18B15CS311: Computer Networks and Internet of Things (CN & IoT) Lab (EVEN 2021)

Assignment – 09,10,11, and 12

IoT development boards and interfacing with sensors / IoT Application Development

The objective the lab assignments 09 to 10 is to make the students to familiar with the basics of IoT with microcontroller and sensing hardware kits. As part of it, the Arduino and Rasberry Pi kits will be introduced.

1. **Environment setup**

   To work with this lab, one need to have 1) Arduino / Rasberry Pi hardware kit, or 2) Arduino / Rasberry Pi virtual simulators. For hardware kits, one may visit online store for purchasing the components and kits. Example sites are https://robu.in/, https://www.electronicshub.org/arduino-starter-kit/ , or browse through e-commerce sites. As an alternative to these, one may visit the following online virtual labs for working with basic circuit design and programming. The following are the online virtual kits and free tools available for simulating the IoT.

   1.1) Online virtual Arduino kit:

   1.1.1) Visit the link https://www.tinkercad.com/join

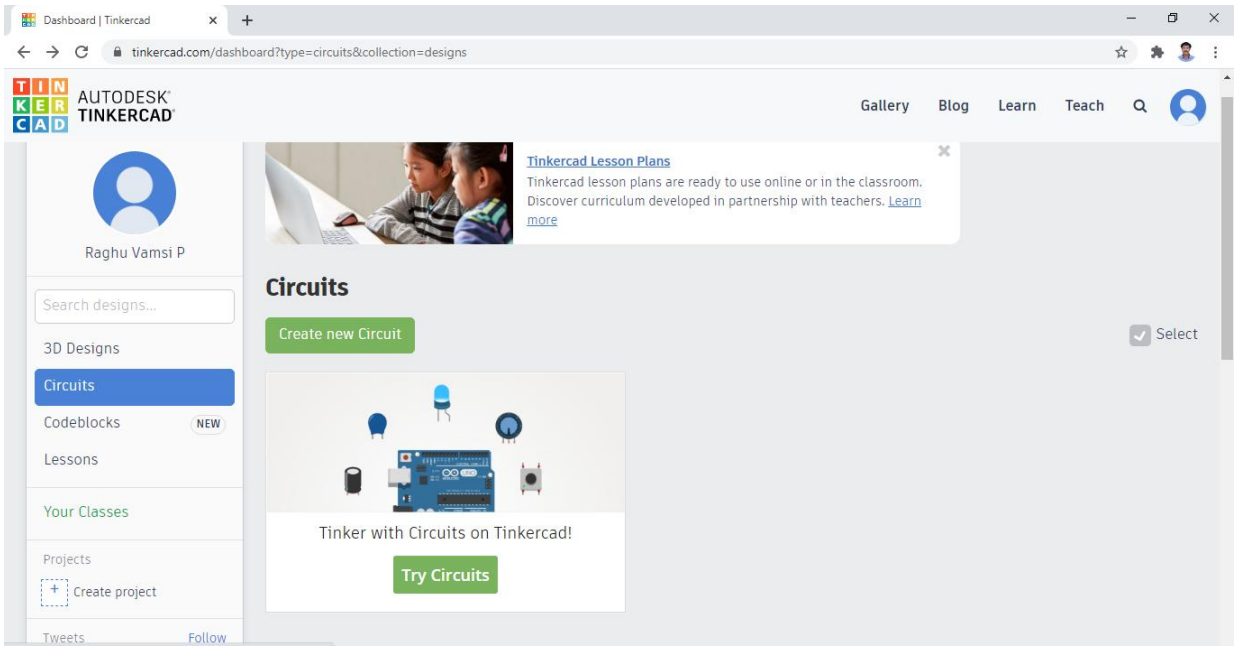
   1.1.2) Create a personal Account

   1.1.3) You may either register a new account / login via gmail id.

