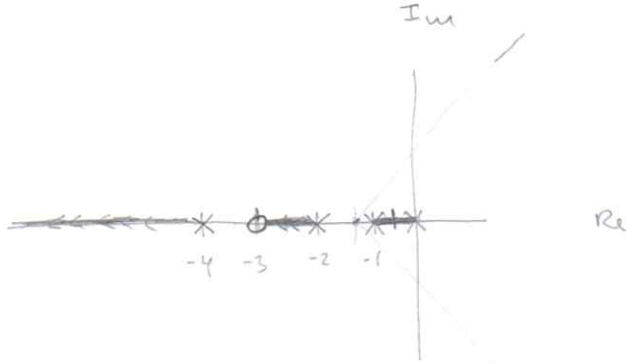
testes

1C) $$FTMA = K\,\frac{(s+3)}{s(s+1)(s+2)(s+4)}$$



calculador:

Ramos: 4

Assymptotes: 3

Angulos Asym: $-180°; -60°; 60°$

intercepcao Asym: $-1,333$

2 Ramos já definidos.

$$FTMA = \frac{N(s)}{D(s)} \qquad N(s) = K(s+3)$$
$$D(s) = s(s+1)(s+2)(s+4)$$

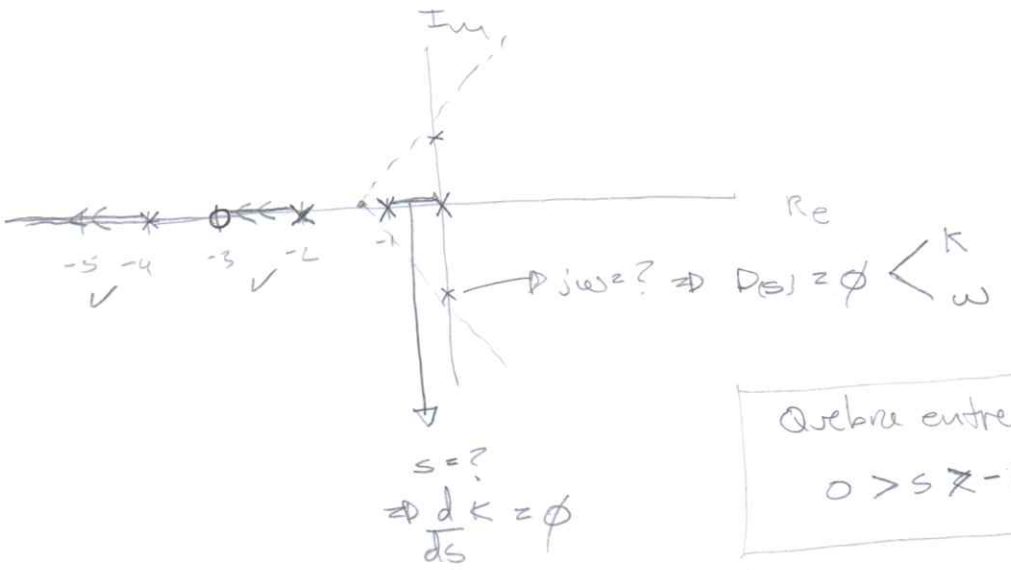
$$FTMF = \frac{\frac{N(s)}{D(s)}}{1+\frac{N(s)}{D(s)}} = \frac{\frac{N(s)}{D(s)}}{\frac{D(s)+N(s)}{D(s)}} = \frac{N(s)}{D(s)+N(s)}$$
$$= \frac{K(s+3)}{s(s+1)(s+2)(s+4)+K(s+3)}$$

$$\begin{cases} D(s)+N(s)\big|_{s=j\omega} = 0 \quad ; K=? \; ; \omega=? \\ \frac{N(s)}{D(s)} = -1 \Rightarrow \frac{d}{ds}K = 0 \; ; s=? \quad \vee \quad FTMA+1=0 \end{cases}$$

$$D(s)+N(s) = s(s+1)(s+2)(s+4)+K(s+3) = (s^2+s)(s+2)(s+4)+Ks+3K$$
$$= (s^3+2s^2+s^2+2s)(s+4)+Ks+3K$$
$$= s^4+4s^3+2s^3+8s^2+s^3+4s^2+2s^2+8s+Ks+3K$$
$$= s^4+7s^3+14s^2+(8+K)s+3K$$

$$\frac{N(s)}{D(s)} = -1 \Leftrightarrow K = -\frac{s(s+1)(s+2)(s+4)}{(s+3)} \wedge \frac{d}{ds}K = 0$$

1 c)



Quebra entre
$0 > s \geq -1$

LGR FTMA
4 branches
3 Asymptotes
Angle 60°, 180°, 300°
at -1,33°
existe intercepção com eixo imaginário.

