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Homework 4 ELEC 372

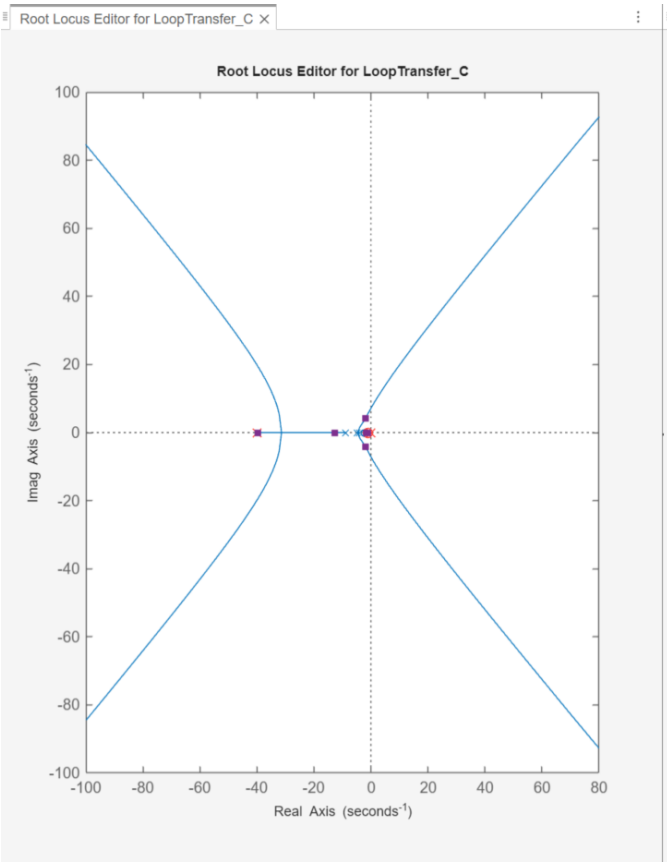
The feedback control system where

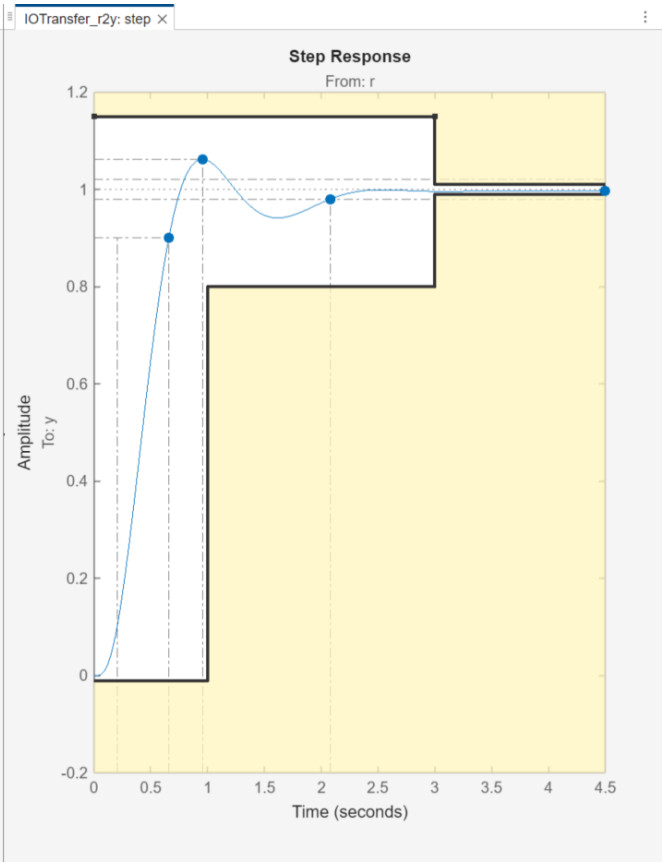
$$G(s) = \frac{s+2}{(s+1)(s+4)(s+5)(s+9)}$$

such that

- The steady-state tracking error due to a step reference signal is zero[1]
- The step response of the closed-loop system has a settling time $T_s(98\%) \leq 3$ sec
- The step response of the closed-loop system has an overshoot $\%OS \leq 15\%$

is given using rtool:





