

ECE203 DC Circuits

Midterm Exam 2A 10/13/2009

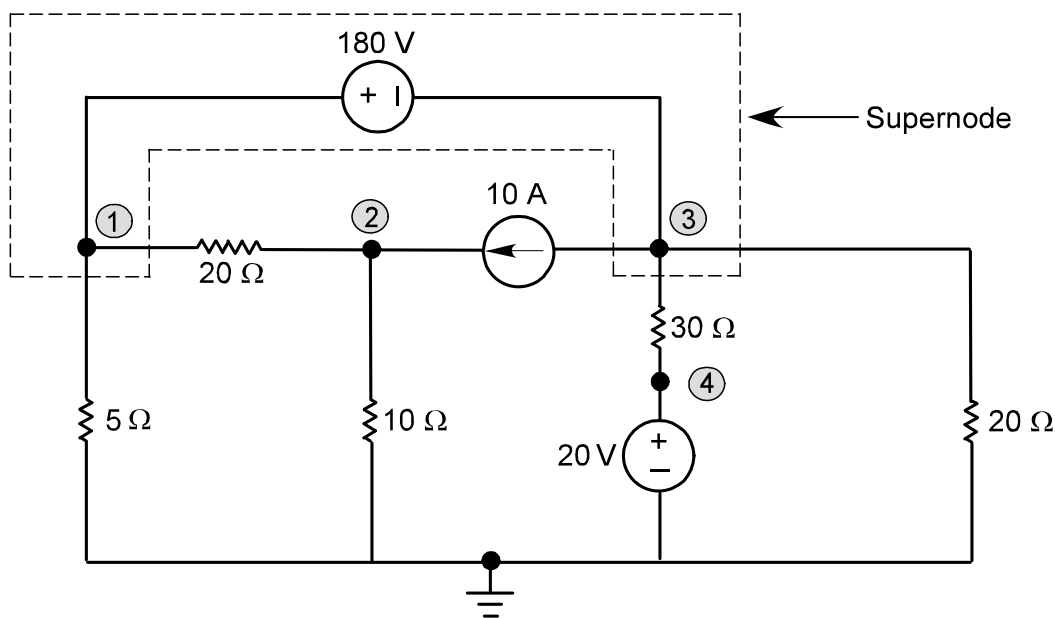
NAME: _____ KEY _____

- **NO PARTIAL CREDIT WILL BE GIVEN** without a full explanation of the procedure followed to arrive at your solution.
- An 8 ½ x11 inch formula sheet may be used. Laptops may not be used.
- Time allowed : 50 minutes.
- Put a box around your solution. **DON'T FORGET UNITS AND CONDITIONS ON VALIDITY.**
- You may use both sides of this sheet of paper for your answer. Please use the back of the previous page.

Question #	Possible Points	Awarded Points
1	25	
2	25	
3	25	
4	25	
Total	100	

1.

- a) Write the nodal equations needed to solve for all nodal voltages in the following circuit. **Do not attempt to solve these equations.**



$$V_1 = V_3 + 180 \text{ and } V_4 = 20$$

$$\frac{V_1}{5} + \frac{V_1 - V_2}{20} + 10 + \frac{V_3}{20} + \frac{V_3 - 20}{30} = 0$$

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

- b) Assume the answer to part (a) is the following set of equations (NOTE: this is **not** the answer to part (a)). Solve them for all nodal voltages. Use the back of the previous page.

$$V_3 = V_1 + 20$$

$$19 + \frac{V_1 - 180}{10} + \frac{V_1}{20} + \frac{V_1 + 20}{20} + \frac{(V_1 + 20) - V_2}{5} = 0$$

