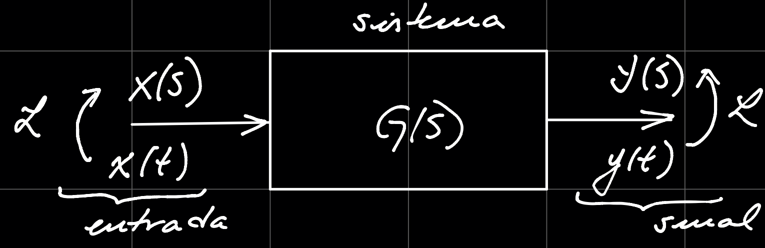
SISTEMAS CONTROLE



$\underbrace{\text{L.I.T.}}$

$$\frac{Y(S)}{X(S)} = G(S)$$

$G(S) \longrightarrow$ Ganho do sistema

Função de transferência

Exemplo:

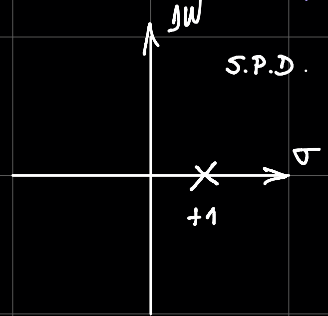
$$G(S) = \frac{1}{S-1} \longleftarrow \text{FÍSICO ou ``REAL''}$$

SISTEMA $\longrightarrow$ PÓLOS // ZEROS

$N(S) = 1$ $\qquad$ $D(S) = S-1 = 0$

$$\downarrow$$

$$\underbrace{P_1 = +1}_{\text{INSTÁVEL}}$$



$x(t) = \delta(t) \longrightarrow y(t) = ?$

$\downarrow \mathcal{L}$

$X(S) = 1 \longrightarrow Y(S) = G(S) \cdot X(S)$

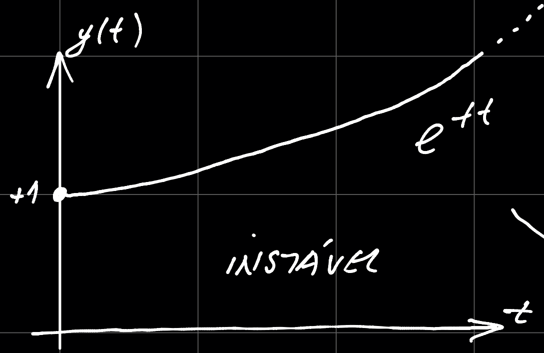
$Y(S) = G(S) \cdot 1$

CONTROLE

$$Y(s) = G(s) = \frac{1}{s-1}$$

$$\mathcal{L}^{-1}$$

$$y(t) = \underbrace{e^{+t}\mu(t)}$$

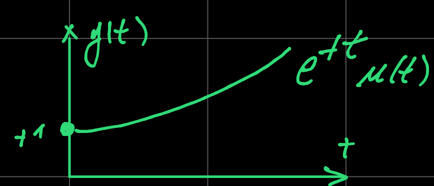


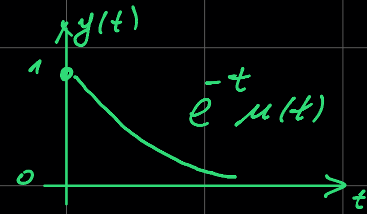
$t \to \infty$

$y(t) \to \infty$

$$\underbrace{\frac{1}{s-1}}_{\text{INSTÁVEL}} \xrightarrow{\delta(t)} \frac{1}{s+1}$$

ESTÁVEL

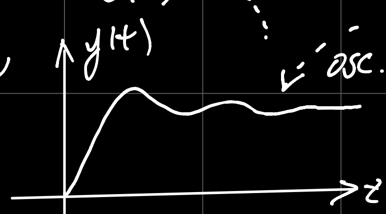




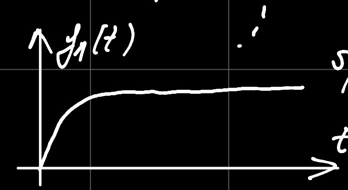
$$G(s) = \frac{N(s)}{D(s)} \longrightarrow G_1(s) = \frac{N_1(s)}{D_1(s)}$$

$\mu(t) = \varepsilon(t)$ degrau

AO DEGRAU



OSC.

