

Print your name: _____ Sign your name: _____



Portland State
UNIVERSITY

ME 120: Introduction to Engineering

FINAL EXAMINATION – SECTIONS A & B Fall 2015

TIME ALLOWED: One (1) hour and fifty (50) minutes

TOTAL: 150 points

INSTRUCTIONS: **DO NOT OPEN THE EXAM BOOKLET UNTIL YOU ARE TOLD TO DO SO.**

Answer **all questions**.

Section A is multiple-choice and is out of 20 points.

Section B consists of longer answer questions and is out of 80 points.

Section C consists of practical exercises using MS Excel and SolidWorks and is out of 50 points.

You will have seventy (70) minutes to complete both Sections A and B after which time you will be given a further forty (40) minutes to complete Section C.

All answers except diagrams and sketches **must be in ink**.

Correcting fluid or tape is not permitted.

Hand held devices other than non-programmable calculators are not allowed.

NOTES:

Points allocated to each question are shown in brackets at the end of each question.

Candidates are expected to select and use appropriate formulae in problem solving.

Candidates should show **all working** in calculations.

Helpful formulae and data are shown in the appendices.

Answer question 1 (multi-choice) using the answer sheet at the rear of this paper.

Section A - Multi-choice (20 points)

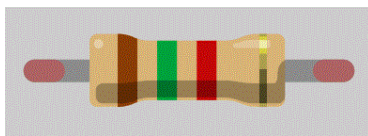
Answer this section on the answer sheet provided at the rear of this paper.

You will score two (+2) points for every CORRECT answer; minus one (-1) point for every INCORRECT answer and zero (0) points for NO ANSWER. You cannot score less than zero.

1. In linear regression, the least squares method is a method where we try to minimize the distance between the data points and the linear curve (also called best fit)
 - A. True
 - B. False
2. In order to run correctly, the Arduino board always needs to be connected to your computer
 - A. True
 - B. False
3. When uploaded, how will the given code appear in the serial monitor?

```
void setup() {  
  Serial.begin(9600);  
}  
  
void loop() {  
  int i = 0;  
  i = i + 1;  
  Serial.println(i);  
}
```

- A. The serial monitor will constantly scroll between the values 0 and 4 increasing by increments of 1.
 - B. The serial monitor will constantly scroll with the value 1.
 - C. The serial monitor will constantly scroll with the value 5.
 - D. The serial monitor will constantly increase the value by 1.
4. Determine the resistance of the shown resistor.



- A. 5.1 k Ω
- B. 2.1 M Ω
- C. 250 Ω
- D. 1.5 k Ω

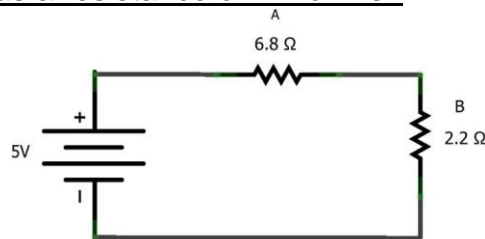
color	digit
black	0
brown	1
red	2
orange	3
yellow	4
green	5
blue	6
violet	7
gray	8
white	9

5. For the following code, what is the value of n?

```
int x,y,z;  
float n;  
x=1;  
y=3;  
n=x-y-0.5;
```

- A. -2.5
- B. -2.0
- C. 2.0
- D. 2.5

6. What is the total resistance of the circuit shown if resistor A has a resistance of 6.8 ohms and resistor B has a resistance of 2.2 ohms?



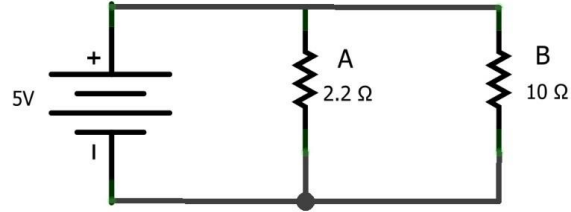
- A. 6.8 ohms
- B. 9 ohms
- C. 1.66 ohms
- D. 4.6 ohms

7. When uploaded, how will the following code appear in the serial monitor?

```
void setup() {  
  Serial.begin(9600);  
}  
  
void loop() {  
  int i;  
  for ( i=0; i<5; i++ ) {  
    Serial.println(i);  
  }  
}
```

- A. The serial monitor will constantly increase the value by 1.
- B. The serial monitor will constantly scroll with the value 5.
- C. The serial monitor will constantly scroll between the values 0 and 4 increasing by increments of 1.
- D. The serial monitor will constantly scroll between the values 0 and 10 increasing by increments of 1.

