ECET 3000 – Spring 2018.

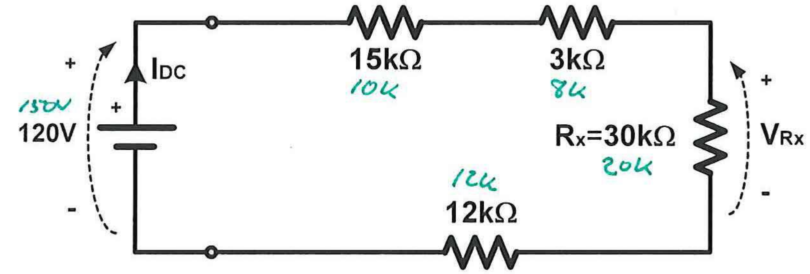
Electrical Principles – Exam I **Print Name (Last Name First):** KEY

Instructions: Show all of your work... No credit will be given for illegible or illogical work, or for final answers that are not justified by the work shown. Place all final answers in the spaces provided. This exam is **closed book**. You may find the following formulas helpful during this exam:

$$V = I \cdot R \qquad R_{EQseries} = R_1 + R_2 + \ldots + R_N \qquad \text{KVL: } \sum V_{Rises} - \sum V_{Drops} = 0 \text{ (around a closed loop)} \qquad V_X = V_{total} \cdot \left(\frac{R_X}{R_{EQseries}} \right)$$

$$P = V \cdot I \qquad R_{EQparallel} = \left[\frac{1}{R_1} + \frac{1}{R_2} + \ldots + \frac{1}{R_N} \right]^{-1} \qquad \text{KCL: } \sum I_{Entering} - \sum I_{Exiting} = 0 \text{ (a specific node)} \qquad I_X = I_{total} \cdot \left(\frac{R_{EQparallel}}{R_X} \right)$$

(16) **Problem #1)** Given the following circuit:



Determine:

a) the **total resistance REQseries** "seen" by the voltage source,
b) the magnitude of the **current IDC** that will flow out of the voltage source,
c) the total electric **power**, **PDC**, produced by the voltage source, and
d) the electric **power, PRx,** consumed by resistor Rx.

$R_{eq} = 15k + 3k + 30k + 12k = \boxed{60k\Omega}$

$I_{DC} = \frac{120V}{R_{eq}} = \frac{120V}{60{,}000} = \boxed{0.002A}$

$P_{DC} = V_{DC} \cdot I_{DC} = (120V)(0.002A) = \boxed{0.24W}$

$V_{Rx} = I_{Rx} \cdot R_x = (0.002A)(30{,}000\Omega) = 60V$

$P_{Rx} = V_{Rx} \cdot I_{Rx} = (60V)(0.002A) = \boxed{0.12W}$

$R_{eq} = 10 + 8 + 20 + 12 = \boxed{50k\Omega}$

$I_{DC} = \frac{150V}{50{,}000} = \boxed{0.003A}$

$P_{DC} = (150)(0.003) = \boxed{0.45W}$

$V_x = (0.003)(20000) = 60V$

$P_x = (60V)(0.003) = \boxed{0.18W}$

REQseries =	60	50	(kΩ)
IDC =	0.002	0.003	(A)
PDC =	0.24	0.45	(W)
PRx =	0.12	0.18	(W)

(4) **Problem #2)** Determine the **voltage VRx** as shown in the above circuit using a ***voltage divider equation***:

You must show work utilizing a voltage divider equation to receive credit for part (c).

$V_{Rx} = V_{DC}\left(\frac{R_x}{R_{eq}}\right) = 120\left(\frac{30k}{60k}\right) = \boxed{60V}$

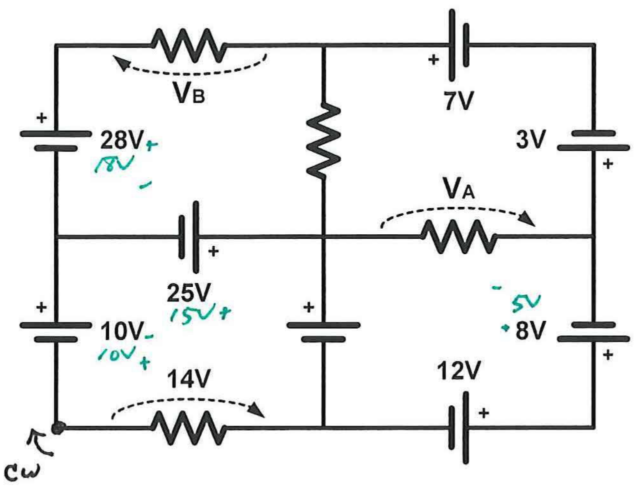
$V_x = 150\left(\frac{20k}{50k}\right) = \boxed{60V}$

VRx = 60 **(V)**

(10) **Problem #3)** Use ***Kirchhoff's Voltage Law*** (KVL) to determine the voltage-rises V_A and V_B as defined in the following circuit.

