Name: _____ (please print)

Signature: _____

ECE 2300 – Exam #1
March 2, 2013

Keep this exam closed and face up until you are told to begin.

1. This exam is closed book, closed notes. You may use one 8.5" x 11" crib sheet, or its equivalent.
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.
3. It is assumed that your work will begin on the same page as the problem statement. If you choose to begin your work on another page, you must indicate this on the page with the problem statement, with a clear indication of where the work can be found. **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 exam will be included between square brackets.
5. Do not use red ink. Do not use red pencil.
6. You will have 90 minutes to work on this exam.

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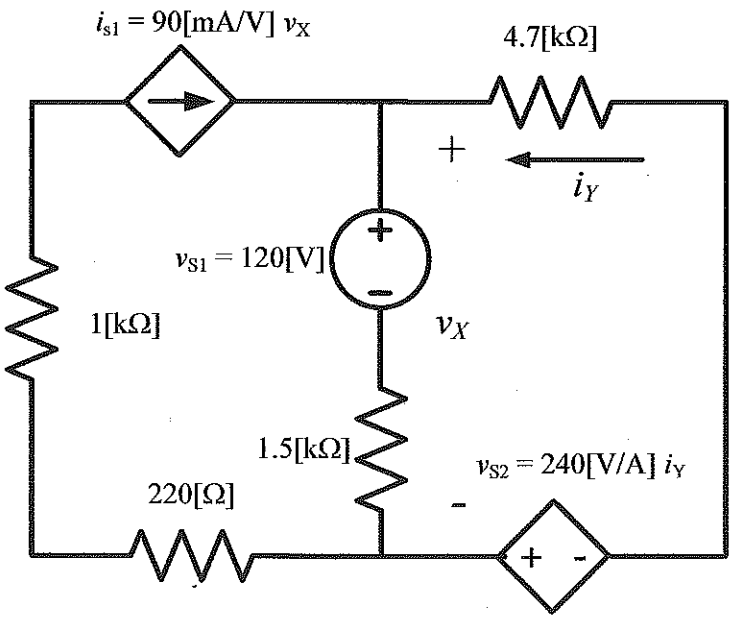
_____/35

_____/30

_____/100

Room for extra work

1. (35 points) For the circuit below, find the energy delivered by the dependent voltage source in a 5 second time interval.



Room for extra work

2. (35 points) A device, shown in Figure 1, has the voltage vs. current relationship plotted in Figure 2. The device can be modeled by a current source in parallel with a resistance.

Assume that two identical versions of this device are connected as shown in Figure 3. Notice the polarity of the device, as shown by the terminals labeled A and B.

a) Find v_X.
b) Find the power delivered by the voltage source in Figure 3.

