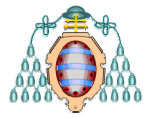


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de Oviedo



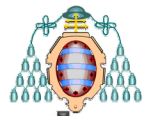
# Actuadores

Sistemas Automáticos– Tema 15

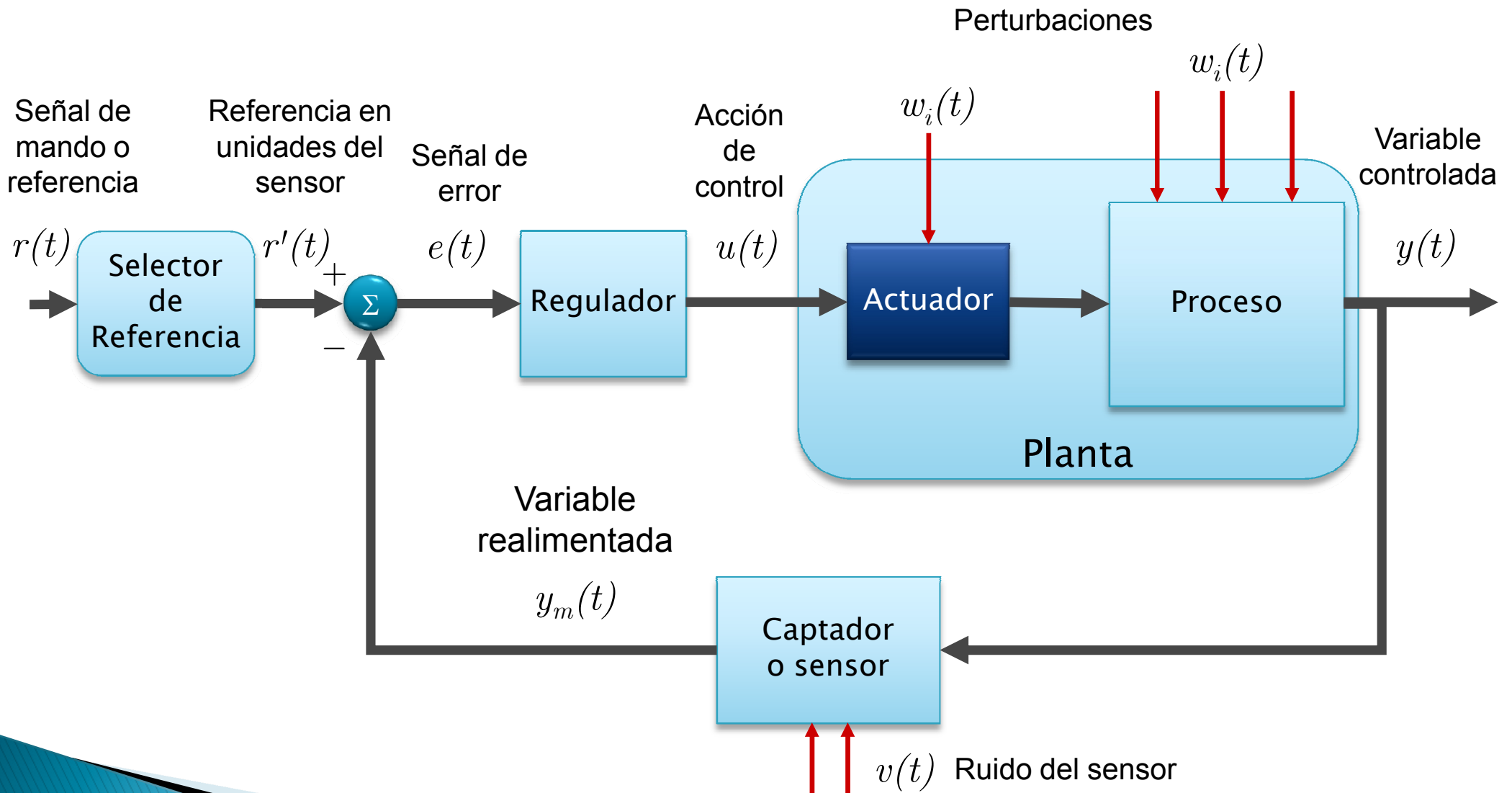


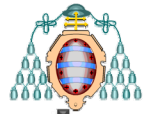
# Contenidos

- ▶ El actuador en la cadena de control
- ▶ Limitaciones de los actuadores
- ▶ Ancho de banda
- ▶ Retardo de transporte
- ▶ Saturación
- ▶ Zona muerta y Slew rate



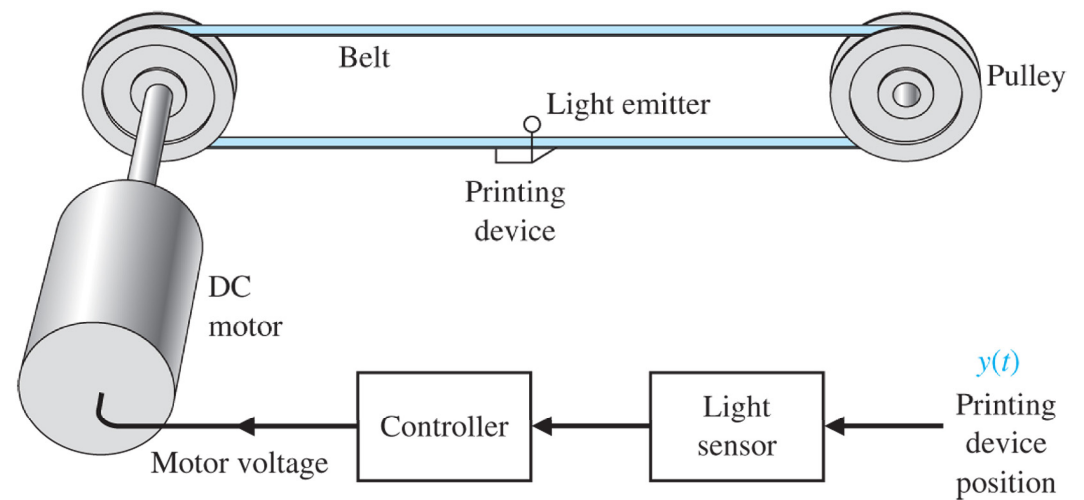
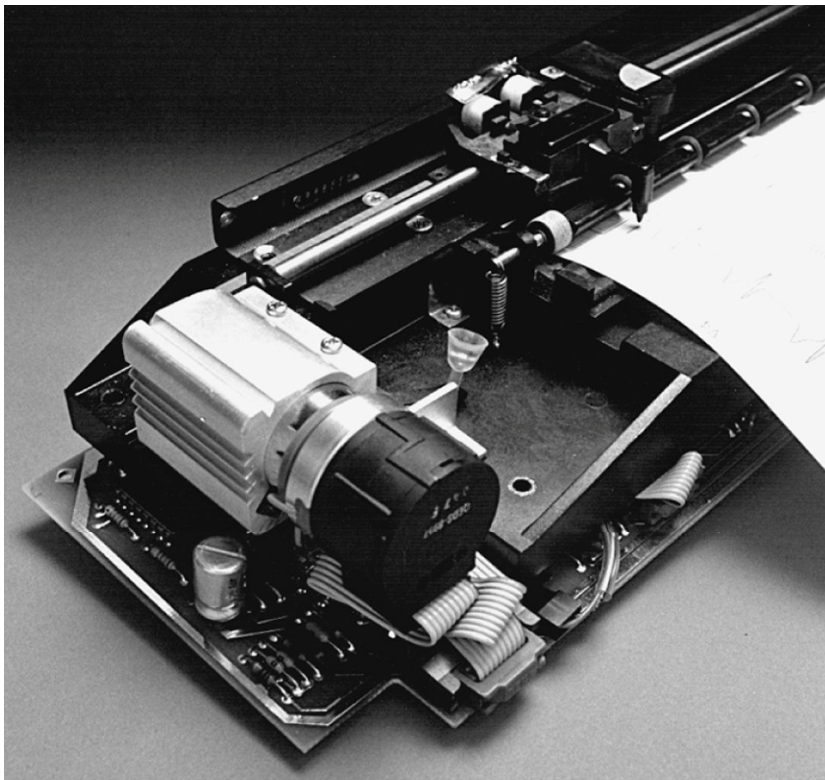
# El actuador en la cadena de control





