1 b) $GH(s) = K \dfrac{3s}{(s+2)(s^2+6s+18)}$

$$FTMA = \frac{K\ 3s}{(s+2)(s^2+6s+18)} \qquad N(s) = K\ 3s$$

$$D(s) = (s+2)(s^2+6s+18)$$

$$FTMF = \frac{FTMA}{1+FTMA} = \frac{FTMA}{1+\frac{K.3s}{(s+2)(s^2+6s+18)}}$$

$$= \frac{FTMA}{\frac{(s+2)(s^2+6s+18)+K\,3s}{(s+2)(s^2+6s+18)}}$$

$$= \frac{K.3s}{(s+2)(s^2+6s+18)+K\,3s}$$

$$D(s) = (s+2)(s^2+6s+18) + K\,3s$$

$$D(s)\big|_{s=j\omega} = \phi \quad ; \quad D(s) = 0 \quad ; \quad \frac{d}{ds} K = \phi \qquad s = ?$$

$K = ?\ ; \omega = ?$

$$D(s) = s^3+6s^2+18s+2s^2+12s+36+K\,3s$$
$$= s^3+8s^2+(30+3K)s+36$$

$$(30+3K)s = -s^3-8s^2-36$$

$$(30+3K) = \frac{-s^3-8s^2-36}{s}$$

$$3K = \frac{-s^3-8s^2-36}{s} - 30$$

$$K = \frac{-s^3-8s^2-36}{3s} - \frac{30}{3}\ {}^{\times s}$$

$$= \frac{-s^3-8s^2-36-30s}{3s} = \frac{-(s^3+8s^2+30s+36)}{3s}$$

$$\frac{d}{ds} K = -\frac{(3s^2+16s+30).3s - 3(s^3+8s^2+30s+36)}{9s^2}$$

$$= -\frac{9s^3+48s^2+90s-3s^3-24s^2-90s-108}{9s^2} = \phi$$

$$s \simeq 1{,}766$$

1b)