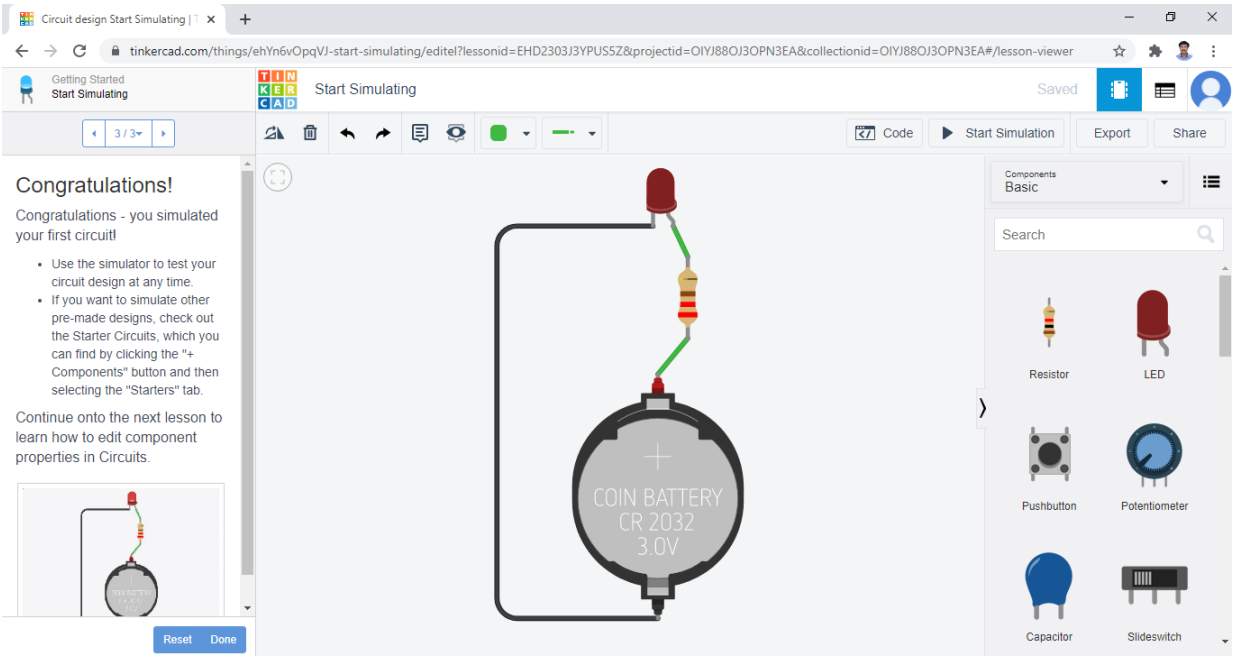
   1.1.4) Accept the verification link sent to the gmail to work with the Tinkercad.

   1.1.5) Once login, click on Circuits menu available in the left side.

   1.1.6) Choose Create New Circuit.