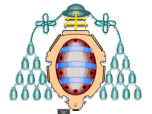
# El actuador en la cadena de control

## ► Motores



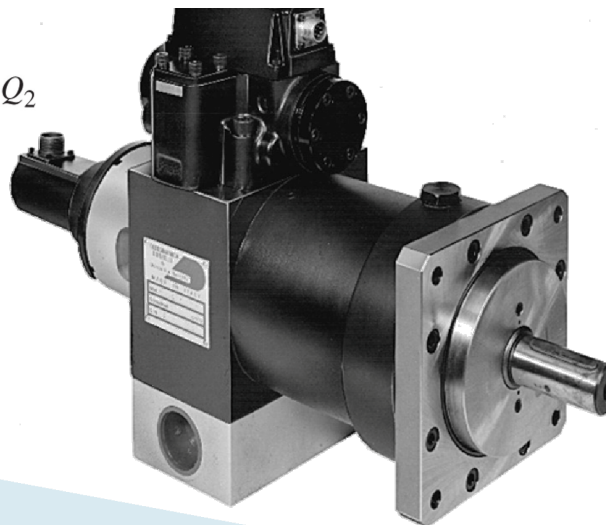
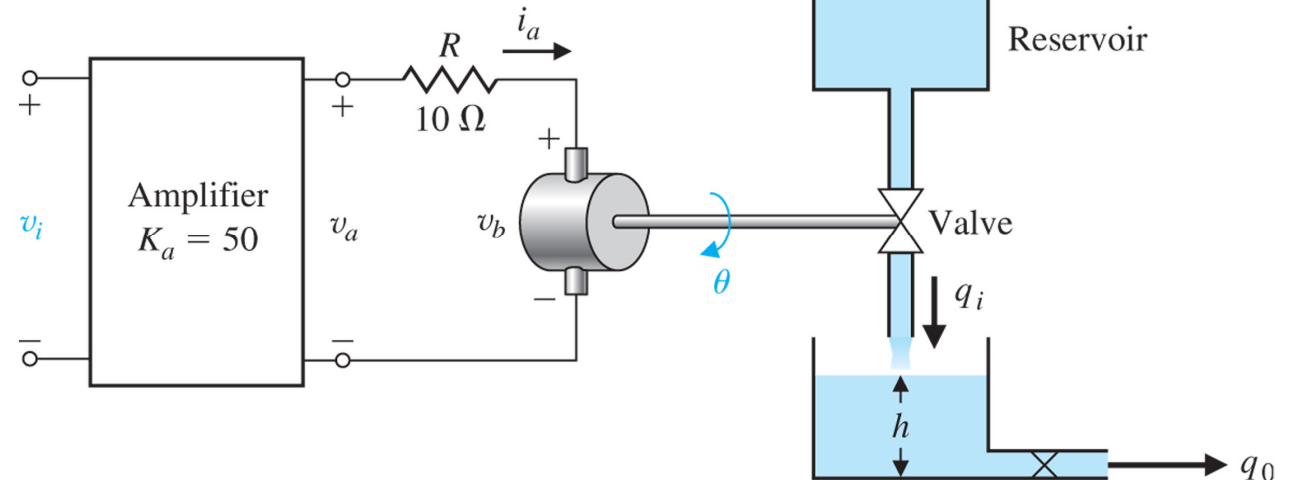
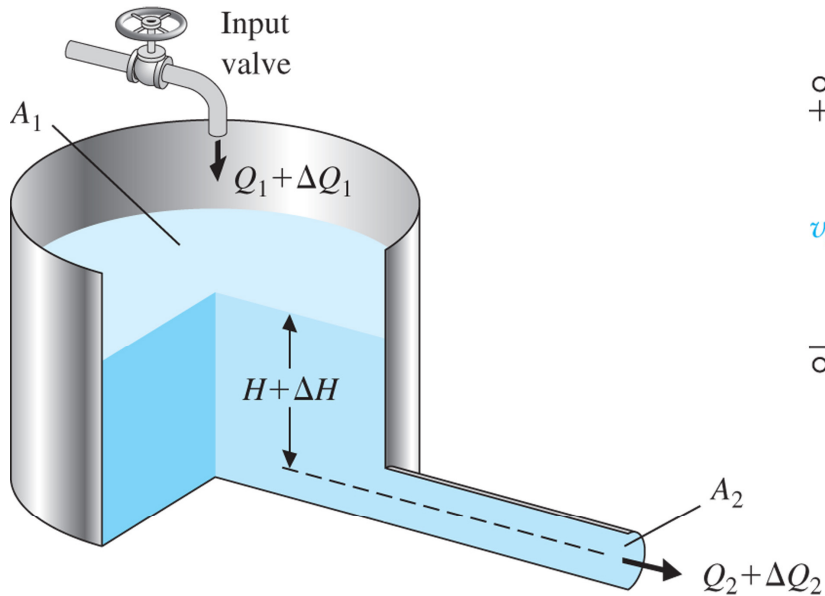
Figuras: Dorf, *et al.*  
"Modern Control Systems" 10<sup>th</sup> ed.



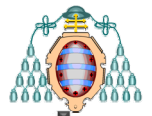


# El actuador en la cadena de control

## ► Electroválvulas



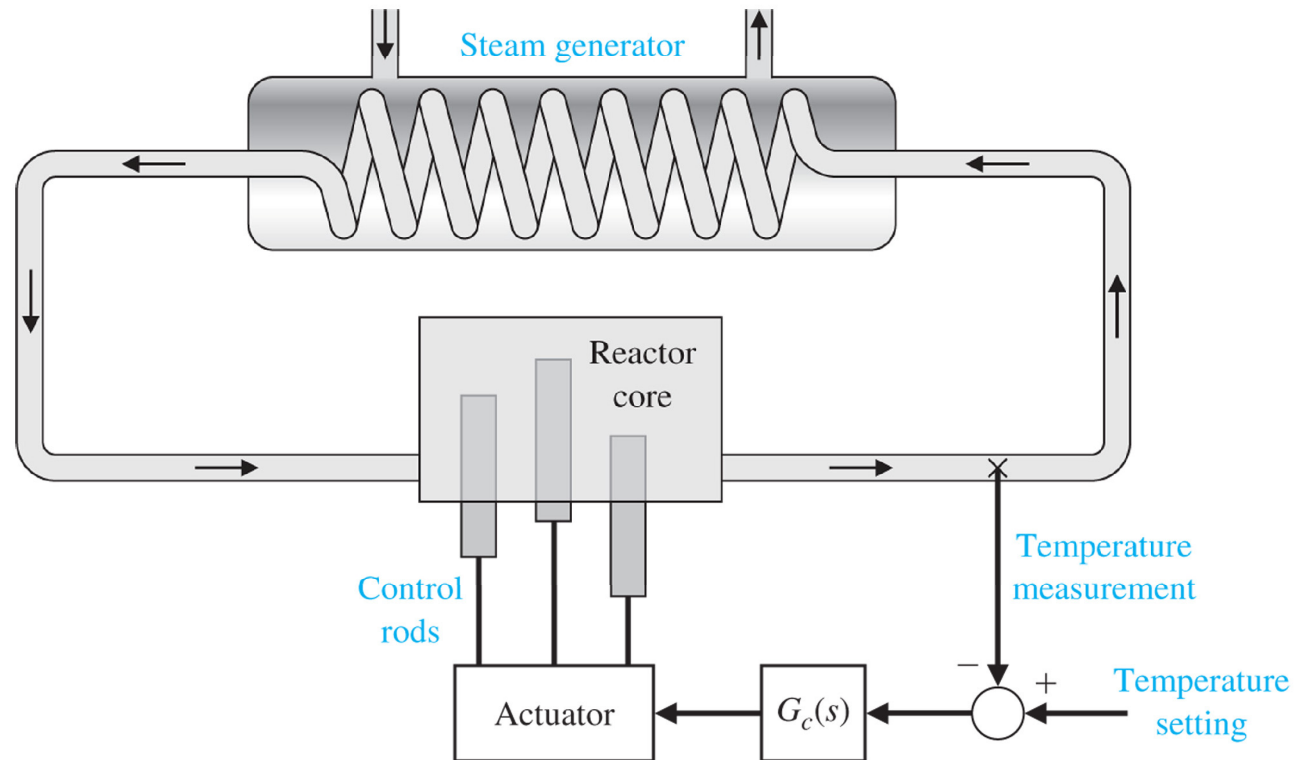
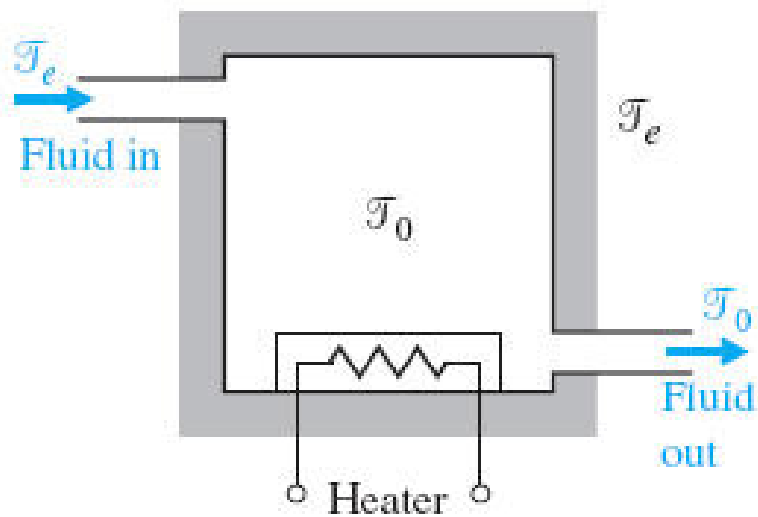
Figuras: Dorf, *et al.*  
 "Modern Control Systems" 10<sup>th</sup> ed.



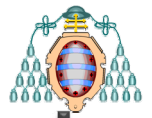
# El actuador en la cadena de control

## ► Calefactores

16. Thermal heating system

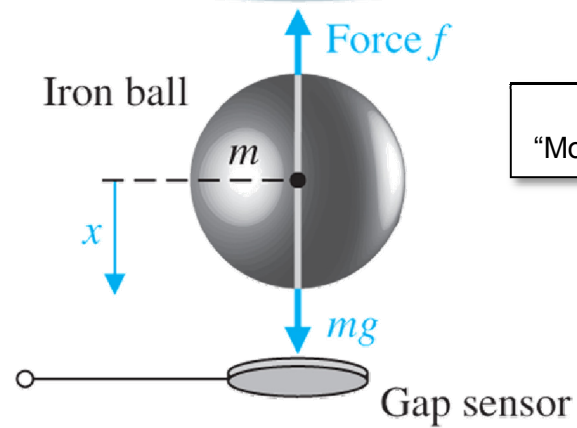
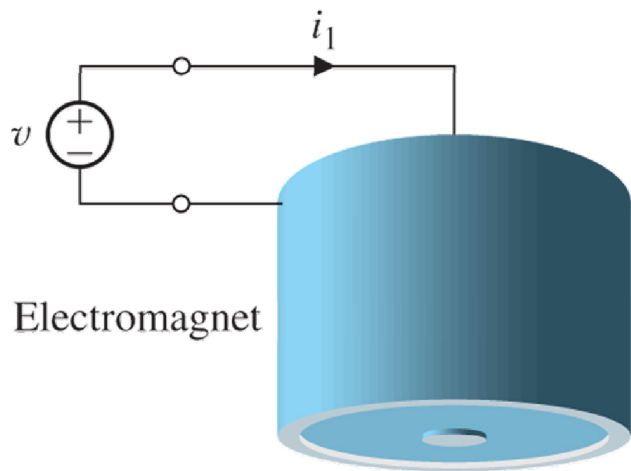


Figuras: Dorf, *et al.*  
 "Modern Control Systems" 10<sup>th</sup> ed.

