ECET 3000

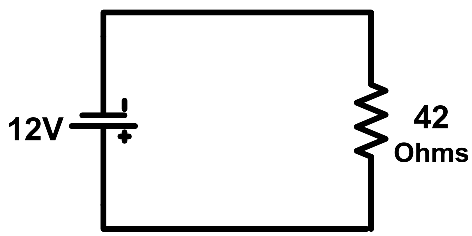
Electrical Principles – Exam I **Sample Problems**

Instructions: Show all of your work, making sure your work in legible and that your reasoning can be followed. 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:

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

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

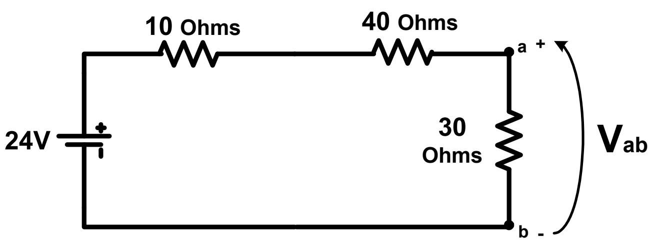
Problem #1) Determine the magnitude of the current **I** will flow through the resistor and the electrical power **P** consumed by the resistor in the following circuit. Additionally, draw an arrow labeled with a capital "**I**" to show the direction of current flow in the circuit.



I = ______________________ **(A)**

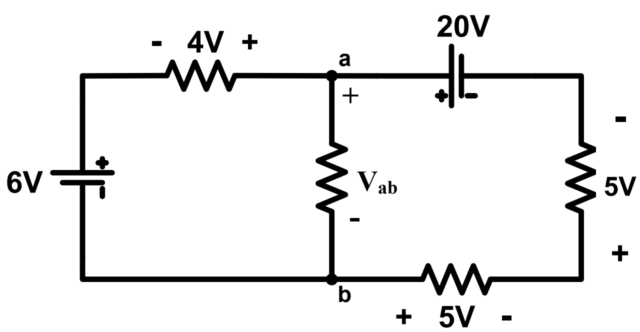
P = ______________________ **(W)**

Problem #2) Determine the voltage $\mathbf{V_{ab}}$, as shown in the following circuit, using the **Voltage Divider Rule**.



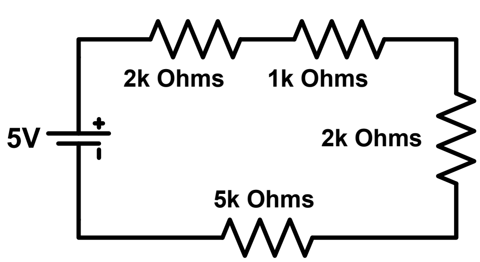
$\mathbf{V_{ab}}$ **=** ______________________ **(V)**

Problem #3) Determine the voltage $\mathbf{V_{ab}}$ as shown in the following circuit using **Kirchhoff's Voltage Law**.



$\mathbf{V_{ab}}$ **=** ______________________ **(V)**

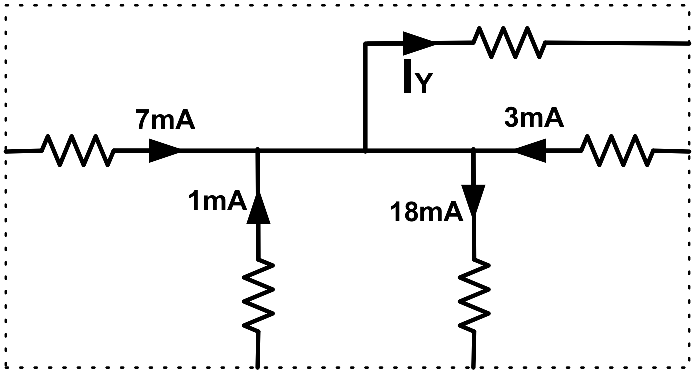
Problem #4) Determine the total series equivalent resistance $\mathbf{R_{EQseries}}$ "seen" by the voltage source as well as the magnitude of the current **I** that will flow in the circuit.



$\mathbf{R_{EQseries}}$ **=** ______________________ **(kΩ)**

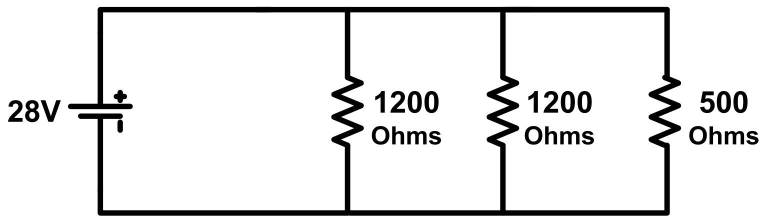
I = ______________________ **(mA)**

Problem #5) Determine the current I_Y as labeled using **Kirchhoff's Current Law**.



