

Analog Electronics II

Test 2

Op Amp Circuits

Name _____ KEY _____

Demonstrate your Best Professional Work!

- Show ALL Formulas and Calculations to get credit: No work = no credit
- Remember the expected format: Formula, Calculations, Result.
- One 8x11, normal font, formula sheet permitted: no text, no circuitry, no hints. Hand in formula sheet with test.
- Answer ALL parts to ALL questions. REMEMBER ALL EQUIVALENT CIRCUITS!
- Show and label ALL signals, values, units, and important attributes on all plots.
- Desktop clear except for writing implements, eraser, small ruler. No electronic devices are allowed other than a calculator - includes i-devices, desktop computers, MP3 players, and phones.

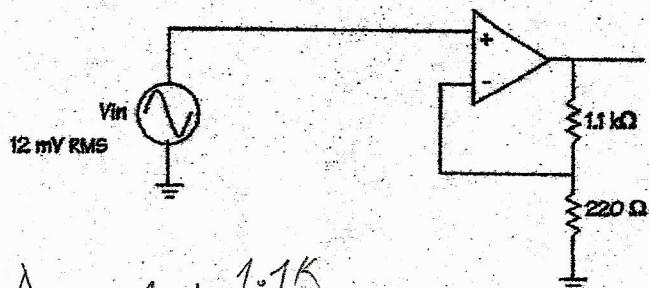
Fall, 2015
R. Medykiewicz

1	8
2	8
3	4
4	4
5	4
6	4
7	4
8	4

9	4
10	4
11	4
12	8
13	10
14	10
15	10
16	8

$\sum = 98 \text{ pts} \rightarrow \text{cooper BASE}$

Find the indicated values for the amplifier circuit.



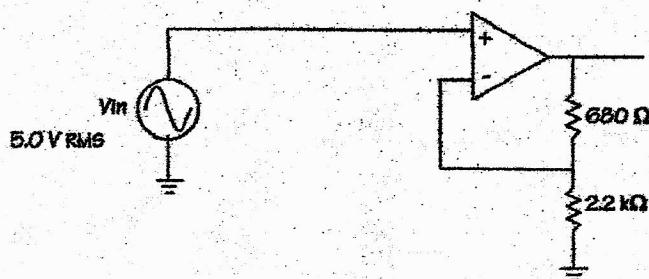
$$A_V = 1 + \frac{1.1K}{220\Omega}$$

$$= 6$$

$$V_{out} = 12 \text{ mV RMS} * A_V = 72 \text{ mV RMS}$$

$$Av \quad \underline{\underline{6}}$$

$$v_{out} \quad \underline{\underline{72 \text{ mV RMS}}}$$



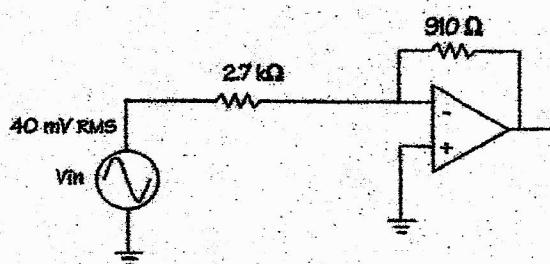
$$A_V = 1 + \frac{680}{2.2k} = 1.31$$

$$V_{out} = 5 \text{ V RMS} * 1.31 = 6.54 \text{ V RMS}$$

$$Av \quad \underline{\underline{1.31}}$$

$$v_{out} \quad \underline{\underline{6.54 \text{ V RMS}}}$$

Find the indicated values for the amplifier circuit.

