Name: _____ (please print)

Signature: _____

ECE 2201 -- Exam # 2
March 24, 2018

Keep this exam closed until you are told to begin.

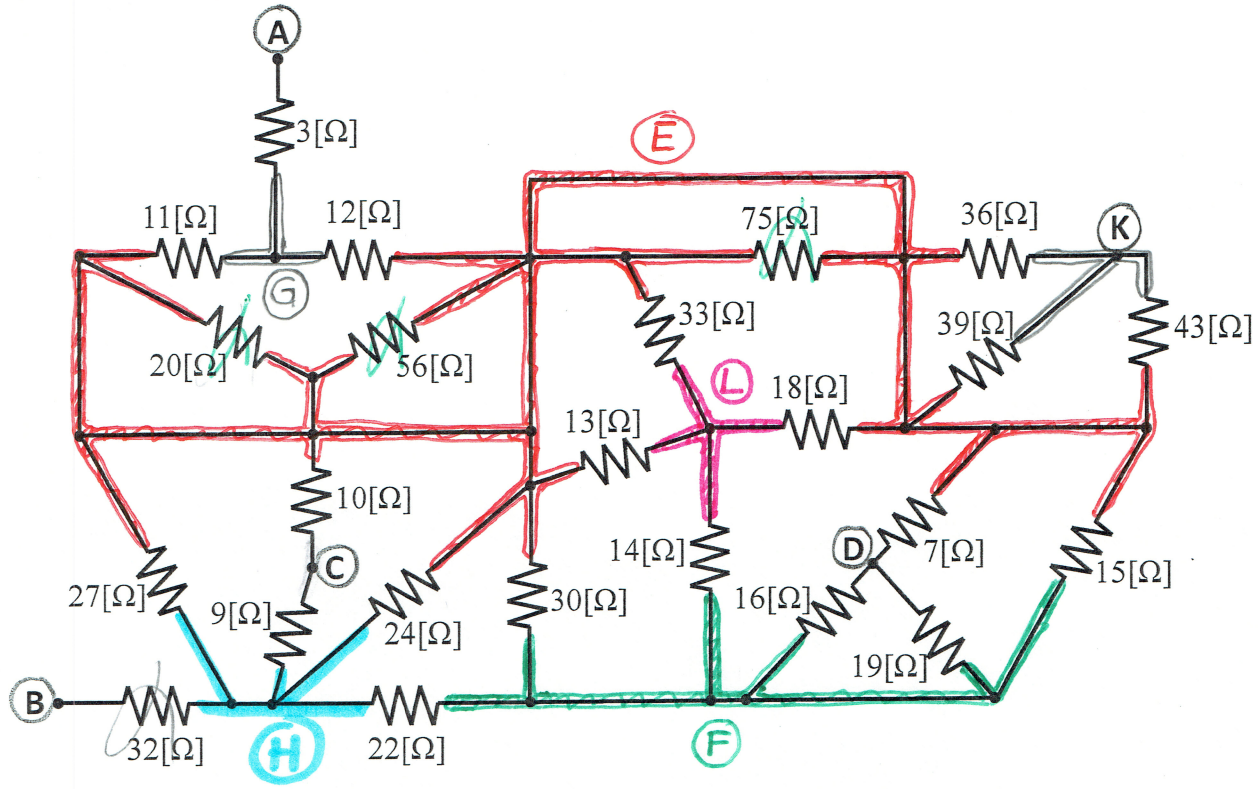
1. This exam is closed book, closed notes. You may use one 8.5" x 11" crib sheet, or its equivalent.
2. Show all work on these pages. Show all work necessary to complete the problem. A solution without the appropriate work shown will receive no credit. A solution that is not given in a reasonable order will lose credit. Clearly indicate your answer (for example by enclosing it in a box).
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.