8. What is the total resistance of the circuit shown if resistor A has a resistance of 2.2 ohms and resistor B has a resistance of 10 ohms?

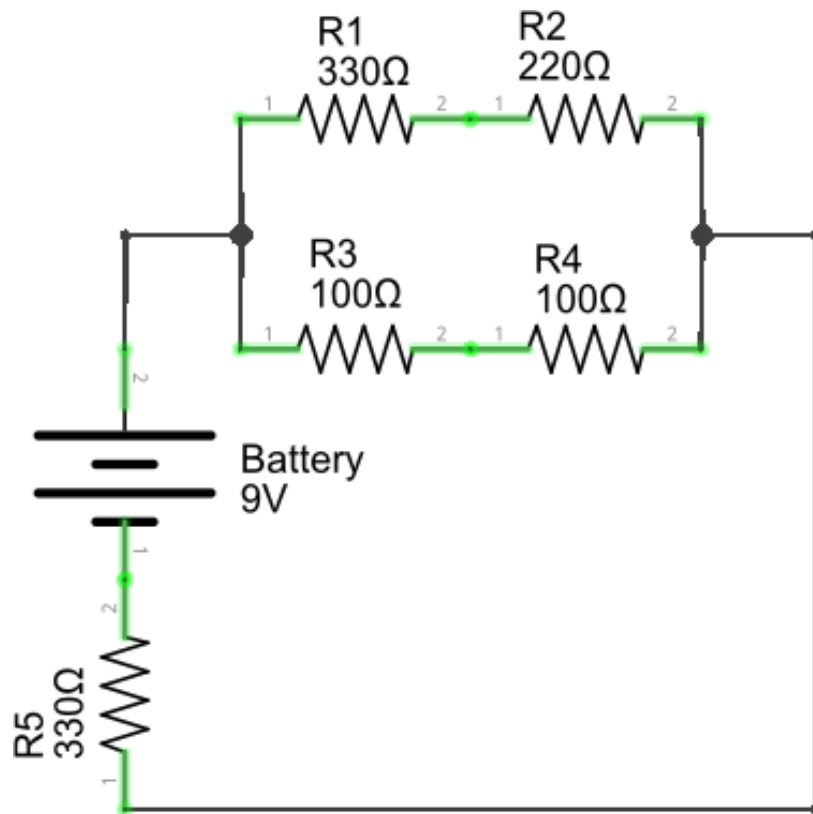


- A. 12.2 ohms
B. 1.8 ohms
C. 7.8 ohms
D. 0.55 ohms
9. To measure voltage the multimeter should be placed in:
- A. Parallel
B. Series
C. It does not matter
D. A multimeter cannot measure voltage
10. The second argument of the function analogWrite is the duty cycle. Its value varies between:
- A. 0 and 1023
B. 0 and 255
C. 0 and 5
D. 0 and 1

Section B – Long answer questions

Question 1: For the circuit shown, fill in the missing values in the table below.

(20 points)



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	R1	R2	R3	R4	R5	Req
V						
I						
R						
P						

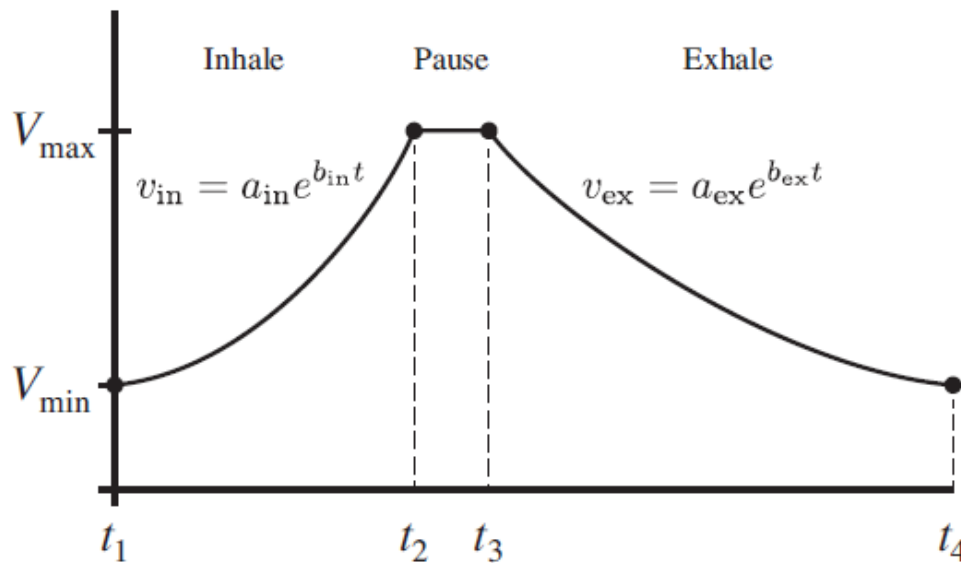
Question 1 working

Question 2: A mathematical model for a “breathing LED” is to be represented as shown in the figure show below.

