University Badji Mokhtar-Annaba
Department of Electronics
3rd year License in Automatique L3 (S5)
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TP on Linear Systems Control (CSL)

TP N° : 02 (continued) Study and synthesis of regulators in the frequency domain

Part 3: PID Controller (Proportional, Integral, Derivative)

Objective of the Lab

This lab aims to understand the effect of the actions of a PID controller in the frequency domain. We will use the Matlab/Simulink software to simulate the PID controller.

1. Definitions:

The PID controller, also called a PID corrector (proportional, integral, derivative), is a control system that improves the performance of a servo system, that is, a closed-loop system or process. It is the most widely used regulator in the industry, where its correction qualities apply to multiple physical quantities.

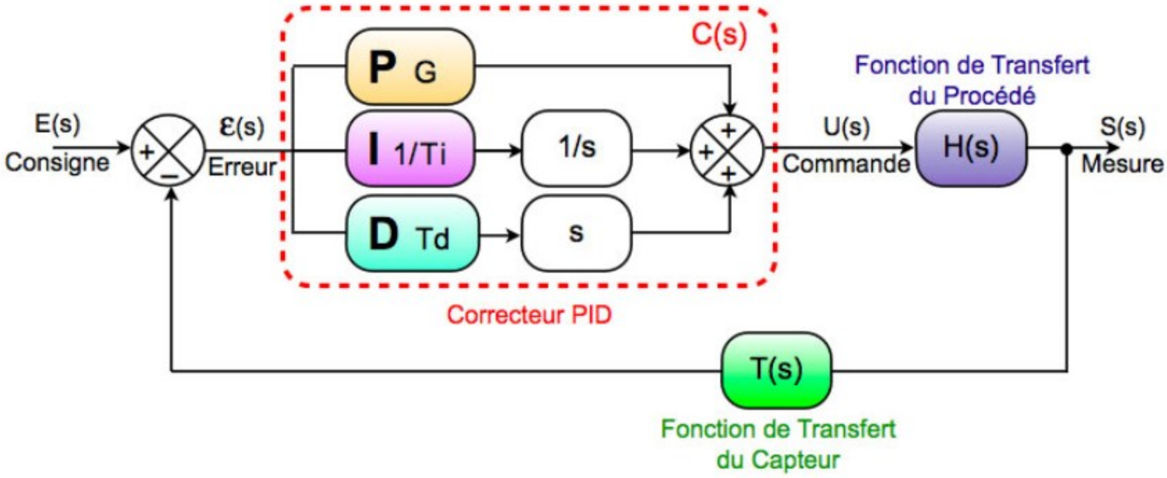
1-1 General Principle

A controller is a calculation algorithm that delivers a control signal based on the difference between the setpoint and the measurement (the error).

The PID controller acts in three ways:

• Proportional action: the error is multiplied by a gain G; • Integral action: the error is integrated and divided by a gain Ti; • Derivative action: the error is derived and multiplied by a gain Td.

The PID controller: increases the system's class and thus improves accuracy, but also speed and stability



The role of the regulator is to limit the variations of the measured quantity when the system is subjected to disturbances of the quantities

1-2 Frequency analysis of controllers

The synthesis in the frequency domain is based on the frequency response. The method is graphical. We can use the common representations of the frequency response (Bode, Nyquist (polar), Black-Nichols).

The preferred method is based on the Bode diagram. Before considering the synthesis of controllers, it is useful to analyze their properties in the frequency domain.

Let's recall the intrinsic properties of the controllers:

Contrôleurs	Propriétés	Compensateur utilisé
PI	Eliminé l'erreur	Avance de phase :diminue l'erreur
PD	Améliore la stabilité	Retard de phase : Améliore la stabilité
PID	Eliminé l'erreur+ Améliore la stabilité	Avance+ Retard de phase : diminue l'erreur+ Améliore la stabilité

Proportional-Integral-Derivative PID Controller

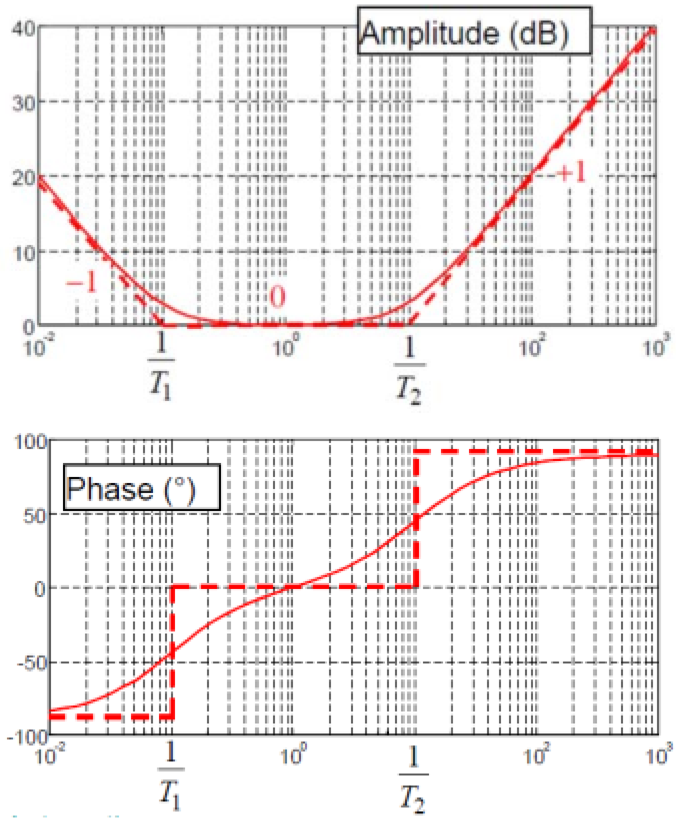
When we increase the derivative action Kd, the system becomes faster. The transfer function of the PID controller is given by: C = Kc*ε + Ki*1/s + Kd*s

Phase advance at high frequencies

• Amplification at high frequencies ⇒ PD effect at high frequencies • Infinite gain at low frequencies • Phase delay at low frequencies ⇒ PD effect at low frequencies

• Medium frequencies: little influence of the corrector

- **Effets du correcteur**



Manipulation :

Avec Logiciel Matlab/Simulink, programmer dans un m-file le système G(p) donné par la fonction de transfert du système suivant :

$$G(p) = \frac{1}{p^2 + p + 1}$$

- ✓ Insérer un correcteur de type PID de la forme suivante : C= Kc*ε+ Ki*1/s+Kd*s .
- ✓ Tracer la réponse indicielle du système en BF sans correcteur et avec correcteur .
- ✓ Que conclure sur les resultats obtenus ?
- ✓ Montrez l'interet de l'utilsation de ce correcteur.

Manipulation: With Matlab/Simulink software, program the system G(p) given by the transfer function of the following system in an m-file:

$$G(p) = \frac{1}{p^2 + p + 1}$$

1. Insert a PID controller of the following form: C= Kc*ε+ Ki*1/s+Kd*s.
2. Plot the step response of the system in BF without a controller and with a controller.
3. What can we conclude from the results obtained?
4. Show the interest in using this corrector.