

# ME 511 Mechatronics @ UIC

## Introduction to simulators for simple circuits and Arduino programming

This lab is to be done individually and at home. Due date Jan 19, 2023 (Thu).

## 1 Prelab (not graded)

### 1.1 Motivation

The goals of the lab are as follows: (1) Introduction to circuit simulator (2) Introduction to Arduino Coding on simulator

### 1.2 Assigned Reading/Coding

This part of the Lab needs to be done before you come to the lab. Assigned reading from the textbook is listed below

1. **Create an account.** Go to <https://www.tinkercad.com/>. On the top right click “signup”. Then click “Students, join a class”. Use the code 7HHT36KGCGXC and then create a new user name to sign up and use your existing username (if you have already joined TinkerCAD) to sign-in.
2. **Getting started with circuits.** Once you are logged in you should be on the dashboard. If not, then use this link which will get you to the dashboard assuming you are logged in <https://www.tinkercad.com/dashboard>. On the right side you should see “+ New”. Click on this icon and choose “Circuit”. Now follow the instructions on this video on how to create a simple circuit using a bulb and a piezo (speaker) <https://youtu.be/bpF287c-cUA>. Here is a video that shows how to use an ammeter and voltmeter <https://youtu.be/Uv5ATZ2JslY>.
3. **Getting started with Arduino code.** Go back to the dashboard and choose circuit (see instructions above). Now choose the Arduino UNO. If it is not visible use the search feature. Drop the Arduino UNO on the left side. Now select “Code”. By default this is set to block code. In the drop down bar choose “Text”.

(1) Write the following Arduino code:

```
void setup()
{
  Serial.begin(9600);
  Serial.print("Hello in setup \n");
}
void loop()
{
}
```

Start the simulation. Open the “Serial Monitor” which is right below the code. You should see “Hello in setup” printed.

(2) Write the following Arduino code:

```

void setup()
{
  Serial.begin(9600);
}
void loop()
{
  Serial.print("Hello in loop \n");
}

```

Start the simulation. You should see “Hello in loop” printed several times. From this you can conclude that setup() function runs once and the loop() function runs continuously. Now add a delay by writing *delay(2000)* after Serial.print and run the code.

(3) Write the following Arduino code that prints a variable:

```

int var = 5;
void setup()
{
  Serial.begin(9600);
}
void loop()
{
  Serial.print(var);
  Serial.print("\n");
}

```

4. **Connecting devices and programming the Arduino:** Choose the Piezo (speaker). Connect the positive to pin 12 (Digital PWM-) on the Uno and negative to Ground (GND). Now copy paste the code from this webpage and start the simulation:

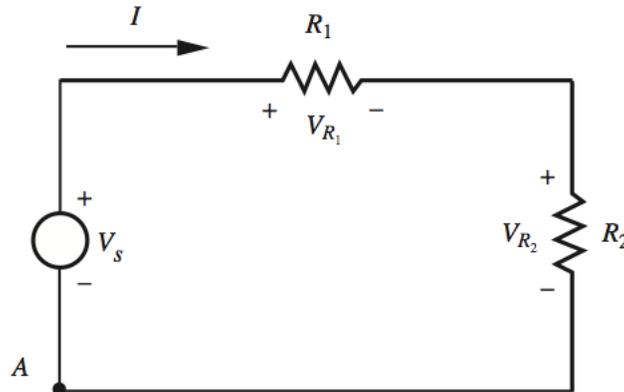
<https://learn.adafruit.com/adafruit-arduino-lesson-10-making-sounds/playing-a-scale>

## 2 Labwork (graded)

### Equipment list

1. [Tinkercad.com](https://www.tinkercad.com)

### 2.1 (20 points) Series circuit as a voltage divider



For the circuit shown above use Kirchoff's laws to compute the voltage  $V_{R_2}$  across resistance  $R_2$  as a function of  $R_1$ ,  $R_2$  and supply voltage and write it below

$$V_{R_2} = \text{-----};$$

Now choose  $R_1$  and  $R_2$  such that the voltage across  $R_2$  is  $V_s/3$ .