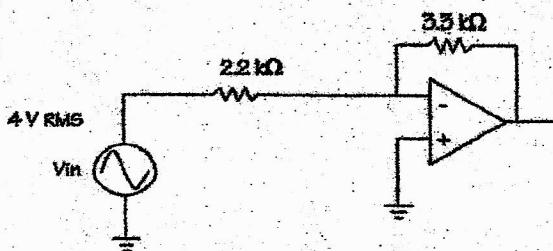


$$A_V = - \frac{910}{2.7k} = - .337$$

$$V_{out} = 40mVRMS * - .337 = 13mV RMS$$

$$AV = - .337$$

$$V_{out} = 13mV RMS$$



$$A_V = - \frac{3.3k\Omega}{2.2k\Omega} = 1.5$$

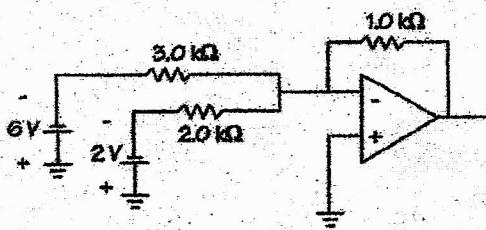
$$V_{out} = 4V RMS * - 1.5 = -6V RMS$$

$$AV = - 1.5$$

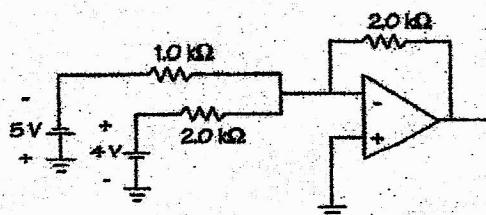
$$V_{out} = -6V RMS$$

Find the indicated values for the amplifier circuit.

$$V_{out} = - \left(\frac{-6V}{3k} + \frac{-2V}{2k} \right) * 1k = \left(\frac{6}{3} + \frac{2}{2} \right) = (2+1) = 3V$$



$$V_{out} = -3V$$



$$V_{out} = 6V$$

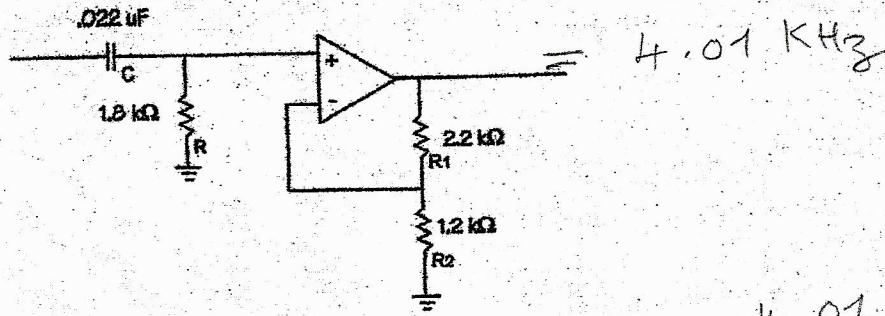
$$V_{out} = - \left(\frac{-5}{1k} + \frac{4}{2k} \right) * 2k$$

$$= \left(\frac{5*2k}{1k} - \frac{4*2k}{2k} \right) = 10 - 4$$

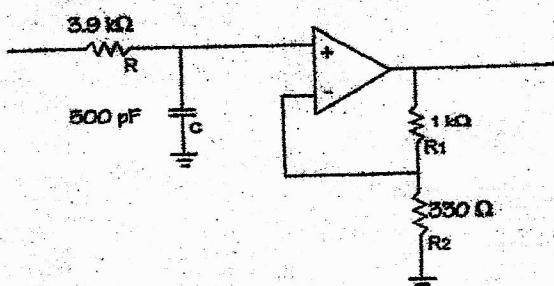
$$= 6V$$

Find the indicated values for the active filter.

