ELEC 341 – Graded Assignments

Assignment A6
Proportional Control

100 Marks

Required Files

Available on Canvas

- **e341-a6.pdf** — *Assignment description (this document)*
- **a6Submit.p** — *Grading script (**LATEST** version)*
- **e341-APE.pdf** — *Instructions for submitting graded work (for reference)*

Topics

Open-Loop Gain
- root locus & ultimate gain

Closed-Loop Gain
- proportional control

Tuned Response
- closed-loop metrics & RCGs

Figure 1

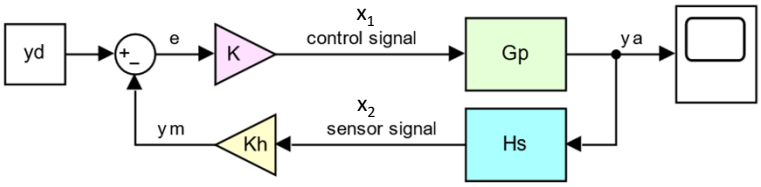
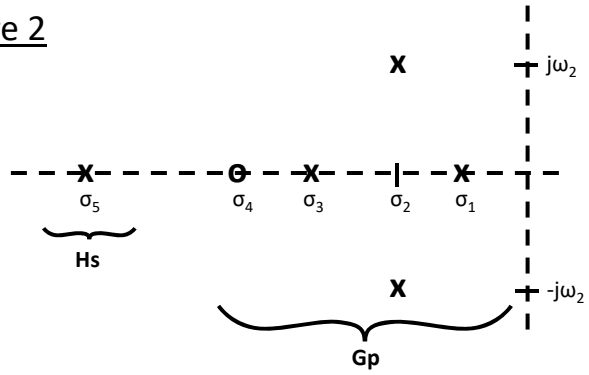


Figure 2



Parameter	Value	Physical Units
σ_1	#A x -1	rad/s
σ_2	#B x -2	rad/s
ω_2	#C x 2	rad/s
σ_3	#D x -3	rad/s
σ_4	#E x -5	rad/s
σ_5	#F x -12	rad/s
K_p	#A^{-1} x 3	m/V
K_s	#B^{-1} x 5	V/m

A proportional controller **K** controls a plant **Gp** with a sensor **Hs**, as shown in **Figure 1**.
Gp and **Hs** have the Open-Loop characteristics shown in **Figure 2**.
$\mathbf{K_p}$ is the dc gain of the plant $\mathbf{G_p}$, and $\mathbf{K_s}$ is the dc gain of the sensor $\mathbf{H_s}$.
Find feedback gain $\mathbf{K_h}$.
Find forward path gain **G**: $\mathbf{G = y_a/x_1}$
Find feedback path gain **H**: $\mathbf{H = y_m/y_a}$
Find ultimate gain $\mathbf{K_u}$.

1. 20 mark(s) Open-Loop TF

- Q1.Kh (m/V) Scalar
- Q1.G (m/V) LTI
- Q1.H (m/m) LTI
- Q1.Ku (V/m) Scalar

COW: *Use **pzmap()** or **rla()** to check your poles & zeros.*

Set the gain to half the ultimate gain: $\mathbf{K = K_u/2}$.
Find the closed-loop transfer function: $\mathbf{G_{cl} = y_a/y_d}$

2. 10 mark(s) Closed-Loop TF

- Q2.Gcl (pure) LTI

Get the step response of the closed-loop system.
Find rise-time $\mathbf{T_r}$, peak-time $\mathbf{T_p}$, and settle-time $\mathbf{T_s}$.
Find final value $\mathbf{y_f}$, peak value $\mathbf{y_p}$, and steady-state error $\mathbf{E_{ss}}$.
Find percentage over-shoot, $\mathbf{OS_u}$ and $\mathbf{OS_y}$.
There is no such thing as **under-shoot**. If a system does not overshoot, then: **OS = 0**.

3. 20 mark(s) Step Response

- Q3.Tr (s) Scalar
- Q3.Tp (s) Scalar
- Q3.Ts (s) Scalar
- Q3.yf (m) Scalar
- Q3.yp (m) Scalar
- Q3.Ess (%) Scalar
- Q3.OSu (%) Scalar
- Q3.OSy (%) Scalar

***COW**: Are these values reasonable for proportional control ???*
For what type of practical system would this be an acceptable response ???

RCG: $\mathbf{OS_y}$ = **20%** (no more, no less)
Find the gain **K** to meet the above RCG for a **Unit Step** input.
Find the resulting settle time $\mathbf{T_s}$ and steady-state error $\mathbf{E_{ss}}$.

4. 25 mark(s) Tuned Gain #1

- Q4.K (V/m) Scalar
- Q4.Ts (s) Scalar
- Q4.Ess (%) Scalar

RCG: $\mathbf{T_p}$ = **90%** (of $\mathbf{T_p}$ from Q3)
Find the gain **K** to meet the above RCG for a **Unit Step** input.
Find the resulting settle time $\mathbf{T_s}$ and steady-state error $\mathbf{E_{ss}}$.

5. 25 mark(s) Tuned Gain #2

- Q5.K (V/m) Scalar
- Q5.Ts (s) Scalar
- Q5.Ess (%) Scalar

***COW**: If you had to satisfy both RCGs simultaneously, how could you do that ???*