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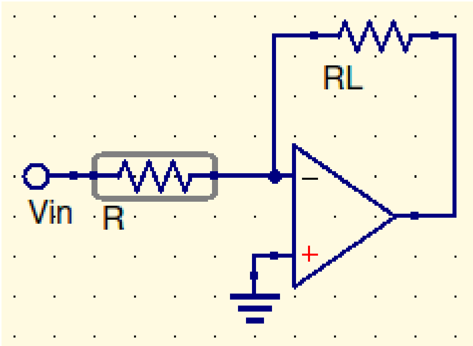
Homework 2: Due 1/29/2020

7. Consider the circuit below, with $R = 1k\Omega$.



1. Determine the transconductance.

$$g = \frac{1}{R} = \frac{1}{1k\Omega} = 100\mu S \tag{1}$$

2. For $V_1 = 10V$ determine i_L for $R_L = 500\Omega$.

$$\begin{aligned} i_L = i_i = \frac{V_i}{R} = \frac{10V}{1k\Omega} \\ i_L = 1mA \end{aligned} \tag{2}$$

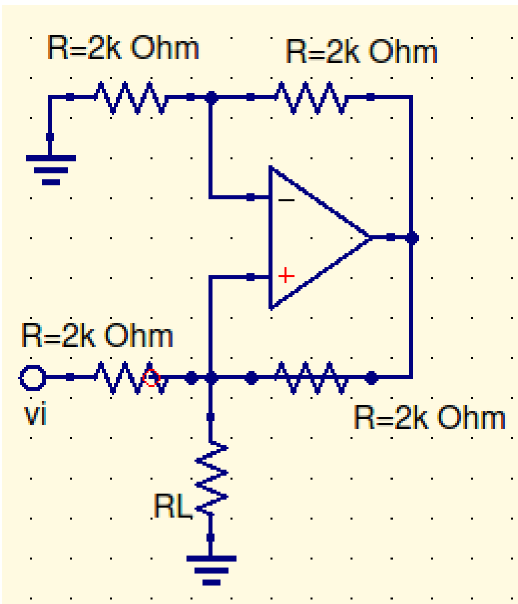
3. Repeat (2.) for $R_L = 1k\Omega$.

$i_i = i_L \therefore i_L = 1mA$

4. Determine the maximum value for R_L for linear operation.

$$\begin{aligned} i_i R_L < V_{sat}; i_i = 1mA; V_{sat} = 13V \\ R_L = 1.3k\Omega \end{aligned} \tag{3}$$

8. Consider the circuit below.



1. Determine the transconductance.

$$g = \frac{1}{R} = \frac{1}{2k\Omega} = 500\mu S \tag{4}$$

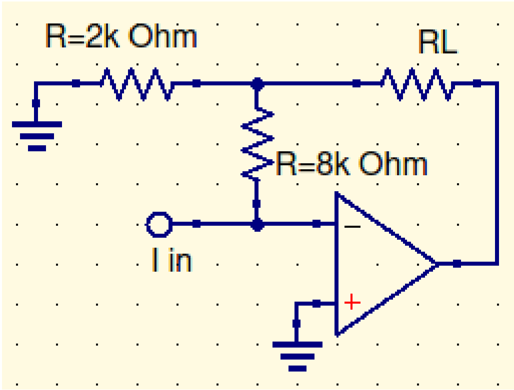
2. For $V_i = 6V$ and $R_L = 1.2k\Omega$, determine i_L.

$$\begin{aligned} i_L &= \frac{V_i}{R} = \frac{6V}{2k\Omega} \\ i_L &= 3mA \end{aligned} \tag{5}$$

3. Determine the maximum value for R_L for linear operation.

$$R_L i_L < \frac{V_{sat}}{2} \tag{6}$$

9. Consider the circuit below.



1. Determine the value of β.

$$\begin{aligned} \beta = 1 + \frac{R_2}{R_1} &= 1 + \frac{8k\Omega}{2k\Omega} \\ \beta &= 5 \end{aligned} \tag{7}$$

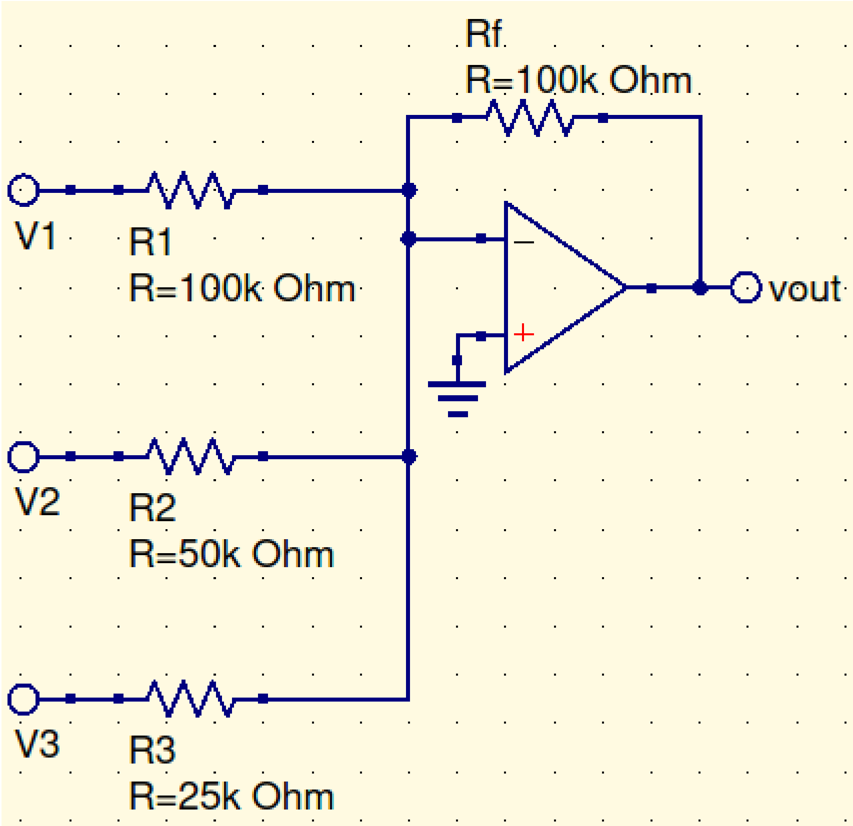
2. For $i_i = 0.6mA$ and $R_L = 1k\Omega$, verify linear operation.

