Name: Solutions! (please print)

Signature: _____

ECE 2201 – Exam 2
November 10, 2018

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.
3. Show your work clearly. If the grader has difficulty following or understanding your work, you will lose credit.
4. Show all units in solutions, intermediate results, and figures. Units in the quiz 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.

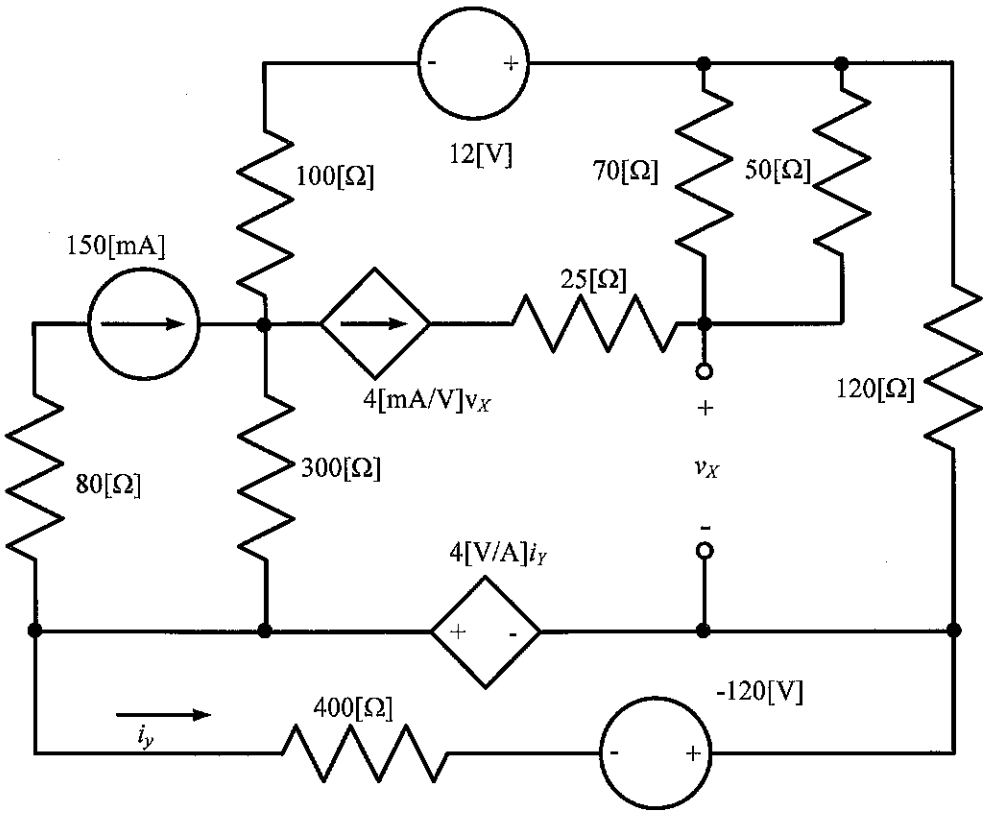
1. _____/30
2. _____/35
3. _____/35

Total = 100

Room for extra work

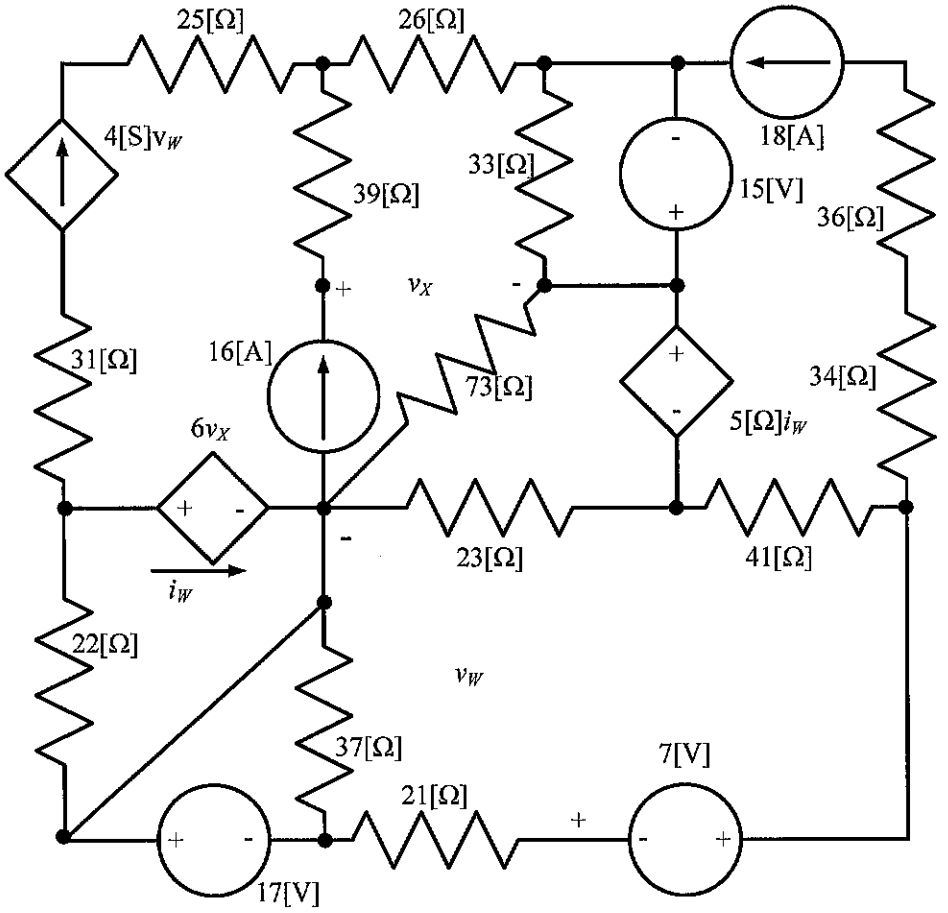
1. {30 Points} For the circuit below, do the following

