EEET-221 Final Exam

Skyler MacDougall

1. If $I_{b+} = 214nA\ and\ I_{b-} = 188nA$, determine I_{os}.
    1. 26nA
    2. 214nA
    3. 402nA
    4. 201.00nA
2. If $V_{in1} = 7V. V_{in2} = 1V, V_{O_{SAT}} = \pm 15V, R_L = 5k\Omega$ in figure 1, determine the output current I_L of the comparitor (the current through R_L).

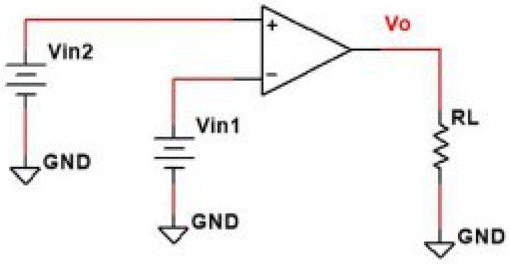
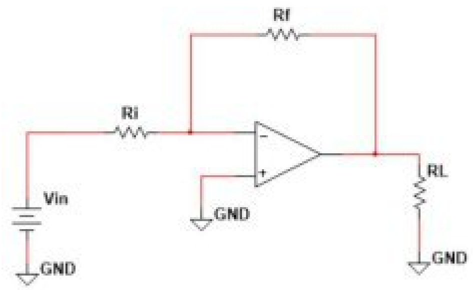


Figure 1: Comparitor

    1. 1.20mA
    2. 0.80mA
    3. -3.00mA
    4. 3.00mA
3. An op-amp has a slew rate of $4\frac{V}{\mu s}$ and is convigured as a non-inverting amplifier, where $R_f = 9.9k\Omega, R_i = 3.2k\Omega$. If a $8.00mV$ peak sine wave is applied to the non-inverting input, determine the slew rate limiting frequency.
    1. 19.4MHz
    2. 79.6MHz
    3. 122.1MHz
    4. 246.2MHz
4. An op-amp has a unity gain frequency of 4MHz and is configured as a non-inverting amplifier where $R_f = 9.8k\Omega, R_i = 3.2k\Omega$. Calculate the rise time (t_{CL}) associated with the amplifier.
    1. 4.00ns
    2. 1015.63ns
    3. 0.98ns
    4. 355.47ns
5. Find the voltage at the inverting input if:

$$\begin{aligned} V_{in} &= 1.06V \\ R_i &= 62k\Omega \\ R_f &= 18k\Omega \\ R_L &= 134k\Omega \end{aligned} \qquad (1)$$



$$\begin{aligned} V_- &= V_+ \\ &\therefore \\ V_- &= 0V \end{aligned} \tag{2}$$

6. Find the current in R_f if, using the diagram in question 5:

$$\begin{aligned} V_{in} &= 0.20V \\ R_i &= 2k\Omega \\ R_f &= 5k\Omega \\ R_L &= 133k\Omega \end{aligned} \tag{3}$$

$$\begin{aligned} V_o &= (1 + \frac{R_f}{R_i})V_i \\ V_0 &= 700mV \\ I_f &= \frac{0.2V - 0.7V}{5k\Omega} \\ &\boxed{I_f = -100mA} \end{aligned} \tag{4}$$

7. Find the voltage at the inverting input, given the diagram in question 5 and:

$$\begin{aligned} V_{in} &= 0.22V \\ R_i &= 40k\Omega \\ R_f &= 12k\Omega \\ R_L &= 141k\Omega \end{aligned} \tag{5}$$

$$\begin{aligned} V_- &= V_+ \\ &\boxed{V_- = 0.22V} \end{aligned} \tag{6}$$

8. FInd the noise gain given the diagram in question 5 and:

$$\begin{aligned} V_{in} &= 0.54V \\ R_i &= 14k\Omega \\ R_f &= 17k\Omega \\ R_L &= 151k\Omega \end{aligned} \tag{7}$$

$$\begin{aligned} k_n &= 1 + \frac{R_f}{R_i} = 1 + \frac{17\,\cancel{k\Omega}}{14\,\cancel{k\Omega}} \\ &\boxed{k_n = 2.2143} \end{aligned} \tag{8}$$