$$D(s)\Big|_{s=j\omega} = \phi$$

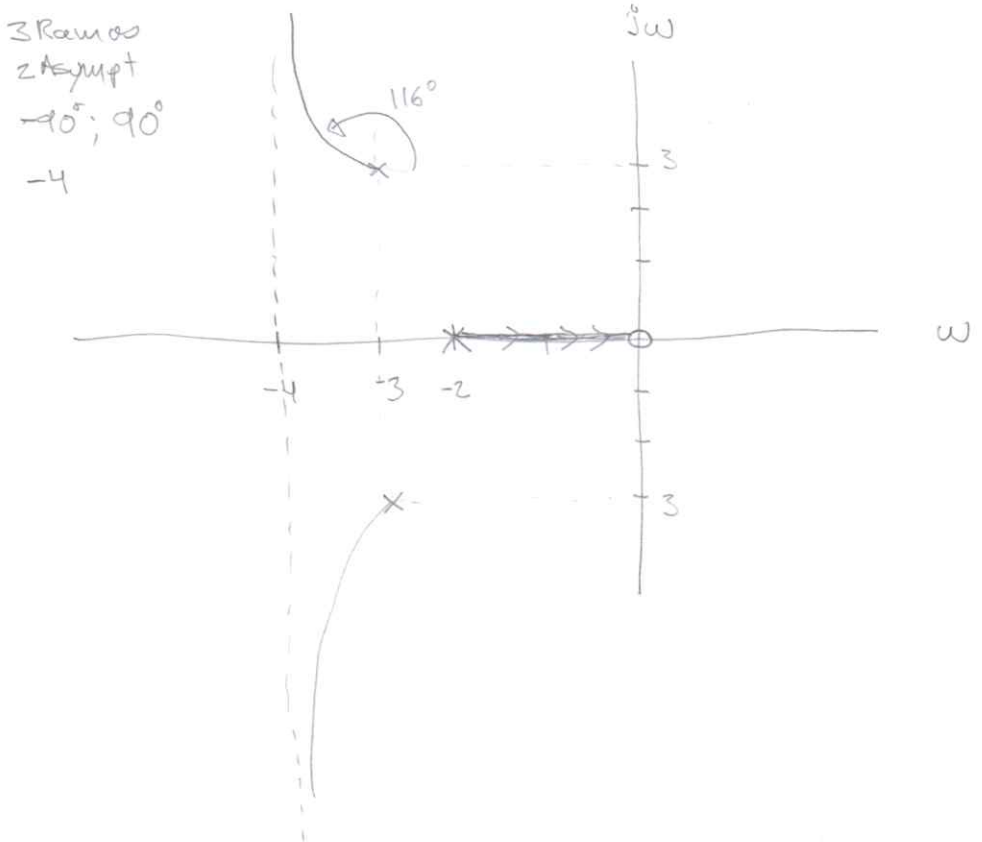
$$s^3+8s^2+(30+3K)s+36 = 0$$

$$-j\omega^3-8\omega^2+(30+3K)j\omega+36=0$$

$$\begin{cases} -j\omega^3+(30+3K)j\omega = \phi & \times \frac{1}{j\omega} \\ -8\omega^2+36=\phi & \times \frac{1}{4} \end{cases}$$

$$\begin{cases} -\omega^2+(30+3K)=\phi \\ \omega^2 = \frac{36}{8} = 4{,}5 \end{cases} \Leftrightarrow -4{,}5+30+3K=0 \Leftrightarrow K=\frac{-25{,}5}{3}$$

$$K=-8{,}5$$



1

b)

$$G H(s) = K \frac{3s}{(s+2)(s^2+6s+18)}$$

$$K \cdot \frac{3s}{(s+2)(s^2+6s+18)} = -1$$

$D = 3$ { $-90°$ $-270°$ $-450°$
$N = 1$ { $90°$ $270°$ $450°$

$\delta = -4$

Zeros: 0

Polos: -2; $-3+3i$; $-3-3i$.

$$K = -\frac{(s+2)(s^2+6s+18)}{3s}$$

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

$$= -\frac{(3s^2+16s+30)\cdot 3s - 3(s^3+8s^2+30s+36)}{9s^2}$$

$$= -\frac{9s^3+48s^2+90s - 3s^3-24s^2-90s-108}{9s^2}$$

$$= -\frac{6s^3+24s^2-108}{9s^2}$$

Cal)