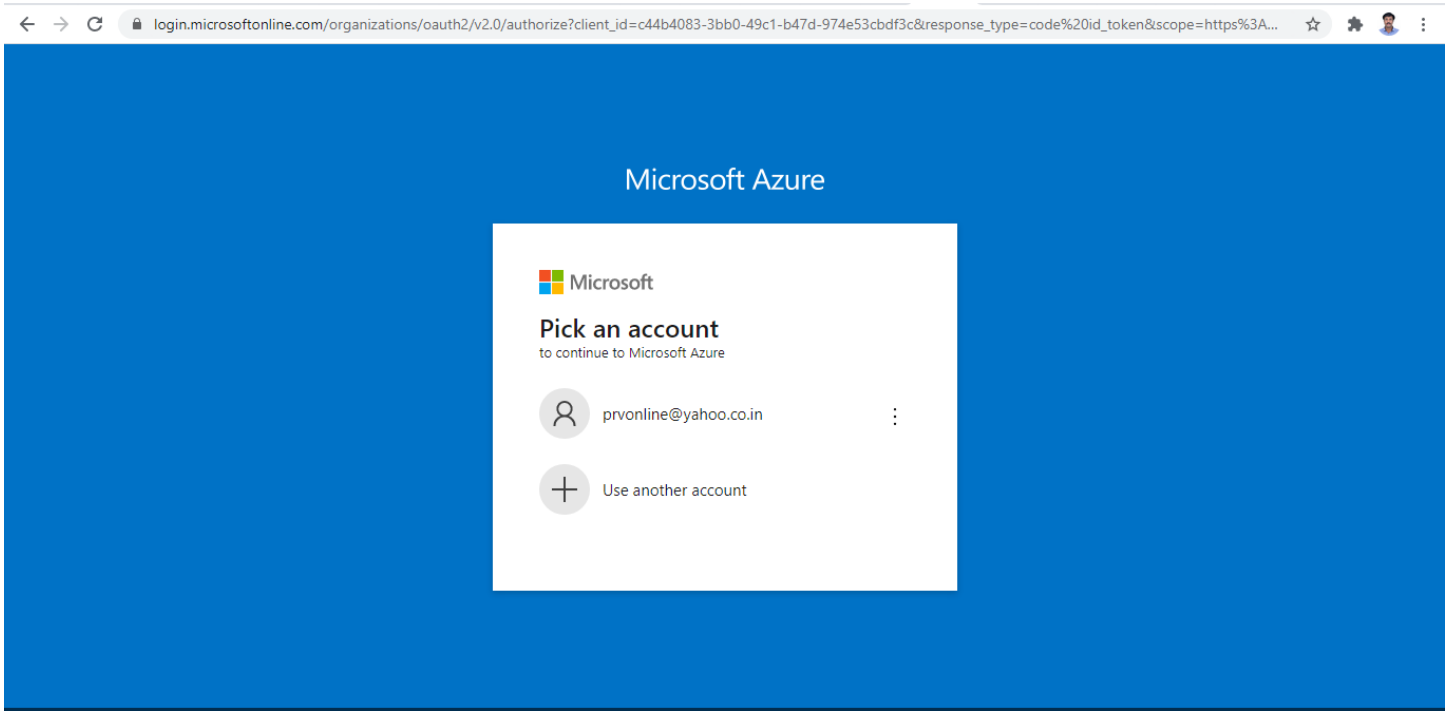
1.1.7) To know how this the circuits will work, one may chose Try Circuits and follow the on screen instructions.



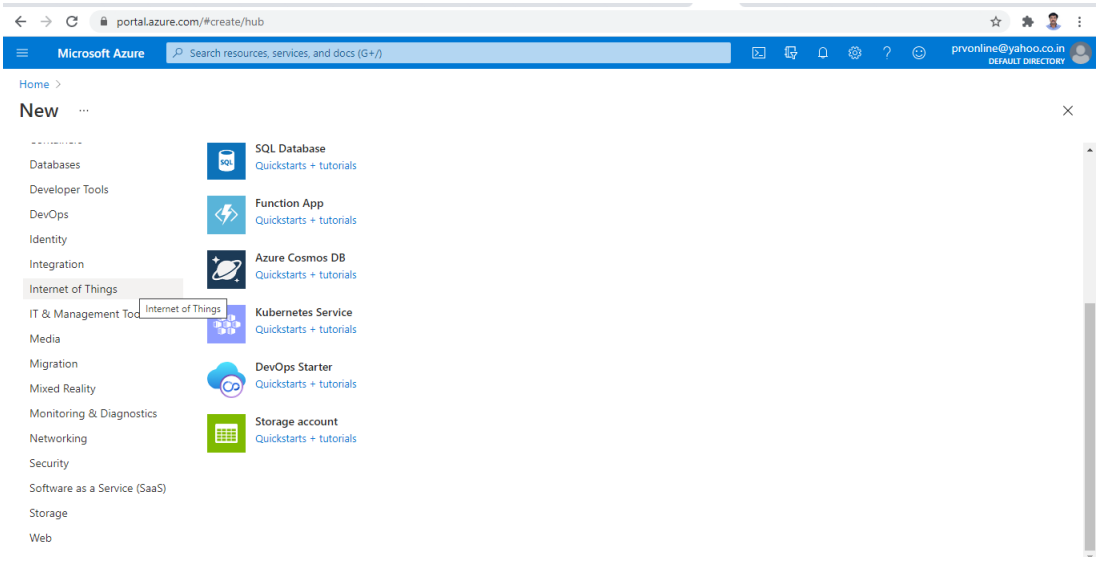
1.2 Online Rasberry Pi Simulator Kit

NOTE: To work with this simulator, Microsoft Azure login should be created. Further, a personalized IoT hub module to be created in the Azure. This module can be used for free up to 365 days. Further, Microsoft will ask for user details such as phone number and credit card information. Anyone who don't want to provide this sensitive details may ignore it and recommended to purchase and exercise Rasberry Pi circuit.