1. _____/35
2. _____/35
3. _____/30

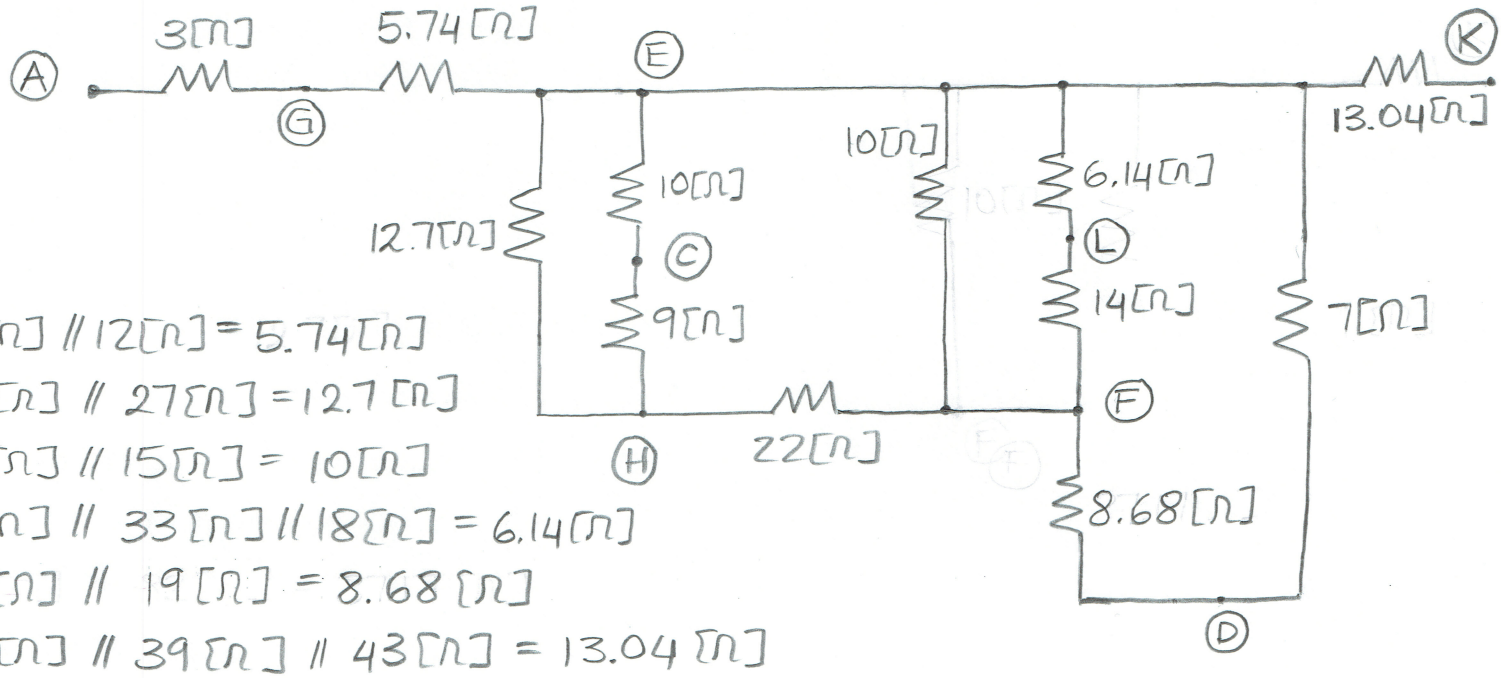
Total = 100

Room for extra work

1. {35 Points} Use the circuit given below to solve this problem.
a) Find the equivalent resistance of this circuit with respect to terminals A and D.
b) Find the equivalent resistance of this circuit with respect to terminals C and K.



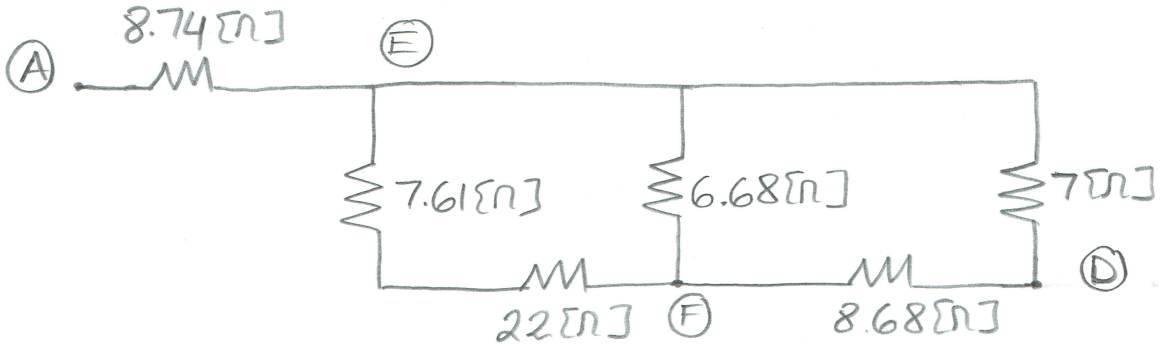
20[Ω], 56[Ω] and 75[Ω] resistors are shorted. 32[Ω] resistor open-circuited. Redrawing the circuit, we get:



