9a) $$G(s) = \frac{10}{s(s+1)\cdot(s+5)}$$

- Rewrite the T.F as a product of Basic factors:

$$G(s) = 10 \cdot \frac{1}{5} \cdot \frac{1}{s+1} \cdot \frac{1}{(s+5)}$$

- convert into standard time constant form:

$$G(s) = 10 \cdot \frac{1}{5} \cdot \frac{1}{s+1} \cdot \frac{1}{5(\frac{s}{5}+1)}$$

$$= 2 \cdot \frac{1}{s} \cdot \frac{1}{s+1} \cdot \frac{1}{(\frac{s}{5}+1)}$$

- Replace "s" by "jw":

$$G(jw) = 2 \cdot \frac{1}{jw} \cdot \frac{1}{jw+1} \cdot \frac{1}{(\frac{jw}{5}+1)}$$

Gain

Pole at origin

Pole at frequency 1 rad/sec

Pole at frequency 5 rad/sec

- $|G(jw)| = 20\,Log\,|G(jw)|$

$$= 20\,Log(2) - 20\,Log(w) - 20\,Log(|1+jw|) - 20\,Log(|1+\frac{jw}{5}|)$$

$$= \underline{6\,dB} - 20\,Log(w) - 20\,Log(|1+jw|) - 20\,Log(|1+\frac{jw}{5}|)$$

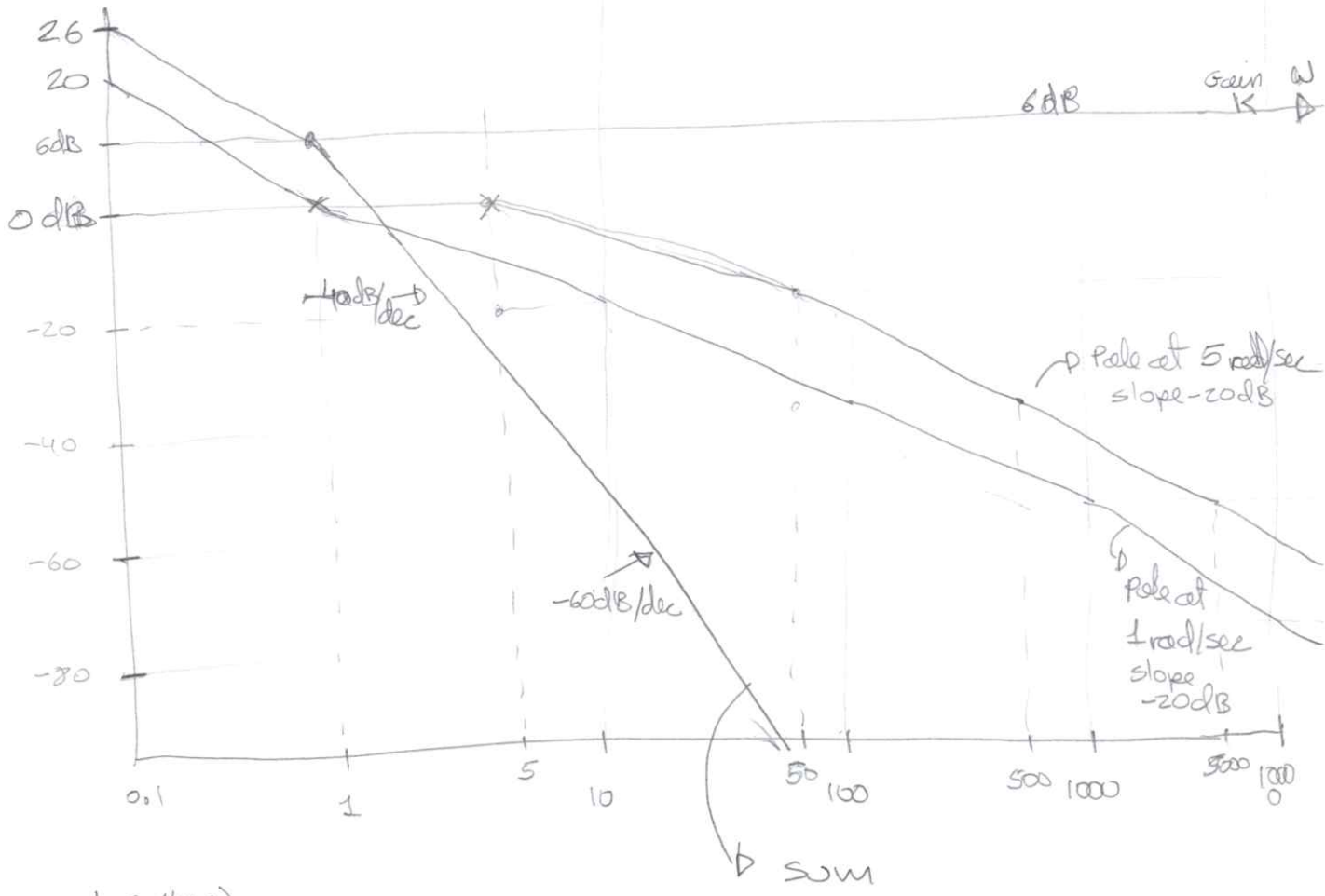
- $\underline{\angle G(jw)}$:

$$\underline{\angle G(jw)} = arg(2) - arg(jw) - arg(1+jw) - arg(1+\frac{jw}{5})$$

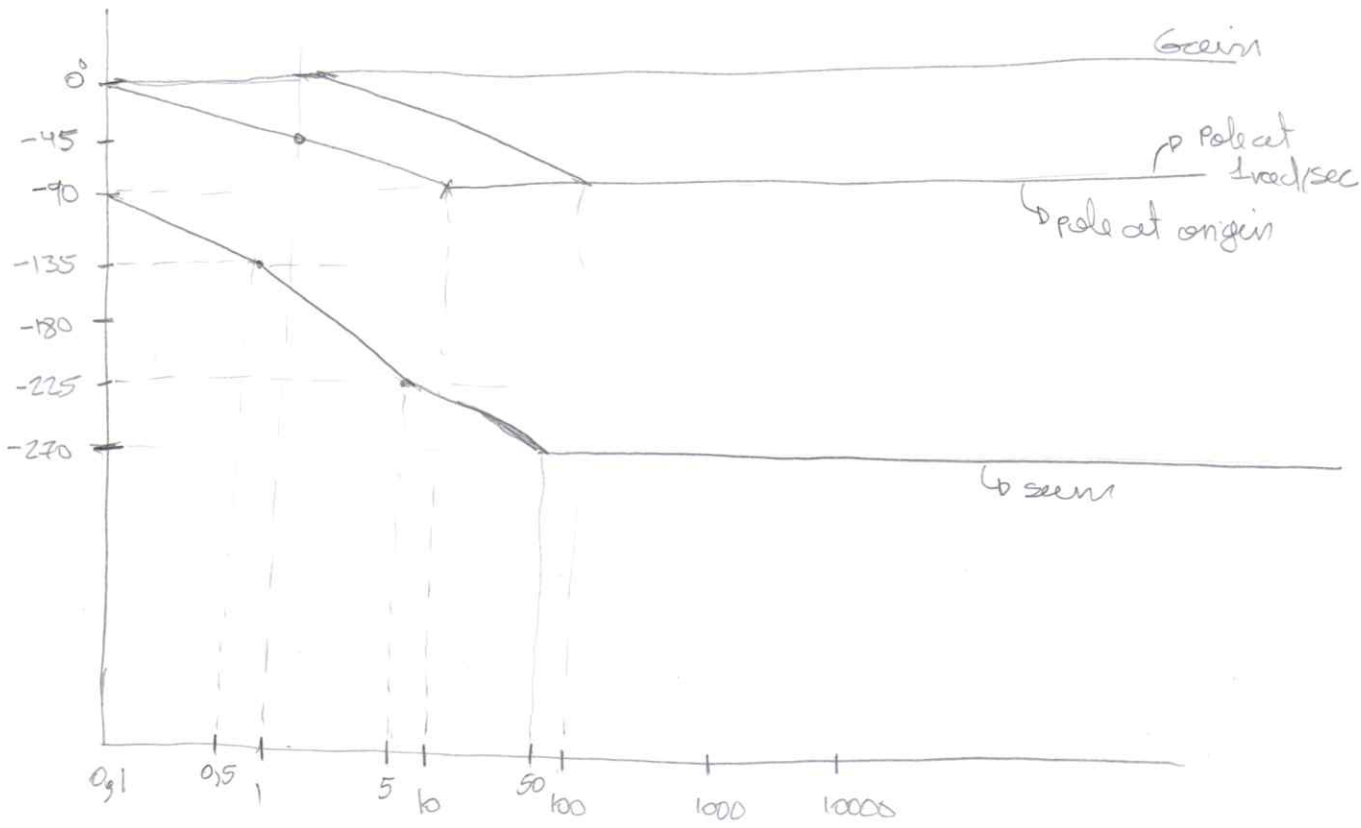
$$= \phi - 90^\circ - arg(1+jw) - arg(1+\frac{jw}{5})$$