a) Find the voltage v_x.
b) Find the power delivered by the dependent current source.



Room for extra work

2. {35 Points} Write a complete set of **node voltage equations** that could be used to solve the circuit below. Do not simplify the circuit and do not solve the equations.



Room for extra work

3. {35 Points} Device 1, shown in Figure 1, can be modeled as a voltage source in series with a resistance. When Device 1 is connected to the circuit shown in Figure 2, the voltage v_M is measured to be 3.8[V].

Device 2, shown in Figure 3, can also be modeled as a voltage source in series with a resistance. The relationship between the current through Device 2 and voltage across Device 2, is shown in Figure 4.

a) Find a model for Device 2. Draw your model showing terminals **c** and **d**.
b) When both Device 1 and Device 2 are connected to the circuit shown in Figure 5, a voltage v_Z of 9.4[V] is measured. Find a model for Device 1. Draw your model showing terminals **a** and **b**.

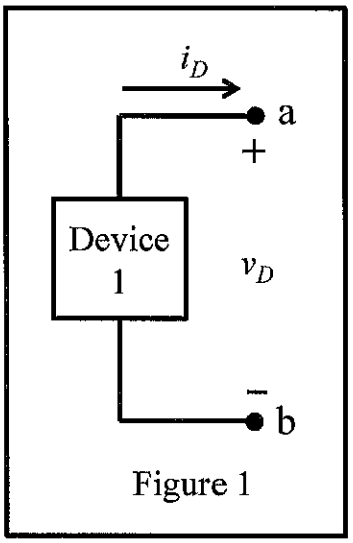


Figure 1

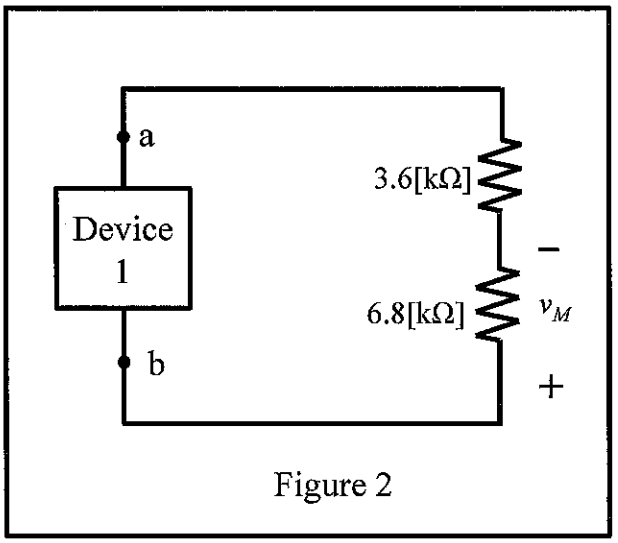


Figure 2

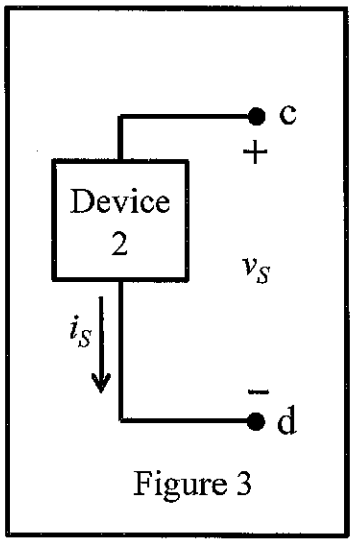


Figure 3

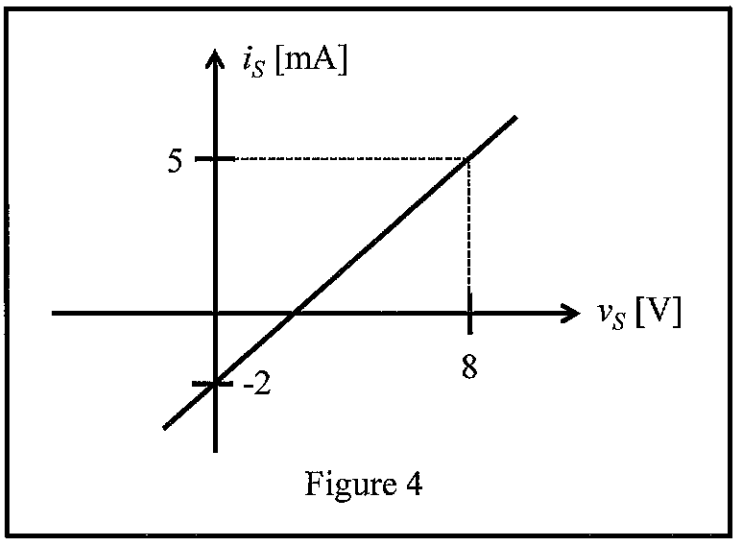


Figure 4

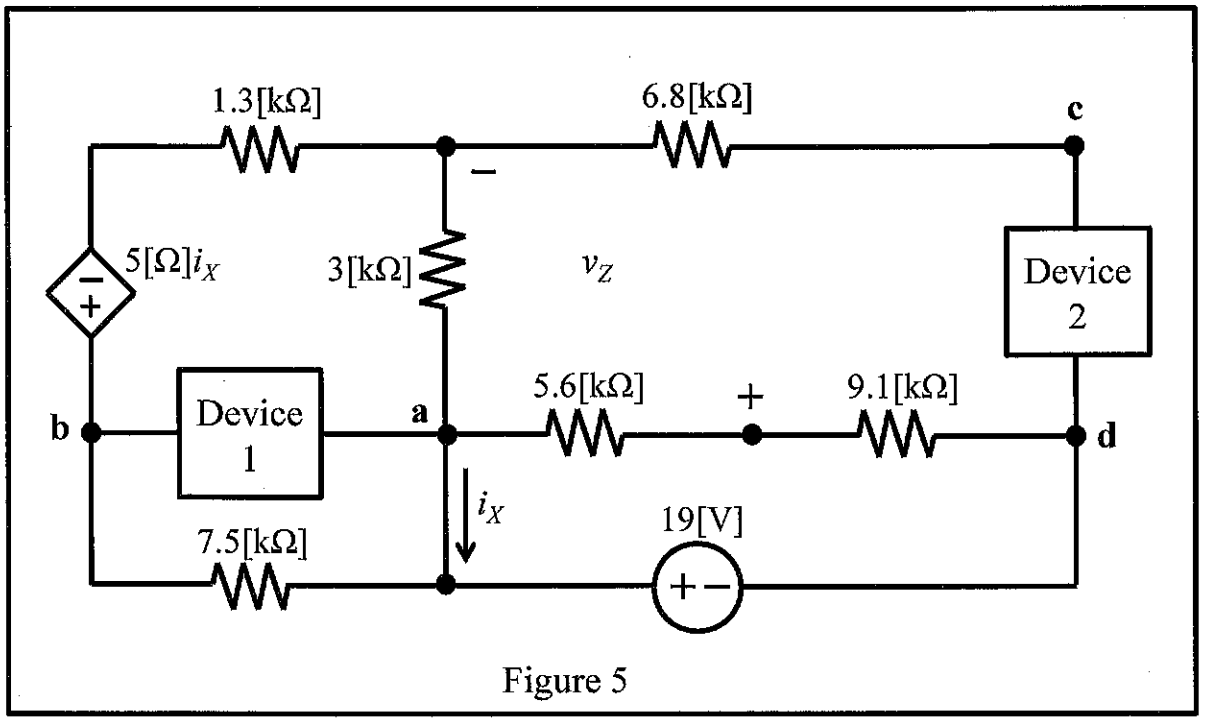
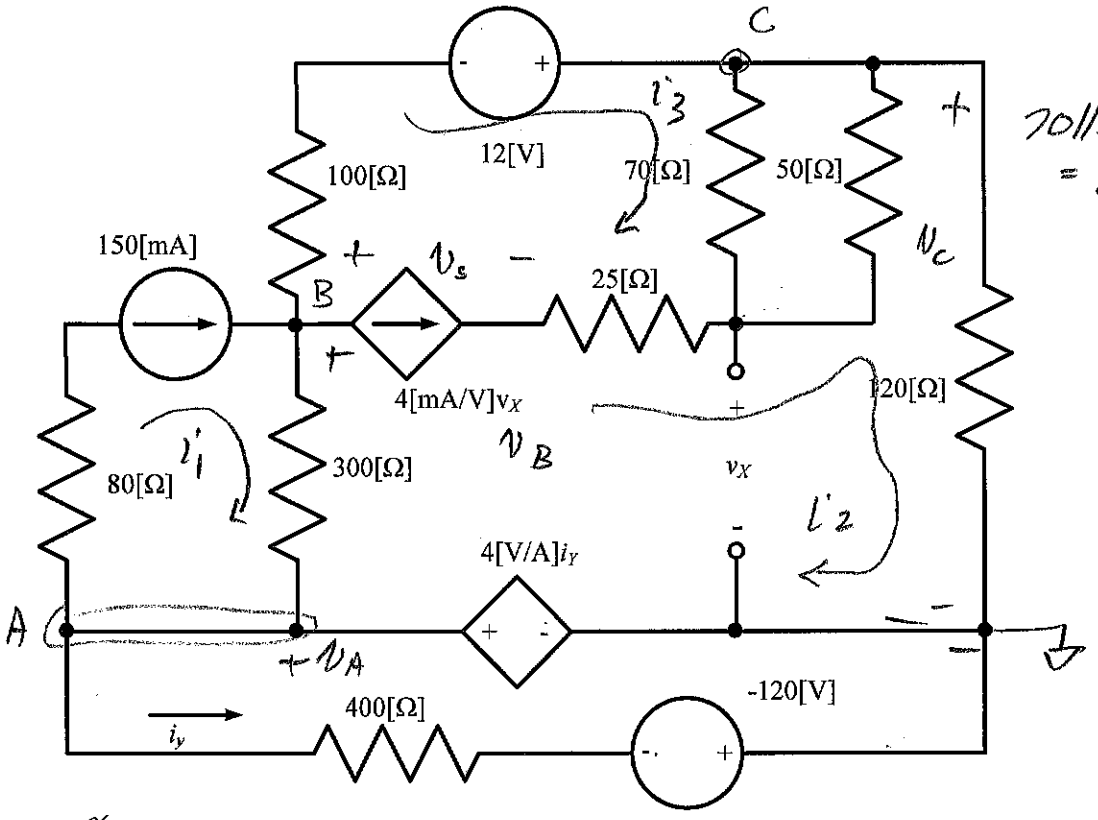

