Desk Copy

ECE 300
Spring Semester, 2004
HW Set #3
PM Section

February 5, 2004 **Name** Green
wlg Print (last, first)

Use engineering paper. Work only on one side of the paper. Use this sheet as your cover sheet, placed on top of your work and stapled in the top left-hand corner. Number the problems at the top of the page, in the center of the sheet. **Do neat work. Underline your answers. Show how you got your equations. Be sure to show how you got your answers.** Each problem counts 5 points.

✓ 3.38 $I_x = 1$ mA, $V_o = 4$ V

✓ 3.39 $V_o = 32.25$ V

✓ 3.40 $V_o = 4$ V

✓ 3.43 $V_o = (4/3)$ V

✓ 3.47 $I_o = 7$ mA

✓ 3.51 $V_o = 2$ V

✓ 3.54 $I_o = 2$ mA

✓ 3.65 $V_o = 6$ V

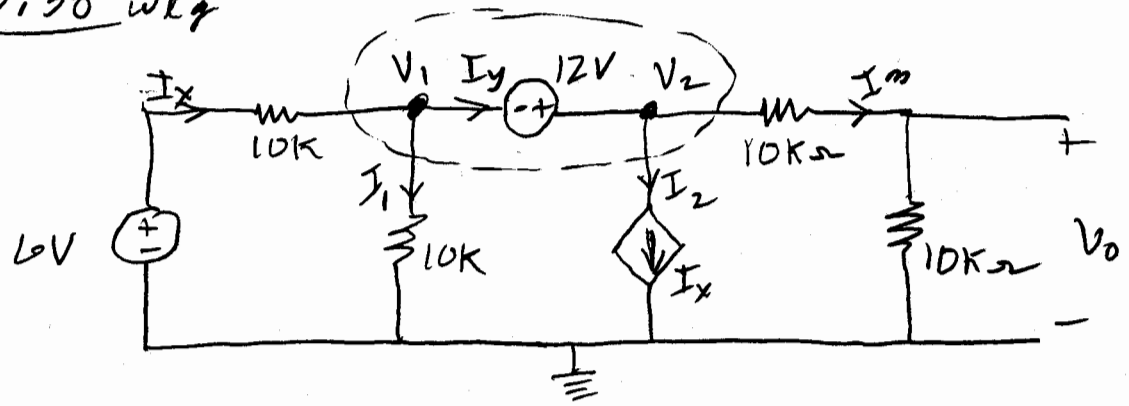
✓ 3.71 $V_o = -10$ V

✓ 3.74 $V_o = -11.2$ V

✓ 3FE-1 $V_o = (10/3)$ V

✓ 3FE-3 $I_x = 12$ A

3.38 wkg



At V_1: $\frac{V_1 - 6}{10K} + \frac{V_1}{10K} + I_x + \frac{V_2}{20K} = 0$

$I_x = \frac{6 - V_1}{10K}$

$\frac{V_1 - 6}{10K} + \frac{V_1}{10K} + \frac{6 - V_1}{10K} + \frac{V_2}{20K} = 0$

$2V_1 - 12 + 2V_1 + 12 - 2V_1 + V_2 = 0$

$$2V_1 + V_2 = 0$$

Constraint:

$$V_1 - V_2 = -12$$

so

$V_1 = -4V$

$V_2 = 8V$

$V_o = \frac{10V_2}{10+10} = 4V$

$I_x = \frac{6 - V_1}{10K} = \frac{6+4}{10K} = 1mA$

$I_1 = \frac{V_1}{10K} = \frac{-4}{10K} = -0.4mA$

3.78

cont.