11[Ω] // 12[Ω] = 5.74[Ω]
24[Ω] // 27[Ω] = 12.7[Ω]
30[Ω] // 15[Ω] = 10[Ω]
13[Ω] // 33[Ω] // 18[Ω] = 6.14[Ω]
16[Ω] // 19[Ω] = 8.68[Ω]
36[Ω] // 39[Ω] // 43[Ω] = 13.04[Ω]

Room for extra work

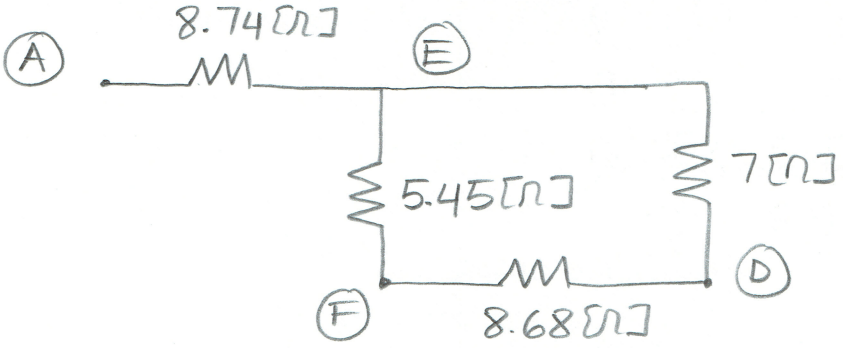
(a) 13.04 [Ω] is open-circuited.



$3[\Omega] + 5.74[\Omega] = 8.74[\Omega]$

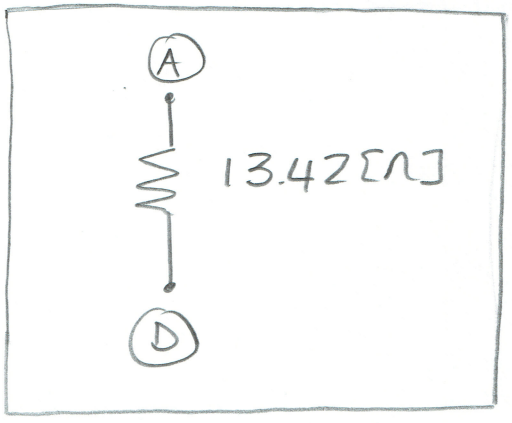
$(10[\Omega] + 9[\Omega]) \,//\, 12.7[\Omega] = 7.61[\Omega]$