$x = s^3+6s^2+18s+2s^2+12s+36$

$\frac{dx}{ds} = 3s^2+12s+18+4s+12$

$= 3s^2+16s+30$

$x = s^3+8s^2+30s+36$

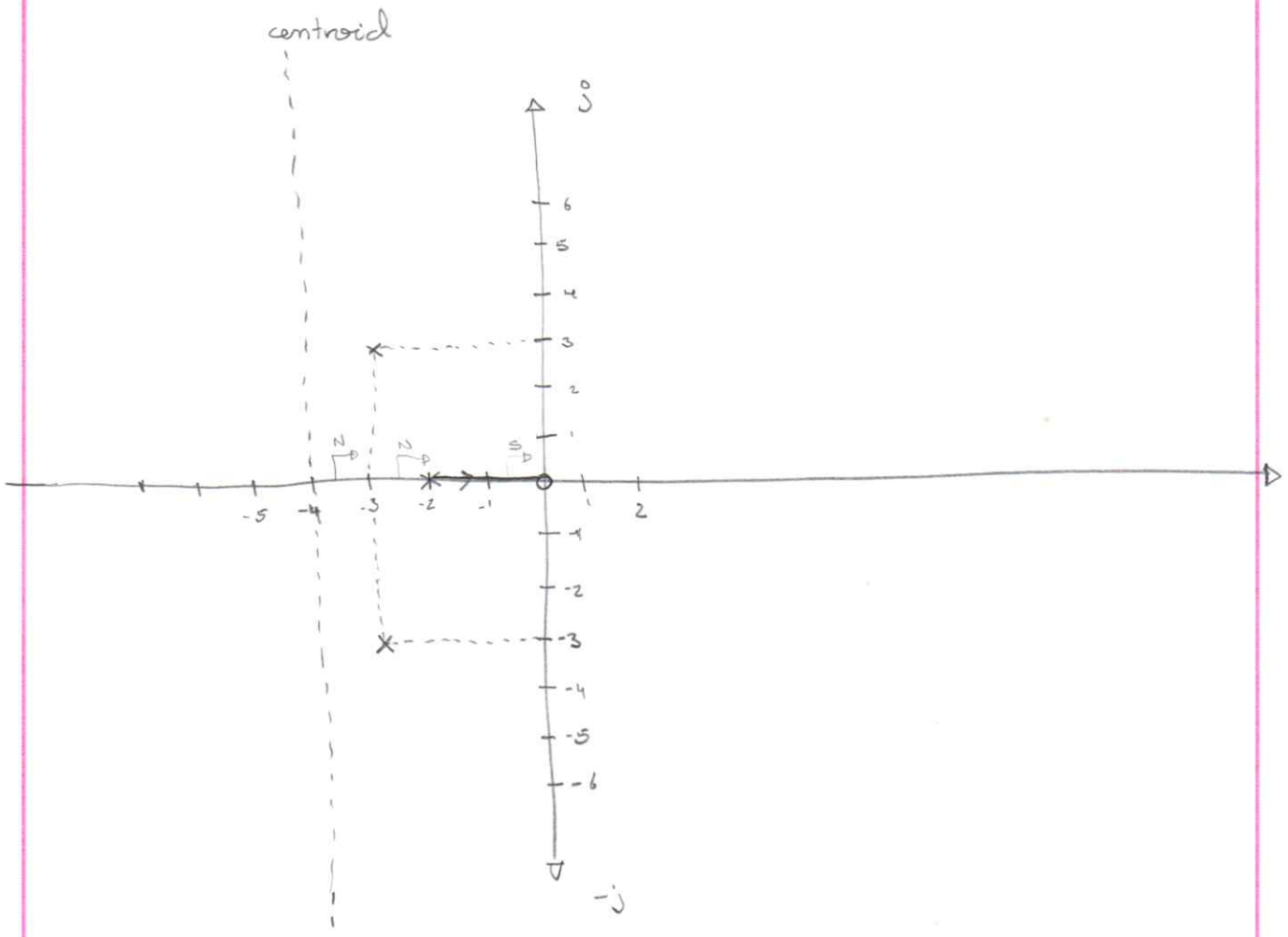
$$6s^3+24s^2-108 = 0$$

$-2,883+1,3691i$; $-2,883-1,3691i$; $1,7667$

$$K \frac{3s}{s^3+8s^2+30s+36} + 1 = 0$$

$$K + \frac{s^3+8s^2+30s+36}{3s} = 0$$

$$\frac{s^3+8s^2+30s+36+3Ks}{3s} = 0$$



$$s^3 + 8s^2 + (30+3K)s + 36 = 0$$

$$s = j\omega$$

$$(j\omega)^3 - 8\omega^2 + (30+3K)j\omega + 36 = 0$$

$$\begin{cases} (j\omega)^3 + (30+3K)j\omega = 0 \\ -8\omega^2 + 36 = 0 \end{cases} \qquad \begin{cases} j\omega\left((j\omega)^2 + (30+3K)\right) = 0 \\ \omega = \pm\sqrt{4{,}5} \end{cases}$$

1b)

$$D(s) = (s+2)(s^2+6s+18) + K3s = 0$$

$$K = -\frac{(s+2)(s^2+6s+18)}{3s}$$

$$(s^2+6s+18)\times s + (s^2+6s+18)\times 2 + K3s = \phi$$

$$s^3 + \underline{6s^2} + (18s) + \underline{2s^2} + (12s) + 36 + (K3s) = \phi$$

$$s^3 + 8s^2 + (30+K3)s + 36 = \phi$$

— // —

$$\frac{d}{ds}K = -\frac{d}{ds}\frac{s^3+8s^2+30s+36}{3s}$$

$$\phi = -\frac{(s^2+16s+30)\times 3s - 3(s^3+8s^2+30s+36)}{3^2 s^2}$$

$$(s^2+16s+30)\times 3s - 3(s^3+8s^2+30s+36) = \phi$$

$$3s^3 + 48s^2 + 90s - (3s^3 + 24s^2 + 90s + 108) = \phi$$

$$24s^2 - 108 = 0$$

$$s^2 = \frac{108}{24} \Rightarrow s = \pm\sqrt{\frac{108}{24}}$$

$$= \pm\frac{3\sqrt{2}}{2} \approx \pm 2{,}121$$

$\pm\frac{3\sqrt{2}}{2}$ não pertence a LGR.

, logo não existe ponto de quebra.

— // —

$$s^3 + 8s^2 + (30+K3)s + 36 = \phi \;\Big|_{s=jw}$$

$$-jw - 8w + (30+K3)jw + 36 = \phi$$

$$\begin{cases} -w + 30 + K3 = \phi \\ -8w + 36 = \phi \end{cases} \begin{cases} -4{,}5 + 30 + K3 = \phi \\ w = \frac{36}{8} = 4{,}5 \end{cases} \begin{cases} K = -8{,}5 \\ w = 4{,}5 \end{cases}$$

$w = 4{,}5$ não pertence a LGR

logo não existe intercepção com eixo imaginário

better draw first LGR and determine if necessary take these steps.