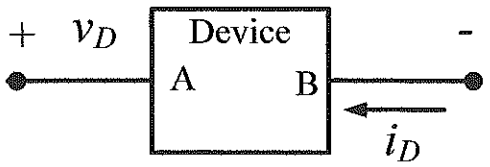


Figure 1

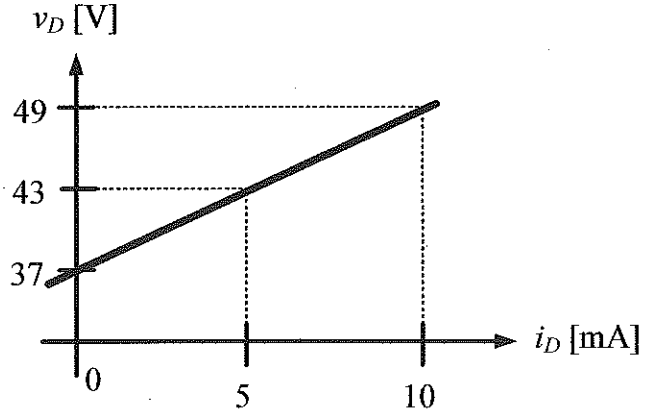


Figure 2

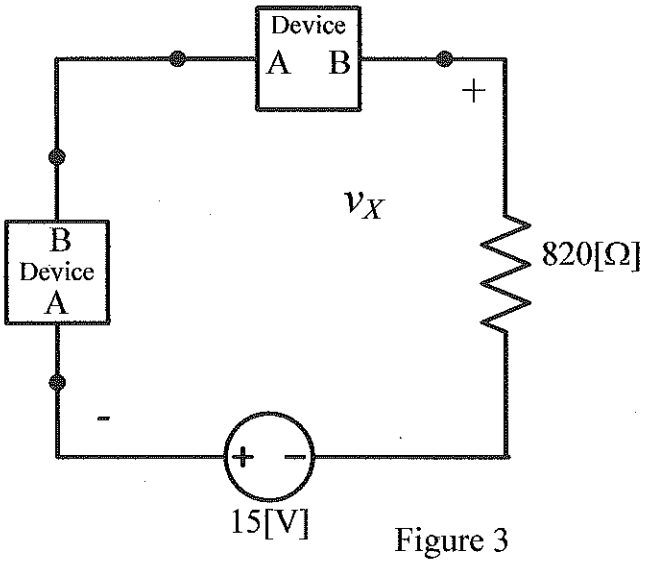
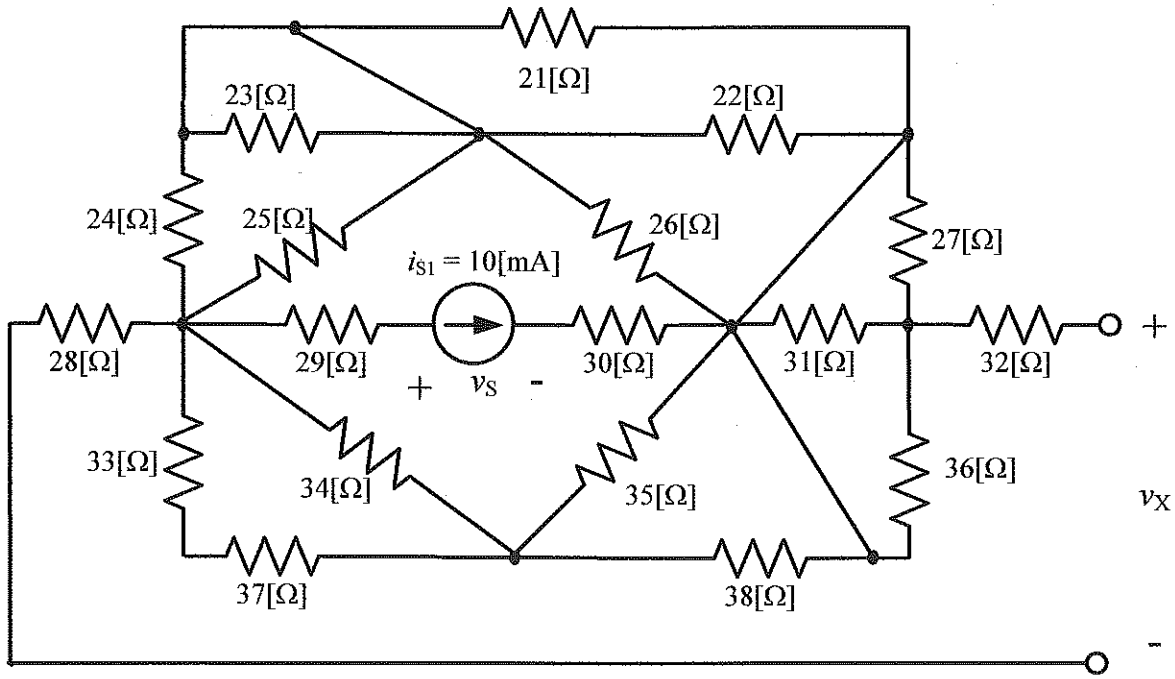


