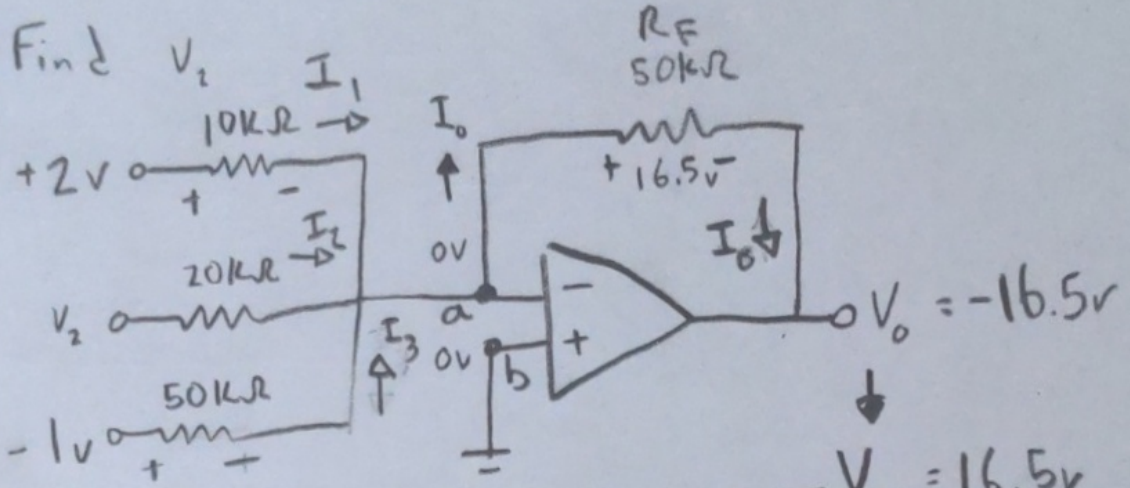
Chris Hunt Homework 9 ENGR 201

9.1) Find V_2



$$I_o = \frac{16.5v}{50k\Omega} = .33mA$$

@a) $I_o = I_1 + I_2 + I_3$

$$.33mA = \frac{2v}{10k\Omega} + \frac{-1v}{50k\Omega} + \frac{V_2}{20k\Omega}$$

$$-\frac{2v}{10k\Omega} + \frac{1v}{50k\Omega}$$

$$\left(\frac{V_2}{20k\Omega} = 1.5 \times 10^{-4} A\right) 20k\Omega$$

$$\boxed{V_2 = 3v}$$

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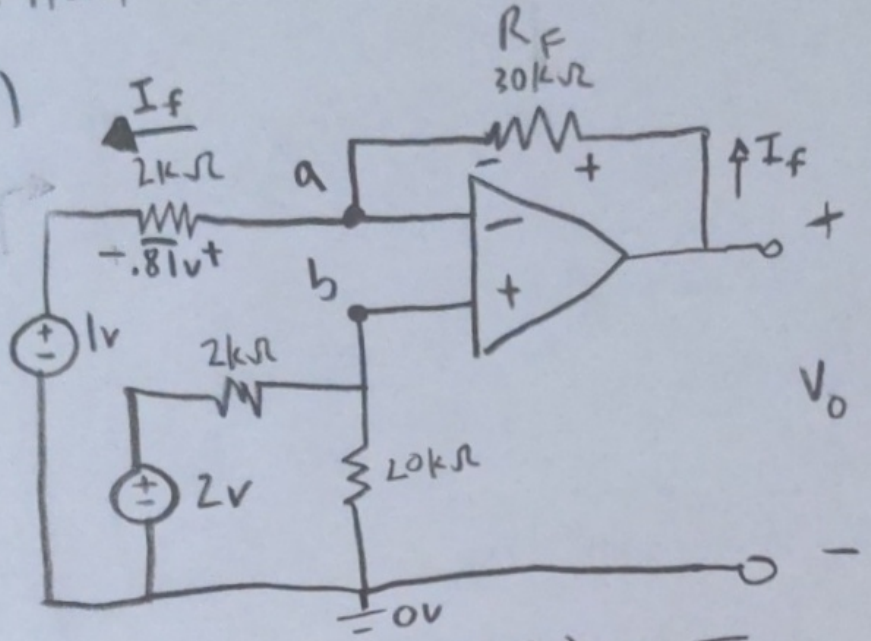
9.21)



