Name: _____ (please print)

Signature: _____

ECE 2201 – Exam 2
October 21, 2017

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. _____/25
2. _____/35
3. _____/40

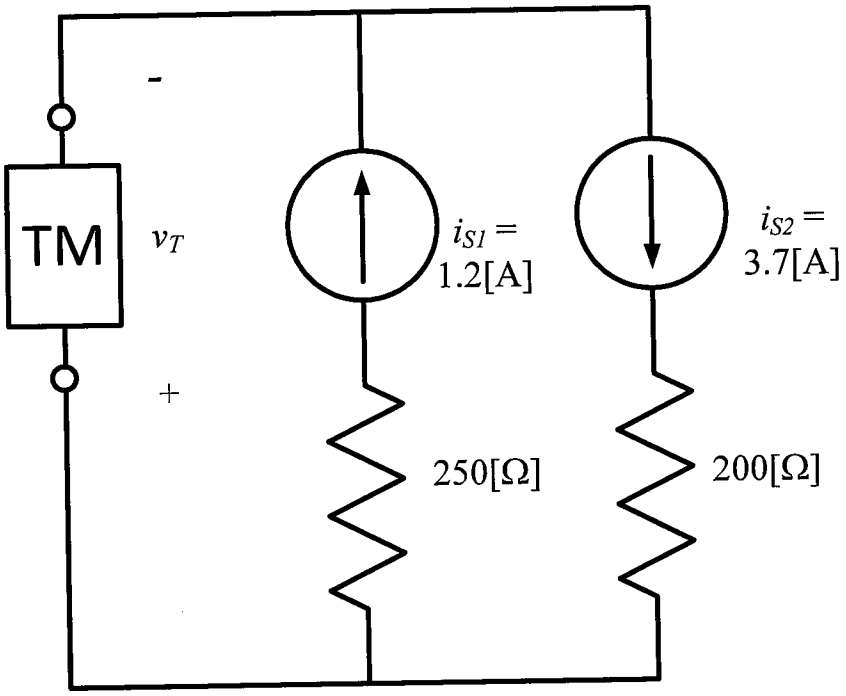
Total = 100

Room for extra work

1. {25 Points} A revolutionary new device called the TrombettaMax (TM) is delivering **energy** to the circuit shown below as follows.

$$w_{del\ by\ T} = 30e^{-0.005\left[\frac{1}{\mu s}\right]t}\ [J], t > 0$$

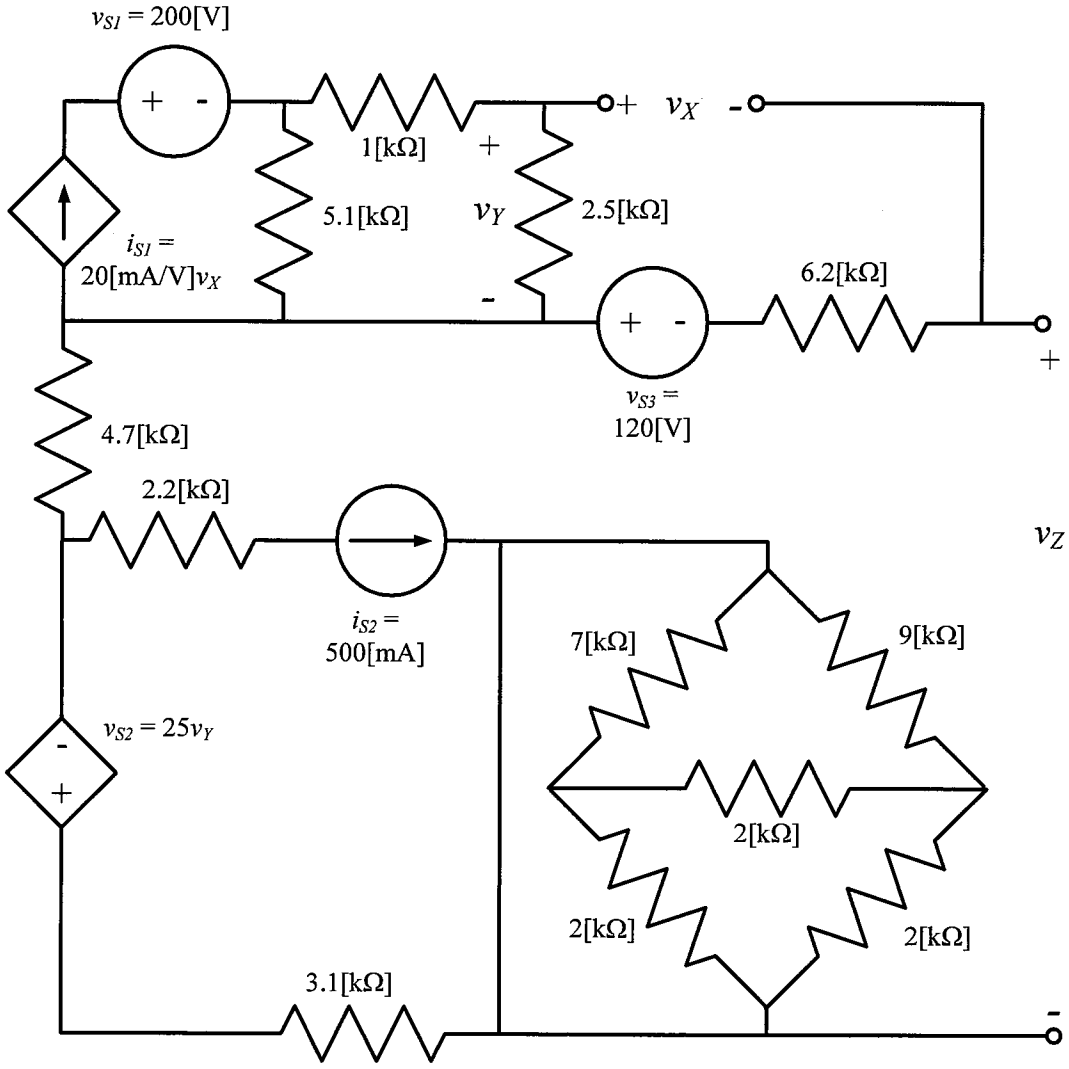
i) Find the voltage v_T.
ii) Find the power absorbed by the source i_{S1}.