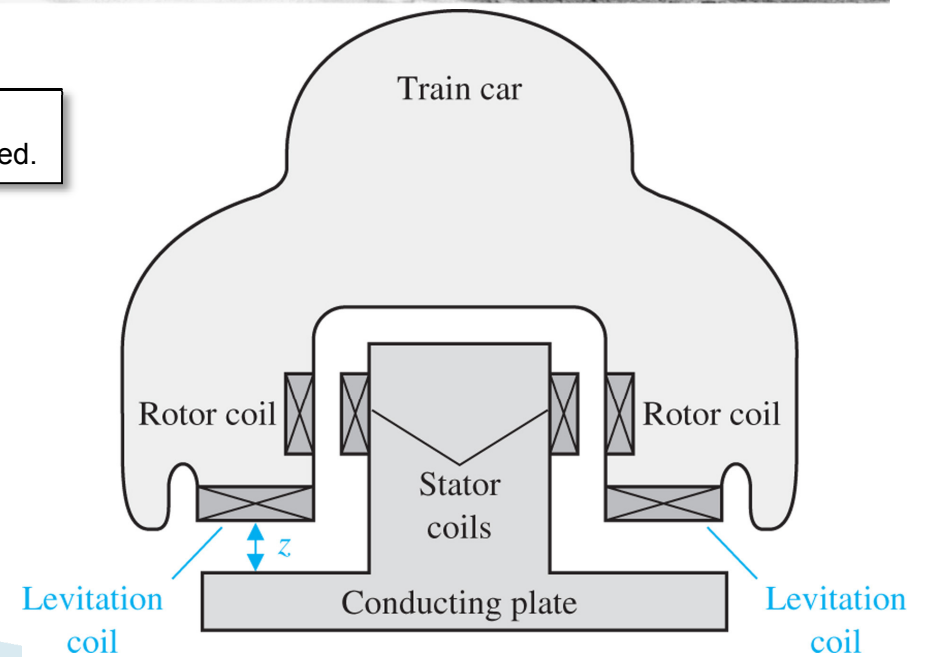


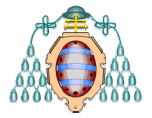
# El actuador en la cadena de control

## ► Electroimanes



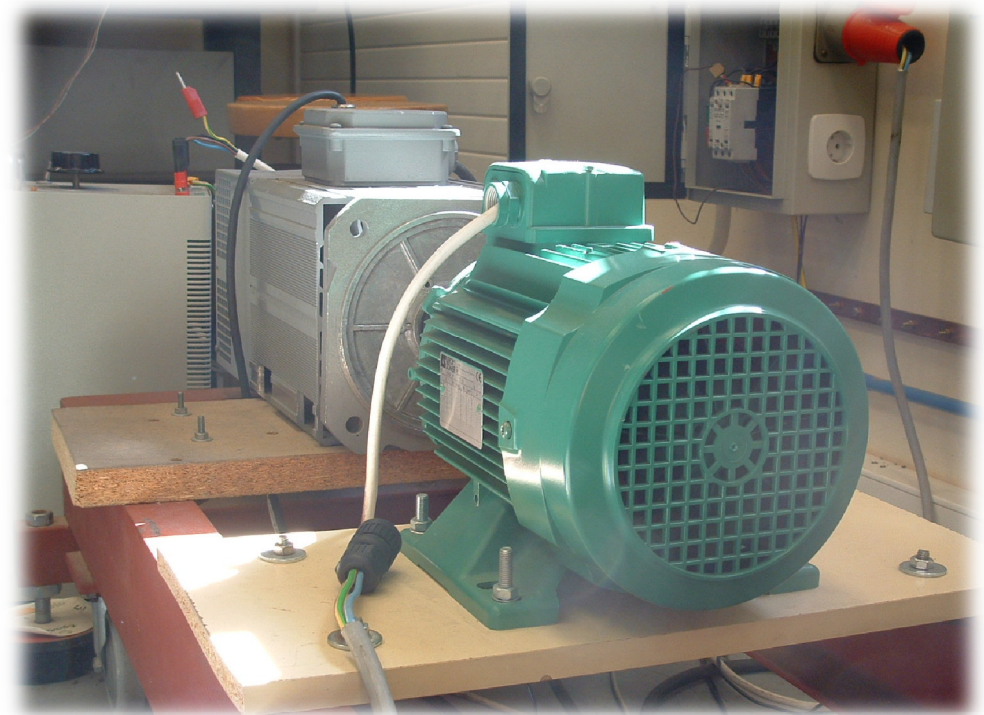
Figuras: Dorf, *et al.*  
 "Modern Control Systems" 10<sup>th</sup> ed.



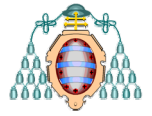


# Limitaciones de los actuadores

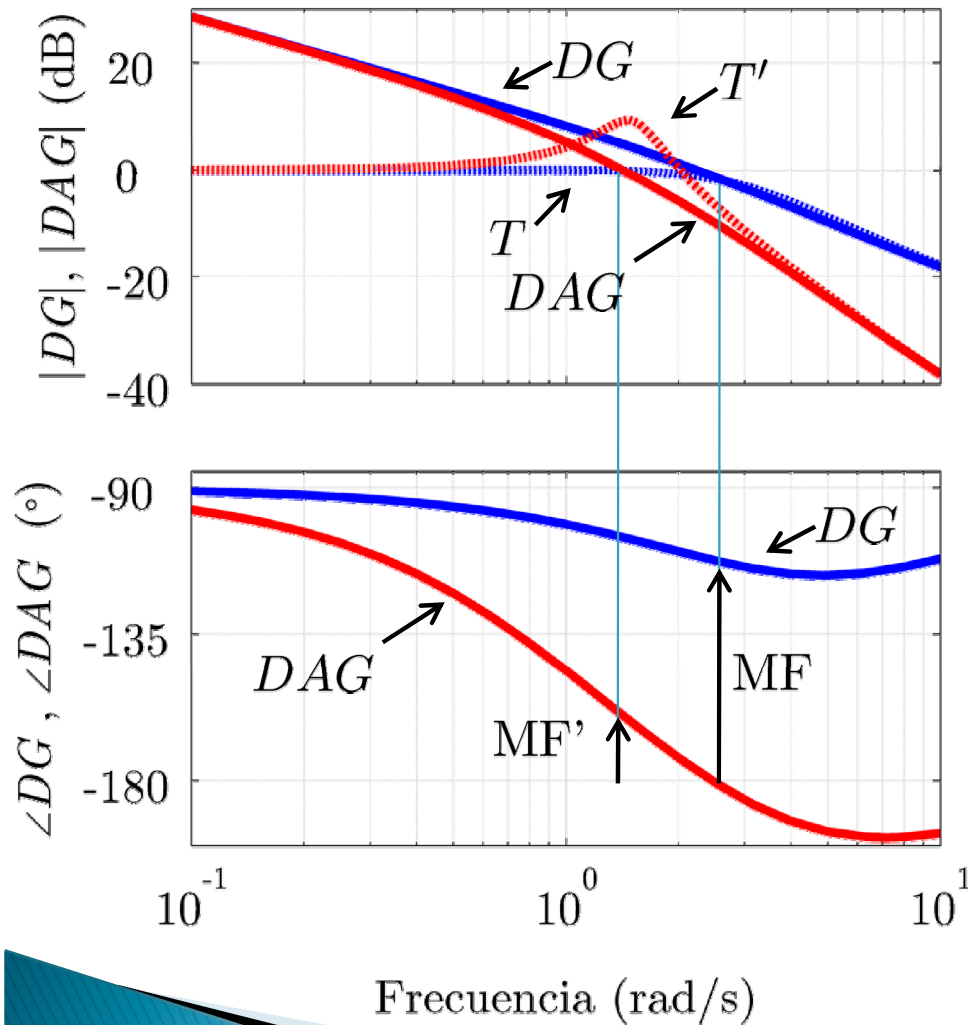
- ▶ **Dinámicas**
  - Ancho de banda
  - Retardo de transporte
  
- ▶ **Estáticas**
  - Saturación
  - Zona muerta
  - Slew-rate







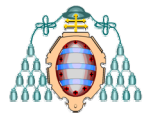
# Ancho de banda



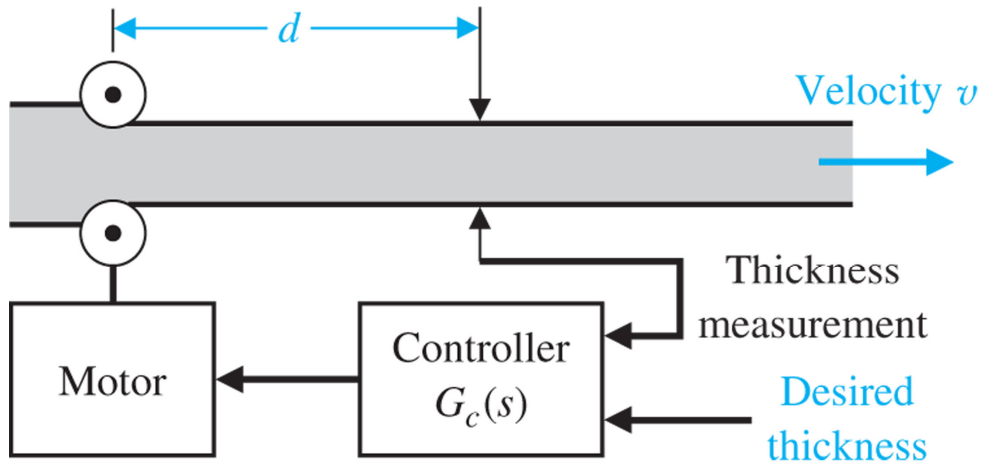
Si el ancho de banda del actuador no es mayor que el ancho de banda del sistema realimentado suponiendo actuador ideal:

- El ancho de banda real queda reducido
- Disminuye la estabilidad relativa
- Más sensibilidad
- Más oscilación

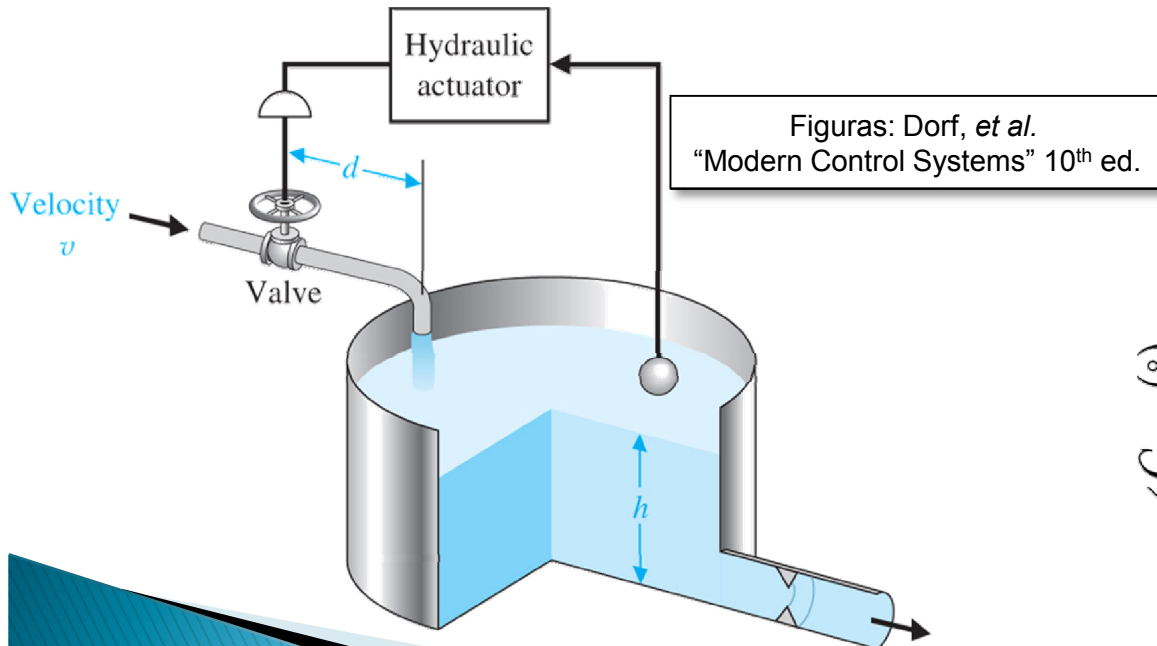




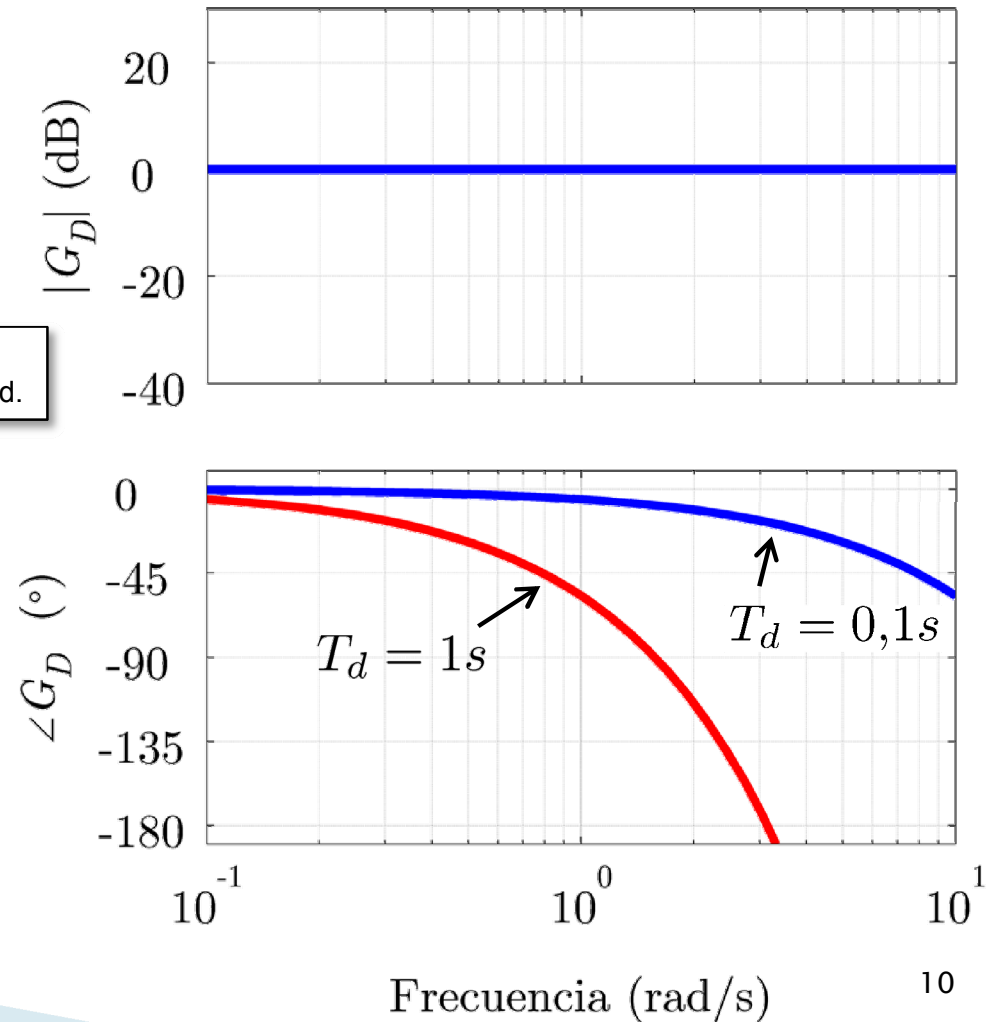
# Retardo de transporte

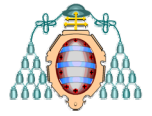


$$G_D(s) = e^{-s \cdot T_d}$$

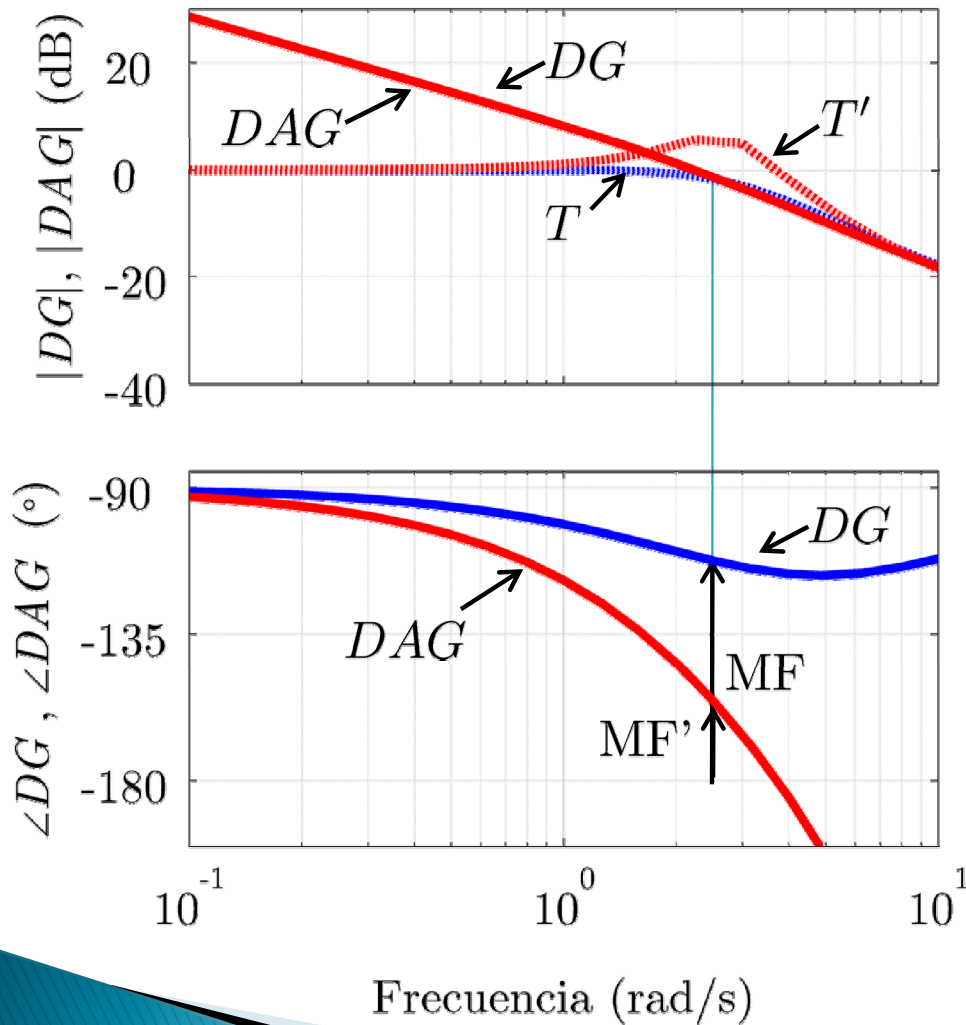


Figuras: Dorf, *et al.*  
"Modern Control Systems" 10<sup>th</sup> ed.



