ELEC 341 – Graded Assignments

Assignment A7
Delay, Filters & PD-Control

10 Marks

Learning Objectives

DAQ & Processing Delay
Weighted Sum Filters
PD (Lead) Controller Design

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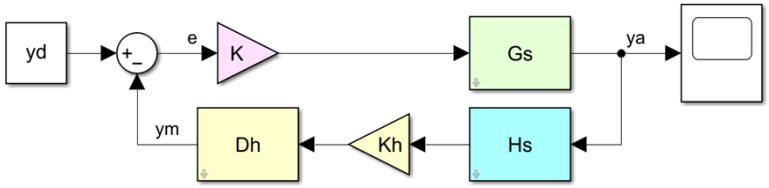
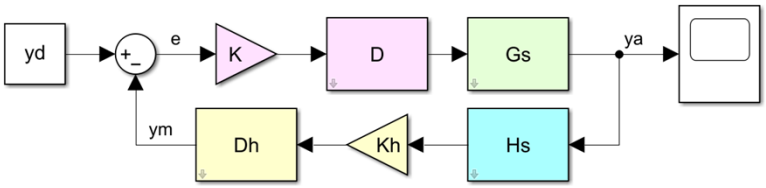
*In Fig 1, a P-controller controls a system **Gs** using a sensor **Hs**.*
*The micro-controller ISR executes at the specified Control Frequency **CF**.*
***Gs** and **Hs** have the Open-Loop characteristics specified in Assignment #6.*
*In Fig 2, the P-controller is replaced by a generic controller **KD**.*

Figure 1



CF = 10 #G (Hz)

Figure 2



Q1 1 mark(s) Delay

Compute the controller pole frequency **wd** that accounts for read and write delays.

- Q1.wd (rad/s) Scalar

***Note**: pole **frequency** is positive, even when the pole itself is negative (left-half plane).*

Q2 1 mark(s) Control System with Delay

Compute the controller feedback dynamics **Dh** and open-loop transfer function **GH**.
Find the ultimate gain **Ku** and closed-loop transfer function **Gcl** with **K = Ku/2**.
Calculate the steady-state error **Ess** of **Gcl**.

- Q2.Ess (%) Scalar

***COW**:*

*Do you expect **Ess** to change much after adding **Dh** to **GH** ???*
How much did it change ??? Check Assignment #6.

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*The analog position sensor noise requires a weighted-sum filter using **Nh** coefficients.*
***Nh** = #G*

Q3 2 mark(s) Filter Design
Specify the effective delay multiple **Ndt** (number of control cycles).
Determine the new filter pole frequency **wd** that accounts for read, write and filter delays.
- Q3.Ndt (pure) Scalar
- Q3.wd (rad/s) Scalar

Determine Dh which includes the weighted sum filter you designed.
The feedback path is finished. Now design the forward path of the controller.
The application of the control system has the following RCGs:
*Requirement **GOS** = 0%*
*Goal **Ess** = minimum*

Q4 2 mark(s) P-Controller Design
Design a P-controller that satisfies the RCGs.
Specify controller gain **K** and compute steady-state error **Ess**.
- Q4.K (V/m) Scalar
- Q4.Ess (%) Scalar

Q5 2 mark(s) PD-Controller Design
Design a PD-controller that cancels the most dominant real **system** pole and satisfies the RCGs.
Specify the master gain **K** , derivative gain **Kd**, and steady-state error **Ess**.
- Q5.K (V/m) Scalar
- Q5.Kd (pure) Scalar
- Q5.Ess (%) Scalar

Q6 2 mark(s) PD-Controller Design
Design a PD-controller that cancels the 2nd most dominant real **system** pole and satisfies the RCGs.
Specify the master gain **K** , derivative gain **Kd**, and steady-state error **Ess**.
- Q6.K (V/m) Scalar
- Q6.Kd (pure) Scalar
- Q6.Ess (%) Scalar

*Was **Ess** improved by PD-Control ???*
Why or why not ??? Consult the Root Locus of each control system.
Which system pole did you cancel to get better results ???

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