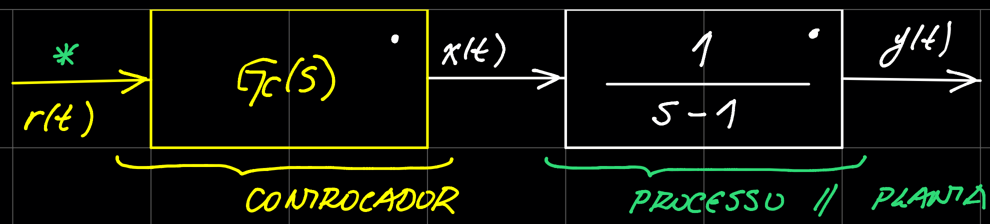


S/ OSC.

CONTROLE

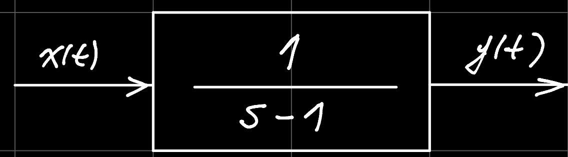
- MALHA ABERTA
- MALHA FECHADA

$$\frac{1}{s+1}$$



(•)

$$\frac{y(S)}{X(S)} = \frac{1}{S-1}$$



$$\frac{y(S)}{R(S)} = \frac{1}{S+1} \quad \ldots\ldots \quad G_c(S) = \_\_\_\_\_\_$$

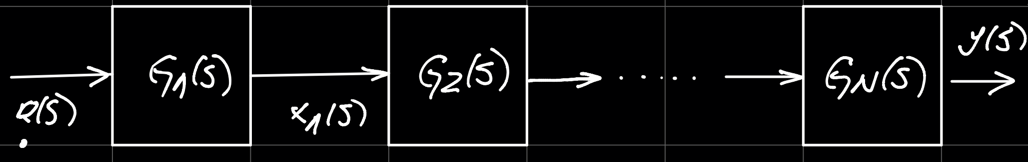
(•) CASCATA ... SÉRIE

$$y(S)/X(S) = \frac{1}{S-1}\,, \quad X(S)/R(S) = G_c(S) \longleftarrow$$

$$y(S)/R(S) =$$

$$X(S) = G_c(S) \, . \, R(S) \longrightarrow y(S)/X(S) = y(S)/G_c(S)\,R(S)$$

$$\frac{y(S)}{R(S)} = \underbrace{G_c(S) \, . \, \frac{1}{S-1}}$$



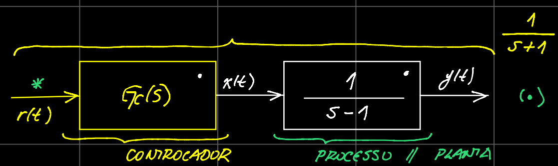
PD

$$\frac{y(S)}{R(S)} = \underbrace{G_1(S) \, . \, G_2(S)} \ldots G_N(S) \quad !$$

$$\frac{Y(s)}{R(s)} = G_c(s) \cdot \frac{1}{s-1} = \frac{1}{s+1}$$

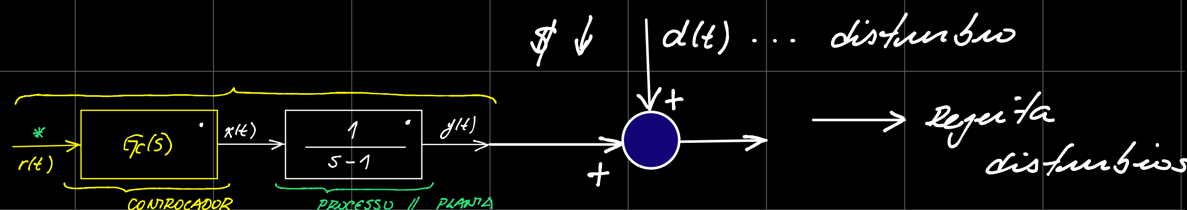
- VIÁVEL
- RECOMENDÁVEL

$$\therefore \; G_c(s) = \underbrace{\frac{s-1}{s+1}}_{\text{CONTROLADOR}} \leftarrow \ldots \text{ VIÁVEL} \Downarrow \text{ ENG? INCONV.?}$$