$$f_c = \frac{1}{2\pi RC} = 1 / (2\pi * 1.8k * .022 * 10^{-6})$$



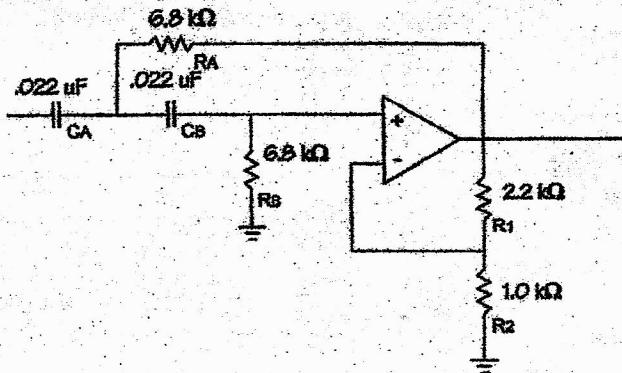
$$f_c = 4.01 \text{ kHz}$$



$$f_c = 81.61 \text{ kHz}$$

$$f_c = 1 / (2\pi * 3.9k * 500 * 10^{-12})$$
$$= 81.61 \text{ kHz}$$

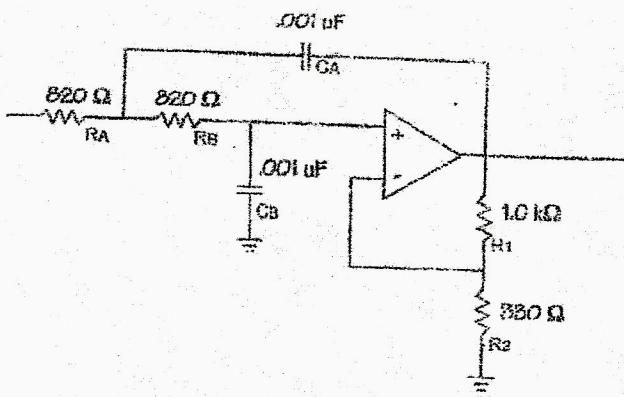
Find the indicated values for the active filter.



$$\begin{aligned}f_c &= \left(2\pi * \sqrt{6.8 \text{ k} * 6.8 \text{ k} * 0.022 \mu\text{F} * 0.022 \mu\text{F}} \right)^{-1} \\&= \left(2\pi * 6.8 \text{ k} * 0.022 \mu\text{F} \right)^{-1} \\&= \left(2\pi * 6800 * 0.022 * 10^{-6} \right)^{-1} \\&= 1.06 \text{ kHz}\end{aligned}$$

f_c 1.06 kHz

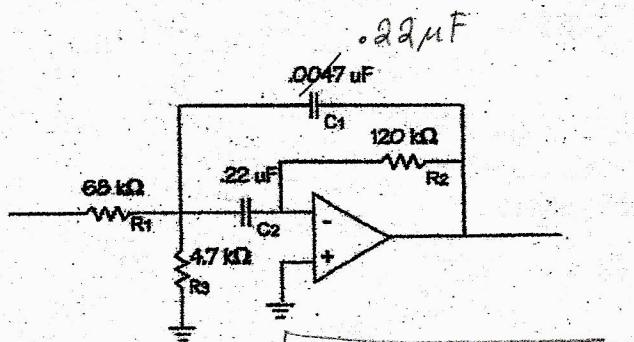
Find the indicated values for the active filter.



$$f_e = \left(2\pi * \sqrt{820 + 820 * .001\mu F * .001\mu F} \right)^{-1}$$
$$= \left(2\pi * 820 * .001 * 10^6 \right)^{-1}$$
$$= 194.09 \text{ kHz}$$

f_c 194.09 kHz

Find the indicated values for the active filter.

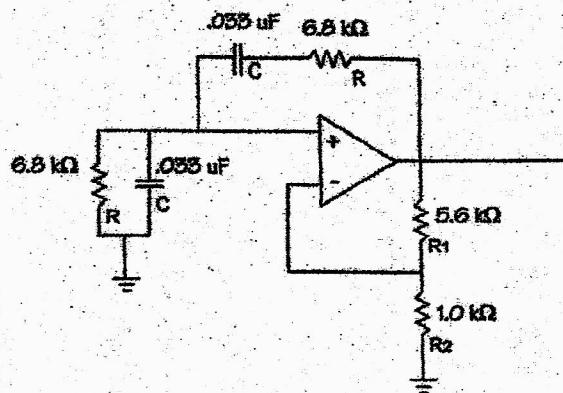


$$f_c = \frac{1}{2\pi \times 0.22 \times 10^6} \quad \frac{6.8k + 4.7k}{6.8k \times 4.7k \times 120k}$$

$$= 39.61 \text{ Hz}$$

$$f_c = \underline{\underline{39.61 \text{ Hz}}}$$

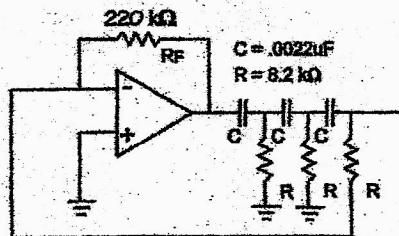
Find the indicated value for the oscillator.



