11.2

From KCL and the properties of the ideal op-amp:

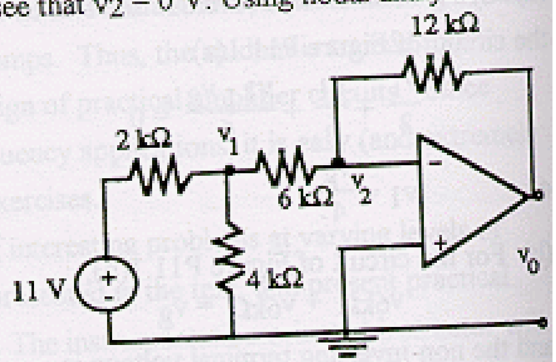
$$\frac{v_i}{R_1} + \frac{v_o}{R_2} = 0$$

From this equation, then:

$$\frac{v_o}{v_i} = -\frac{R_2}{R_1} \Rightarrow A_v = -\frac{R_2}{R_1}$$

EIT 11.6

Looking at the figure, we can immediately see that $v_2 = 0$ V. Using nodal analysis:



$$\left(\frac{1}{4000} + \frac{1}{2000} + \frac{1}{6000}\right) v_1 - \frac{1}{2000}\ 11 = 0$$

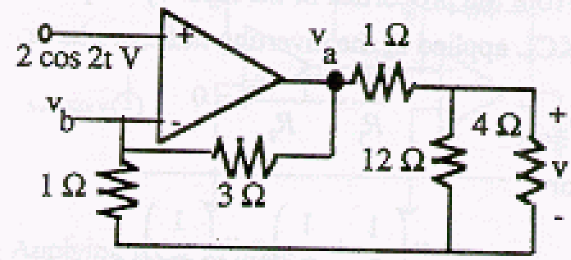
$$-\left(\frac{1}{6000}\right) v_1 - \left(\frac{1}{12000}\right) v_o = 0$$

Solving for v_1 and v_o,

$$v_1 = 6 \text{ V}$$

and $$v_o = -12 \text{ V}$$

11.3



Since the op-amp attempts to maintain zero voltage difference between the inverting and the non-inverting terminal,

$$v_b = 2 \cos 2t$$

But $v_b = v_a \frac{1}{1+3}$, and

$$v_a = 4\, v_b = 8 \cos 2t$$

Using nodal analysis:

$$\left(1 + \frac{1}{12} + \frac{1}{4}\right) v = v_a$$

or $$v = \frac{12}{16}\, v_a = 6 \cos 2t \text{ V}$$

EIT 11.7

Using nodal analysis:

$$-\left(\frac{1}{2}\right)10 - \left(\frac{1}{4} + \frac{1}{6}\right) v_o = 0$$

or $$v_o = -12 \text{ V}$$

Therefore,

$$i = -\left(-\frac{12}{6}\right) = 2 \text{ A}$$

11.10

Applying KCL at the inverting terminal:

$$v3 = (1 + \frac{Rf}{R})v^-$$

Applying KCL at the noninverting terminal:

$$\left(\frac{1}{R_2} + \frac{1}{R_1}\right)v^+ - \frac{1}{R_2}v_2 - \frac{1}{R_1}v_1 = 0$$

or

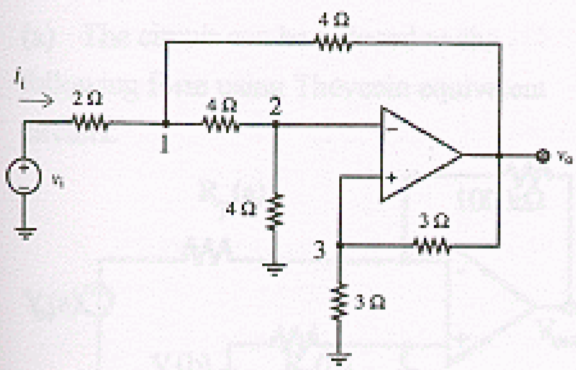
$$v^+ = \frac{R1}{R1 + R2}v2 + \frac{R2}{R1 + R2}v1$$

therefore,

$$v3 = (1 + \frac{Rf}{R})(\frac{R1}{R1 + R2}v2 + \frac{R2}{R1 + R2}v1)$$

and the circuit does indeed compute the weighted sum of the inputs.

11.12



Applying KVL at node 1:

$$\frac{v_1 - v_i}{2} + \frac{v_1 - v_2}{4} + \frac{v_1 - v_o}{4} = 0$$

or

$$-2v_i + 4v_1 - v_2 = v_o \quad (1)$$

Again, at node 2:

$$\frac{v_2 - v_1}{4} + \frac{v_2}{4} = 0$$

or

$$2v_2 = v_1 \quad (2)$$

Similarly, at node 3:

$$\frac{v_2}{3} + \frac{v_2 - v_o}{3} = 0$$

or

$$v_2 = \frac{1}{2}v_o \quad (3)$$

Substituting (3) into (2):

$$v_o = v_1$$

Substituting (2) and (3) into (3):

$$-2v_i = v_o + \frac{1}{2}v_o - 8\left(\frac{1}{2}v_o\right)$$

or

$$\frac{v_o}{v_i} = \frac{4}{5}$$

$$\therefore A_v = \frac{4}{5}$$

Now, since

$$i_i = \frac{v_i - v_1}{2} = \frac{v_i - v_o}{2} = \frac{v_i - \frac{4}{5}v_i}{2} = \frac{1}{8}v_i$$

then

$$G = \frac{i_i}{v_i} = \frac{1}{8}S$$