Name: Solution

Instructor: __________________

Section: ________________

ENGR 120 - Exam 1
October 13, 2015

Allowed Materials: F.E. approved calculator(s) see syllabus; pencils and/or pens.

Honor Statement: On my honor, I promise that I have not received any unauthorized assistance on this exam. I did not look at another student's paper, I didn't view any unauthorized written materials, I didn't talk or listen to another student, I didn't use an unauthorized calculator, I didn't use any electronic device, any visual or auditory signals, or any other techniques of exchanging information with others.) I have maintained the highest standards of academic integrity while completing this exam.

Signed: __________________

Instructions: Encode your answer to each question by darkening the appropriate circle on your response form. You are also encouraged to work neatly and circle your chosen answers on the exam document so that you are better able to review your work if you find the need. However, the answers you encode on the response form will be taken as your definitive answers, and the entire basis for your grade. Please review your response form carefully before submission.

1. (2 point deduction for failure to complete this problem!) Write in all of the indicated information in the boxes of your response form.
Write your name on this exam and sign the Honor Statement.

Notes:
- If your last name is too long, just write the first 10 letters.
- "F.I." and "M.I." are your first and middle initials, respectively.
- Your "Username" is the first part of your LA Tech email address.
- For "Section" use the guide provided to the right.
- Your "Exam Form" is printed on the upper right corner of this page.
- Indicate "ENGR" as the "Program".

For Course Section:

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Choices = 

- **A**: "I properly completed all required items in problem 1, so I will not lose these points.
- **B**: "I did not properly complete problem 1 because I am fine with losing these points."

2. (3 points) Given the color pattern indicated, which value could be the actual resistance of the resistor shown?

Color pattern = ("black" "orange" "violet" "gold")

```
30000000
  ^
  3
  0
```

Upper = 30000000 + 1500000 = 31500000Ω

Lower = 30000000 - 1500000 = 28500000Ω

\[ \frac{30000000}{3} = 100 \]

\[ x = 15000000Ω \]

\[ \text{Range:} \]

\[ \text{Upper} = 30000000 + 1500000 = 31500000Ω \]

\[ \text{Lower} = 30000000 - 1500000 = 28500000Ω \]
3. (3 points) You take several different sizes of standard alkaline batteries and connect them all in series (with the head of each one touching the tail of the next). If the number of each size cell in your set is listed below, what will be the total voltage?

\[ D_{\text{cells}} = 2 \quad \text{AA}_{\text{cells}} = 3 \quad \text{AAA}_{\text{cells}} = 3 \]

\[ 2(1.5V) + 3(1.5V) + 3(1.5V) = 12V \]

Choices = \[
\begin{array}{c}
\text{A} & 10.5 \\
\text{B} & 15.0 \\
\text{C} & 16.5 \\
\text{D} & 12.0 \\
\text{E} & 13.5 \\
\text{F} & 0.0 \\
\text{G} & 1.5 \\
\text{H} & 9.0 \\
\end{array}
\]

4. (3 points) The tool in SolidWorks used to create a rounded internal or external face along one or more edges is:

Choices = \[
\begin{array}{c}
\text{A} & \text{"revolve"} \\
\text{B} & \text{"revolved cut"} \\
\text{C} & \text{"extrude"} \\
\text{D} & \text{"fillet"} \\
\text{E} & \text{"linear pattern"} \\
\text{F} & \text{"rib"} \\
\text{G} & \text{"mirror"} \\
\text{H} & \text{"swept cut"} \\
\end{array}
\]

5. (3 points) What is the potential difference across the 5Ω resistor?

\[ \text{B/C THEY ARE ALL IN PARALLEL} \]
\[ \text{POTENTIAL DIFFERENCE FOR EACH IS THE SAME AS THE VOLTAGE SOURCE.} \]

6. (3 points) Which command is used in the Arduino IDE to establish a pin as either an input or an output?