$(6.14[\Omega] + 14[\Omega]) \,//\, 10[\Omega] = 6.68[\Omega]$



$22[\Omega] + 7.61[\Omega] = 29.61[\Omega]$

$29.61[\Omega] \,//\, 6.68[\Omega] = 5.45[\Omega]$



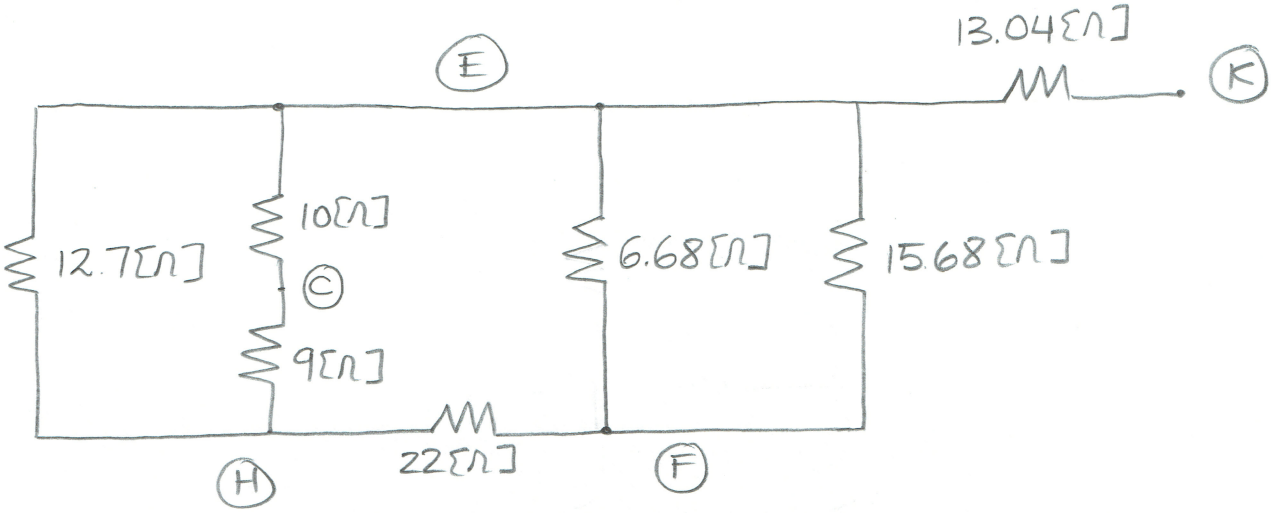
$8.68[\Omega] + 5.45[\Omega] = 14.13[\Omega]$

$14.13[\Omega] \,//\, 7[\Omega] = 4.68[\Omega]$

$4.68[\Omega] + 8.74[\Omega] = 13.42[\Omega]$

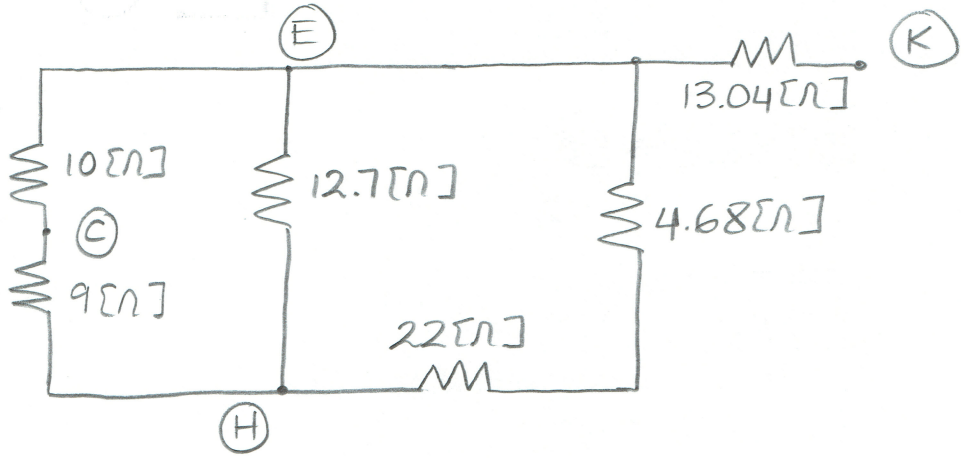
Room for extra work

(b) 3[Ω] and 5.74[Ω] resistors are open-circuited now.

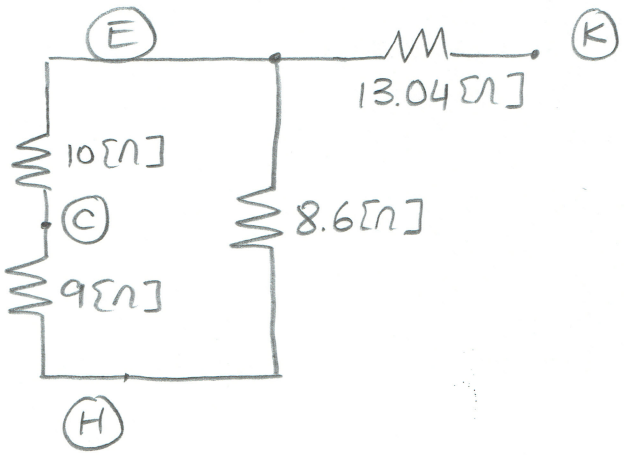


$(6.14[\Omega] + 14[\Omega]) \,//\, 10[\Omega] = 6.68[\Omega]$

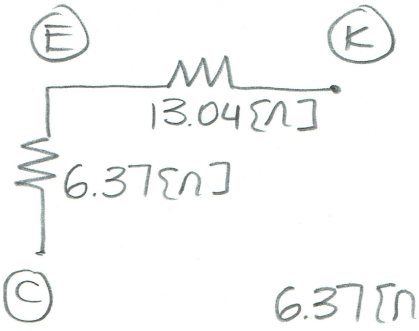
$8.68[\Omega] + 7[\Omega] = 15.68[\Omega]$

