ELEC 341 – Graded Assignments

Assignment A-7

10 Marks

Learning Objectives

- Lead (PD) Control
- Root Locus Plots
- Controller Dynamics
- Master Gain

- Matlab
  - rla()
- Simulink
  - n/a

The simple control system in Fig 1 has the OL pole-zero plot and DC-Gain shown in Fig 2.
U and Y are desired and actual velocity with units (m/s).
You already computed the open-loop transfer function GH. Re-use it.
H is your micro-controller dynamics which introduces the pole at 2CF, as shown in Fig 2.
Develop the following Lead Controller.

- *Derivative pole at 2CF (finite difference with no additional filtering)*
- *Zero placed to cancel the system pole indicated in Fig 2.*
- *Gain K of half the Ultimate Gain Ku*

Calc 1 1 mark(s) Lead Dynamics

Compute the controller Dynamics D.
Also compute the corresponding Derivative Gain Kd.

- C1_D = Lead Controller Dynamics
- C1_Kd = Derivative Gain

Figure 1

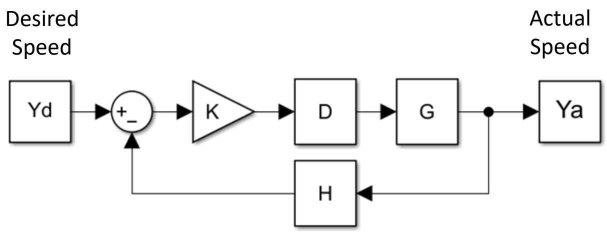


Figure 2

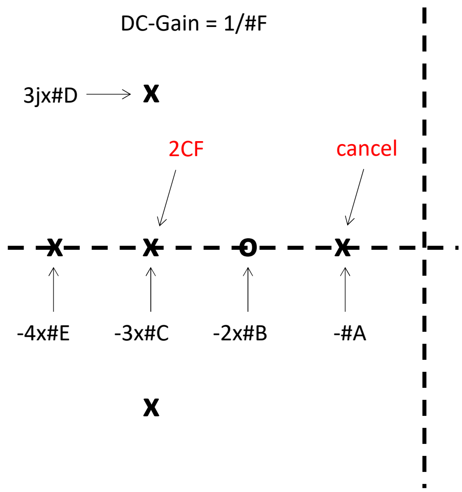


Fig 1 1 mark(s) Root Locus

Use **rla()** to generate the Root Locus of the CL Transfer Function.
- Root Locus

Since K affects the pole locations, you have to choose a value to compute a CL Xfer Func.

Make sure you UNDERSTAND the difference between K and Kp. They are both proportional gains after all, but they are neither the same, nor inter-changeable.

Calc 2 1 mark(s) Closed-Loop Transfer Function

Compute the closed-loop transfer function T with **K = Ku/2**.
Calculate the steady-state error for that value of K.
- C2_T (pure) = Actual Speed / Desired Speed
- C2_Ess (%) = Percentage Difference between Desired & Actual Speed

Obviously, there is no specific application so you can't say for sure, but for a "typical" control system, does this seem like an acceptable SS Error ???

Now that you have done all the overhead work, it's time to experiment.

Start by generating a step response.

The main performance measures are SS Error and Overshoot. Adjust K until you develop an understanding of how each is affected. Find a reasonable trade-off.

Adjust the zero location until you develop an understanding of how each is affected. Find a reasonable trade-off.

Each time, re-generate the Root Locus to make sure you are getting what you expect.

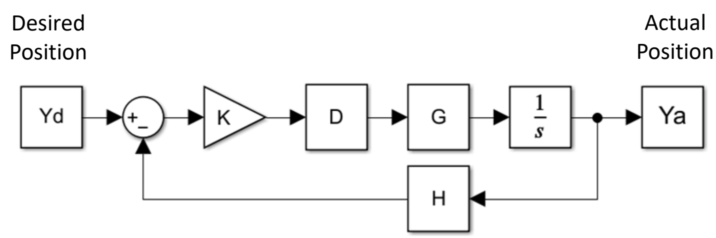
Fig 2 2 mark(s) Step Response

Generate the step response of the Closed-Loop transfer function.
- Original Step Response black
- Tuned Step Response red

You decided to control position instead of velocity so you replaced the velocity sensor with a position sensor as shown in Fig 3.

Do everything all over again.

Figure 3



Calc 3 1 mark(s) Lead Dynamics

- C3_D = Lead Controller Dynamics
- C3_Kd = Derivative Gain

Fig 3 1 mark(s) Root Locus

- Root Locus

Calc 4 1 mark(s) Closed-Loop Transfer Function

- C4_T (pure) = Actual Position / Desired Position
- C4_Ess (%) = Percentage Difference between Desired & Actual Position

Fig 4 2 mark(s) Step Response

- Original Step Response black
- Tuned Step Response red

The change to the transfer function seemed pretty minor.

Did the Root Locus change much ??? How about the step response ???

Is it better or worse ??? If better, can we do something similar in the speed controller ???