**Name:** ________________________________________ **(Print)**

**Signature** ________________________________________

**Date:** _____________

# ECE 2300 -- Quiz #3

S.R. Brankovic Section – MW 11:30 AM

October 5, 2005

# KEEP THIS QUIZ CLOSED AND FACE UP UNTIL YOU ARE TOLD TO BEGIN.

1. This quiz is closed book, closed notes.
2. Show all work on these pages. Show all work necessary to complete the problem. A solution without the appropriate work shown will receive no credit. A solution which is not given in a reasonable order will lose credit. **If your work continues on to another page, indicate clearly where your work can be found. Failure to indicate this clearly will result in a loss of credit.**
4. Show all units in solutions, intermediate results, and figures. Units in the quiz will be included between square brackets.
5. Do not use red ink. Do not use red pencil.
6. You will have 25 minutes to work on this quiz.

_________________/100 %

Problem #1.
Use the node-voltage method to write a complete set of independent equations that could be used to solve this circuit shown in Figure 1. **Do not attempt to solve the equations**. **Do not attempt to simplify the circuit**.

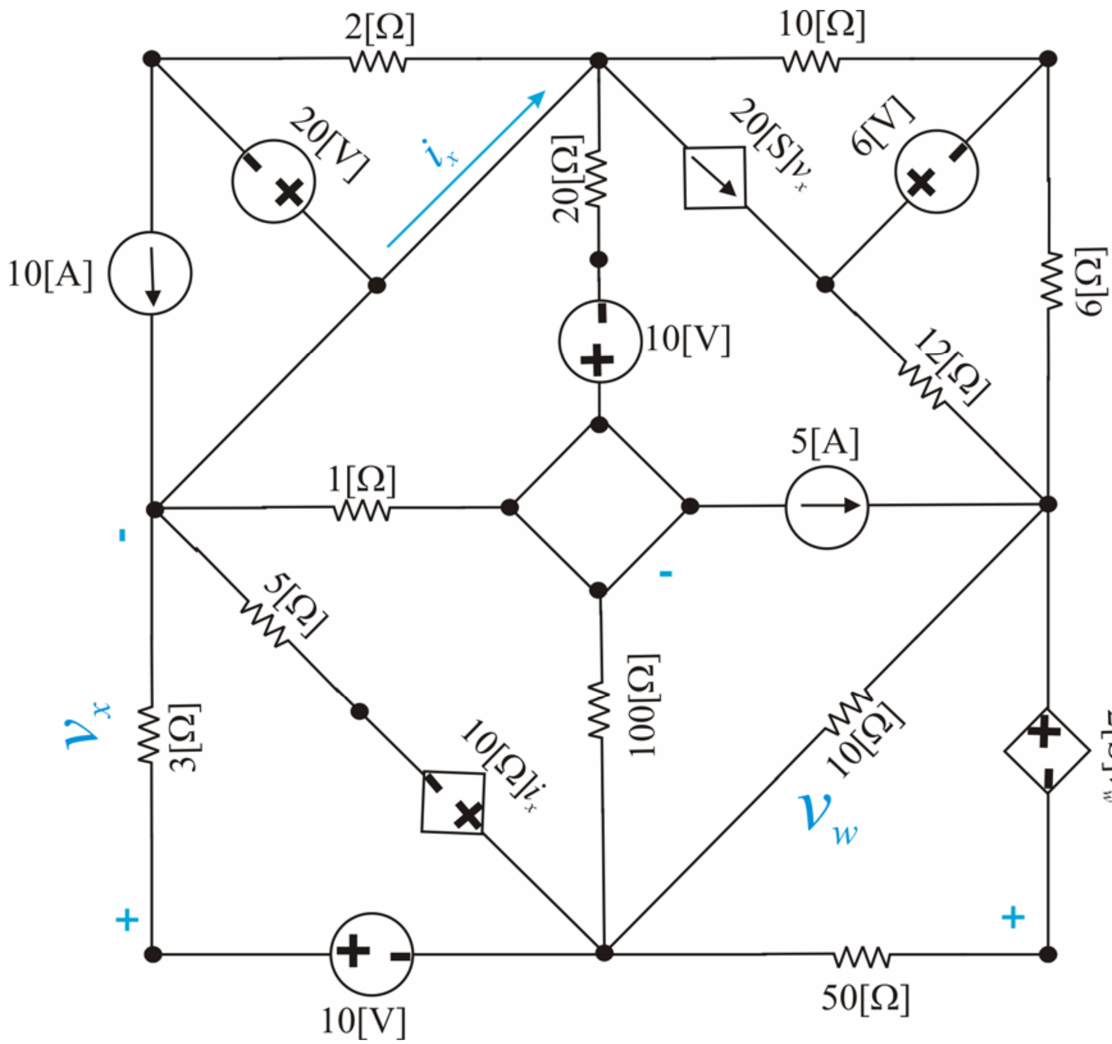


Figure 1.

Solution:

