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Exam 2

Due April 22nd at 8pm

1. If $V_{IN1} = 6V,\ V_{IN2} = 2V, V_{O(SAT)} = \pm 13V, R_L = 5k\Omega$ in the following image, determine the output voltage V_O of the comparitor.

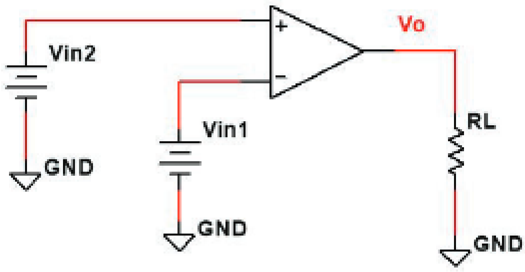


Figure 1

$$V_{IN1} > V_{IN2};\ V_{IN1} = inverting\ input \tag{1}$$
$$\therefore$$
$$\boxed{V_O = -13V = (a)}$$

2. If $V_{IN1} = 6V, V_{IN2} = 1V, V_{O(SAT)} = \pm 13V, R_L = 4k\Omega$, determine the output current I_L (the current through R_L) of the comparator. (Using the comparator noted in question 1)

$$VV_{IN1} > V_{IN2};\ V_{IN1} = inverting\ input \tag{2}$$
$$\therefore$$
$$V_O = -13V$$
$$I_L = \frac{V_O}{R_L} = \frac{-13V}{4k\Omega}$$
$$\boxed{I_L = -3.25mA = (d)}$$

3. For a non-inverting amplifier with $R_f = 9k\Omega, R_i = 5k\Omega$ and the total RMS noise level referred to the input is $7\mu V$, select the noise level.

$$A = 1 + \frac{R_f}{R_i} = 1 + \frac{9k\Omega}{5k\Omega} = 2.8 \tag{3}$$
$$V_o = V_i * A = V_i = 7\mu V * 2.8$$
$$\boxed{V_{o\ Noise} = 19.6\mu V = (b)}$$

4. An amplifier has a common mode gain of $30dB$ and a differential gain of $110dB$. What is the common mode rejection ratio?

$$CMRR = 20log(\frac{A_d}{|A_{cm}|}) \tag{4}$$
$$CMRR = 20log(\frac{11\cancel{0dB}}{|3\cancel{0dB}|})$$
$$CMMR = 11.28dB$$

(c)

5. An op-amp has a slew-rate of $5\frac{V}{\mu s}$ and is configured as a non-inverting amplifier, with $R_f = 9.6k\Omega, R_i = 4.2k\Omega$. If an $8.00mV$ peak sine wave is applied to the non-inverting input, determine the slew-rate limiting frequency.

$$f_{sr} = \frac{S}{2\pi V_o};\ V_o = V_i * (1 + \frac{R_f}{R_i}) \tag{5}$$

$$f_{sr} = \frac{S}{2\pi V_i * (1 + \frac{R_f}{R_i})}$$

$$f_{sr} = \frac{5\frac{\cancel{V}}{\mu s}}{2 * \pi * 8m\cancel{V} * (1 + \frac{9.6\cancel{k\Omega}}{4.2\cancel{k\Omega}})}$$

$$f_{sr} = \frac{5}{2 * \pi * 0.0008 * 3.28} MHz$$

$$\boxed{f_{sr} = 30.27MHz \approx 30.3MHz = (a)}$$

6. An op-amp has a unity gain frequency of $4MHz$ and is configured as a non-inverting amplifier with $R_f = 10.0k\Omega, R_i = 4.4k\Omega$. Calculate the rise time (t_{CL}) associated with the amplifier.

$$T_{sr} = \frac{0.35}{BW};\ BW = \frac{B}{k_n};\ k_n = 1 + \frac{R_f}{R_i} \tag{6}$$

$$T_{sr} = \frac{0.35}{\frac{B}{1+\frac{R_f}{R_i}}}$$

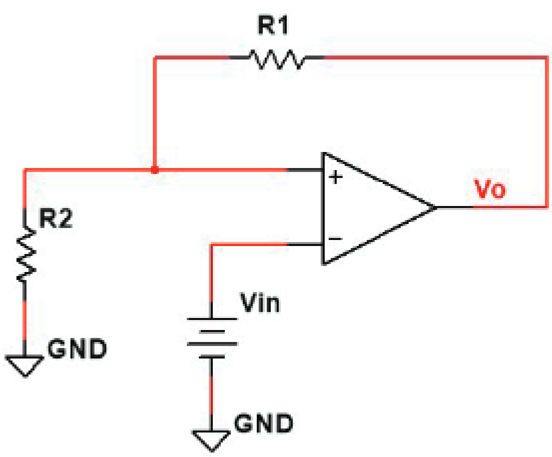
$$T_{sr} = \frac{0.35}{\frac{4MHz}{1+\frac{10.0\cancel{k\Omega}}{4.4\cancel{k\Omega}}}}$$