1.3[kΩ]
6.8[kΩ]
c
5[Ω]i_X
3[kΩ]
v_Z
Device 2
b
Device 1
a
5.6[kΩ]
9.1[kΩ]
d
i_X
19[V]
7.5[kΩ]

Figure 5

Room for extra work

1. {30 Points} For the circuit below, do the following

a) Find the voltage v_x.
b) Find the power delivered by the dependent current source.



70//50 = 29.17 [Ω]

a) NVM

$v_A = 4\, i'_y$ x4

$-0.150 + 0.004\, v_x + \frac{v_B - v_C + 12}{100} + \frac{v_B - v_A}{300} = 0$ x5

$\frac{v_C - v_B - 12}{100} - 0.004 v_x + \frac{v_C}{120} = 0$ x5

$i'_y = \frac{v_A - 120}{400}$ x3

$-v_x + 0.004\, v_x \cdot 29.17 + v_C = 0$ x5

+20

Solve: $v_A = -1.212$ [V] $v_B = 7.847$ [V] $v_C = 14.376$ [V]

$i'_y = -0.3630$ [A] $\boxed{v_x = 16.27\ [V]}$

+3

Room for extra work

$$v_s + 0.004 v_x \cdot (25 + 29.17) + v_c - v_B = 0 \qquad +5$$

$$v_s = -10.05 \text{ [V]}$$

$$\boxed{P_{del\ by\ 4v_x} = -0.004 v_x \cdot v_s = 0.654 \text{ [W]}} \qquad +2$$

