Name: ___________Solution_____________ (please print)

Signature: ____________________________

ECE 2201 -- Exam # 2
April 13, 2019

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

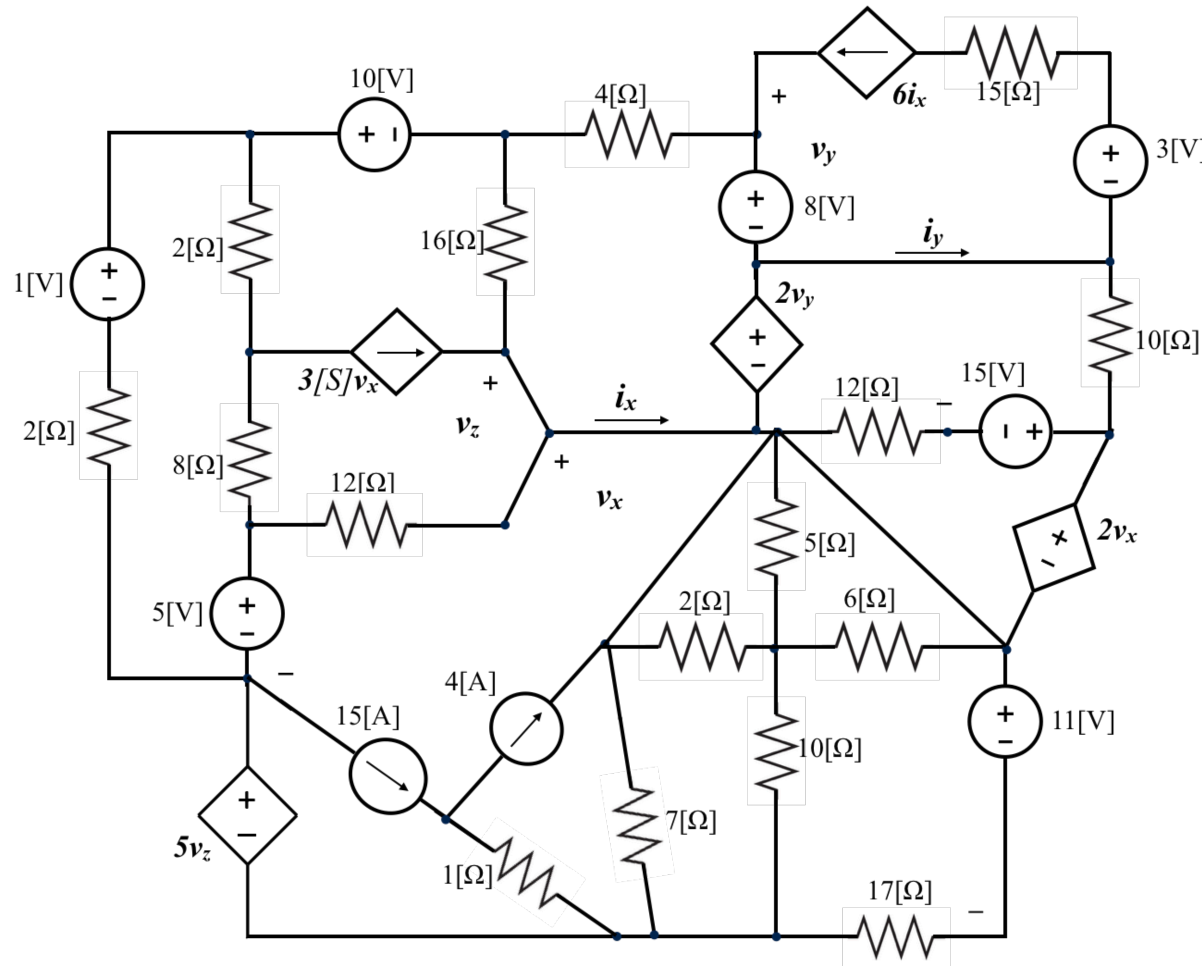
2. ________________/32

3. ________________/33

Total = 100

Room for extra work

1. {35 Points} Use the Node-voltage method to write a complete set of equations that could be used to solve the circuit below. Do not attempt to simplify the circuit. Do not attempt to simplify or solve the equations. Define all variables.



