

CASE WESTERN RESERVE UNIVERSITY
Case School of Engineering
Department of Electrical Engineering and Computer Science
ENGR 210. Introduction to Circuits and Instruments (4)

14/20

Quiz No. 7

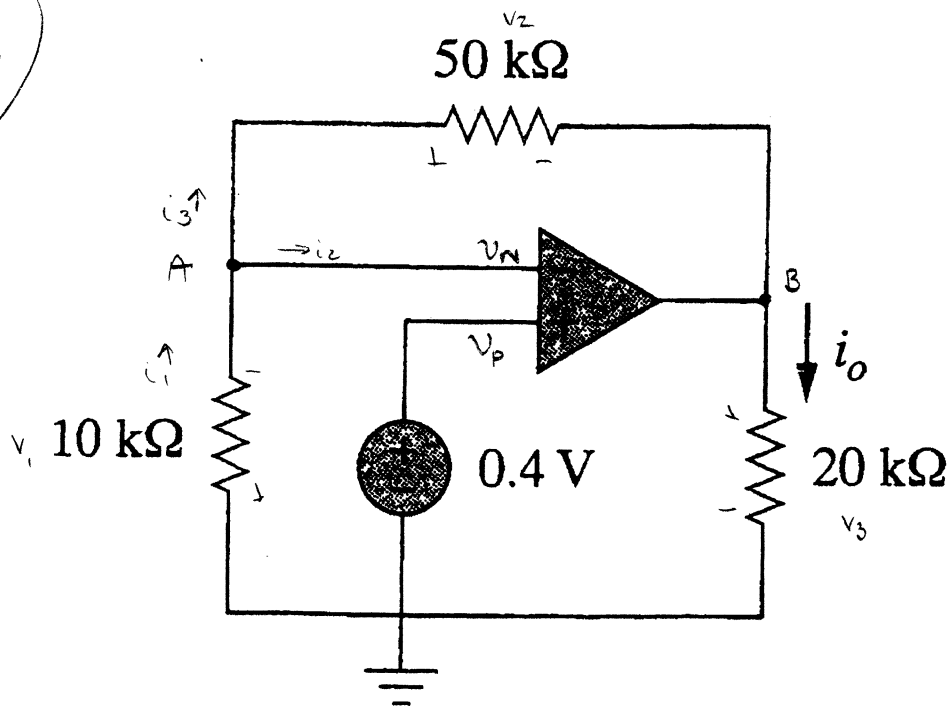
3/4/05

PUT ANSWERS IN THE SPACE PROVIDED AND, IF APPROPRIATE, SHOW YOUR WORK. BE SURE TO STATE ANY ASSUMPTIONS

Problem 1 (10 points)

Determine i_o in the circuit below. $i_o = 1.2 \times 10^{-4} \text{ Amp}$ ✓

10



Inverting $-\frac{R_2}{R_1}$

$$V_p = .4V$$

$$V_n = .4V$$

Since I know the value of $V_n \Rightarrow$ equals value at A
but the current at that pt = 0