MCM $\quad i_1' = 0.150$ [A] $\quad (\times 2)$

$400 i_y' + 120 - 41 i_y' = 0 \quad (\times 3)$

$100 i_3' - 12 + 120 i_2' - 41 i_y' + 300(i_2' - i_1') = 0 \quad (\times 6)$

$i_2' - i_3' = 0.004 v_x \quad (\times 4)$

$-v_x + 0.004 v_x \cdot 29.17 + 120 i_2' = 0 \quad (\times 5)$ $\Big\}$ +20

Solve: $\quad i_1' = 0.150$ [A] $\quad i_2' = 0.1198$ [A] $\quad i_3' = -0.0547$ [A]

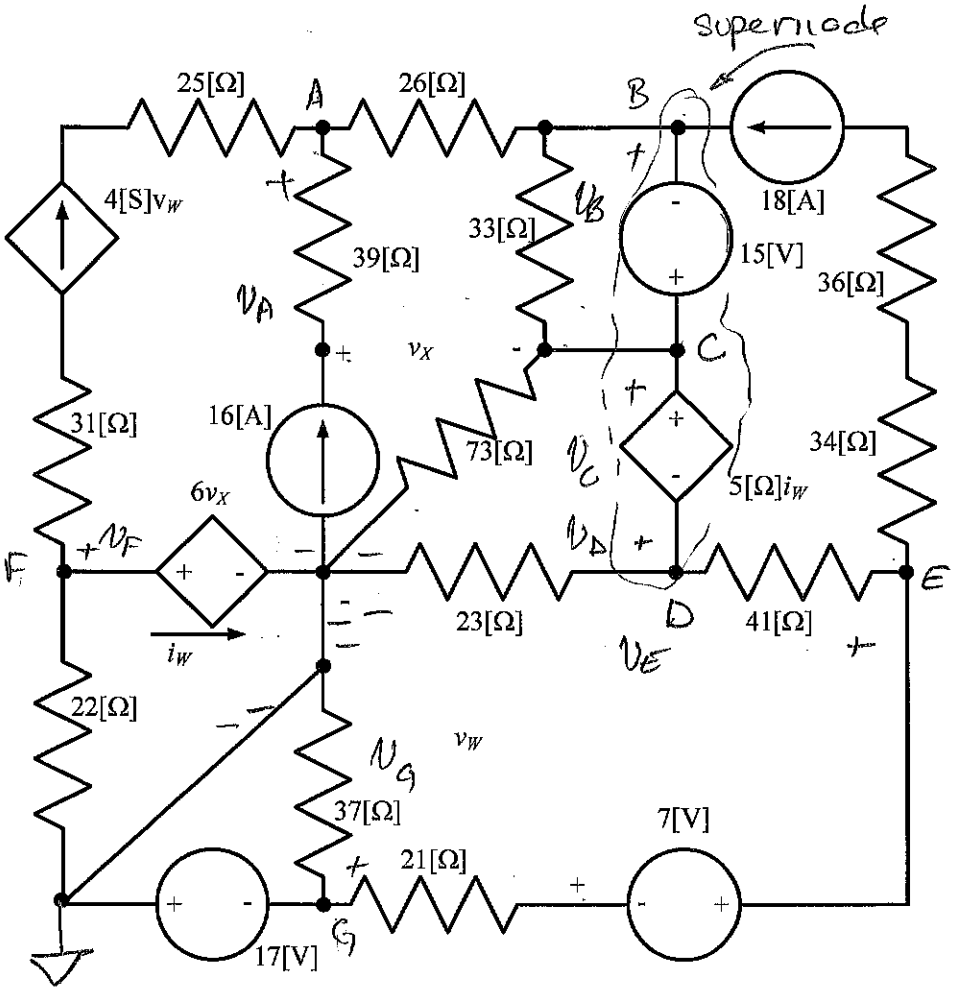
$i_y' = -0.3030$ [A] $\quad \boxed{v_x = 16.27 \text{ [V]}}$ $\Big\}$ +3

$$v_s + 25(i_2' - i_3') + v_x - 41 i_y' + 300(i_2' - i_1') = 0 \qquad +5$$

$$v_s = -10.05 \text{ [V]}$$

$$\boxed{P_{del\ by\ 4v_x} = -v_s \cdot 0.004 v_x = 0.654 \text{ [W]}} \qquad +2$$

2. {35 Points} Write a complete set of **node voltage equations** that could be used to solve the circuit below. Do not simplify the circuit and do not solve the equations.



