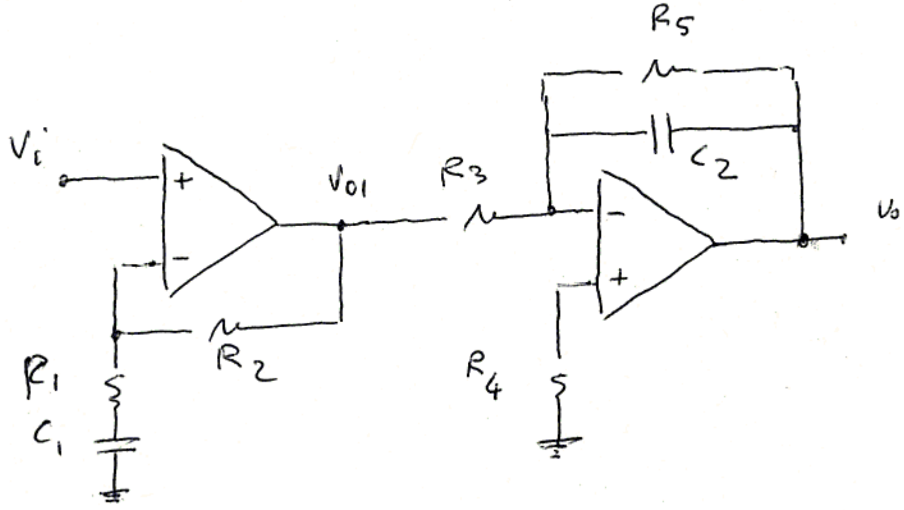
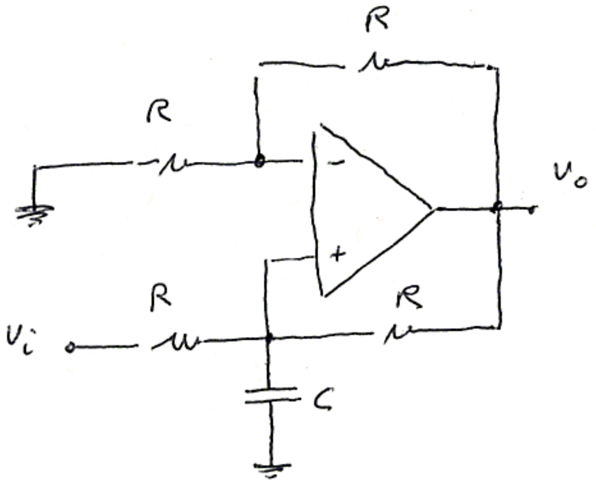
A

- DETERMINARE LA FUNZIONE DI TRASFERIMENTO $\frac{V_o}{V_i}$ E LE PULSAZIONI DEI RELATIVI POLI E ZERI
  DET. GUADAGNO PER $f \to 0$ E $f \to \infty$