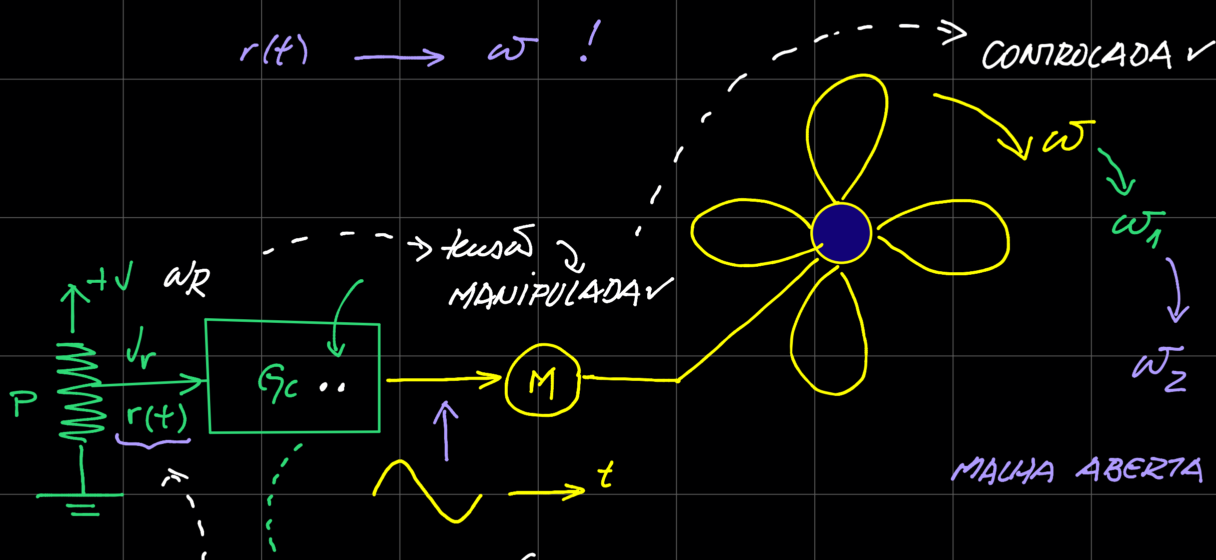


MALHA ABERTA

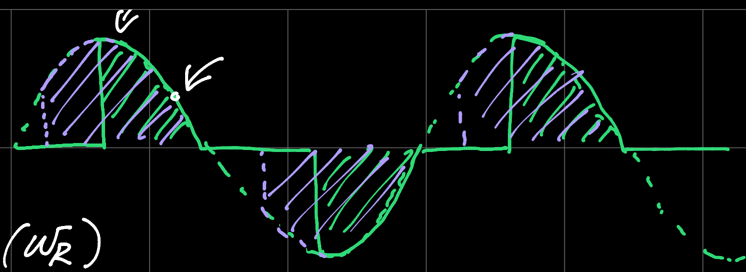
$$G_{ma}(s) = G_c(s) \cdot \frac{1}{s-1}$$