$I_2 = I_x = 1\,mA$

$I_3 = \frac{V_2}{20k} = \frac{8}{20K} = 0.4\,mA$

At

V_1

$I_x = I_y + I_1$

$I_y = I_x - I_1 = 1mA - (-.4mA)$

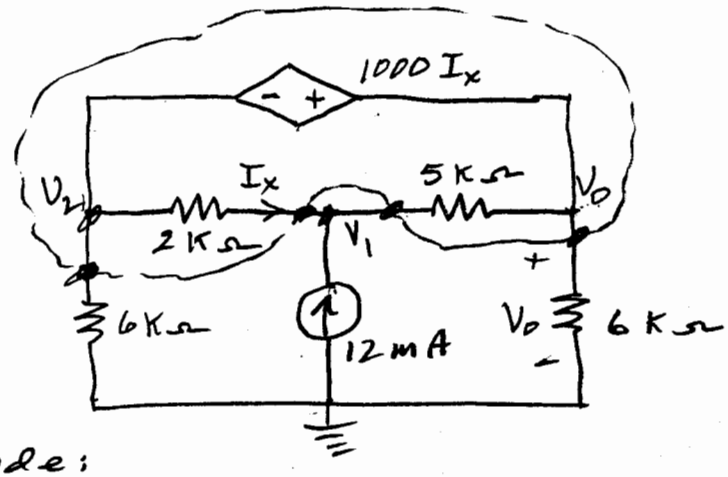
$\boxed{I_y = 1.4\,mA}$

At V_2

$I_y = I_2 + I_3$

$1.4mA = 1mA + 0.4\,mA$ check

3.39 Use nodal analysis to find V_o.



At supernode:

$$\frac{V_o}{6k} + \frac{V_o - V_1}{5K} + \frac{V_2 - V_1}{2K} + \frac{V_2}{6K} = 0$$

$$5V_o + 6V_o - 6V_1 + 15V_2 - 15V_1 + 5V_2 = 0$$

$$\boxed{11V_o - 21V_1 + 20V_2 = 0}$$

Constraint Eq'n:

$$V_2 + 1K I_x - V_o = 0$$

but $I_x = \frac{V_2 - V_1}{2K}$

$$V_2 + 1K\left[\frac{V_2 - V_1}{2K}\right] - V_o = 0$$

$$2V_2 + V_2 - V_1 - 2V_o = 0$$

$$\boxed{-2V_o - V_1 + 3V_2 = 0}$$

Now go to node V_1

3.39 cont

At V_1:

$$\frac{V_2 - V_1}{2k} + \frac{12A}{k} + \frac{V_o - V_1}{5k} = 0$$

$$5V_2 - 5V_1 + 120 + 2V_o - 2V_1 = 0$$

$$2V_o - 7V_1 + 5V_2 = -120$$

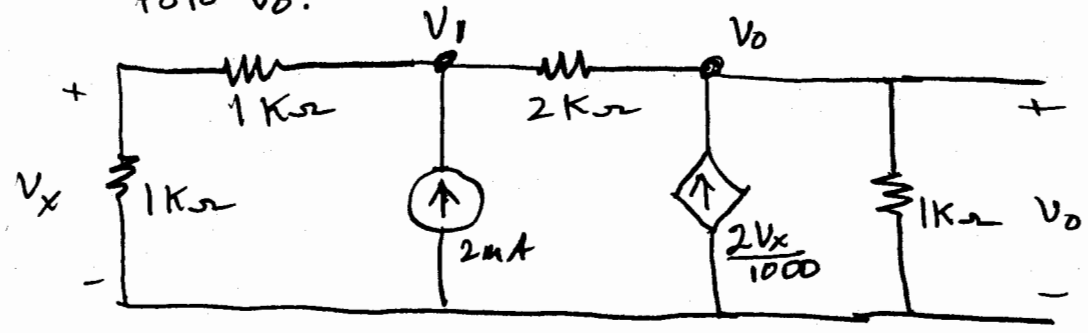
$$\begin{bmatrix} 11 & -21 & 20 \\ -2 & -1 & 3 \\ 2 & -7 & 5 \end{bmatrix} \begin{bmatrix} V_o \\ V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ -120 \end{bmatrix}$$

$V_o = 32.3\ V$

$V_1 = 54.8\ V$

$V_2 = 39.8\ V$

3.40 wlg: Use nodal analysis to solve for V_o.