A: $-4v_w - 16[A] + \frac{v_A - v_B}{26} = 0$ +5

B,C,D: $-18[A] + \frac{v_B - v_A}{26} + \frac{v_C}{73} + \frac{v_D - v_E}{41} + \frac{v_D}{23} = 0$ +6

$v_B - v_C = -15[V]$ +2 $\quad v_C - v_D = 5i_w$ +2

E: $18[A] + \frac{v_E - v_D}{41} + \frac{v_E - v_G - 7}{21} = 0$ +5 F: $v_F = 6 \cdot v_x$ +2 G: $v_G = -17[V]$ +2

v_w: $v_w - v_E + 7 = 0$ +3 $\quad v_x$: $v_x + 15 + v_B - v_A - 16 \cdot 39 = 0$ +5

i_w: $i_w + \frac{v_E}{22} + 4 \cdot v_w = 0$ +3

(624)

3. {35 Points} Device 1, shown in Figure 1, can be modeled as a voltage source in series with a resistance. When Device 1 is connected to the circuit shown in Figure 2, the voltage v_M is measured to be 3.8[V].

Device 2, shown in Figure 3, can also be modeled as a voltage source in series with a resistance. The relationship between the current through Device 2 and voltage across Device 2, is shown in Figure 4.

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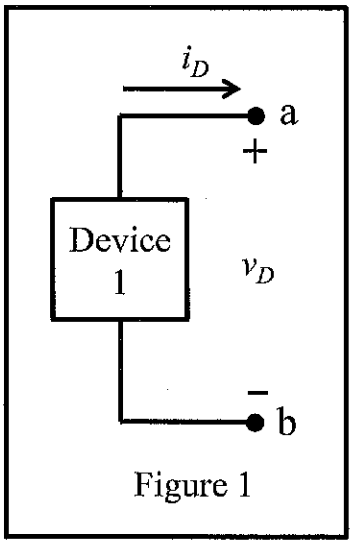