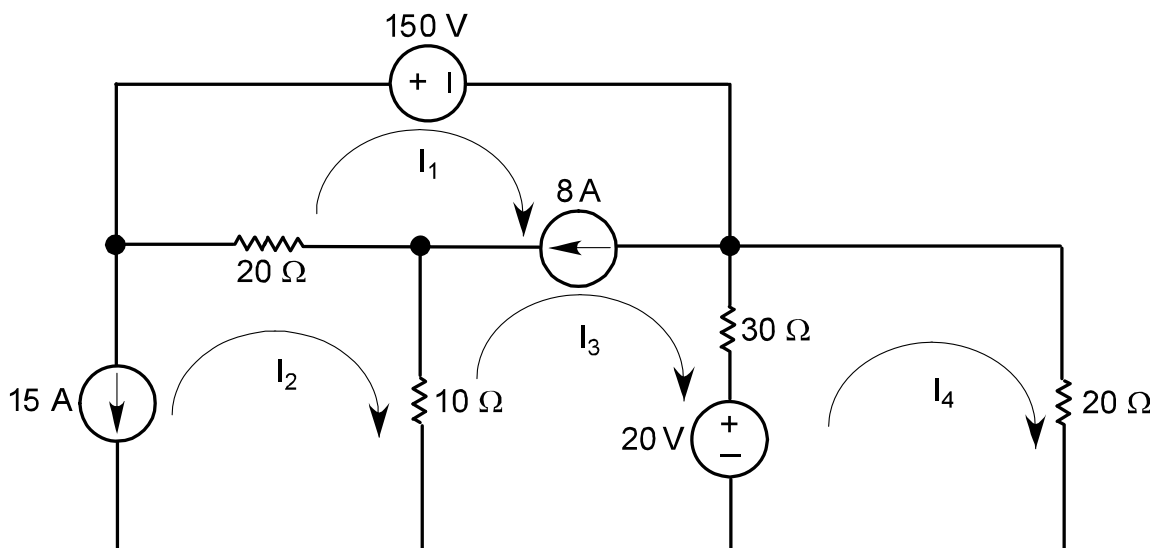
$$-19 + \frac{V_2 - (V_1 + 20)}{5} + \frac{V_2}{30} = 0$$

The above equations give: $0.4V_1 - 0.2V_2 = -6$ and $-0.2V_1 + 0.2333V_2 = 23$

Which solve to: $V_1 = 60 \text{ V}$, $V_2 = 150 \text{ V}$ and $V_3 = 80 \text{ V}$

2.

- a) Write the mesh equations needed to solve for all mesh currents in the following circuit. **Do not attempt to solve these equations.**



$$I_1 - I_3 = 8$$

$$I_2 = -15$$

$$150 + 30(I_3 - I_4) + 20 + 10(I_3 - I_2) + 20(I_1 - I_2) = 0$$

$$30(I_4 - I_3) + 20 I_4 - 20 = 0$$

- b) Assume part of the answer to part (a) is $I_3 = -9$ A (NOTE: this is **not** the answer to part (a)). Determine the power produced by the 150 V source.

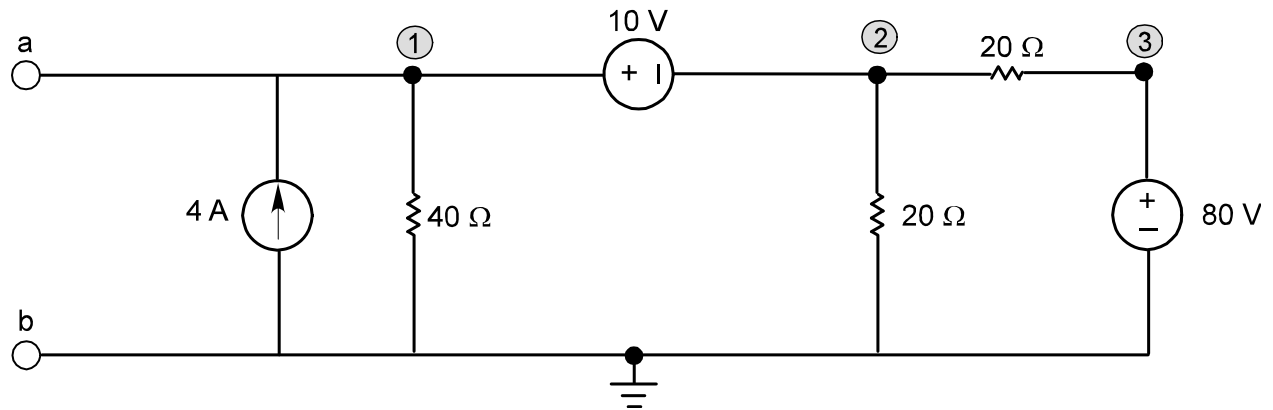
Given: $I_1 - I_3 = 8$ and $I_3 = -9$ then $I_1 = -1$ A

Because I_1 enters the "+" terminal the power "consumed" is given by:

$$P_{150V} = +150I_1$$

$$P_{150V} = 150 \times (-1) = -150 \text{ W (consumed)} = +150 \text{ W (produced)}$$

3. For the circuit shown below:



- Write and solve the nodal equation needed to determine V_1 .
- De-activate the sources and determine the resistance seen by terminals a—b, when they are open-circuited.
- Draw the Thevenin Equivalent at terminals a—b.
(NOTE: you can use source transforms to check this result, if you have time.)