Figure 3

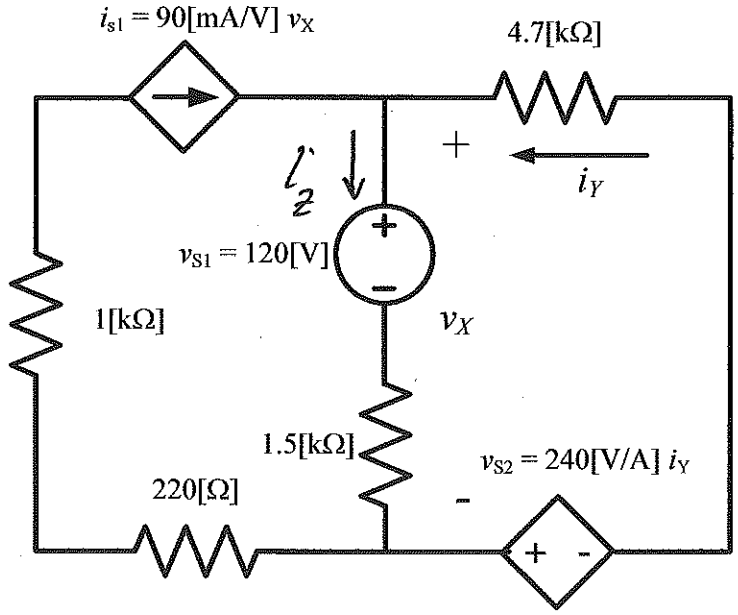
Room for extra work

3. (30 points) Find the voltage v_S.



Room for extra work

1. (35 points) For the circuit below, find the energy delivered by the dependent voltage source in a 5 second time interval.



we will need equations to find i_2', i_Y', and v_X:

KCL $\quad 0.09\, v_x + i_Y' = i_2'$

KVL $\quad 4700\, i_Y' + 120 + 1500\, i_2' + 240\, i_Y' = 0$

KVL $\quad v_x = 120 + 1500\, i_2'$

I did not write a KVL around the left-hand loop because it would have introduced another unknown, namely, the voltage across i_{s1}' (which is not 0!). There is nothing particulary wrong with that, but it means I have another equation to solve for something I don't need anyway (the voltage across i_{s1}').

Room for extra work

Solving these three equations gives:

$i_Y = 0.1817$ [mA] $\quad i_Z = -80.60$ [mA] $\quad v_x = -0.8976$ [V]

Now

$$p_{\text{del by } v_{s2}} = -v_{s2} \cdot i_Y$$

$$= -(240\, i_Y)\, i_Y$$

$$= -7.924 \times 10^{-6} \text{ [W]}$$

$$w_{\text{del by } v_{s2}} = \int_0^{t=5\text{[s]}} p_{\text{del by } v_{s2}}\, dt$$

$$= (-7.924 \times 10^{-6})(5-0)$$

$$= -3.962 \times 10^{-5} \text{ [J]}$$

$$= -39.62 \text{ [}\mu\text{J]}$$

2. (35 points) A device, shown in Figure 1, has the voltage vs. current relationship plotted in Figure 2. The device can be modeled by a current source in parallel with a resistance.

Assume that two identical versions of this device are connected as shown in Figure 3. Notice the polarity of the device, as shown by the terminals labeled A and B.

a) Find v_X.
b) Find the power delivered by the voltage source in Figure 3.