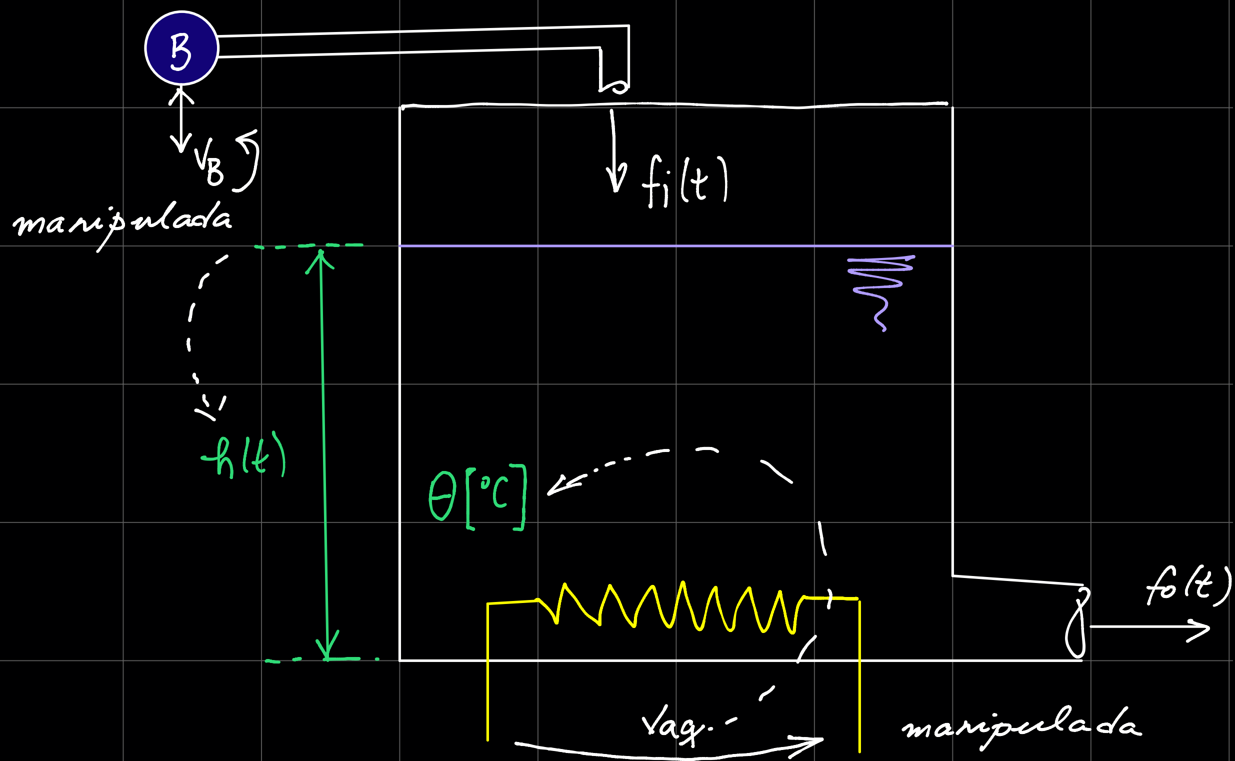


$r(t) \longrightarrow \omega$!



• REFERÊNCIA ou SET-POINT (W_R)