$$f = 1 / (2\pi \times 6.8 \text{ k} \times 0.033 \times 10^{-6})$$
$$= 709 \text{ Hz}$$

709 Hz

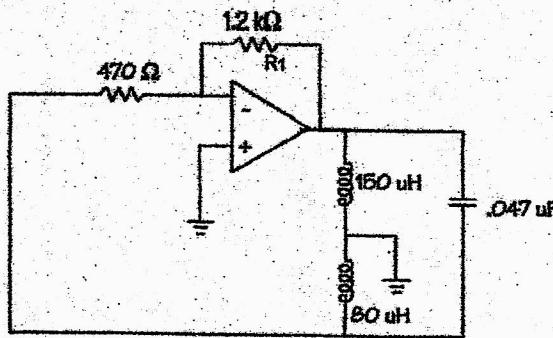
Find the indicated value for the oscillator.



$$f = 1/(2 \pi \sqrt{6} * 8.2k * .0022 * 10^{-6})$$
$$= 3.6 \text{ KHz}$$

3.6 KHz

Find the indicated value for the oscillator.

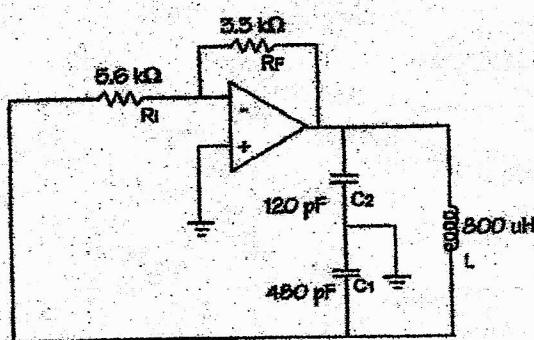


$$f = \frac{1}{2\pi \sqrt{(150 + 80) * 10^{-6} * 0.047 * 10^{-6}}}$$

$$= 48.4 \text{ kHz}$$

$$\underline{48.4 \text{ kHz}}$$

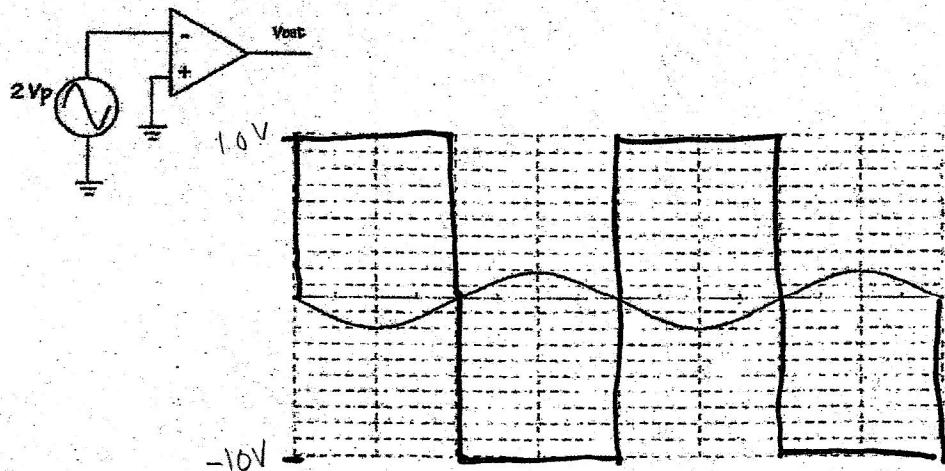
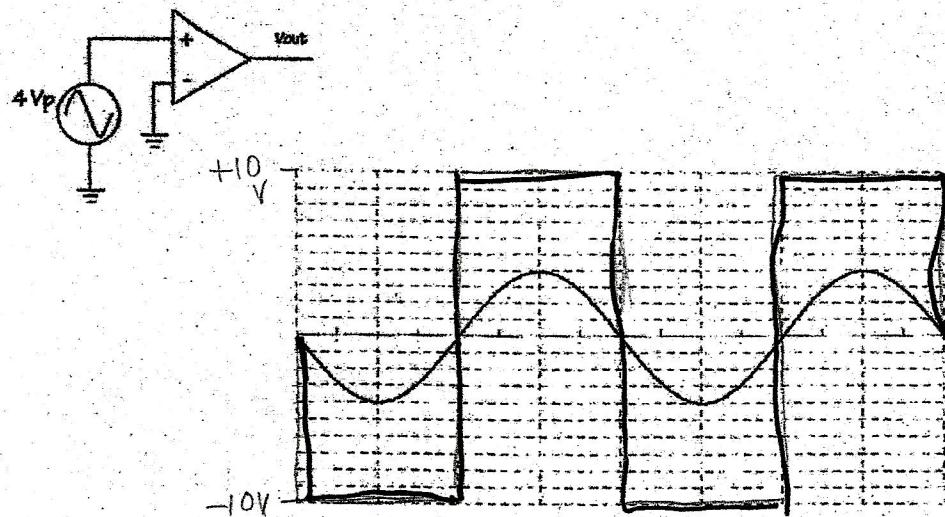
Find the indicated value for the oscillator.



