332:221 Principles of Electrical Engineering I – Fall 2007

The Assigned Home-work problems for chapter 5 from 7-th edition of the book.

Chapter 5:

5.1 to 5.3, 5.6, 5.7, 5.16, 5.17, 5.19, 5.22, 5.23, 5.29 to 5.31: Ideal Op-Amp Circuits.

5.37 and 5.38: Difference amplifier and CMRR. (*Solutions to these problems will not be posted.*)

5.39: Non-ideal Op-Amp Circuit.

5.1 The op amp in the circuit in Fig. P5.1 is ideal.

P

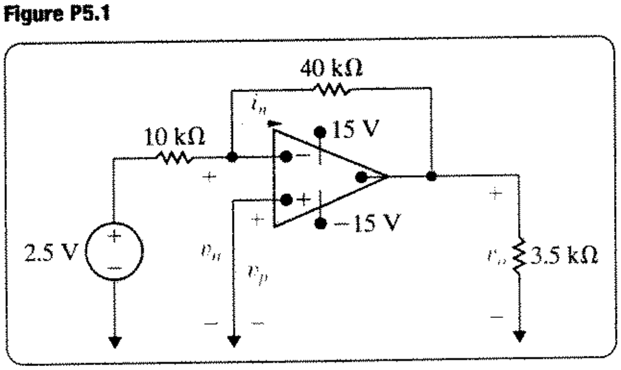
a) Label the five op amp terminals with their names.

b) What ideal op amp constraint determines the value of i_n? What is this value?

c) What ideal op amp constraint determines the value of $(v_p - v_n)$? What is this value?

d) Calculate v_o.

Figure P5.1



5.2 The op amp in the circuit in Fig. P5.2 is ideal.

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a) Calculate v_o if $v_a = 4$ V and $v_b = 0$ V.

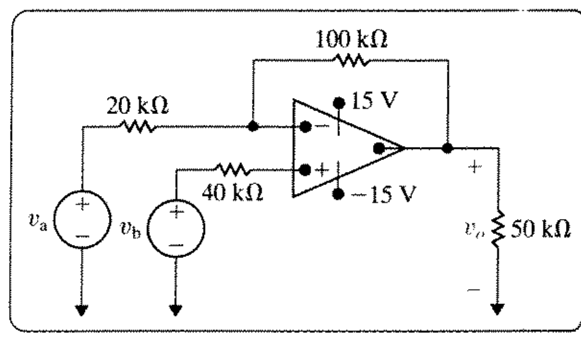
b) Calculate v_o if $v_a = 2$ V and $v_b = 0$ V.

c) Calculate v_o if $v_a = 2$ V and $v_b = 1$ V.

d) Calculate v_o if $v_a = 1$ V and $v_b = 2$ V.

e) If $v_b = 1.6$ V, specify the range of v_a such that the amplifier does not saturate.

Figure P5.2



5.3 Find i_o in the circuit in Fig. P5.3 if the op amp is ideal.

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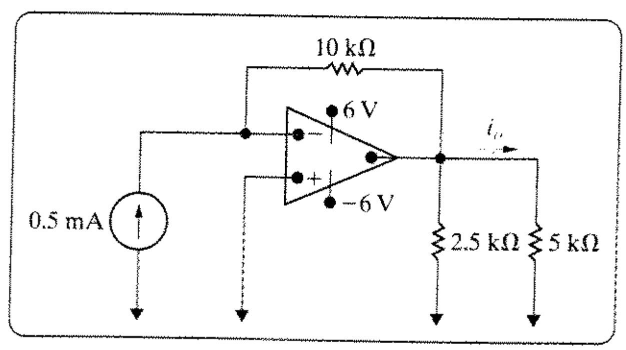
Figure P5.3



5.6 a) Design an inverting amplifier using an ideal op amp that has a gain of 6. Use only 20 kΩ resistors.

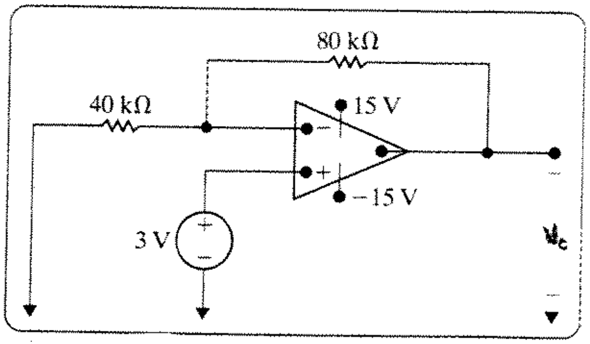
b) If you wish to amplify a 3 V input signal using the circuit you designed in part (a), what are the smallest power supply signals you can use?

5.7 The op amp in the circuit of Fig. P5.7 is ideal.

a) What op amp circuit configuration is this?

b) Calculate v_o.