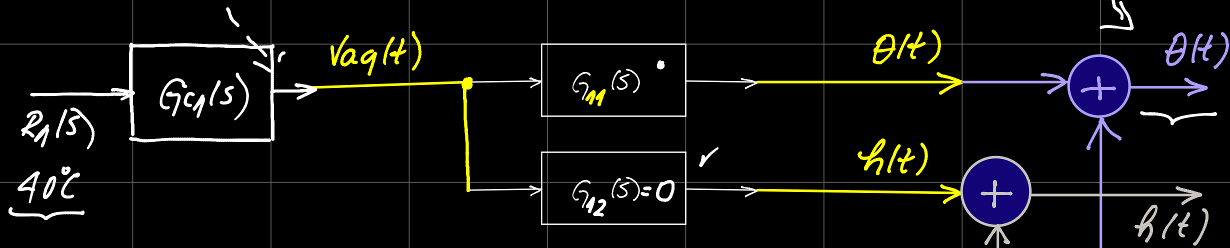


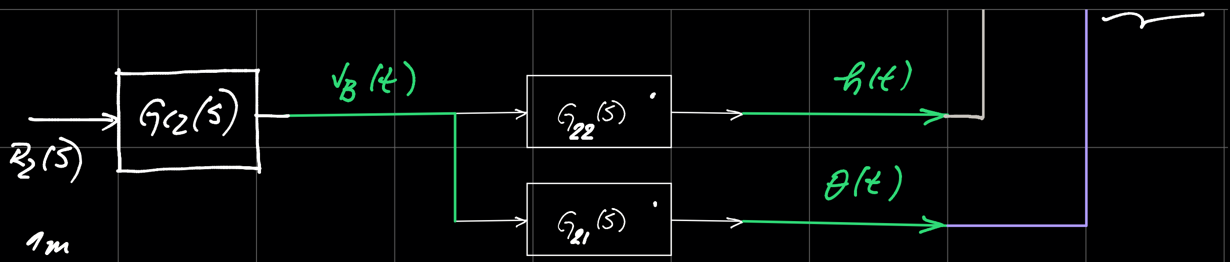


(•) CONTROLADA: Temperatura e nível

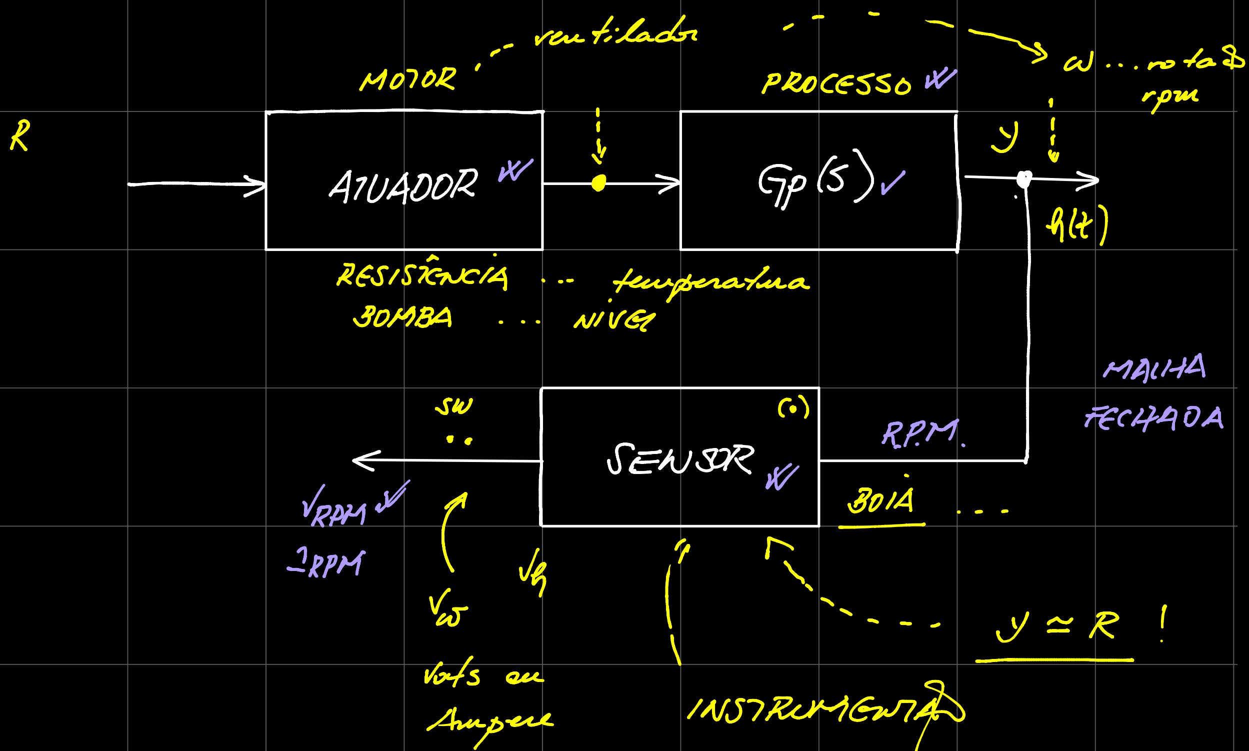
2 variáveis manipuladas — MIMO

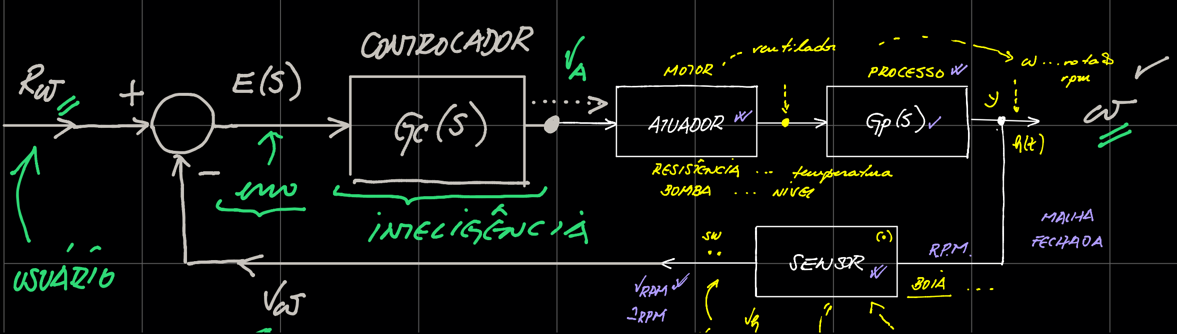
2 variáveis controladas





"malha aberta"





medida

V_W Volts ou Ampere INSTRUMENTAÇÃO $y \simeq R$!