$$f = 1 / (2\pi \sqrt{800 * 10^6 * \left(\frac{(120 * 10^{12} * 480 * 10^{12})}{(120 + 480) * 10^{12}} \right)})$$
$$= 1 / (2\pi \sqrt{\frac{800 * 120 * 480 * 10^{18}}{(120 + 480)}})$$
$$= 574.3 \text{ KHz}$$

574.3 KHz

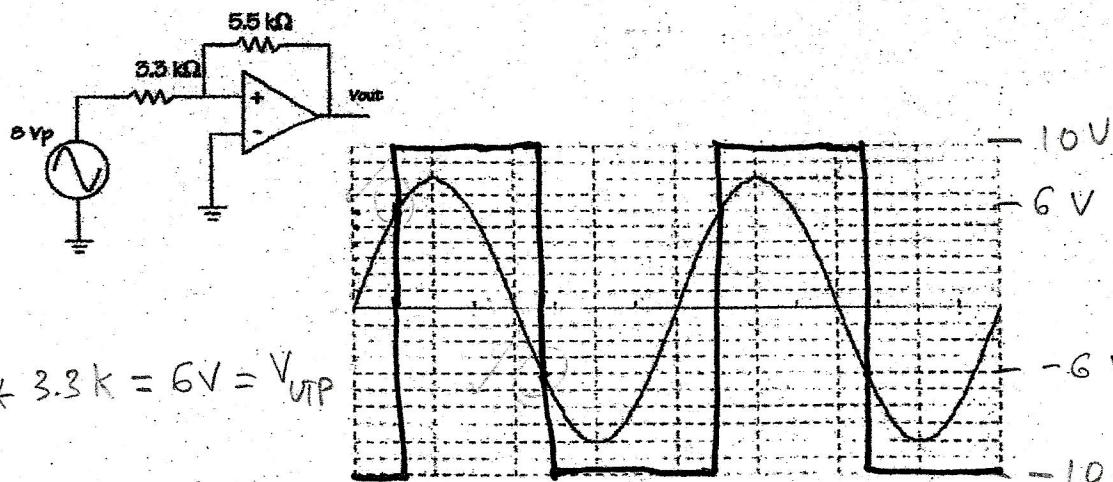
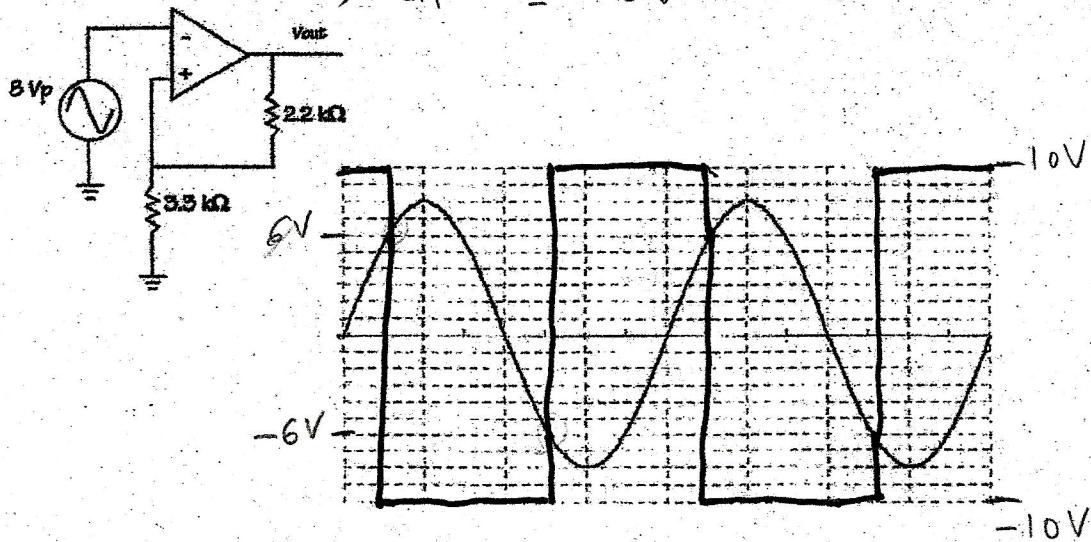
Assume a split supply voltage of $\pm 10V$, and assume $V_{sat} = V_{CC} = 10V$. Sketch v_{out} along with the graph of v_{in} .