Room for extra work

2. {32 Points} Device 1 shown in Figure 1, can be modeled as a voltage source in series with a resistance with terminals A and B. When this device is connected to the circuit shown in Figure 1, $i_s = 0.8$[mA] is measured. When a 5[kΩ] resistor is connected to the same circuit, the voltage of 2.5[V] is measured at the terminals A and B.
Device 2, shown in Figure 2, can be modeled as a 10[V] voltage source in series with a 2[kΩ] resistance with terminals C and D.

a) Find a model for Device 1 and draw this model showing terminals A and B.
b) For the circuit with both devices connected, as shown in Figure 3, find the power delivered by the independent current source.

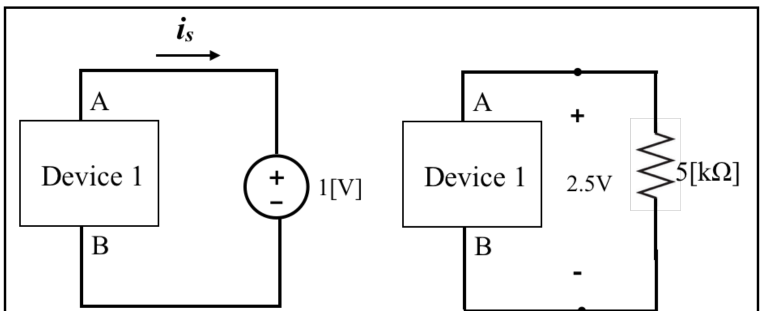


Figure 1.

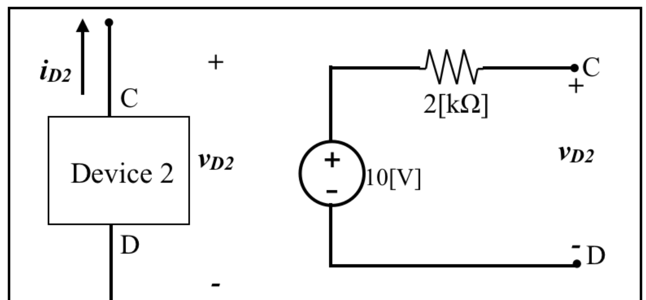


Figure 2.

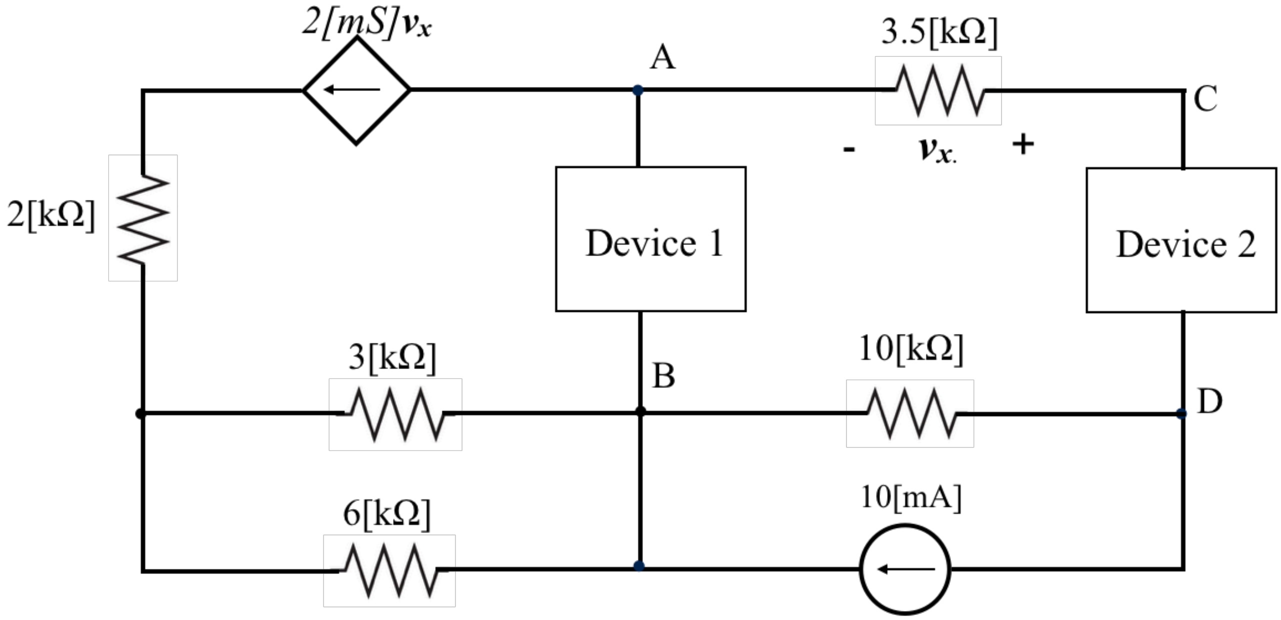


Figure 3.

