

$$G_{ol} = K / (s+1)(s+2)(s+3)$$

$$N := 500$$

$$k := 0..N$$

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

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

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

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

$$K := 1$$

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

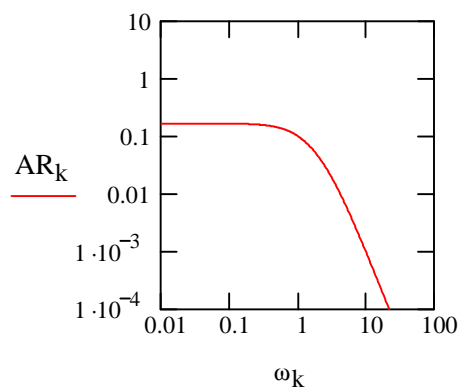
$$G1(s) := \left( \frac{1}{s+1} \right)$$

$$G2(s) := \left( \frac{1}{s+2} \right)$$

$$G3(s) := \left( \frac{1}{s+3} \right)$$

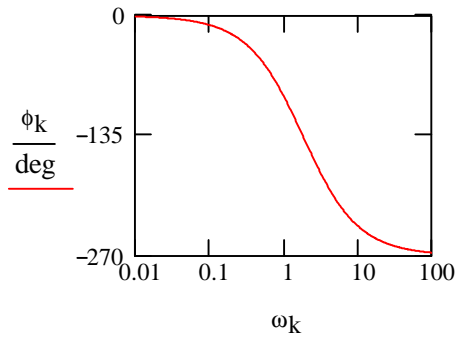
$$AR1_k := |G1(i \cdot \omega_k)| \quad AR2_k := |G2(i \cdot \omega_k)| \quad AR3_k := |G3(i \cdot \omega_k)|$$

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



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

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



## Applicazione del criterio di stabilità di Bode

Calcolo della frequenza di crossover

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

Given

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

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

$$\omega_{CO} = 3.317$$

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

Calcolo del K limite

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

$$AR(\omega_{CO}) = 0.017$$

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

$$K_{lim} = 60$$

## Diagramma di Nyquist

$$N := 500$$

$$k := 0..N$$

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

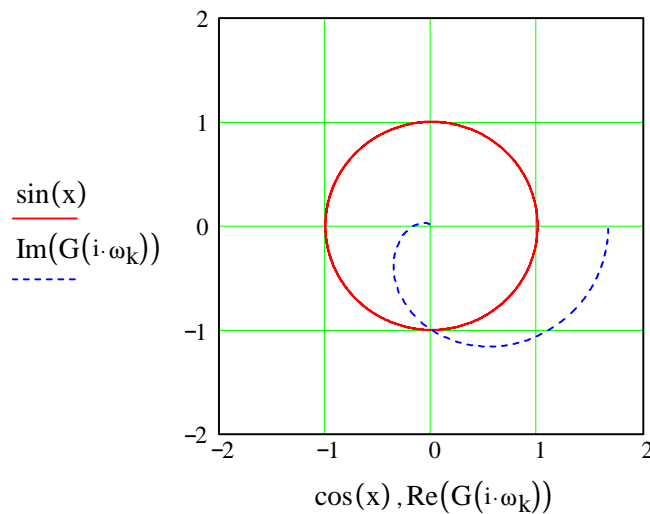
$$\text{Max} := 2$$

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

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

$$K := 10$$

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



**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