$$V_n = V_A = .4V$$

$$i_1 - i_2 - i_3 = 0$$

$$i_1 = i_3$$

$$i_1 = \frac{0 - V_A}{10k\Omega} \Rightarrow \frac{-.4}{10 \times 10^3}$$

$$i_1 = -4 \times 10^{-5} \text{ A}$$

$$i_3 = -4 \times 10^{-5} \text{ Amp}$$

$$i_2 = \frac{V_A - V_B}{50 \times 10^3}$$

$$-4 \times 10^{-5} (50 \times 10^3) = .4 - V_B$$

Since I know the V_B and $R = 20k$

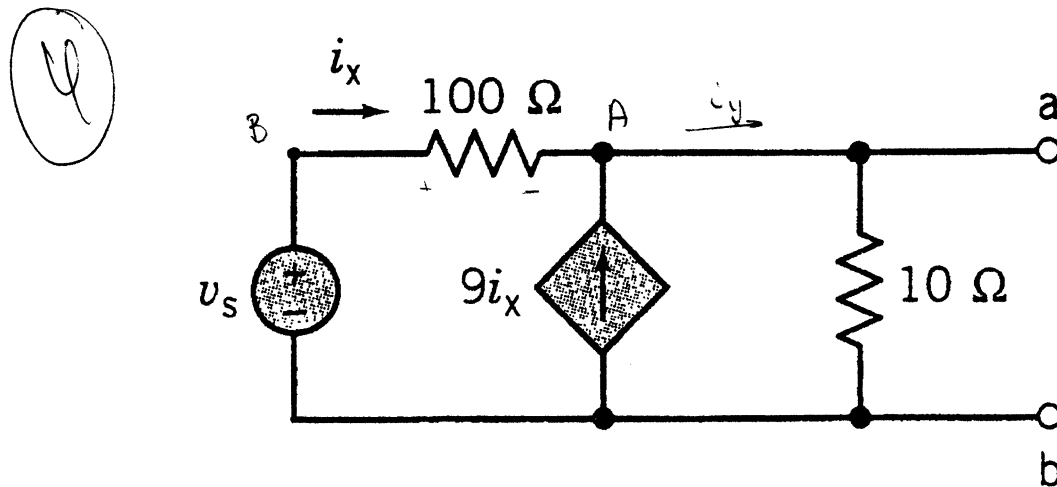
$$V = IR$$

$$I = \frac{V}{R} \Rightarrow \frac{2.4}{20 \times 10^3}$$

$$I = 1.2 \times 10^{-4} \text{ Am}$$

Problem 2 (10 points)

Determine the Thevenin equivalent circuit for the circuit shown below at the output terminals a-b.



$$v_s = v_B$$

$$i_x = \frac{v_B - v_A}{100\Omega} \Rightarrow \frac{v_s - v_A}{100}$$

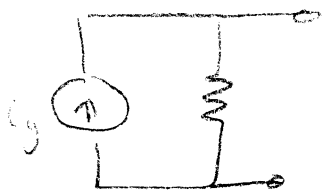
KCL @ Node A

$$i_x + 9i_x - i_y = 0 \Rightarrow i_x + 9i_x = i_y$$

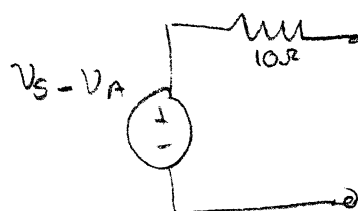
$$10i_x = i_y \Rightarrow 10\left(\frac{v_s - v_A}{100}\right) = i_y$$

Since I know the Current and Resistor is in parallel

I can take the Current (Norton) and turn it to voltage



$$\Rightarrow V = IR \Rightarrow \left(\frac{v_s - v_A}{10}\right)(10) \Rightarrow V = v_s - v_A$$



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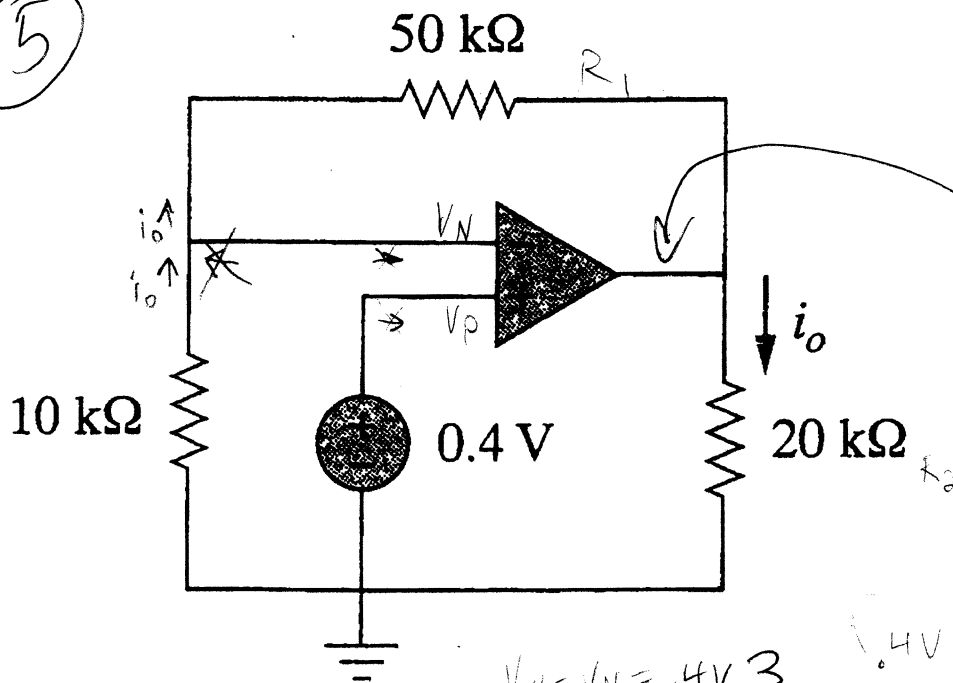
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PUT ANSWERS IN THE SPACE PROVIDED AND, IF APPROPRIATE, SHOW YOUR WORK. BE SURE TO STATE ANY ASSUMPTIONS

