ELEC 341 – Graded Assignments

Assignment A-8

10 Marks

Learning Objectives

- Lag (PI) Control
- Nyquist Plots
- Controller Dynamics
- Master Gain

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

The system (GH) in Fig 1 has the poles, zeros 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 Lag Controller.

- *Zero placed to cancel the system pole indicated in Fig 2.*

Calc 1 1 mark(s) Lag Dynamics

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

- C1_D = Lead Controller Dynamics
- C1_Kd = Derivative Gain

Figure 1

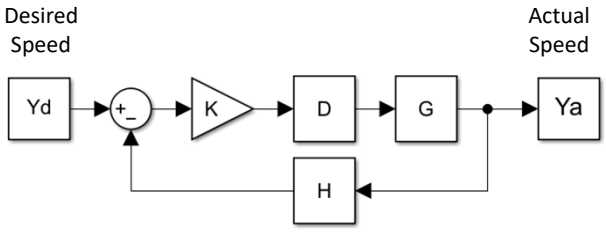

Figure 2

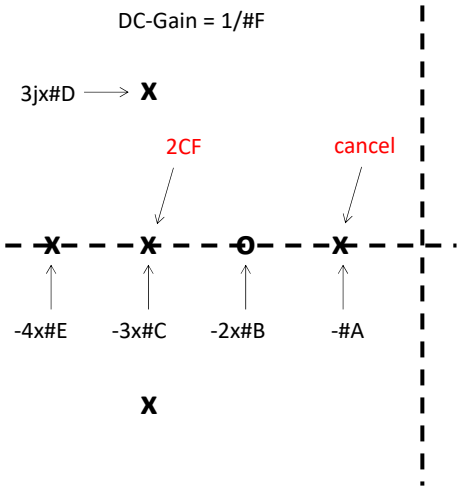

Fig 1 1/2 mark(s) Root Locus

Use **rla()** to generate the Root Locus of DGH.

- Root Locus

Fig 2 1/2 mark(s) Nyquist Plot

Use **nyqlog()** to generate the Nyquist Plot of DGH.

- Nyquist Plot

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

Compute the ultimate gain (Ku) of KGH.

Compute the closed-loop transfer function T with **K = Ku/2**.

- C2_T (pure) = Actual Speed / Desired Speed

Why not calculate SS Error ??? Not important any more ???

Adjust the zero and gain K for a reasonable trade-off between Overshoot and Settle Time.

Fig 3 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.

Re-compute the Dynamics the same way.

Re-generate the Root Locus & Nyquist plots.

Figure 3

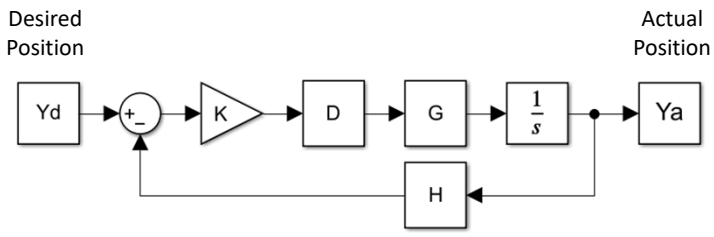

Fig 4 1/2 mark(s) Root Locus

Use **rla()** to generate the Root Locus.

- Root Locus

Fig 5 1/2 mark(s) Nyquist Plot

Use **nyqlog()** to generate the Nyquist Plot.

- Nyquist Plot

What is Ku ???

Recall, K either expands (larger values) or shrinks (smaller values) the Nyquist contour UNIFORMLY.

Must you expand or shrink the Nyquist contour to avoid encircling -1 ???

Calc 3 1 mark(s) Lag Zero

Place the Lag zero one decade before the Phase X-Over Frequency to improve stability.

- C3_z = Lag Controller Zero

Fig 6 1/2 mark(s) Root Locus

Use **rla()** to generate the Root Locus.

- Root Locus

Fig 7 1/2 mark(s) Nyquist Plot

Use **nyqlog()** to generate the Nyquist Plot.

- Nyquist Plot

Adjust the zero and gain K for a reasonable trade-off between Overshoot and Settle Time.

Fig 8 2 mark(s) Step Response

Generate the step response of the Closed-Loop transfer function.

- Original Step Response black
- Tuned Step Response red