At V_1

$$\frac{V_1}{2K} + \frac{V_1 - V_o}{2K} = \frac{2}{K}$$

$$V_1 + V_1 - V_o = 4$$

$$\boxed{-V_o + 2V_1 = 4}$$

At V_o

$$\frac{V_o - V_1}{2K} + \frac{V_o}{1K} = \frac{2V_x}{1K} = 2\left[\frac{V_1 \times 1K}{2K}\right] = V_1$$

$$V_o - V_1 + 2V_o = 2V_1$$

$$3V_o - 3V_1 = 0$$

$$\boxed{V_o - V_1 = 0}$$

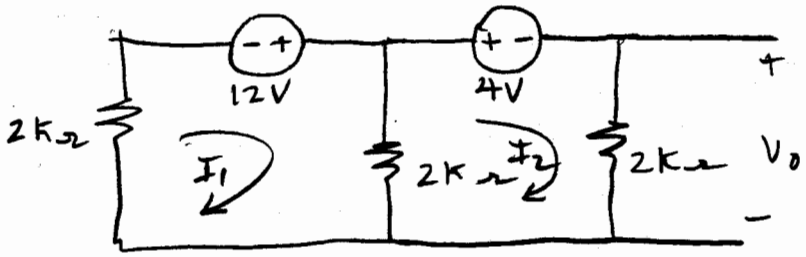
$$\begin{bmatrix} -1 & 2 \\ 1 & -1 \end{bmatrix} \begin{bmatrix} V_o \\ V_1 \end{bmatrix} = \begin{bmatrix} 4 \\ 0 \end{bmatrix}$$

$$V_o = 4V$$

$$V_1 = 4V$$

3.43 wlg

Find V_o using mesh analysis



$$2kI_1 - 12 + 2kI_1 - 2I_2 = 0$$

$$4kI_1 - 2kI_2 = 12$$

$$2k(I_2 - I_1) + 4 + 2kI_2 = 0$$

$$-2kI_1 + 4kI_2 = -4$$

$$\begin{bmatrix} 4k & -2k \\ -2k & 4k \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 12 \\ -4 \end{bmatrix}$$