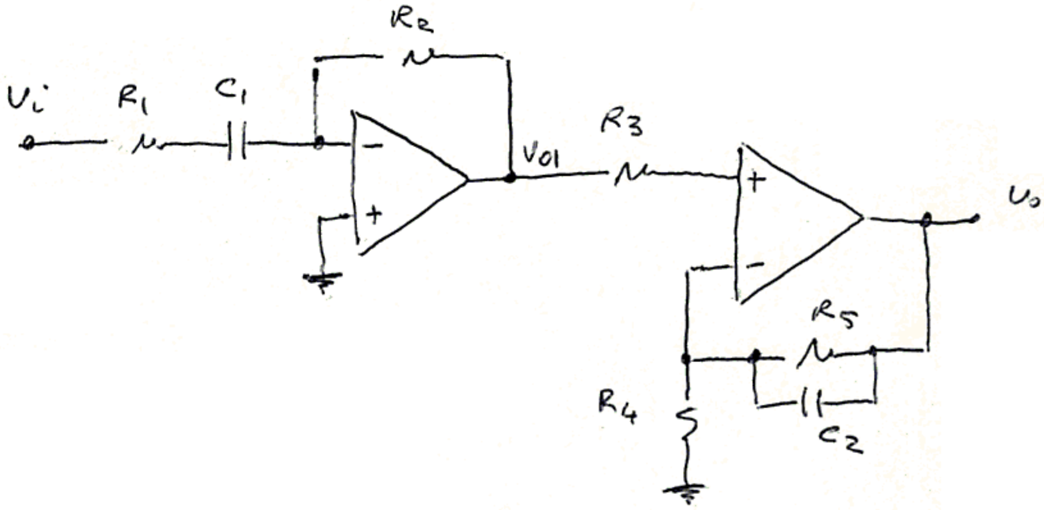
B

- DETERMINARE LA FUNZIONE DI TRASFERIMENTO $\frac{V_o}{V_i}$ ED EVENTUALI POLI E ZERI



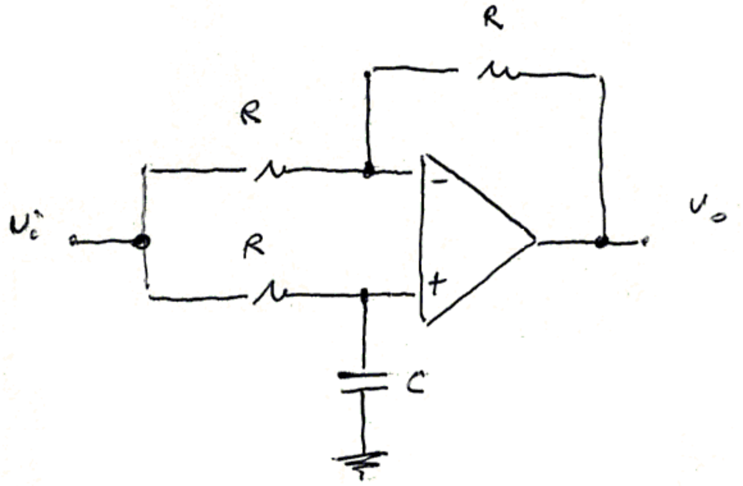
C

- DETERMINARE LA FUNZIONE DI TRASFERIMENTO $\frac{V_0}{V_i}$ E LE PULSAZIONI DEI RELATIVI POLI E ZERI
DET. GUADAGNO PER $f \to 0$ E $f \to \infty$



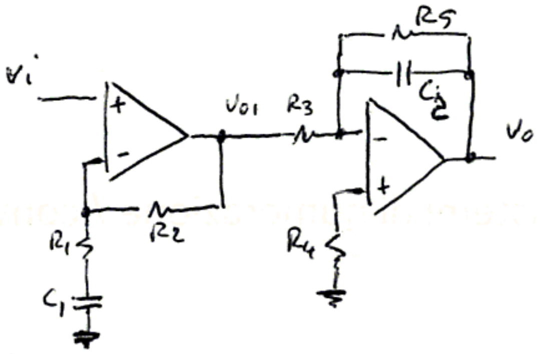
D

- DETERMINARE LA FUNZIONE DI TRASFERIMENTO $\frac{V_0}{V_i}$ ED EVENTUALI POLI E ZERI



A

$$Hp. \begin{cases} \text{OP.AMP IDEALE} \begin{cases} A_d = \infty \rightarrow V^- = V^+ \\ R_{in} = \infty \rightarrow I^- = I^+ = 0 \\ R_O = 0 \end{cases} \\ \text{FUNZ. LINEARE} \end{cases}$$



$$V_{O1} = V_i \frac{R_2 + Z_1}{Z_1} \quad \left\{ Z_1 = R_1 + \frac{1}{sC_1} = \frac{1+sR_1C_1}{sC_1} \right\}$$

$$V_{O1} = V_i \frac{R_2 + \frac{1+sR_1C_1}{sC_1}}{\frac{1+sR_1C_1}{sC_1}} = V_i \frac{1+sR_1C_1+sR_2C_1}{1+sR_1C_1} = V_i \frac{1+s(R_1+R_2)C_1}{1+sR_1C_1}$$

$$I^+ = 0 \rightarrow V^+ = R_4 I^+ = 0 \qquad V^- = V^+ = 0$$

$$V_o = -\frac{Z_5}{R_3} V_{O1} \quad \left\{ Z_5 = R_5 // \frac{1}{sC_2} = \frac{R_5 \cdot \frac{1}{sC_2}}{R_5 + \frac{1}{sC_2}} = \frac{R_5}{1+sR_5C_2} \right\}$$

$$V_o = -\frac{R_5}{R_3} \cdot \frac{1}{1+sR_5C_2} V_{O1}$$

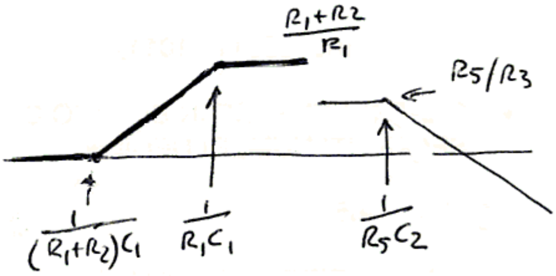
$$V_o = -\frac{R_5}{R_3} \cdot \frac{1+s(R_1+R_2)C_1}{(1+sR_1C_1)(1+sR_5C_2)} V_i$$