Assume a split supply voltage of +/- 10V, and assume $V_{sat} = V_{cc} = 10V$. Sketch v_{out} along with the graph of v_{in} . Label the trip points.

$$V_{UTP} = 10V * \left(\frac{3.3k}{2.2 + 3.3} \right) = 6V$$

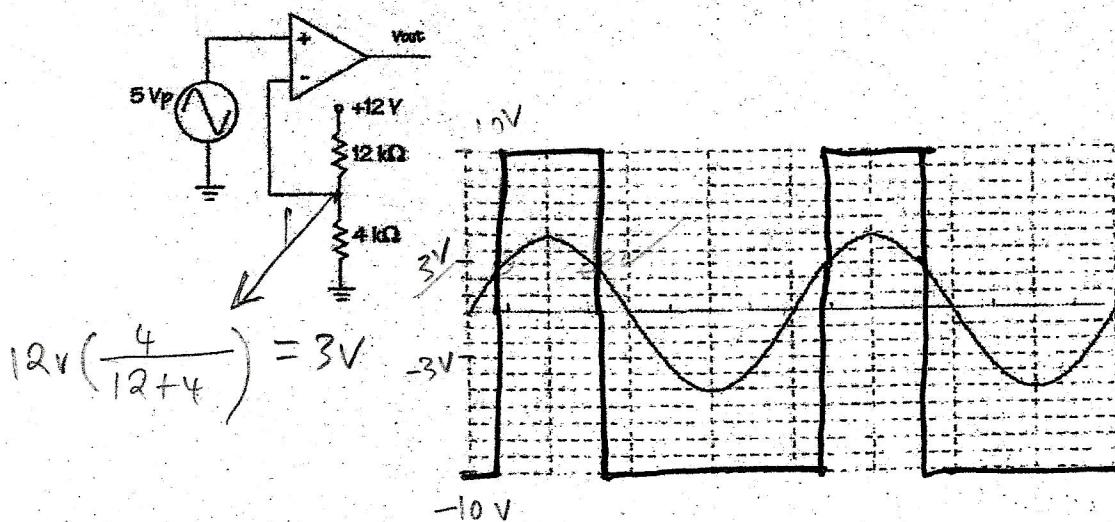
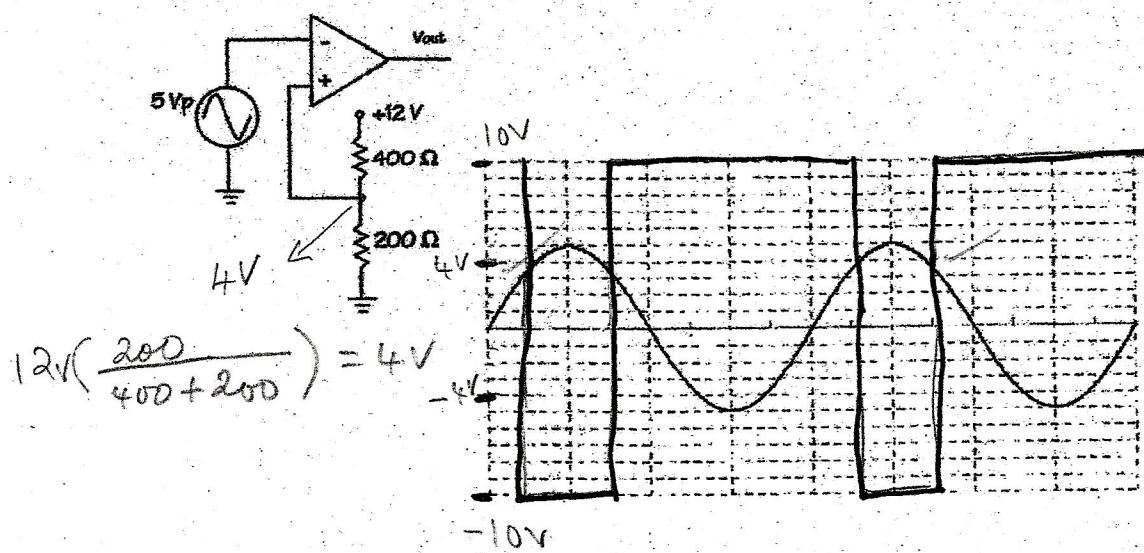
$$\Rightarrow V_{LTP} = -6V$$