Figure 1

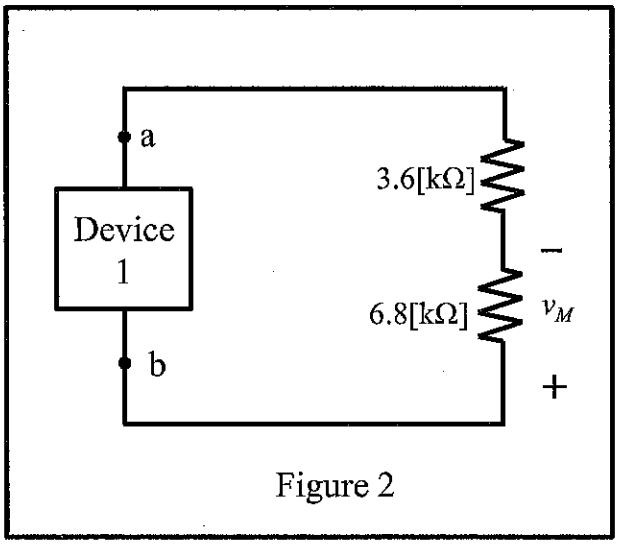


Figure 2

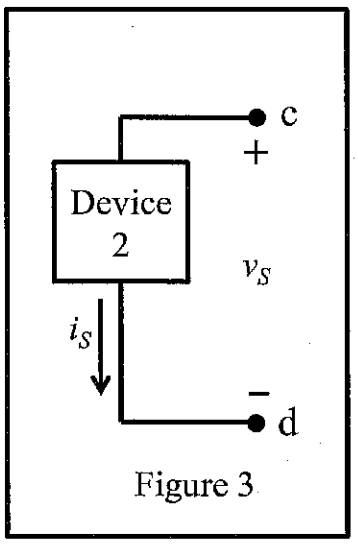


Figure 3

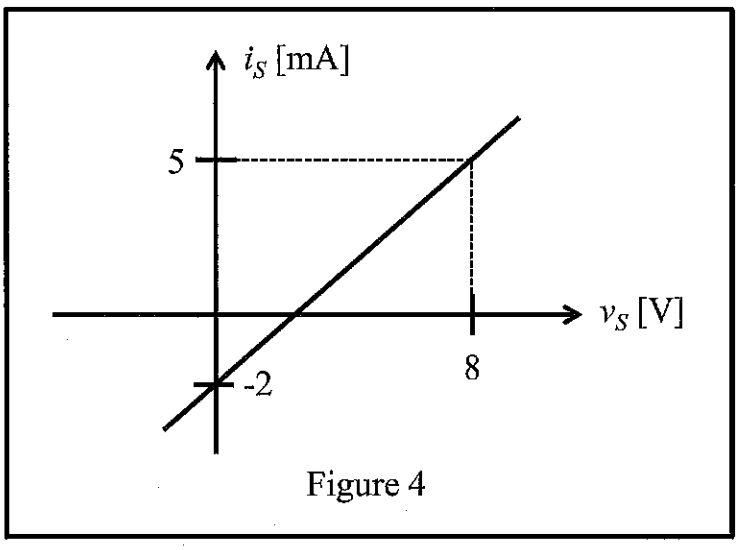


Figure 4

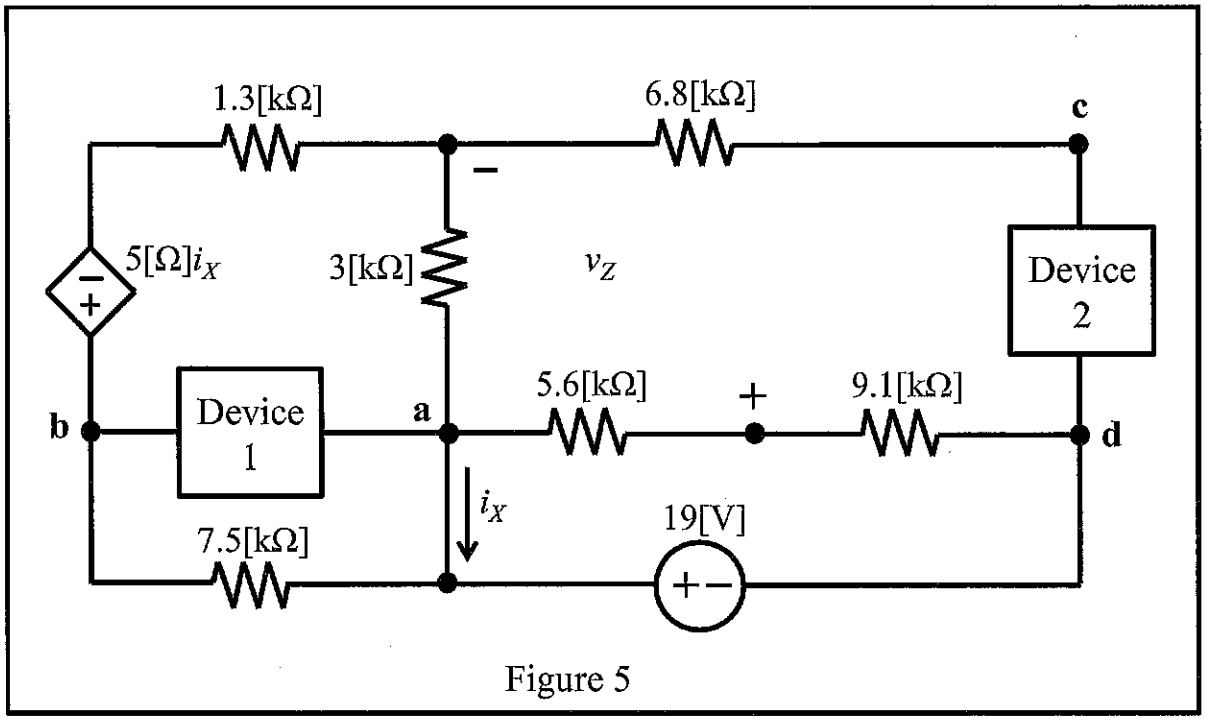
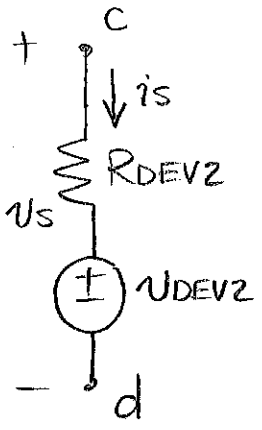


Figure 5

a)



Using the characteristics shown in Fig 4,

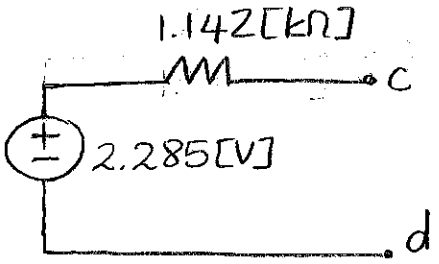
$$i_S = \frac{7}{8}\left[\frac{mA}{V}\right] v_S - 2[mA] \quad \text{or we can write:}$$

$$v_S = (i_S + 2[mA])\ \frac{8}{7}\left[\frac{V}{mA}\right]$$

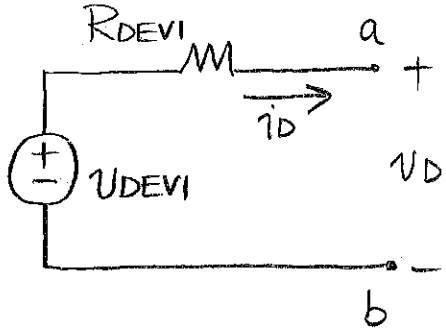
→ KVL: $v_S = i_S \cdot R_{DEV2} + v_{DEV2}$