Room for extra work

3. {33 Points} The Device, shown in Figure 1, can be modeled as a voltage source in series with a resistance. Its $i_D(v_D)$ characteristic is shown in Figure 1.
The device is then connected in the circuit shown in Figure 2.

For your solution, **do not use** the Node-Voltage Method or the Mesh-Current Method.
a) Apply **source transformation** theorem for the circuit **marked by a box.**
b) Find a model of the Device and draw it showing terminals A and B.
c) Find the power delivered by the independent voltage source 5[V] connected to the terminals A and B.

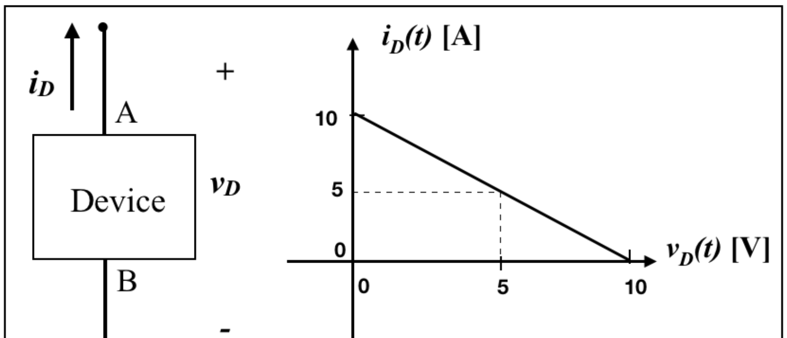


Figure 1.