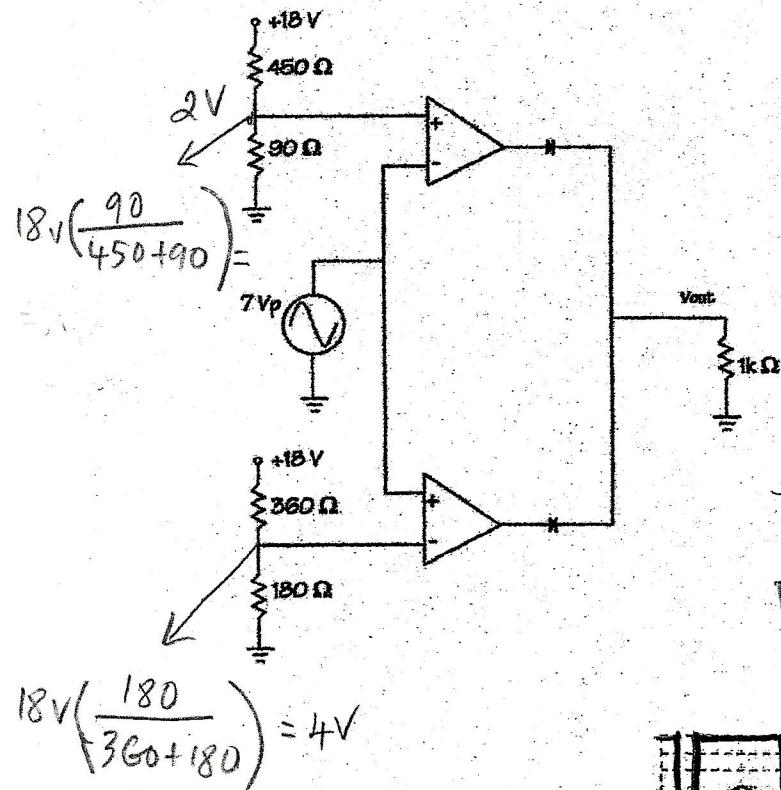
$$\left(\frac{10V}{5.5k} \right) * 3.3k = 6V = V_{UTP}$$

$$\Rightarrow V_{LTP} = -6V$$

Assume a split supply voltage of +/- 10V, and assume $V_{sat} = V_{cc} = 10V$. Sketch v_{out} along with the graph of v_{in} . Label the trip points.

