ESE 271 First Exam Name:

Spring, 2002 ID Number:

Do not place your answers on this front page.

Each problem is worth 25 points.

Prob. 1:

Prob. 2:

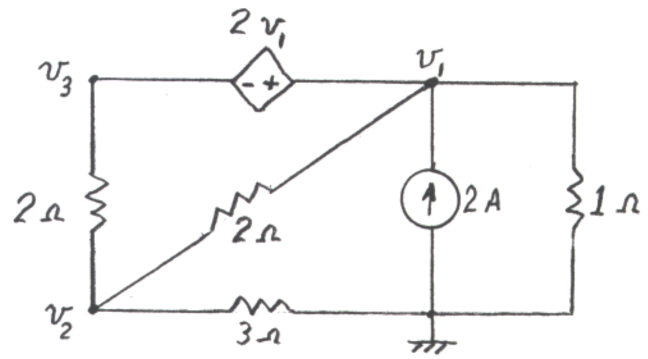
Prob. 3:

Prob. 4:

Prob. 1:

Using a nodal analysis, write three equations for the unknown node voltages v_1, v_2, and v_3. Then, combine those equations into matrix form using those unknown node voltages in the order stated.

(Write your answers neatly—otherwise, points may be taken off.)



INSIDE A BALLOON AROUND THE DEPENDENT VOLTAGE SOURCE:

$$v_1 - v_3 = 2v_1 \quad \Rightarrow \quad v_1 + v_3 = 0$$

ON THAT BALLOON:

$$\frac{v_3 - v_2}{2} + \frac{v_1 - v_2}{2} - 2 + \frac{v_1}{1} = 0 \quad \Rightarrow \quad 3v_1 - 2v_2 + v_3 = 4$$

AT THE NODE FOR v_2:

$$\frac{v_2 - v_3}{2} + \frac{v_2 - v_1}{2} + \frac{v_2}{3} = 0 \quad \Rightarrow \quad -3v_1 + 8v_2 - 3v_3 = 0$$

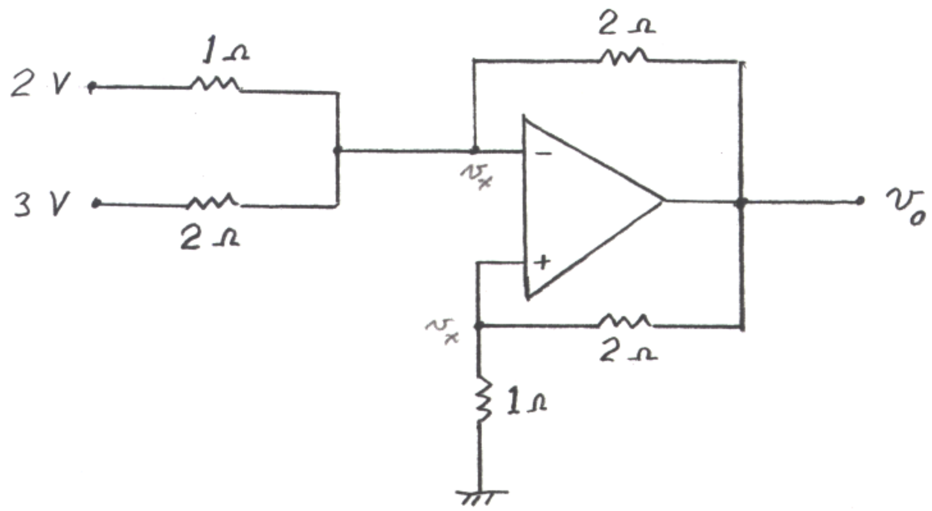
So,

$$\begin{bmatrix} 1 & 0 & 1 \\ 3 & -2 & 1 \\ -3 & 8 & -3 \end{bmatrix} \begin{bmatrix} v_1 \\ v_2 \\ v_3 \end{bmatrix} = \begin{bmatrix} 0 \\ 4 \\ 0 \end{bmatrix}$$

NOTE: REARRANGEMENTS OF THESE EQUATIONS WILL YIELD OTHER CORRECT ANSWERS.