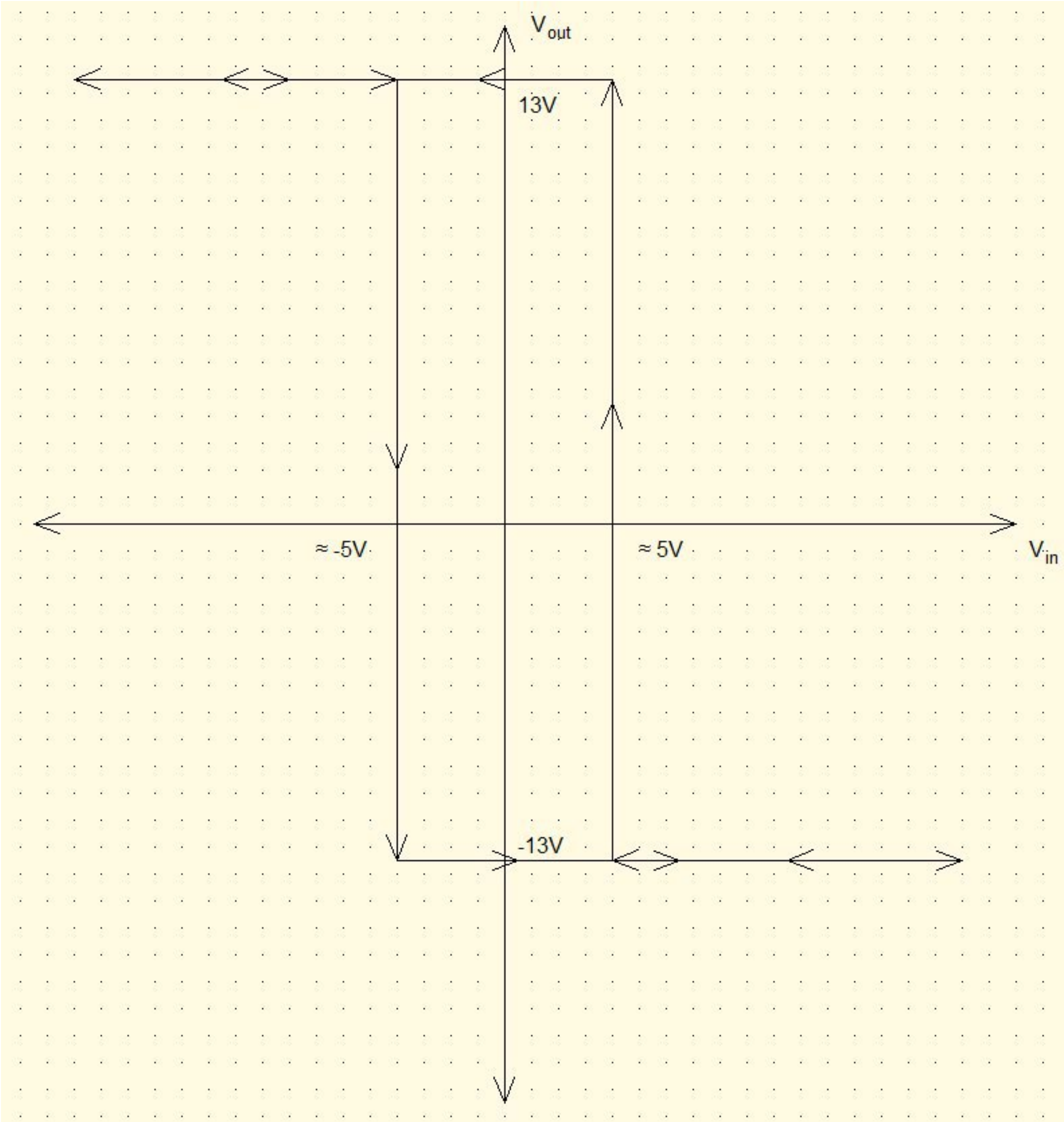
$$T_{sr} = \frac{0.35}{\frac{4}{3.\overline{27}}}\mu s$$