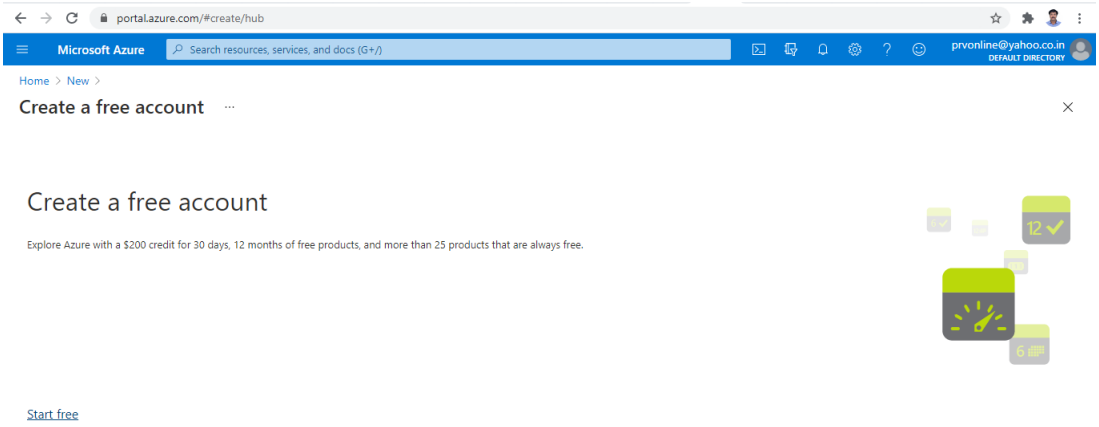
1.2.1) create an account in Microsoft azure https://portal.azure.com/ and create/login via it.



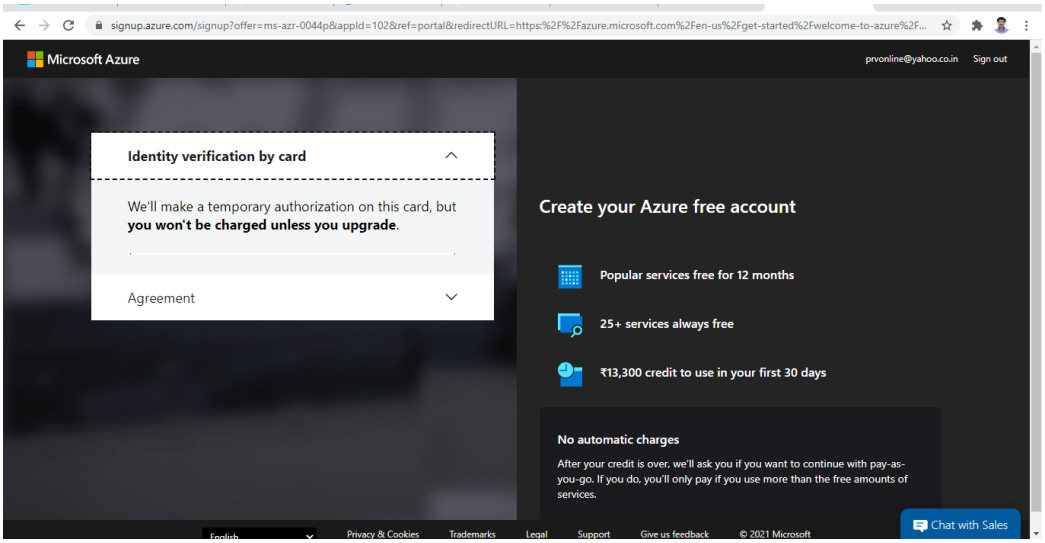
1.2.2) Choose **Create a Resource > Internet of Things > IoT Hub**