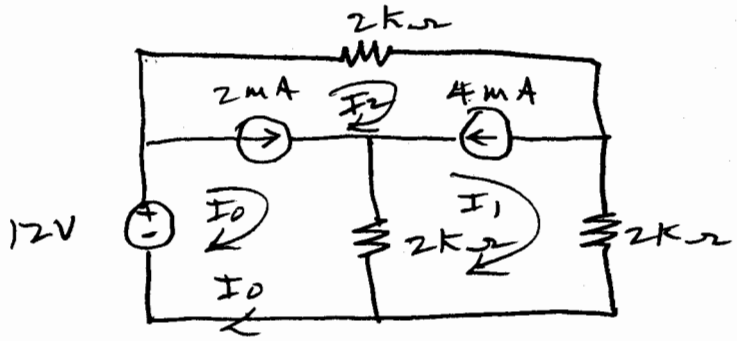
$$I_1 = 0.333\,mA$$

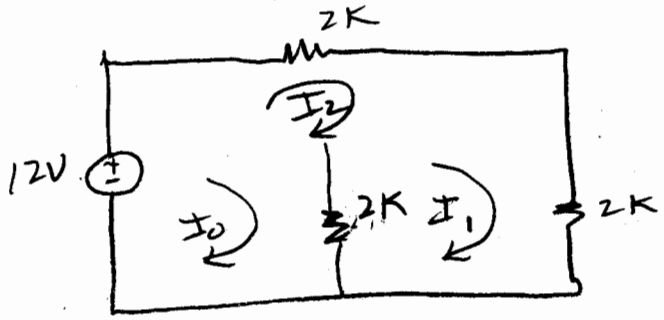
$$I_2 = 0.667\,mA$$

$$V_o = (2k)I_2$$

$$V_o = 1.33\,V$$

3.47 wkg: use loop analysis to find I_o





$-12 + 2K I_2 + 2K I_1 = 0$

$0 I_0 + 2K I_1 + 2K I_2 = 12$

$I_0 - I_2 = 2mA$

$I_0 + 0 I_1 - I_2 = 2mA$

$I_2 - I_1 = 4mA$

$0 I_0 - I_1 + I_2 = 4mA$

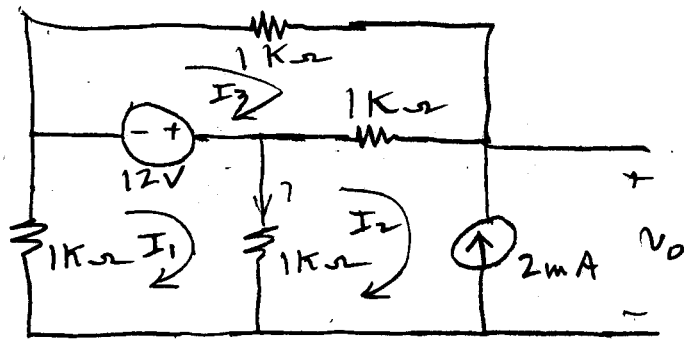
$$\begin{bmatrix} 0 & 2K & 2K \\ 1 & 0 & -1 \\ 0 & -1 & 1 \end{bmatrix} \begin{bmatrix} I_0 \\ I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 12 \\ 2mA \\ 4mA \end{bmatrix}$$

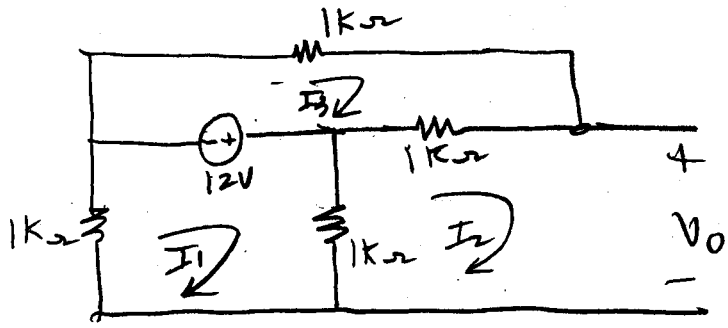
$I_0 = 7mA$

$I_1 = 1mA$

$I_2 = 5mA$

3.51 wlg Find V_o using mesh analysis





$1K I_1 - 12 + (I_1 - I_2)1K = 0$

$$2K I_1 - 1K I_2 + 0 I_3 = 12$$

$12 + 1K I_3 + 1K I_3 - 1K I_2 = 0$

$$0 I_1 - 1K I_2 + 2K I_3 = -12$$

$-1 I_2 = -2mA$

$$0 I_1 + I_2 + 0 I_3 = -2mA$$

$$\begin{bmatrix} 2K & -1K & 0 \\ 0 & -1K & 2K \\ 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} 12 \\ -12 \\ -2mA \end{bmatrix}$$

3.51 wkg cont.

$I_1 = 5\,mA$

$I_2 = -2\,mA$

$I_3 = -7\,mA$

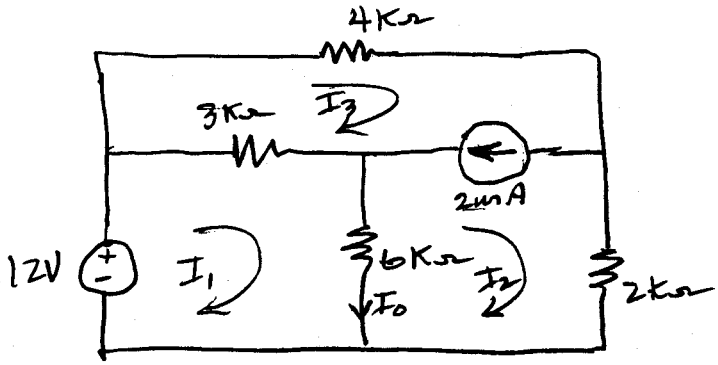
$V_o + (1K)I_3 + (1K)I_1 = 0$

$V_o = -1K\,(I_1 + I_3)$

$V_o = -1K\,(5\,mA - 7\,mA)$

$\boxed{V_o = 2\,V}$

3.54 wlg



$3K(I_1 - I_3) + 6K(I_1 - I_2) = 12$

$9KI_1 - 6KI_2 - 3KI_3 = 12$ ✓

$(4K)I_3 + (2K)I_2 = 12$

$0I_1 + 2KI_2 + 4KI_3 = 12$ ✓

$I_3 - I_2 = 2\,mA$ ✓

$0I_1 - I_2 + I_3 = 2mA$

$$\begin{bmatrix} 9K & -6K & -3K \\ 0 & 2K & 4K \\ 0 & -1 & 1 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} 12 \\ 12 \\ .002 \end{bmatrix}$$

