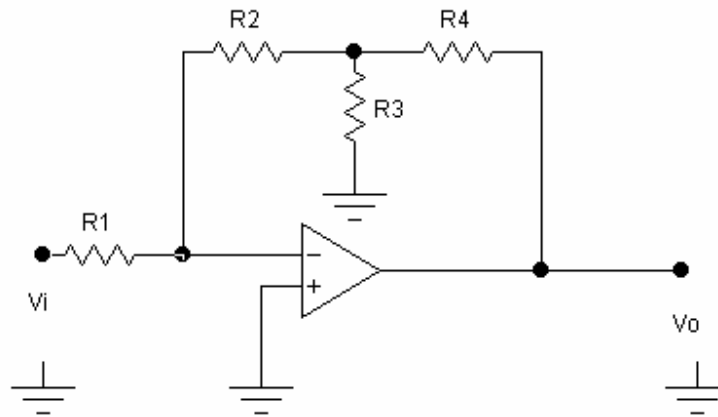




1. Consider The circuit shown below with  $R_1=R_2=R_4=1M\Omega$  , and assume the op amp to be ideal . Find values for  $R_3$  to obtain the following gains:

- a-  $-10 V/V$   
b-  $-100 V/V$



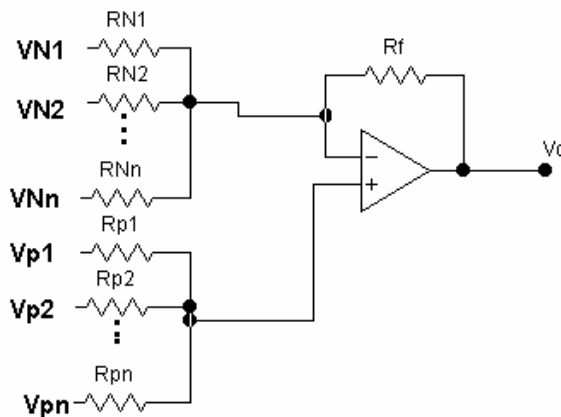
2. a-Use the superposition to show that the output of the circuit below is given by:

$$V_o = -R_f \left[ \frac{v_{N1}}{R_{N1}} + \frac{v_{N2}}{R_{N2}} + \dots + \frac{v_{Nn}}{R_{Nn}} \right] + \left( 1 + \frac{R_f}{R_N} \right) R_p \left[ \frac{v_{p1}}{R_{p1}} + \frac{v_{p2}}{R_{p2}} + \dots + \frac{v_{pn}}{R_{pn}} \right]$$

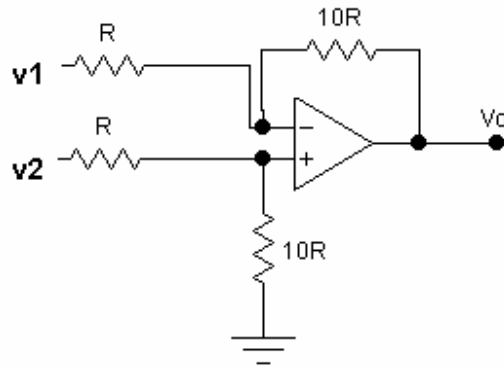
where  $R_p=R_{p1} // R_{p2} // R_{p3} // \dots // R_{pn}$ , and  
 $R_N=R_{N1} // R_{N2} // R_{N3} // \dots // R_{Nn}$

- b- Design a circuit to obtain:

$$V_o = -2v_{N1} + v_{p1} + 2v_{p2}$$



3. For the circuit shown below, use the superposition to find  $V_o$  in terms of the input voltages  $v_1$  and  $v_2$ . Assume an ideal op amp for:
- $$v_1 = 10\sin(2\pi \times 60t) - 0.1\sin(2\pi \times 1000t), \text{volts}$$
- $$v_2 = 10\sin(2\pi \times 60t) + 0.1\sin(2\pi \times 1000t), \text{volts}$$



4. It is required to connect a 10-V source with a source resistance of  $100\text{k}\Omega$  to a  $1\text{-k}\Omega$  load. Find the voltage that will appear across the load if:
- the source is connected directly to the load.
  - An op-amp unity-gain buffer is inserted between the source and the load.
- In each case, find the load current and the current supplied by the source. Where does the current come from in case (b)?
5. Consider the instrumentation amplifier discussed in the lecture with a common-mode input voltage of  $+5\text{V}$  (dc) and a differential input signal of  $10\text{-mV}$  peak sine wave. Let  $R_1 = 1\text{k}\Omega$ ,  $R_2 = 0.5\text{M}\Omega$ ,  $R_3 = R_4 = 10\text{k}\Omega$ . Find the voltage at every node of the circuit.