Figure P5.7



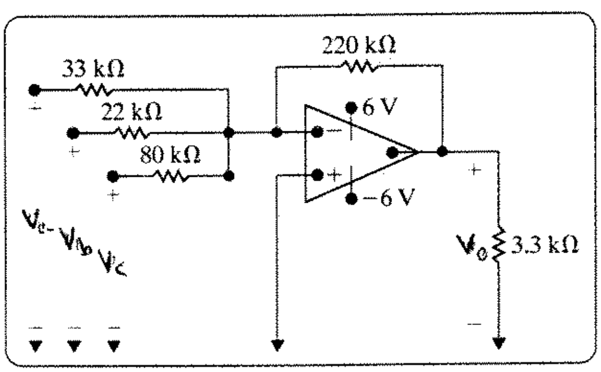
5.16 The op amp in Fig. P5.16 is ideal.

a) What circuit configuration is shown in this figure?

b) Find v_o if $v_a = 1.2$ V, $v_b = -1.5$ V, and $v_c = 4$ V.

c) The voltages v_a and v_c remain at 1.2 V and 4 V, respectively. What are the limits on v_b if the op amp operates within its linear region?

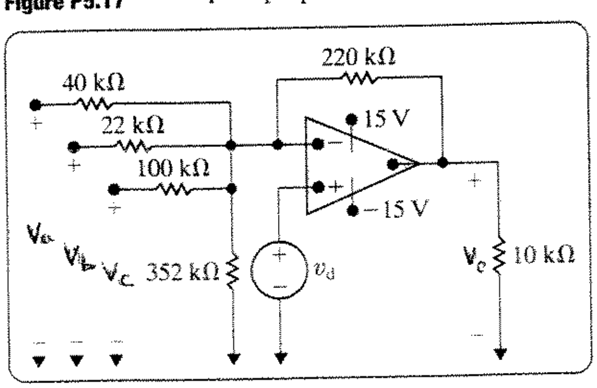
Figure P5.16



5.17 a) The op amp in Fig. P5.17 is ideal. Find v_o if $v_a = 4$ V, $v_b = 9$ V, $v_c = 13$ V, and $v_d = 8$ V.

b) Assume v_b, v_c, and v_d retain their values as given in (a). Specify the range of v_a such that the op amp operates within its linear region.

Figure P5.17



5.19 Design an inverting summing amplifier so that

$$v_o = -(2v_a + 4v_b + 6v_c + 8v_d).$$

If the feedback resistor (R_f) is chosen to be 48 kΩ, draw a circuit diagram of the amplifier and specify the values of R_a, R_b, R_c, and R_d.

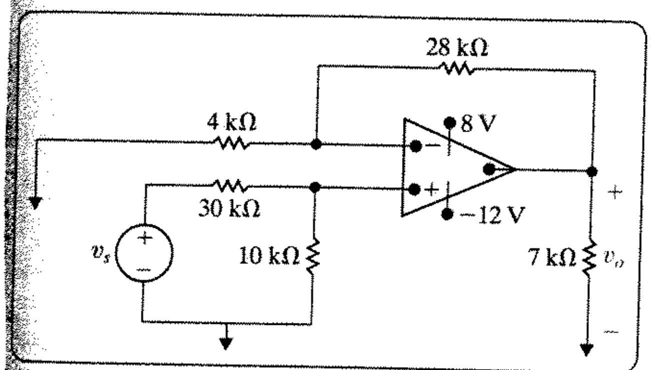
5.22 The op amp in the circuit of Fig. P5.22 is ideal.

a) What op amp circuit configuration is this?

b) Find v_o in terms of v_s.

c) Find the range of values for v_s such that v_o does not saturate and the op amp remains in its linear region of operation.

Figure P5.22



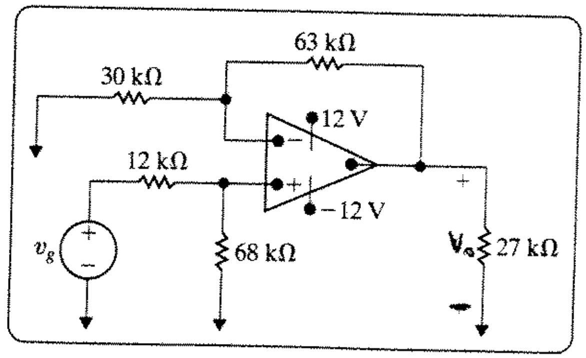
5.23 The op amp in the circuit shown in Fig. P5.23 is ideal.

a) Calculate v_o when v_g equals 4 V.

b) Specify the range of values of v_g so that the op amp operates in a linear mode.

c) Assume that v_g equals 2 V and that the 63 kΩ resistor is replaced with a variable resistor. What value of the variable resistor will cause the op amp to saturate?

