ELG 3331: A Tutorial for Chapter 8

Problem 8.13

a. The circuit is non-inverting amplifier, and

$$v_o = \left(1 + \frac{\mathrm{R_F}}{\mathrm{R_2}}\right) v_S$$

b. Accordingly

$$v_o = \left(1 + \frac{220}{1.8}\right) v_S = 2.464 + 0.1232\cos(\omega t)\ \mathrm{V}$$

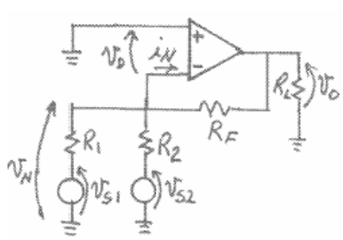
Problem 8.14

$v_o = v_S$

Problem 8.17

The operational amplifier has a very input resistance, a very large open loop gain (μ), and a very small output resistance. Accordingly, it can be modeled with small error as an ideal operational amplifier.

Use KVL:
$v_D + v_N = 0$
$v_D = 0,\ v_N = 0$



Use KCL:

$$i_N + \frac{v_N\text{-}v_{S2}}{R_2} + \frac{v_N - v_{S1}}{R_1} + \frac{v_N - v_o}{R_F} = 0$$
$$v_N = 0$$
$$i_N = 0$$
$$v_o = -\frac{R_F}{R_1} v_{S1} - \frac{R_F}{R_2} v_{S2} = \left(-\frac{2.2}{0.85}\right)(7\ \mathrm{mV}) + \left(-\frac{2.2}{1.5}\right)(7\ \mathrm{mV}) = -28.38\ \mathrm{mV}$$

Use the above results: A_{v1} = -2.588 and A_{v2} = -1.467

Problem 8.40

The circuit is for low-pass filter.

$$V_o(j\omega) = -\frac{R_2}{R_1}\frac{1}{1 + j\omega CR_2}V_S(j\omega)$$

b.

$$H(j\omega) = \frac{V_o(j\omega)}{V_i(j\omega)} = -\frac{R_2}{R_1}\frac{1}{1 + j\omega CR_2}$$

c. The gain in decibel is obtained by

$$\left|H(j0)dB = 20\log\frac{R_2}{R_1} = 20\log\frac{22}{9.1} = 7.66\text{ dB}\right|$$

The cutoff frequency is

$$\omega_o = \frac{1}{CR_2} = \frac{1}{0.47\times 10^{-6}\times 22\times 10^3} = 96.71\text{ rad/s}$$

Problem 8.41

The amplifier is low-pass filter.

$$H(j\omega) = \frac{V_o(j\omega)}{V_i(j\omega)} = -\frac{R_2}{R_1}\frac{1}{1 + j\omega CR_2}$$

The gain in decibel is obtained by evaluating $|H(j\omega)|$ at $\omega = 0$. For example

$$20\log\frac{R_2}{R_1} = 20\log\frac{68}{2.2} = 29.8\text{ dB}$$

The cutoff frequency is

$$\omega_o = \frac{1}{CR_2} = \frac{1}{0.47\times 10^{-9}\times 68\times 10^3} = 31289\text{ rad/s}$$