I_Y = _______________________ **(mA)**

Problem #6) Determine the total parallel equivalent resistance $\mathbf{R_{EQparallel}}$ "seen" by the voltage source as well as the magnitude of the total current **I** that will flow out of the source.



$\mathbf{R_{EQparallel}}$ = _______________________ **(Ω)**

I = _______________________ **(mA)**

Problem #7) Given your results from Problem #6, determine the magnitude of the current that will flow in the 500 ohm resistor using the **Current Divider Rule**.

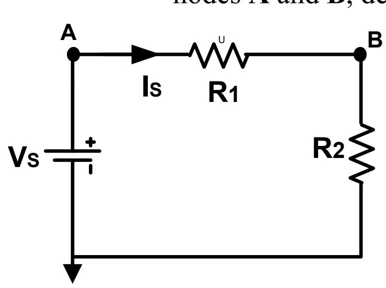
$\mathbf{I_{500}}$ = _______________________ **(mA)**

Problem #8) Given the following circuit having the component values: $\mathbf{V_S}$ **= 16** volts, $\mathbf{R_1}$ **= 300 Ω**, $\mathbf{R_2}$ **= 600 Ω**,

a) Determine the node voltages $\mathbf{V_A}$ and $\mathbf{V_B}$ in the circuit as well as the source current $\mathbf{I_S}$.

b) If the resistor $\mathbf{R_1}$ is removed from the circuit such that nodes **A** and **B** are no longer connected (open circuited), determine the new values for $\mathbf{V_A}$, $\mathbf{V_B}$, and $\mathbf{I_S}$.

c) Assuming that resistor $\mathbf{R_1}$ was removed as specified in part-b, if an ideal wire is connected between nodes **A** and **B**, determine the new values for $\mathbf{V_A}$, $\mathbf{V_B}$, and $\mathbf{I_S}$.



a) $\mathbf{V_A}$ = _______________________ **(V)**

$\mathbf{V_B}$ = _______________________ **(V)**

$\mathbf{I_S}$ = _______________________ **(A)**

b) $\mathbf{V_A}$ = _______________________ **(V)**

$\mathbf{V_B}$ = _______________________ **(V)**

$\mathbf{I_S}$ = _______________________ **(A)**

c) $\mathbf{V_A}$ = _______________________ **(V)**

$\mathbf{V_B}$ = _______________________ **(V)**

$\mathbf{I_S}$ = _______________________ **(A)**

Problem #9) When a **200Ω** resistor is supplied by a DC voltage source, the resistor consumes **2.88W** of power.

a) Determine the magnitude of the source voltage $\mathbf{V_{DC}}$.

b) If the source **voltage magnitude is doubled** (x2), determine the new magnitude of the **power** that the resistor will consume assuming that the resistance remains constant at 200Ω.

c) If the source voltage is set back to the same value as determined in part-a of this problem but the **magnitude of the resistance is doubled** (x2), determine the new magnitude of the resistor **power**.

a) $\mathbf{V_{DC}}$ = ____________________ **(V)**

b) $\mathbf{P_R}$ = ____________________ **(W)**

c) $\mathbf{P_R}$ = ____________________ **(W)**

Problem T/F) Specify whether each of the statements are **TRUE** or **FALSE**.

__________ The ***direction of the voltage rise*** across a resistor will always be in the same direction as the actual electron flow through the resistor.

__________ ***Kirchhoff's Voltage Law*** states that the sum of voltages rises around a closed-loop in a circuit will always be greater than zero.

__________ The ***parallel equivalent resistance*** of multiple resistors connected in parallel will always be less than the value of the smallest resistor in the parallel connection.

__________ There is never a potential difference (voltage) across an idea wire.

__________ If two resistors are in ***series*** with each other in an active circuit then the two resistors will have the same magnitude currents flowing through them.

__________ Within a circuit, ***parallel resistors*** must have the same current flowing through all of them.

__________ Given a set of ***series*** connected resistors, if additional resistors are added to the series combination then the total equivalent resistance will decrease.

__________ Given a circuit containing a single voltage source and one or more resistors, ***current will flow "out of" the positive terminal*** of the voltage source.

__________ If two resistors having the same resistance value are in ***series*** with each other in an active circuit then the two resistors will have the same magnitude voltage rise across them.

__________ According to ***Kirchhoff's Current Law***, if all of the currents for a given node are defined in a direction such that they are all "entering" the node, then the sum of these currents must be zero.