9a) continuação

$20 \log |G(j\omega)|$



$|G(j\omega)|$



No caso de ~~raízes~~ complexos

$$\frac{1}{s^2+0,4s+4} = G(s)$$

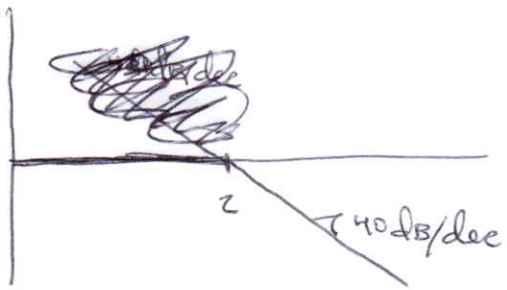
$$G(s) = \frac{1}{4} \cdot \frac{1}{\frac{s^2}{4}+0,1s+1}$$

$$G(j\omega) = \frac{1}{4} \cdot \frac{1}{\left(\frac{j\omega}{2}\right)^2+0,1j\omega+1}$$

$$\Rightarrow \omega_n = 2$$

$$\omega_r = \omega_n \sqrt{1-2\xi^2}$$

$$M_r = \frac{1}{2\xi\sqrt{1-\xi^2}}$$



$$G(s) = \frac{1}{s} = \frac{1}{j\omega}$$

$$|G(s)| = \frac{1}{\omega}$$

$$\arg[G(j\omega)] = -90^\circ$$

— // —

$$G(s) = \frac{1}{sT+1}$$

$$|G(j\omega)| = \frac{1}{\sqrt{(\omega T)^2+1}} = \frac{1}{\sqrt{\omega^2 T^2+1}}$$

$$\arg[G(j\omega)] = -\operatorname{arctg}\left(\frac{\omega T}{1}\right)$$

— // —

$$G(s) = \frac{1}{s(sT+1)}$$

$$G(j\omega) = \frac{1}{j\omega(j\omega T+1)}$$

$$= -\frac{T}{\omega^2 T^2+1} - j\,\frac{1}{\omega(\omega^2 T^2+1)}$$

$$|G(j\omega)| = \frac{1}{\sqrt{\omega^4 T^2+\omega^2}}$$

$$\arg[G(j\omega)] = -\operatorname{arctg}\left(-\frac{1}{\omega T}\right)$$

— // —

$$G(s) = e^{-sT} \qquad |G(s)| = 1$$

$$G(j\omega) = e^{-j\omega T}$$

$$\arg[G(s)] = -\omega T$$

$$G(s) = \frac{e^{-sL}}{sT + 1}$$

$$G(j\omega) = \frac{e^{-j\omega L}}{j\omega T + 1}$$

$$|G(j\omega)| = \frac{1}{\sqrt{\omega^2 T^2 + 1}}$$

$$\arg[G(j\omega)] = -\omega L - \operatorname{arctg}(\omega T).$$