Problem 1 (10 points)

Determine i_o in the circuit below. $i_o = \frac{1}{175} \text{ mA} = 5.7 \text{ E-6 A}$

~~5~~ (5)



Handwritten calculations and circuit diagram:

$V_p = V_n = .4 \text{ V}$

$i_o = \frac{.4 \text{ V}}{70 \text{ k}\Omega} = \frac{1}{175} \text{ mA}$

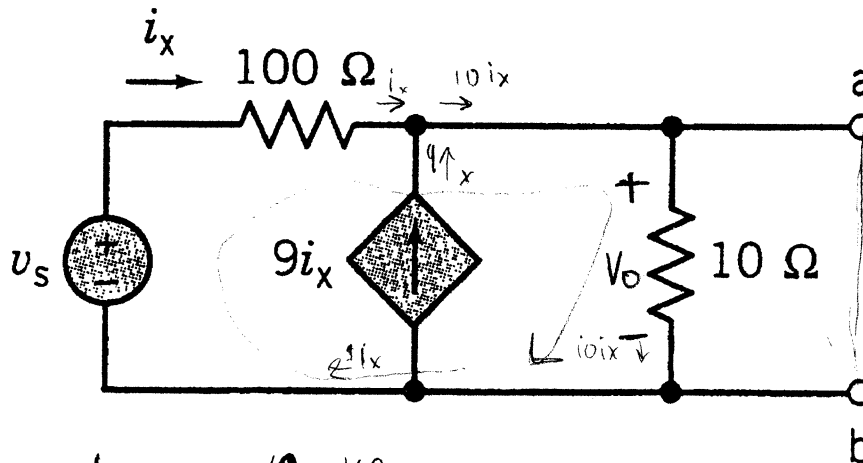
$V_o = \frac{4}{35} \text{ V}$

~~$V_o = \frac{.4 \text{ V} \cdot R_2}{R_1 + R_2}$~~

Problem 2 (10 points)

Determine the Thevenin equivalent circuit for the circuit shown below at the output terminals a-b.

10



$$i_x \cdot 100\Omega + 10i_x \cdot 10\Omega = V_s$$

$$i_x \cdot 200\Omega = V_s$$

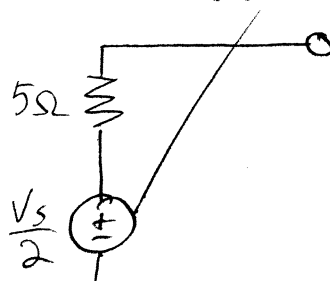
$$V_{ab} = i \cdot R = 10i_x \cdot 10\Omega = \frac{V_s}{2}$$

$$V_T = V_o = V_{ab} = \frac{V_s}{2}$$

$$R_T = \frac{V_T}{i_N} = \frac{\frac{V_s}{2}}{\frac{V_s}{10\Omega}} = \frac{V_s}{2} \cdot \frac{10\Omega}{V_s} = 5\Omega$$