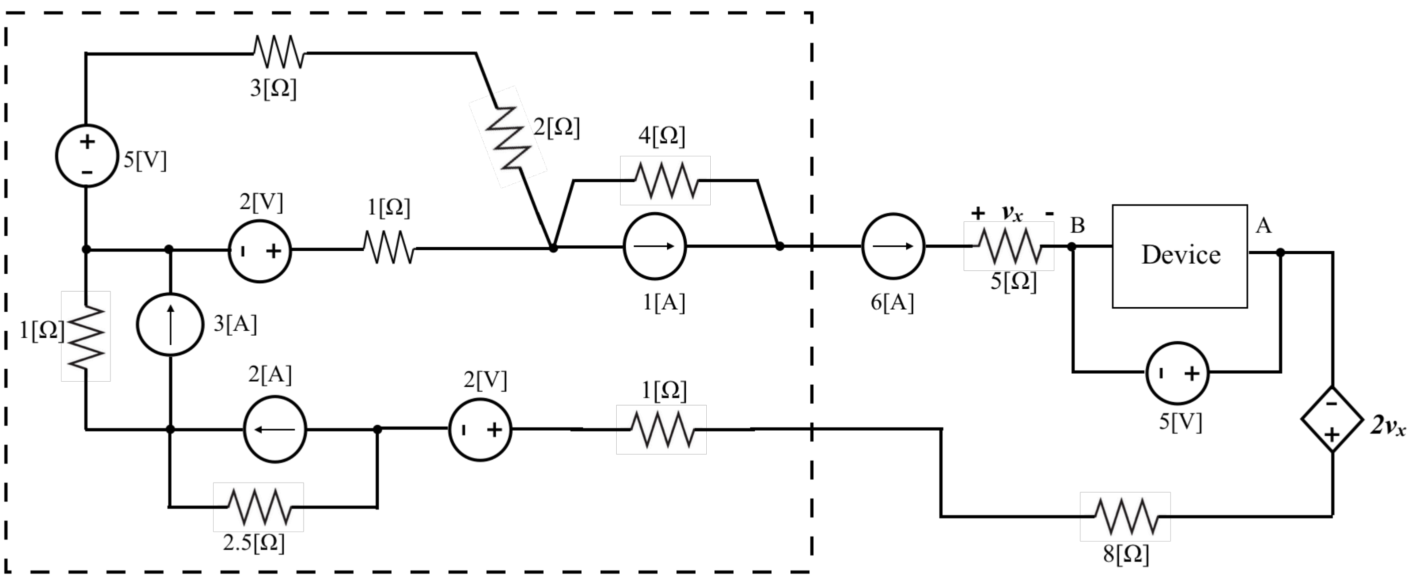
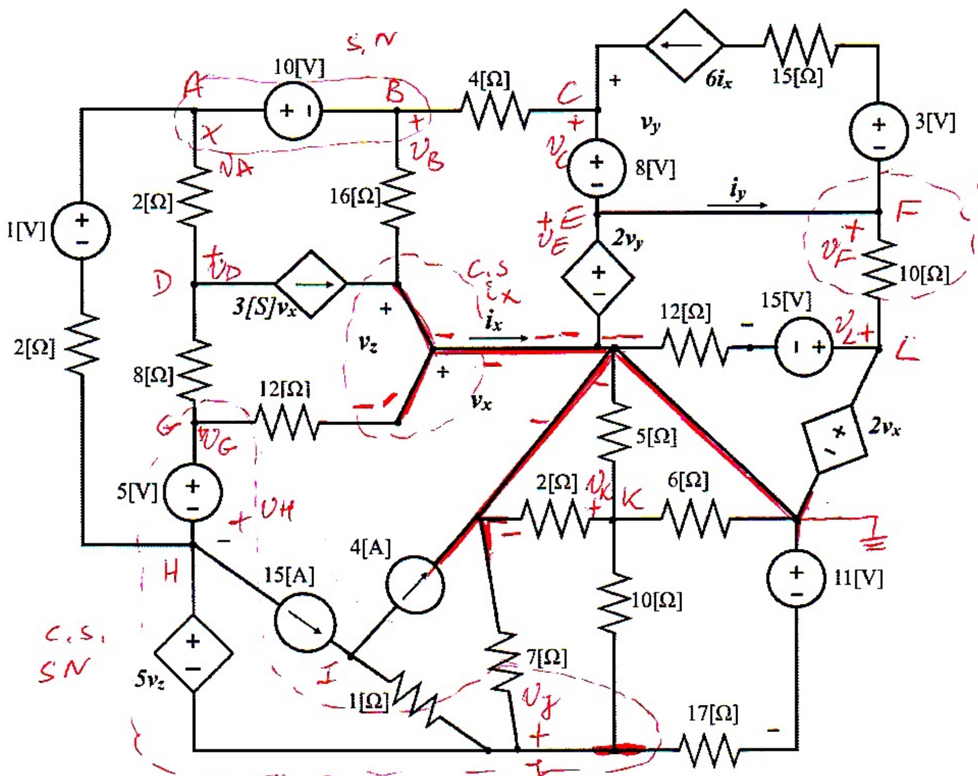


Figure 2.

Room for extra work

1. {35 Points} Use the Node-voltage method to write a complete set of equations that could be used to solve the circuit below. Do not attempt to simplify the circuit. Do not attempt to simplify or solve the equations. Define all variables.



11 node eqs. ; 5 auxiliary eqs.

(A+B) $\frac{v_A - 1 - v_H}{2[\Omega]} + \frac{v_A - v_D}{2[\Omega]} + \frac{v_B - v_C}{4[\Omega]} + \frac{v_B}{16[\Omega]} = 0$

(A+B) $v_A - v_B = 10[V]$

(E)=(F) $v_E = 2v_y = v_F$

(C+E) $v_C = v_E + 8[V]$; (D) $\frac{v_D - v_A}{2[\Omega]} + 3v_x + \frac{v_D - v_G}{8[\Omega]} = 0$

(F)(i_y) $6i_x - i_y + \frac{v_F - v_L}{10[\Omega]} = 0$

(G+J) $\frac{v_G - v_D}{8[\Omega]} + \frac{v_G}{12[\Omega]} + 15[A] + \frac{v_J - v_I}{1[\Omega]} + \frac{v_J}{7[\Omega]} + \frac{v_J - v_K}{10[\Omega]} + \frac{v_J + 11[V]}{17[\Omega]} + \frac{v_H + 1[V] - v_A}{2[\Omega]} = 0$