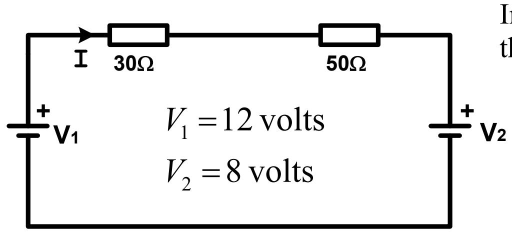
__________ The ***series equivalent resistance*** of multiple resistors connected in series will always be greater than the parallel equivalent resistance of the exact same resistors connected in parallel.

__________ Any two elements within a circuit that are connected across the same two nodes are said to be connected in ***parallel*** with each other.

__________ When analyzing a ***DC*** circuit under ***steady-state conditions***, a capacitor can be replaced by an "open circuit" because there will be no voltage across the capacitor.

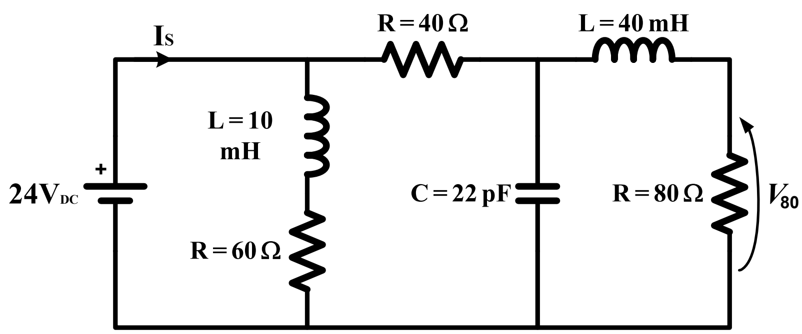
__________ The ***current*** flowing in an ***inductor*** will be proportional to the rate of change (derivative) of the voltage across the inductor.

Problem #10) Given the following DC circuit, solve for the current **I** using **Kirchhoff's Voltage Law** (KVL). In other words, express the resistor voltages in terms of the current **I**, then write the KVL equation for the circuit and solve for the current.



I = ______________________ (A)

Problem #11) Given the **DC steady-state circuit**, determine the **source current**, I_S, and the voltage, V_{80}, across the 80Ω resistor.



I_S = ______________________ **(A)**

V_{80} = ______________________ **(V)**

Answers for Problems 1-10

1) I = ____0.286_____ (A)

P = ____3.43_____ (W)

2) V_{ab} = ____9_______ (V)

3) V_{ab} = ____10_______ (V)

4) $R_{EQseries}$ = _10____ (kΩ)

I = ______0.5_____ (mA)

5) I_Y = _____-7_______ (mA)

6) $R_{EQparallel}$ = _272.7_ (Ω)

I = ___102.67___ (mA)

7) I_{500} = _____56____ (mA)

8) V_A = _____16______ (V)

V_B = ___10.67_____ (V)

I_S = ____0.01778____ (A)

b) V_A = _16_ (V) c) _16_ (V)

V_B = _0_ (V) _16_ (V)

I_S = _0_ (A) _0.0267_ (A)

9) V_{DC} = ____24_____ (V)

P_R = ___11.52_____ (W)

P_R = ___1.44______ (W)

10) KVL Solution

$$V_1 - 30 \cdot I - 50 \cdot I - V_2 = 0$$
$$12 - 30 \cdot I - 50 \cdot I - 8 = 0$$
$$80 \cdot I = 4$$
$$I = 0.5\ amps$$

<u>True/False Answers</u>

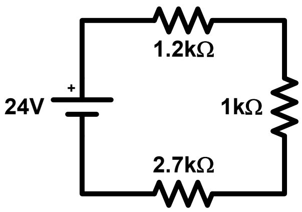
True
False
True
True
True
False
False
True
True
True
True
True
False
False

11) I_S = _____0.6_____ (A)

V_{80} = ____16____ (V)

Extra Problems

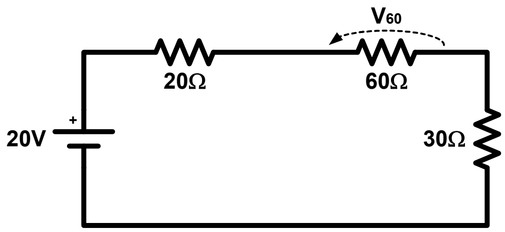
Problem #13) Determine the total equivalent resistance $R_{EQseries}$ "seen" by the voltage source as well as the magnitude of the current **I** that will flow out of the source.