Room for extra work

2. {35 Points} In the circuit below, find

i) the power delivered by i_{S1};
ii) v_Z.



Room for extra work

3. {40 Points} A device can be modeled using a current source in parallel with a resistor. This device is shown in Figure 1. When this device is connected to the circuit in Figure 2 by connecting terminal X to node **A**, and terminal Y to node **D**, v_M is measured to be 8.5[V]. When this device is connected to a 6.2[Ω] resistor, i_M is measured to be 2.4[A]. Find the model parameters for the device, showing terminals X and Y. Show your steps clearly. You are encouraged to redraw the circuit as needed.

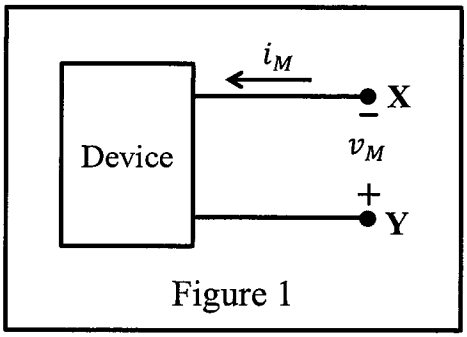


Figure 1

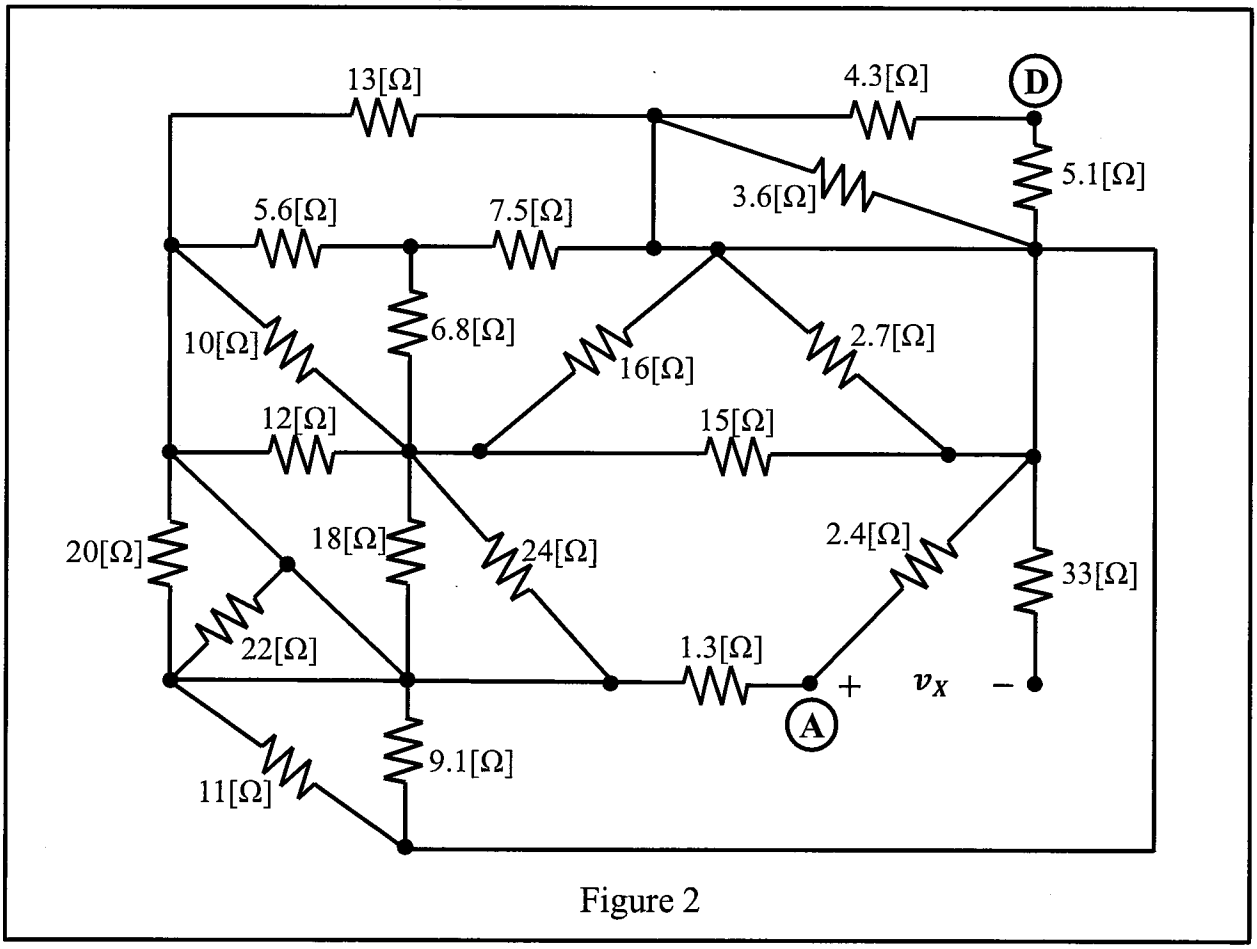


Figure 2

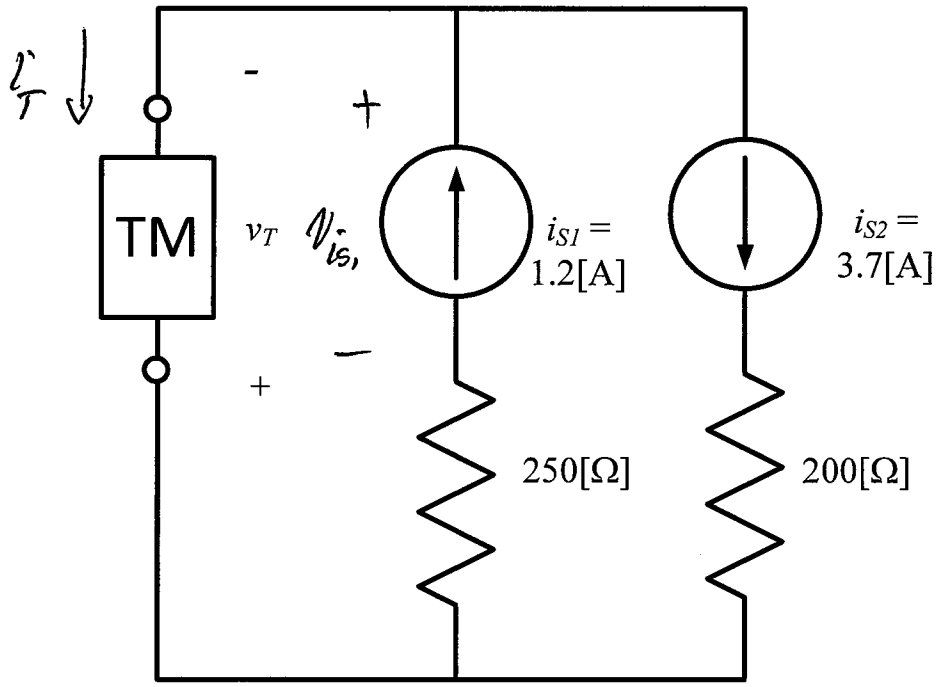
Room for extra work

Room for extra work

1. {25 Points} A revolutionary new device called the TrombettaMax (TM) is delivering **energy** to the circuit shown below as follows.

$$w_{del\ by\ T} = 30e^{-0.005\left[\frac{1}{\mu s}\right]t}\ [J], t > 0$$

i) Find the voltage v_T.
ii) Find the power absorbed by the source i_{S1}.



i)

Defining i_T as shown, we have $P_{del\ by\ TM} = v_T \cdot i_T$.