Room for extra work

(G + H) $v_G - v_H = 5\,[V]$

(H + J) $v_H - v_J = 5 v_Z$

(K) $\frac{v_H}{5[\Omega]} + \frac{v_K}{2[\Omega]} + \frac{v_K - v_y}{10[\Omega]} + \frac{v_K}{6[\Omega]} = 0$

(L) $v_L = 2 v_x$

(i_x) $i_x - 3 v_x - \frac{v_G}{12[\Omega]} - \frac{v_B}{16[\Omega]} = 0$

(i_y) $-i_y + 6 i_x + \frac{v_F - v_L}{10[\Omega]} = 0$ [@ (F)]

Not required b/c there is no dependent source of i_y

(v_x) $v_x = 11\,[V]$

(v_y) $v_y = v_C - v_L - 15[V]$

(v_z) $v_z = -v_H$

2. {32 Points} Device 1 shown in Figure 1, can be modeled as a voltage source in series with a resistance with terminals A and B. When this device is connected to the circuit shown in Figure 1, $i_s = 0.8$[mA] is measured. When a 5[kΩ] resistor is connected to the same circuit, the voltage of 2.5[V] is measured at the terminals A and B.
Device 2, shown in Figure 2, can be modeled as a 10[V] voltage source in series with a 2[kΩ] resistance with terminals C and D.

a) Find a model for Device 1 and draw this model showing terminals A and B.
b) For the circuit with both devices connected, as shown in Figure 3, find the power delivered by the independent current source.

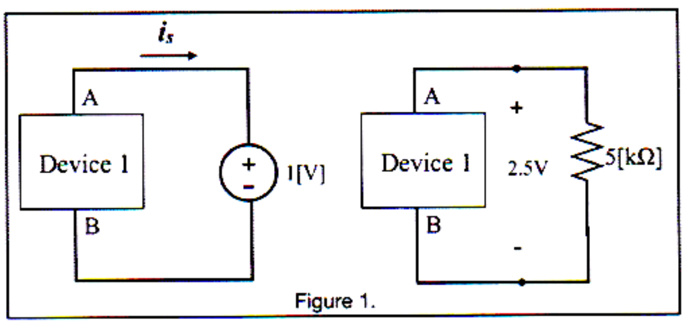


Figure 1.

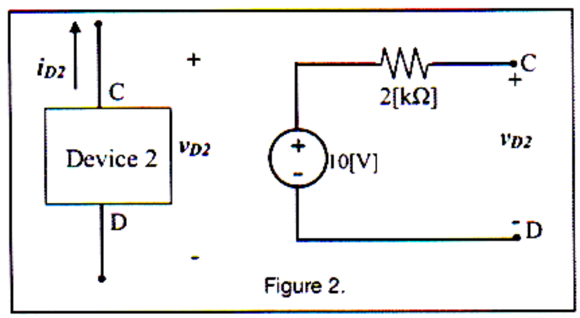


Figure 2.

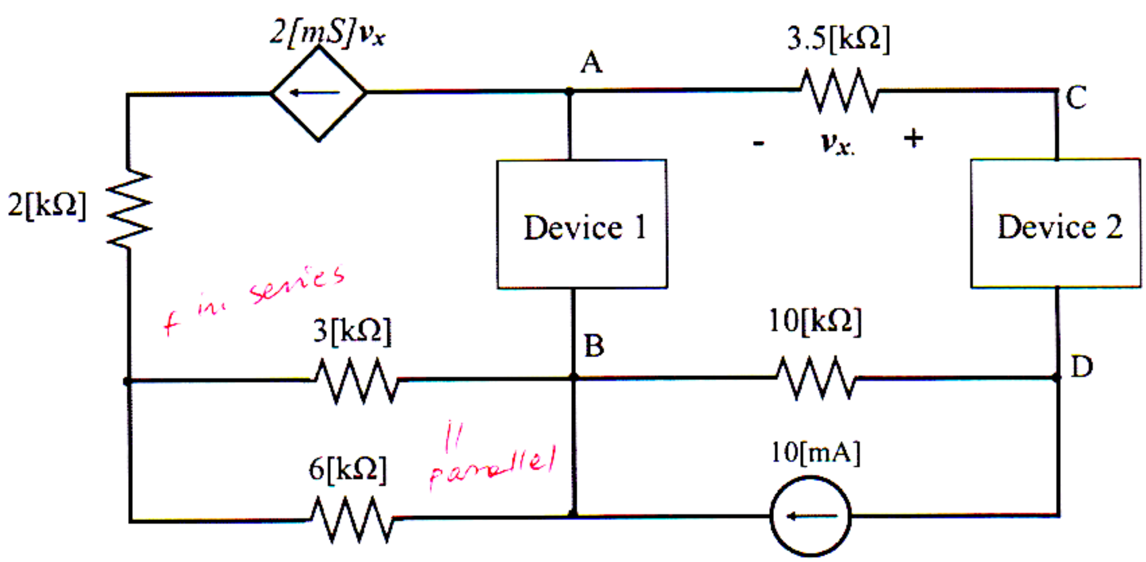
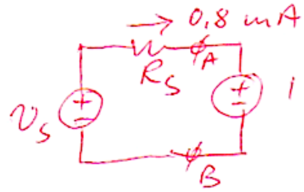
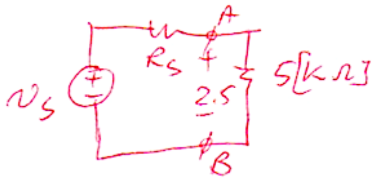