You must completely write out the KVL equations that you utilized to solve V_A and V_B to receive credit for problem.
(Show all of the terms in the equations)

Note that, although some voltages are intentionally not shown, you are provided with enough information to solve the required voltages.



A: $10 + 25 + V_A + 8 - 12 - 14 = \emptyset$

$V_A + 17 = \emptyset \rightarrow V_A = \boxed{-17V}$

B: $10 + 28 - V_B - 7 + 3 + 8 - 12 - 14 = \emptyset$

$16 - V_B = \emptyset \rightarrow V_B = \boxed{16 V}$

A: $-10 + 15 + V_A + 5 - 12 - 14 = \emptyset$

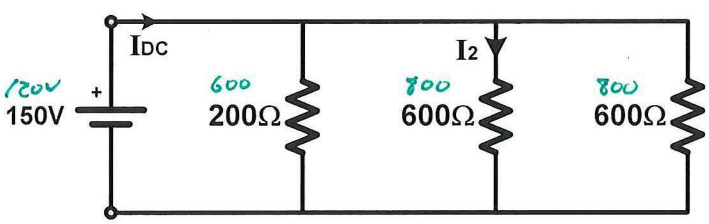
$V_A - 16 = \emptyset \rightarrow V_A = \boxed{16 V}$

B: $-10 + 18 - V_B - 7 + 3 + 5 - 12 - 14 = \emptyset$

$-V_B - 17 = \emptyset \rightarrow V_B = \boxed{-17V}$

V_A =	-17	16	(V)
V_B =	16	-17	(V)

(12) **Problem #4)** Given the following circuit:



You must show work utilizing a current divider equation to receive credit for part (c).

Determine:

a) the **total resistance $R_{EQparallel}$** "seen" by the voltage source,
b) the magnitude of the **current I_{DC}** that will flow out of the voltage source,
c) the **current I_2** as shown in the figure using a ***current divider equation***,

$R_{eq} = \left(\frac{1}{200} + \frac{1}{600} + \frac{1}{600}\right)^{-1} = (0.008\bar{3})^{-1} = \boxed{120\Omega}$

$I_{DC} = \frac{150V}{R_{eq}} = \frac{150V}{120\Omega} = \boxed{1.25A}$

$I_2 = I_{DC}\left(\frac{R_{eq}}{R_2}\right) = (1.25)\left(\frac{120}{600}\right) = \boxed{0.25A}$

$R_{eq} = \left(\frac{1}{600} + \frac{1}{800} + \frac{1}{800}\right)^{-1} = (0.0041\bar{6})^{-1} = \boxed{240\Omega}$

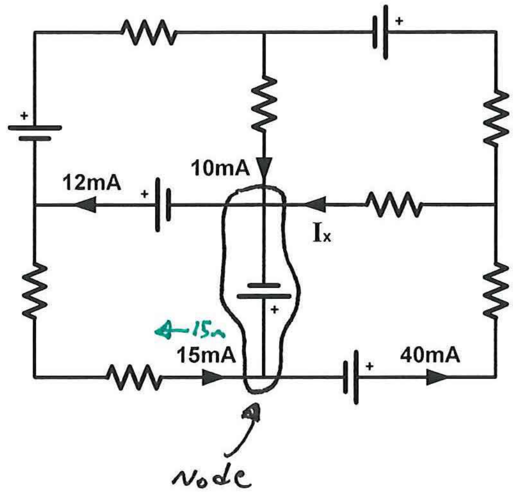
$I_{DC} = \frac{120}{240} = \boxed{0.5A}$

$I_2 = (0.5)\left(\frac{240}{800}\right) = (0.5)(0.3) = \boxed{0.15A}$

$R_{EQparallel}$ =	120	240	(Ω)
I_{DC} =	1.25	0.5	(A)
I_2 =	0.25	0.15	(A)

(6)

Problem #5) Determine the current I_X as defined in the circuit using ***Kirchhoff's Current Law***.