$$R_1 = \text{-----}; R_2 = \text{-----}.$$

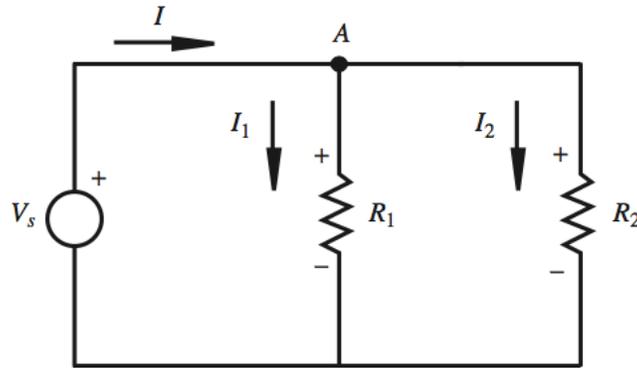
Now build the circuit in Tinkercad and compare the theoretical value with the simulated value.

$$V_{R_2}^{\text{theoretical}} = \text{-----}; V_{R_2}^{\text{simulated}} = \text{-----}.$$

You will need to hookup a voltmeter to measure the voltage. Show the circuit to the teaching assistant for credit.

**How to submit:** On TinkerCAD please submit as part of "Lab1\_2.1 Series circuit". Create the circuit there and use the "notes" features on TinkerCAD to leave the answers to the questions. Your final circuit should have a voltmeter connected so that the instructor/TA can simulate the system to check the answers.

## 2.2 (20 points) Parallel circuit as a current divider



For the circuit shown above use Kirchoff's laws to compute the current  $I_1$  across  $R_1$  and  $I_2$  across resistance  $R_2$ , each as function of only  $R_1$ ,  $R_2$  and total current  $I$  and write it below

$$I_1 = \text{-----}; I_2 = \text{-----};$$

Now choose  $R_1$  and  $R_2$  such that the ratio of voltage  $I_1/I_2$  is 2.

$$R_1 = \text{-----}; R_2 = \text{-----}.$$

Now build the circuit and compare the theoretical value with the simulated value.

$$(I_1/I_2)^{\text{theoretical}} = 2; (I_1/I_2)^{\text{simulator}} = \text{-----}.$$

You will need to hookup an ammeter to measure the current. Show the circuit to the teaching assistant for credit.

**How to submit:** On TinkerCAD please submit as part of "Lab1.2.2 Parallel circuit". Create the circuit there and use the "notes" features on TinkerCAD to leave the answers to the questions. Your final circuit should have an ammeter connected so that the instructor/TA can simulate the system to check the answers.

### 2.3 (15 points) Arduino loops

**This problem tests you on the ability to use a loop in Arduino:** Write code that will print the numbers from 0 to 100. There should be a delay of 1 second between individual prints. **HINT:** Check how to use *for* or *while* loop in C.

**How to submit:** On TinkerCAD please submit as part of “Lab1.2.3 Arduino loops”. The code should produce the intended output when the grader presses “simulate”.

### 2.4 (15 points) Arduino user input/function:

**This problem tests you on the ability to take in user inputs and write a function:** Write code that will take input of two numbers from serial window (the serial window is right below the code block on TinkerCAD) and print their sum in the serial window. Use a function called sum that outputs the sum of given numbers. **HINT:** Use *Serial.read()*. See this example <https://www.arduino.cc/reference/en/language/functions/communication/serial/read/>

**How to submit:** On TinkerCAD please submit as part of “Lab1.2.4 Arduino user input/function”. The code should produce the intended output when the grader presses “simulate”.

### 2.5 (15 points) Arduino random numbers/conditionals:

**This problem tests you on the ability to use random number generator and conditionals:** Write code that will generate random numbers in the range of 0 – 9 every 1 second and prints it to the serial monitor if the number is less than 5. **HINT:** Use *random* to generate random numbers. See this example. <https://www.arduino.cc/reference/en/language/functions/random-numbers/random/>. Use conditionals, *if-else*, for the logic.

**How to submit:** On TinkerCAD please submit as part of “Lab1.2.5 Arduino random numbers/conditionals”. The code should produce the intended output when the grader presses “simulate”.

### 2.6 (15 points) Arduino musical:

**This problem tests you on the ability to search and utilize code from the internet:** Search the internet for a musical and program and play it.

**How to submit:** On TinkerCAD please submit as part of “Lab1.2.6 Arduino musical”. The code should produce the intended output when the grader presses “simulate”.