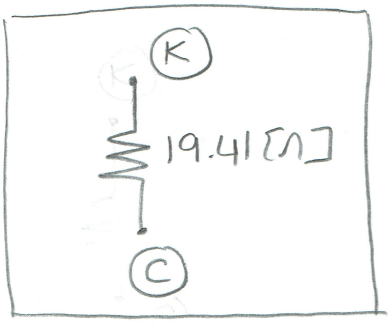


$15.68[\Omega] \,//\, 6.68[\Omega] = 4.68[\Omega]$



$(22[\Omega] + 4.68[\Omega]) \,//\, 12.7[\Omega] = 8.6[\Omega]$





$6.37[\Omega] + 13.04[\Omega] = 19.41[\Omega]$

$(9[\Omega] + 8.6[\Omega]) \,//\, 10[\Omega] = 6.37[\Omega]$

2. {35 Points}

The device shown below in Figure 1 can be modeled as a voltage source in series with a resistance. By consecutively connecting resistors of different values to the output terminals (A-B) we could measure a set of voltages v_T. The results are included in Table 1. Device 2, shown in Figure 2, can be modeled by a current source connected in parallel to a resistance. It's current-voltage characteristic is shown in Figure 3.

These devices are connected in a circuit drawn in Figure 4.

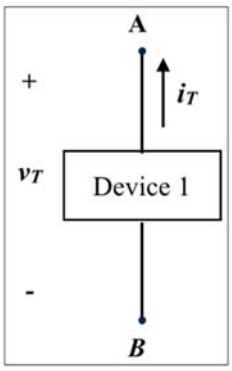


Figure 1

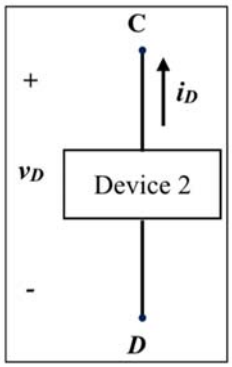


Figure 2

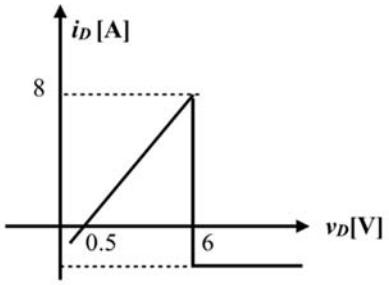


Figure 3

R [Ω]	v_T [V]
2	2
10	5.55
30	7.90

Table 1

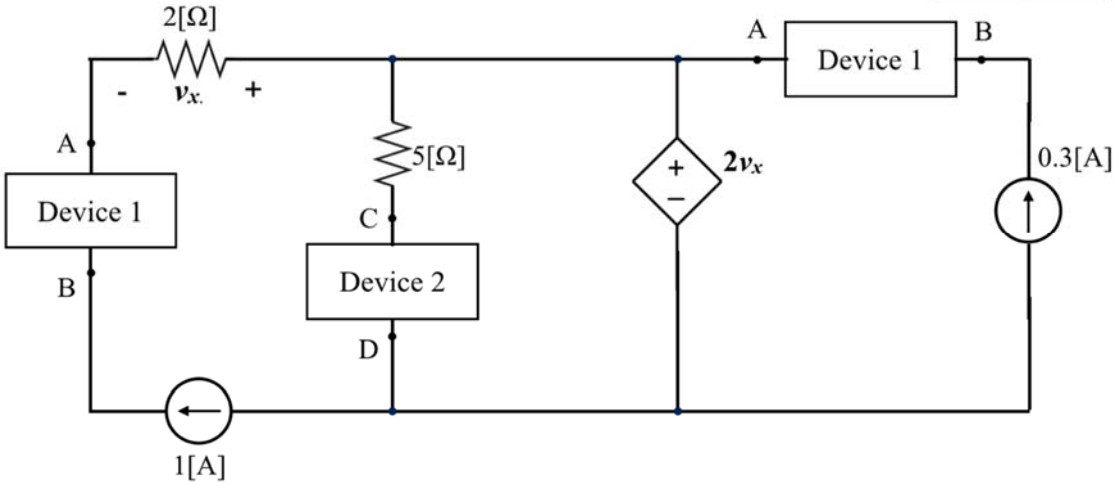
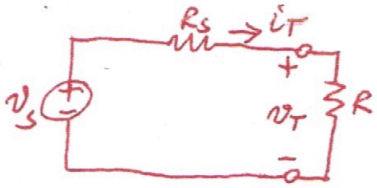


