Name: ______________________________ (please print)

Signature: ___________________________

ECE 2300 -- Exam #1
October 11, 2014

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. _______________/30

2. _______________/35

3. _______________/35

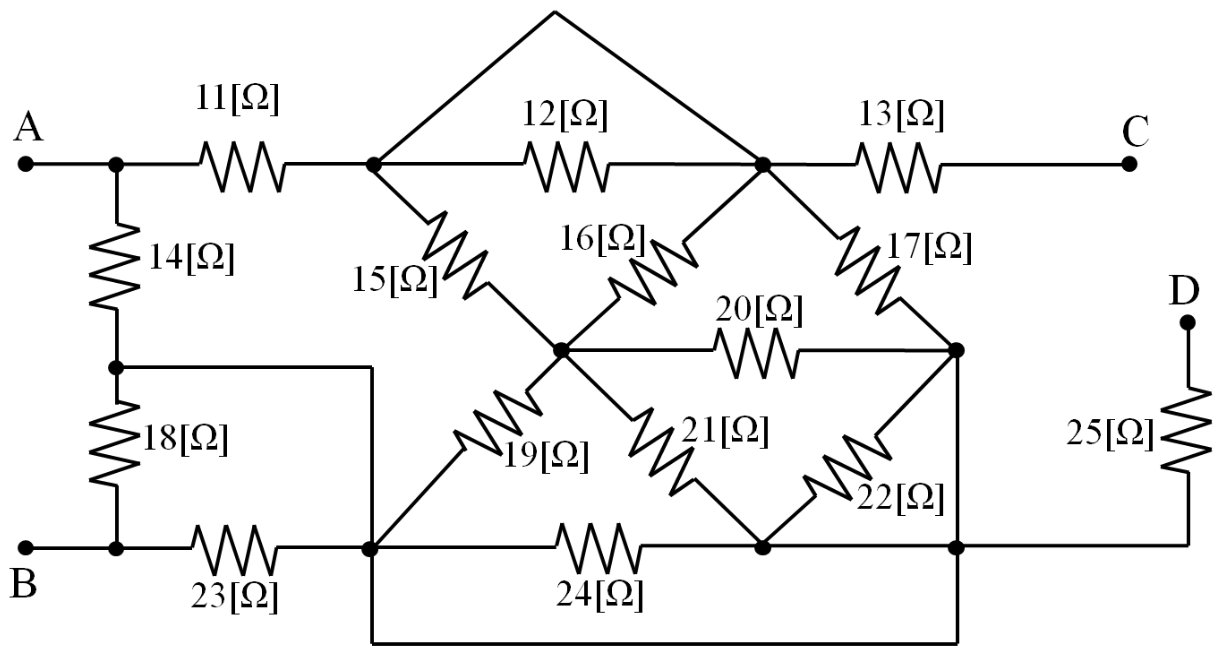
Total = 100

Room for extra work

1. {30 Points} Use the figure given below to solve this problem. Show your steps in some clear fashion. You are strongly encouraged to redraw the diagram as needed to make your work more clear.

a. Find the equivalent resistance of this circuit as seen by terminals A and B.

b. Find the equivalent resistance of this circuit as seen by terminals A and C.



Room for extra work

2. {35 Points} A multi-range voltmeter, shown in Figure 1, is made up of two resistors, R_1 and R_2, and a 180[mV] , 7[mA] full-scale meter. This meter has two scales for reading, one from zero to -50[V] and the other from zero to -125[V], both for voltages with respect to the common terminal. This multi-range voltmeter is connected to the circuit in Figure 2, connecting terminals a to a, b to b, and c to c.

a. Find the reading on the -125[V] of the multi-range voltmeter with the circuit in Figure 2 connected.
b. Find the voltage at the -125[V] terminal with respect to the common terminal with the circuit in Figure 2 connected.