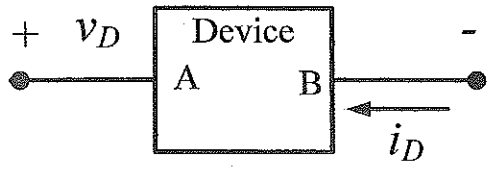


Figure 1

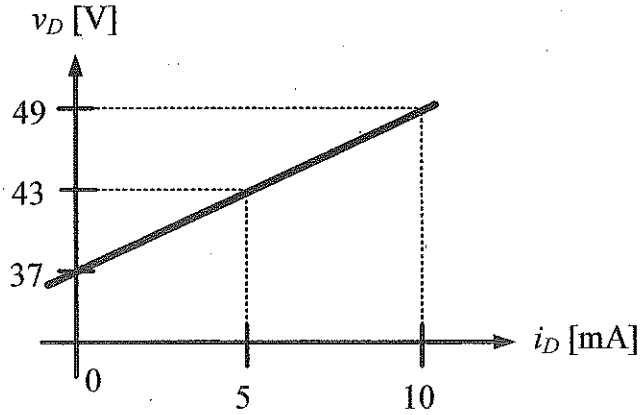


Figure 2

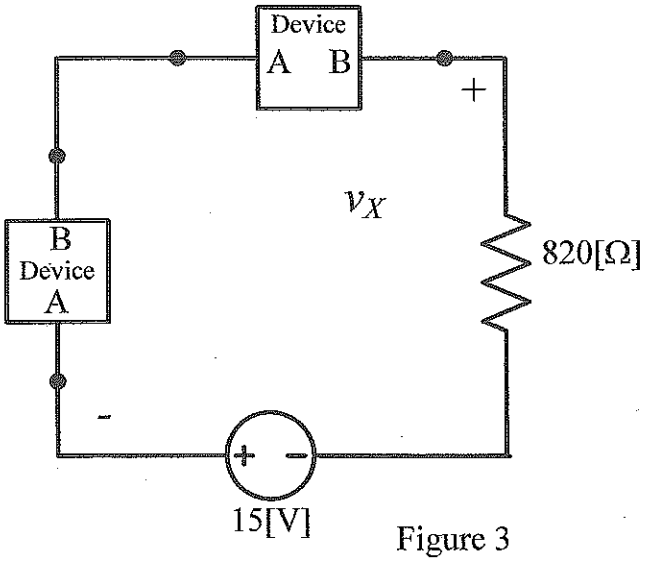
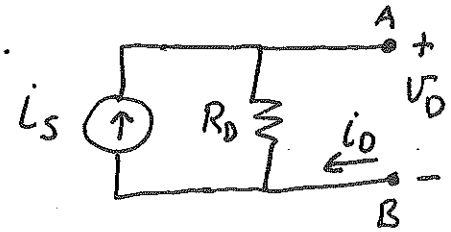


Figure 3

a) We begin the solution by finding a model for the device. We draw a current source in parallel with a resistance.



