Name: Solutions (please print)

Signature: _____

ECE 2201 – Exam 3
November 18, 2017

Keep this exam closed and face up until you are told to begin.

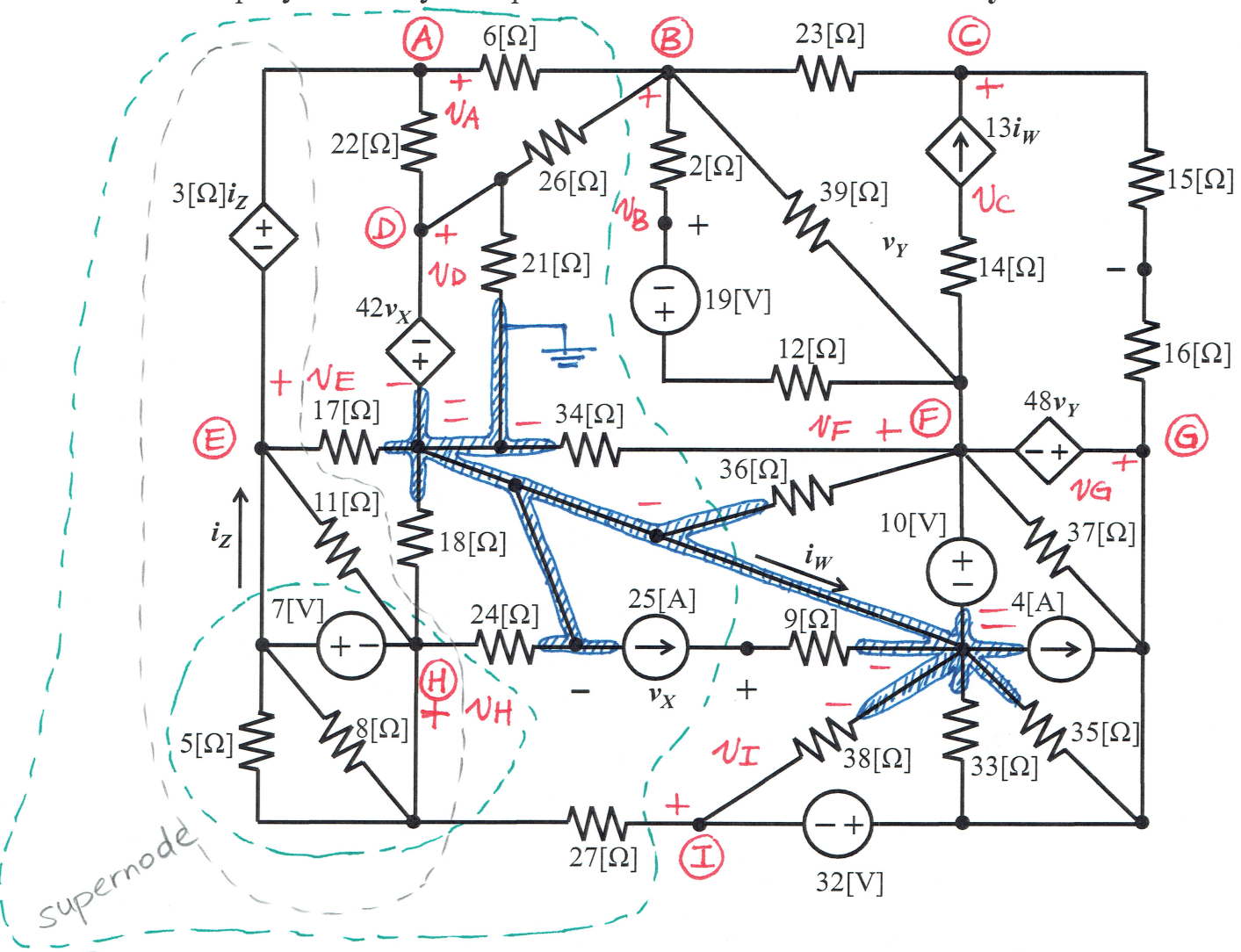
1. This exam is closed book, closed notes. You may use one 8.5" x 11" crib sheet, or its equivalent.
2. Show all work on these pages. Show all work necessary to complete the problem. A solution without the appropriate work shown will receive no credit. A solution which is not given in a reasonable order will lose credit.
3. Show your work clearly. If the grader cannot follow or understand 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. _____/35
2. _____/30
3. _____/35