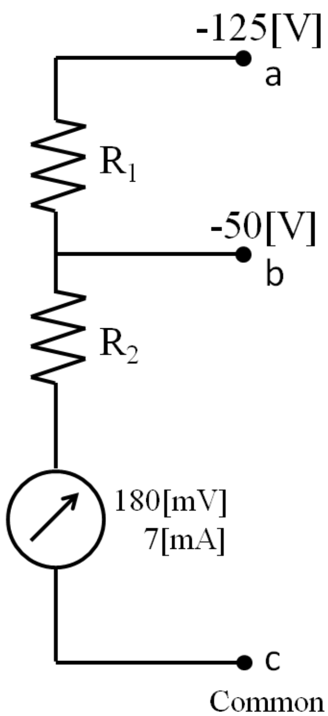


Figure 1

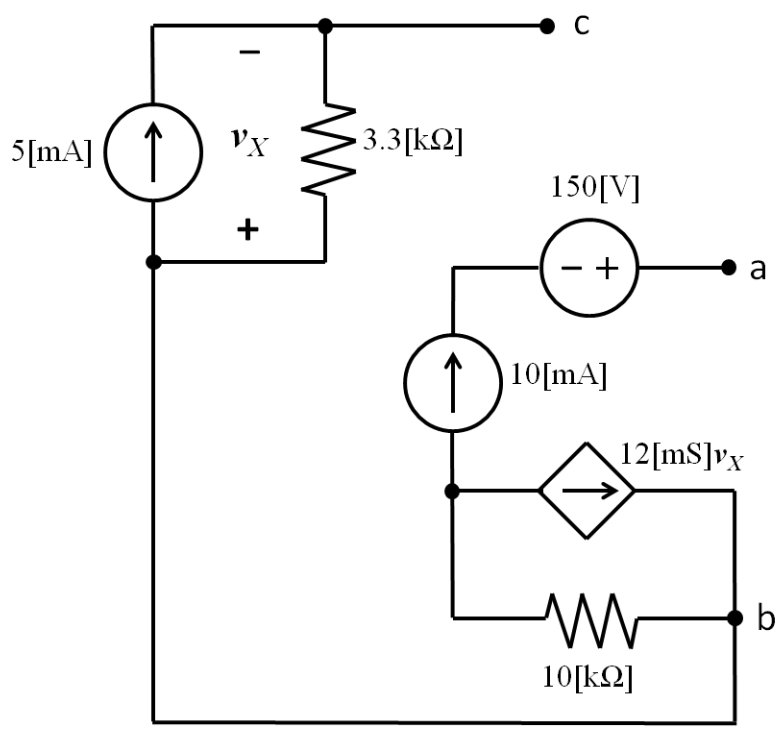
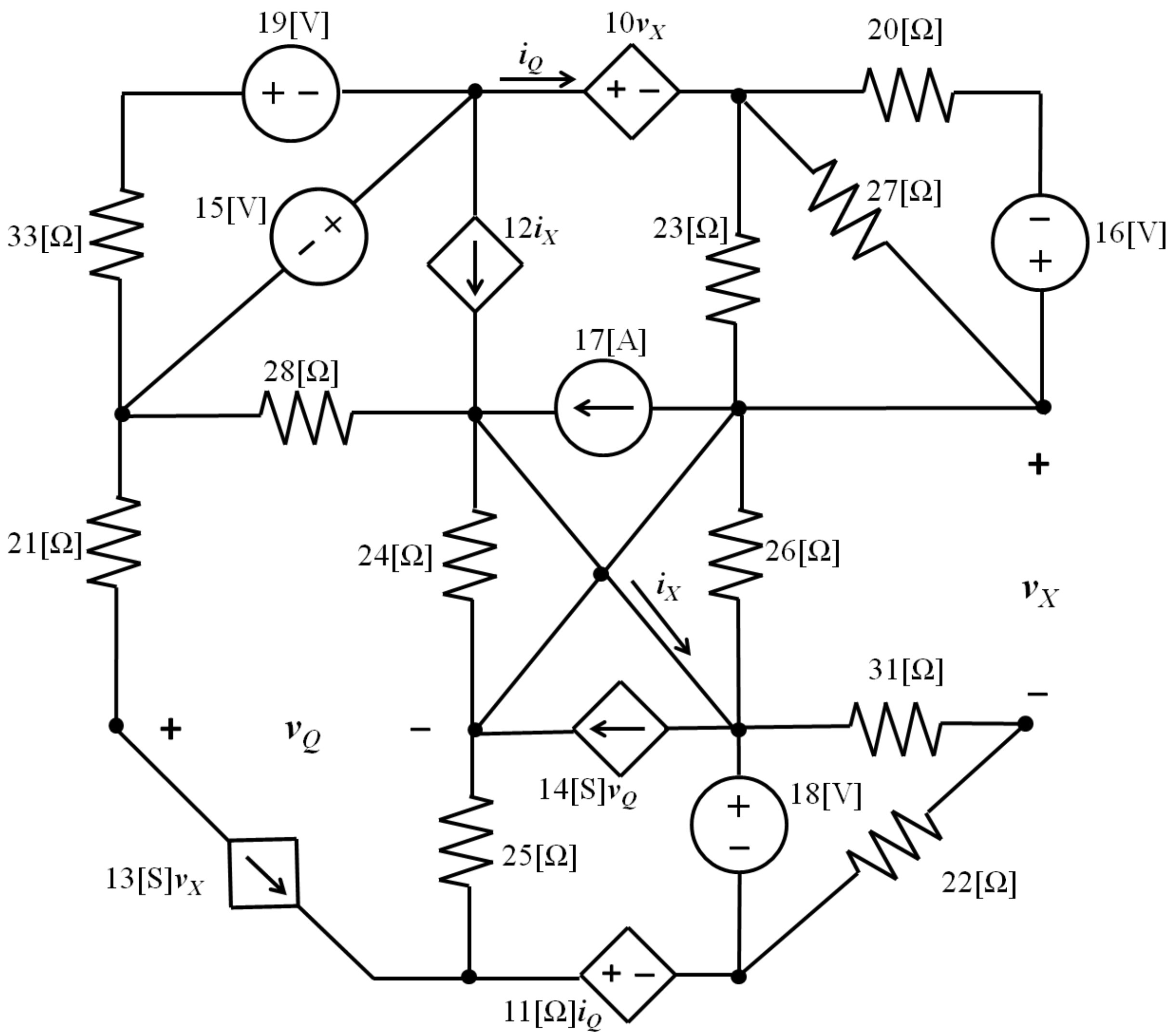


