

$$G_{ol} = K (s+2)(s-0.5-2i)(s-0.5+2i)/s(s+1)^2(s+3-i)(s+3+i)$$

$$N := 500$$

$$k := 0..N$$

$$\text{Min} := -2$$

$$\text{Max} := 2$$

$$\text{espo}(k) := \text{Min} + \frac{k \cdot (\text{Max} - \text{Min})}{N}$$

$$\omega_k := 10^{\text{espo}(k)}$$

$$K := 1$$

$$G(s) := (K) \cdot (s + 2) \cdot (s - 0.5 - 2 \cdot i) \cdot (s - 0.5 + 2 \cdot i) \cdot \left(\frac{1}{s}\right) \cdot \left(\frac{1}{s + 1}\right)^2 \cdot \left(\frac{1}{s + 3 - i}\right) \cdot \left(\frac{1}{s + 3 + i}\right)$$

$$G1(s) := (K) \cdot \frac{(s + 2)}{s}$$

$$G2(s) := (s - 0.5 - 2 \cdot i) \cdot (s - 0.5 + 2 \cdot i)$$

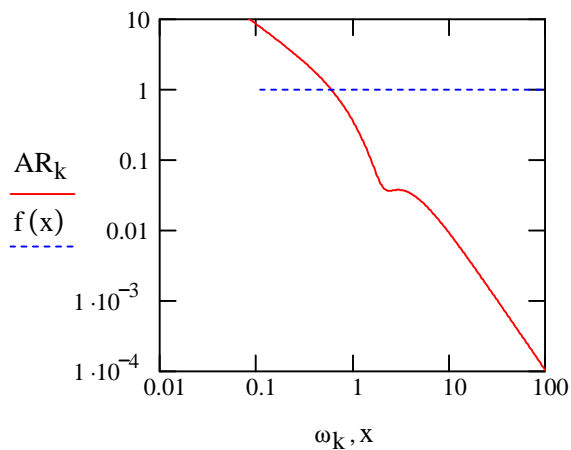
$$G3(s) := \left(\frac{1}{s + 1}\right)^2$$

$$G4(s) := \left(\frac{1}{s + 3 - i}\right) \cdot \left(\frac{1}{s + 3 + i}\right)$$

$$AR2_k := |G2(i \cdot \omega_k)| \quad AR2_k := |G2(i \cdot \omega_k)| \quad AR3_k := |G3(i \cdot \omega_k)| \quad AR4_k := |G4(i \cdot \omega_k)|$$

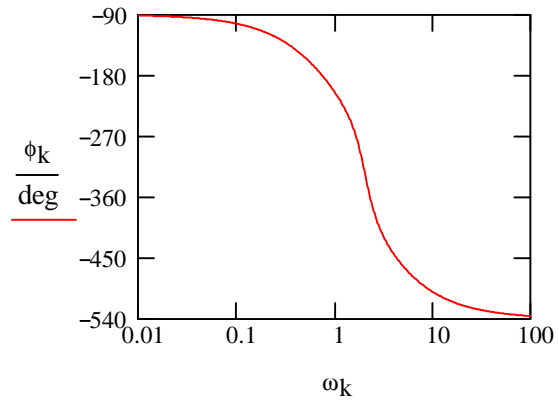
$$AR_k := AR1_k \cdot AR2_k \cdot AR3_k \cdot AR4_k$$

$$f(x) := 1$$



$$\phi_{1k} := \arg(G1(i \cdot \omega_k)) \quad \phi_{2k} := \arg(G2(i \cdot \omega_k)) \quad \phi_{3k} := \arg(G3(i \cdot \omega_k)) \quad \phi_{4k} := \arg(G4(i \cdot \omega_k))$$

$$\phi_k := \phi_{1k} + \phi_{2k} + \phi_{3k} + \phi_{4k}$$



Applicazione del criterio di stabilità di Bode

Calcolo della frequenza di crossover

$$\omega := 1 \quad \phi(\omega) := \arg(G1(i \cdot \omega)) + \arg(G2(i \cdot \omega)) + \arg(G3(i \cdot \omega)) + \arg(G4(i \cdot \omega))$$

Given

$$\phi(\omega) = -\pi$$

$$\omega_{CO} := \text{Find}(\omega)$$

$$\omega_{CO} = 0.748$$

$$\phi(\omega_{CO}) = -3.142$$

Calcolo del K limite

$$AR(\omega) := |G1(i \cdot \omega)| \cdot |G2(i \cdot \omega)| \cdot |G3(i \cdot \omega)| \cdot |G4(i \cdot \omega)|$$

$$AR(\omega_{CO}) = 0.659$$

$$K_{lim} := \frac{1}{AR(\omega_{CO})}$$

$$K_{lim} = 1.518$$

Diagramma di Nyquist

$N := 500$

$k := 0..N$

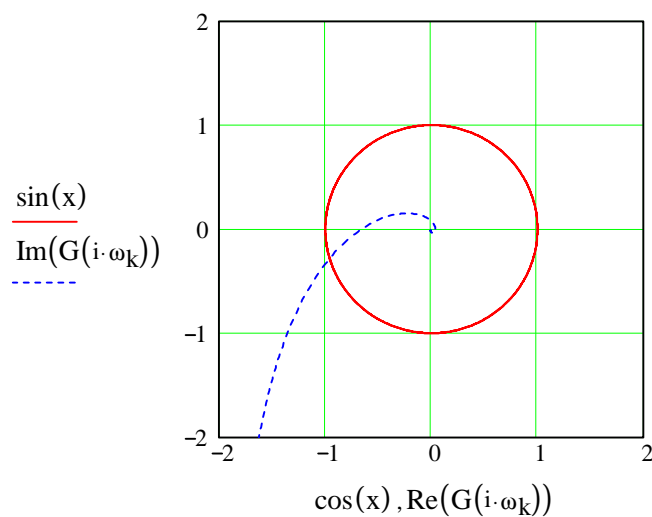
$Min := -2$

$Max := 2$

$espo(k) := Min + \frac{k \cdot (Max - Min)}{N}$

$\omega_k := 10^{espo(k)}$

$K := 1 \cdot 10^{-3}$



Criterio di Nyquist: se il diagramma di Nyquist a ciclo aperto di un sistema feedback circonda il punto $(-1,0)$ al variare della frequenza, la risposta del sistema a ciclo chiuso è instabile.

SUGGERIMENTO: provare ad inserire il Klim calcolato con il criterio di Bode e verificare il criterio di Nyquist