Ganho em $W_m = 1{,}667 = \sqrt{a_2}$

$a = 2{,}7788$

$\phi_{max} = \sin\left(\dfrac{2{,}7788 - 1}{2{,}7788 + 1}\right) \approx 28{,}1°$

$W_m = 10{,}1 = \dfrac{1}{\tau\sqrt{2{,}7788}} \rightsquigarrow \tau \cong 16{,}83^{-1} = 0{,}0594$

$freq_1 = \dfrac{1}{2{,}7788 \cdot 16{,}83^{-1}} = 6{,}0567$

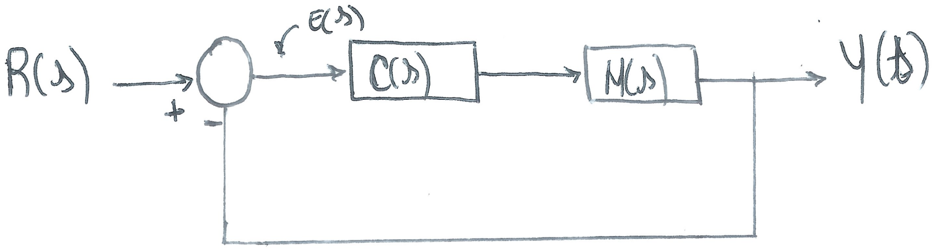
$freq_2 = \dfrac{1}{16{,}83^{-1}} = 16{,}842$

$$G_c = \frac{a_2 \tau s + 1}{\tau s + 1} = \frac{0{,}16515 + 1}{0{,}05937 + 1}$$

→ O ganho na frequência W_m é extraído através da relação

$$\frac{\overbrace{10{,}1}^{\text{Valor desejado (especificação)}}}{\underbrace{6{,}65}_{\text{Posição em rad/s quando } C*G = 0dB}} = 1{,}5187 \rightsquigarrow 10 \log_{10}(1{,}5187) = 1{,}81499 \to 10^{1{,}81499/20} \to 1{,}232$$

$$W_m = 10^{x/20} \xrightarrow{1{,}667} \to 1{,}219 = 1{,}232$$



$$E(s) = R(s) - Y(s)$$

$$E(s).(C(s).G(s)) = Y(s)$$

$$(R(s)-Y(s)).C(s).G(s) = Y(s)$$

$$R(s).C(s).G(s) = Y(s)(C(s).G(s)+1)$$

$$\frac{Y(s)}{R(s)} = \frac{C(s).G(s)}{1+C(s).G(s)}$$

$$1.1)\quad T(s) = \frac{C(s).M(s)}{1+C(s).M(s)} = \frac{\overbrace{K(1+1/s).\frac{(-6s-60)}{0{,}6s^2-10}}^{\text{NUM}}}{\underbrace{1+K\underbrace{(1+1/s)}_{\frac{s+1}{s}}.\frac{(-6s-60)}{0{,}6s^2-10}}_{\text{DEM}}}$$

$$\text{DEM} = \frac{s(0{,}6s^2-10)+K((s+1)(-6s-60))}{s(0{,}6s^2-10)}$$

$$\text{NUM} = \frac{K(s+1)(-6s-60)}{s(0{,}6s^2-10)}$$

$$T(s) = \frac{\frac{K(s+1)(-6s-60)}{\cancel{s(0{,}6s^2-10)}}}{\frac{s(0{,}6s^2-10)+K(s+1)(-6s-60)}{\cancel{s(0{,}6s^2-10)}}}$$

$$T(s) = \frac{K(s+1)(-6s-60)}{s(0{,}6s^2-10)+(K(s+1)(-6s-60))} = \frac{(s+1)(6s+60)}{s(0{,}6s^2-10)+(s+1)(6s+60)}$$

$$T(s) = \frac{6s^2+60s+6s+60}{0{,}6s^3-10s+6s^2+60s+6s+60} = \frac{6s^2+66s+60}{0{,}6s^3+6s^2+56s+60}$$

$$\boxed{\text{Bibo estável}}$$

Calculo do erro em regime permanente

ENTRADA DEGRAU

$$Y(\infty) = \lim_{s \to 0} \cancel{s} \cdot \boxed{\frac{1}{\cancel{s}}} \left(1 - \left(\frac{6s^2 + 66s + 60}{0{,}6s^3 + 6s^2 + 56s + 60} \right) \right) =$$

$R(s) \rightarrow$ ENTRADA

$$Y(\infty) = \left(1 - \frac{60}{60} \right) = 0$$

ERRO DE REGIME PERMANENTE $= 0$

ENTRADA RAMPA

$$Y(\infty) = \lim_{s \to 0} s \cdot \frac{1}{s^2} \left(1 - \left(\frac{6s^2 + 66s + 60}{0{,}6s^3 + 6s^2 + 56s + 60} \right) \right)$$

$$Y(\infty) = \lim_{s \to 0} \cancel{s} \cdot \frac{1}{\cancel{s^2}} \left(\frac{0{,}6s^3 + \cancel{6s^2} + 56s + \cancel{60} - \cancel{6s^2} - 66s - \cancel{60}}{0{,}6s^3 + 6s^2 + 56s + 60} \right)$$

$$Y(\infty) = \lim_{s \to 0} \frac{1}{\cancel{s}} \left(\frac{0{,}6s^3 - 10s}{0{,}6s^3 + 6s^2 + 56s + 60} \right)$$

$$Y(\infty) = \underbrace{\lim_{s \to 0}}_{} \left(\frac{0{,}6s^2 - 10}{0{,}6s^3 + 6s^2 + 56s + 60} \right) = \frac{-10}{60} = \frac{-1}{6}$$

ERRO DE REGIME PERMANENTE $= \frac{-1}{6}$