Figure 2

Room for extra work

3. {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.

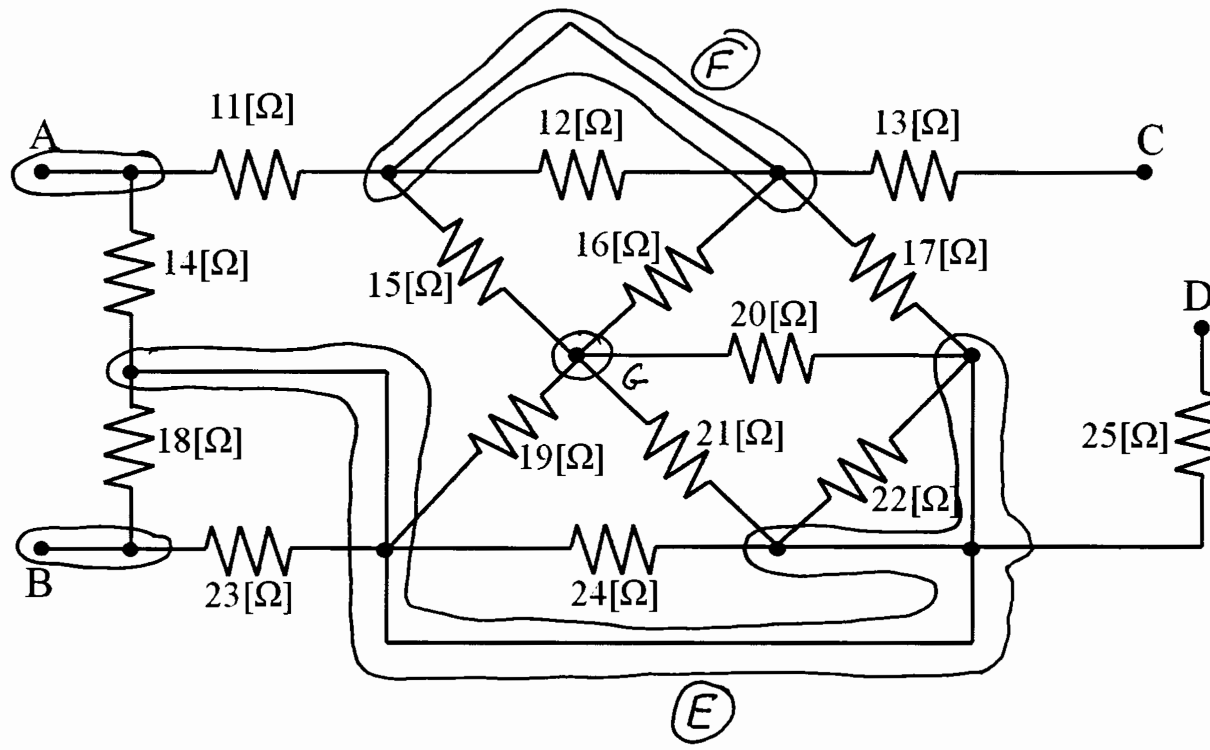


Room for extra work

1. {30 Points} Use the figure given below to solve this problem. Show your steps in some clear fashion. You are strongly encouraged to redraw the diagram as needed to make your work more clear.

a. Find the equivalent resistance of this circuit as seen by terminals A and B.

b. Find the equivalent resistance of this circuit as seen by terminals A and C.



25{Ω} resistor is open-circuited – replace with wire

24 {Ω} resistor is short-circuited – replace with open circuit

22 {Ω} resistor is short-circuited – replace with open circuit

12 {Ω} resistor is short-circuited – replace with open circuit

18{Ω}||23{Ω} = 10.10{Ω}

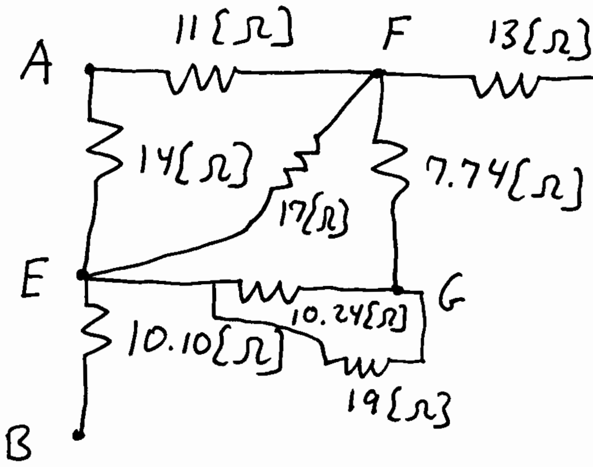
15{Ω}|| 16{Ω} = 7.74{Ω}

20{Ω}|| 21{Ω} = 10.24{Ω}

With these simplifications, let us redraw.

(See next page)

Room for extra work



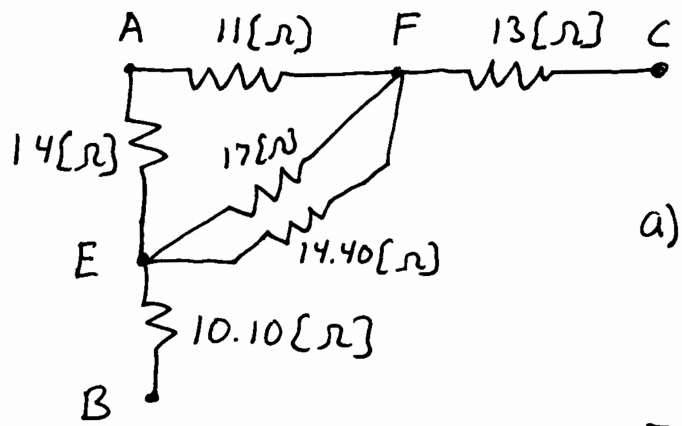
Now, we can see that

$19[\Omega] \,||\, 10.24[\Omega] = 6.66[\Omega]$

and that that parallel combination is in series with 7.74[Ω],

$6.66[\Omega] + 7.74[\Omega] = 14.40[\Omega]$

Let us redraw again.



