Technological University of the Philippines
Manila Campus
College of Industrial Technology
Electronics Engineering Technology

Name: _____
Course/Year/Section: _____
Date Started: _____ *Date Submitted:* _____
Assessed by: _____ *Rating:* _____

PROGRAMMING AND SIMULATING MCU

Module 4

I. OBJECTIVES

At the end of the lesson, the students are expected to:

1. Learn the basic concepts and techniques in programming a microcontroller unit (MCU) - Arduino UNO using a high-level language and a simulation software.
2. Appreciate the importance of C++ language in executing human-level instructions to the MCU.
3. Design and simulate a sample Arduino UNO application circuit or system using TinkerCAD and compute applicable electronic values.

II. GENERAL INFORMATION

1. **ARDUINO INTEGRATED DEVELOPMENT ENVIRONMENT (IDE) -** a software designed by Arduino.cc using Java, but programs can be coded using C++ language. It is composed of text editor (coding) and toolbars, with intuitive graphical user interface (GUI) menus/icons. Arduino programs are called **SKETCHES** with file extension **".ino".** The IDE is generally used for writing, compiling, and uploading codes and is connected to various hardware platforms of Arduino.

2. **TINKERCAD –** an online web application used in designing, simulating, and modeling electronic circuits using computer-aided design (CAD) and electronic components.

3. **ARDUINO PROGRAM STRUCTURE**

   Example:

```
// Comments

#include <LibraryName.h>

const int PIN = 13;
int variable_1;
float variable_2;

void setup() {
  pinMode(PIN, OUTPUT);
}

void loop() {
  digitalWrite(PIN, HIGH);
  delay(1000);
  digitalWrite(PIN, LOW);
  delay(1000);
}
```

3.1 COMMENTS – used to convey information used as a reference by programmers/users; comments are not read or executed by the MCU.

Example:
//This is a comment that describes further a program

3.2 INCLUDE LIBRARIES – used to import external libraries that are necessary to support a program.

Example:
#include <LibraryName.h>

3.3 CONSTANTS - values that do no change all throughout the program. Coded as **"const"**

Example:
Const int PIN=13;

3.4 GLOBAL VARIABLES – variables declared outside any function, usually at the beginning of a program. These are accessible by functions **"setup ()"** and **"loop ()"**

Examples:
int variable_1;
float variable_2;

3.4.1 DATA TYPES

Type	Size	Number Range
Char	1 byte	-128 to 127
Unsigned char	1 byte	0 to 255
Int	2 byte	−32,768 to 32,767
Unsigned int	2 byte	0 to 65,535
Word	2 byte	0 to 65535
Long	4 byte	−2,147,483,648 to 2,147,483,647
Unsigned long	4 byte	0 to 4,294,967,295
Float	4 byte	−3.4028235E+38 to 3.4028235E+38
Double	4 byte	−3.4028235E+38 to 3.4028235E+38
String	1 byte + x	Arrays of char
Array	1 byte + x	Collection of variables

3.5 SETUP FUNCTION – used to initialize the hardware and pertinent setup conditions**.**

Example:

```
void setup () {
    pinMode(PIN, OUTPUT);
}
```

3.6 LOOP FUNCTION – contains the main code that works in continuous loop.

Example:

```
void loop() {
    digitalWrite(PIN, HIGH); // Turn on LED
    delay(1000); // 1 second delay
    digitalWrite(PIN, LOW); // Turn off LED
    delay(1000); // 1 second delay
}
```

