

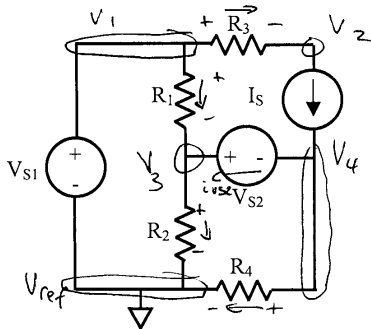
Name SOLUTION

EE301 Feb. 13, 2009

Quiz 3 - No Calculators - pencil (or pen) and paper only

**Problem 1:** Use Node Analysis

1. Identify all of the nodes. Assume the ground node is the reference node and that its voltage is known to be zero. Assume  $V_{S1}$ ,  $V_{S2}$ , and  $R_s$  are given.  ~~$I_s$  too~~
2. List the node voltages that are known (if any).  $V_1$
3. Of the unknown node voltages, list the node voltages that are independent (if any).
4. Of the unknown node voltages, list the node voltages that are dependent (if any).
5. Write the equations to solve for all of the unknown node voltages by **node analysis**.
6. Box the equations you would use to solve the system.
  - a. Reduce to the form of:  $[1/R_1 + 1/R_2]V_1 + [1/R_3]V_2 = V_{S1}/R_4$  (this is not one of the equations - just an example of the level of reduction desired in solution)
7. List the unknown quantities you are solving for.  $\rightarrow V_2, V_3, V_4$
8. Write an equation to solve for the current through  $R_1$  in terms of node voltages.  $\frac{V_1 - V_3}{R_1} = I_{R1}$
9. Write an equation to solve for the voltage across  $R_3$  in terms of node voltages.  $V_{R3} = V_1 - V_2$



2)  $V_1 = V_{S1}$  ←

3)  $V_2$

4)  $V_3, V_4 \rightarrow V_3 - V_4 = V_{S2}$  Eq 1

KCL N3

$$I_{R1} - I_{R2} + I_{S2} = 0$$

KCL N4

$$I_S - I_{S2} - I_{R4} = 0$$

$$I_{S2} = I_S - I_{R4}$$

COMBINED N3 | N4 KCL (SUPERNODE)

$$I_{R1} - I_{R2} + I_{S2} - I_{R4} = 0 \Rightarrow \left[ \frac{V_1 - V_3}{R_1} \right] - \left[ \frac{V_3 - V_{ref}}{R_2} \right] + I_S - \left[ \frac{V_4 - V_{ref}}{R_4} \right] = 0$$

$$\frac{V_{S1}}{R_1} + I_S = \left[ \frac{1}{R_1} + \frac{1}{R_2} \right] V_3 + \left[ \frac{1}{R_4} \right] V_4 \quad \text{Eq. 2}$$

Sol.) KCL N2

$$I_{R3} - I_S = 0$$

$$\frac{V_1 - V_2}{R_3} - I_S = 0$$

$$\boxed{-\frac{V_2}{R_3} = I_S - \frac{V_{S1}}{R_3}} \quad \leftarrow \text{Eq. 2}$$

OR  $V_2 = R_3(I_S - V_{S1}/R_3)$

$$V_2 = R_3 I_S - V_{S1}$$