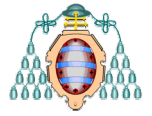


# Retardo de transporte

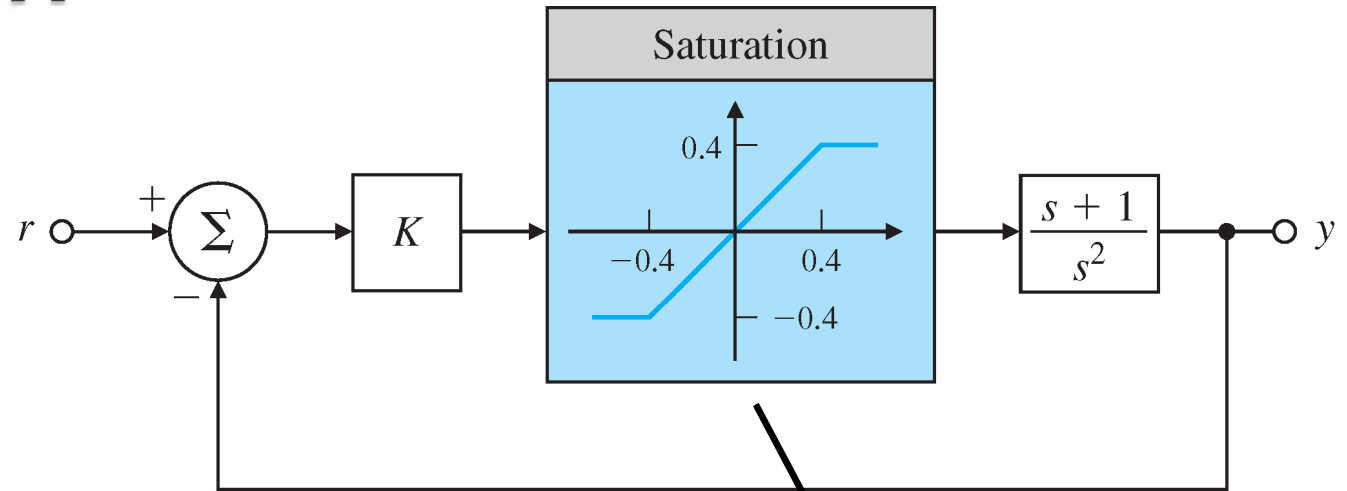
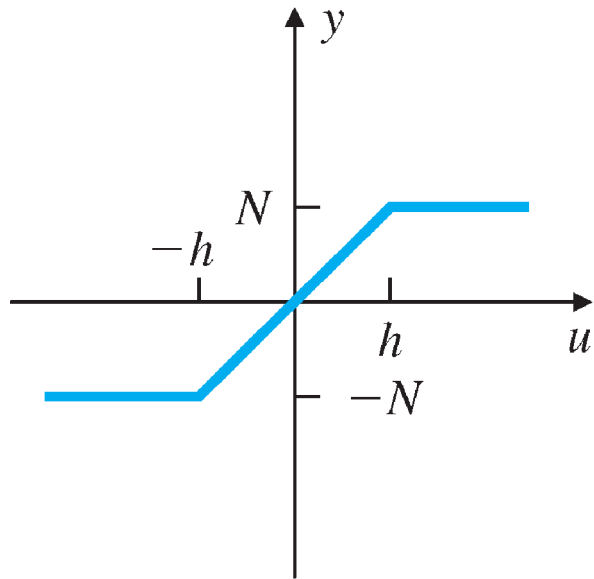


Si el actuador es (o tiene) un retardo puro que no se ha tenido en cuenta en el diseño se reduce el margen de fase:

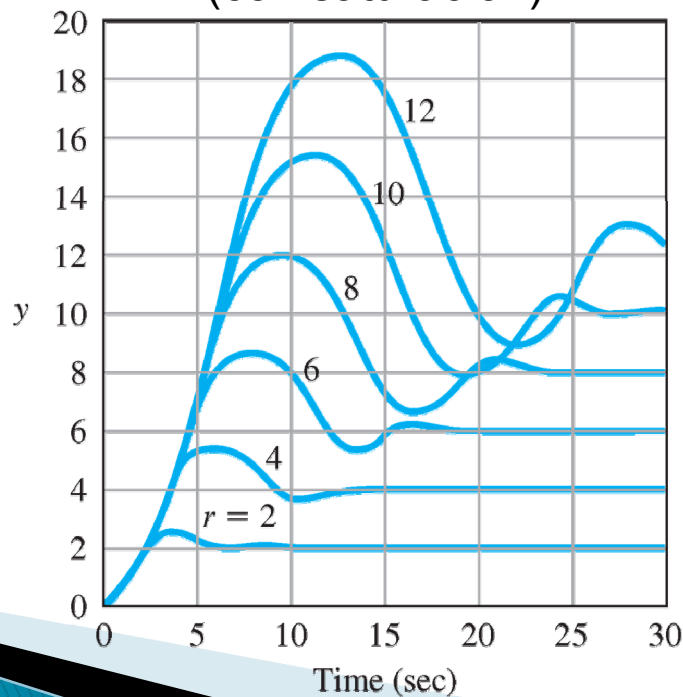
- Disminuye la estabilidad relativa
- Más sensibilidad
- Más oscilación



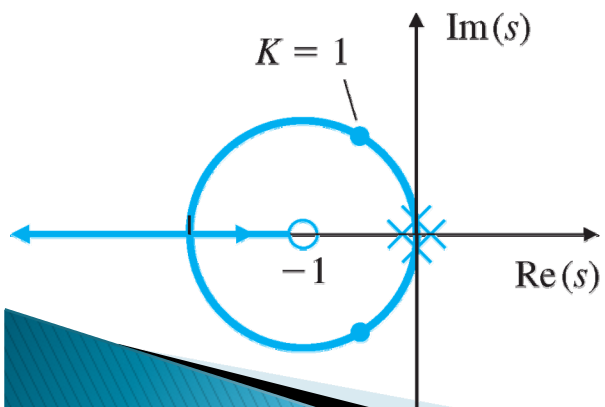
# Saturación



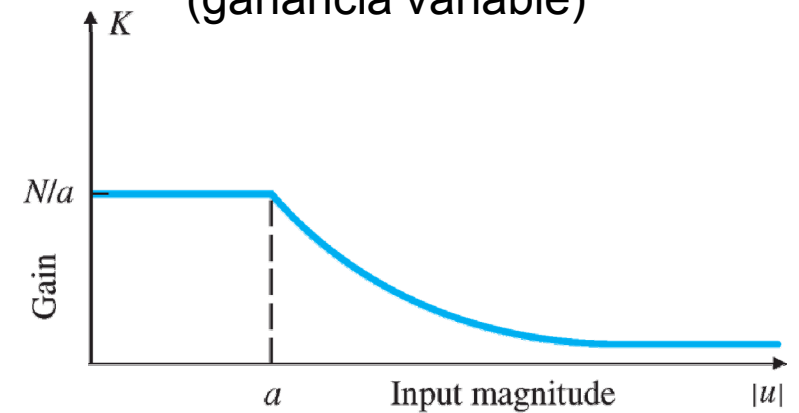
Respuesta a escalón  
(con saturación)

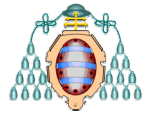


Lugar de las raíces  
(sin saturación)



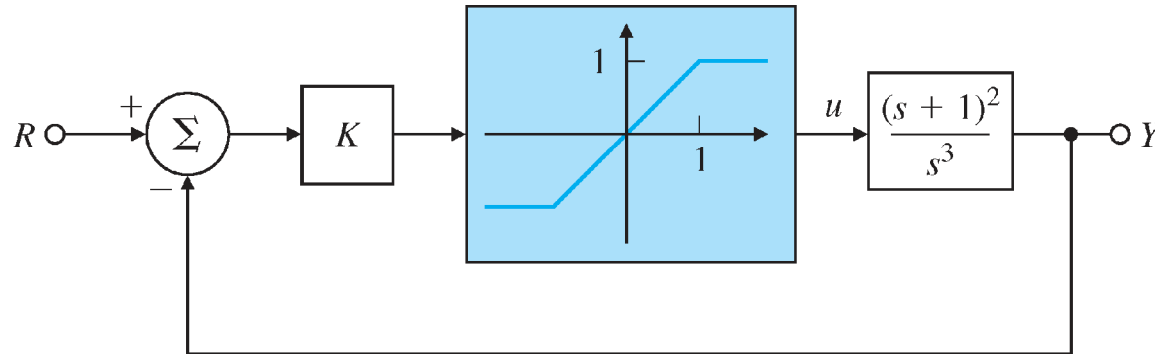
Ganancia efectiva  
(ganancia variable)