Compensator

C = 200 $\times \frac{(1+s)}{s(1+0.025s)}$

Pole-Zero

Dynamics

Type	Location	Damping	Frequency
Integrator	0	-1	0
Real Pole	-40	1	40
Real Zero	-1	1	1

Design requirement: Step response bound from 0 to 4.5 (seconds)

Design requirement parameters

Initial value	0		Final value	1
Step time	0	seconds		
Rise time	1	seconds	% Rise	80
Settling time	3	seconds	% Settling	1
% Overshoot	15		% Undershoot	1

Problem 2 (4 points). Consider the following transfer function:

$$G(s) = 10\frac{s+100}{(s-10)(s+1)}$$

Draw on a paper the asymptotic Bode plots (modulus and phase) of $G(j\omega)$

$$G(s) = 10\,\frac{s+100}{(s-10)(s+1)}$$

$$= 10\,\frac{100\left(\frac{s}{100}+1\right)}{-10\left(\frac{s}{10}+1\right)(s+1)}$$

$$= -100\,\frac{\left(\frac{s}{100}+1\right)}{\left(\frac{s}{10}+1\right)(s+1)}$$

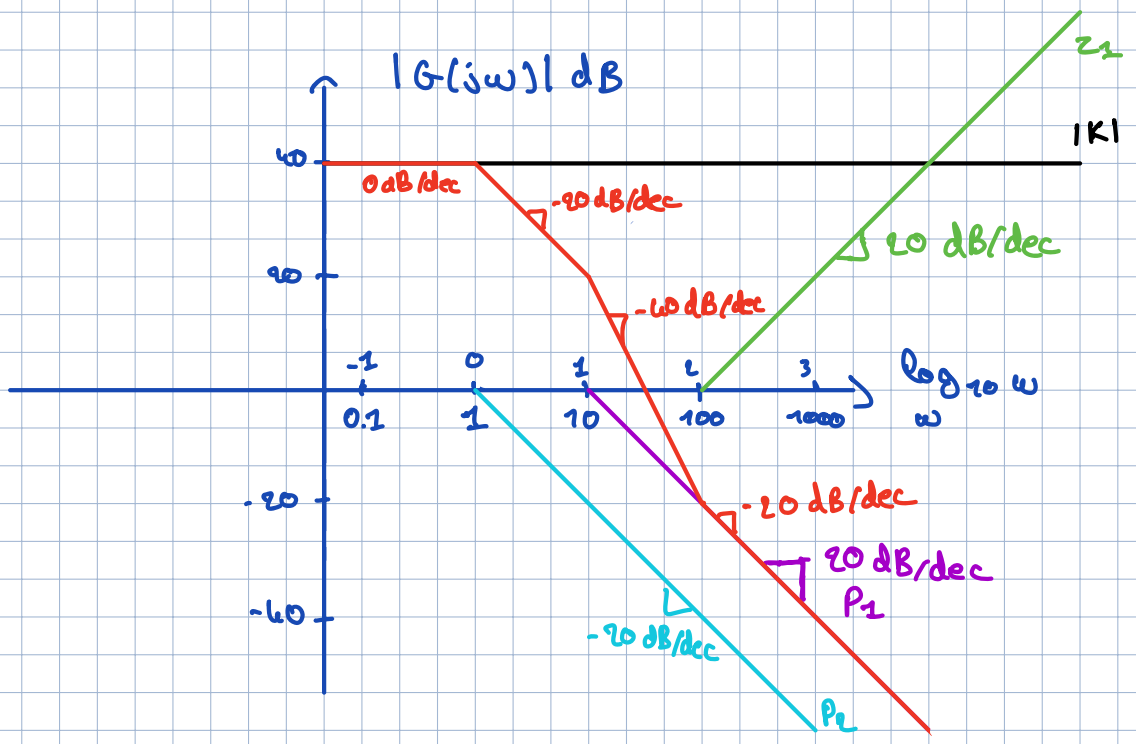
$$G(j\omega) = -100\,\frac{\left(\frac{j\omega}{100}+1\right)}{\left(\frac{j\omega}{10}+1\right)(j\omega+1)}$$

