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ECE 53A Fall 2007, Midterm 1, October 16, 2007, Name **SOLUTIONS**

1. A battery has a rating of voltage=11V and current capacity=7AH. The battery is used to supply a portable computer which consumes 20W. What is the energy capacity (WH) of the battery? How long can the computer function on a fully charged battery?

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77 WH

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$\frac{77}{20}$ H

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2. A copper wire has dimensions of 30um thickness, 100um width, and 10cm length. The resistivity of the copper is about 2uohm-cm.

a. Derive the resistance of the wire.

$$\frac{2\times10^{-6} * 10}{\cancel{30}3\times10^{-4} * 100\times10^{-4}} = \frac{2}{3}\Omega$$

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b. Suppose the wire carries 0.1A current. Derive the voltage drop across the wire and power consumption on the wire.

$V = IR = (0.1)(2/3)$

$P = VI = I^2R = (0.1)^2 * \frac{2}{3}$

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3. The analysis of a linear resistive network uses three sets of equations: branch equations, Kirchhoff's current law and Kirchhoff's voltage law.

a. Describe the definition of the three sets of the equations.

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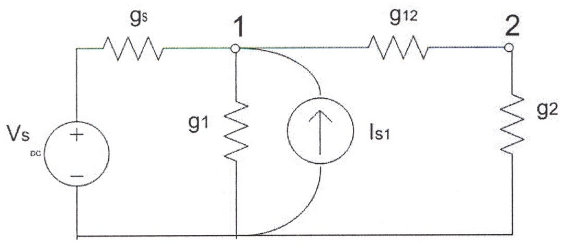
b. Use the following circuit as an example to derive the admittance matrix for nodal analysis.



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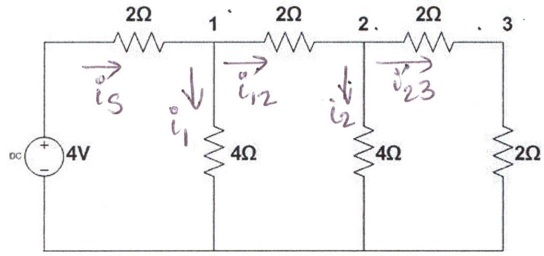
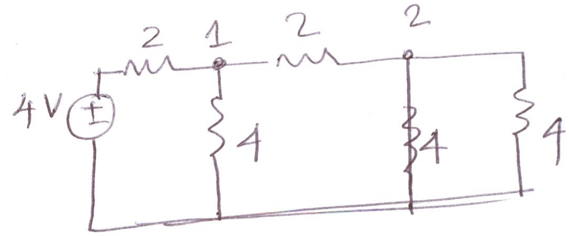
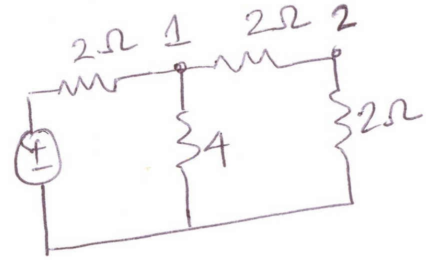
$$\begin{bmatrix} g_s + g_1 + g_{12} & -g_{12} \\ -g_{12} & g_{12} + g_2 \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} V_s g_s + I_{S1} \\ 0 \end{bmatrix}$$

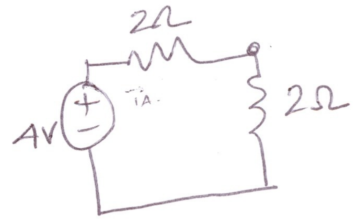
10 $8 \times 1 + 2$ For method.

4. Given a serial-parallel network shown in the figure derive the node voltages and branch currents of the circuit.









$V_1 = 2V$

$i_s = \frac{4V}{4\Omega} = 1A$

$i_1 = \frac{V_1}{4\Omega} = \frac{2}{4} = \frac{1}{2}A$

$\Rightarrow i_{12} = \frac{1}{2}A$

$\therefore V_2 = 2 - \frac{1}{2} * 2 = 1V$

$i_2 = \frac{1V}{4\Omega} = \frac{1}{4}A$

$\Rightarrow i_{23} = i_{12} - i_2 = \frac{1}{2} - \frac{1}{4} = \frac{1}{4}A$

$\Rightarrow V_3 = V_2 - i_{23} * 2 = 1V - \frac{1}{4} * 2 = \frac{1}{2}V$

$V_1 = 2V$ $\quad i_1 = \frac{1}{2}A$ $\quad i_{12} = \frac{1}{2}A$.

