Bode Plots / Nyquist and Stability Margin (GM. PM)

Ex: R → (+, −) E → C → G → Y, with L(s) = CG

TF: R→E is $\frac{1}{1+CG} = \frac{1}{1+L(s)}$ ⇒ -1 is the critical point.

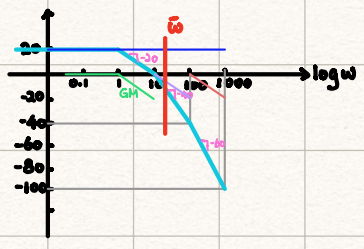
Let $L(s) = \frac{10^4}{(s+1)(s+10)(s+100)}$. draw Bode plot / Nyquist plot. Find GM.PM.

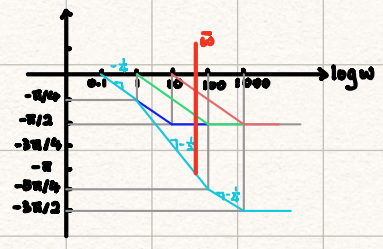
For Nyquist criteria. n=0 (# of poles in ORHP)

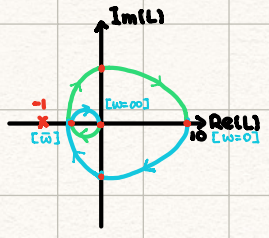
$$L(s) = \frac{10^4}{1\cdot 10\cdot 100\cdot (1+s)(1+\frac{s}{10})(1+\frac{s}{100})} \quad (10^4 \to 10 = K;\ 1,\ 10,\ 100)$$

$$\Rightarrow \begin{cases} |L|_{dB} = 20\log K + \left|\frac{1}{1+s}\right|_{dB} + \left|\frac{1}{1+s/10}\right|_{dB} + \left|\frac{1}{1+s/100}\right|_{dB} \\ Arg[L] = 0 + Arg\left[\frac{1}{1+s}\right] + Arg\left[\frac{1}{1+s/10}\right] + Arg\left[\frac{1}{1+s/100}\right] \end{cases}$$

⇒ Use superposition of elementary Bode plots Read PM at |L|=0 dB







⇒ The feedback loop is BIBO stable N=0

$PM = Arg[L(j\omega_c)] + \pi = -\frac{3}{4}\pi + \pi = \frac{\pi}{4}$ $\omega_c = 10$

★ $|L|_{dB} = 0dB$ ⇒ find ω_c ★ $Arg[L(j\bar{\omega})] = -\pi$ ⇒ find $\bar{\omega}$

$GM = \frac{1}{|L(j\bar{\omega})|}$ $GM_{dB} = -|L(j\bar{\omega})|_{dB}$