$17[\Omega] \,||\, 14.40[\Omega] = 7.79[\Omega]$

a) for part a), nothing is connected to C, so we ignore 13[Ω] resistor

$7.79[\Omega] + 11[\Omega] = 18.79[\Omega]$

$18.79[\Omega] \,||\, 14[\Omega] = 8.02[\Omega]$

$8.02[\Omega] + 10.10[\Omega] = \boxed{18.12[\Omega]}$

b) for part b) nothing is connected to B, so we ignore the 10.10[Ω] resistor, $7.79[\Omega] + 14[\Omega] = 21.79[\Omega]$

$21.79[\Omega] \,||\, (11[\Omega]) = 7.31[\Omega]$

$7.31[\Omega] + 13[\Omega] = \boxed{20.31[\Omega]}$

2. {35 Points} A multi-range voltmeter, shown in Figure 1, is made up of two resistors, R_1 and R_2, and a 180[mV] , 7[mA] full-scale meter. This meter has two scales for reading, one from zero to -50[V] and the other from zero to -125[V], both for voltages with respect to the common terminal. This multi-range voltmeter is connected to the circuit in Figure 2, connecting terminals a to a, b to b, and c to c.

a. Find the reading on the -125[V] scale of the multi-range voltmeter with the circuit in Figure 2 connected.
b. Find the voltage at the -125[V] terminal with respect to the common terminal with the circuit in Figure 2 connected.

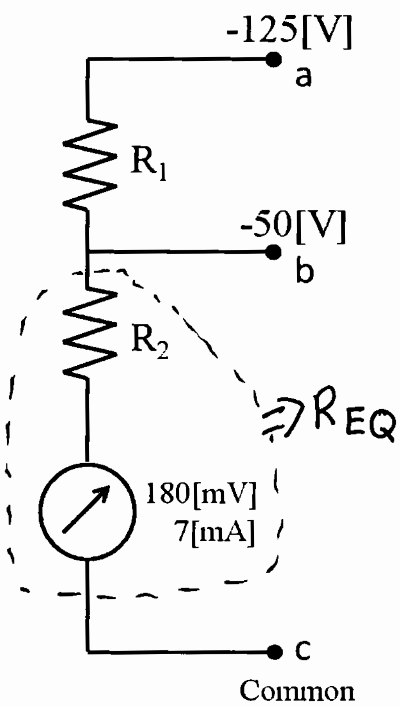


Figure 1

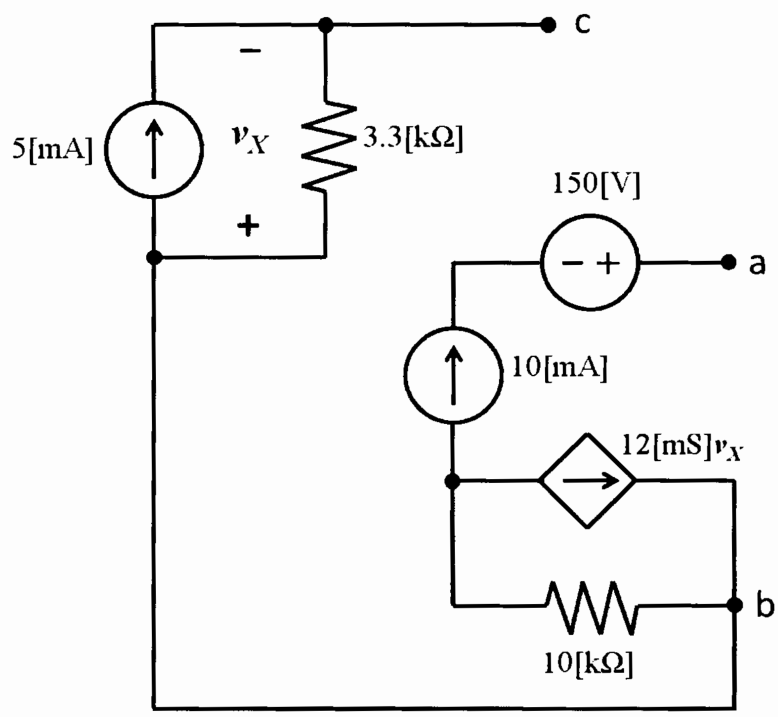


Figure 2

With these voltage polarities, positive currents will flow up the page.