$$\boxed{T_{sr} = 286.\overline{36}ns = (d)}$$

7. Sketch the input characteristic curve given the below image and:

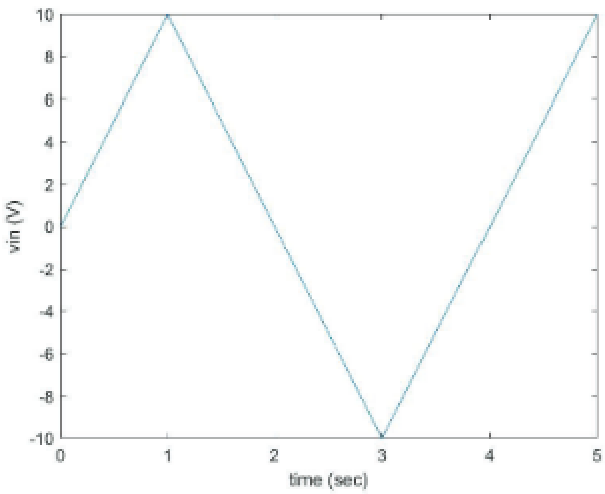
$$\begin{aligned} R_1 &= 8.1k\Omega \\ R_2 &= 3.1k\Omega \\ V_{O(STAT)} &= \pm 13V \end{aligned} \tag{7}$$