$$R_T = 5\Omega$$

$$V_T = \frac{V_s}{2}$$



$$i_N = 10i_x$$

$$-V_s + i_x \cdot 100\Omega = 0$$

$$i_x = \frac{V_s}{100\Omega}$$

$$i_N = \frac{V_s}{10\Omega}$$

Name: Kevin Engel Section: TA CWRU e-mail: kte1

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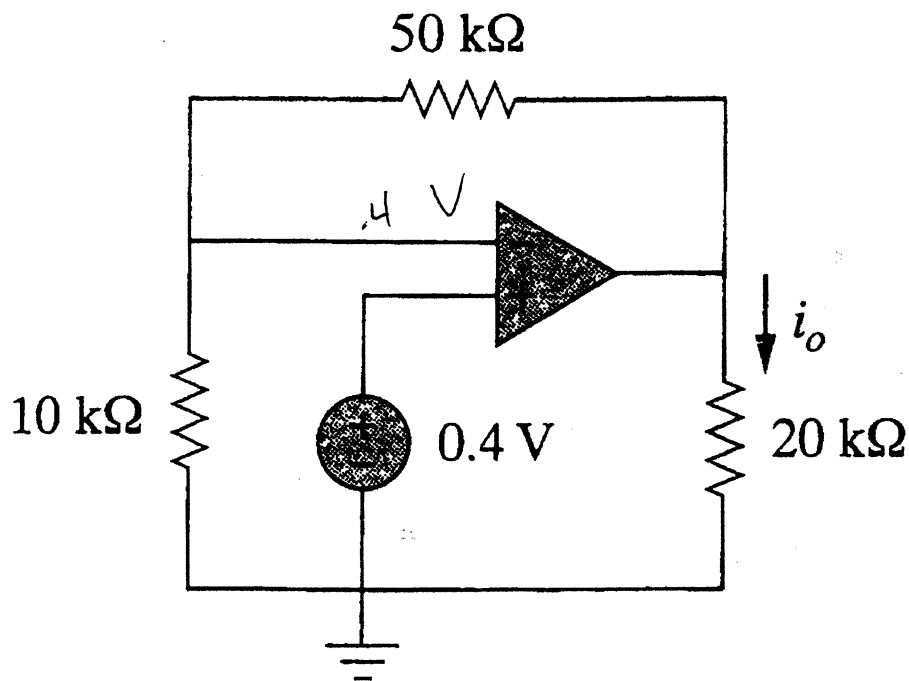
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PUT ANSWERS IN THE SPACE PROVIDED AND, IF APPROPRIATE, SHOW YOUR WORK. BE SURE TO STATE ANY ASSUMPTIONS

Problem 1 (10 points)

Determine i_o in the circuit below. $i_o =$.12 mA

(10)



$$\frac{V_o - .4}{50000} = \frac{.4}{10000}$$

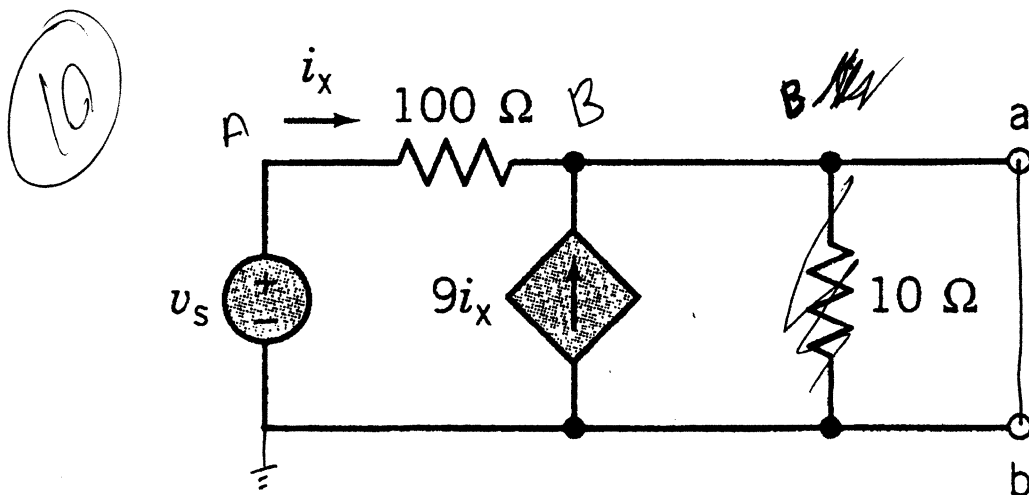
$$V_o = 2.4 \text{ V}$$

$$i_o = \frac{2.4}{20}$$

$$= .12 \text{ mA}$$

Problem 2 (10 points)

Determine the Thevenin equivalent circuit for the circuit shown below at the output terminals a-b.



$$A = V_s$$

$$I_x = \frac{A - B}{100}$$

$$\frac{A - B}{100} + \frac{9A - 9B}{100} = \frac{B}{10}$$

$$V_{oc} = \frac{1}{2} V_s$$

$$.1 V_s = .2 B$$

$$B = \frac{1}{2} V_s$$

$$A = V_s \quad B = 0$$

$$I_x = \frac{V_s}{100}$$

$$I_{sc} = \frac{V_s}{100} + 9 \frac{V_s}{100} = \frac{V_s}{10}$$

$$V = IR$$

$$\frac{V_s}{2} = \frac{V_s}{10} R_T$$

$$R_T = 5$$



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Quiz No. 8

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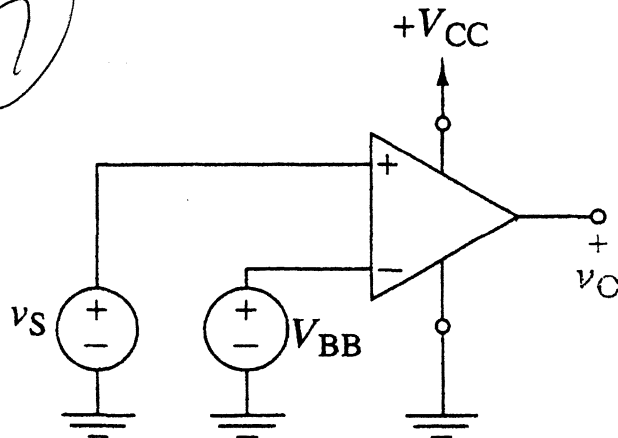
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PUT ANSWERS IN THE SPACE PROVIDED AND, IF APPROPRIATE, SHOW YOUR WORK. BE SURE TO STATE ANY ASSUMPTIONS