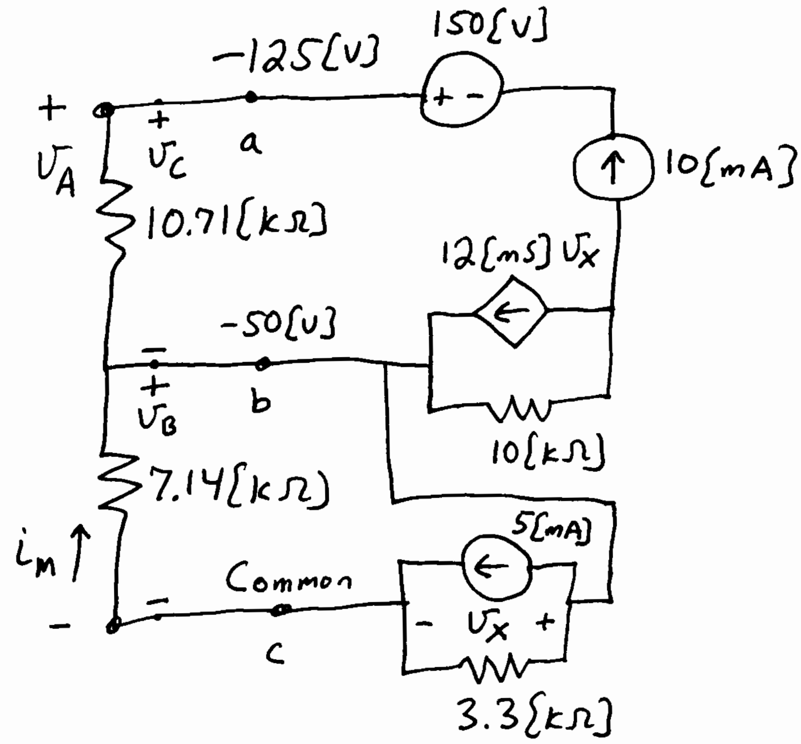
$$R_1 = \frac{75\{V\}}{7\{mA\}} = 10.71\{k\Omega\}$$

$$R_{EQ} = \frac{50\{V\}}{7\{mA\}} = 7.14\{k\Omega\}$$

Next, we redraw, connecting Figure 1 to Figure 2. The key is to keep all connections correct

See next page

Room for extra work



a) 3.3[kΩ] and 7.14[kΩ] are in parallel, fed by 5[mA].

CDR)

$$i_m = 5[mA]\left(\frac{3.3[k\Omega]}{3.3[k\Omega]+7.14[k\Omega]}\right) = 1.576[mA]$$

$$\frac{i_m}{7[mA]} = \frac{v_{reading}}{-125[V]}$$ by the proportionality of all scales on voltmeters and ammeters.