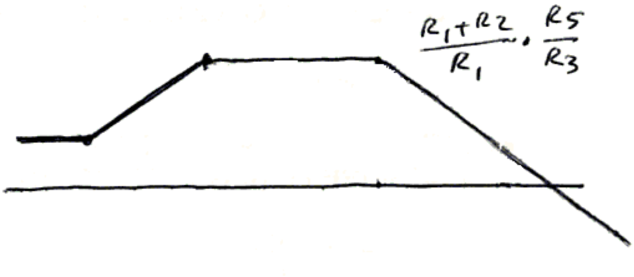
$$F(s) = \frac{V_o}{V_i} = -\frac{R_5}{R_3} \cdot \frac{1+s(R_1+R_2)C_1}{(1+sR_1C_1)(1+sR_5C_2)}$$

ZERI $\quad s = -\frac{1}{(R_1+R_2)C_1} \quad z_1$

POLI $\quad s = -\frac{1}{R_1C_1} \quad p_1$

$\quad s = -\frac{1}{R_5C_2} \quad p_2$

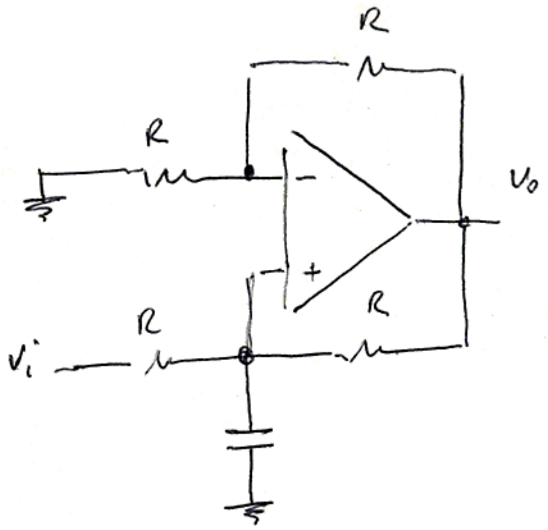


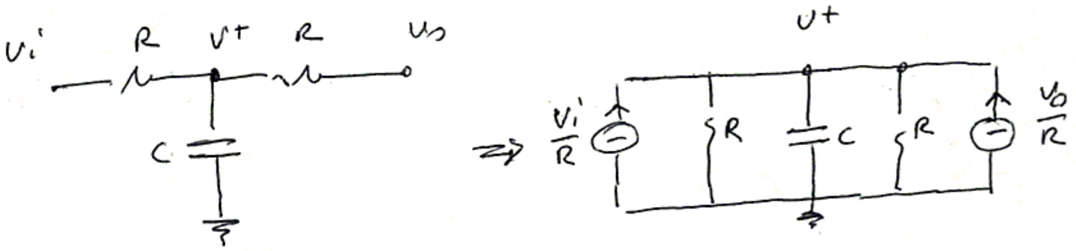


PER $f \rightarrow 0$ $\quad$ C : CIRC. APERTO $\quad V_{O1} = V_i \quad V_o = -\frac{R_5}{R_3} V_{O1} = -\frac{R_5}{R_3} V_i \quad \frac{V_o}{V_i} = -\frac{R_5}{R_3}$

PER $f \rightarrow \infty$ $\quad$ C : CTO CTO $\quad V_{O1} = \frac{R_1+R_2}{R_1} V_i \quad V_o = 0$

B





$$v^+ = \frac{V_i + V_0}{R} \cdot \frac{\frac{R}{2} \cdot \frac{1}{sC}}{\frac{R}{2} + \frac{1}{sC}} = \frac{V_i + V_0}{\cancel{R}} \cdot \frac{\cancel{R}}{2 + sRC} = \frac{V_i + V_0}{2 + sRC}$$

