ESE 271 First Exam Name:

Fall, 2009 ID Number:

Do not place your answers on this front page.

Each problem is worth 25 points.

Prob. 1:

Prob. 2:

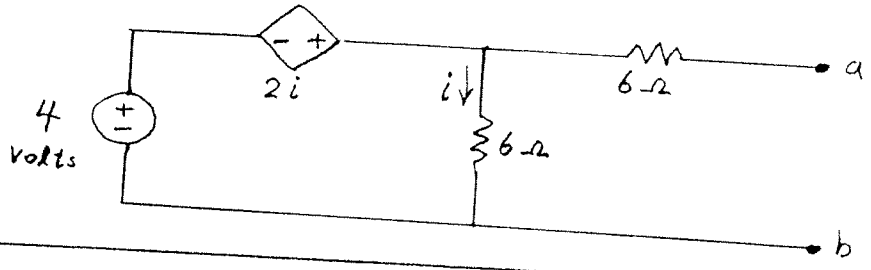
Prob. 3:

Prob. 4:

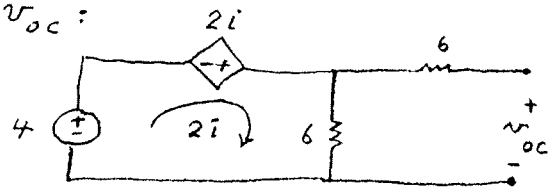
1st exam

Prob. 1:

Find the Thevenin equivalent circuit as seen from the terminals: a,b.



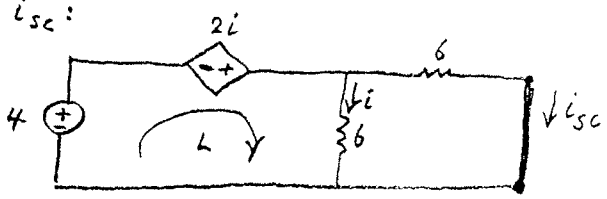

To get $v_{oc}$:




KVL: $-4 - 2i + 6i = 0$. So, $i = 1\,A$

$\therefore v_{oc} = 6\ V$

To get $i_{sc}$:



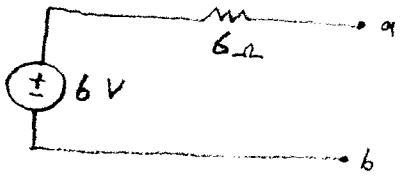

$i = i_{sc}$

KVL around the loop L: $-4 - 2i_{sc} + 6i_{sc} = 0$

So, $i_{sc} = 1\ A$.

So, $r_{TH} = \frac{v_{oc}}{i_{sc}} = \frac{6}{1} = 6\,\Omega$

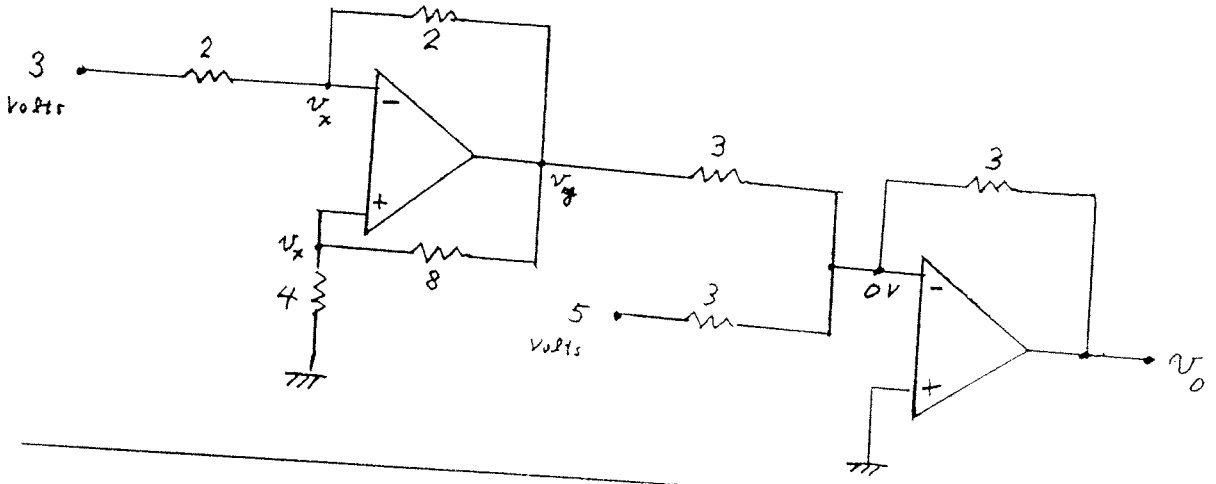
Thevenin's circuit is:



1st exam

**Prob. 2:**

Find the output voltage $v_o$. Use the virtual-short virtual-open model for the op-amps. (Resistor values are in kΩ.)




$$\frac{3 - v_x}{2} + \frac{v_y - v_x}{2} = 0$$

$$v_x = v_y \frac{4}{4+8}$$

} HENCE, BY SECOND EQUATION

$$v_y = 3 v_x$$

BY FIRST EQUATION: $v_x = -3$ V

So, $v_y = -9$ V

$3 - v_x + 3v_x - v_y = 0$

$v_x = -3$

ALSO

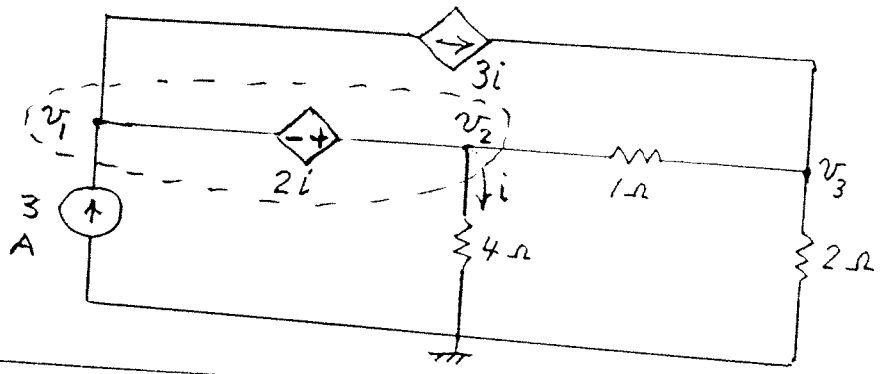
$$\frac{v_y}{3} + \frac{5}{3} + \frac{v_o}{3} = 0$$

So, $v_o = 4$ V

1st exam

**Prob. 3:**

Using a nodal analysis, determine the node voltage $v_2$.




PUT A BALLOON AROUND THE 2i DEPENDENT SOURCE.

INSIDE THAT BALLOON:

$$v_2 - v_1 = 2i = 2\,\frac{v_2}{4} = \frac{v_2}{2}\,, \qquad i = \frac{v_2}{4}$$

THUS, $\boxed{-2v_1 + v_2 = 0}$

KCL ON THE BALLOON:

$$-3 + 3i + \frac{v_2}{4} + \frac{v_2 - v_3}{1} = 0$$

$$\boxed{2v_2 - v_3 = 3}$$

KCL AT $v_3$ NODE: $\quad -3i + \dfrac{v_3 - v_2}{1} + \dfrac{v_3}{2} = 0$

$$\boxed{-7v_2 + 6v_3 = 0}$$

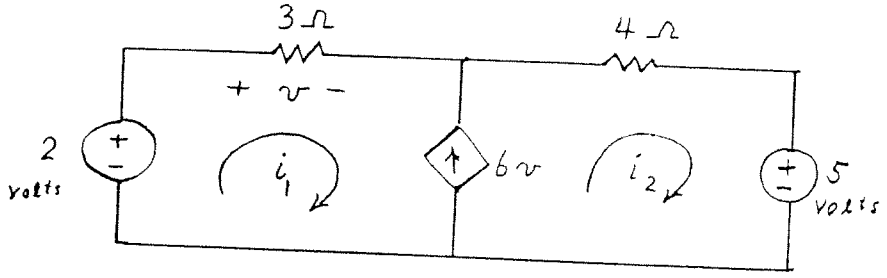
SOLVING THE SECOND AND THIRD EQUATIONS:

$$v_2 = \frac{18}{5}$$

1st exam

**Prob. 4:**

Do a mesh analysis to write two simultaneous equations in $i_1$ and $i_2$ as the unknowns. Display your answer by filling in the appropriate numbers in the following matrix equation.




$$\begin{bmatrix} -19 & 1 \\ 3 & 4 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \end{bmatrix} = \begin{bmatrix} 0 \\ -3 \end{bmatrix}$$

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At dependent source:

$$i_2 - i_1 = 6v = 6 \times 3i_1 = 18i_1$$

THUS, $\quad -19i_1 + i_2 = 0$

THEN, KVL AROUND OUTER LOOP:

$$-2 + 3i_1 + 4i_2 + 5 = 0$$

THUS,

$$3i_1 + 4i_2 = -3$$