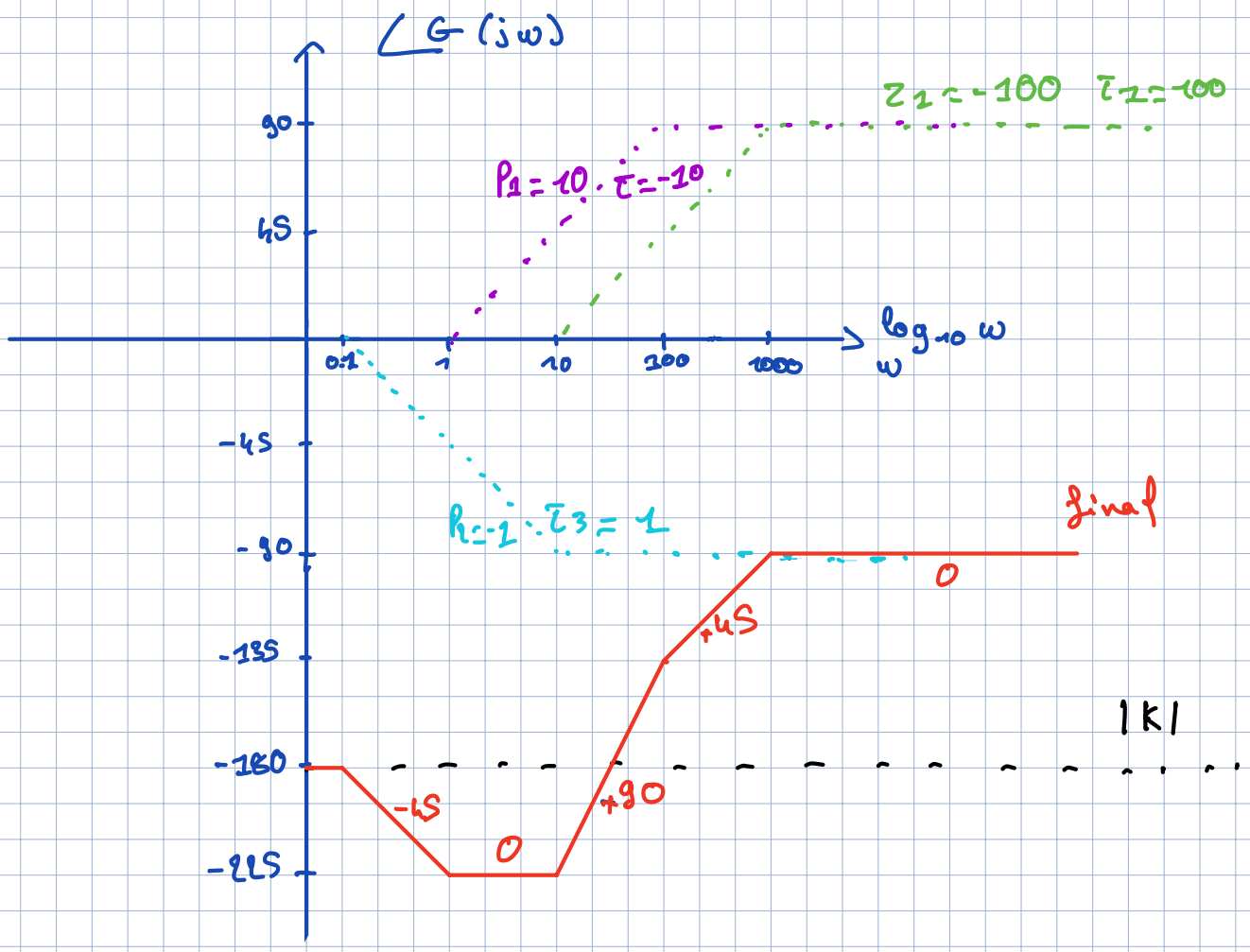
$z_1 = -100 \quad \tau_1 = 100$

$p_1 = +10 \quad \tau_2 = -10$

$p_2 = -1 \quad \tau_3 = 1$

Gain (-100) Gain dB $= 20\log_{10}|-100| =$ 40 dB




∠G(jω)
90
45
-45
-90
-135
-180
-225
0.1
1
10
100
1000
ω
log10 ω
z1 = -100 τ1 = 100
p1 = 10 τ = -10
p = -1 τ3 = 1
finale
0
+45
+90
-45
0
|k|