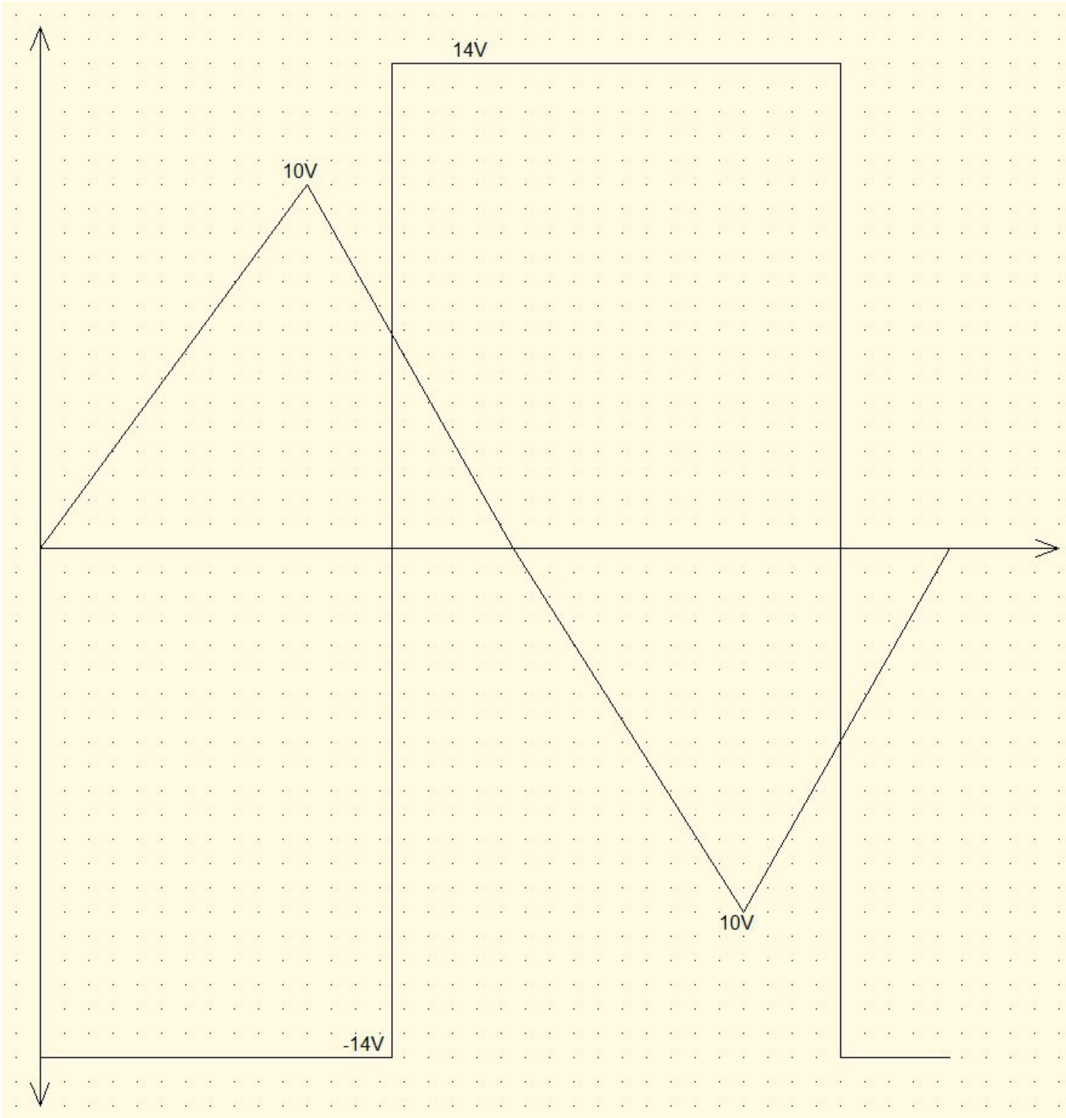




8. Sketch the output curve given the input curve shown below and the following:

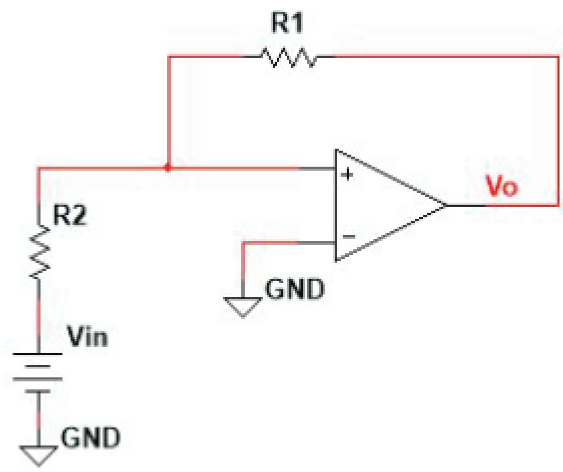
$$R_1 = 8.2k\Omega \tag{8}$$
$$R_2 = 4.6k\Omega$$
$$V_{O(SAT)} = \pm 14V$$