$R_{EQseries}$ = ___4.9___ (kΩ)

I = ___4.898___ (mA)

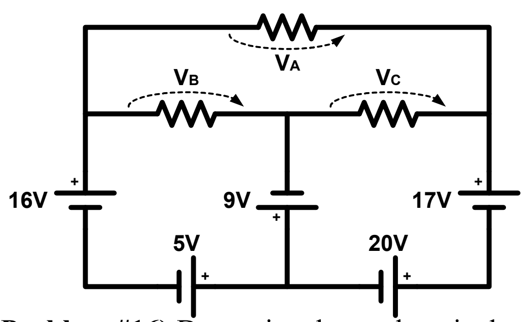
Problem #14) Determine the voltage V_{60} as shown in the following circuit using a "***voltage divider equation***".



V_{60} = ___10.91___ (V)

Problem #15) Use ***Kirchhoff's Voltage Law*** (KVL) to determine the voltage rises V_A, V_B, and V_C across the three resistors as defined in the following circuit.

(Note – to receive credit, you <u>must</u> show the three KVL equations that you used to get your answers)

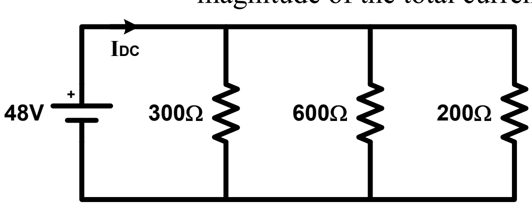


V_A = ___+26___ (V)

V_B = ___–20___ (V)

V_C = ___+46___ (V)

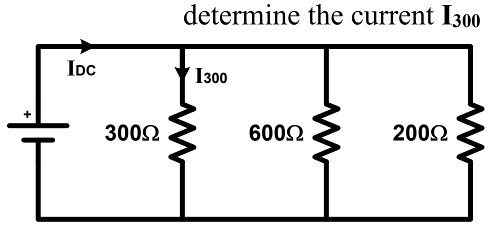
Problem #16) Determine the total equivalent resistance $R_{EQparallel}$ "seen" by the voltage source as well as the magnitude of the total current I_{DC} that will flow out of the source.



$R_{EQparallel}$ = ___100___ (Ω)

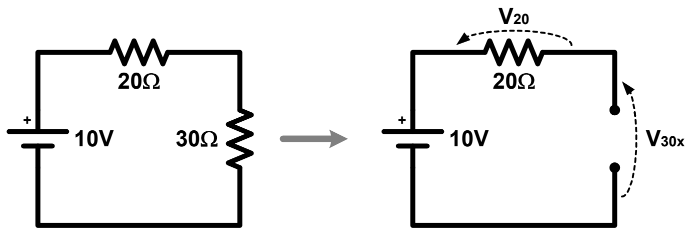
I_{DC} = ___0.48___ (A)

Problem #17) Given the same set of parallel resistors and the value of I_{DC} that you calculated in problem #4, determine the current I_{300} as shown in the following circuit using a "***current divider equation***".



I_{300} = ___0.16___ (A)

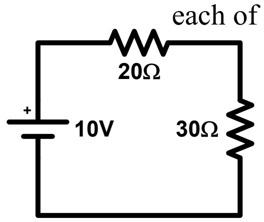
Problem #18) Given the circuit shown below to the left, if the 30Ω resistor is removed from the circuit (as shown to the right), determine the voltage across the 20Ω resistor, $\mathbf{V_{20}}$, along with the voltage across the terminals where the 30Ω resistor used to be connected, $\mathbf{V_{30x}}$.



V_{20} = ______0______ (V)

V_{30x} = ______10______ (V)

Problem #19) Given the circuit shown below, determine the magnitude of the **power** that will be consumed by each of the resistors and the magnitude of the power that will be produced by the voltage source.

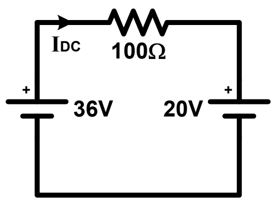


$P_{20\Omega}$ = ______0.8______ (W)

$P_{30\Omega}$ = ______1.2______ (W)

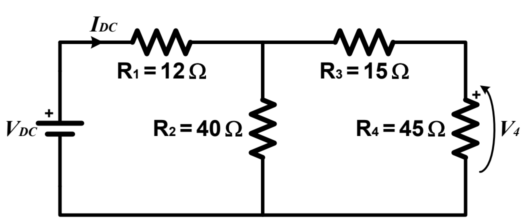
P_{source} = ______2.0______ (W)

Problem #20) Given the following circuit, determine the current $\mathbf{I_{DC}}$ that will in the circuit (as shown).



I_{DC} = ______0.16______ (A)

Problem #21) Determine the **source current** $\mathbf{I_{DC}}$ and the **resistor voltage** $\mathbf{V_4}$ as shown in the following circuit using the **Reduce and Return Method** if the source voltage is $V_{DC} = 72$ volts.



I_{DC} = ______2______ (A)

V_4 = ______36______ (V)