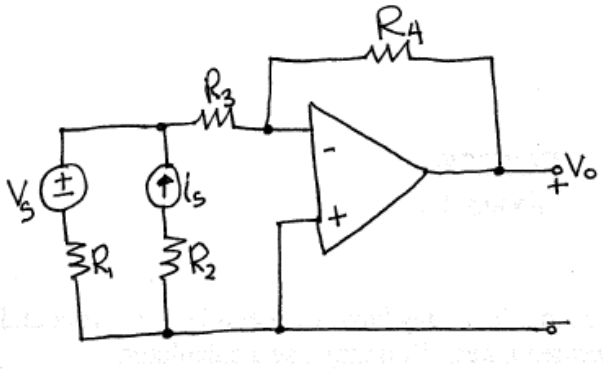
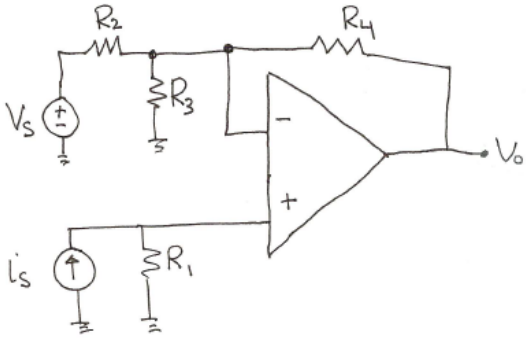
ECE2280 Homework #9

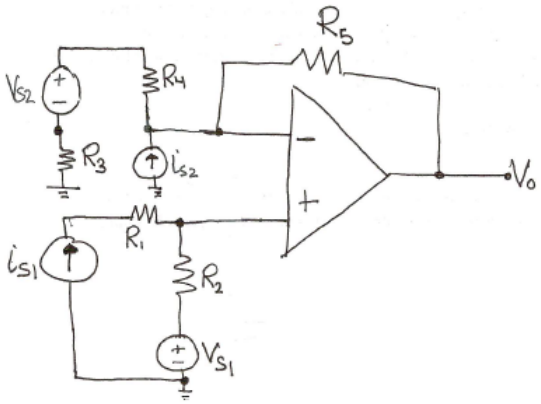
1. Derive an expression for V_o in terms of not more than V_s, i_s, R_1, R_2, R_3, and R_4 of the circuit below by assuming an ideal operational amplifier:



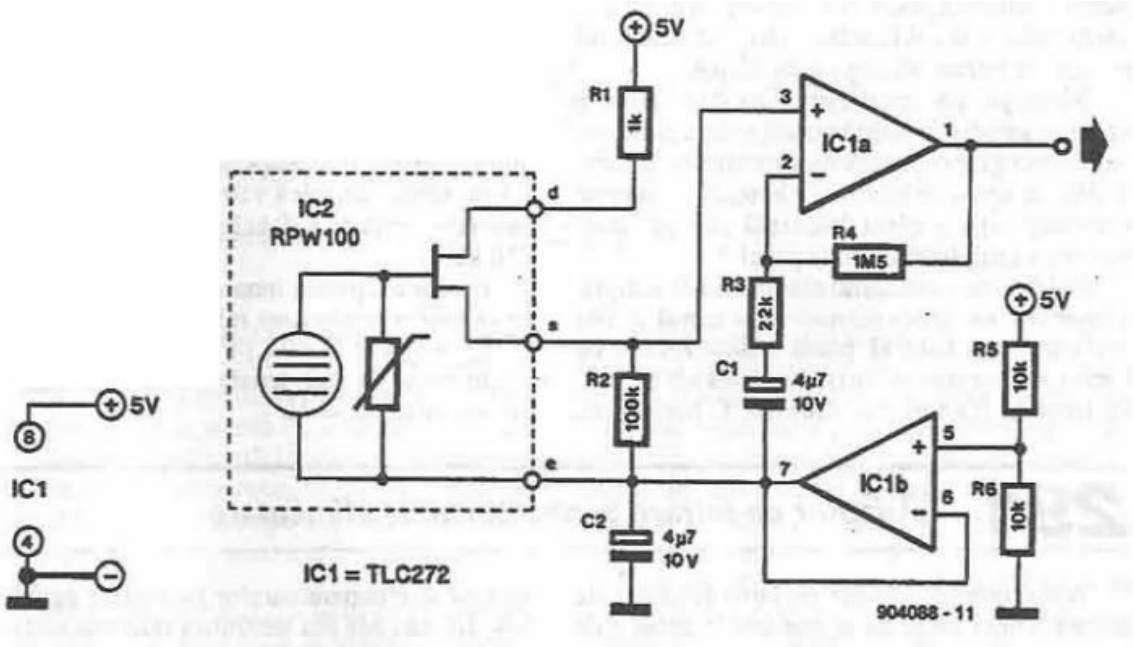
2. Use the ideal model to solve for V_o in the circuit below in terms of not more than R_1, R_2, R_3, R_4, V_s, and i_s. Take a Thevenin equivalent at each input terminal to aid in solving for V_o.