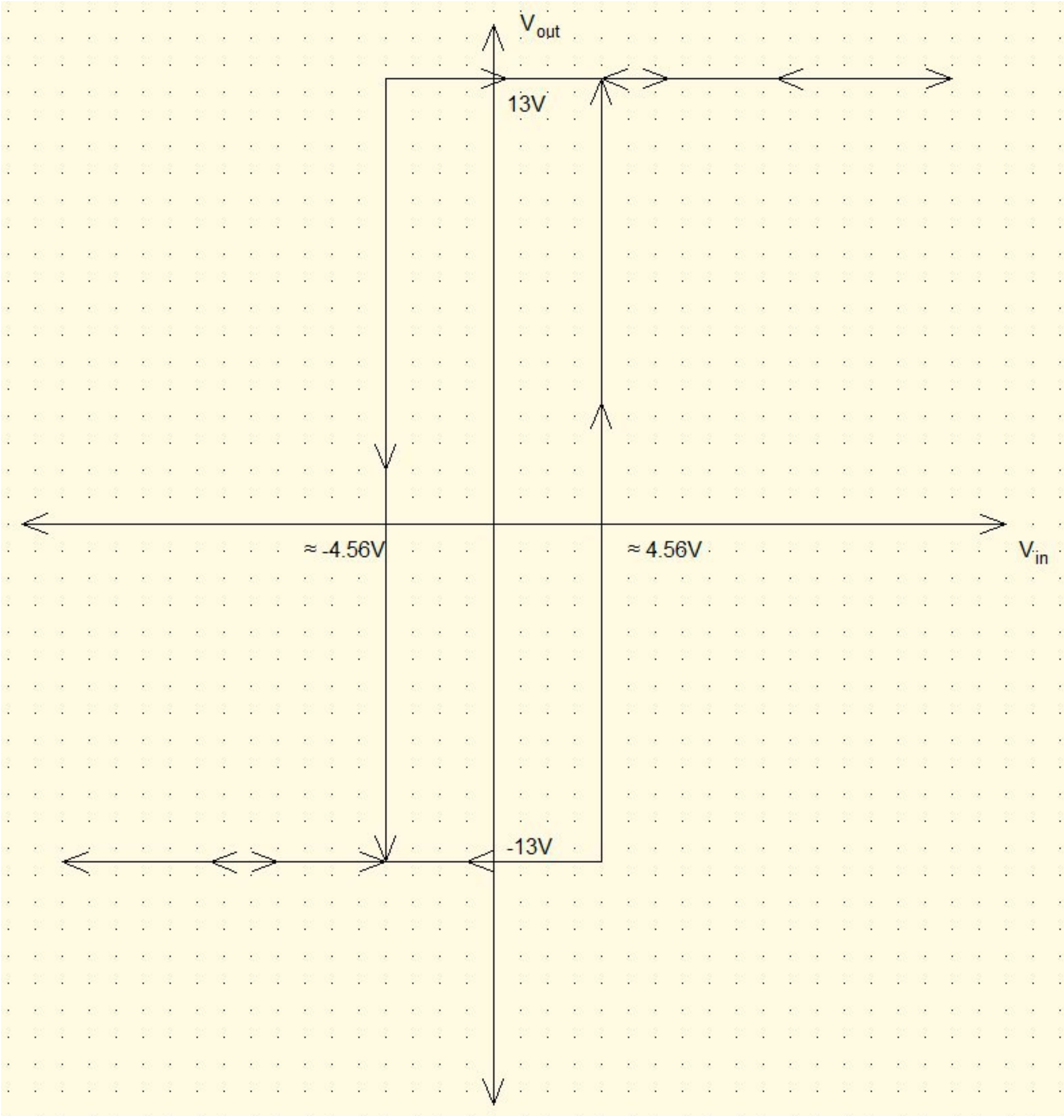




9. Sketch the input-output characteristic curve given the image below and the following:

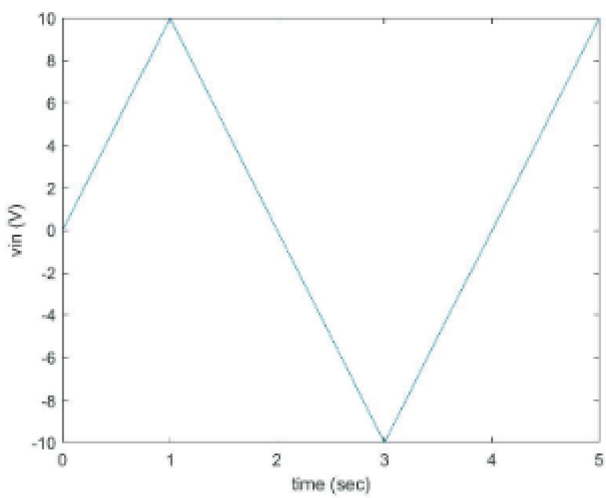
$$\begin{aligned} R_1 &= 9.4k\Omega \\ R_2 &= 3.3k\Omega \\ V_{O(SAT)} &= \pm 13V \end{aligned} \tag{9}$$

