Q4 1 mark(s) Ultimate Gain

Compute the ultimate gain of DGH.
Compute the closed-loop transfer function X with K = Ku/2.

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

Figure 2



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

REQUIREMENTS:

Overshoot < 20%

GOALS:

Ts as small as possible.

Q5 3 mark(s) Tuned Position Control

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

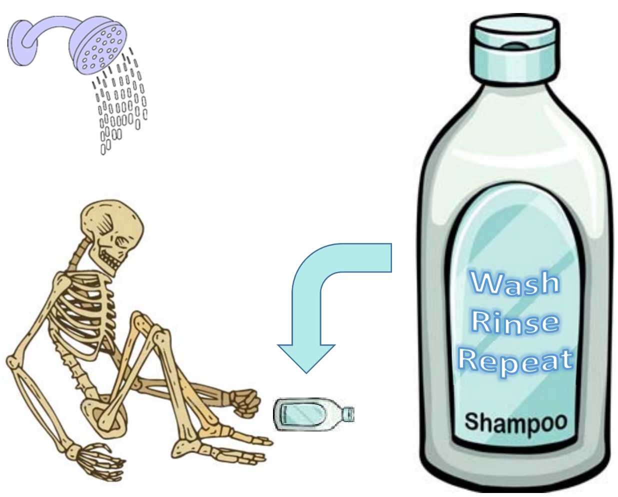
- Q5.K (Vs/m) Scalar
- Q5.Z (rad/s) Scalar
- Q5.X (pure) LTI

COW*: After tuning*

Generate a Root Locus on the tuned system.

Check the Ultimate Gain.

Try to figure out why your choice of zero location had the desired effect.



death of a programmer