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 this circuit. Do not simplify the circuit. Do not attempt to simplify or solve your equations. **Define all variables clearly.**



A+E+H $\quad \frac{v_A - v_B}{6[\Omega]} + \frac{v_A - v_D}{22[\Omega]} + \frac{v_E}{17[\Omega]} + \frac{v_H}{18[\Omega]} + \frac{v_H}{24[\Omega]} + \frac{v_H - v_I}{27[\Omega]} = 0$

A+E $\quad v_A - v_E = 3[\Omega]\, i_Z$

E+H $\quad v_E - v_H = 7[V]$

B $\quad \frac{v_B - v_A}{6[\Omega]} + \frac{v_B - v_D}{26[\Omega]} + \frac{v_B - v_F + 19[V]}{2[\Omega] + 12[\Omega]} + \frac{v_B - v_F}{39[\Omega]} + \frac{v_B - v_C}{23[\Omega]} = 0$

Room for extra work

(C) $\frac{v_C - v_B}{23[\Omega]} - 13 i_W + \frac{v_C - v_G}{31[\Omega]} = 0$

(D) $v_D = -42 v_X$ (F) $v_F = 10[V]$

(F+G) $v_G - v_F = 48 v_Y$ (I+G) $v_G - v_I = 32[V]$

Auxiliary equations:

(iz) $i_Z + \frac{v_H - v_E}{11[\Omega]} + \frac{v_H}{18[\Omega]} + \frac{v_H}{24[\Omega]} + \frac{v_H - v_I}{27[\Omega]} = 0$

(iw) $\frac{v_A - v_B}{6[\Omega]} + \frac{v_D - v_B}{26[\Omega]} - \frac{v_F}{34[\Omega]} - \frac{v_F}{36[\Omega]} + i_W + 25[A] + \frac{v_H - v_I}{27[\Omega]} = 0$

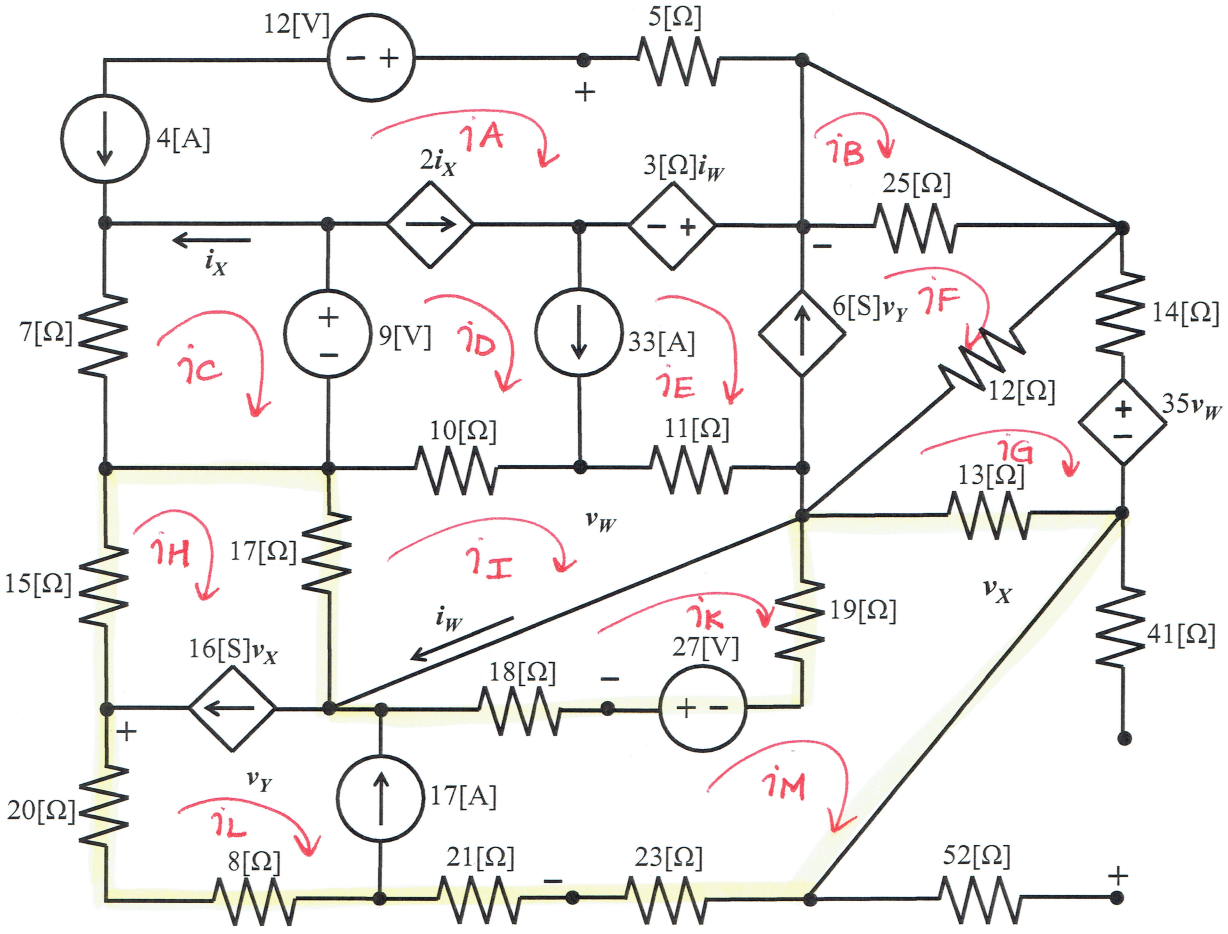
(vy) $\frac{v_F - v_B - 19[V]}{14[\Omega]} \cdot 2[\Omega] + v_B - v_C + \frac{v_C - v_G}{31[\Omega]} \cdot 15[\Omega] - v_Y = 0$