Figure 3.

Room for extra work



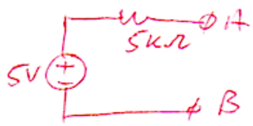
$$v_S - 0.8 \cdot R_S = 1[V] \quad (1)$$



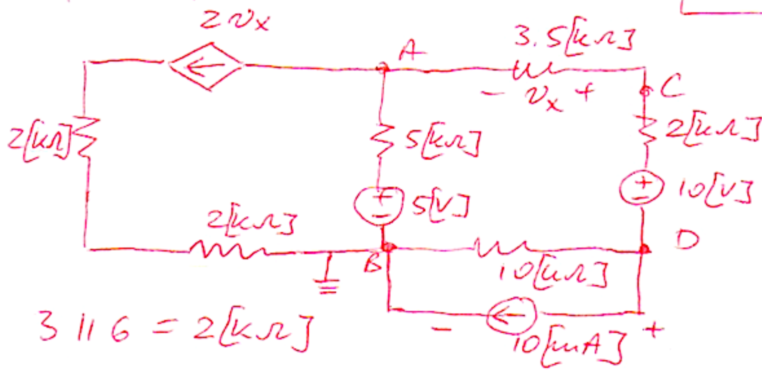
$$2.5[V] = \frac{v_S}{R_S + 5[k\Omega]} \cdot 5[k\Omega]$$

$$\downarrow$$

$$5v_S - 2.5R_S = 12.5 \quad (2)$$



solve : $v_S = 5[V]$, $R_S = 5[k\Omega]$



$3 \parallel 6 = 2[k\Omega]$

NVM

@ Ⓐ $\quad 2v_x + \frac{v_A - 5[V]}{5[k\Omega]} + \frac{v_A - 10[V] - v_D}{(2+3.5)[k\Omega]} = 0 \quad (1)$

@ D $\quad 10[mA] + \frac{v_D}{10[k\Omega]} + \frac{v_D + 10[V] - v_A}{(2+3.5)[k\Omega]} = 0 \quad (2)$

$$v_x = \frac{v_D + 10[V] - v_A}{(2+3.5)[\Omega]} \cdot 3.5[\Omega] \quad (3)$$

Solve: $v_x = 22.93[V]$

$v_A = -191.6[V]$

$v_D = -165.5[V]$

$P_{del,\,10[mA]} = -(-165.5) \cdot 10$

$= 1.655[W]$

3. {33 Points} The Device, shown in Figure 1, can be modeled as a voltage source in series with a resistance. Its $i_D(v_D)$ characteristic is shown in Figure 1.
The device is then connected in the circuit shown in Figure 2.

For your solution, **do not use** the Node-Voltage Method or the Mesh-Current Method.