$$D(s) = s(s+1)(s+2)(s+4) + K(s+3) = 0$$

$$K = -\frac{s(s+1)(s+2)(s+4)}{s+3}$$

$$K = -\frac{(s^2+s)(s+2)(s+4)}{(s+3)}$$

$$K = -\frac{(s^3+2s^2+s^2+2s)(s+4)}{(s+3)}$$

$$K = -\frac{(s^4+2s^3+s^3+2s^2+4s^3+8s^2+4s^2+8s)}{(s+3)}$$

$$\frac{d}{ds}K = -\frac{d}{ds}\frac{(s^4+7s^3+14s^2+8s)}{(s+3)}$$

$$0 = -\frac{(4s^3+21s^2+28s+8).(s+3) - (s^4+7s^3+14s^2+8s)}{(s+3)^2}$$

$$0 = \frac{(4s^4+21s^3+28s^2+8s+12s^3+63s^2+84s+24) - (s^4+7s^3+14s^2+8s)}{(s+3)^2}$$

$$0 = 3s^4+26s^3+77s^2+84s+24$$

calculadora EQUA → Poly → 4

$x_1 = -0,434$
$x_2 = -1,609$
$x_3 = -3,311 + 0,6812j$
$x_4 = -3,311 - 0,6812j$

LGR $0 > s > -1$ / Real
⇒ $x_1 = -0,434$ ✓

$D(s) = 0$ intercepção eixo imaginário

$$s^4 + 7s^3 + 14s^2 + 8s + K(s+3) = 0 \;\Big|_{s=j\omega}$$

$$s^4 + 7s^3 + 14s^2 + 8s + Ks + 3K = 0 \;\Big|_{s=j\omega}$$

$$s^4 + 7s^3 + 14s^2 + (8+K)s + 3K = \phi$$

$$(j\omega)^4 + 7(j\omega)^3 + 14(j\omega)^2 + (8+K)j\omega + 3K = \phi$$

$$\omega^4 - 7j\omega^3 - 14\omega^2 + (8+K)j\omega + 3K = \phi$$

$$\begin{cases} \text{Im}: -7\omega^3 + (8+K)\omega = \phi \\ \text{Re}: \omega^4 - 14\omega^2 + 3K = 0 \end{cases} \Rightarrow \begin{cases} -7\omega^3 + 8\omega + K\omega = \phi \\ \omega^4 - 14\omega^2 + 3K = \phi \end{cases}$$

$$\begin{cases} \text{Im}: \omega(-7\omega^2 + 8 + K) = \phi \\ \text{Re}: \omega^4 - 14\omega^2 + 3K = \phi \end{cases} \Rightarrow \begin{cases} \omega = \phi \;\vee\; -7\omega^2 + 8 + K = \phi \end{cases}$$

if $\omega = \phi \Rightarrow K = \phi$

$$-7\omega^2 + 8 + K = 0 \Rightarrow K = 7\omega^2 - 8$$

$$\omega^4 - 14\omega^2 + 3(7\omega^2 - 8) = \phi$$

$$\omega^4 - 14\omega^2 + 21\omega^2 - 24 = \phi$$

$$\omega^4 + 7\omega^2 - 24 = \phi$$

calculadora. EQUA → Poly → 4

$$\begin{cases} x_1 = 1{,}5877 \\ x_2 = -1{,}587 \\ x_3 = 3{,}0855i \\ x_4 = -3{,}0855i \end{cases} \quad \begin{matrix} K = 9{,}6455 \\ K = 9{,}6455 \end{matrix}$$

1c) $K\,\frac{s+3}{s(s+1)(s+2)(s+4)} = -1$

D(s) of FTMF

$$K = -\frac{s(s+1)(s+2)(s+4)}{s+3}$$

$$\frac{d}{d(s)}K = \emptyset \;;\; s = ?$$

$$\begin{aligned} \text{Ca)} &= -(s^2+s)(s+2)(s+4) \\ &= (s^3+2s^2+s^2+2s)(s+4) \\ &= s^4+4s^3+2s^3+8s^2+s^3+4s^2+2s^2+8s \\ &= s^4+7s^3+14s^2+8s \end{aligned}$$

$$K = -\frac{s^4+7s^3+14s^2+8s}{s+3}$$

$$K = -\frac{(4s^3+21s^2+28s+8)(s+3)-(s^4+7s^3+14s^2+8s)}{(s+3)^2}$$

$$\begin{aligned} K'=0 \text{ ED} &= -[(4s^4+12s^3+21s^3+63s^2+28s^2+84s+8s+24 \\ &\quad -(s^4+7s^3+14s^2+8s)] \\ &= -4s^4-33s^3-91s^2-92s-24+s^4+7s^3+14s^2+8s \\ &= -3s^4-12s^3-77s^2-84s-24 = \emptyset \end{aligned}$$

1

c)

$$GH(s) = K \frac{(s+3)}{s(s+1)(s+2)(s+4)}$$

$$K \frac{(s+3)}{s(s+1)(s+2)(s+4)} = -1$$

$$K = - \frac{s(s+1)(s+2)(s+4)}{(s+3)}$$

$$\frac{d}{ds} K = 0$$

formula

$$\sigma = \frac{\Sigma(s+p) - \Sigma(s+z)}{D-N}$$

$$\phi = \frac{(2L+1)}{D-N} \cdot 180^\circ$$

$$K \frac{(s+3)}{s(s+1)(s+2)(s+4)} + 1 \Big| = 0$$

$s = jw$.

$D = 4$ $\{ -60^\circ \; -180^\circ \; -300^\circ \; -420^\circ$

$N = 1$ $\{ 60^\circ \; 180^\circ \; 300^\circ \; 420^\circ$

zeros: -3

polos: $0; -1; -2; -4$.

$\sigma = -1{,}333$