Microelectronics Circuit Analysis and Design
Homework(2nd)

Yuejin Xie U202210333

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9.45 Consider the ideal noninverting op-amp circuit in Figure P9.45. (a) Derive the expression for v_O as a function of v_{I1} and v_{I2}. (b) Find v_O for $v_{I1} = 0.2V$ and $v_{I2} = 0.3V$. (c) Find v_O for $v_{I1} = +0.25V$and $v_{I2} = -0.40V$.

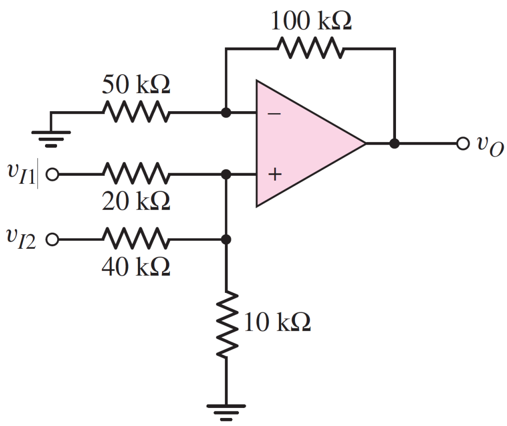

Figure 1: Problem 9.45

Solution:

(a)Because of "virtual short" , "virtual open" , we have euqations as follow:

$$\begin{cases} \dfrac{v_{I1}-v_+}{20k\Omega}+\dfrac{v_{I2}-v_+}{40k\Omega}=\dfrac{v_+-0}{10k\Omega} \\ v_+=v_- \\ \dfrac{0-v_-}{50k\Omega}=\dfrac{v_--v_O}{100k\Omega} \end{cases} \Rightarrow v_O=\frac{6v_{I1}+3v_{I2}}{7} \quad (1)$$

(b)substitute $v_{I1} = 0.2V$ and $v_{I2} = 0.3V$ into the (1) $\Rightarrow v_O = 0.3V$

(c)substitute $v_{I1} = +0.25V$and $v_{I2} = -0.40V$ into the (1) $\Rightarrow v_O = 42.86mV$

9.75 The circuit in Figure P9.75 is a first-order low-pass active filter. (a) Show that the voltage transfer function is given by

$$A_v = -\frac{R_2}{R_1} \cdot \frac{1}{1 + j\omega R_2 C_2}$$

(b) What is the voltage gain at dc $(\omega = 0)$? (c) At what frequency is the magnitude of the voltage gain a factor of $\sqrt{2}$ less that the dc value? (This is the -3 dB frequency.)

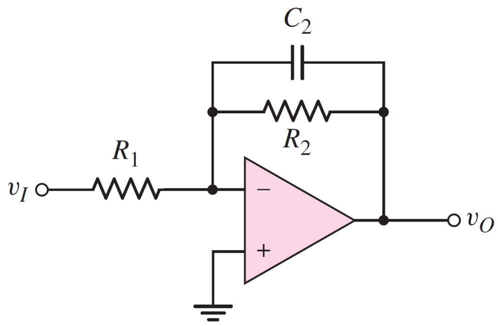

Figure 2: Problem 9.75

Solution:

(a)Because of "virtual short" , "virtual open" , we have euqations as follow:

$$\begin{cases} \dfrac{v_I - v_-}{R_1} = \dfrac{v_- - v_O}{R_2} + \dfrac{v_- - v_O}{\dfrac{1}{jwC_2}} \\ v_+ = v_- = 0 \end{cases} \Rightarrow A_v = \frac{v_I}{v_O} = -\frac{R_2}{R_1} \cdot \frac{1}{1 + j\omega R_2 C_2}$$

(b)when $\omega = 0, A_v(DC) = -\dfrac{R_2}{R_1}$

(c)$|A_v| = \dfrac{A_v(DC)}{\sqrt{2}} \Rightarrow \omega = \dfrac{1}{R_2 C_2} \Rightarrow f = \dfrac{1}{2\pi R_2 C_2}$