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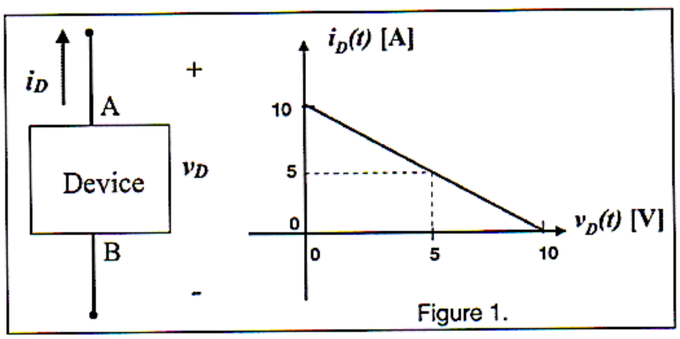
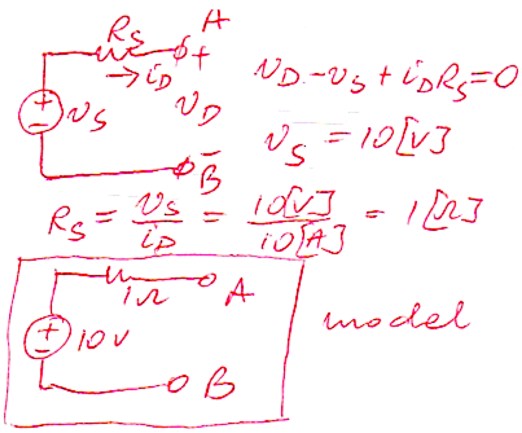


Figure 1.



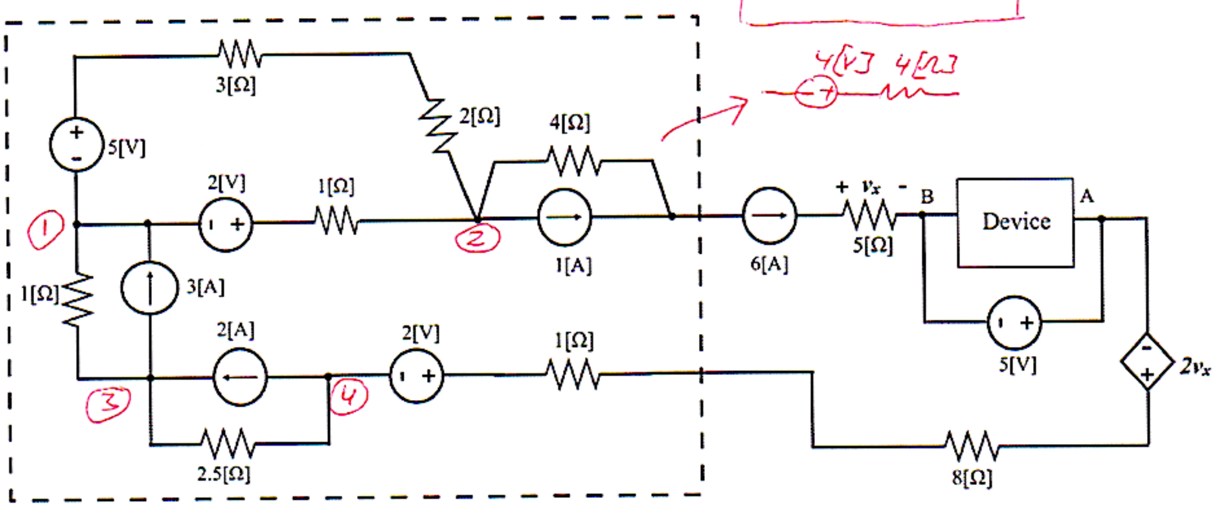
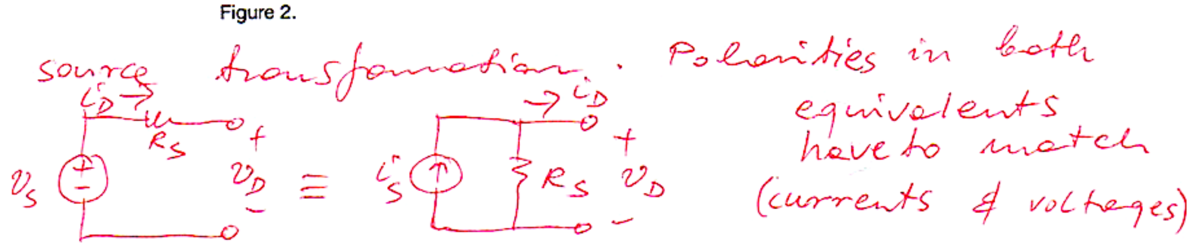
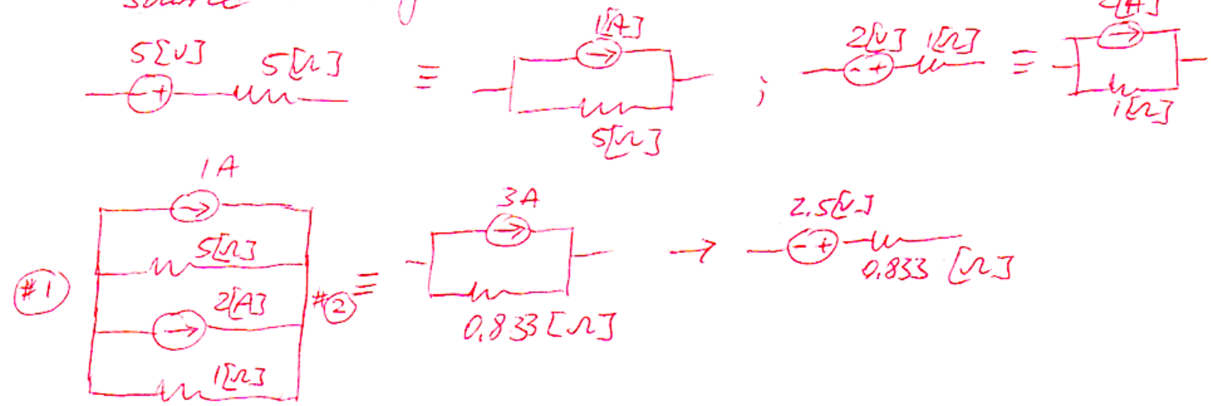