$V_2 = 1V$ $\quad i_2 = \frac{1}{4}A$

$V_3 = \frac{1}{2}V$ $\quad i_3 = \frac{1}{4}A$

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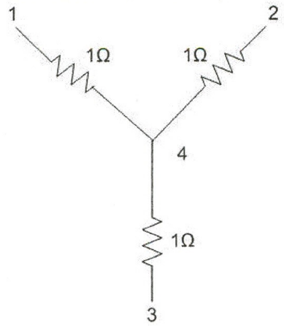
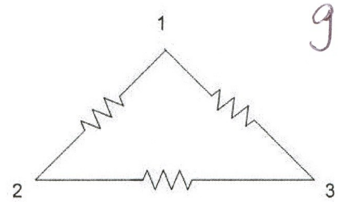
5. Given the following two Y shaped networks shown in the figure, the central node has no other connection, derive the two equivalent Delta networks.





$$g_{12} = \frac{1 * 1}{3} = \frac{1}{3}$$

$$r_{12} = r_{13} = r_{23} = \frac{3}{1}\,\Omega$$

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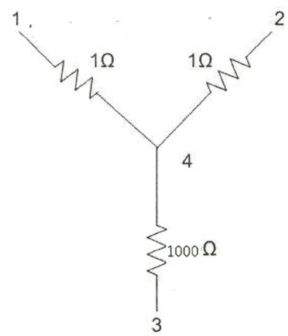

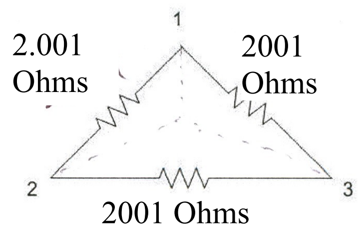

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G12 = g1*g2/(g1+g2+g3) = 1/2.001
i.e R12 = 2.001 Ohms

G13 = g1*g3/(g1+g2+g3) = .001/2.001
i.e R13 = 2001 Ohms

G23 = g2*g3/(g1+g2+g3) = .001/2.001
i.e R12 = 2001 Ohms

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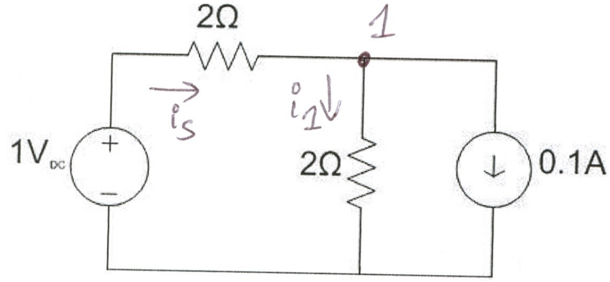
6. Use the superposition technique to derive the node voltages and branch currents of the circuit in the figure.



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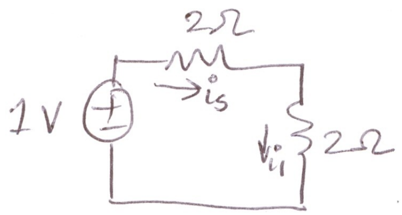

$V_1' = \frac{1}{2}V = .5V$

$i_1' = i_s = \frac{1}{4}A = .25A$

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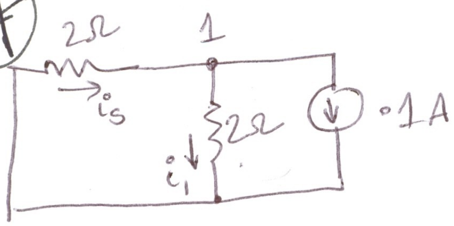

$i_1 = -0.05A$

$i_s = +0.05A$

$V_1'' = -0.05 \times 2\Omega = -0.1V$

$V_1 = \cancel{\frac{1}{2}} \; 0.5V - 0.1V = 0.4V.$

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$i_1 = .25A - .05A = \underline{.20A}$

$i_s = .25A + .05A = \underline{.30A}$

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7. A linear resistive network has only two ports as interface. Assume that the total current flowing into the two ports is zero, i.e. the current flowing into the first port is equal to the current flowing out the second port. The only equipment available is a voltmeter, and a 100 ohm resistor to shunt between the two ports.

Without the shunt resistor, the voltage across the two ports is 2V. With the shunt resistor, the voltage is 1V.

a. Derive the Thevenin's equivalent circuit of the network.

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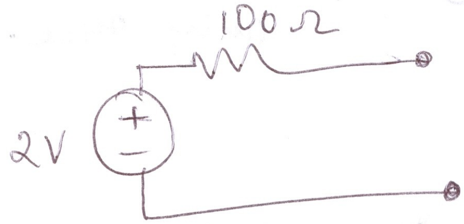

b. Derive the Norton's equivalent circuit of the network.

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