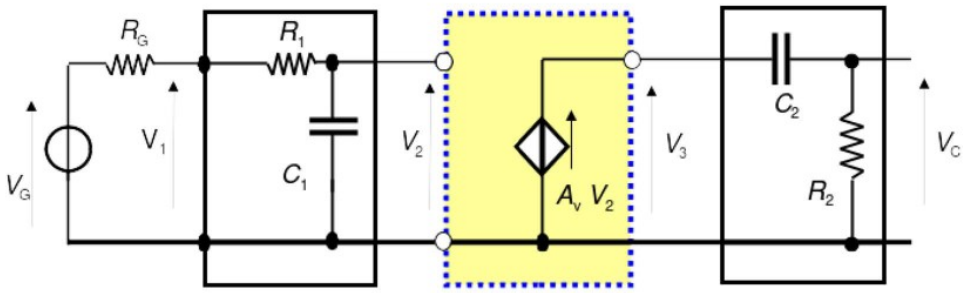
1- Sistemi elettronici, tecnologie e misure

Esercizio 1

Si consideri il seguente circuito



1. Calcolare V_C/V_G nel dominio di Laplace.
2. Dati i seguenti valori:
   - $R_G = 600\ \Omega$
   - $R_1 = 10\ \text{k}\Omega$
   - $R_2 = 1.2\ \text{k}\Omega$
   - $C_1 = 1\ \text{nF}$
   - $C_2 = 100\ \mu\text{F}$
   - $A_v = 1000$

   calcolare zero e poli.
3. Disegnare i diagrammi di Bode: ampiezza e fase

Svolgimento

Nel dominio di Laplace

$$Z(s) = \begin{cases} R & \text{per le resistenze} \\ \dfrac{1}{s\,C} & \text{per i condensatori} \end{cases}$$

Dal circuito in esame, la tensione di uscita si scrive come:

$$V_C(s) = \frac{Z_{R_2}}{Z_{R_2} + Z_{C_2}(s)}\, V_3(s) = \frac{Z_{R_2}}{Z_{R_2} + Z_{C_2}(s)}\, A_v\, V_2(s)$$

$$V_2(s) = \frac{Z_{C_1}(s)}{Z_{C_1}(s) + Z_{R_1} + Z_{R_G}}\, V_G(s)$$

$$\frac{V_C(s)}{V_G(s)} = A_v\, \frac{Z_{R_2}}{Z_{R_2} + Z_{C_2}(s)}\, \frac{Z_{C_1}(s)}{Z_{C_1}(s) + Z_{R_1} + Z_{R_G}}$$

Funzione di trasferimento:

$$H(s) = \frac{V_C(s)}{V_G(s)} = A_v \underbrace{\frac{1}{1 + s\,C_1\,(R_1 + R_G)}}_{\tau_1 = C_1\,(R_1 + R_G)} \underbrace{\frac{s\,C_2\,R_2}{1 + s\,C_2\,R_2}}_{\tau_2 = C_2\,R_2} = A_v\,\frac{s\,\tau_2}{(1 + s\,\tau_1)\,(1 + s\,\tau_2)}$$

- Zeri: $s = 0$ (nell'origine)
- Poli:
  - $s_1 = -1/\tau_1 \approx -9.4 \times 10^4$ rad/s $\sim -10^5$ rad/s
  - $s_2 = -1/\tau_2 \approx -8$ rad/s ~ -10 rad/s

Diagramma di Bode: modulo

$$20\log_{10}|H(j\,\omega)| = 20\log_{10}(Av) + 20\log_{10}\left(\frac{\omega}{|s_2|}\right) - 20\log_{10}\sqrt{1 + \frac{\omega^2}{s_1^2}} - 20\log_{10}\sqrt{1 + \frac{\omega^2}{s_2^2}}$$

dove

- $20\log_{10}(Av)$ (= 60 dB)
- $20\log_{10}\left(\frac{\omega}{|s_2|}\right) \rightarrow$ 20 dB/decade
- $20\log_{10}\sqrt{1 + \frac{\omega^2}{s^2}} = \begin{cases} 0\text{ dB} & \text{for } \omega \ll |s| \\ 3\text{ dB} & \text{for } \omega \approx |s| \\ 20\log_{10}\frac{\omega}{|s|}\text{ dB} & \text{for } \omega \gg |s| \end{cases}$

Diagramma di Bode del modulo:

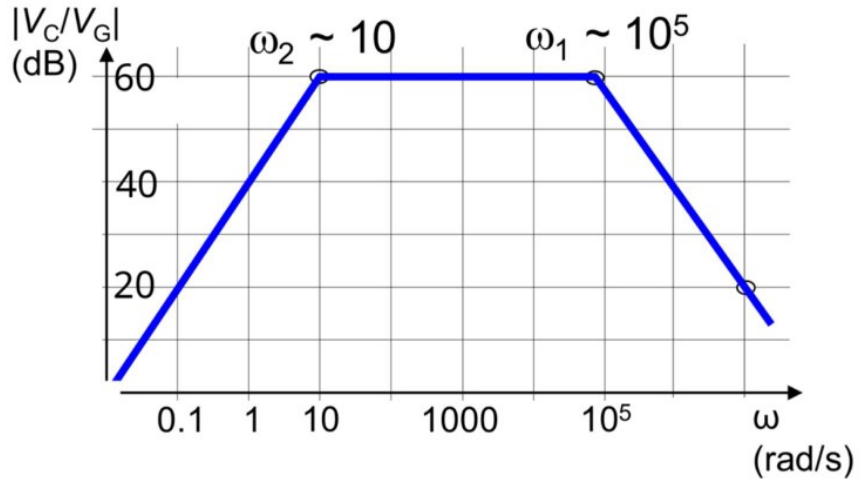
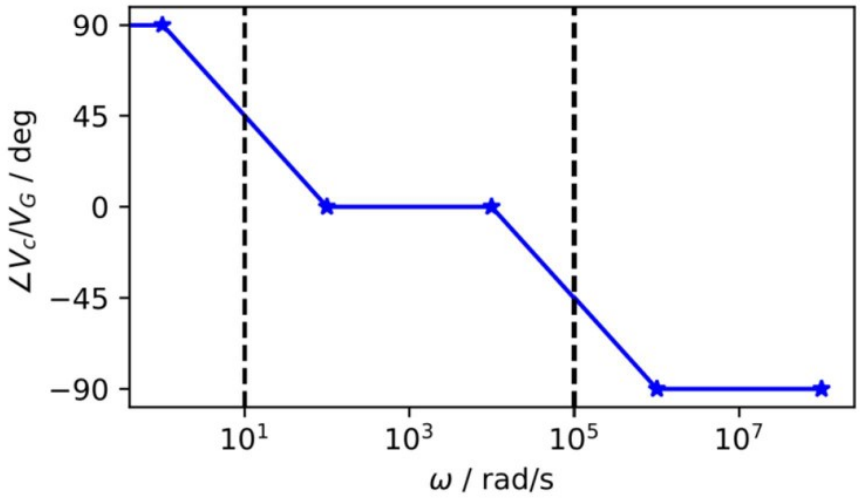


Diagramma di Bode: Fase

$$\angle H(j\,\omega) = \angle Av + \angle j\,\frac{\omega}{-s_2} - \angle\left(1 - \frac{j\,\omega}{s_1}\right) - \angle\left(1 - \frac{j\,\omega}{s_2}\right)$$

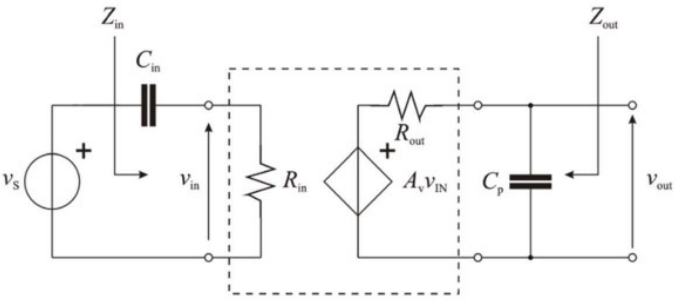
- $\angle Av = 0$
- $\angle j\,\frac{\omega}{-s_2} = 90\ \text{deg}$
- $\angle\left(1 - \frac{j\,\omega}{s}\right) = \begin{cases} 0\ \text{deg} & \text{for } \omega \ll |s| \\ 45\ \text{deg} & \text{for } \omega \approx |s| \\ 90\ \text{deg} & \text{for } \omega \gg |s| \end{cases}$

Diagramma di Bode della fase:



Esercizio 2 (Per casa)

Si consideri il seguente circuito:



$A_V = 10$
$R_{in} = 100K\Omega$
$R_{out} = 10K\Omega$
$C_p = 100pF$
$C_{in} = 1\mu F$

1. Determinare le funzioni
   - Av= Vout(s)/Vs(s)
   - Zin(s)
   - Zout(s)

2. Disegnare i diagrammi di Bode delle funzioni Av(s), Zin(s), Zout()