Choices = \[
\begin{array}{c}
\text{A} & \text{"void setup"} \\
\text{B} & \text{"digitalWrite"} \\
\text{C} & \text{"pinMode"} \\
\text{D} & \text{"for"} \\
\text{E} & \text{"void loop"} \\
\text{F} & \text{"i"} \\
\text{G} & \text{"digitalwrite"} \\
\text{H} & \text{"delay"} \\
\end{array}
\]
7. (3 points) Given the below circuit diagram, identify the location and direction that LED shown can be connected such that it immediately illuminates.

Choices = 

A. "a to c & b to f"
B. "a to c & b to d"
C. "b to c & a to d"
D. "a to f & b to e"
E. "a to c & b to e"
F. "Both answer choices A and B"
G. "Both answer choices C and D"
H. "No combination works"

8. (3 points) How many holes should you have punched into your Aluminum plate that you used to construct your robot?

Choices =

A 4
B 11
C 0
D 9
E 8
F 7
G 3
H 6

9. (3 points) Which Arduino command, if used repeatedly, will continue to print all data (x) on a single row of your serial monitor?

Choices =

A. "Serial.println(x)"
B. "pinMode(x, OUTPUT)"
C. "digitalWrite(x)"
D. "Serial.println(x)"
E. "digitalRead(x)"
F. "Serial.begin(x)"
G. "void setup(x)"
H. "pinMode(x, OUTPUT)"

10. (3 points) This is the measure of electric potential in a circuit:

Choices =

A. "Joules"
B. "Amperes"
C. "Work"
D. "Voltage"
E. "Resistance"
F. "Coulombs"
G. "Power"
H. "Current"
11. (3 points) In a circuit with a single battery ($V_1$) and a single resistor ($R_1$), what is the current flowing through the circuit?

\[ I = \frac{V_1}{R_1} \]

Choices:
- A. $V_1 R_1$
- B. $V_1/R_1$
- C. $V_1 R_1$
- D. $R_1/V_1$
- E. $R_1 V_1$
- F. $(V_1 + V_1)/R_1$
- G. $V_1$
- H. $V_1 R_1$

12. (5 points) If the current shown leaves the power source, then the resistance of $R_1$ is closest to:

\[ R_1 = \frac{V}{I} = \frac{5V}{0.04A} = 125\Omega \]

Choices:
- A. 86.95 Ω
- B. 94.60 Ω
- C. 102.16 Ω
- D. 109.75 Ω
- E. 117.40 Ω
- F. 125.00 Ω
- G. 132.59 Ω
- H. 140.18 Ω

13. (5 points) The power consumed by resistor $R_2$ is closest to:

\[ \text{Choices:} \]
- A. 4.00 mW
- B. 4.32 mW
- C. 4.65 mW
- D. 4.97 mW
- E. 5.29 mW
- F. 5.61 mW
- G. 5.93 mW
- H. 6.25 mW

\[ R_{eq} = 470\Omega + 220\Omega + 330\Omega = 1020\Omega \]

\[ I = \frac{V}{R_{eq}} = \frac{5V}{1020\Omega} = 0.0049A \]

\[ P = I^2 R_e = (0.0049A)^2 (220\Omega) = 0.005286W = 5.286\text{mW} \]
14. (5 points) For the circuit shown, the current through resistor R1 is closest to:

\[
I_1 = \frac{\Delta V_{R2}}{R_2} = \frac{9V}{660\Omega} = 0.0136A = 13.6mA
\]

Choices =

- "A" 9.48 mA
- "B" 10.33 mA
- "C" 11.14 mA
- "D" 11.97 mA
- "E" 12.81 mA
- "F" 13.64 mA
- "G" 14.46 mA
- "H" 15.29 mA

15. (5 points) Suppose you have a flashlight whose bulb has a known resistance of R = 13 Ω. In order to power the flashlight, you connect a number of 1.5V AA batteries (number given below) in series, with the head of each touching the tail of the next. If you leave the flashlight on for a total time = 5 minutes, how many electrons leave the negative terminal of the battery?