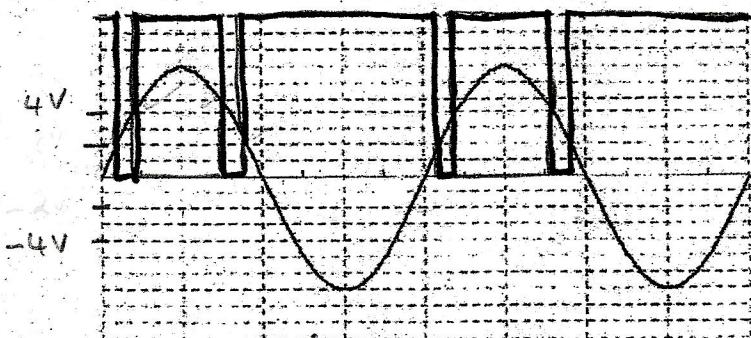


Assume a split supply voltage of +/- 10V, and assume $V_{sat} = V_{cc} = 10V$. Sketch v_{out} along with the graph of v_{in} . Label the trip points.

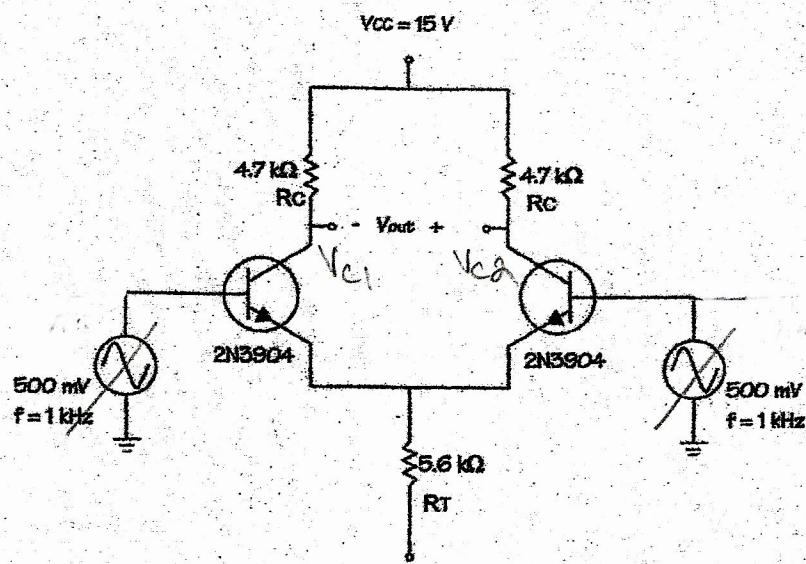


Trip points at 2V and 4V

Diodes prevent negative half-cycles



Find the indicated values.



Assume both bases are grounded, the components are the same

$$I_T = \underline{2.55 \text{ mA}}$$

$$V_E = -0.7 \text{ V}$$

$$I_C = \underline{1.27 \text{ mA}}$$

$$\Rightarrow V_{RT} = -0.7 \text{ V} - (-15 \text{ V}) = 14.3 \text{ V}$$

$$V_C = \underline{8.99 \text{ V}}$$

$$\Rightarrow I_T = 14.3 \text{ V} / R_T = 14.3 \text{ V} / 5600 \\ = 2.55 \text{ mA}$$

$$V_{out} = \underline{0 \text{ V}}$$

$$\Rightarrow I_C = I_T / 2 = 1.27 \text{ mA}$$

$$\Rightarrow V_C = V_{CC} - (I_C * R_C) = 15 - (1.27 \text{ mA} * 4.7 \text{ k}) \\ = 8.99 \text{ V} \text{ in both collectors}$$

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$$\Rightarrow V_{out} = (V_{C1} - V_{C2}) = (8.99 - 8.99) = 0$$

(+8)