$E(s)$ ... sinal ... ERRO ATUANTE

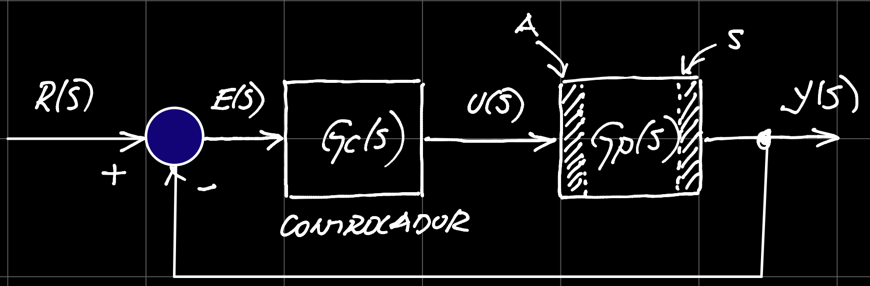
$R_W(s)$ ... sinal ... REFERÊNCIA ajustada pelo usuário

objetivos ⟶ erro ⟶ 0 ... $y(t) \to R(t)$

QUAL o $G_c(s)$ que garante ?

Existe mais de um $G_c(s)$?

Se existir, como escolher $G_c(s)$?



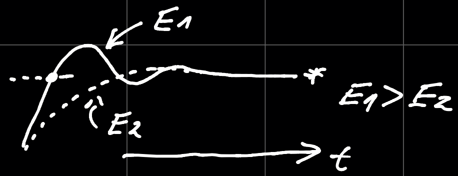
MALHA FECHADA

$R(S)$ ... REFERÊNCIA (USUÁRIO)

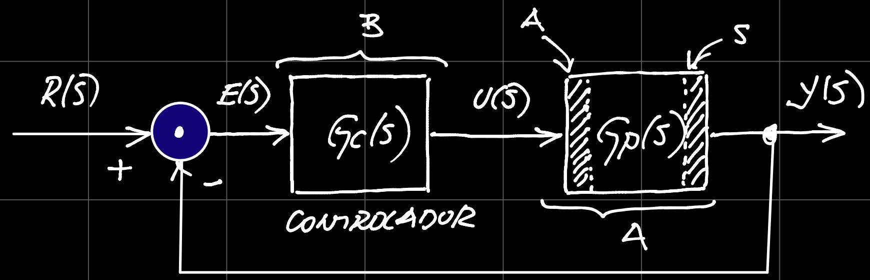
$E(S)$ ... ERRO ATUANTE

$U(S)$ ... ESFORÇO DE CONTROLE (MANIPULADA)

$Y(S)$ ... VARIÁVEL CONTROLADA - SAÍDA



$\underbrace{\text{TRANSITÓRIO}}$



$$\frac{Y(s)}{R(s)} = ? \qquad \frac{E(s)}{R(s)} = ?$$

$$Y(s) = G_p(s).U(s) \quad (A)$$
$$\underbrace{U(s)} = G_c(s).E(s) \quad (B)$$
$$\underbrace{E(s)} = R(s) - Y(s)$$
$$U(s) = G_c(s).(R(s) - Y(s))$$

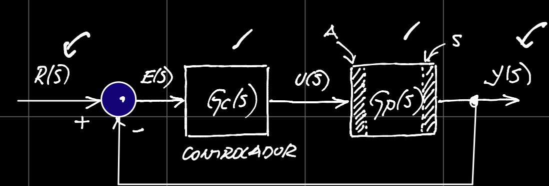
$$Y(s) = G_p(s).G_c(s).[R(s) - Y(s)]$$
$$Y(s) = G_p(s).G_c(s).R(s) - G_p(s)G_c(s).Y(s)$$

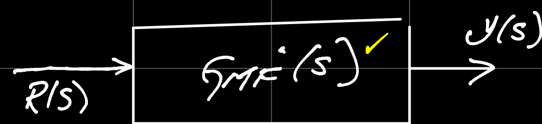
$$Y(s)[1 + G_c(s)G_p(s)] = G_c(s)G_p(s).R(s)$$

saída

$$\frac{Y(s)}{R(s)} = \frac{G_c(s).G_p(s)}{1 + G_c(s).G_p(s)} \quad \ldots \quad G_{MF}(s) \; !$$

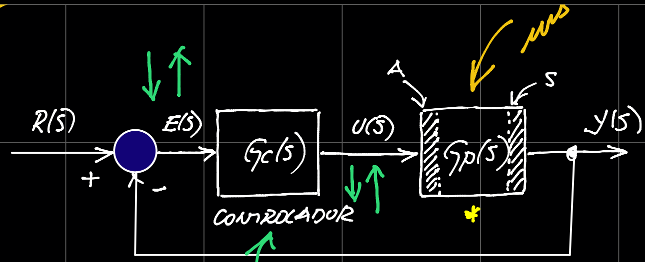
entrada





K>1 (estável)!!!