Also, $P_{del\ by\ TM} = \frac{dw_{del\ by\ T}}{dt} = \frac{d}{dt}\left(30e^{-0.005\left[\frac{1}{\mu s}\right]t}\right)$

$= 30\left(-0.005\left[\frac{1}{\mu s}\right]e^{-0.005\left[\frac{1}{\mu s}\right]t}\right)$

$= -1.5 \times 10^{5} e^{-0.005\left[\frac{1}{\mu s}\right]t}$ [W]

Now $i_T = (1.2 - 3.7)$ [A] $= -2.5$ [A]

Room for extra work

$$v_T = \frac{p_{\text{del by TH}}}{i_T} = 6\times10^4\, e^{-0.005\,[\frac{1}{\mu s}]\,t} \quad [V]$$

ii)

$$p_{\text{abs by } i_{s1}} = -v_{i_{s1}} \cdot i_{s1}$$

$$v_{i_{s1}} - 250(1.2) + v_T = 0$$

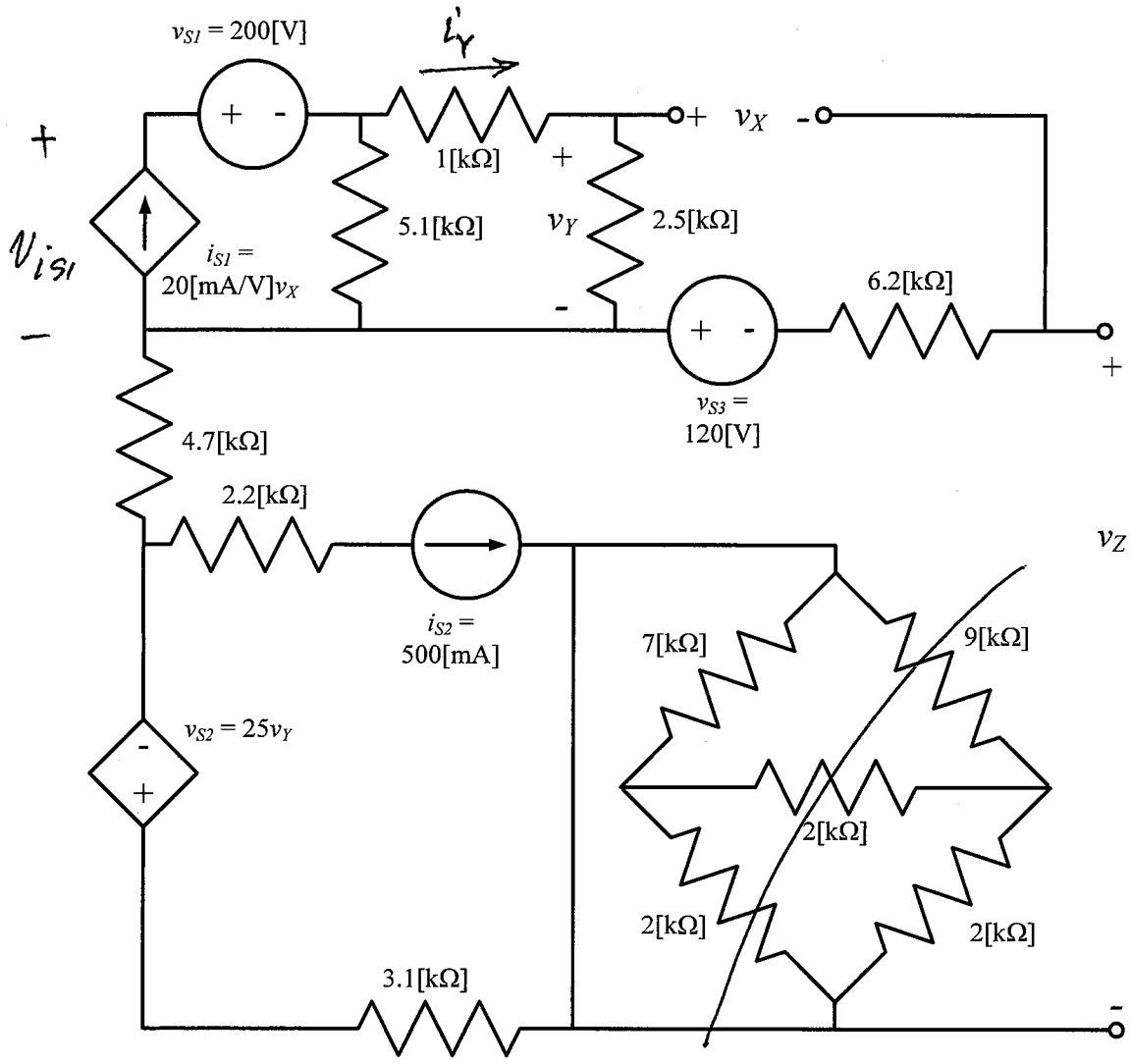
$$v_{i_{s1}} = \left(300 - 6\times10^4\, e^{-0.005\,[\frac{1}{\mu s}]\,t}\right) \quad [V]$$