1.2.3) Create free account



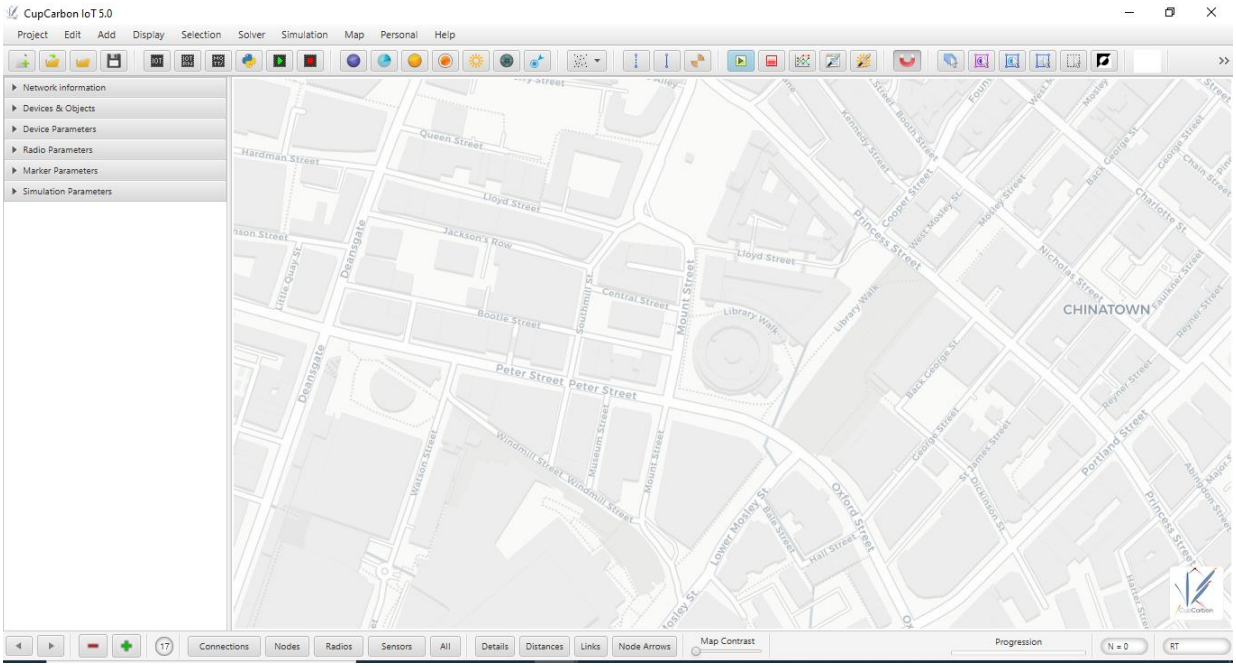
1.2.4) Verify your phone number and enter credit card details



1.2.5) Visit the online simulator at https://azure-samples.github.io/raspberry-pi-web-simulator/ and follow the steps provided in the Help section.

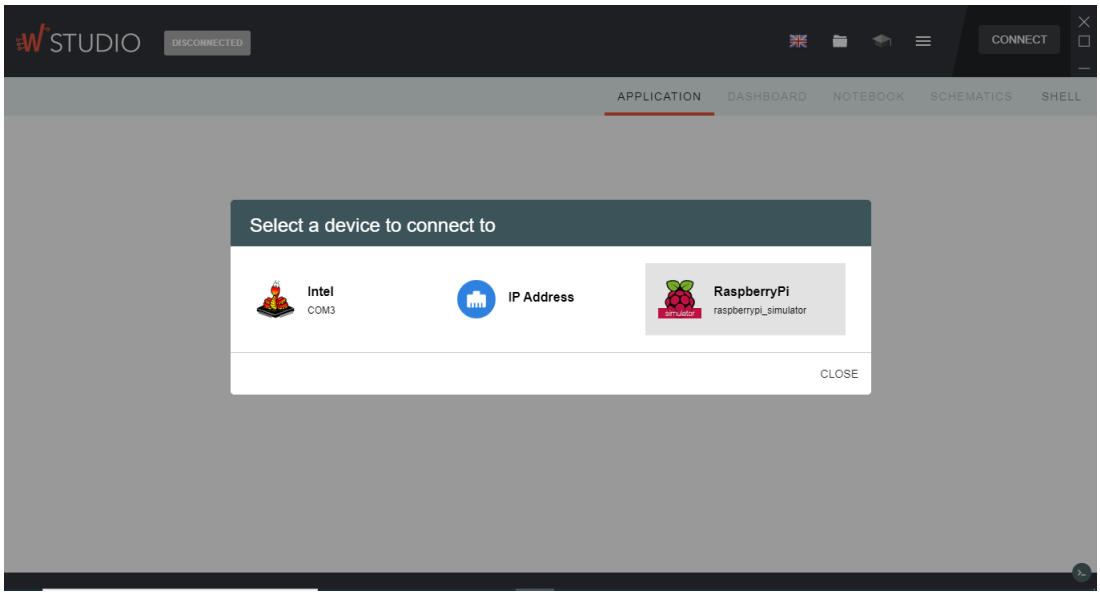
1.3) Free IoT Wireless Sensor Networks and Smart City Simulator