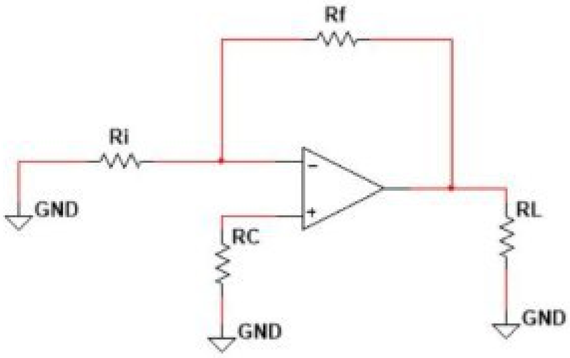
9. Find the current in R_L given the diagram in question 5 and:

$$\begin{aligned} V_{in} &= 0.58V \\ R_i &= 65k\Omega \\ R_f &= 21k\Omega \\ R_L &= 139k\Omega \end{aligned} \tag{9}$$

$$V_o = (1 + \frac{R_f}{R_i})V_i = (1 + \frac{21k\Omega}{65k\Omega})0.58V \tag{10}$$
$$V_o = 767.38mV$$
$$I_L = \frac{V_o}{R_L} = \frac{767.38mV}{139k\Omega}$$
$$\boxed{I_L = 5.52\mu A}$$

10. Find V_L given:

$$V_{io} = 4mV \tag{11}$$
$$R_i = 2k\Omega$$
$$R_c = 2k\Omega$$
$$R_f = 153k\Omega$$



$$V_L = V_{io}(1 + \frac{R_f}{R_i}) = 4mV(1 + \frac{153k\Omega}{2k\Omega}) \tag{12}$$
$$\boxed{V_L = 310mV}$$

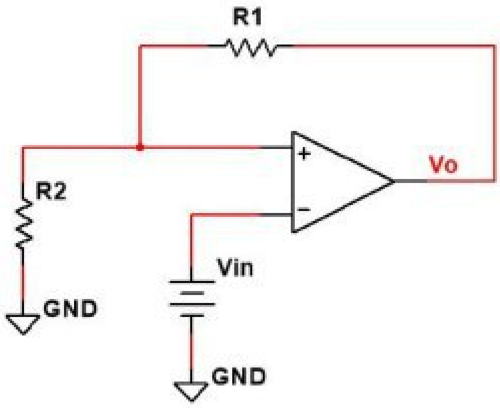
11. Find the closed loop 3dB bandwidth for a non-inverting amplifier if given the following:

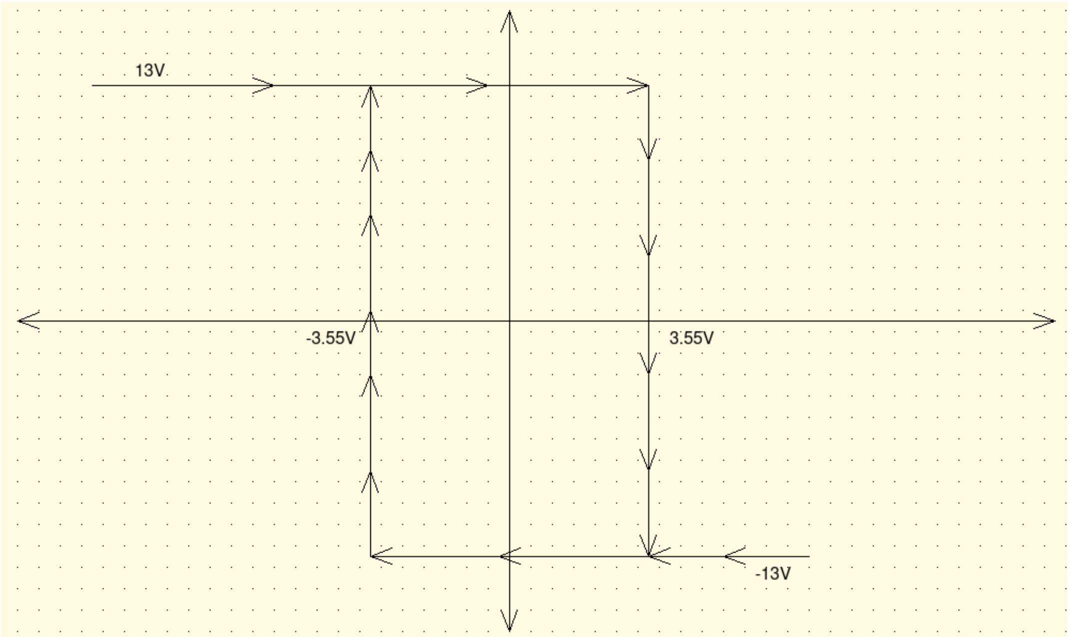
$$B = 3MHz \tag{13}$$
$$R_i = 2kHz$$
$$R_f = 177k\Omega$$