3. Use the ideal model to solve for V_o in the circuit below in terms of not more than $R_1, R_2, R_3, R_4, R_5, V_{s1}, V_{s2}, i_{s1}$ and i_{s2}. Take a Thevenin equivalent at each input terminal to aid in solving for V_o.



4.



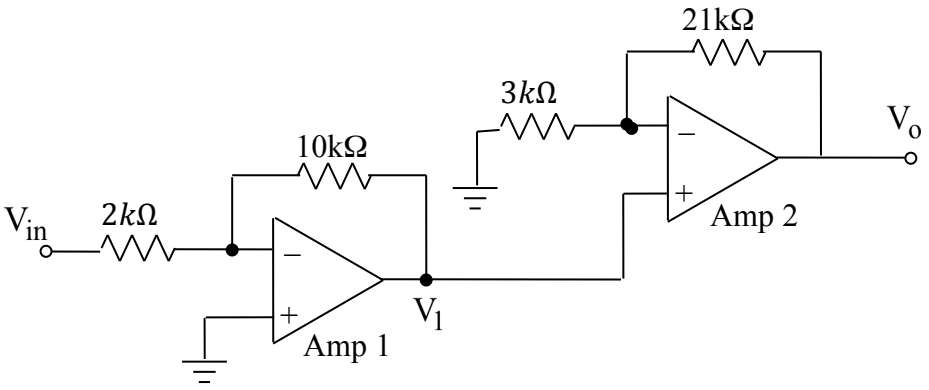
[http://www.electroniccircuitsdesign.com/sensors/tlc272-proximity-detector-circuit.html]

The above circuit is a proximity sensor detector. The TLC272 proximity detector circuit has a sensitive surface which was divided in two, so that it can sense if the heat source is coming from the left or right. Indication for cold objects will be exactly opposite of the warm objects. The IC1b is used to create a stable reference voltage.

(a) Is the IC1a amplifier acting as an inverting, noninverting, summer, difference, or voltage follower amplifier?

(b) Is the IC1b amplifier acting as an inverting, noninverting, summer, difference, or voltage follower amplifier?

5. Use the circuit below:

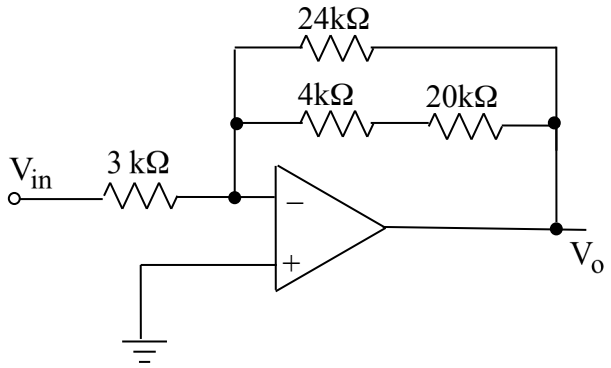


Modify the above circuit to compensate for input bias current on both amplifiers.

6. You are given the following characteristics for a real amplifier:

Input offset voltage,	V_{ios}=5mV
Input Resistance,	R_i=1MΩ
Unity-gain bandwidth,	f_T=12MHz
Output swing limits,	within 2Volts of power supply
Slew Rate,	SR=4 $\frac{V}{\mu sec}$

Given the following circuit with the operational amplifier powered at ±12V.

