Chapter 5, Solution 10.

Since no current enters the op amp, the voltage at the input of the op amp is v_s. Hence

$$v_s = v_o \left(\frac{10}{10+10}\right) = \frac{v_o}{2} \quad \longrightarrow \quad \frac{v_o}{v_s} = \underline{\mathbf{2}}$$

Chapter 5, Solution 25.

This is a voltage follower. If v_1 is the output of the op amp,

$v_1 = 2V$

$$v_o = \frac{20k}{20k+12k} v_1 = \frac{20}{32}(12) = \underline{1.25\text{ V}}$$

Chapter 5, Solution 47.

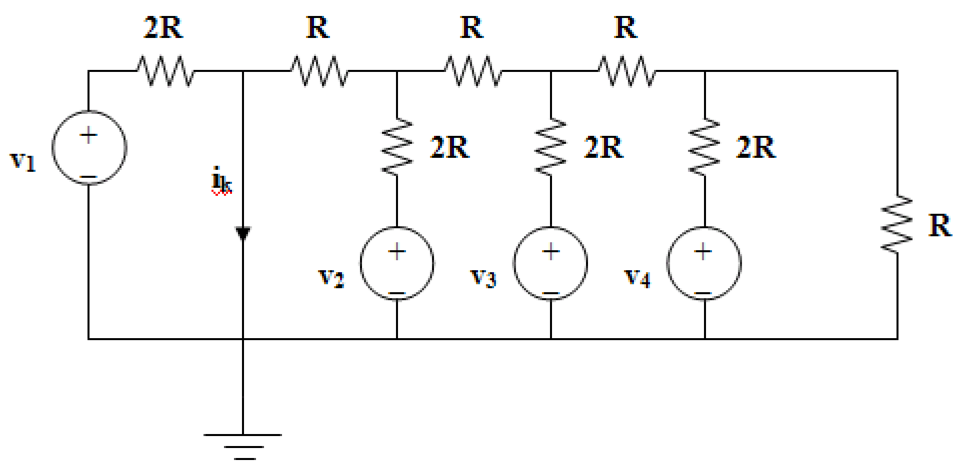
Using eq. (5.18), $R_1 = 2k\Omega,\ R_2 = 30k\Omega,\ R_3 = 2k\Omega,\ R_4 = 20k\Omega$

$$v_o = \frac{30(1+2/30)}{2(1+2/20)} v_2 - \frac{30}{2} V_1 = \frac{32}{2.2}(2) - 15(1) = \underline{14.09\text{ V}}$$

Chapter 5, Solution 84.

For (a), the process of the proof is time consuming and the results are only approximate, but close enough for the applications where this device is used.

(a) The easiest way to solve this problem is to use superposition and to solve for each term letting all of the corresponding voltages be equal to zero. Also, starting with each current contribution (i_k) equal to one amp and working backwards is easiest.



For the first case, let $v_2 = v_3 = v_4 = 0$, and $i_1 = 1A$.

Therefore, $v_1 = 2R$ volts or $i_1 = v_1/(2R)$.

Second case, let $v_1 = v_3 = v_4 = 0$, and $i_2 = 1A$.

Therefore, $v_2 = 85R/21$ volts or $i_2 = 21v_2/(85R)$. Clearly this is not $(1/4^{th})$, so where is the difference? $(21/85) = 0.247$ which is a really good approximation for 0.25. Since this is a practical electronic circuit, the result is good enough for all practical purposes.

Now for the third case, let $v_1 = v_2 = v_4 = 0$, and $i_3 = 1A$.

Therefore, $v_3 = 8.5R$ volts or $i_3 = v_3/(8.5R)$. Clearly this is not $(1/8^{th})$, so where is the difference? $(1/8.5) = 0.11765$ which is a really good approximation for 0.125. Since this is a practical electronic circuit, the result is good enough for all practical purposes.

Finally, for the fourth case, let $v_1 = v_2 = v_4 = 0$, and $i_3 = 1A$.

Therefore, $v_4 = 16.25R$ volts or $i_4 = v_4/(16.25R)$. Clearly this is not $(1/16^{th})$, so where is the difference? $(1/16.25) = 0.06154$ which is a really good approximation for 0.0625. Since this is a practical electronic circuit, the result is good enough for all practical purposes.

Please note that a goal of a lot of electronic design is to come up with practical circuits that are economical to design and build yet give the desired results.

(a) If $R_f = 12$ k ohms and $R = 10$ k ohms,

$$-v_o = (12/20)[v_1 + (v_2/2) + (v_3/4) + (v_4/8)]$$

$$= 0.6[v_1 + 0.5v_2 + 0.25v_3 + 0.125v_4]$$

For $[v_1\ v_2\ v_3\ v_4] = [1\ 0\ 11]$,

$$|v_o| = 0.6[1 + 0.25 + 0.125] = \underline{\mathbf{825\ mV}}$$

For $[v_1\ v_2\ v_3\ v_4] = [0\ 1\ 0\ 1]$,

$$|v_o| = 0.6[0.5 + 0.125] = \underline{\mathbf{375\ mV}}$$