$$BW = \frac{B}{k_n} = \frac{3MHz}{1 + \frac{R_f}{R_i}} = \frac{3MHz}{1 + \frac{177k\Omega}{2k\Omega}} = \frac{3MHz}{89.5} \tag{14}$$
$$\boxed{BW = 33.52kHz}$$

12. Sketch the input-output characteristic curve, given:

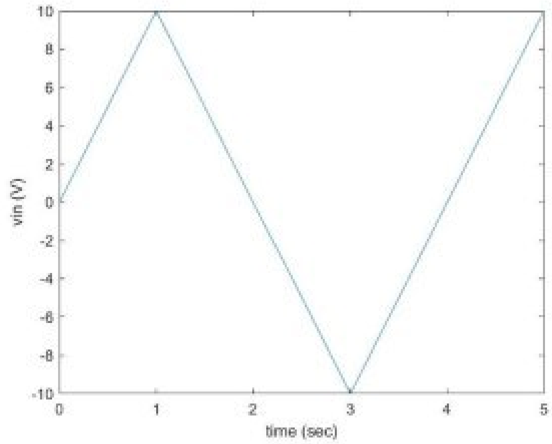
$$R_1 = 9.3k\Omega \tag{15}$$
$$R_2 = 3.9k\Omega$$
$$V_{O_{SAT}} = \pm 12V$$