Problem 1 Comparators (10 points)

The circuit below has $V_{CC}=+15$ volts and $V_{BB}=+7.5$ volts.

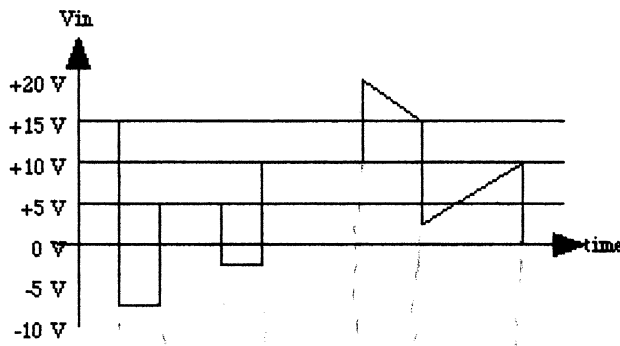
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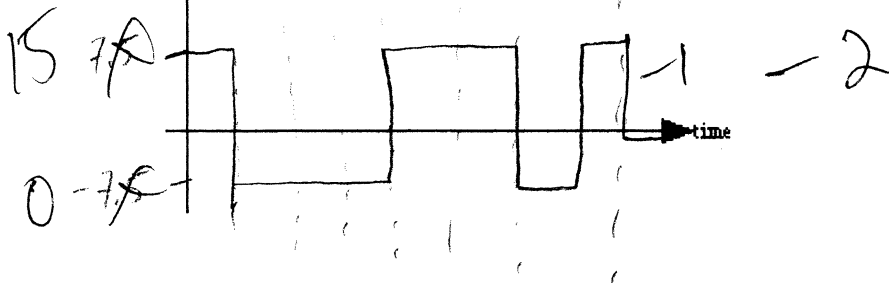
(a) What is the range of possible output voltages v_O ?

0 - 15V

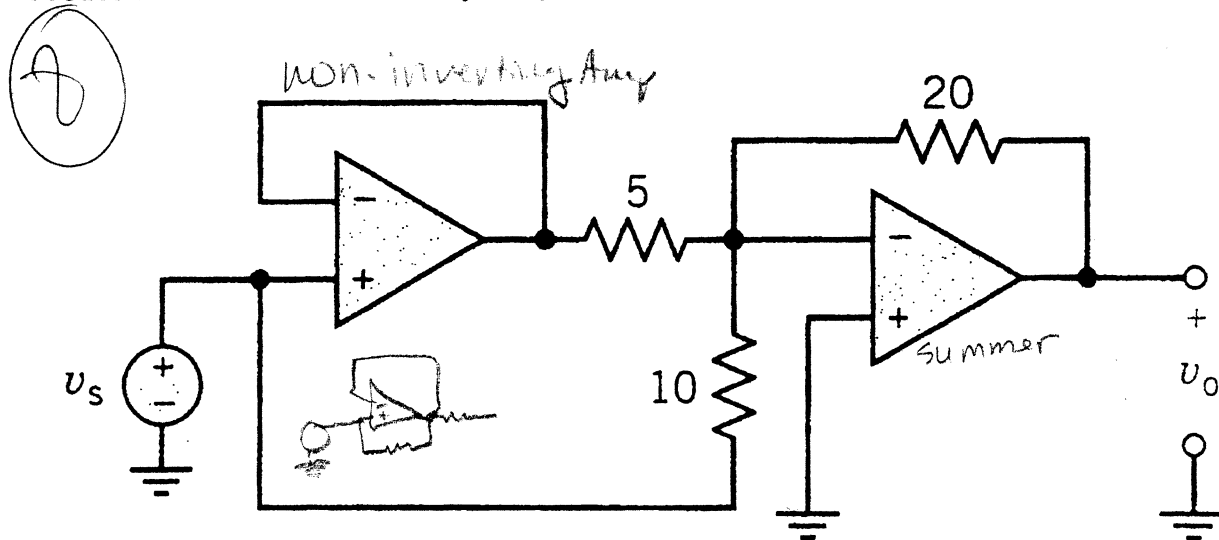
(b) Suppose V_{in} is the waveform below. Sketch the corresponding values of V_o for this circuit. Be sure to label the values of the output voltages and when any voltages change.