Figure 4.

a. Find the equivalent model for Device 1 and draw its schematic showing terminals A and B. Sketch i_T vs. v_T characteristic for this device.
b. For what range of v_D voltage values the Device 2 delivers power? Find the equivalent model for Device 2 in this range. Draw its schematic showing terminals C and D.
c. Calculate power delivered by the Device 2 when it is connected in the circuit shown in Figure 4.

Room for extra work

Device ①



Use table ①

$R \leftrightarrow v_T$

Voltage divider

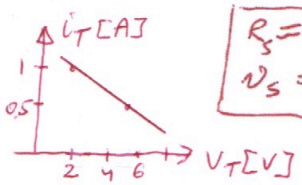
$$v_T = \frac{v_s}{R_s + R} \cdot R$$

this is your current i_T

$$\left.\begin{aligned} 2 &= \frac{v_s}{R_s+2}\cdot 2 \\ 5.55 &= \frac{v_s}{R_s+10}\cdot 10 \end{aligned}\right\} \rightarrow \begin{cases} R_s - v_s = -2 \\ 5.55 R_s - 10 v_s = -55.5 \end{cases}$$

plot

v_T[V]	i_T[A]	R[Ω]
2	1	2
5.55	0.56	10
7.90	0.26	30

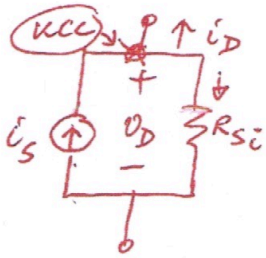


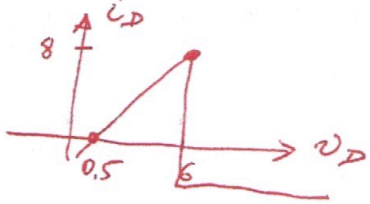
↓ solve

$R_s = 7.98\,\Omega$

$v_s = 9.98\,V$

Device ②





We need only the voltage range where $i_D > 0$

KCL & $i_D(v_D)$ plot

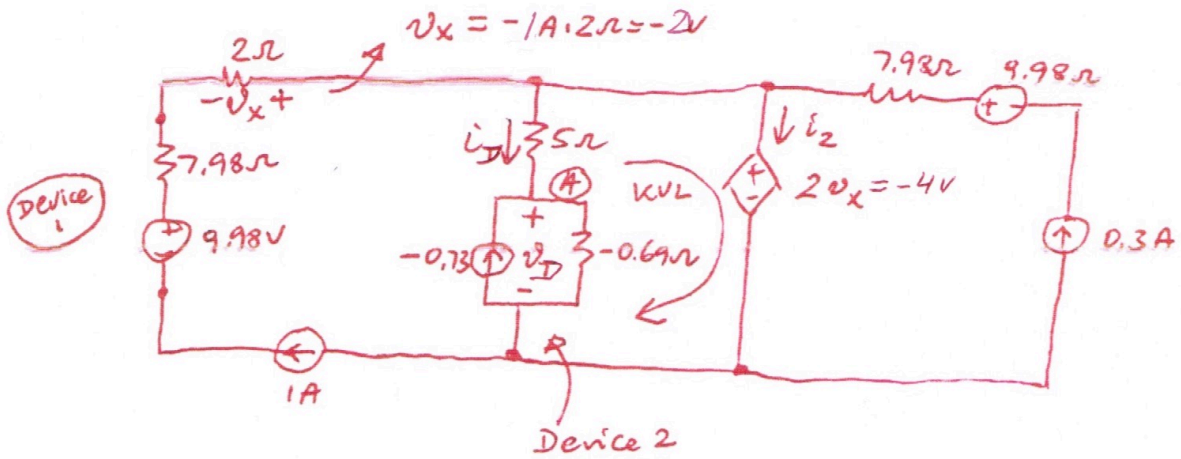
$$i_D - i_S + \frac{v_D}{R_{Si}} = 0$$

$$\begin{cases} 0 - i_S + \frac{0.5}{R_{Si}} = 0 \\ 8 - i_S + \frac{6}{R_{Si}} = 0 \end{cases}$$

$R_{Si} = -0.69\,\Omega$