$$\therefore\ p_{\text{abs by } i_{s1}} = \left(-360 + 7.2\times10^4\, e^{-0.005\,[\frac{1}{\mu s}]\,t}\right) [W]$$

2. {35 Points} In the circuit below, find

i) the power delivered by i_{S1}; +25 +10

ii) v_Z.



We ignore the resistance network on the bottom right because it is in parallel with a short.

i) CDR applies to the dependent current source:

$$v_Y = \underbrace{0.02\, v_X \frac{5100}{5100 + 3500}}_{i'_Y} \cdot 2500 = 29.65\, v_X$$

Room for extra work

KVL:

$$-v_Y + v_X - 120\,[V] = 0$$

+ 12

$$v_X = -4,188\,[V]$$

$$v_Y = -124.19\,[V] \Rightarrow i'_y = \frac{v_Y}{2500} = -49.68\,[mA]$$

$$v_{is_1} = 200 + i'_Y\,(3500) = 26.15\,[V]$$ +10

+3

$$\therefore \boxed{P_{del\ by\ i_{s_1}} = v_{is_1} \cdot i'_{s_1} = (26.15)(0.02)(-4.188) = -2.19\,[W]}$$

ii)

$$v_Z + 0.5(3100) + 25\,v_Y + 120 = 0$$

$$\boxed{v_Z = 1,432.25\ [V]}$$ +10

$$i'_{s_1} = 0.02\,v_X = -81.76\,[mA]$$

$$i'_Y = 11.66\,\left[\frac{mA}{V}\right] v_X$$

3. {40 Points} A device can be modeled using a current source in parallel with a resistor. This device is shown in Figure 1. When this device is connected to the circuit in Figure 2 by connecting terminal X to node **A**, and terminal Y to node **D**, v_M is measured to be 8.5[V]. When this device is connected to a 6.2[Ω] resistor, i_M is measured to be 2.4[A]. Find the model parameters for the device, showing terminals X and Y. Show your steps clearly. You are encouraged to redraw the circuit as needed.