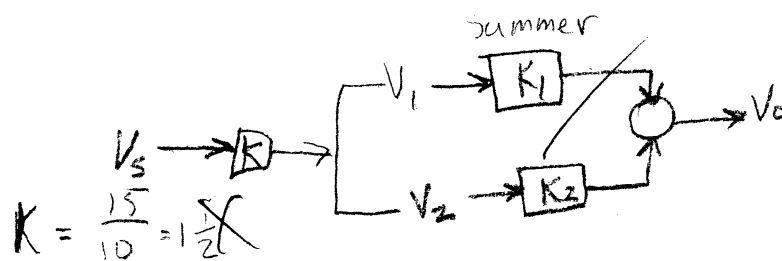
$$V_S = V_{BB} = 7.5V$$



Problem 2 Circuits with Multiple Op-Amps (10 points)



(a) Draw a block diagram of the above circuit showing the function of each OP AMP.



$$K_1 = -\frac{20}{5} = -4$$

$$K_2 = -\frac{20}{10} = -2$$

(b) Determine the output voltage v_o for this circuit.

$$V_o = V_s (K_1 + K_2 + K)$$

$$V_o = -4\frac{1}{2} V_s$$

ENGR 210. Introduction to Circuits and Instruments (4)

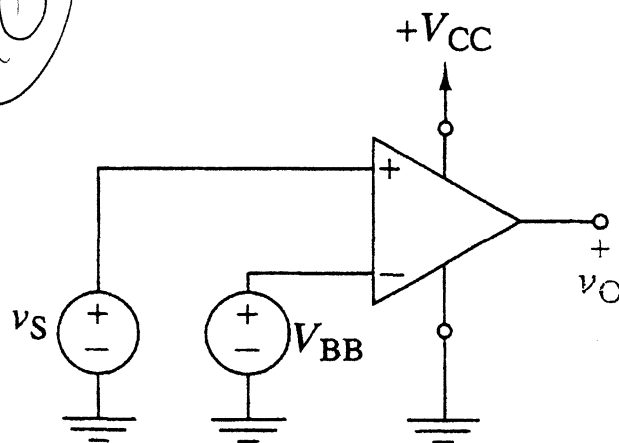
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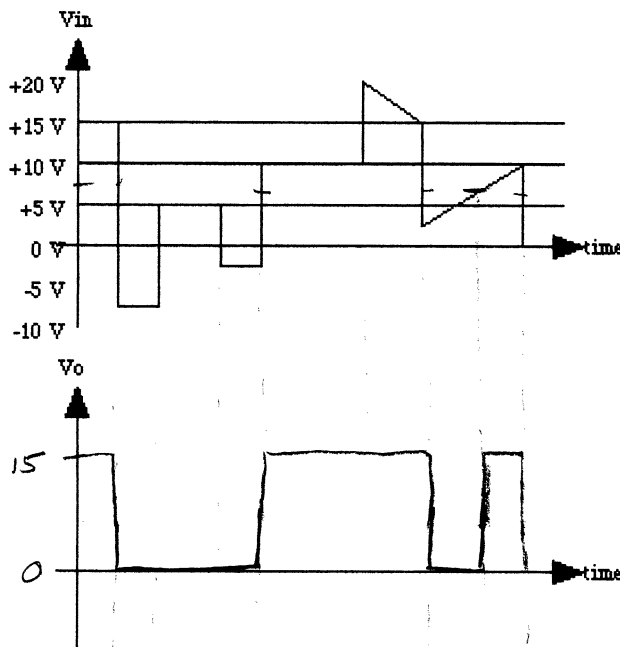
Problem 1 Comparators (10 points)

The circuit below has $V_{CC}=+15$ volts and $V_{BB}=+7.5$ volts.