KCL: $i_D + \frac{v_D}{R_D} - i_S = 0$

Plug in 2 values from Fig. 2

$\frac{37[V]}{R_D} - i_S = 0$

$5[mA] + \frac{43[V]}{R_D} - i_S = 0$

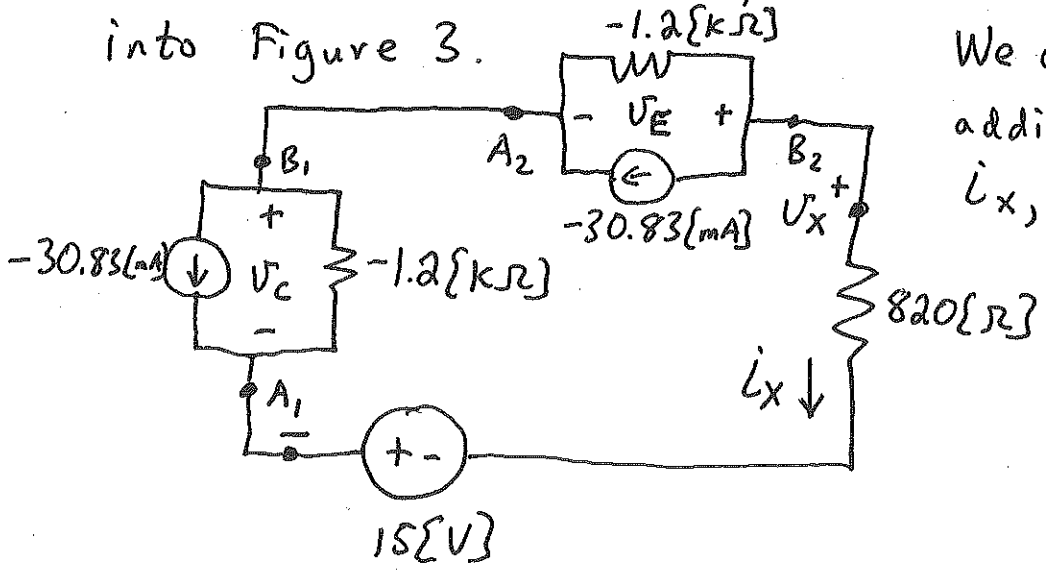
See next page

② Continued. Solving, we get

$$R_D = -1200[\Omega]$$

$$i_s = -30.83[mA]$$

Using these values, we plug two of these circuits into Figure 3.



We define 3 additional variables, i_x, v_c, and v_E.

KVL) $-v_c - v_E + v_x = 0$

$-v_x + i_x\, 820[\Omega] - 15[V] = 0$

KCL) $i_x - 30.83[mA] + \dfrac{v_E}{-1200[\Omega]} = 0$ @ B_2

$i_x - 30.83[mA] + \dfrac{v_c}{-1200[\Omega]} = 0$ @ B_1

Solving:) $\boxed{v_x = 15.62[V]}$ $\quad v_c = 7.81[V]$

$i_x = 37.34[mA]$ $\quad v_E = 7.81[V]$

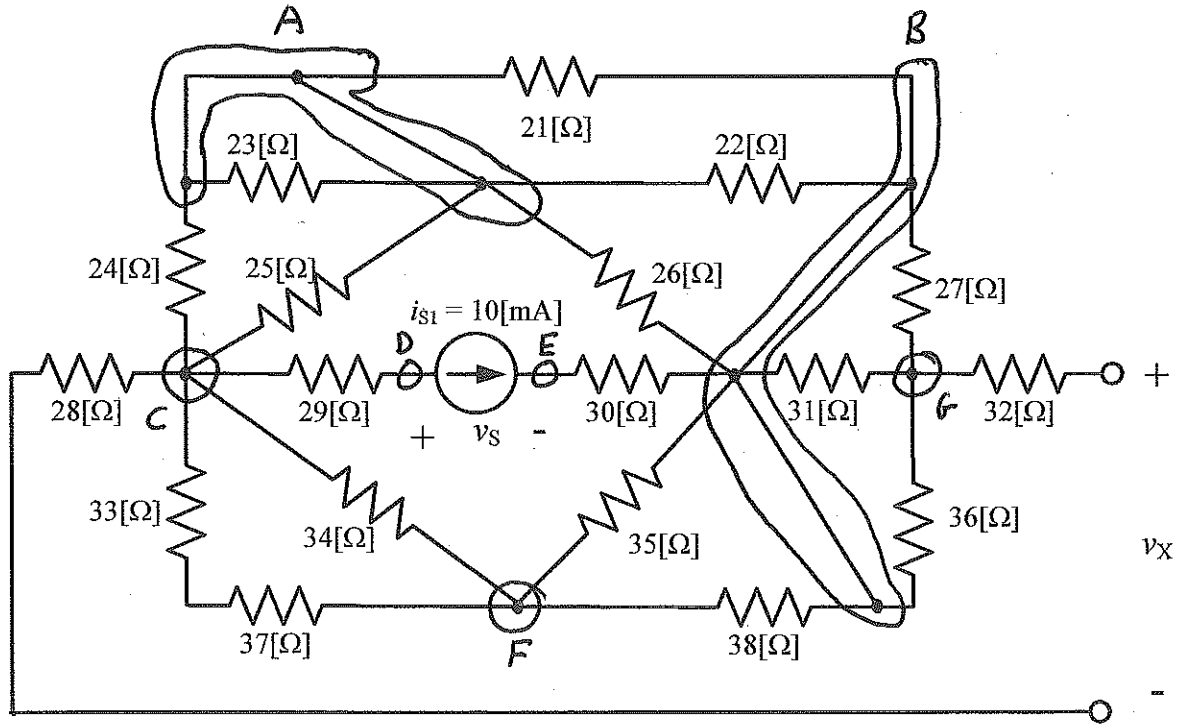
(see next page)

b) $p_{DEL.BY.15[V]} = 15[V]\, i_x$

$= (15[V])(37.34[mA])$

$$\boxed{p_{DEL.BY.15[V]} = 560.1[mW]}$$

3. (30 points) Find the voltage v_S.