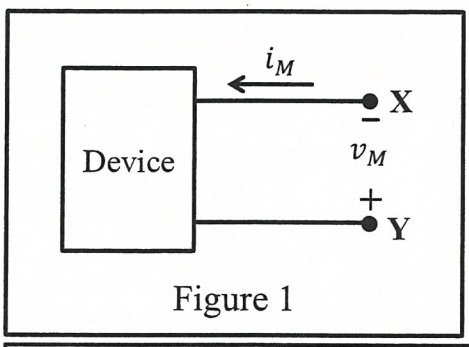


Figure 1

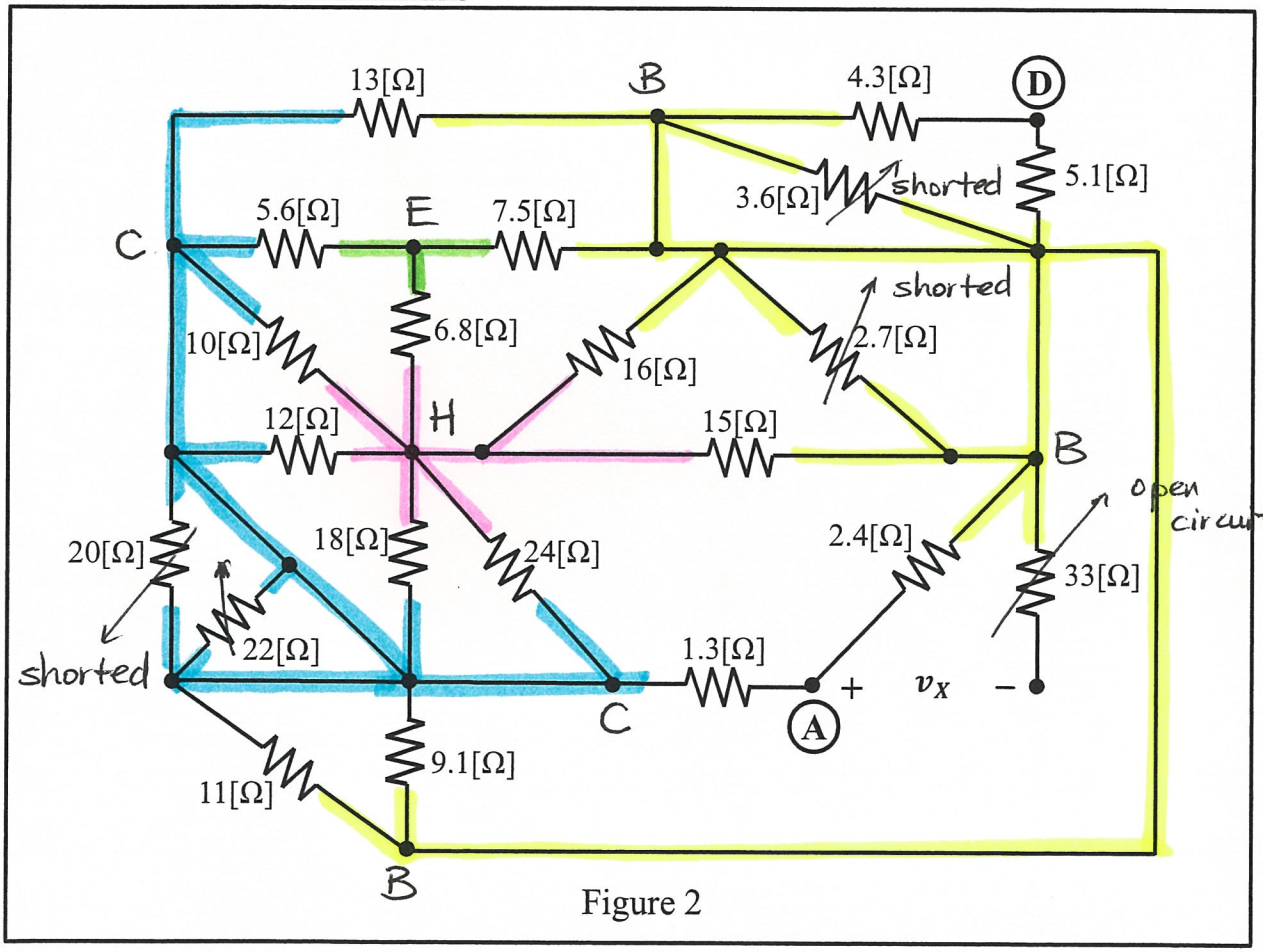
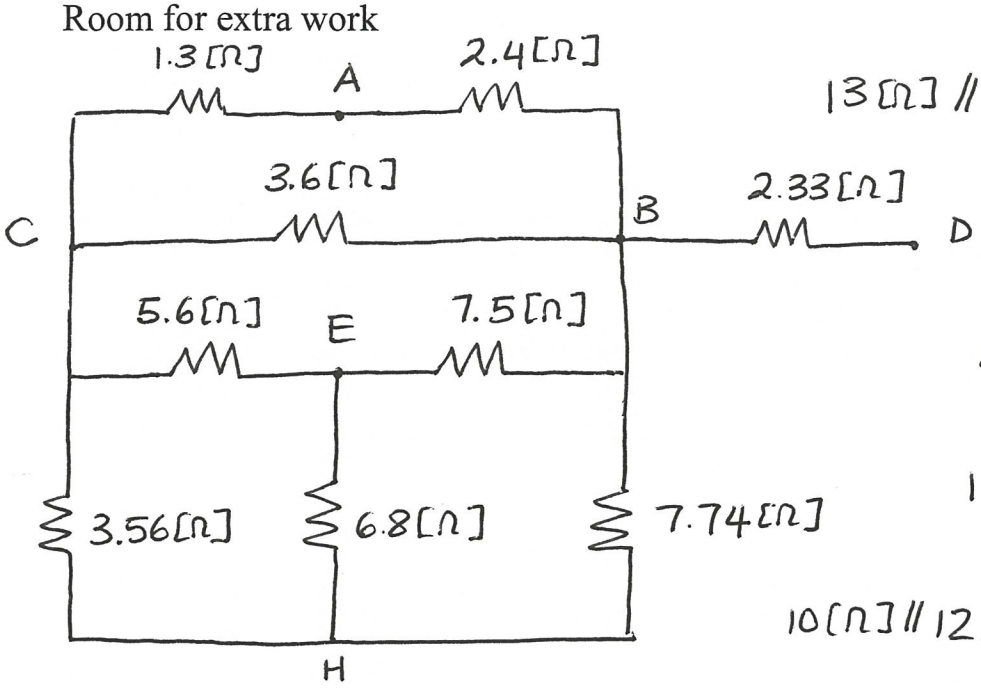