1.3.1) Visit the link http://cupcarbon.com/download.html and download the CupCarbon 5.0 tool. Java latest version and JRE is required to run this tool. Once the downloaded file is extracted, run the file cupcarbon.jar to view the Cup Carbon IoT 5.0 GUI.



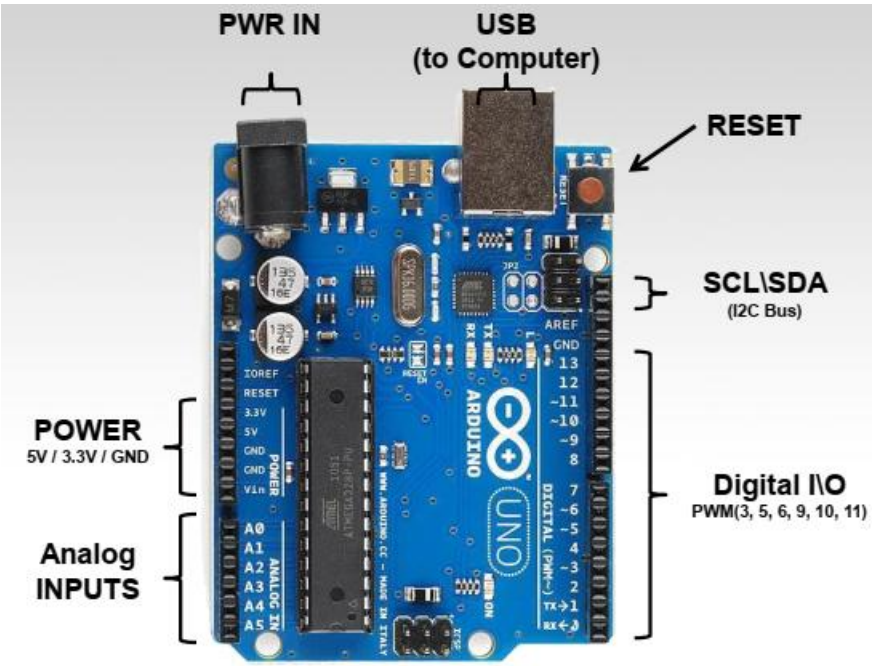
1.4 Free tool for Arduino and Rasberry Pi Simulation

Visit the link https://wyliodrin.studio/ and download the studio IDE. The following figure shows the Wyliodrin Studio IDE.