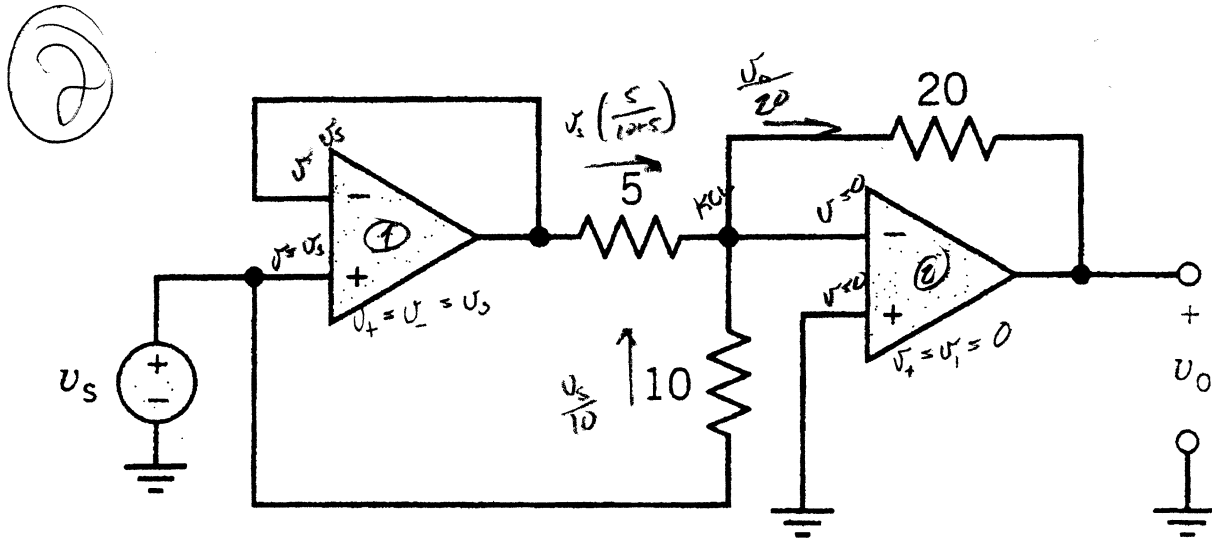


$$v_S = v_{in}$$

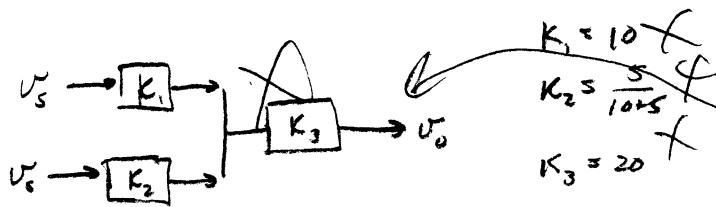
- (a) What is the range of possible output voltages v_O ? 15 volts to 0 volts
- (b) Suppose v_{in} is the waveform below. Sketch the corresponding values of v_O for this circuit. Be sure to label the values of the output voltages and when any voltages change.



Problem 2 Circuits with Multiple Op-Amps (10 points)



(a) Draw a block diagram of the above circuit showing the function of each OP AMP.



(b) Determine the output voltage v_o for this circuit.

KCL @ v_-

$$\frac{v_s}{10} + \frac{5v_o}{10+5} = \frac{v_o}{20}$$

$$v_s \left(\frac{1}{10} + \frac{5}{15} \right) = \frac{v_o}{20}$$

$$20v_s \left(\frac{3}{30} + \frac{10}{30} \right) = v_o$$

$$v_o = \frac{26}{3} v_s$$

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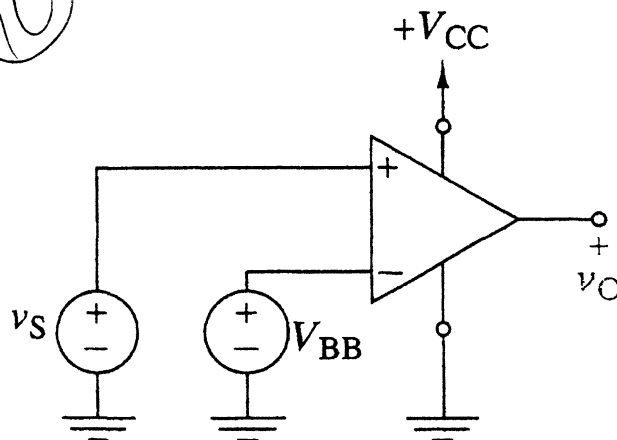
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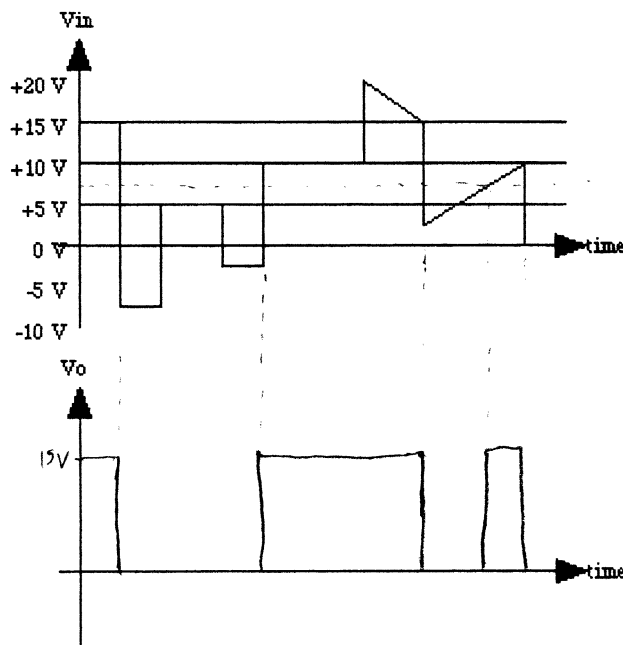
Problem 1 Comparators (10 points)