\[
V = 2(1.5V) = 3V
\]

number = 2 batteries

Choices =

- "A" 4.058 \times 10^{20} electrons
- "B" 4.32 \times 10^{20} electrons
- "C" 4.583 \times 10^{20} electrons
- "D" 4.846 \times 10^{20} electrons
- "E" 5.107 \times 10^{20} electrons
- "F" 5.368 \times 10^{20} electrons
- "G" 5.633 \times 10^{20} electrons
- "H" 5.893 \times 10^{20} electrons

\[
I = \frac{V}{R} = \frac{3V}{13\Omega} = 0.230769A
\]

\[
0.230769 \times \frac{6.24 \times 10^{18} e^-}{5 \text{min}} \times \frac{60s}{1 \text{min}} = 4.32 \times 10^{20} e^-
\]
16. (5 points) A student would like to use Excel to calculate the volumes of cylinders with different heights and radii. To save time, the student wants to be able to type the formula for calculating the volume of a cylinder one time in cell C4 and then drag the cell so that the other cells will have the same formula but only use their respective heights and radii. The formula the student should type into cell C4 is ...

The equation to calculate the volume of a cylinder is:

\[ V = \pi r^2 h \]

17. (5 points) The power dissipated by R3 is closest to:

\[ P = I^2 R \]

\[ I = \frac{V}{R_{eq}} = \frac{5V}{550\Omega} = 0.0091A \]

\[ P_{R3} = I^2 R_3 = (0.0091A)^2 (150\Omega) = 0.0124W \]
18. (5 points) For the circuit below (where V1 = 5V, R1 = 1000Ω, R2 = 470Ω, R3 = 220Ω), the voltage drop across R3 is closest to:

\[ \text{Req} = \frac{R_2 + R_3}{2} = \frac{470Ω + 220Ω}{2} = 690Ω \]

\[ I_2 = \frac{V}{\text{Req}} = \frac{5V}{690Ω} = 0.007246A \]

\[ \Delta V_{R3} = I_2 (R_3) = (0.007246A)(220Ω) = 1.594V \]

Choices = A 1.6  B 2.4  C 3.9  D 4.1  E 5.0  F 6.2  G 2.7  H 1.9

19. (5 points) The power dissipated by R3 is \( P_{R3} = 200 \text{ W} \). With the given resistor values, what is the current flowing through R3?

\[ P = I^2 R \]

\[ I = \sqrt{\frac{P_{R3}}{R_3}} = \sqrt{\frac{200\text{ W}}{8Ω}} = 5A \]

Choices = A 4.6  B 5.0  C 5.4  D 5.7  E 6.1  F 6.4  G 6.8  H 7.1
20. (5 points) The power dissipated by $R_3$ is $P_{R3} = 200$ W. With the given resistor values, what is the value of the voltage source $V_1$?

**NOTE:** THIS CIRCUIT IS THE SAME AS #19

Therefore

$I = 5A$

$$V_{R2} = I \times R_2 = 5A \times 16 \Omega = 80V$$

$$V_{R3} = I \times R_3 = 5A \times 8 \Omega = 40V$$

$$V_1 = V_{R2} + V_{R3} = 80V + 40V = 120V$$

21. (5 points) The current flowing through $R_1$ is $I_1 = 2A$. With the given resistor values, what is the current leaving the source?