4. MORE ARDUINO PROGRAM REFERENCES https://www.arduino.cc/reference/en/

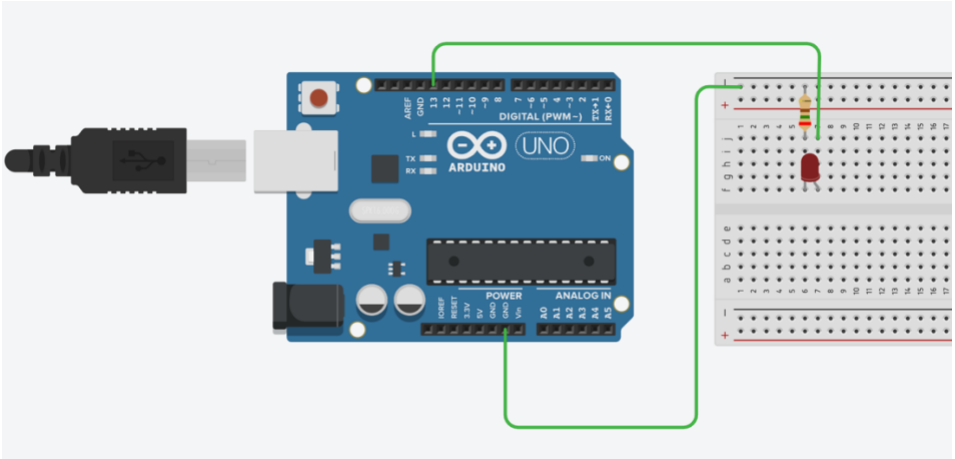
III. SAMPLE PROGRAMS

4.1 A LED is connected to digital pinout 13, then it turns on and off with 1 second delay.

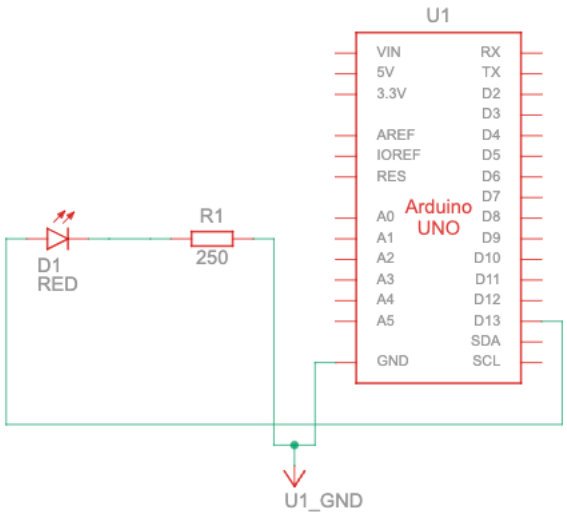
a. **Compute for the limiting Resistor**

R = V/ I = 5v/ 20mA = 250 Ω

b. **TinkerCAD Pictorial Diagram**



c. **TinkerCAD Schematic Diagram**



d. **C++ Program**

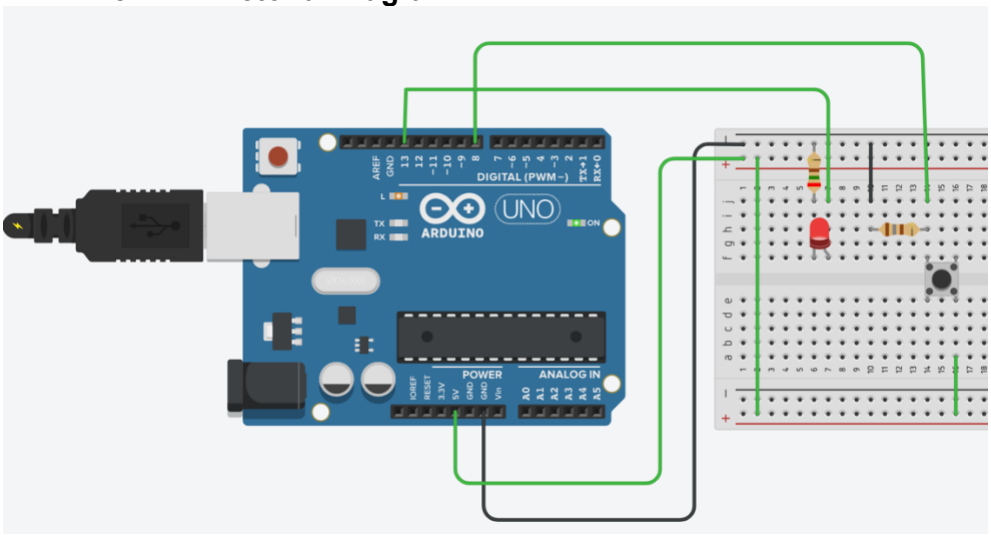
```
//turn an LED on and off

const int LED = 13;

void setup() {
  pinMode(LED, OUTPUT);
}

void loop()
{
  digitalWrite(LED, HIGH);
  delay(1000); // Wait for 1000 millisecond(s)
  digitalWrite(LED, LOW);
  delay(1000); // Wait for 1000 millisecond(s)
}
```

4.2 A push button is connected to digital pinout 8, and a LED is connected to digital pinout 13. When the push button is activated, the LED turns on and off for 10 counts with 500 ms delay. Otherwise, the LED is on.