...tável



$$G_p(S) = \frac{1}{S-1}$$

PÓLO : $+1$ *

INSTÁVEL

$G_c(S) = K$ ... ganho proporcional

$$U(S) = K \cdot E(S)$$

$$G_{MF}(s) = \frac{K \cdot \frac{1}{S-1}}{1 + K \cdot \frac{1}{S-1}} =$$

$$\frac{Y(S)^{\text{saída}}}{R(S)_{\text{entrada}}} = \frac{G_c(S) \cdot G_p(S)}{1 + G_c(S) \cdot G_p(S)} = \frac{K}{S - 1 + K}$$

$$G_{MF}(S) = \frac{K}{S \underbrace{- 1 + K}_{>0}} = \frac{Y(S)}{R(S)}$$

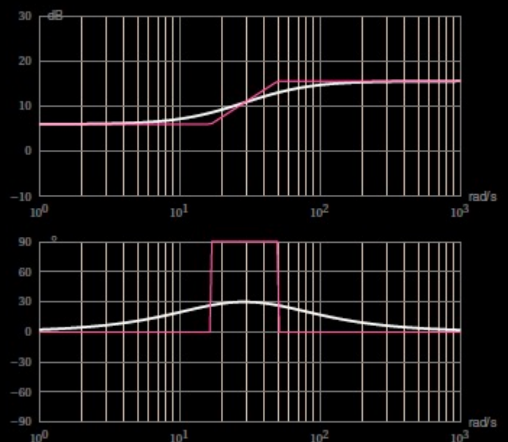
$$G_{MA}(S) = \frac{K}{S-1} \Rightarrow \text{PÓLO } +1$$

PÓLO : $S - 1 + K = 0$ ... $p = 1 - K$ $\underbrace{(p < 0)}_{\text{estável}}$

$\underline{\underline{K > 1}}$ estável

$+1)$

$)$


dB
30
20
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rad/s
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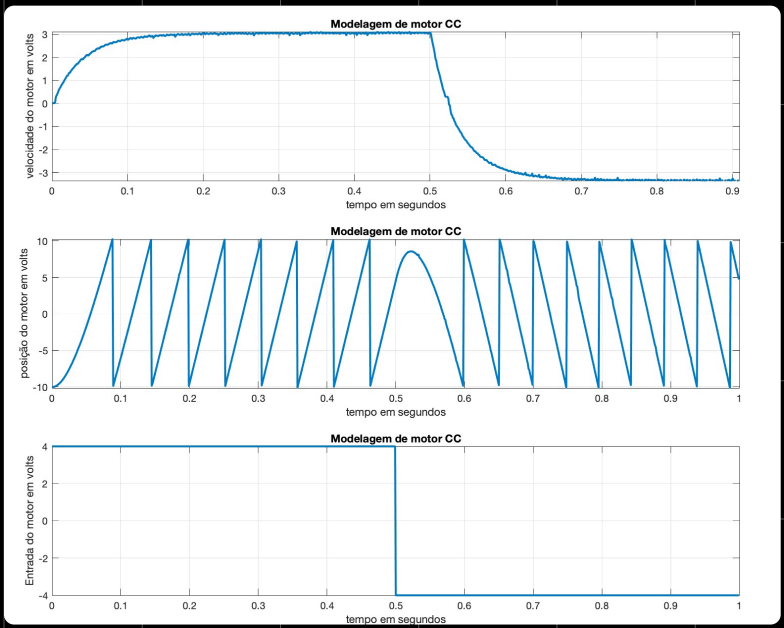
Modelagem de motor CC
velocidade do motor em volts
tempo em segundos
Modelagem de motor CC
posição do motor em volts
tempo em segundos
Modelagem de motor CC
Entrada do motor em volts
tempo em segundos