$I_1 = 2.667$

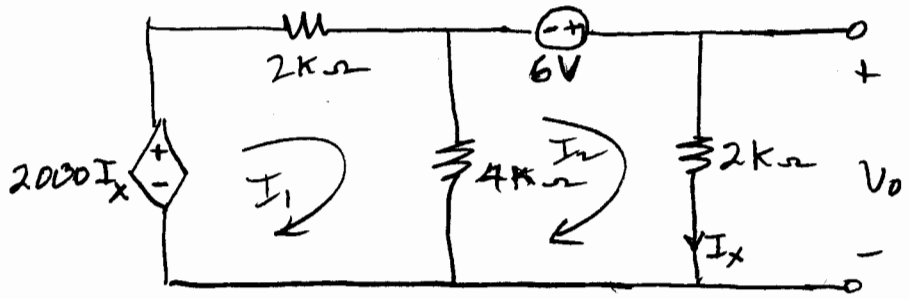
$I_2 = 0.667$

$I_3 = 2.667$

$I_0 = I_1 - I_2 = 2.667 - 0.667$

$I_0 = 2\,mA$

3.65 wlg



$$6K I_1 - 4K I_2 = 2000 I_x = 2000 I_2$$

$$\boxed{6K I_1 - 6K I_2 = 0}$$

$$\boxed{-4K I_1 + 6K I_2 = 6}$$

$$\begin{bmatrix} 6K & -6K \\ -4K & 6K \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 0 \\ 6 \end{bmatrix}$$

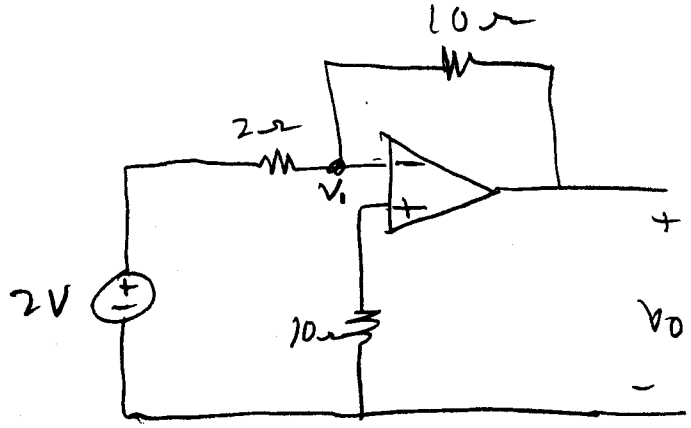
$I_1 = 3\,mA$

$I_2 = 3\,mA$

$V_o = I_2 \times 2K = (3mA)(2K)$

$$\boxed{V_o = 6V}$$

3.71 wlg



At V_1:

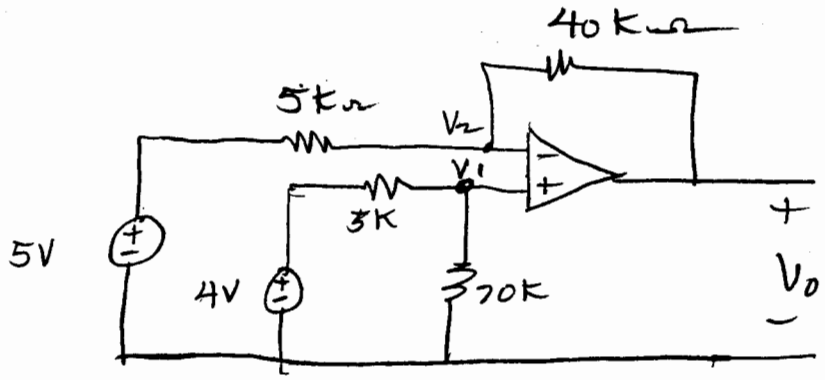
$$\frac{2 - V_1}{2} = \frac{V_1 - V_o}{10}$$