Figure P5.23

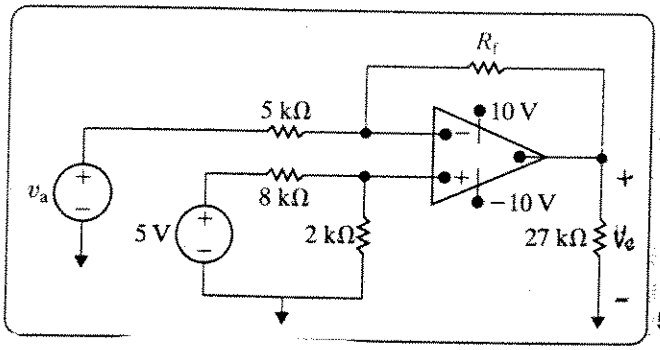


5.29 The op amp in the circuit of Fig. P5.29 is ideal. What value of R_f will give the equation

$$v_o = 5 - 4v_a$$

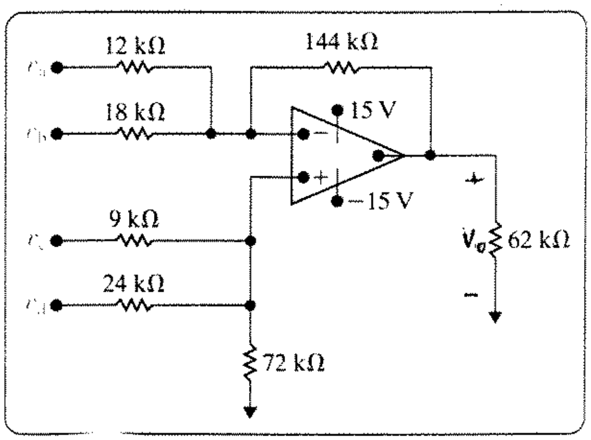
for this circuit.

Figure P5.29



5.30 The op amp in the adder-subtracter circuit shown in Fig. P5.30 is ideal.

Figure P5.30



a) Find v_o when $v_a = 0.5$ V, $v_b = 0.3$ V, $v_c = 0.6$ V, and $v_d = 0.8$ V.

b) If v_a, v_b, and v_d are held constant, what values of v_c will not saturate the op amp?

5.31 The resistors in the difference amplifier shown in Fig. 5.13 are $R_a = 10\,\text{k}\Omega$, $R_b = 100\,\text{k}\Omega$, $R_c = 33\,\text{k}\Omega$, and $R_d = 47\,\text{k}\Omega$. The signal voltages v_a and v_b are 0.67 and 0.8 V, respectively, and $V_{CC} = \pm 5$ V.

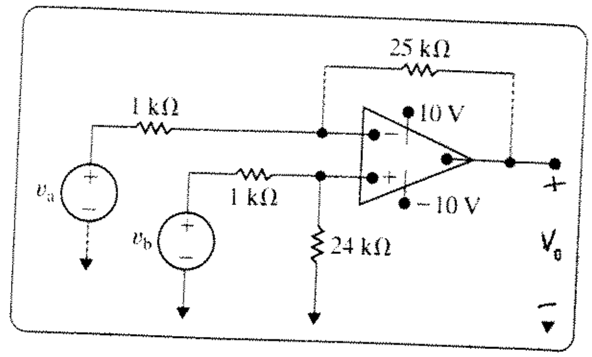
a) Find v_o.

b) What is the resistance seen by the signal source v_a?

c) What is the resistance seen by the signal source v_b?

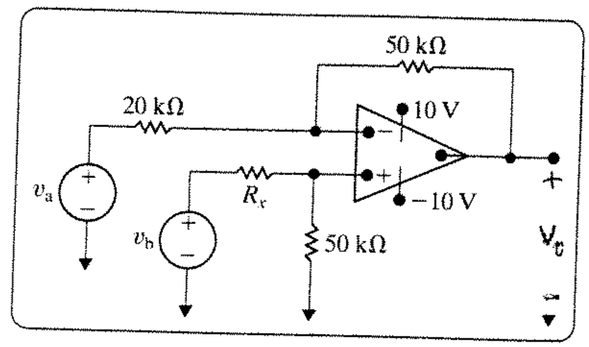
5.37 In the difference amplifier shown in Fig. P5.37, compute (a) the differential mode gain, (b) the common mode gain, and (c) the CMRR.

Figure P5.37



5.38 In the difference amplifier shown in Fig. P5.38, what value of R_x yields a CMRR ≥ 1000?

Figure P5.38



5.39 The inverting amplifier in the circuit shown has an input resistance of 500 kΩ, an output resistance of 5 kΩ, and an open-loop gain of 300,000. Assume that the amplifier is operating in its linear region.

a) Calculate the voltage gain (v_o/v_g) of the amplifier.

b) Calculate the value of v_n in microvolts when $v_g = 1$ V.

c) Calculate the resistance seen by the signal source (v_g).

d) Repeat (a)–(c) using the ideal model for the op amp.