$$G_{ol} = 2.98\ K\ (s+2.25)/(s+1.45)(s+2.85)^2(s+4.35)$$

$N := 500$

$k := 0 .. N$

$Min := -2$

$Max := 2$

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

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

$K := 1$

$$G(s) := 2.98 \cdot (K) \cdot (s + 2.25) \cdot \left(\frac{1}{s + 2.85}\right)^2 \cdot \left(\frac{1}{s + 1.45}\right) \cdot \left(\frac{1}{s + 4.35}\right)$$

$$G1(s) := 2.98 \cdot (K) \cdot (s + 2.25)$$

$$G2(s) := \left(\frac{1}{s + 2.85}\right)^2$$

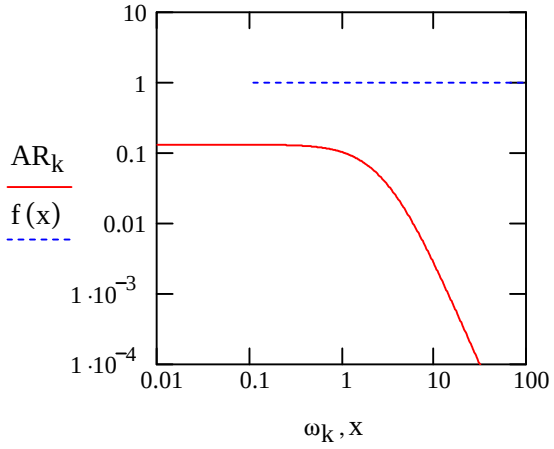
$$G3(s) := \left(\frac{1}{s + 1.45}\right)$$

$$G4(s) := \left(\frac{1}{s + 4.35}\right)$$

$AR1_k := |G1(i \cdot \omega_k)|$ $AR2_k := |G2(i \cdot \omega_k)|$ $AR3_k := |G3(i \cdot \omega_k)|$ $AR4_k := |G4(i \cdot \omega_k)|$

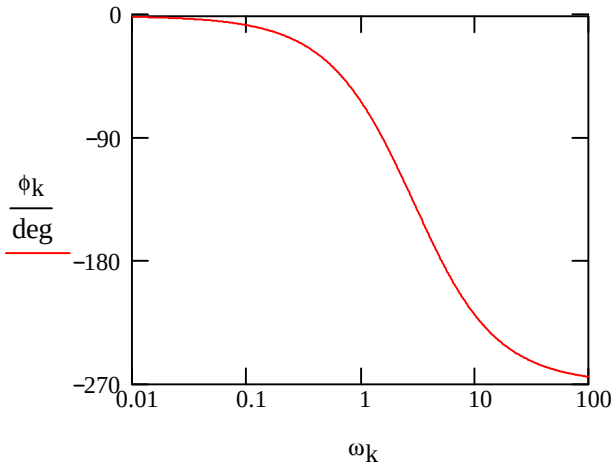
$AR_k := AR1_k \cdot AR2_k \cdot AR3_k \cdot AR4_k$

$f(x) := 1$



$\phi 1_k := \arg(G1(i\cdot\omega_k))$ $\phi 2_k := \arg(G2(i\cdot\omega_k))$ $\phi 3_k := \arg(G3(i\cdot\omega_k))$ $\phi 4_k := \arg(G4(i\cdot\omega_k))$

$\phi_k := \phi 1_k + \phi 2_k + \phi 3_k + \phi 4_k$



Applicazione del criterio di stabilità di Bode

Calcolo della frequenza di crossover

$\omega := 5$ $\phi(\omega) := \arg(G1(i\cdot\omega)) + \arg(G2(i\cdot\omega)) + \arg(G3(i\cdot\omega)) + \arg(G4(i\cdot\omega))$

Given

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

$\omega co := \text{Find}(\omega)$

$\omega co = 5.167$

$\phi(\omega co) = -3.142$

Calcolo del K limite

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

$AR(\omega co) = 0.013$

$Klim := \frac{1}{AR(\omega co)}$

$Klim = 75.15$

Diagramma di Nyquist

$N := 500$

$k := 0 .. N$

$Min := -2$

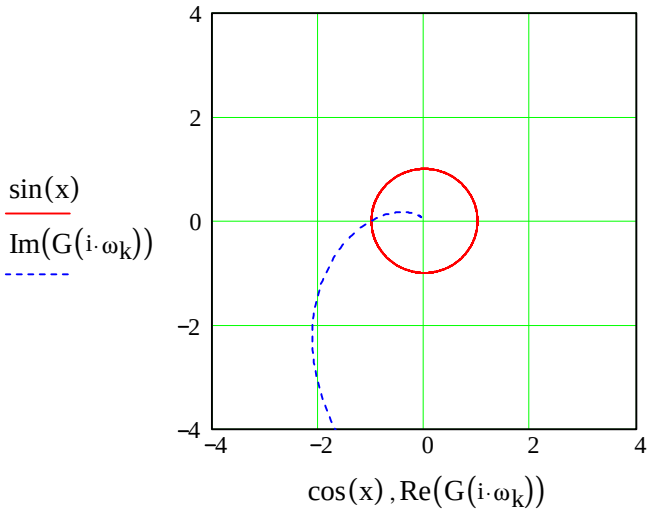
$Max := 2$

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

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

$K := 75.15$

$$G(s) := 2.98 \cdot (K) \cdot (s + 2.25) \cdot \left(\frac{1}{s + 2.85}\right)^2 \cdot \left(\frac{1}{s + 1.45}\right) \cdot \left(\frac{1}{s + 4.35}\right)$$



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.