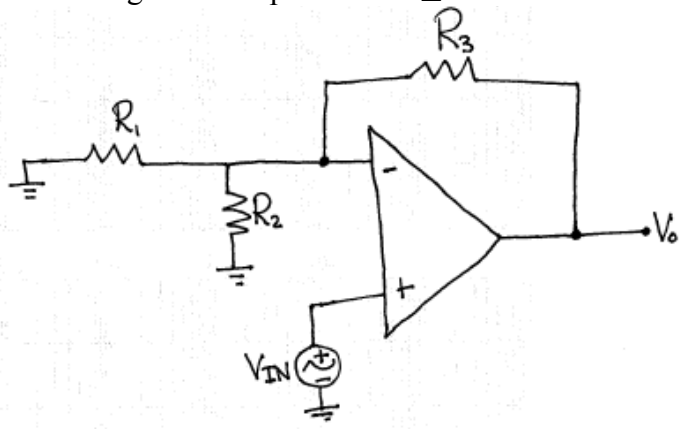


a) Find the ideal gain of the above circuit.
b) For small input signals, what is the bandwidth of the circuit
c) What is the bandwidth when the circuit is operated to produce the maximum possible peak voltage value?
d) For V_{in}=0.001sin(2π90kt), what is the ideal value for the peak to peak voltage value at the output?
e) For V_{in}=0.002sin(2π90kt), what is the peak to peak voltage value at the output considering the input offset voltage?
f) How should the circuit above be modified to minimize the effect of the input bias current? Draw the schematic of the modified circuit and state values of added component(s).

7. You are given the following characteristics for a real amplifier:

Input offset voltage,	V_{ios}=4mV
Input Resistance,	R_i=2MΩ
Unity-gain bandwidth,	f_T=10MHz
Output swing limits,	within 2Volts of power supply
Slew Rate,	SR=5 $\frac{V}{\mu sec}$

The following circuit is powered at ±12V:



a) State the equation for Vo. Include no more than V_{IN}, R_1, R_2, and R_3.

b) If $R_1 = R_2 = 10k$ and $R_3 = 100k$, what is the bandwidth of the circuit. Consider both the effect due to slew rate (use the maximum output value possible) compared to the effect due to the unity gain bandwidth.

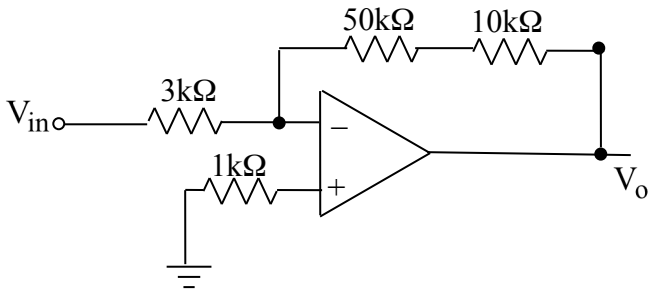
c) For $V_{in} = 0.001\sin(2\pi 90kt)$, what is the PEAK(not peak to peak) value at the output considering the input offset voltage?

d) How should the circuit above be modified to minimize the effect of the input bias current? Draw the schematic of the modified circuit and state values of added component(s).

8. You are given the following characteristics for a real amplifier:

Input offset voltage,	$V_{ios} = 3mV$
Input Resistance,	$R_i = 2M\Omega$
Unity-gain bandwidth,	$f_T = 80MHz$
Output swing limits,	within 2Volts of power supply
Slew Rate,	$SR = 3\frac{V}{\mu sec}$

The following circuit is powered at $\pm 9V$:



a) What value is the ideal gain?

b) What is the bandwidth of the circuit considering both the Unity-gain bandwidth limitations and the slew rate effect for an input of $V_{in} = 0.001\sin(\omega t)$?

9. Use the information from problem 8:

a) For $V_{in} = 0.001\sin(\omega t)$, what is the **maximum** and **minimum** values seen at the output considering only the input offset voltage?

b) How should the circuit above be modified(do not remove any resistors) to minimize the effect of the input bias current? Draw the schematic of the modified circuit and state values of added component(s).

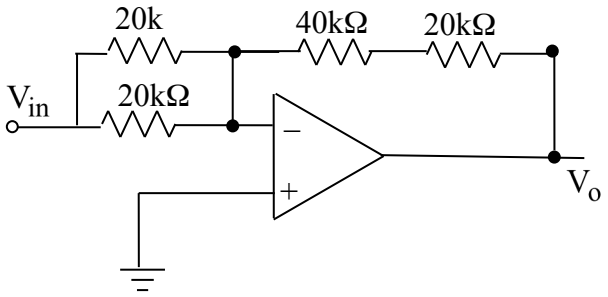
10. Use:

Input offset voltage, V_{ios}=5mV

Unity-gain bandwidth, f_T=12MHz

Slew Rate, SR=4 $\frac{V}{\mu sec}$

Vin=1msin($2\pi 90kt$)



Given the following circuit with the operational amplifier powered at $\pm$12V.

a) Find the ideal gain of the above circuit.

g) For the given input, what is the bandwidth of the circuit. Take into consideration two nonideal effects.

h) Create a rough sketch of the output voltage considering the input offset voltage. Mark the max, min and offset values.

i) How should the circuit above be modified to minimize the effect of the input bias current? Draw the schematic of the modified circuit and state values of added component(s).