$$V_a = V_b = 2v\left(\frac{20k\Omega}{22k\Omega}\right) = 1.\overline{81}v$$

$$I_F = \frac{.\overline{81}v}{2k\Omega} = .41mA$$

$$V_{R_F} = 30k\Omega \cdot .41mA$$

$$V_{R_f} = 12.3v$$

$$V_o = V_a + V_{R_f}$$

$$V_o = 1.\overline{81}v + 12.3v$$

$$\boxed{V_o = 14.12v}$$

or $V_o = 2v\left(\frac{20k\Omega}{22k\Omega}\right)\left(\frac{32k\Omega}{2k\Omega}\right) - 1v\left(\frac{30k\Omega}{2k\Omega}\right)$

$$\boxed{V_o = 14.09_v}$$

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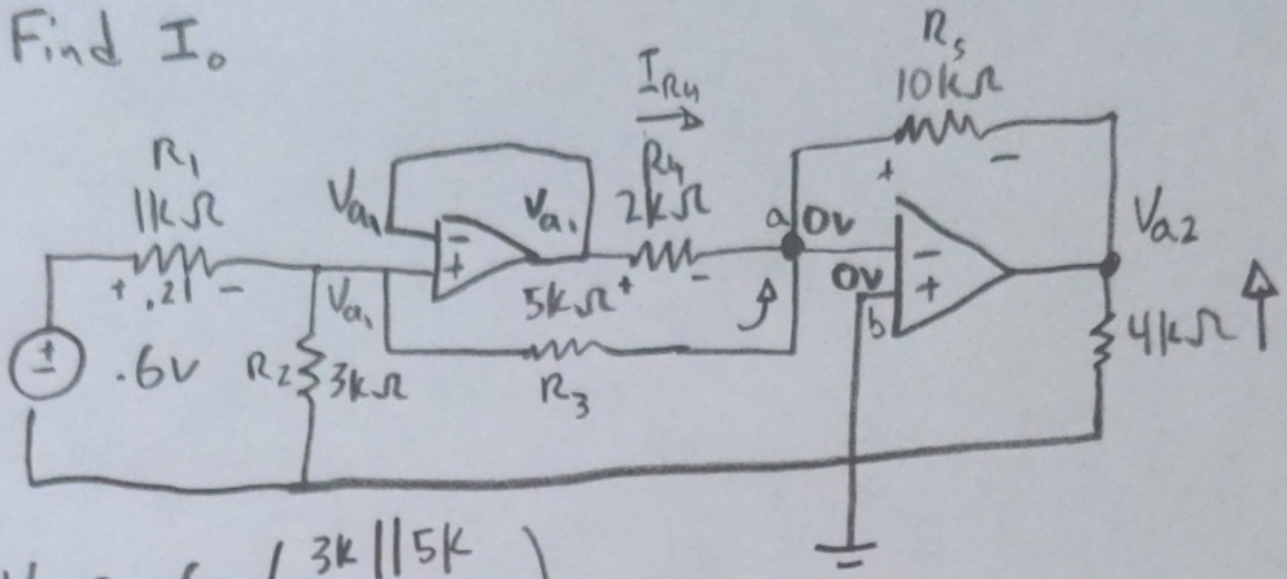
9.3) Find I_o



$$V_{a1} = .6v\left(\frac{3k \,||\, 5k}{1k + 3k \,||\, 5k}\right)$$

$V_{a1} = .39v \qquad V_{R4} = .39v \qquad I_{R4} = \frac{.39v}{2k\Omega} = .195mA$