Figure 2

Room for extra work



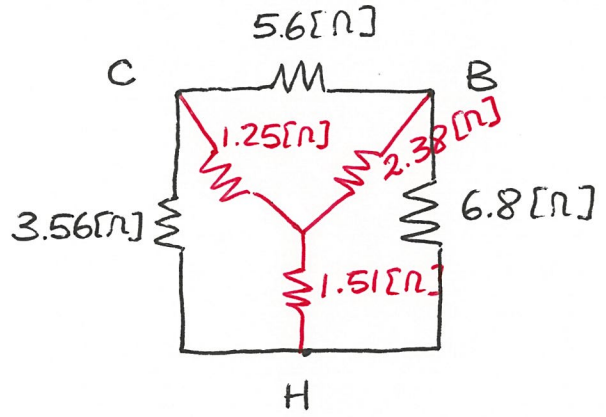
$13[\Omega] \,//\, 9.1[\Omega] \,//\, 11[\Omega] = 3.6[\Omega]$

$4.3[\Omega] \,//\, 5.1[\Omega] = 2.33[\Omega]$

$16[\Omega] \,//\, 15[\Omega] = 7.74[\Omega]$

$10[\Omega] \,//\, 12[\Omega] \,//\, 18[\Omega] \,//\, 24[\Omega] = 3.56[\Omega]$

Now we need to apply delta-to-wye:



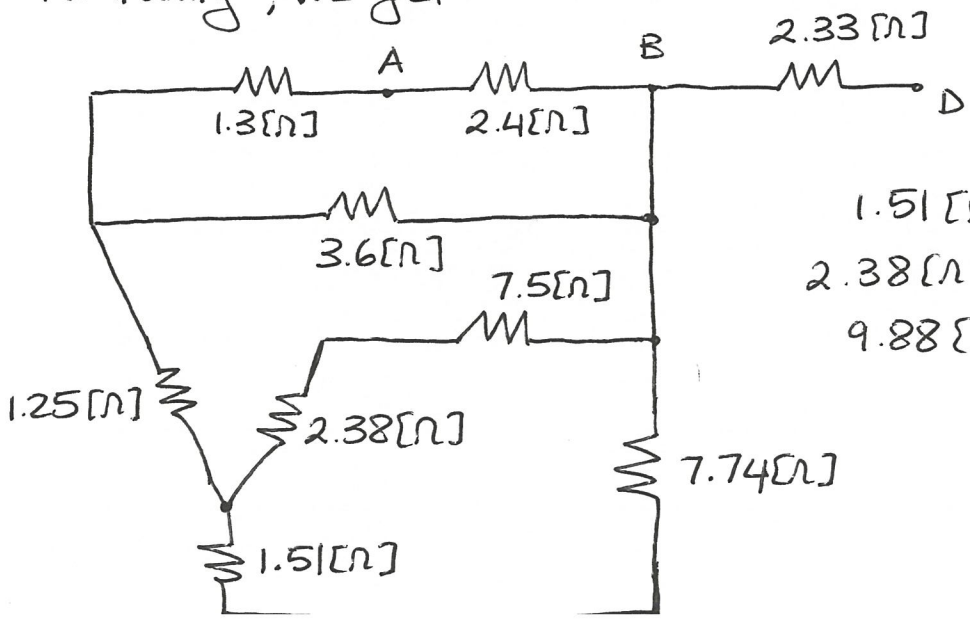
$R_T = 3.56 + 5.6 + 6.8 = 15.96[\Omega]$