$$V_1 = I_1 \times R_1 = 2A \times 8 \Omega = 16V$$

$$I_2 = \frac{V_1}{R_2} = \frac{16V}{4 \Omega} = 4A$$

$$I_3 = I_1 = 2A \text{ (because of the same resistance)}$$

$$I_4 = \frac{V_1}{R_4} = \frac{16V}{20 \Omega} = 0.8A$$

$$I_{\text{source}} = I_1 + I_2 + I_3 + I_4$$

$$= 2A + 4A + 2A + 0.8A$$

$$= 8.8A$$
22. (5 points) The equivalent resistance of the resistor network shown is closest to:

\[
\begin{align*}
\text{Choices} & = \\
\text{"A"} & = 33 \\
\text{"B"} & = 36 \\
\text{"C"} & = 38 \\
\text{"D"} & = 41 \\
\text{"E"} & = 44 \\
\text{"F"} & = 47 \\
\text{"G"} & = 50 \\
\text{"H"} & = 53
\end{align*}
\]

\[
\begin{align*}
R_1 & = 17\,\Omega \\
R_2 & = 12\,\Omega \\
R_3 & = 24\,\Omega \\
R_4 & = 2\,\Omega \\
R_5 & = 10\,\Omega \\
R_6 & = 20\,\Omega \\
R_7 & = 20\,\Omega \\
R_8 & = 60\,\Omega \\
R_9 & = 20\,\Omega \\
R_{10} & = 80\,\Omega \\
R_{11} & = 24\,\Omega \\
R_{12} & = 48\,\Omega \\
R_{13} & = 17\,\Omega
\end{align*}
\]

\[
\begin{align*}
\text{Re}_{eq_1} & = \frac{1}{\frac{1}{12\,\Omega} + \frac{1}{24\,\Omega}} = 8\,\Omega \\
\text{Re}_{eq_2} & = \frac{1}{\frac{1}{10\,\Omega} + \frac{1}{20\,\Omega} + \frac{1}{60\,\Omega}} = 10\,\Omega \\
\text{Re}_{eq_3} & = \frac{1}{\frac{1}{20\,\Omega} + \frac{1}{80\,\Omega} + \frac{1}{20\,\Omega} + \frac{1}{48\,\Omega}} = 8\,\Omega \\
\text{Re}_{eq_4} & = \frac{1}{\frac{1}{8\,\Omega} + \frac{1}{10\,\Omega}} = 5\,\Omega
\end{align*}
\]

\[
\text{Re}_e = 17\,\Omega + 5\,\Omega + 8\,\Omega + 17\,\Omega = 47\,\Omega
\]
23. (5 points) Two multimeters are used to evaluate a circuit, where one measures current and the other measures voltage (as indicated). The values of the measured voltage and current are provided below.

The value of the resistance of R2 is closest to . . .

\[ V_m = 25.3 \text{ V} \]
\[ I_m = 1 \text{ A} \]

Kirchhoff’s Voltage Law:
\[ 50 \text{ V} = V_{S1} + V_m + V_{S2} + V_{R2} \]

Applying Ohm’s Law to the voltage’s above we know 1A current passes through all but they are in series.

\[ S_0 = V_{S1} + V_m + V_{S2} + V_{R2} \]
\[ F_{0} = 1 \text{ A} (S2) + 25.3 \text{ V} + 1 \text{ A} (S1) + 1 \text{ A} (R2) \]
\[ R_2 = 4.7 \text{ k}\Omega \]

24. (5 points) If \( R_1 = 100 \Omega \) and \( R_2 = 470 \Omega \), then the current flowing through the circuit is closest to . . .

\[ R_{eq1} = \frac{1}{R_{1} + R_{2}} = 50 \text{ \Omega} \]

\[ R_{eq2} = \frac{1}{R_{1} + R_{2}} \]
\[ = 227.25 \text{ \Omega} \]

\[ R_{eq} = 50 \Omega + 52 \Omega + 50 \Omega + 50 \Omega + 227.25 \Omega = 477.25 \Omega \]