$$\begin{aligned} (R_2 + \beta R_L)(i_i) &< V_{sat} \\ (8k\Omega + 5(1k\Omega))(0.6mA) &< 13V \\ 13\cancel{k}\Omega * 0.6\cancel{m}A &< 13V \\ 7.8V &< 13V \end{aligned} \tag{8}$$

3. Determine i_L for the conditions in (2.)

$$\begin{aligned} i_L &= \beta i_i \\ i_L &= 3mA \end{aligned} \tag{9}$$

15. Consider the circuit below.



1. Write an equation for V_O in terms of the three input voltages.

$$V_O = -(V_1 + 2V_2 + 4V_3) \tag{10}$$

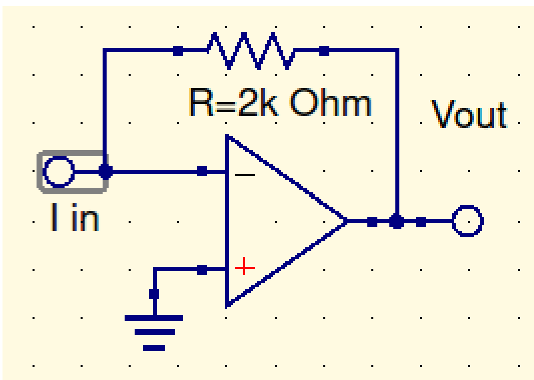
2. Determine V_O given $V_1 = 10V; V_2 = 3V; V_3 = -7V$.

$$V_O = -(10V + 2(3V) + 4(-7V)) = 28V - 16V \tag{11}$$
$$V_O = 12V$$

3. Determine V_O given $V_1 = 8V; V_2 = -4V; V_3 = 5V$.

$$V_O = -(\cancel{8V} + \cancel{2(4V)} + 4(5V)) \tag{12}$$
$$V_O = -20V$$

35. Design a current controlled voltage source to have a transresistance of $2k\Omega$. Then determine the peak value $i_{i_{pk}}$ permitted for the input current for linear operation.



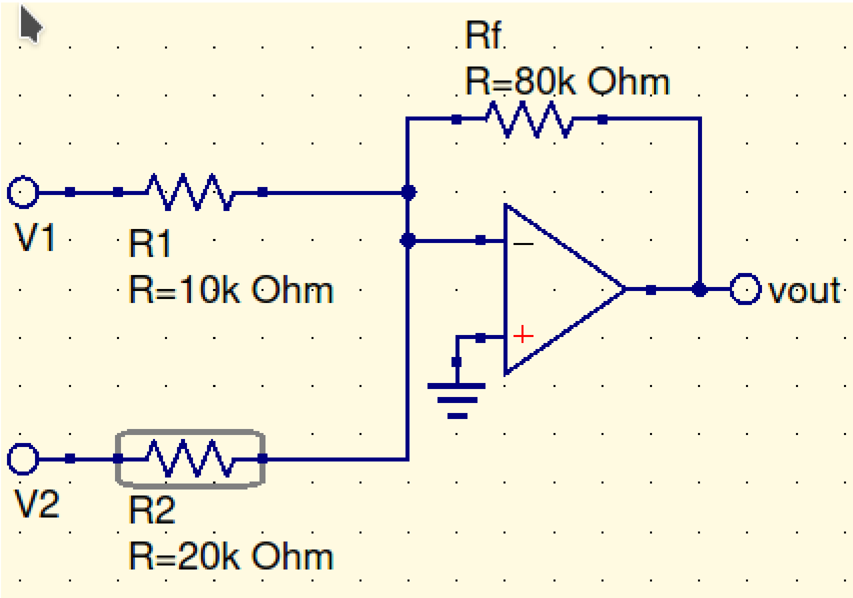
$$V_O = -Ri_i < V_{sat} \tag{13}$$
$$2k\Omega * i_i < 13V$$
$$i_i = 6.5mA$$

39. Design a linear combination circuit to combine two signals as follows:

$$v_o = -4v_1 - 8v_2 \tag{14}$$

Using the following specifications:

1. $R_{in} \geq 10k\Omega$ at both inputs
2. All resistance values $\leq 100k\Omega$



41. Design a balanced closed-loop differential circuit to combine two signals as follows:

$$v_o = 3(v_1 - v_2) \tag{15}$$

Use resistances in the range of $10k\Omega - 100k\Omega$.