Badji Mokhtar University – Annaba
3rd Year License (L3) in Automatique
Department of Electronics
Academic Year: 2025–2026

Linear Systems Control (LSC)
Homework No. 1

Exercise 1 :

We consider a process with transfer function D(s):

$$\mathbf{D(s) = \frac{1000}{s(s+10)^2}}$$

1. This system is placed in a unity feedback control with a **Proportional (P) controller** of gain ***k***. Give the functional diagram of the controlled system.
2. Calculate the value of ***k*** that ensures the system has a phase margin of **45**°.
3. The setpoint is a unit step signal. Calculate the error between the setpoint and the system output. Answer the same question if the setpoint is a ramp with a slope of 1.

4. We now want a servo system that meets the following conditions:
   - Zero static error, $\varepsilon_p(\infty) = 0$,
   - Speed error, $\varepsilon_v(\infty) = 5\%$.

To do this, we add a **phase lag compensator (**un correcteur à **retard de phase**.**)** to the **proportional controller P.**

- Give the new functional diagram of the **servo system**(**de l'asservissement**.).
- Calculate the parameters of the controller.

Exercise 2 :

We again consider the transfer function system G(s):

$$\mathbf{G(s) = \frac{1000}{s(s+10)^2}}$$

The Bode diagram of the system G(s) is represented by the following figure:

1. According to the Bode diagram without calculation. Determine the cutoff frequency (ω_c) and the phase margin (($\Delta\boldsymbol{\varphi}$)

2- We wish to implement a unity feedback control system using a phase-lead controller that meets the following specifications:

- A cutoff pulse $\omega_c = 5$ *rad /s* ,
- A phase margin $\Delta\varphi = 70^\circ$,
- Zero static error.

1- Draw the functional diagram of the closed-loop system.

2- Determine the phase margin that the uncorrected system would have at this frequency (($\omega_c = 5$ *rad /s*).

3- Deduce the parameters of the controller used.

Exercise 3 :

We again consider the system of transfer functions F(s):

$$\mathbf{F(s) = \frac{1000}{s(s+10)^2}}$$

The Bode plot of the system F(s) is represented by the following figure:

1- Based on the Bode plot without calculation, determine the cutoff frequency (ω_c) and the phase margin ($\Delta\varphi$).

2- We wish to implement a unity feedback control system using a controller that meets the following specifications:

- Closed-loop overshoot $D_{BF} \leq 5\%$,
- A damping coefficient ξ=0.7
- Response time **at 5% of 0.6s,**
- Zero statistical error
- A phase margin $\Delta\varphi = 70^\circ$
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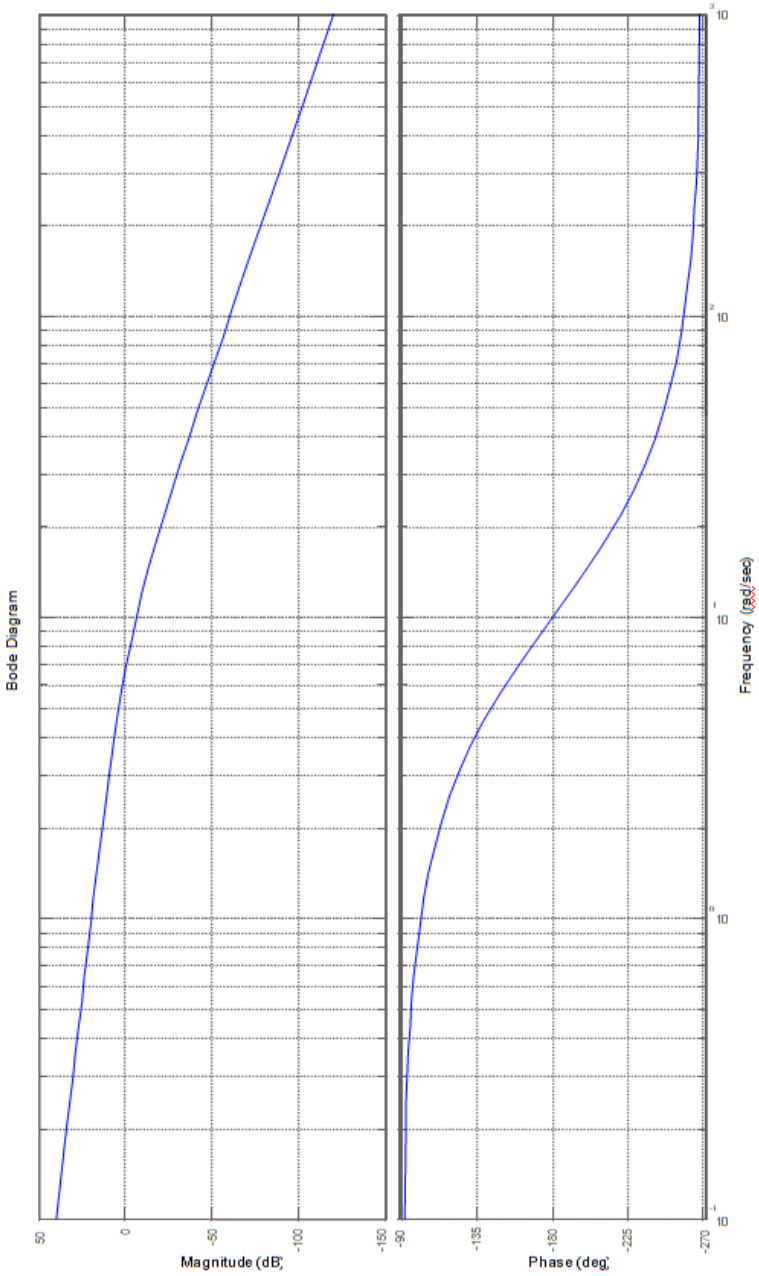
Requested work:

- ✓ Provide the functional diagram of the servo system.
- ✓ Propose a controller and calculate its parameters.


Bode Diagram
Magnitude (dB)
Phase (deg)
Frequency (rad/sec)
50
0
-50
-100
-150
-90
-135
-180
-225
-270
10^3
10^2
10^1
10^0
10^-1