Homework Set 1 Solutions
EECE2412: Electronics– Spring 2013

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A note about Problem 2.47:
The voltage gain is given by:

$$A(f) = \left[\frac{10}{1 + j\left(f/10^5\right)}\right]^2$$

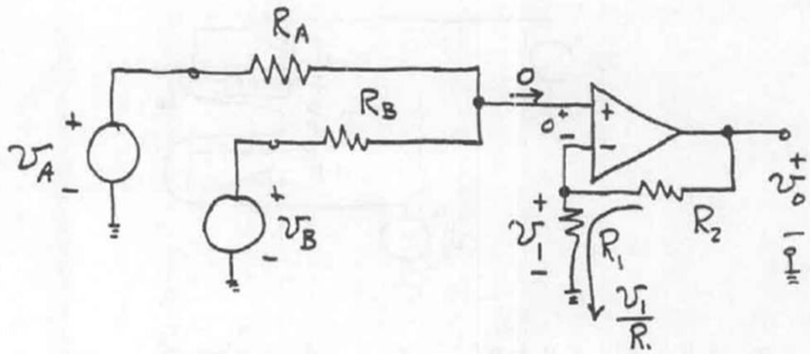
The power gain may be found by:

$$A_p(f) = A(f)A(f)^*$$

where the symbol * denotes the complex conjugate. This results in a power gain of

$$A_p(f) = A(f)A(f)^* = \left[\frac{10}{1 + j\left(f/10^5\right)}\right]^2 \cdot \left[\frac{10}{1 - j\left(f/10^5\right)}\right]^2$$

Problem 2.22



$$\frac{v_1 - v_A}{R_A} + \frac{v_1 - v_B}{R_B} = 0 \qquad \Rightarrow \qquad v_1 = \frac{v_A R_B + v_B R_A}{R_A + R_B}$$

$$v_o = v_1 + R_2 \frac{v_1}{R_1} = \frac{R_1 + R_2}{R_1} v_1$$

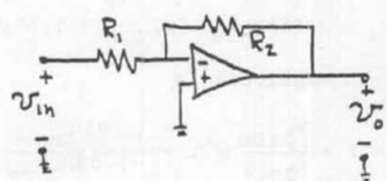
$$v_o = \frac{R_1 + R_2}{R_1} \times \frac{v_A R_B + v_B R_A}{R_A + R_B}$$

$$v_o = A_A v_A + A_B v_B$$

where $A_A = \dfrac{R_1 + R_2}{R_1} \times \dfrac{R_B}{R_A + R_B}$

and $A_B = \dfrac{R_1 + R_2}{R_1} \times \dfrac{R_A}{R_A + R_B}$

Problem 2.26



Because $A_v = -R_2/R_1$, we select the nominal resistances such that $R_{2nom} = 2R_{1nom}$. Given 5%-tolerances we have

$$R_{1min} = 0.95R_{1nom} \qquad R_{1max} = 1.05R_{1nom}$$

$$R_{2min} = 0.95R_{2nom} \qquad R_{2max} = 1.05R_{2nom}$$

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Then the minimum gain magnitude is

$$|A_v|_{min} = \frac{R_{2min}}{R_{1max}} = \frac{0.95R_{2nom}}{1.05R_{1nom}} = 1.81$$

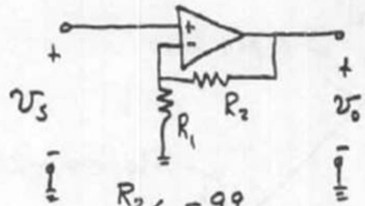
Similarly

$$|A_v|_{max} = \frac{R_{2max}}{R_{1min}} = \frac{1.05R_{2nom}}{0.95R_{1nom}} = 2.21$$

The tolerances of the gain magnitude are -9.5% and +10.5%.

Problem 2.47

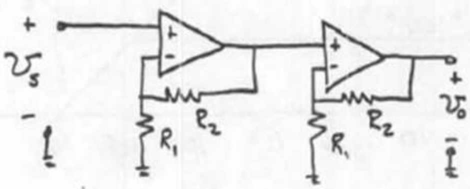
Alternative 1:



$R_2/R_1 = 99$

The half-power bandwidth is $f_{BCL} = f_t/A_{0CL} = 10^6/100 = 10$ kHz

Alternative 2:



$R_2/R_1 = 9$

For each stage we have $f_{BCL} = f_t/A_{0CL} = 10^6/10 = 100$ kHz

$$A_{CL}(f) = \frac{A_{0CL}}{1 + j(f/f_{BCL})} = \frac{10}{1 + j(f/10^5)}$$

The overall gain is

$$A(f) = \left[\frac{10}{1 + j(f/10^5)}\right]^2$$

At the half-power frequency f_H we have:

$$\frac{100}{\sqrt{2}} = \frac{100}{1 + (f_H/10^5)^2}$$

Solving we find f_H = 64.4 kHz compared with 10 kHz for the single stage amplifier.

Problem 2.55

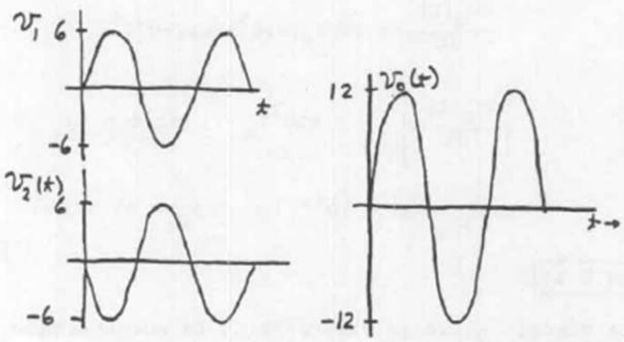
(a) Refer to the circuit shown in Figure P2.55 in the text. Notice that the upper op amp is configured as a noninverting amplifier with a gain of 2. The lower op amp is configured as an inverting amplifier with a gain of -2. Thus we have

$$v_2(t) = -2v_s(t)$$

$$v_1(t) = 2v_s(t)$$

$$v_o(t) = v_1(t) - v_2(t) = 4v_s(t) \quad \Rightarrow \quad A_{vs} = \frac{v_o}{v_s} = 4$$

(b)



(c) $v_o(t)$ is clipped when it reaches amplitudes of ±28 V.