We begin by naming the nodes, as on the diagram. Next, we simplify.

28[Ω] has no current through it, short circuit

32[Ω] has no current through it, short circuit

23[Ω] has no voltage across it, open circuit

$27[\Omega] \,||\, 31[\Omega] \,||\, 36[\Omega] = 10.30[\Omega]$

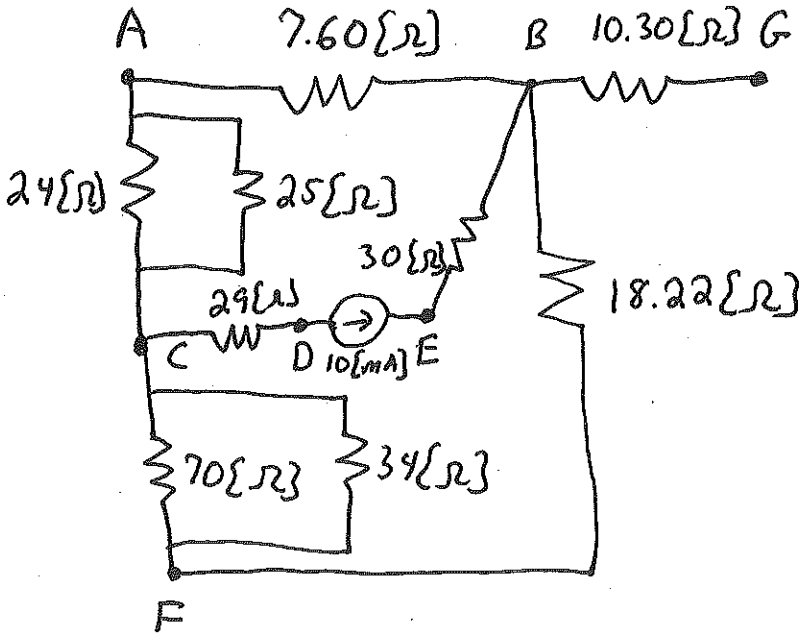
$35[\Omega] \,||\, 38[\Omega] = 18.22[\Omega]$

$33[\Omega] + 37[\Omega] = 70[\Omega]$

$21[\Omega] \,||\, 22[\Omega] \,||\, 26[\Omega] = 7.60[\Omega]$

See next page

With these simplifications, we redraw.

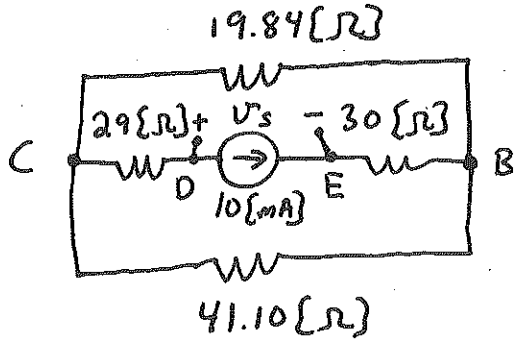


10.30[Ω] has no current through it, short circuit.

$$(70[\Omega] \,||\, 34[\Omega]) + 18.22[\Omega] = 41.10[\Omega]$$

$$(24[\Omega] \,||\, 25[\Omega]) + 7.60[\Omega] = 19.84[\Omega]$$

Redrawing again,



$$(19.84[\Omega] \,||\, 41.10[\Omega]) + 29[\Omega] + 30[\Omega] =$$

$$Req = 72.38[\Omega]$$

By Ohm's Law

$$V_S = -(10[mA])(72.38[\Omega]) =$$

$$\boxed{V_S = -723.8[mV]}$$