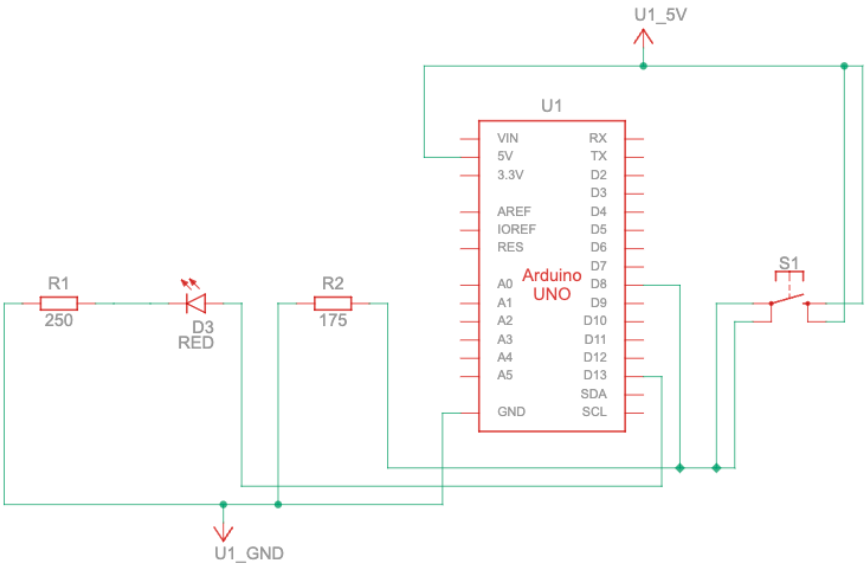
a. **Compute for the pull-down Resistor**

R = Vcc-VL/I =5- (5*.3)/ 20mA = 175 Ω

b. **TinkerCAD Pictorial Diagram**



c. **TinkerCAD Schematic Diagram**



d. **C++ Program**

```
const int ledPin = 13;
const int buttonPin = 8;
int buttonState = 0;

void setup() {
  pinMode(buttonPin, INPUT);
  pinMode(ledPin, OUTPUT);
```

```
}

void loop() {

  buttonState = digitalRead(buttonPin);


  if (buttonState == HIGH) {
    for (int i = 0; i < 10; i++)
    {
      digitalWrite(ledPin, HIGH);
      delay(500);
      digitalWrite(ledPin, LOW);
      delay(500);
    }
  }
    else (buttonState == LOW);
    {
      digitalWrite(ledPin, HIGH);
    }
  }
```

IV. CHECKPOINT

1. Design an Arduino UNO interface using TinkerCAD. For each condition, show the schematic diagram, pictorial diagram, computations, and C++ program. The following are the requirements (100 points)

    - Turn on 5 green LEDs for 5 seconds then turn off afterwards.
    - If pushbutton 1 is activated, 5 green LEDs will turn on for 2 seconds. Meanwhile, if pushbutton 2 is activated, 5 red LEDs will turn on for 5 seconds.
    - If pushbutton 1 is activated, 10 yellow LEDs will light in sequence (i.e., running lights from left to right). Meanwhile, if pushbutton 2 is activated these LEDs light up in reverse mode. There is a pull-down resistor used to minimize voltage fluctuation.

2. In reference to your proposed microcontroller application study, design the schematic diagram, pictorial diagram, computations, and C++ program. Simulate and take a video recording on the functional operation of the system (100 points)
3. Specify the percentage contribution of each group member (100% total). Each member should sign to confirm the breakdown of contribution.