Given the following parameters:

Vmin	5	t1	0
Vmax	12	t2	5
		t3	6
		t4	12

- a) Calculate the values of the a and b constants for both inhale and exhale cycles (8 points)
- b) Calculate the voltage at different times of the breathing cycle as indicated in the table on the next page. (12 points)



$$v = a_{in} e^{b_{in} t}$$

$$v = a_{ex} e^{b_{ex} t}$$

$$a = \exp \left[\frac{t_A \ln(v_B) - t_B \ln(v_A)}{t_A - t_B} \right]$$

$$b = \frac{\ln(v_A) - \ln(v_B)}{t_A - t_B}$$

Question 2 (cont)

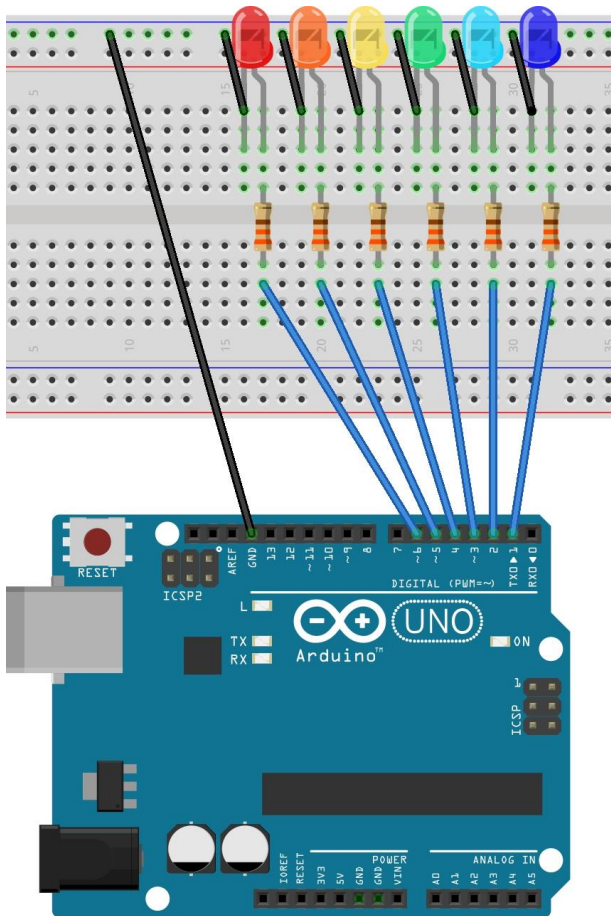
Time	Voltage
1	
2	
4	
8	
9	
11	

Question 3

a) What does the circuit below do? The arduino board is connected to a computer, running the code written to the right.

Be as explicit as possible.

(7 points)



```
int timer = 100;

void setup() {
  for (int thisPin = 2; thisPin < 6; thisPin++) {
    pinMode(thisPin, OUTPUT);
  }
}

void loop() {
  for (int thisPin = 2; thisPin < 6; thisPin++) {
    digitalWrite(thisPin, HIGH);
    delay(timer);
    digitalWrite(thisPin, LOW);
  }

  for (int thisPin = 5; thisPin >= 2; thisPin--) {
    digitalWrite(thisPin, HIGH);
    delay(timer);
    digitalWrite(thisPin, LOW);
  }
}
```

b) Re-write the code shown in a) using a user-defined function. The code modification should not change the behavior of the circuit. The user-defined function will be called in the void loop() function and will have three arguments: the lowest and highest digital pin numbers used to turn the LEDs on, and the time LEDs will be on. It should be the only line of code in the void loop() function.

(10 points)

c) Show how you would change the code shown in a), to have only every other LED turn on?
(you can write on the printed code)

(3 points)

Question 4

- a) Describe the six (6) different holes (holes for zip ties count as one type) drilled in the pump body: list the hole types in chronological order, with briefly describing their purpose. (8 points)
- b) Distinguish which hole needed relatively high precision, medium precision, low precision. Explain why. (4 points)
- c) Describe all the components added to the pump body to fabricate the pump, with clearly describing their purpose. The only parts missing to run the pump should be hoses and power supply. (8 points)

ROUGH WORKING – will NOT be graded

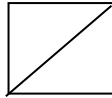
ROUGH WORKING – will NOT be graded

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SECTION A – MULTI CHOICE ANSWER SHEET

Indicate your answers like this:



	a	b	c	d
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				