\[ I = \frac{V}{R_{eq}} = \frac{5 \text{ V}}{477.25 \Omega} = 0.01048 \text{ A} = 10.48 \text{ mA} \]
25. (5 points) The engineering professors have decided to open our own alligator farm and have just purchased our first alligator. We want to highlight her name ("Allie", of course) on our new sign. We have purchased a power source capable of providing \( V_1 = 400 \text{ V} \) and \( I_1 = 2 \text{ A} \). The circuit we developed for the sign is shown below. If the lamps we are using to light up the sign can be modeled as simple resistors, and each lamp, which looks like a segment of an LED, has the same value of resistance, then what is the minimum value of resistance we can use for the lamps to get the brightest-looking sign without exceeding the capabilities of the power source? (Note: The "A" has 6 lamps, each of the "L"'s have 3 lamps, the "I" has 2 lamps, and the "E" has 5 lamps.)

Choices = \[
\begin{align*}
\text{"A"} & \quad 11.30 \\
\text{"B"} & \quad 12.40 \\
\text{"C"} & \quad 13.45 \\
\text{"D"} & \quad 14.54 \\
\text{"E"} & \quad 15.62 \\
\text{"F"} & \quad 16.69 \\
\text{"G"} & \quad 17.78 \\
\text{"H"} & \quad 18.86
\end{align*}
\]

\[
\begin{align*}
\text{Ohm's Law} \\
R &= \frac{V}{I} \\
\frac{45R}{4} &= \frac{400V}{2A} \\
R &= \frac{400V \cdot 4}{2A} \cdot \frac{45}{4} \\
R &= 17.78 \Omega
\end{align*}
\]
28. (5 points) Given the circuit diagram and the values listed, find the total power dissipated by the network of resistors. The power is nearest to...

Choices =  

\[\begin{align*}
\text{A} & \quad 291.1 \\
\text{B} & \quad 312.8 \\
\text{C} & \quad 334.4 \\
\text{D} & \quad 356.0 \\
\text{E} & \quad 377.8 \\
\text{F} & \quad 399.2 \\
\text{G} & \quad 421.0 \\
\text{H} & \quad 442.9
\end{align*}\]

\[V = 80 \, \text{V} \quad R_1 = 90 \, \Omega \]

\[R_2 = 180 \, \Omega \quad R_3 = 135 \, \Omega \]

\[R_4 = 195 \, \Omega \quad R_4 = 31 \, \Omega \]

\[R_6 = 12 \, \Omega \quad R_7 = 7 \, \Omega \]

\[\begin{align*}
R_{eq_1} &= \frac{1}{\frac{1}{90\,\Omega} + \frac{1}{180\,\Omega}} = 60\,\Omega \\
R_{eq_2} &= \frac{1}{\frac{1}{60\,\Omega+135\,\Omega} + \frac{1}{145\,\Omega}} = 97.5\,\Omega \\
R_{eq_3} &= \frac{1}{\frac{1}{97.5\,\Omega+31\,\Omega} + \frac{1}{12\,\Omega}} = 10.975\,\Omega \\
R_{eq} &= 10.975\,\Omega + 7.5\,\Omega = 17.975\,\Omega \\
\text{P} &= \frac{V^2}{R_{eq}} = \frac{(80\,\text{V})^2}{17.975\,\Omega} = 356.05\,\text{W}
\end{align*}\]
1. (2 point deduction for failure to complete this problem!)
   
   - Write in all of the indicated information in the boxes of your response form.
   - Darken the appropriate circles to encode the corresponding information.
   - Write your name on this exam and sign the Honor Statement.

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   - Indicate "ENGR" as the "Program"

   Choices = ("A" "I properly completed all required items in problem 1, so I will not lose these points." )
   ("B" "I did not properly complete problem 1 because I am fine with losing these points." )

   Reference Information:

   1 coulomb = 6.24(10)^18 electrons
   Avogadro's Number = 6.022(10)^23 per mol

   1 inch = 2.54 cm

   Cu = 1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^1

   color    digit
   black    0
   brown    1
   red      2
   orange   3
   yellow   4
   green    5
   blue     6
   violet   7
   gray     8
   white    9