We have to check carefully this a little odd looking circuit. If we have done that, we would see that there are 7 essential nodes. We would see also that we do have two dependent voltage sources and one dependent current source with unknown variables $v_w$, $v_x$ and $i_x$ on which they depend on. This means that we need to write $n$-1+3=9 (n= # of essential nodes) independent equations in order to solve this circuit. So the first thing to do is to identify the nodes, lavel them and label the node votages. Also we need to pick the most convenient essential node to be our reference node (the essential node with biggest number of connections). In Figure 2 our circuit with new labels and identified nodes and node voltages is presented. So let's start writing our equations:

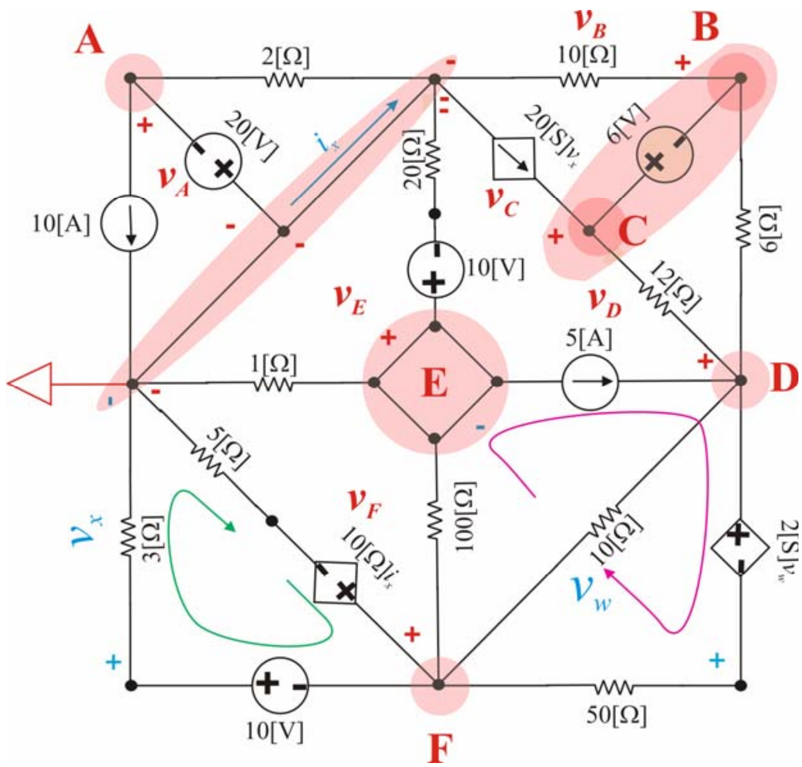


**Figure 2.** Circuit in Figure 1 labeled according to equation set presented below.

A) This is the simplest and the best case, we do have the voltage source in between the essential node and the reference node:

$$v_A = -20[V]$$

B) +C) Here we have the voltage source between the two essential nodes (B+C) situation. So we have a SUPER NODE, we need SUPER NODE KCL EQUATION, so we will than consider equation for B+C closed surface shown in Fig 2. We have:

B+C) $$\frac{v_B}{10[\Omega]} + \frac{v_B - v_D}{6[\Omega]} - 20[S] \cdot v_x + \frac{v_C - v_D}{12[\Omega]} = 0$$

We also need additional equation, called constraint equation for this super node which is:

B+C) $$v_C - v_B = 6[V]$$

D) For this node we have situation where the voltage source is in series with the element of the circuit (resistor) so we should have KCL equation that looks like:

$$\frac{v_D - v_B}{6[\Omega]} + \frac{v_D - v_C}{12[\Omega]} - 5[A] + \frac{v_D - (v_F + 2[S]\cdot v_W)}{50[\Omega]} + \frac{v_D - v_F}{10[\Omega]} = 0$$

E) For this node the situation is the same as for D, so KCL equation we have:

$$5[A] + \frac{v_E - 10[V]}{20[\Omega]} + \frac{v_E}{1[\Omega]} + \frac{v_E - v_F}{100[\Omega]} = 0$$

F) And for this node the situation is similar again as for the node E and D, so we have KCL equation that is:

$$\frac{v_F + 10[V]}{3[\Omega]} + \frac{v_F - 10[\Omega]\cdot i_X}{5[\Omega]} + \frac{v_F - v_E}{100[\Omega]} + \frac{v_F - v_D}{10[\Omega]} + \frac{v_F - v_D + 2[S]\cdot v_W}{50[\Omega]} = 0$$

Now, since we finished our KCL equations set for our essential nodes, we need to define our variables, upon which our dependent sources depend on, so let's do it for $i_x$ first:

$$KCL \text{ for the node in between the A and B}:$$
$$i_X = -\frac{v_A}{2[\Omega]} - \frac{v_B}{10[\Omega]} + 20[S]\cdot v_X - \frac{v_E - 10[V]}{20[\Omega]}$$

And to define $v_x$ we will be using KVL for the green loop indicated in Figure 2.;

$$v_X = v_F + 10[V]$$

And for $v_w$ we will be using KVL for pink loop indicated in Figure 2:

$$v_E - v_D + 2[S]\cdot v_w + v_w = 0 \Rightarrow v_W = \frac{v_D - v_E}{(2[S]+1)}$$

And that is the end of the problem, the full set of the equation is listed below:

$$v_A = -20[V]$$
$$\frac{v_B}{10[\Omega]} + \frac{v_B - v_D}{6[\Omega]} - 20[S]\cdot v_x + \frac{v_C - v_D}{12[\Omega]} = 0$$
$$v_C - v_B = 6[V]$$
$$\frac{v_D - v_B}{6[\Omega]} + \frac{v_D - v_C}{12[\Omega]} - 5[A] + \frac{v_D - (v_F + 2[S]\cdot v_W)}{50[\Omega]} + \frac{v_D - v_F}{10[\Omega]} = 0$$

$$5[A]+\frac{v_E-10[V]}{20[\Omega]}+\frac{v_E}{1[\Omega]}+\frac{v_E-v_F}{100[\Omega]}=0$$

$$\frac{v_F+10[V]}{3[\Omega]}+\frac{v_F-10[\Omega]\cdot i_X}{5[\Omega]}+\frac{v_F-v_E}{100[\Omega]}+\frac{v_F-v_D}{10[\Omega]}+\frac{v_F-v_D+2[S]\cdot v_W}{50[\Omega]}=0$$

$$i_X=-\frac{v_A}{2[\Omega]}-\frac{v_B}{10[\Omega]}+20[S]\cdot v_X-\frac{v_E-10[V]}{20[\Omega]}$$

$$v_X=v_F+10[V]$$

$$v_W=\frac{v_D-v_E}{(2[S]+1)}$$