$R_{DEV2} = 8[V]/7[mA] = 1.142[k\Omega]$

$v_{DEV2} = \frac{16}{7}[V] = 2.285[V]$



b)

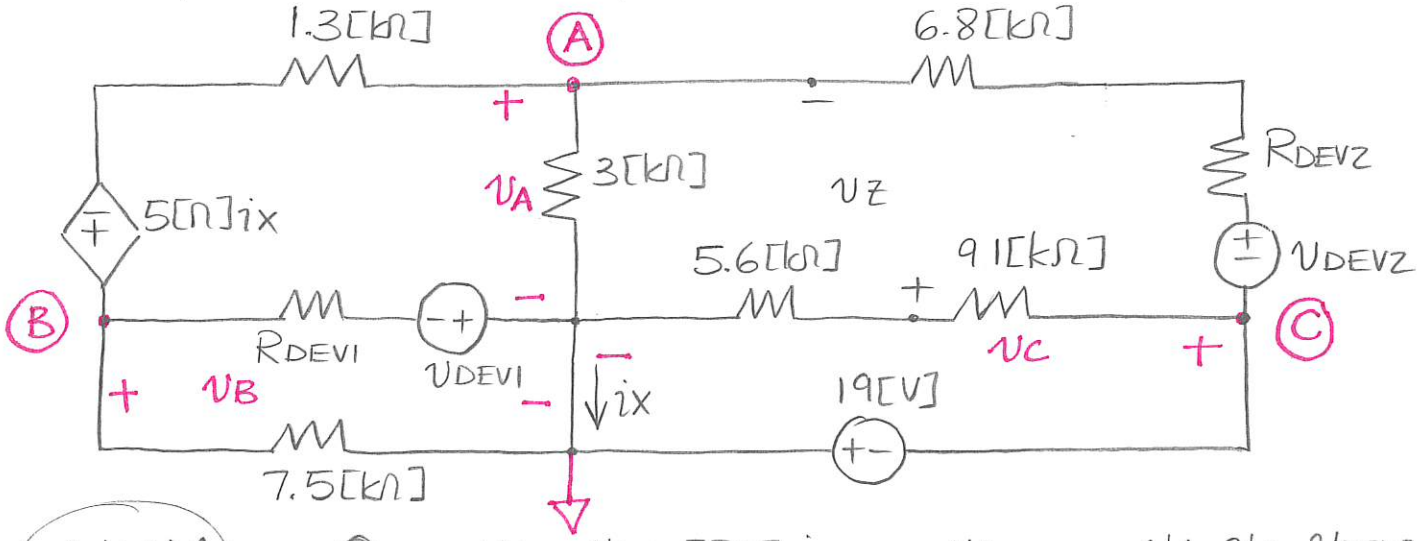


Using Fig. 2, we get:

$$-v_{DEV1} - \frac{v_M}{6.8[k\Omega]}\left(R_{DEV1} + 10.4[k\Omega]\right) = 0 \quad (*)$$

Room for extra work

We have 1 eq, but 2 unknowns. We need to use Fig. 5 to find the model for Device 1.



NVM

(A): $\frac{v_A - v_B + 5[\Omega]\,i_x}{1.3[k\Omega]} + \frac{v_A}{3[k\Omega]} + \frac{v_A - v_C - V_{DEV2}}{6.8[k\Omega] + R_{DEV2}} = 0$

(B) $\frac{v_B - v_A - 5[\Omega]\,i_x}{1.3[k\Omega]} + \frac{v_B + V_{DEV1}}{R_{DEV1}} + \frac{v_B}{7.5[k\Omega]} = 0$

(C) $v_C = -19[V]$

(ix) $i_x - \frac{v_C}{14.7[k\Omega]} - \frac{v_A}{3[k\Omega]} - \frac{v_B + V_{DEV1}}{R_{DEV1}} = 0$

Including eq. (*), we have 5 eqs. But we have 6 unknowns ($v_A, v_B, v_C, i_x, R_{DEV1}, V_{DEV1}$). We need 1 more eq.

(vz) $-v_z - \frac{19[V]}{14.7} \cdot 5.6 - v_A = 0$ and $v_z = 9.4[V]$

Solving, we get:

$R_{DEV1} = -3.196\,[k\Omega]$

$V_{DEV1} = -4.025\,[V]$