Figure 2.

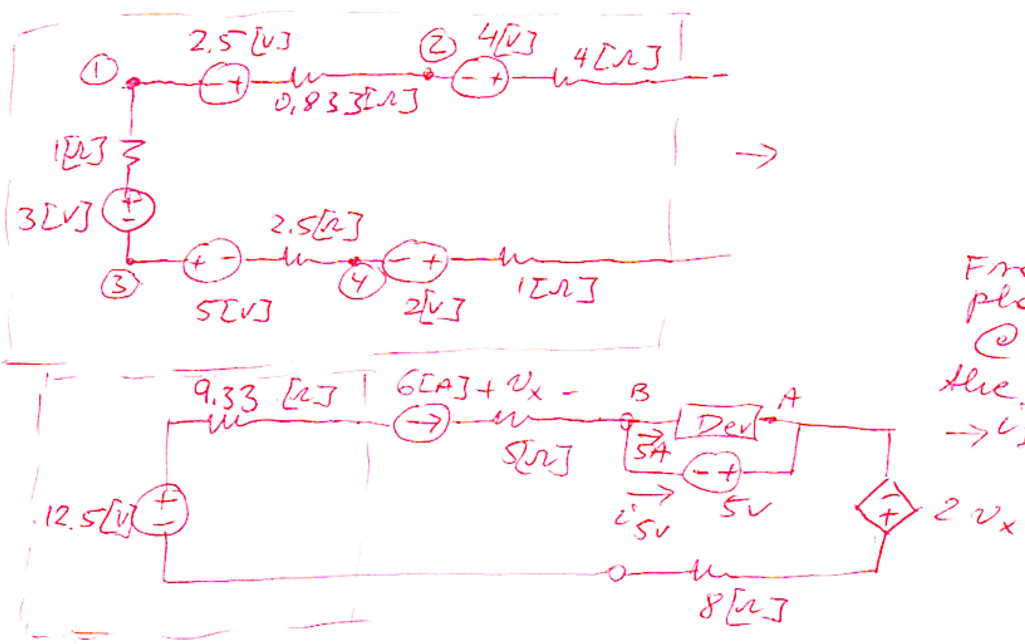


Room for extra work

source transformations



$2[\Omega] \parallel 1[\Omega] = 0.833\ [\Omega]$



From the plot:
@ 5V on the device
$\rightarrow i_D = 5[A]$

KCL in (B) $\quad i_{5V} = 6[A] - 5[A] = 1[A]$

Power delivered by 5[V] source

$P_{del,5V} = 5[W]$