EE231 ELECTRIC CIRCUITS
SUMMER-2014

MIDTERM #1 SOLUTIONS

July 21, 2014
Total Time Allowed: 1.5 hours

1. Closed book exam.
2. You can use a calculator. NO cell phone or computer.
3. If you put down the wrong answer, partial credits will be given only if you show the correct steps.
4. Points will be taken off for answers without units.

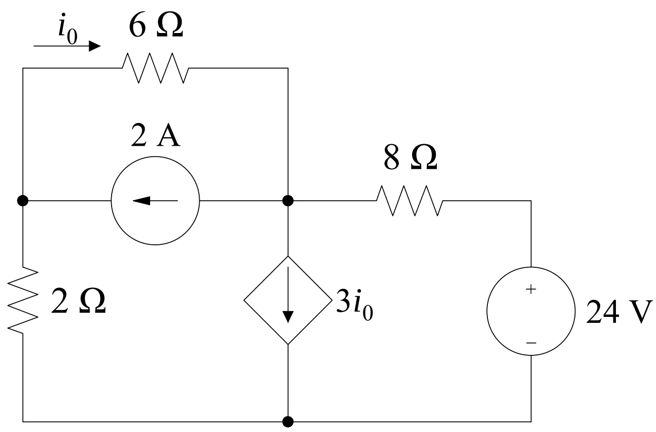
Name: ___________________________

Student ID: _______________________

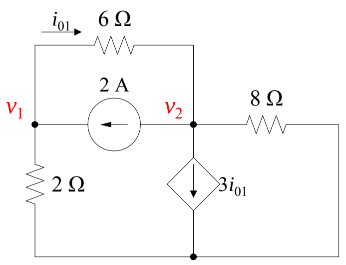
Signature: ________________________

QUESTIONS

1- For the circuit given below, use superposition to find the power dissipated on 6Ω resistance.



1. Apply the 2A-source, turn off the 24V-source:



Nodal analysis:

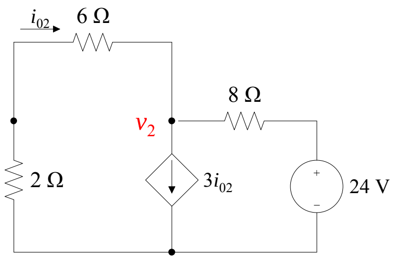
KCL eqn. for node 1: $\frac{v_1}{2} - 2 + \frac{v_1 - v_2}{6} = 0 \Rightarrow 4v_1 - v_2 = 12$ (1)

KCL eqn. for node 2: $\frac{v_2 - v_1}{6} + 2 + 3i_{01} + \frac{v_2}{8} = 0$

$i_{01} = \frac{v_1 - v_2}{6} \Rightarrow 8v_1 - 5v_2 = -48$ (2)

(1) & (2) $\Rightarrow v_1 = 9$ V $\quad v_2 = 24$ V $\quad i_{01} = \frac{9-24}{6} = -2.5$ A

2. <u>Apply the 24V -source, turn off the 2A -source:</u>

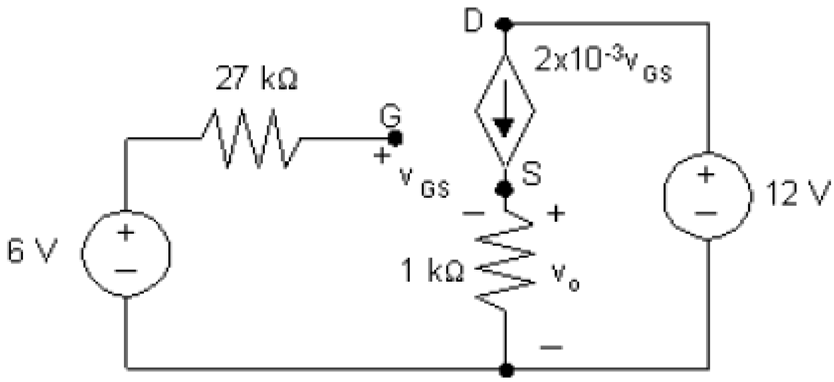


KCL eqn. for node 2: $\frac{v_2}{8} + 3i_{02} + \frac{v_2 - 24}{8} = 0$

$i_{02} = -\frac{v_2}{8} \Rightarrow v_2 = -24 \text{ V} \Rightarrow i_{02} = 3 \text{ A}$