$$I_{R1} = \frac{.21v}{1k\Omega} = .21mA$$

$$I_{R3} = .21mA\left(\frac{3k\Omega}{8k\Omega}\right) = .0788mA$$

$I_{R5} = I_{R4} + I_{R3} \rightarrow I_{R5} = .27375mA \qquad V_{R5} = 2.738V$

$$V_{a2} = 0v - V_{R5} = -2.738V$$

$$i_o = \frac{0 - V_{a2}}{4k\Omega} \rightarrow \frac{2.738V}{4k\Omega}$$

$$\boxed{i_o = .6845mA}$$

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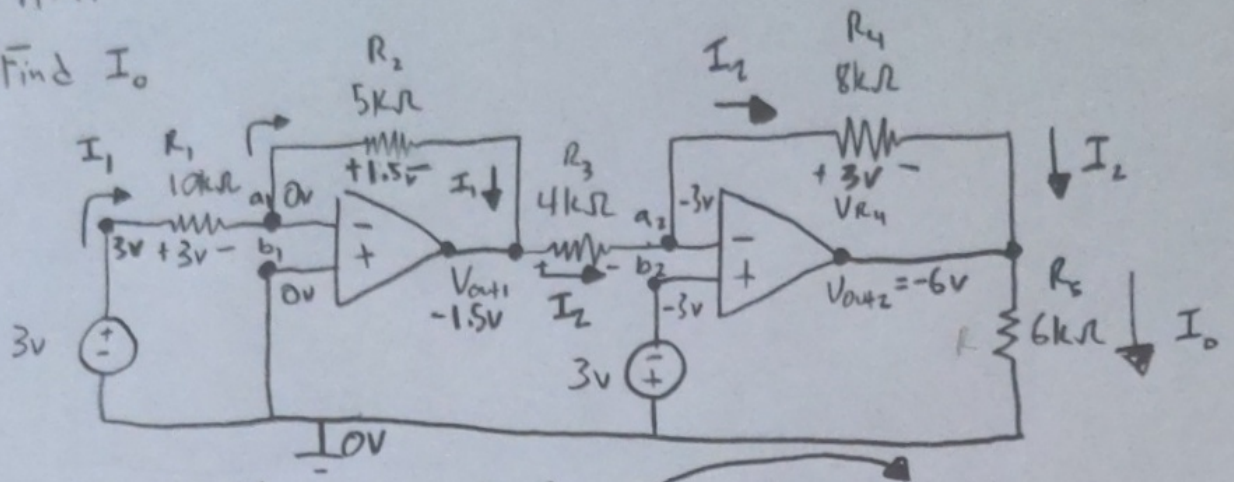
9.4) Find I_o



$$I_1 = \frac{3v - V_{a1}}{10K\Omega} \qquad V_{R_2} = I_1 \cdot R_2 \qquad V_{out1} = V_{a1} - V_{R_2}$$

$$I_1 = \frac{3v}{10K\Omega} \rightarrow \boxed{I_1 = .3\ mA} \qquad V_{out1} = 0v - (.3mA \cdot 5k\Omega)$$

$$\boxed{V_{out1} = -1.5v}$$

$$V_{R_3} = V_{out1} - V_{a2}$$

$$V_{R_3} = -1.5v - (-3v)$$

$$V_{R_3} = 1.5v \rightarrow \boxed{I_2 = \frac{V_{R_3}}{R_3} = .375mA}$$

$$V_{R_4} = I_2 \cdot R_4 \rightarrow V_{R_4} = .375mA \cdot 8k\Omega \rightarrow V_{R_4} = 3v$$

$$V_{out2} = V_{a2} - V_{R4} \rightarrow V_{out2} = -3v - 3v \rightarrow V_{out2} = -6v$$

$$I_o = \frac{V_{out2} - 0}{R_5} \rightarrow I_o = \frac{-6v}{6k\Omega} \rightarrow \boxed{I_o = -1mA}$$

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9.5) Design an Op Amp circuit that performs this Function $V_o = 3V_1 - 5V_2$

Create a difference amplifier

$$V_o = \frac{R_2(1+R_1/R_2)}{R_1(1+R_3/R_4)} V_2 - \frac{R_2}{R_1} V_1$$

$$\frac{R_2(1+R_1/R_2)}{R_1(1+R_3/R_4)} = 3 \quad \text{and} \quad \frac{R_2}{R_1} = 5 \rightarrow R_2 = 5R_1$$

$$\frac{5R_1(1+R_1/R_2)}{R_1(1+R_3/R_4)} = 3 \rightarrow 5\left(\frac{1+R_1/R_2}{1+R_3/R_4}\right) = \frac{3}{5} \rightarrow \frac{1+R_1/R_2}{1+R_3/R_4} = \frac{3}{5}$$

$$\frac{\frac{6}{5}}{(1+R_3/R_4)} = \frac{3}{5} \rightarrow 2 = 1 + \frac{R_3}{R_4} = 1 = \frac{R_3}{R_4} \rightarrow R_3 = R_4$$

$$-1 \quad -1$$