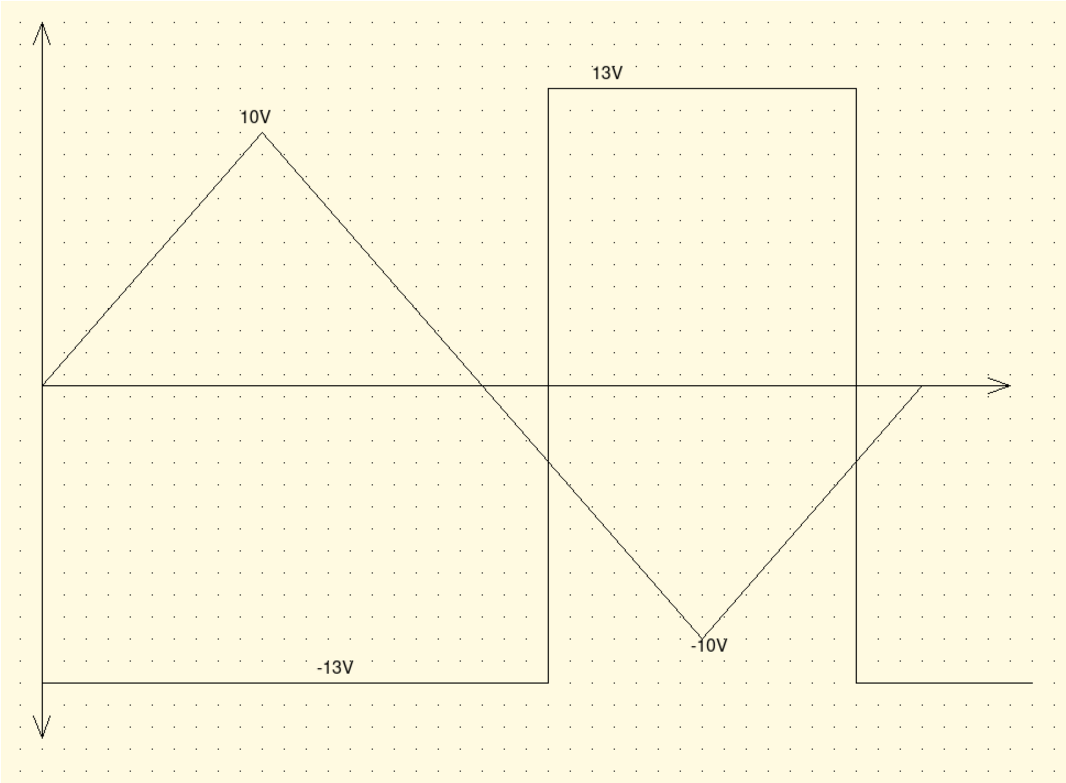




13. Sketch the output curve given the diagram in question 12 and:

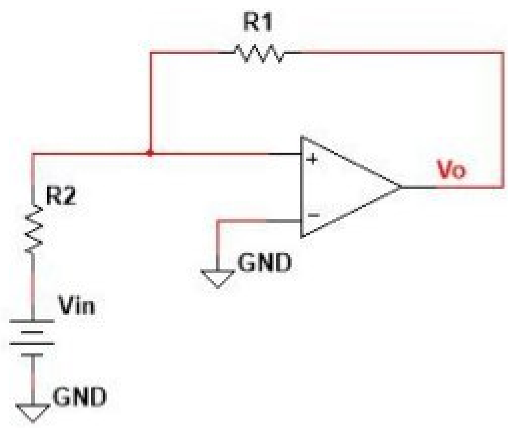
$$
\begin{aligned}
R_1 &= 9.5k\Omega \\
R_2 &= 3.5k\Omega \\
V_{O_{SAT}} &= \pm 13V
\end{aligned}
\tag{16}
$$