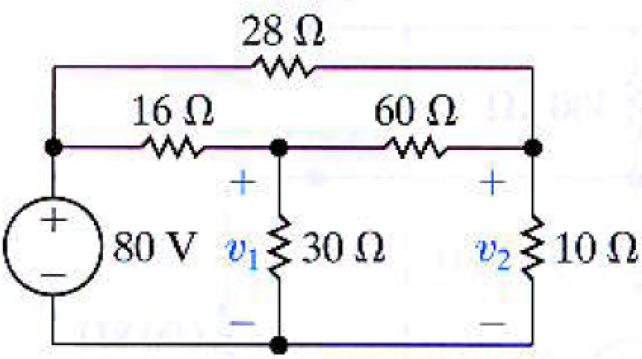
$\therefore i_0 = i_{01} + i_{02} = 0.5 \text{ A}$

2- Given the circuit shown in the figure, find the values of v_{GS} and v_o.

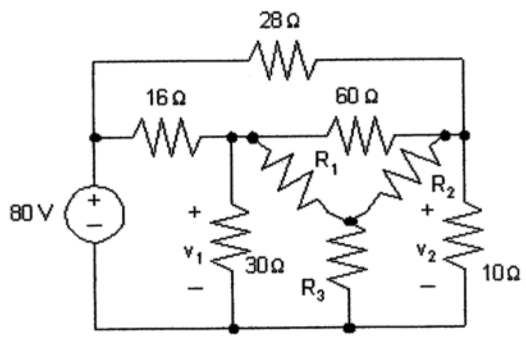


V_G=6V
V_{GS}=6-V_S
V_o=V_s=2.10-3.V_{GS}.1k
V_s=2.(6-V_s)
V_s=12-2Vs
V_s=4V
V_{GS}=6-4=2V

3- Use a Δ-to-Y transformation to find the voltages v_1 and v_2 in the circuit given below.



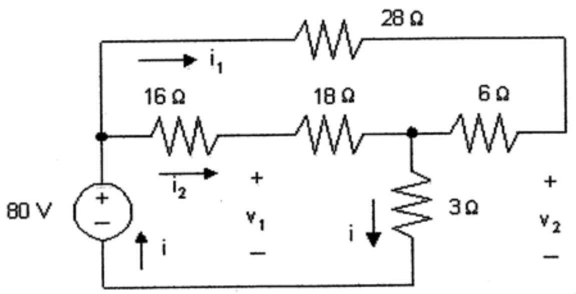
Begin by transforming the Δ-connected resistors $(10\,\Omega, 30\,\Omega, 60\,\Omega)$ to Y-connected resistors. Both the Y-connected and Δ-connected resistors are shown below to assist in using Eqs. 3.44 – 3.46:



Now use Eqs. 3.44 – 3.46 to calculate the values of the Y-connected resistors:

$$R_1 = \frac{(30)(60)}{10+30+60} = 18\,\Omega; \quad R_2 = \frac{(60)(10)}{10+30+60} = 6\,\Omega; \quad R_3 = \frac{(30)(10)}{10+30+60} = 3\,\Omega$$

The transformed circuit is shown below:



The equivalent resistance seen by the 80 V source can be calculated by making series and parallel combinations of the resistors to the right of the 24 V source:

$$R_{\rm eq} = (28+6)\|(16+18) + 3 = 34\|34 + 3 = 17 + 3 = 20\,\Omega$$

Therefore, the current i in the 80 V source is given by

$$i = \frac{80\text{ V}}{20\,\Omega} = 4\text{ A}$$

Use current division to calculate the currents i_1 and i_2. Note that the current i_1 flows in the branch containing the $28\,\Omega$ and $6\,\Omega$ series connected resistors, while the current i_2 flows in the parallel branch that contains the series connection of the $16\,\Omega$ and $18\,\Omega$ resistors:

$$i_1 = \frac{16+18}{16+18+28+6}(i) = \frac{34}{68}(4\text{ A}) = 2\text{ A}, \qquad \text{and} \qquad i_2 = 4\text{ A} - 2\text{ A} = 2\text{ A}$$

Now use KVL and Ohm's law to calculate v_1. Note that v_1 is the sum of the voltage drop across the $18\,\Omega$ resistor, $18i_2$, and the voltage drop across the $3\,\Omega$ resistor, $3i$:

$$v_1 = 18i_2 + 3i = 18(2\text{ A}) + 3(4\text{ A}) = 36 + 12 = 48\text{ V}$$

Finally, use KVL and Ohm's law to calculate v_2. Note that v_2 is the sum of the voltage drop across the $6\,\Omega$ resistor, $6i_1$, and the voltage drop across the $3\,\Omega$ resistor, $3i$:

$$v_2 = 6i_1 + 3i = 6(2\text{ A}) + 3(4\text{ A}) = 12 + 12 = 24\text{ V}$$