but $V_1 = 0$

$$1 = -\frac{V_o}{10}$$

$$\boxed{V_o = -10V}$$

3.74 Wlg



$$V_1 = \frac{4 \times 20K}{5K + 20K} = \frac{80}{25} = V_2 = 3.2$$

$$\frac{5 - V_2}{5K} = \frac{V_2 - V_o}{40K}$$

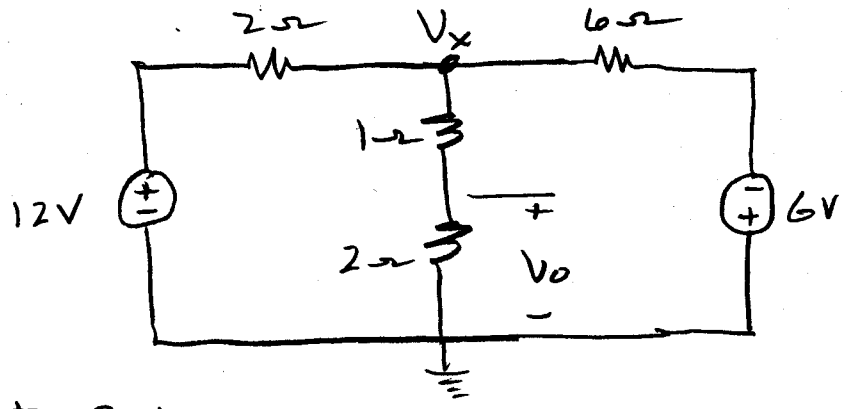
$$\frac{5 - 3.2}{5K} = \frac{3.2 - V_o}{40K}$$

$$(1.8)40K = 16K - 5KV_o$$

$$5V_o = -72 + 16 = -56$$

$$\boxed{V_o = -11.2}$$

3FE-1



Find V_o:

I will use nodal analysis to find V_x

$$\frac{V_x - 12}{2} + \frac{V_x + 6}{6} + \frac{V_x}{3} = 0$$

$$3V_x - 36 + V_x + 6 + 2V_x = 0$$

$$6V_x = 30$$

$$V_x = 5\ V$$

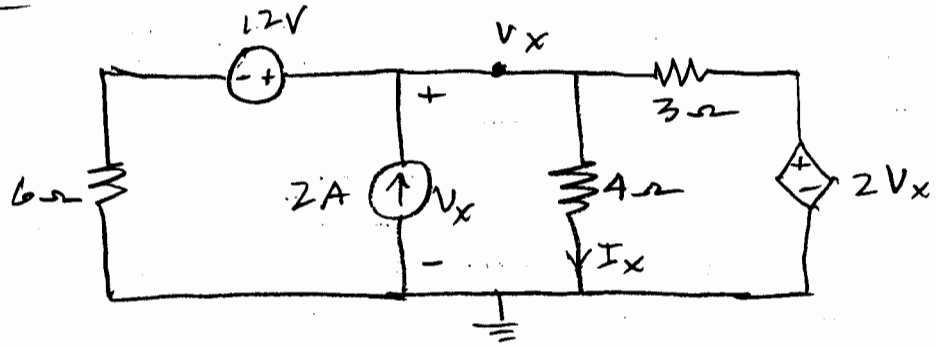
Use voltage division

$$V_o = \frac{V_x \times 2}{1+2}$$

$$V_o = \frac{5 \times 2}{3}$$

$$\boxed{V_o = \frac{10}{3}\ V}$$

3FE-3



Use nodal analysis to find V_x's

$$\frac{V_x - 12}{6} + \frac{V_x}{4} + \frac{V_x - 2V_x}{3} = 2A$$

$$2V_x - 24 + 3V_x + 4V_x - 8V_x = 24$$

$$V_x = 48$$

$$I_x = \frac{V_x}{4} = \frac{48}{4}$$

$$I_x = 12\ A$$