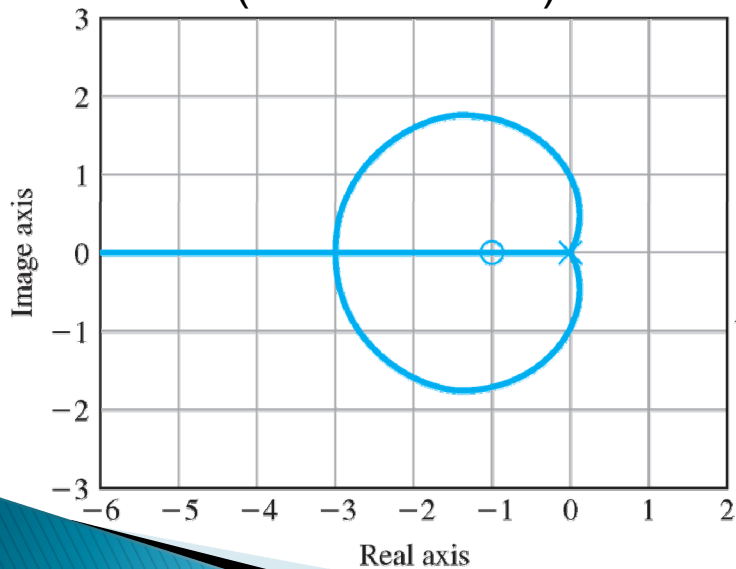


# Saturación

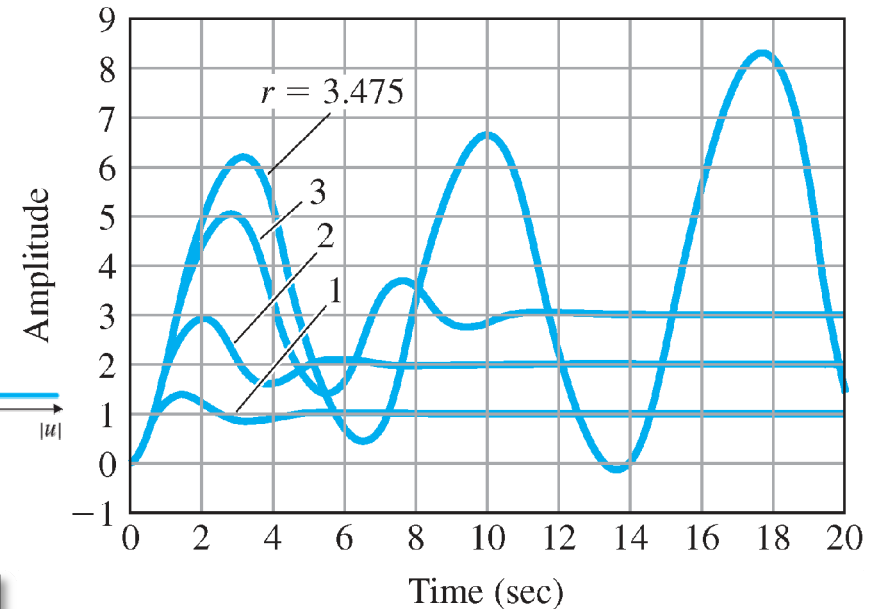
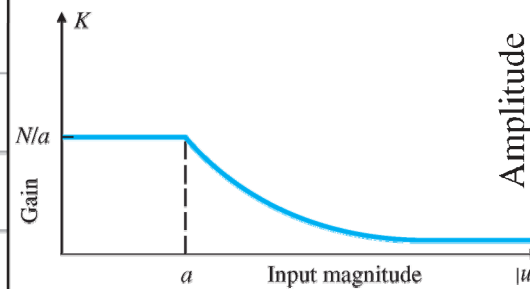
## ► Sistemas condicionalmente estables



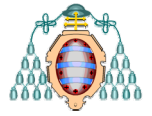
Lugar de las raíces  
(sin saturación)



Respuesta a escalón  
(con saturación)

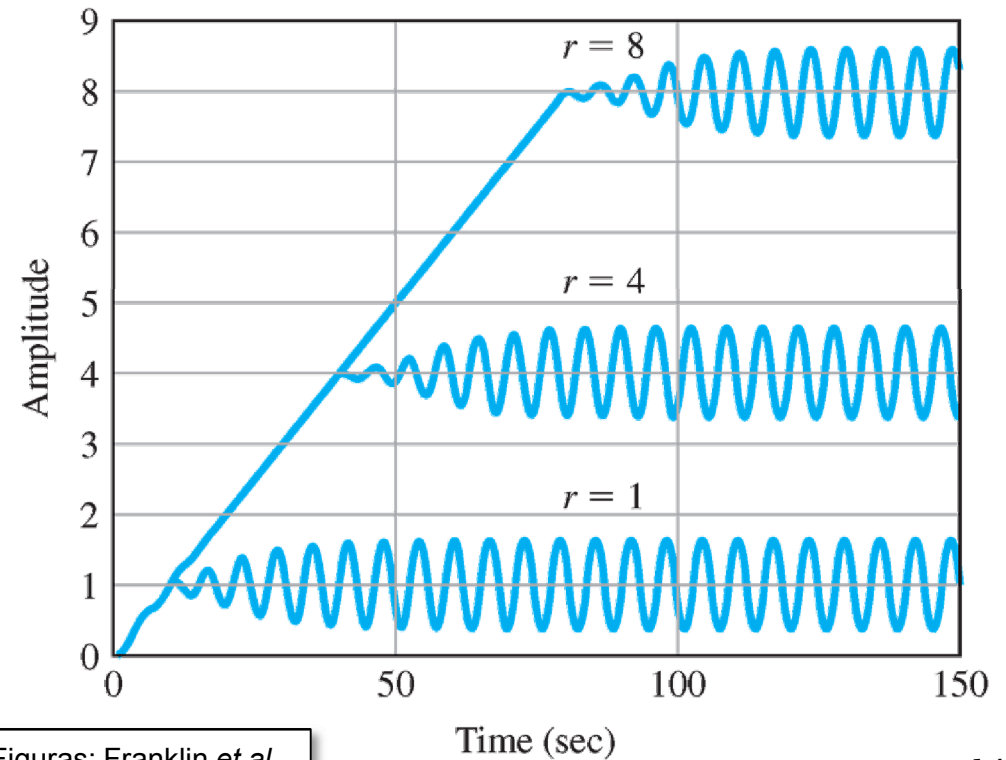
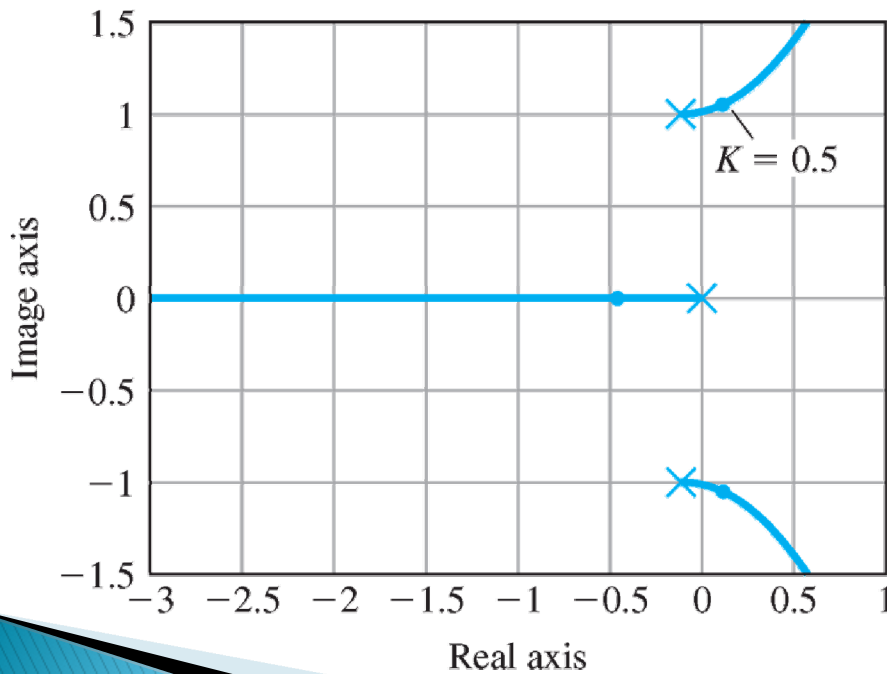
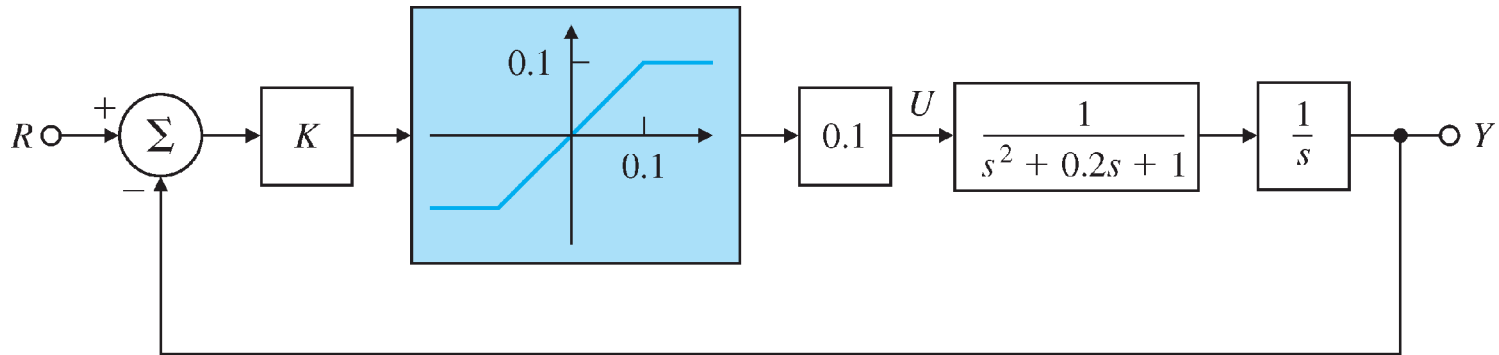