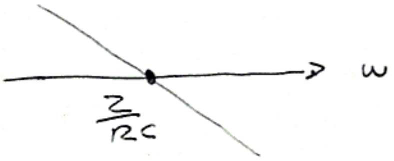
$$v^- = v^+$$

$$V_0 = 2V^- = 2\,\frac{V_i + V_0}{2 + sRC}$$

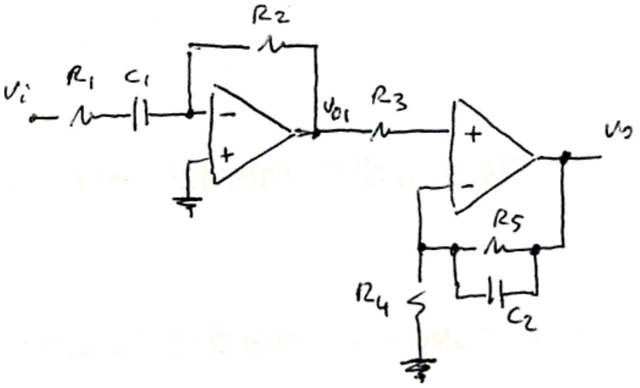
$$\cancel{2V_0} + sRCV_0 = 2V_i + \cancel{2V_0}$$

$$\frac{V_0}{V_i} = \frac{2}{sRC}$$

INTEGRATORE
NON INVERTENTE



C



Hp
- OP AMP IDEALE
  - $A_d = \infty \rightarrow V^- = V^+$
  - $R_{in} = \infty \rightarrow I^- = I^+ = 0$
  - $R_0 = 0$
- FUNZ. LINEARE

$$V_{01} = -\frac{R_2}{Z_1} V_i \qquad \left\{ Z_1 = R_1 + \frac{1}{sC_1} = \frac{1 + sR_1C_1}{sC_1} \right\}$$

$$V_{01} = -\frac{R_2}{\frac{1+sR_1C_1}{sC_1}} V_i = -\frac{sR_2C_1}{1+sR_1C_1} V_i$$

$$I^+ = 0 \rightarrow V_{R_3} = R_3 I^+ = 0 \qquad V^+ = V_{01}$$

$$V_0 = \frac{R_4 + Z_5}{R_4} V^+ \qquad \left\{ Z_5 = R_5 /\!/ \frac{1}{sC_2} = \frac{R_5 \cdot \frac{1}{sC_2}}{R_5 + \frac{1}{sC_2}} = \frac{R_5}{1 + sR_5C_2} \right\}$$

$$V_0 = +\frac{1}{R_4}\left(R_4 + \frac{R_5}{1+sR_5C_2}\right) V^+ = \frac{1}{R_4}\left(\frac{R_4 + R_5 + sR_4R_5C_2}{1+sR_5C_2}\right) V^+ = \frac{R_4+R_5}{R_4} \cdot \frac{1 + s\frac{R_4R_5}{R_4+R_5}C_2}{1+sR_5C_2} V^+$$

$$V_0 = -\frac{R_4+R_5}{R_4} \cdot \frac{sR_2C_1}{1+sR_1C_1} \cdot \frac{1 + s\frac{R_4R_5}{R_4+R_5}C_2}{1+sR_5C_2} V_i$$

$$F(s) = \frac{V_0}{V_i} = -\frac{R_4+R_5}{R_4} \cdot \frac{sR_2C_1}{1+sR_1C_1} \cdot \frac{1 + s\frac{R_4R_5}{R_4+R_5}C_2}{1+sR_5C_2}$$

ZERI

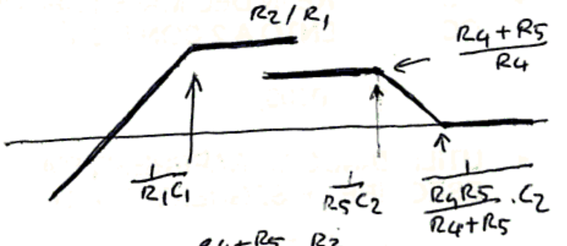
$s = 0$ $\quad z_1$

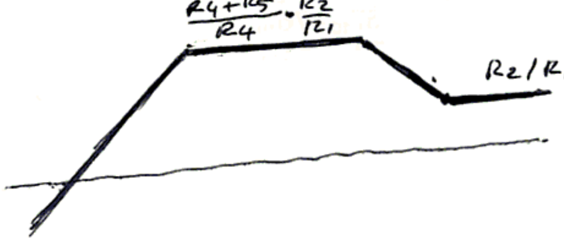
$s = -\dfrac{1}{\frac{R_4R_5}{R_4+R_5} C_2}$ $\quad z_2$