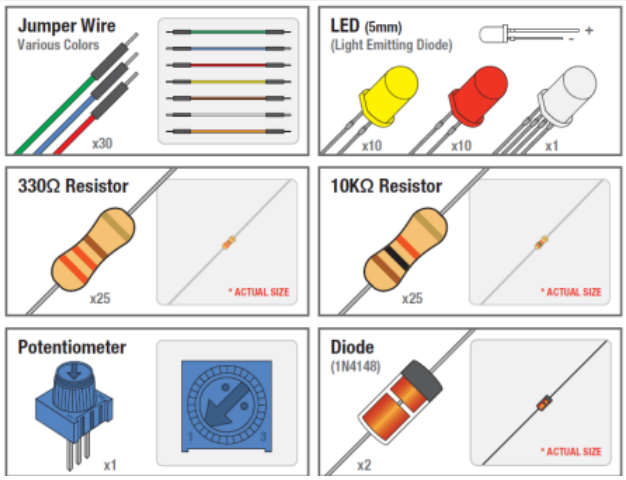
2. Introduction to Arduino Board

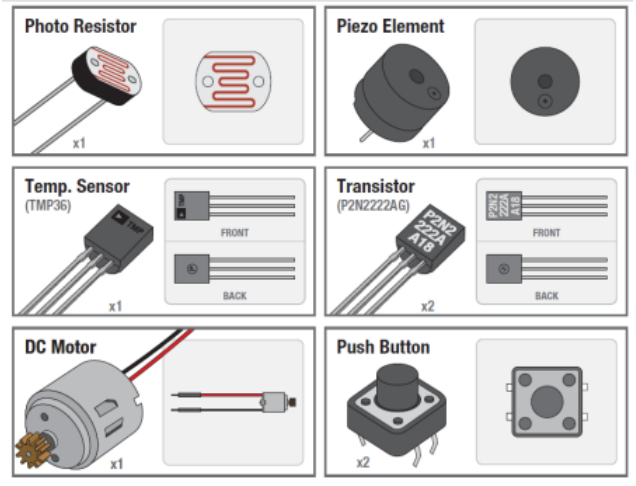
2.1 This board is Open Source Hardware with Atmel Processor. The Coding made to this board is accessible & transferrable to other languages (C++, Processing, java). The following figure shows the Arduino UNO board

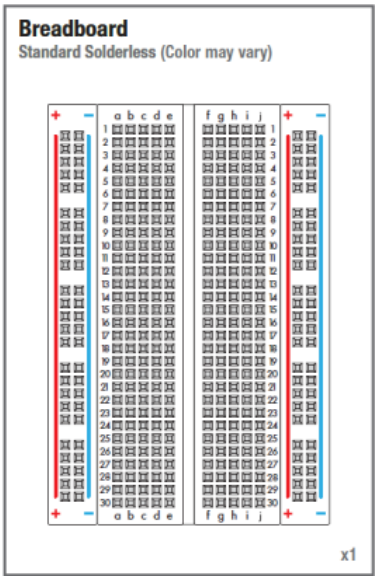


2.2 Most frequently used components with this board are as follows

Name	Image	Type	Function
Push Button		Digital Input	Switch - Closes or opens circuit
Trim potentiometer		Analog Input	Variable resistor
Photoresistor		Analog Input	Light Dependent Resistor (LDR)
Relay		Digital Output	Switch driven by a small signal
Temp Sensor		Analog Input	Temp Dependent Resistor
Flex Sensor		Analog Input	Variable resistor
Soft Trimpot		Analog Input	Variable resistor
RGB LED		Dig & Analog Output	16,777,216 different colors







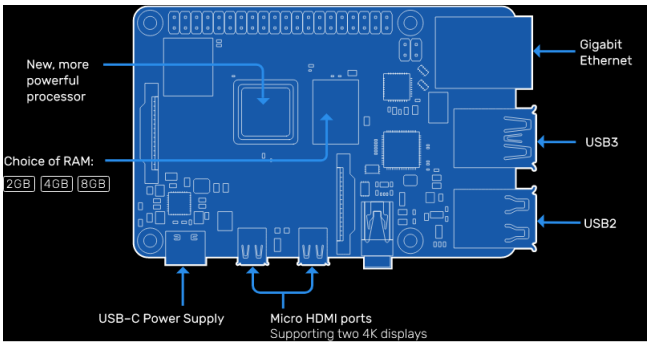
2.3 Visit the link https://www.arduino.cc/en/Guide for downloading and setting up the Arduino IDE.