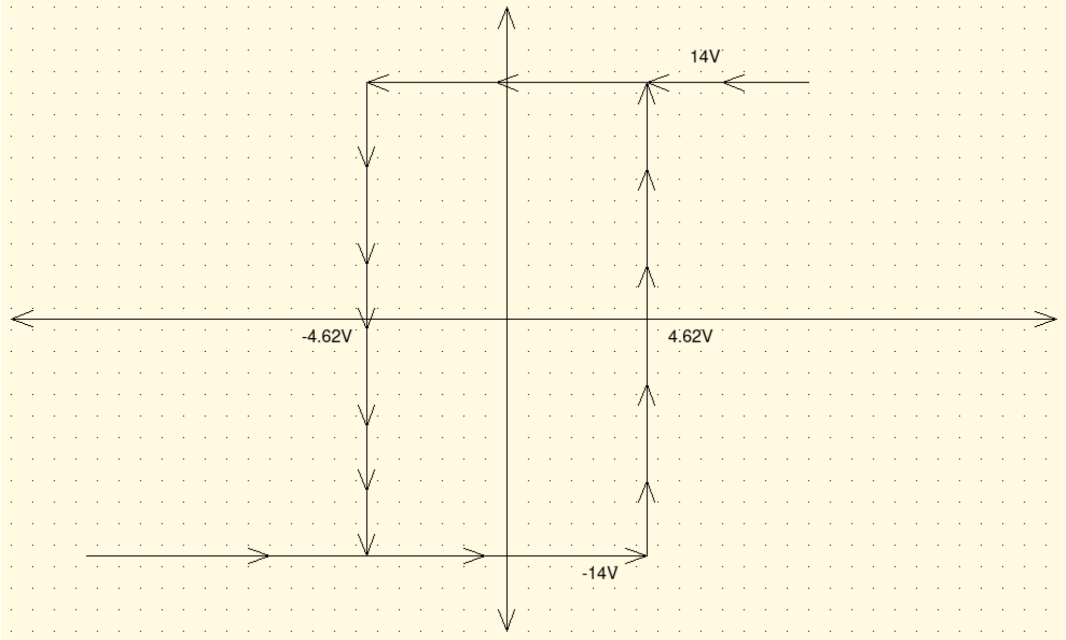




14. Sketch the input-output characteristic curve given:

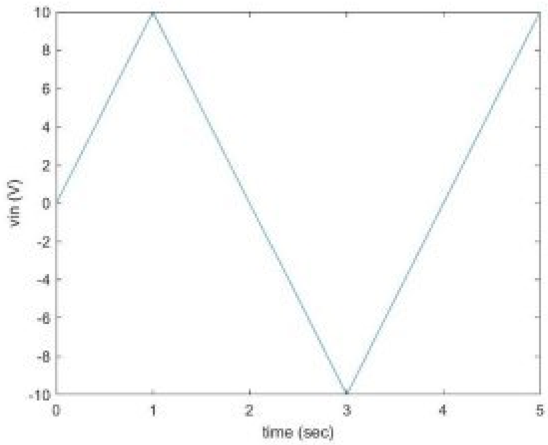
$$R_1 = 9.7k\Omega \tag{17}$$
$$R_2 = 3.2k\Omega$$
$$V_{O_{SAT}} = \pm 14V$$

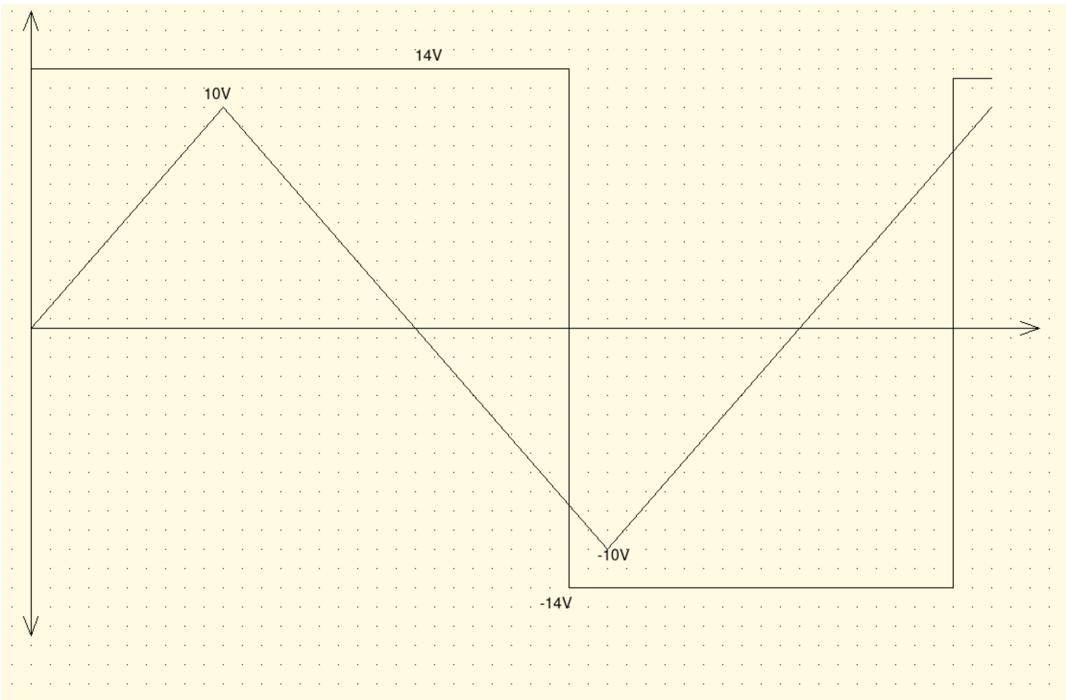




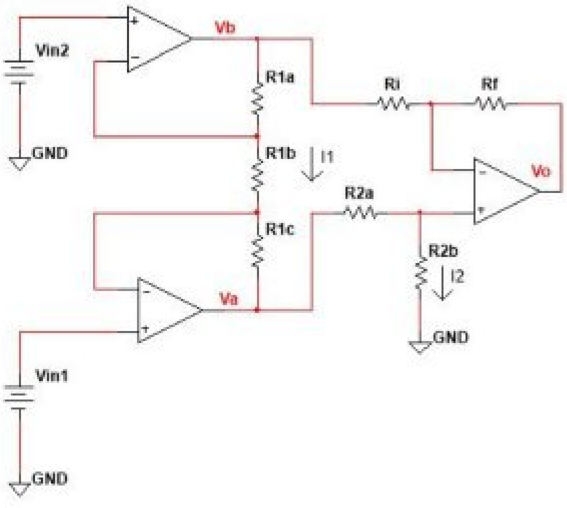
15. Sketch the output curve given the diagram in question 14 and:

$$\begin{aligned} R_1 &= 8.1k\Omega \\ R_2 &= 4.7k\Omega \\ V_{O_{SAT}} &= \pm 14V \end{aligned} \tag{18}$$