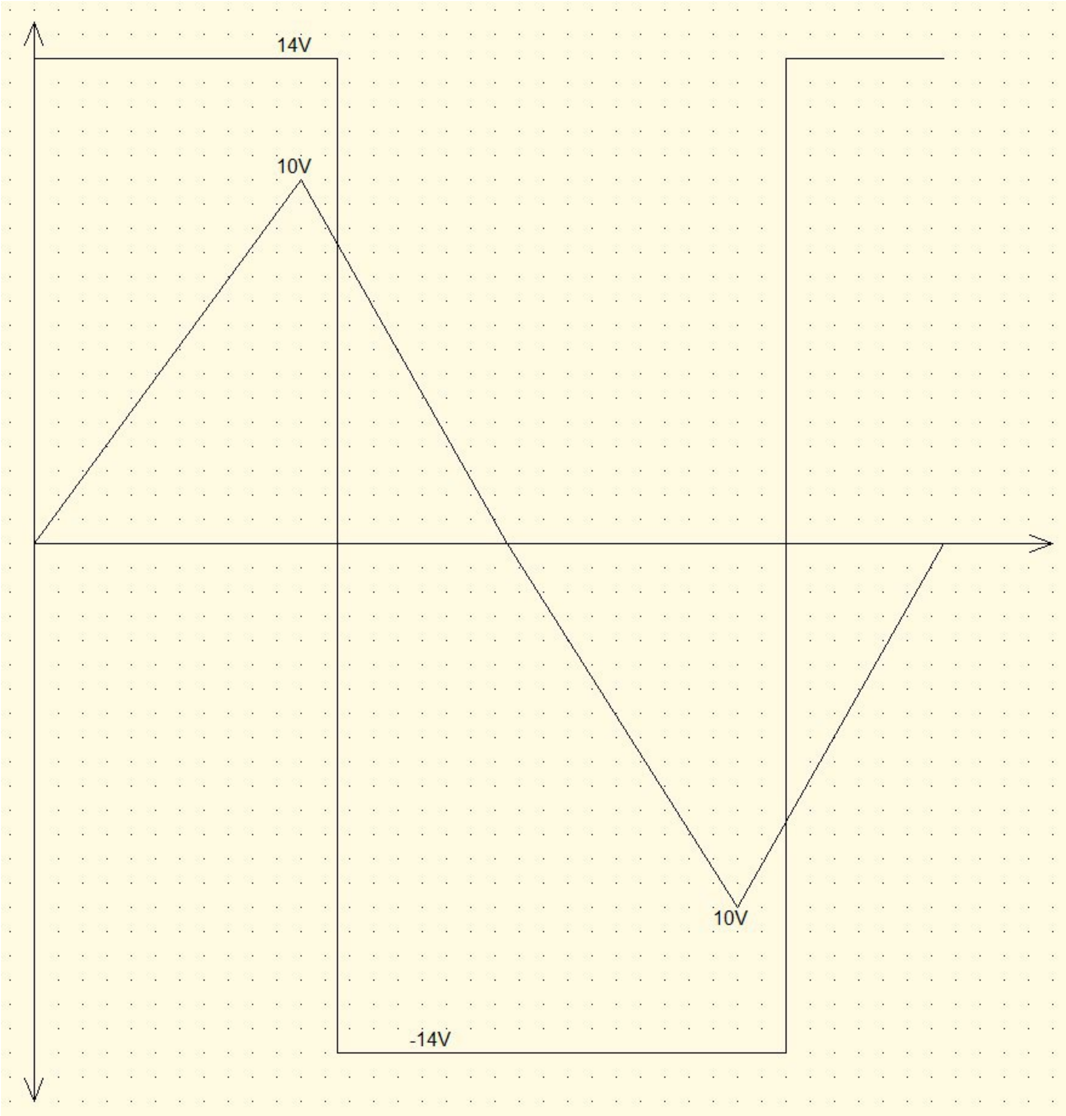




10. Sketch the output curve given the input curve below and the following:

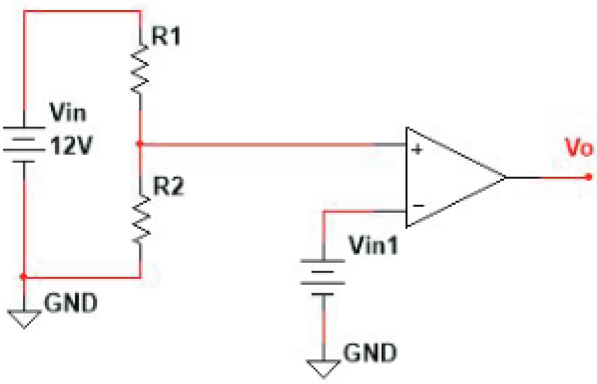
$$
\begin{aligned}
R_1 &= 9.0k\Omega \\
R_2 &= 4.9k\Omega \\
V_{O(SAT)} &= \pm 13V
\end{aligned}
\tag{10}
$$