You must completely write out the KCL equation(s) that you utilized to solve I_x to receive credit for problem.
(Show all of the terms in the equations)

Note that, although many currents are intentionally not shown, you are provided with enough information to solve the required current.

$I_{in} = Out$

$10mA + 15mA + I_X = 12mA + 40mA$

$25mA + I_X = 52mA$

$I_X = \boxed{27mA}$

$10m + I_X = 12m + 15m + 40m$

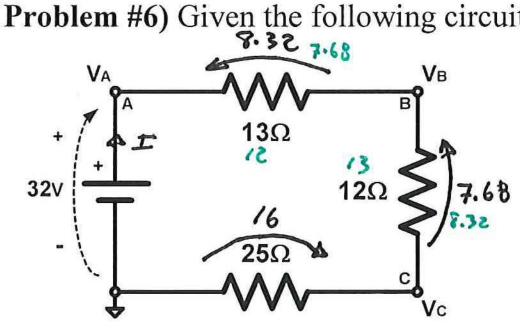
$10m + I_X = 67m$

$I_X = \boxed{57mA}$

$I_X =$ 27 | 57 (mA)

(18)

Problem #6) Given the following circuit:



a) Determine the **node voltages** V_A, V_B, and V_C in the circuit.

b) If an ideal wire is connected from node **B** to node **C**, determine the new **node voltages** V_A, V_B, and V_C.

$I = \frac{32}{13+12+25} = \frac{32}{50} = 0.64A$

$V_A = 0 + 32 = \boxed{32V}$

$V_B = V_A - 8.32 = \boxed{23.68V}$

$V_C = V_B - 7.68 = \boxed{16V}$

$I = 0.64$

$V_A = \boxed{32V}$

$V_B = 32 - 7.68 = \boxed{24.32V}$

$V_C = V_B - 8.32 = \boxed{16V}$

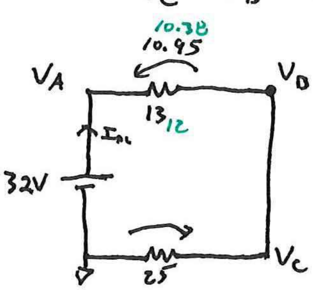
$I_{BC} = \frac{32}{37} = 0.865A$

$V_A = \boxed{32V}$

$V_B = 32 - 10.38 = \boxed{21.62V}$

$V_C = V_B = \boxed{21.62V}$

used resistor voltages instead of node voltages -10//



$I_{BC} = \frac{32}{13+25} = \frac{32}{38} = 0.842A$

$V_A = \boxed{32V}$

$V_B = V_A - 10.95 = \boxed{21.05V}$

$V_C = V_B = \boxed{21.05V}$

a)	$V_A =$	32	32 (V)
	$V_B =$	23.68	24.32 (V)
	$V_C =$	16	16 (V)
b)	$V_A =$	32	32 (V)
	$V_B =$	21.05	21.62 (V)
	$V_C =$	21.05	21.62 (V)

(14)

Problem 7) Specify whether each of the statements are **TRUE** or **FALSE**.

TRUE — false — Given a circuit that contains a single voltage source connected to multiple resistors, ***electrons*** will actually flow "out of" the positive terminal of the voltage source.

TRUE — false — If two resistors are connected in ***parallel*** with each other in an active circuit, then the two resistors will have the same magnitude current flowing through them.

TRUE — TRUE — If an ***ideal wire*** is connected across the same two nodes to which a resistor is connected, then no current will flow through the resistor.

false — TRUE — If an ***ideal wire*** is connected across the same two nodes to which a resistor is connected, then there will be zero voltage across the resistor.

false — TRUE — Based to ***Kirchhoff's Voltage Law***, if all of the voltage-rises are defined in the clockwise direction around a closed-loop path, then at least one of the voltages must be negative.

false — false — The ***parallel equivalent resistance*** of a set of parallel-connected resistors must be greater than the value of the smallest resistor in the set.

TRUE — TRUE — **Resistors** convert electrical energy into heat.