$$V_2 = V_1 - 10 \quad \text{and} \quad V_3 = 80$$

$$-4 + \frac{V_1}{40} + \frac{V_2}{20} + \frac{V_2 - 80}{20} = 0$$

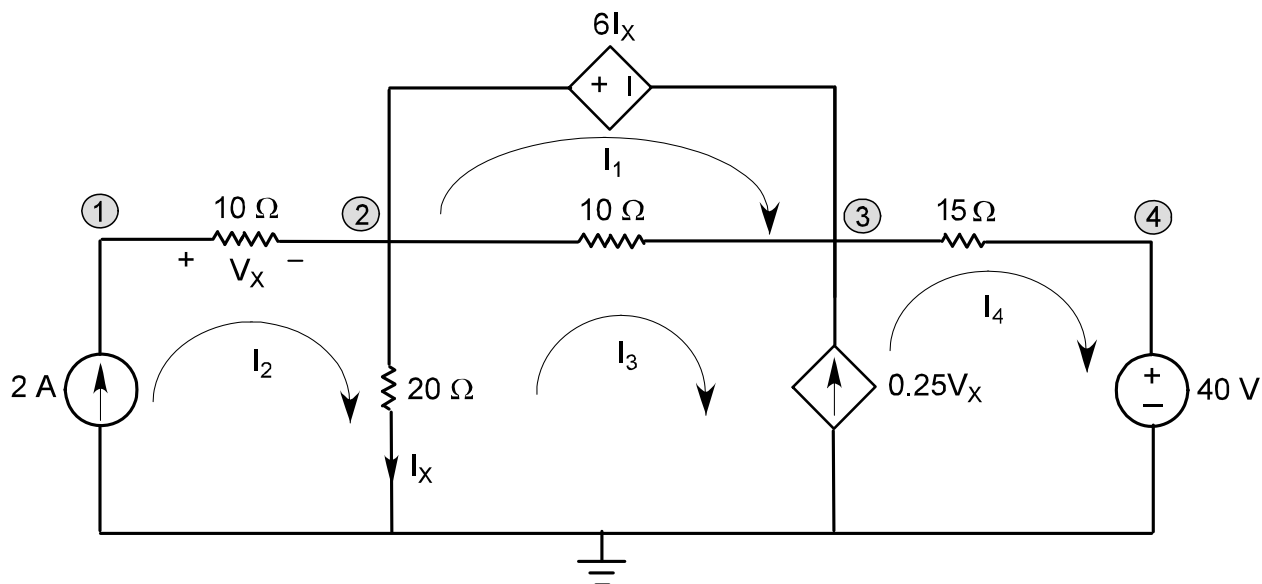
$$-4 + \frac{V_1}{40} + \frac{V_1 - 10}{20} + \frac{V_1 - 90}{20} = 0$$

$$0.125V_1 = 9$$

This solves to: $V_1 = 72 \text{ V} = V_{Th}$

$$R_{Th} = 40 // 20 // 20 = 8 \Omega$$

4. Use either nodal analysis or mesh analysis (your choice) to solve for either the nodal voltages or the mesh currents.



Using Nodal analysis:

$$V_2 = V_3 + 6I_X \text{ and } I_X = 0.05V_2 \text{ so } 0.7V_2 = V_3 \text{ also } V_4 = 40 \text{ V}$$

$$-2 + \frac{V_2}{20} - 0.25V_X + \frac{V_3 - 40}{15} = 0$$

Since: $V_X = V_1 - V_2$ then

$$-2 + \frac{V_2}{20} + 0.25V_2 - 0.25V_1 + \frac{0.7V_2 - 40}{15} = 0$$

$$-0.25V_1 + 0.3467V_2 = 4.667 \text{ and } V_2 = V_1 - 20, \text{ so } -0.25V_1 + 0.3467V_1 = 11.6$$

Which solves to: $V_1 = 120 \text{ V}$, $V_2 = 100 \text{ V}$ and $V_3 = 70 \text{ V}$

Using Mesh analysis:

$$I_4 - I_3 = 0.25V_X \text{ and } V_X = 10I_2 = 20 \text{ V so } I_4 - I_3 = 5 \text{ V}$$

$$6(I_2 - I_3) + 10(I_1 - I_3) = 0 \text{ putting } I_2 = 2 \text{ gives } 10I_1 - 16I_3 = -12$$

$$20(I_3 - I_2) + 10(I_3 - I_1) + 15I_4 + 40 = 0$$

$$-10I_1 + 30I_3 + 15I_4 = 0$$

Which solves to: $I_1 = -6 \text{ A}$, $I_2 = 2 \text{ A}$, $I_3 = -3 \text{ A}$ and $I_4 = 2 \text{ A}$