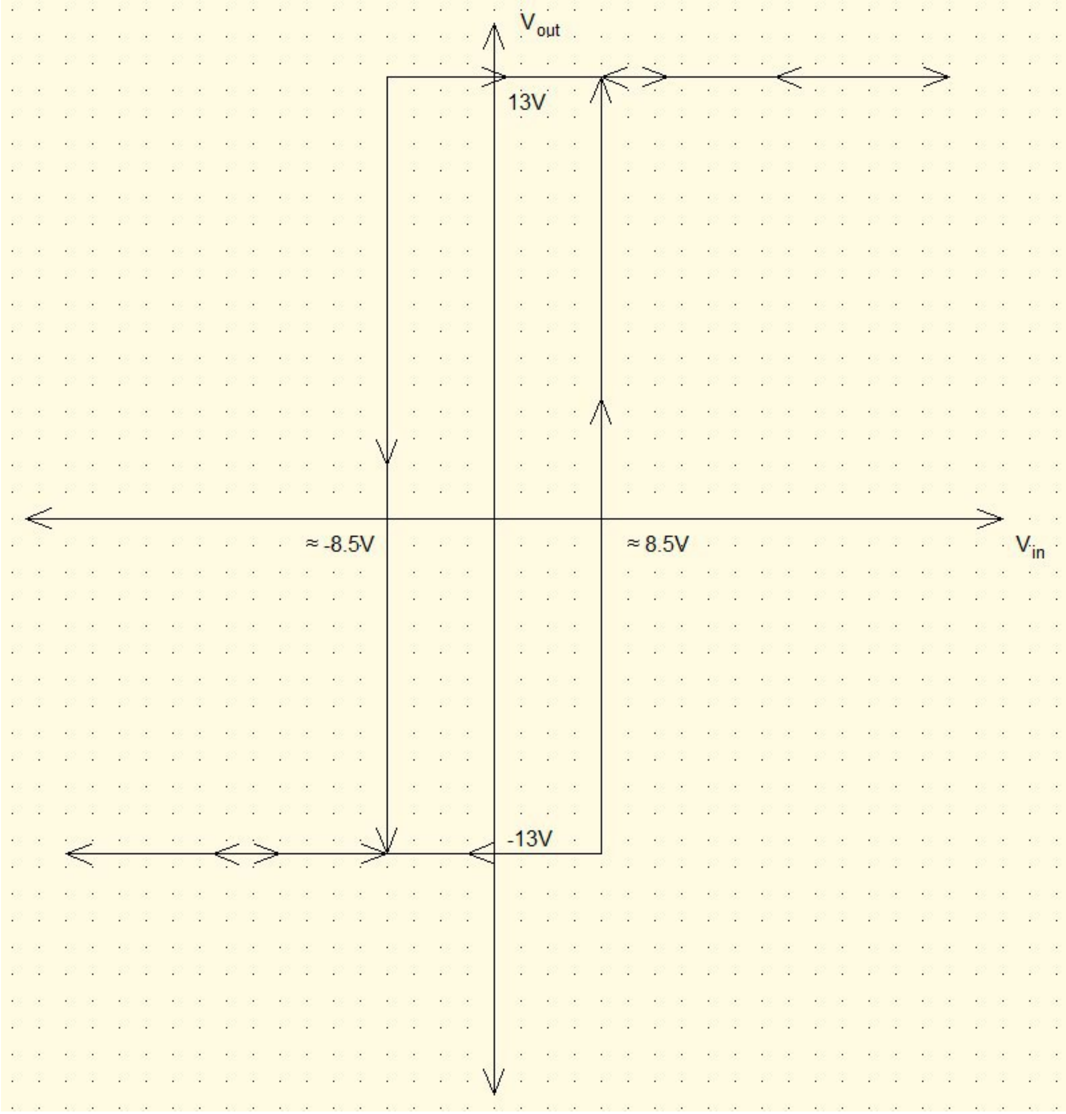




11. Sketch the input-output characteristic curve given the below image and the following:

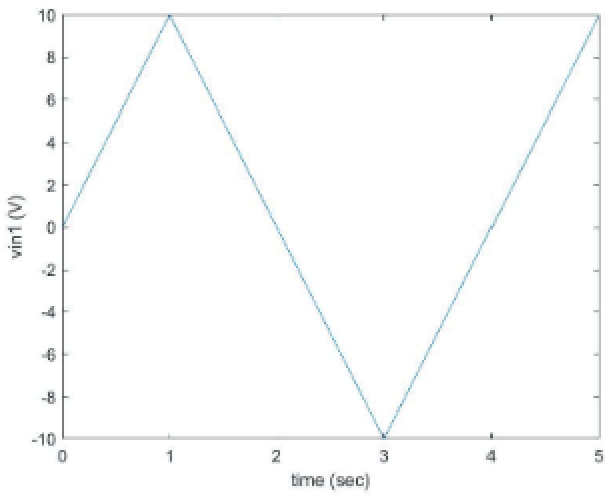
$$\begin{aligned} R_1 &= 9.6k\Omega \\ R_2 &= 3.9k\Omega \\ V_{O(SAT)} &= \pm 13V \end{aligned} \tag{11}$$