So, $v_{reading} = \left(\frac{1.576}{7}\right)(-125[V]) = \boxed{-28.14[V]}$

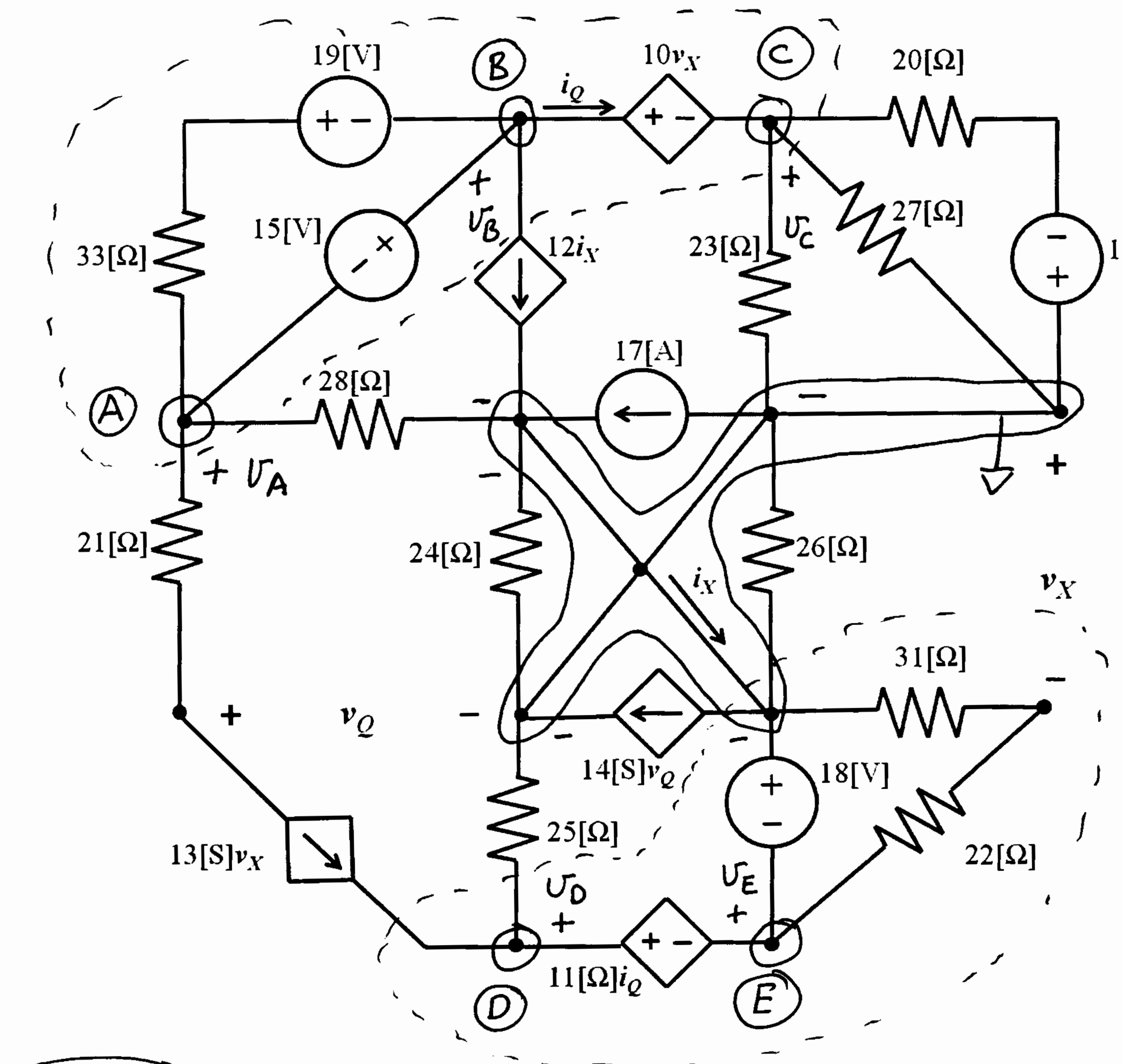
b) We want v_A in the diagram above. We know $v_B = -i_m \, 7.14[k\Omega]$

$v_B = -11.25[V]$

$v_C = 10[mA]\,10.71[k\Omega] = 107.1[V]$

And $v_A = v_C + v_B = 107.1[V] - 11.25[V] = \boxed{95.85[V]}$

3. {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.



(A+B+C) $\frac{v_C + 16[V]}{20[\Omega]} + \frac{v_C}{27[\Omega]} + \frac{v_C}{23[\Omega]} + 12 i_X + \frac{v_A}{28[\Omega]} + 13[S]v_X = 0$

(A+B) $v_B - v_A = 15[V]$

(B+C) $v_B - v_C = 10 v_X$

(D+E) $v_D - v_E = 11[\Omega] i_Q$

(E) $v_E = -18[V]$

See next page

Room for extra work

(v_X) $$v_X + v_E\left(\frac{31\{\Omega\}}{31\{\Omega\} + 22\{\Omega\}}\right) = 0$$

(i_X) $$-i_X + \frac{0}{26\{\Omega\}} - 13\{S\}v_X + \frac{v_D}{25\{\Omega\}} + 14\{S\}v_Q = 0$$

(i_Q) $$i_Q + 12\,i_X + \frac{v_A}{28\{\Omega\}} + 13\{S\}v_X = 0$$

(v_Q) $$-v_Q - (13\{S\}v_X)21\{\Omega\} + v_A = 0$$