The circuit below has $V_{CC}=+15$ volts and $V_{BB}=+7.5$ volts.

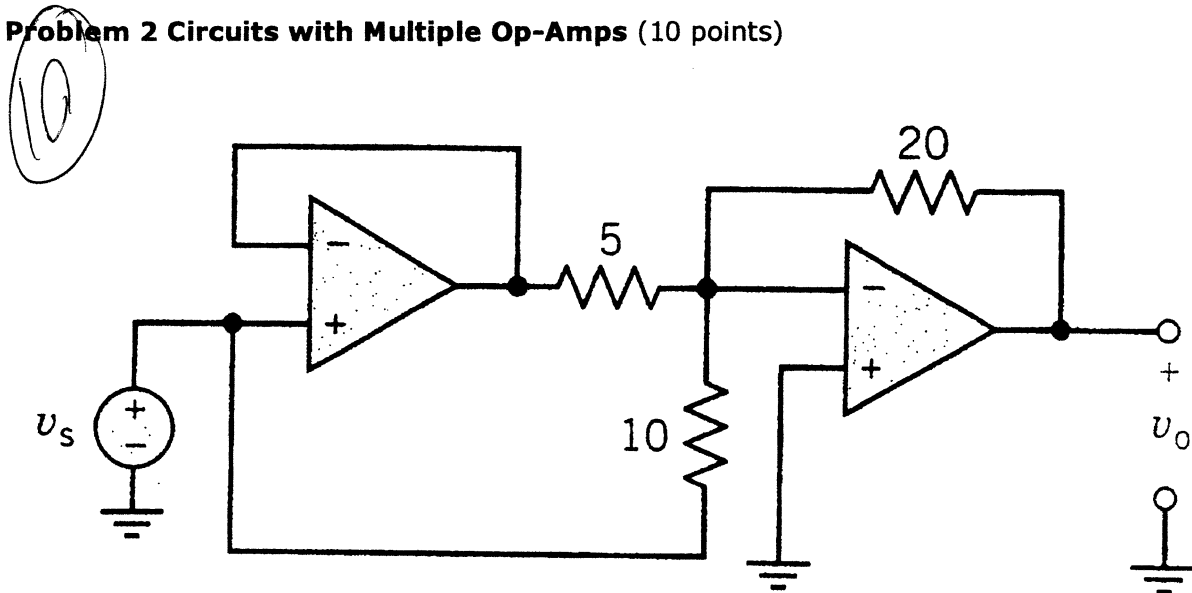
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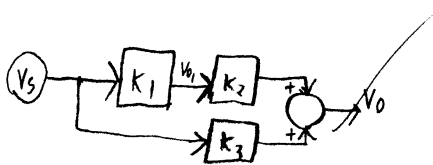
- (a) What is the range of possible output voltages V_O ? *V_O will either be +15V or 0V*
- (b) Suppose V_{in} is the waveform below. Sketch the corresponding values of V_O for this circuit. Be sure to label the values of the output voltages and when any voltages change.



Problem 2 Circuits with Multiple Op-Amps (10 points)



(a) Draw a block diagram of the above circuit showing the function of each OP AMP.



(b) Determine the output voltage v_o for this circuit.

$$K_1 = \frac{R_1 + R_2}{R_2}$$

$$R_1 = 0, R_2 = \infty$$

$$K_1 = 1$$

$$v_{o1} = v_s$$

$$K_2 = \frac{-R_F}{R_1} = \frac{-20}{5}$$

$$K_3 = \frac{-20}{10}$$

$$v_o = -4v_s - 2v_s$$

$$v_o = -6v_s$$