2.4 Board description https://www.tutorialspoint.com/arduino/arduino_board_description.htm

2.5 Programming Tutorial https://www.tutorialspoint.com/arduino/index.htm or https://www.arduino.cc/en/Tutorial/HomePage

3. **Introduction to Rasberry Pi board/kit** (https://www.raspberrypi.org/products/raspberry-pi-4-model-b/specifications/)

   Visit the link https://projects.raspberrypi.org/en/projects/raspberry-pi-getting-started for official documentation of Rasberry Pi.



4. **Introduction to CupCarbon IoT WSN and Smart City Simulator**

   CupCarbon is a Smart City and Internet of Things Wireless Sensor Network (SCI-WSN) simulator. Its objective is to design, visualize, debug and validate distributed algorithms for monitoring, environmental data collection, etc., and to create environmental scenarios such as fires, gas, mobiles, and generally within educational and scientific projects. Not only it can help to visually explain the basic concepts of sensor networks and how they work; it may also support scientists to test their wireless topologies, protocols, etc.

   Features of this tool are

   - The new version IoT (V 5.0)
   - CupCarbon is an IoT and WSN simulation
   - It can be used to design and program distributed systems in general, as well as well WSN and IoT networks
   - The SenScript has been improved and no need to add the symbol $ to the variables
   - CupCarbon offers an ergonomic and easy to use environment for designing scenarios for communication, mobility and natural events
   - It includes the OSM module to design applications dedicated to Smart-cities
   - Many other improvements and bug fixes have been done
   - With the new version 5 you can use the Python language to program your nodes
   - In this way, you can easily explain to your students or your colleagues how to set up distributed wireless and IoT systems in a very easy way based on visualization
   - As you know, the Python language is widely used and easy to learn
   - Also, you can integrate virtual and real IoT nodes like ESP32, Android, iOS and other nodes in the same simulation

- As far as IoT is concerned, CupCarbon offers the possibility to use the MQTT protocol in an easiest way
- You can publish messages, subscribe to many topics and use any broker you want

Visit http://cupcarbon.com/cupcarbon_ug.html for User Guide, and http://labsticc.univ-brest.fr/~bounceur/cupcarbon/examples/ for tutorial examples.

5. Arduino Programming

Visit the link https://www.arduino.cc/en/Tutorial/BuiltInExamples and complete the following programs. Visit YouTube Channel https://www.youtube.com/channel/UCTXWXbEfezxpOQpDr3Bh7Xw for tutorial videos on Arduino circuits with Thinkercad.

1. Blink: Turn an LED on and off.
2. Read Analog Voltage: Reads an analog input and prints the voltage to the Serial Monitor.
3. Button: Use a pushbutton to control an LED.
4. State Change Detection: Count the number of button pushes.
5. Arrays: A variation on the For Loop example that demonstrates how to use an array.
6. For Loop Iteration: Control multiple LEDs with a for loop and.
7. If Statement Conditional: Use an 'if statement' to change the output conditions based on changing the input conditions.
8. Switch Case: How to choose between a discrete number of values.
9. Switch Case 2: A second switch-case example, showing how to take different actions based on the characters received in the serial port.
10. While Statement Conditional: How to use a while loop to calibrate a sensor while a button is being read.
11. Ping: Detect objects with an ultrasonic range finder.

6. Rasberry Pi simulation using wyliodrin.studio

1. Visit the link https://wyliodrin.studio/post/the-raspberry-pi-simulator for introduction to documentation.
2. Visit the link https://wyliodrinstudio.readthedocs.io/en/latest/simulators/raspberrypi.html and conduct the experiments on LED blinking provided in the documentation.
3. Visit YouTube channel https://www.youtube.com/channel/UCDe4G1RXRYsOEJzXHixutRA for video tutorials on Rasberry Pi Simulations.

7. IoT WSN and Smart City Simulation

Visit the link http://labsticc.univ-brest.fr/~bounceur/cupcarbon/examples/ and perform the following programs

1. Example 1: Hello World
2. Example 6 (2): Blinking and LEDs
3. Example 7: Sending and Receiving messages
4. Example 8: Routing messages
5. Example 11: Reading digital sensor values
6. Tutorial 1: Send me your coordinates please

   Visit YouTube Channel https://www.youtube.com/channel/UC_rAd5qpwuPz3myMZfTWbdA for video tutorials on CupCarbon IoT simulator.