60 kΩ
0.002 A
0.24 W

1)	2)	3)	4)	5)	6)	7)	8)
60 kΩ 0.002 A 0.24 W 0.12 W 50 kΩ 0.003 A 0.45 W 0.18 W	60 V	-17 V 16 V 16 V -17 V	120 Ω 1.25 A 0.25 A 240 Ω 0.5 A 0.15 A	27 mA 57 mA	32 V 23.68 V 16 V 32 V 21.05 V 21.05 V 32 V 24.32 V 16 V 32 V 21.62 V 21.62 V	T/F	0.288 A 0.128 A 5.76 V

Do Not Write Below This Line

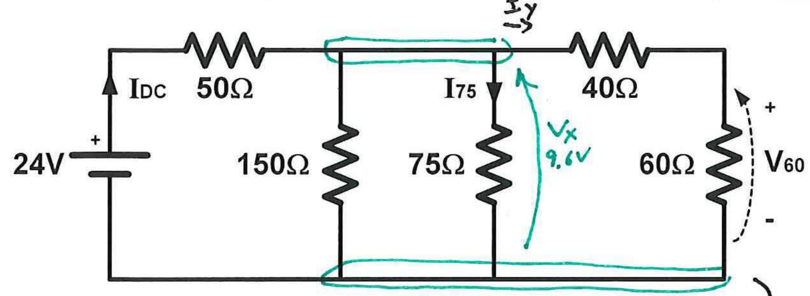
1)______ 16 2)______ 4 3)______ 10 4)______ 12 5)______ 6 6)______ 18 7)______ 14 8)______ 20 Total)__________

ECET 3000 Spring 2018

Electrical Principles – Exam I **Print Name (Last Name First):** ____________________

20

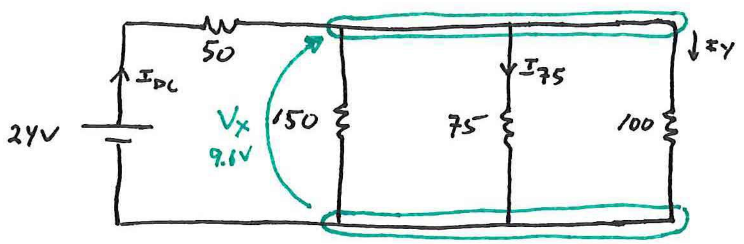
Problem #8) Determine the source current I_{DC}, the current flowing through the 75Ω resistor I_{75}, and the voltage across the 60Ω resistor V_{60} using the ***Reduce and Return Method***.



You must show work utilizing the Reduce and Return Method to receive credit for this problem.

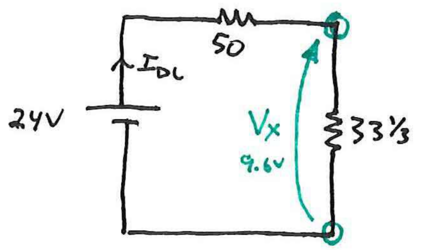
Each time that you "reduce" the circuit, completely draw the reduced circuit and fully label all relevant circuit parameters.

$R_{eq} = 40 + 60 = 100\ \Omega$



$V_{60} \neq V_x$ -4/

$R_{eq} = \left(\frac{1}{150} + \frac{1}{75} + \frac{1}{100}\right)^{-1} = (0.03)^{-1} = 33\tfrac{1}{3}\ \Omega$



$I_{DC} = \frac{24V}{50 + 33\frac{1}{3}} = \frac{24V}{83\frac{1}{3}\Omega} = \boxed{0.288\,A}$

$V_x = I_{DC} \cdot (33\tfrac{1}{3}) = (0.288)(33\tfrac{1}{3}) = 9.6V$ or $V_x = 24\left(\frac{33\frac{1}{3}}{83\frac{1}{3}}\right) = \underline{9.6V}$

$I_{75} = \frac{V_x}{75} = \frac{9.6V}{75\Omega} = \boxed{0.128A}$ or $I_{75} = 0.288\left(\frac{33\frac{1}{3}}{75}\right) = \underline{0.128A}$

$V_{60} = V_x\left(\frac{60}{40+60}\right) = (9.6V)\left(\frac{60\Omega}{100\Omega}\right) = \boxed{5.76V}$ or $I_y = \frac{V_x}{100} = 0.096\,A$

$V_{60} = I_y \cdot 60 = \underline{5.76V}$

$I_{DC} =$ 0.288 (A)

$I_{75} =$ 0.128 (A)

$V_{60} =$ 5.76 (V)