$i_S = -0.725\,A$

Room for extra work



KCL in (A) $\quad -i_D - (-0.73A) + \frac{v_D}{-0.69\Omega} = 0$

KVL $\quad 2v_x - v_D - i_D \cdot 5\Omega = 0$

$$\begin{cases} -i_D - 1.45 \cdot v_D = -0.73 \\ -5i_D - v_D = 4 \end{cases}$$

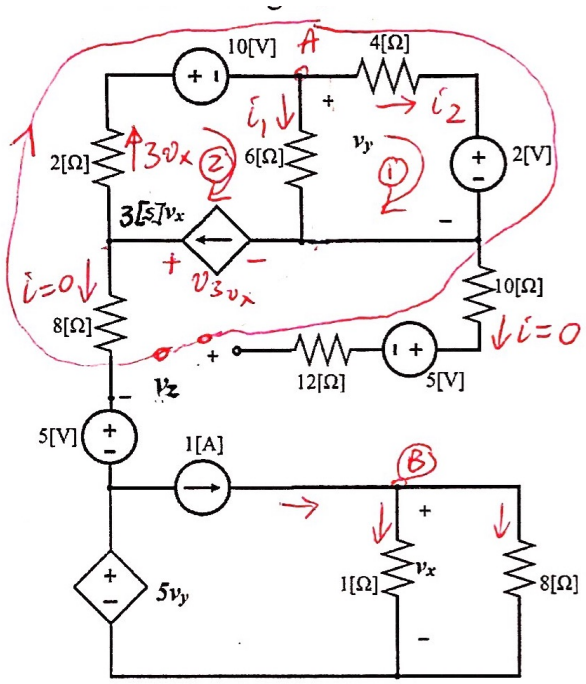
$i_D = -1.045\,A$

$v_D = 1.225\,V$

$P_{del,\,Dev\,2} = -i_D \cdot v_D = 1.28\,[W]$

(i_2 would be necessary if power in $2v_x$ source was required.)

3. {30 Points} In the circuit shown below please
   a. Find the power delivered by $3v_x$ voltage dependent current source.
   b. Find voltage v_z.



To find power in $3v_x$ source – find voltage v_{3v_x} ; Before → find v_x from CDR in (B)

$v_x = (1A \cdot \frac{1118}{1118}) \cdot 1\Omega = 0.89V$

Current = 0.89A

or O.L.

$v_x = 1A \cdot 1\Omega \| 8\Omega = 0.89$

- KCL in (A)

$-3v_x + i_1 + i_2 = 0$

- KVL in (1)

$i_2 \cdot 4 + 2 - i_1 \cdot 6 = 0$

$$\begin{cases} +i_1 + i_2 = 2.67 \\ -i_1 6 + i_2 4 = -2 \end{cases}$$

$i_1 = 1.27A$; $i_2 = 1.42A$

$3v_x = 2.67A$

a) Find power $3v_x$

KVL in (2)

$10 + i_1 \cdot 6 - v_{3v_x} + 3v_x \cdot 2 = 0$

$\downarrow$

$v_{3v_x} = 22.96V$

$P_{del,3v_x} = v_{3v_x} \cdot 3v_x = 61.3$

b) Find v_z

KVL in (3)

$3v_x \cdot 2 + 10 + i_2 \cdot 4 + 2 + 5 + v_z = 0$

$v_z = -5.34 - 10 - 5.68 - 2 - 7 = 0$

$v_z = -28.02V$