16. Determine the current I_1 given all resistors are $2.0k\Omega$ except R_{1b}, which is $4.6k\Omega$, and $V_{in1} = 6V,\ V_{in2} = 13V$.



$$i_1 = \frac{v_1 - v_2}{R_{1b}} = \frac{6V - 13V}{4.6k\Omega} \tag{19}$$
$$\boxed{|i_1 = 1.5mA|}$$

17. Using the same circuit and values, determine I_2.

$$V_a = I_1(R_{1c}) = 1.52mA * 2k\Omega = 3.04V \tag{20}$$
$$3.04V + 6V = 9.04V$$
$$I = \frac{V}{R} = \frac{9.04V}{4k\Omega}$$
$$\boxed{|I_2 = 2.26mA|}$$

18. A 4 pole high pass Butterworth filter has a 3dB cutoff of 6MHz. Use the image below to determine the decibel response at 2MHz.

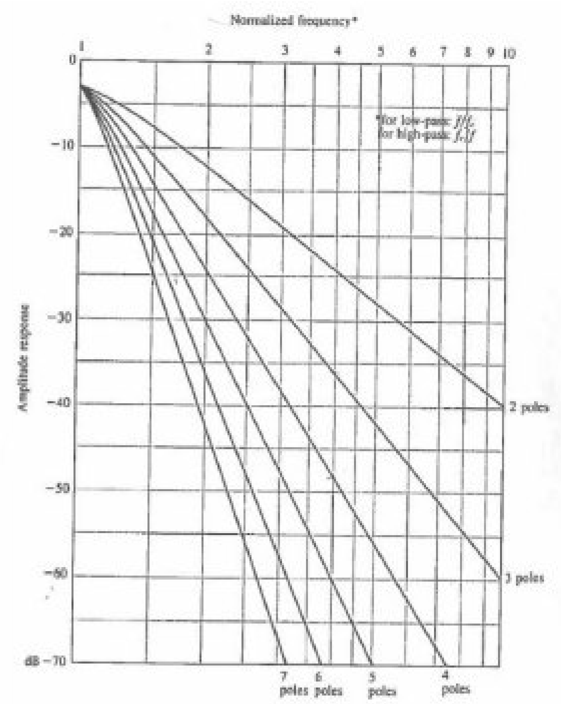
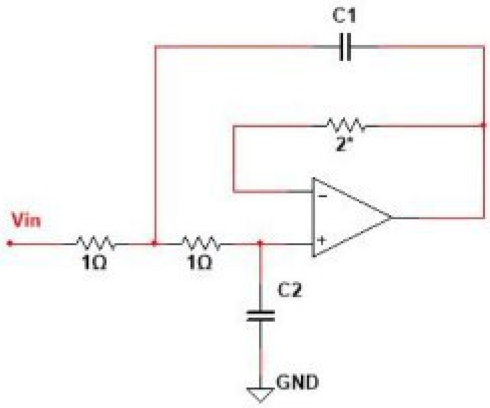


FIGURE 8-7
Stop-band amplitude response of Butterworth filters.

$$\approx -38dB \tag{21}$$

19. Design a 2 pole low-pass butterworth active filter using the unity-gain amplifier (below) to achieve a 3dB frequency of 6KHz. Select the two filter resistances at $12k\Omega$ each. Starting values for C_1 and C_2 are 1.414 and 0.707 respectively.



$$R = 12k\Omega \tag{22}$$
$$C_1 = \frac{1.414F}{12k * 2 * \pi * 12k} = 1.56nF$$
$$C_1 = \frac{0.707F}{12k * 2 * \pi * 12k} = 0.78nF$$

20. What is the minimum order needed for a high pass filter that has a relative amplitude of $\leq 0.100dB\ for\ f \geq 4.0kHz,\ and\ \geq 30.0dB\ for\ f \leq 0.600kHz.$
3 poles.

21. What has been the most confusing point so far in this class?