Figuras: Franklin *et al.*



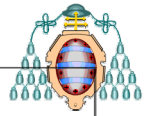
# Saturación

## ► Ciclo límite



Figuras: Franklin *et al.*





# Saturación

## ► Windup

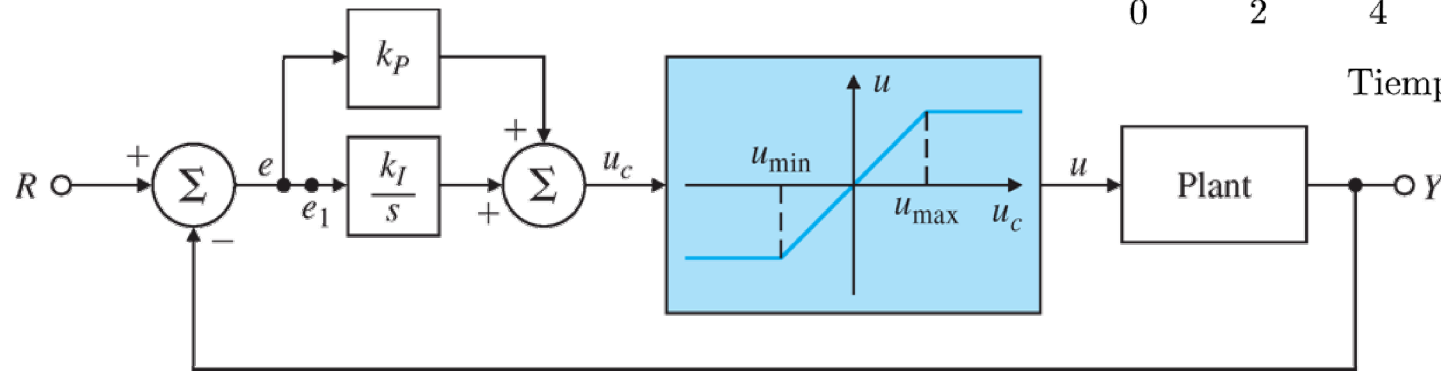
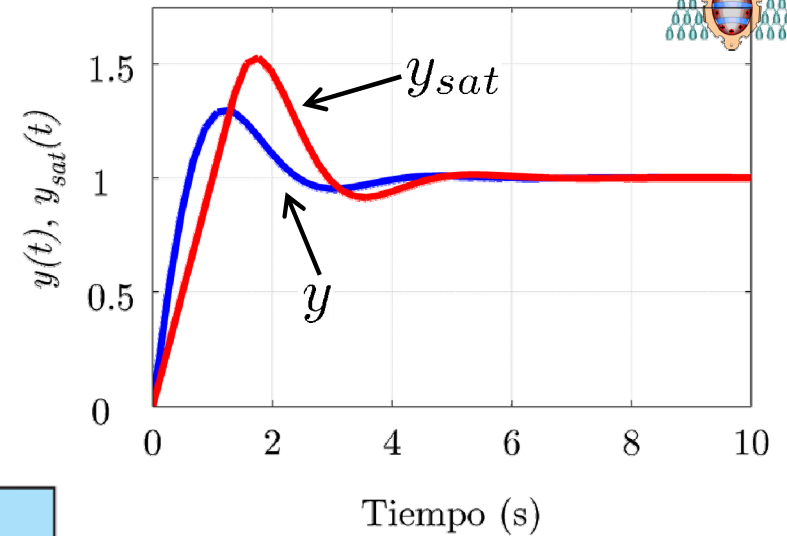
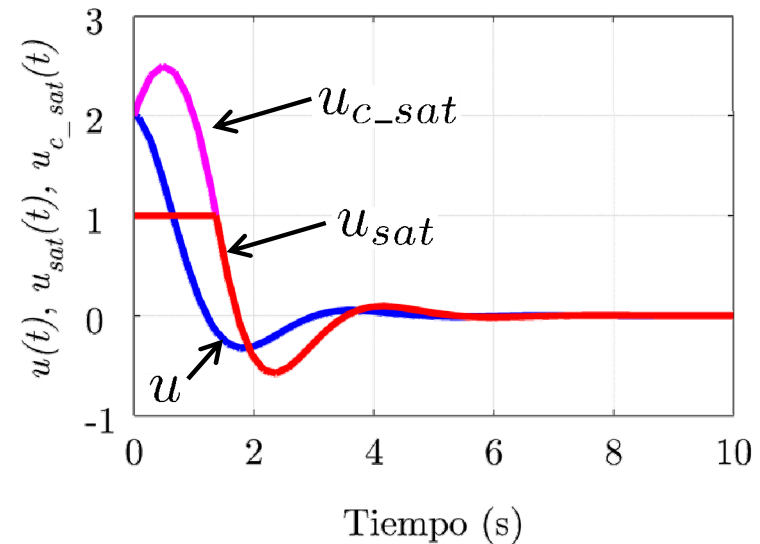
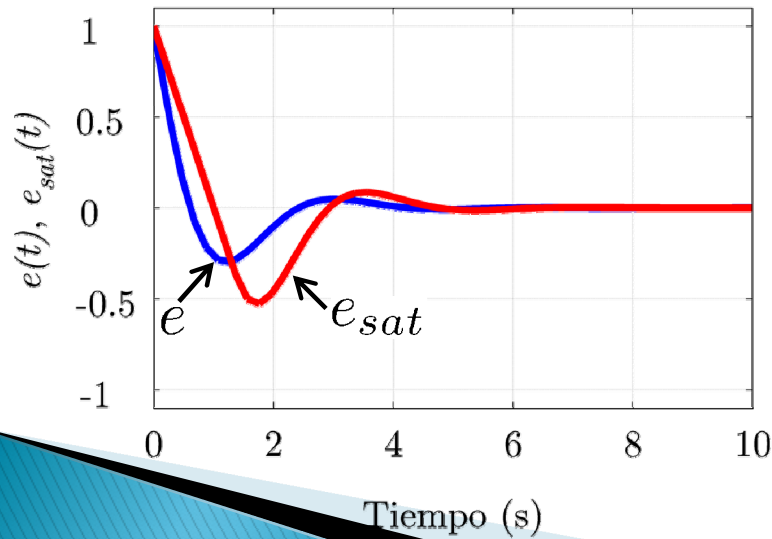
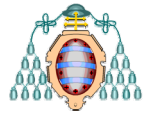


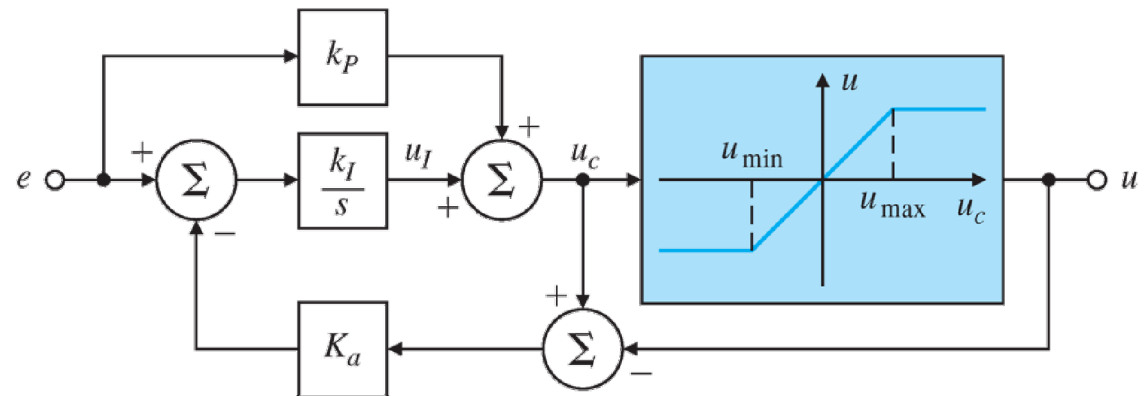
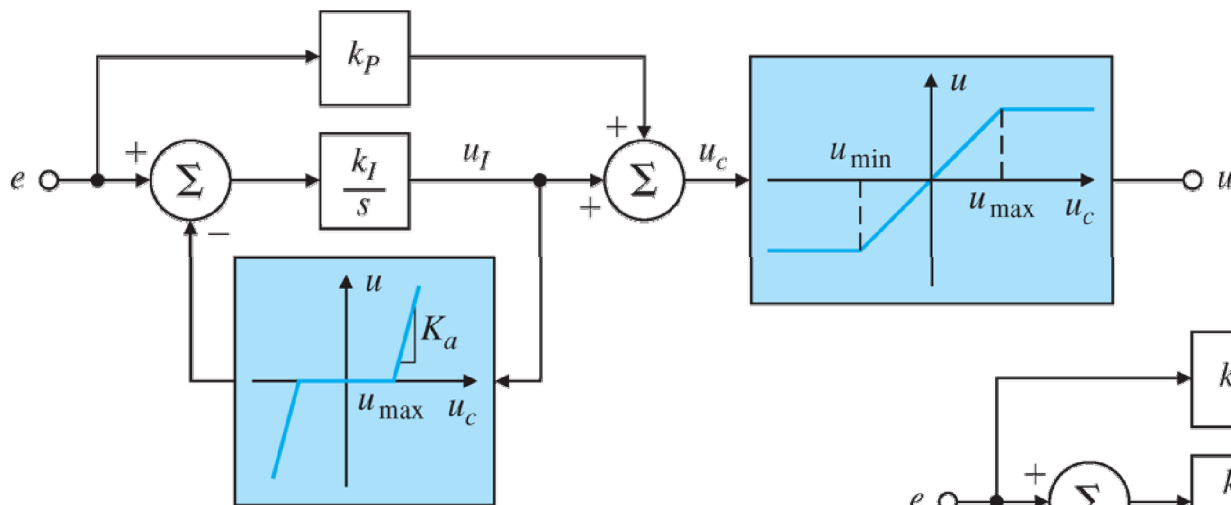
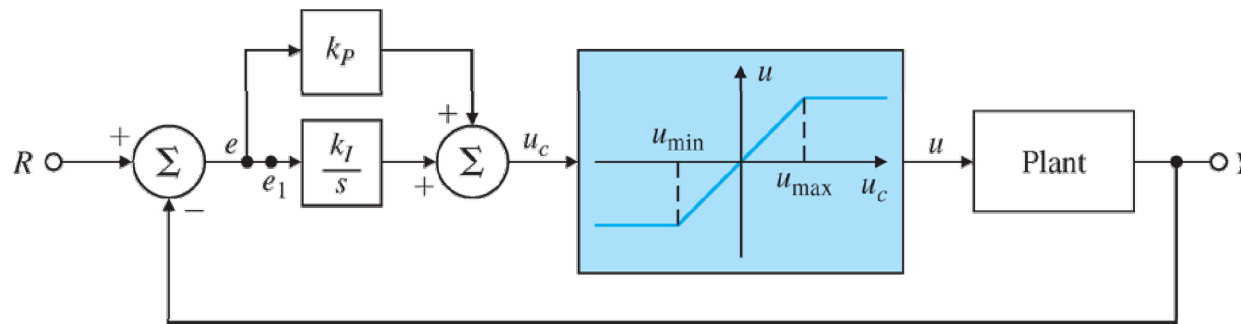
Figura: Franklin et al.