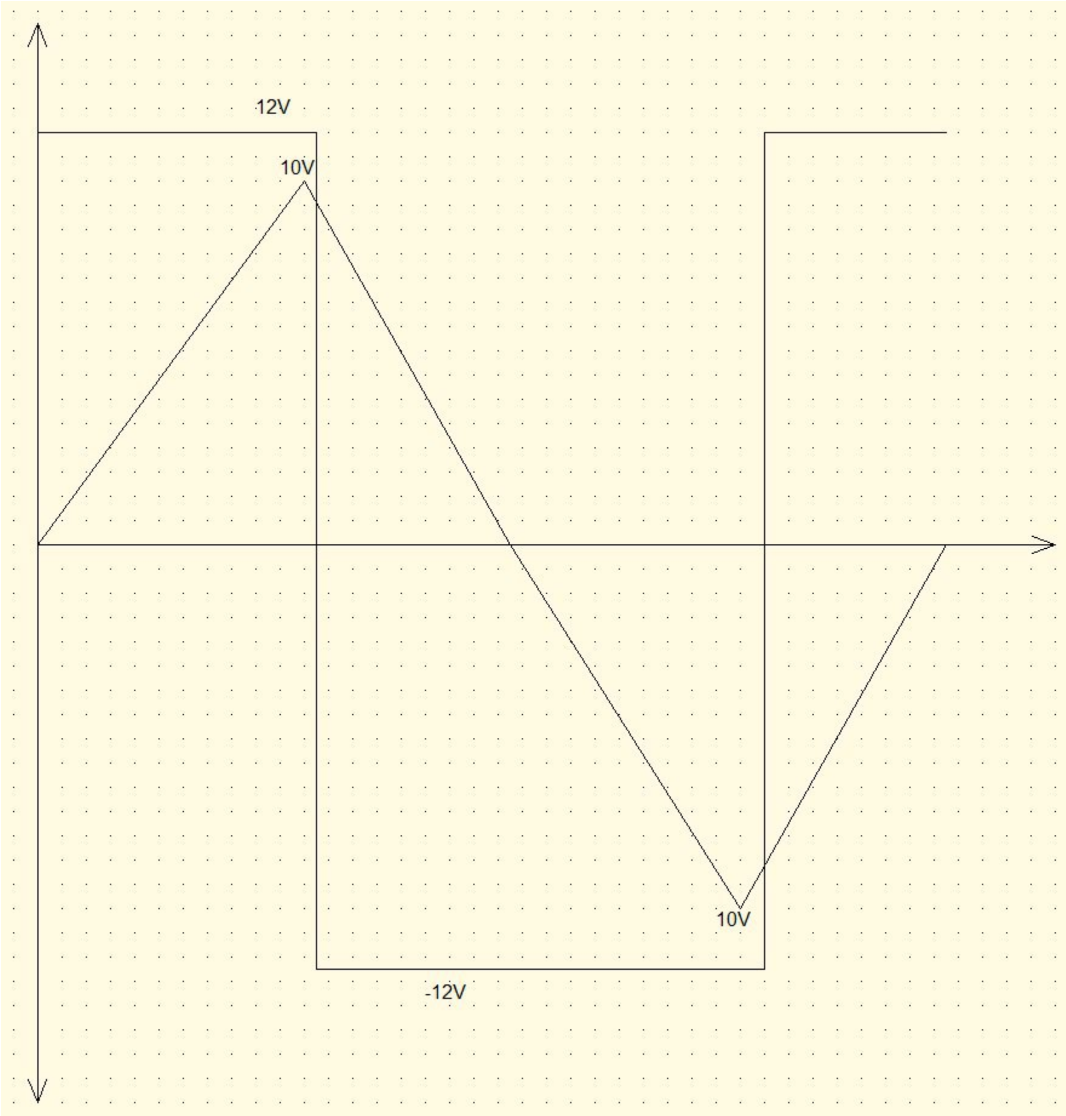




12. Sketch the output curve given the input (V_{in1}) curve and the following:

$$
\begin{aligned}
R_1 &= 9.7k\Omega \\
R_2 &= 3.2k\Omega \\
V_{O(SAT)} &= \pm 12V
\end{aligned} \tag{12}
$$





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

Nothing much in particular, although I may have missed the last couple problems on this exam due to misunderstanding how triggers work.