(vx) $-v_X + 9[\Omega] \cdot 25[A] = 0$

10 essential nodes, 4 dependent source variables

10 − 1 + 4 = 13 equations

2. {30 Points} Use the mesh-current method to write a complete set of equations that could be used to solve the circuit below. Do not simplify the circuit. Do not attempt to simplify or solve your equations. **Define all variables clearly.**



iA $i_A = -4[A]$

iB $25[\Omega](i_B - i_F) = 0$

iC $7[\Omega] \cdot i_C + 9[V] = 0$

iD+iA $i_D - i_A = 2i_X$

iD+iE $i_D - i_E = 33[A]$

iE+iF $i_F - i_E = 6[S]\,v_Y$

iG $12[\Omega](i_G - i_F) + 14[\Omega]\,i_G + 35v_W + 13[\Omega](i_G - i_M) = 0$

Room for extra work

$i_H + i_L + i_M$ $15[\Omega] i_H + 17[\Omega](i_H - i_I) + 18[\Omega](i_M - i_K) + 27[V] +$

$\ldots + 19[\Omega](i_M - i_K) + 13[\Omega](i_M - i_G) + (21+23)[\Omega] i_M + 28[\Omega] i_L = 0$

$i_H + i_L$ $i_H - i_L = 16[S] v_X$ $i_L + i_M$ $i_M - i_L = 17[A]$

i_I $17[\Omega](i_I - i_H) + 10[\Omega](i_I - i_D) + 11[\Omega](i_I - i_E) = 0$

i_K $19[\Omega](i_K - i_M) - 27[V] + 18[\Omega](i_K - i_M) = 0$

Auxiliary equations:

i_X $i_X = i_A - i_C$

i_W $i_W = i_I - i_K$

v_X $+ v_X + 14[\Omega] i_G + 35 v_W = 0$

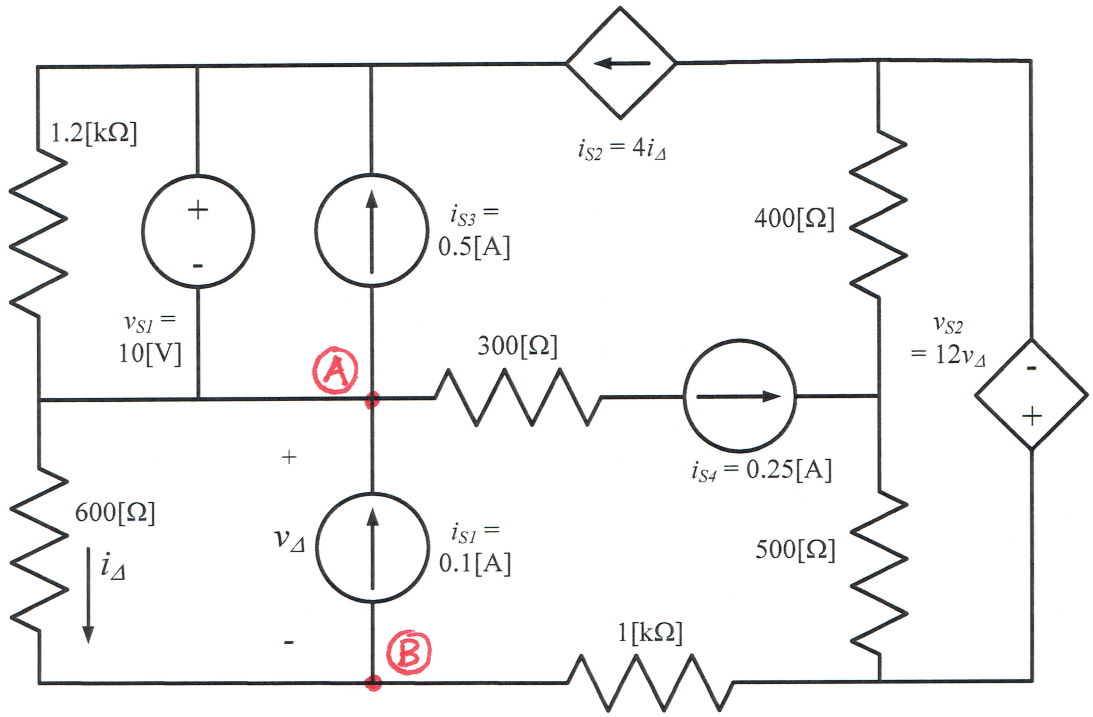
v_Y $- v_Y - (20+8)[\Omega] i_L - 21[\Omega] i_M = 0$

v_W $- v_W - 5[\Omega] .4[A] + 12[\Omega](i_F - i_G) + 18[\Omega](i_M - i_K) = 0$

12 meshes + 5 dependent source variables

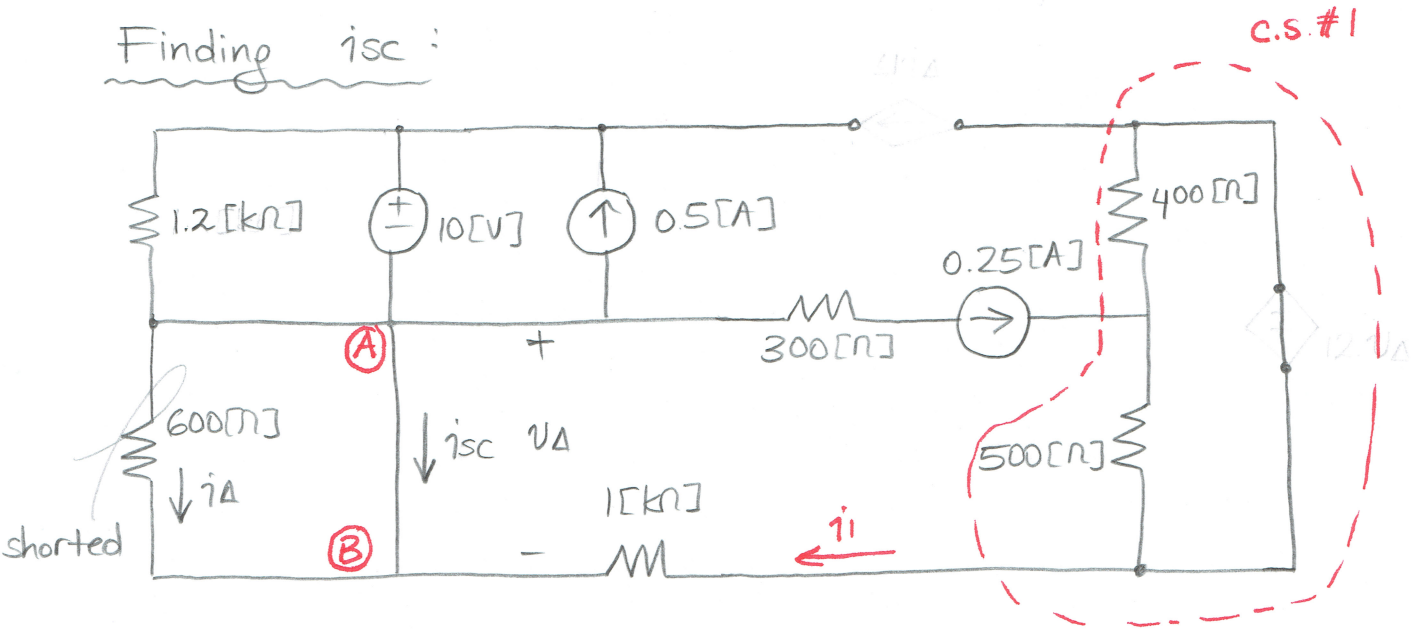
12+5 = 17 equations

3. {35 Points}
i) Find the Norton Equivalent seen by the current source i_{S1}.
ii) Find the power delivered by i_{S1}.