Prob. 2:

Find the output voltage v_o.



$$\frac{2-v_x}{1} + \frac{3-v_x}{2} = \frac{v_x - v_o}{2} \Rightarrow \frac{v_o}{2} - 2v_x = -\frac{7}{2}$$

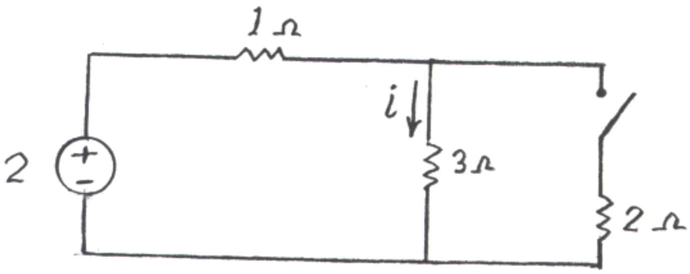
$$v_x = \frac{1}{1+2} v_o \Rightarrow v_o - 3v_x = 0$$

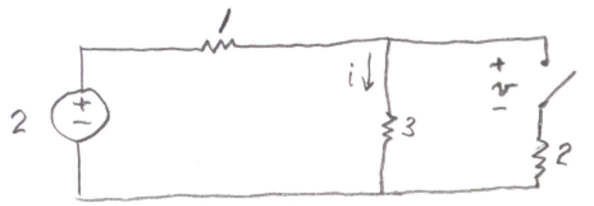
MULTIPLY FIRST EQUATION BY $-\frac{3}{2}$ AND THEN ADD BOTH EQUATIONS

$$v_o = 21 \text{ V}$$

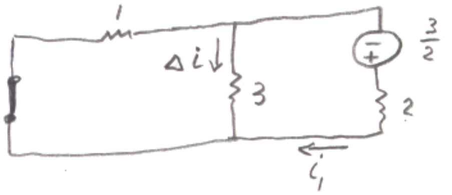
Prob. 3:

How much does i change when the switch is closed?





$$v = 2 \times \frac{3}{1+3} = \frac{3}{2}$$



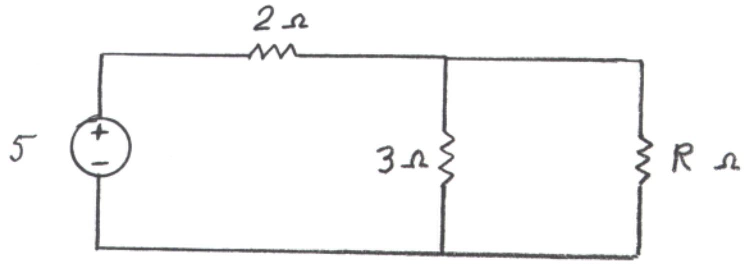
$$i_1 = \frac{\frac{3}{2}}{2 + \frac{3 \times 1}{3+1}} = \frac{\frac{3}{2}}{2 + \frac{3}{4}} = \frac{6}{11}$$

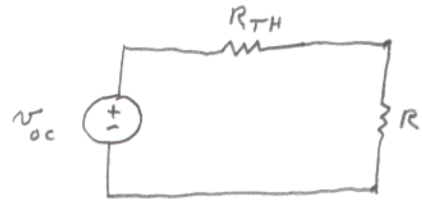
$$\Delta i = -\frac{1}{1+3} \times \frac{6}{11} = -\frac{6}{44} = \underline{\underline{-.1364}}$$

Prob. 4:

(a) For what value of R will the power absorbed in R be a maximum?

(b) What is the value of that maximum power?





$$R_{TH} = \frac{2 \times 3}{2+3} = \frac{6}{5} \ \Omega$$

$$v_{oc} = 5 \times \frac{3}{2+3} = 3 \text{ V}$$

So, for max. power:

(a) $R = R_{TH} = \frac{6}{5} \ \Omega$

(b) $P_{MAX} = \frac{1}{4} \cdot \frac{v_{oc}^2}{R_{TH}} = \frac{1}{4} \times \frac{3^2}{6/5} = \frac{45}{24} = \frac{15}{8} = 1.875 \text{ W}$