$3.56 \times 5.6 / R_T = 1.25[\Omega]$

$5.6 \times 6.8 / R_T = 2.38[\Omega]$

$3.56 \times 6.8 / R_T = 1.51[\Omega]$

Redrawing, we get:

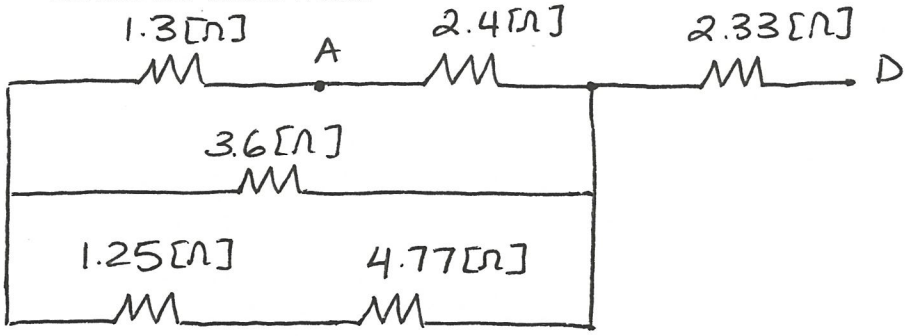


$1.51[\Omega] + 7.74[\Omega] = 9.25[\Omega]$

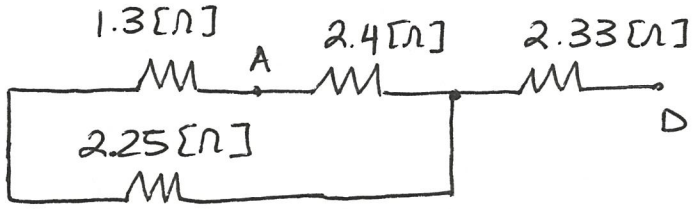
$2.38[\Omega] + 7.5[\Omega] = 9.88[\Omega]$

$9.88[\Omega] \,//\, 9.25[\Omega] = 4.77[\Omega]$

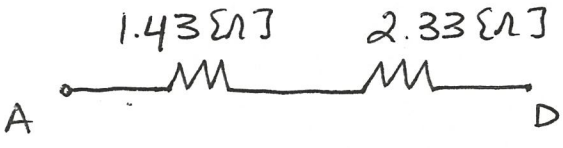
Room for extra work

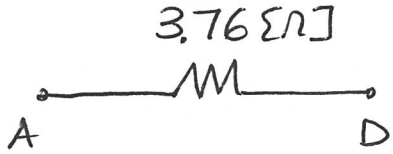


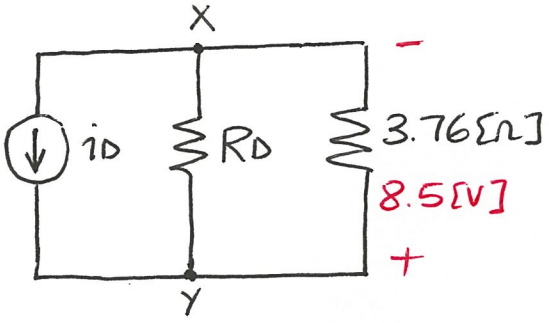
$(1.25+4.77) \,//\, 3.6 = 2.25[\Omega]$



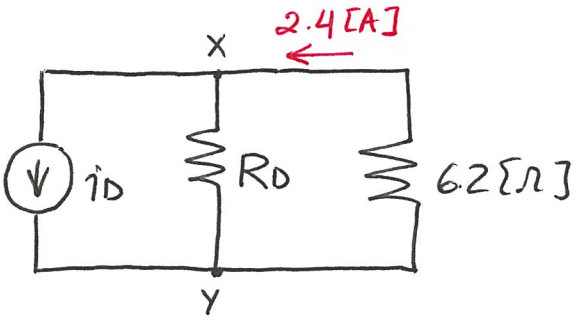
$(2.25+1.3) \,//\, 2.4 = 1.43[\Omega]$







$8.5[V] = i_D \cdot (R_D \,//\, 3.76[\Omega])$ (1)



CDR: $2.4[A] = i_D \cdot \dfrac{R_D}{R_D+6.2[\Omega]}$ (2)

Solving (1) and (2), we get:

$i_D = 2.075[A]$, $R_D = -45.78[\Omega]$