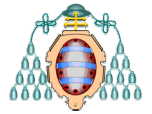




# Saturación

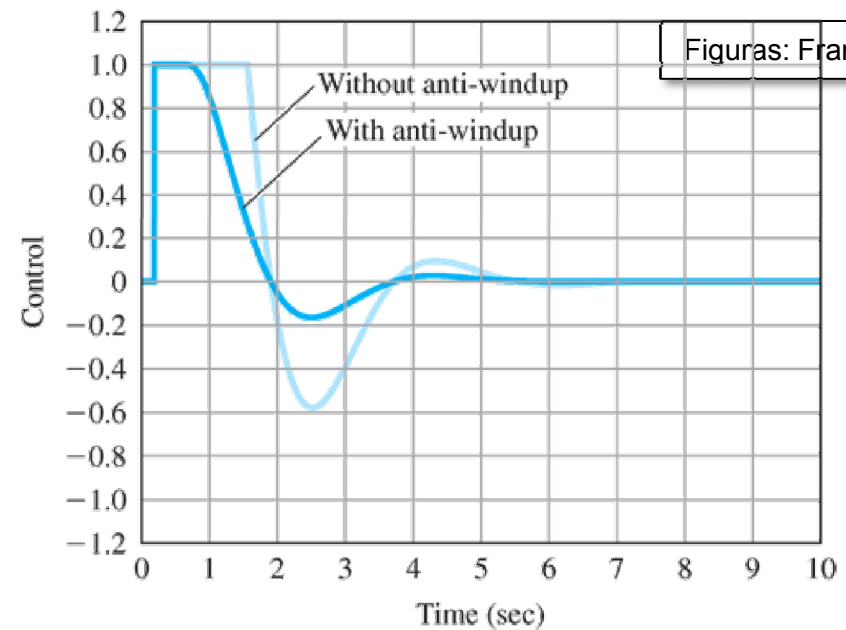
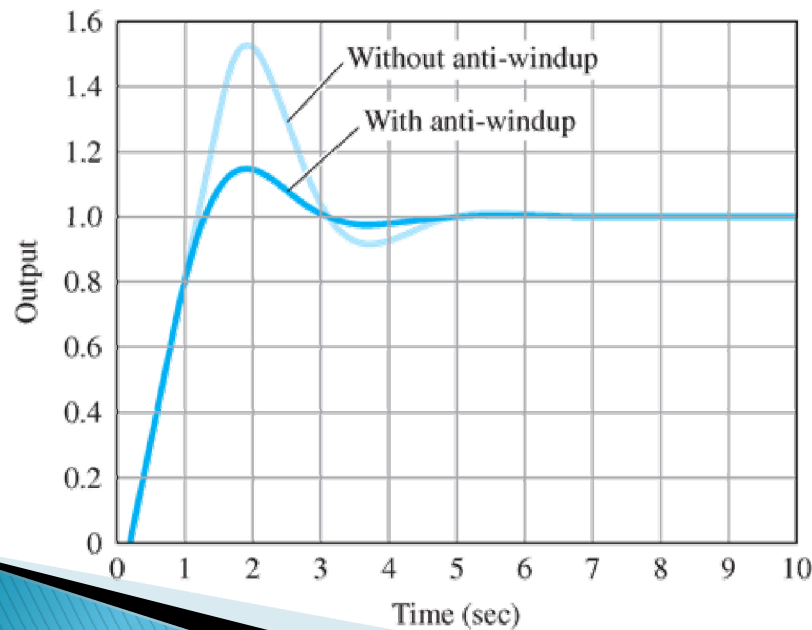
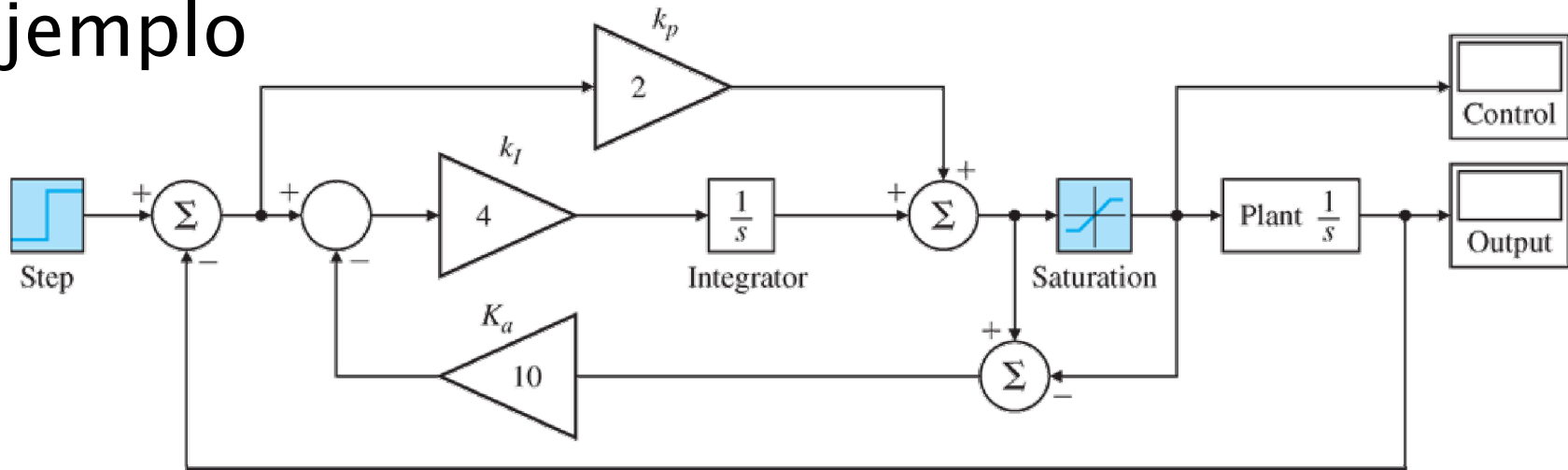
## ► Esquemas antiwindup



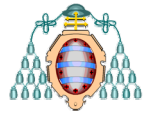


# Saturación

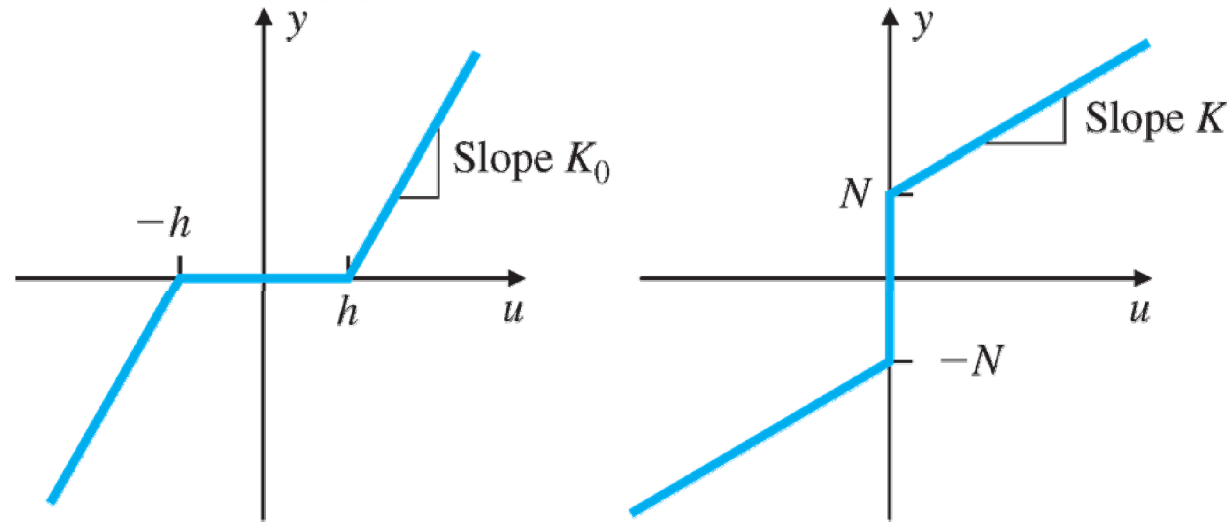
## ► Ejemplo



Figuras: Franklin *et al.*



# Zona muerta



Figuras: Franklin *et al.*

# Slew rate