POLI

$s = -\dfrac{1}{R_1C_1}$ $\quad p_1$

$s = -\dfrac{1}{R_5C_2}$ $\quad p_2$

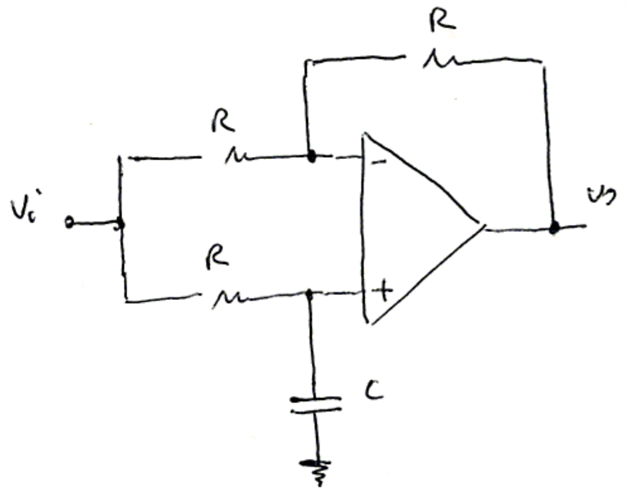




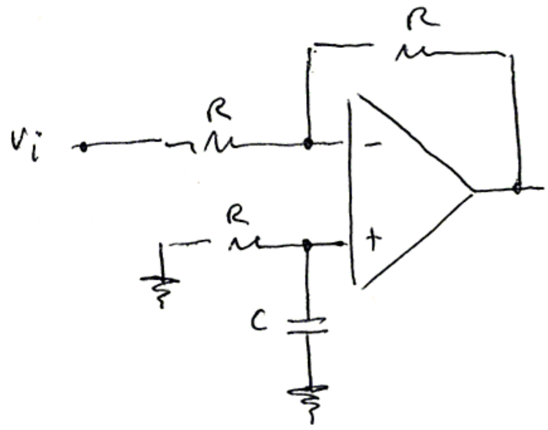
PER $f \rightarrow 0$ $\quad$ C : CIRC. APERTO $\quad V_{01} = 0 \quad V_0 = 0$

PER $f \rightarrow \infty$ $\quad$ C : CTO CTO $\quad V_{01} = -\dfrac{R_2}{R_1} V_i \quad V_0 = V_{01} = -\dfrac{R_2}{R_1} V_i \rightarrow \dfrac{V_0}{V_i} = -\dfrac{R_2}{R_1}$

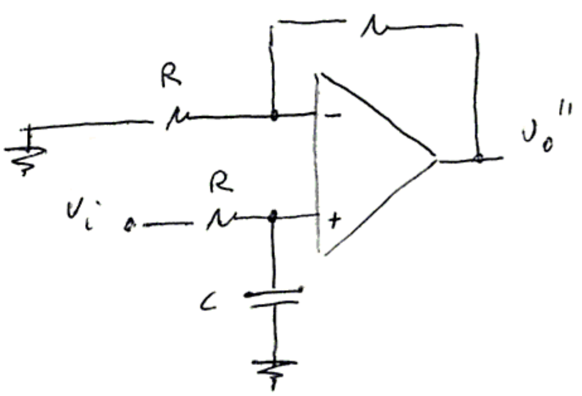
D



PSE



$V_o' = -V_i$



$$v^+ = V_i \frac{\frac{1}{sC}}{R + \frac{1}{sC}} = V_i \frac{1}{1+sRC}$$

$$v^- = v^+$$

$$V_o'' = 2v^- = \frac{2}{1+sRC} V_i$$

$$V_o = V_o' + V_o'' = \frac{2}{1+sRC} V_i - V_i = \frac{2-1-sRC}{1+sRC} V_i = \frac{1-sRC}{1+sRC} V_i$$

SFASATORE
PURO

ZERI $s = \frac{1}{RC}$

POLI $s = -\frac{1}{RC}$