We first need to take out the current source i_{S1}.

Finding i_{SC}:



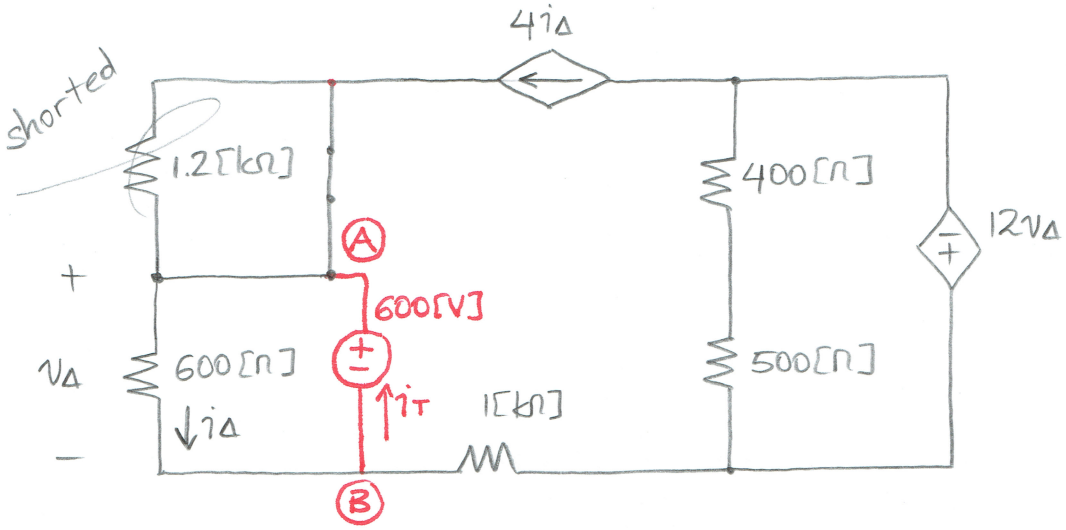
$i_\Delta = 0 \Rightarrow i_{S2} = 4i_\Delta = 0$ $\quad v_\Delta = 0 \Rightarrow v_{S2} = 12v_\Delta = 0$

KCL @ c.s #1 : $i_1 = 0.25[A]$ $\quad$ KCL @ B : $i_{SC} + i_\Delta + i_1 = 0$

$$\boxed{i_{SC} = -0.25[A]}$$

Room for extra work

Finding R_{TH}: First kill all independent sources and then apply test source in active sign convention.



$v_\Delta = 600\,[V]$

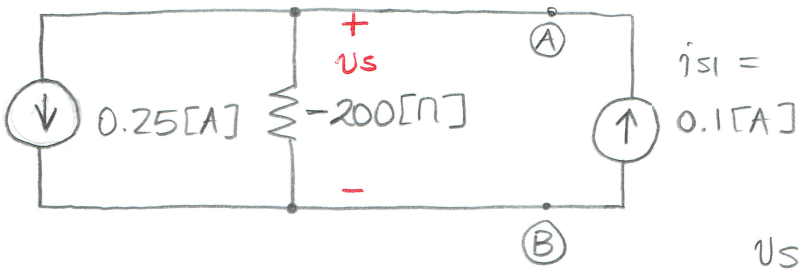
$i_\Delta = \frac{600}{600} = 1\,[A]$

$R_N = \frac{600\,[V]}{i_T}$

KCL @ (A): $-4i_\Delta + i_\Delta - i_T = 0 \Rightarrow i_T = -3\,[A]$

$\boxed{R_N = -200\,[\Omega]}$

$\boxed{i_N = i_{sc} = -0.25\,[A]}$



$p_{DEL,isi} = 0.1\,[A] \cdot v_s$

$v_s = -200\,[\Omega]\,(0.1 - 0.25)\,[A]$

$v_s = 30\,[V]$

$\boxed{p_{DEL,isi} = 3\,[W]}$