Week 1: Basic electronic circuit 1

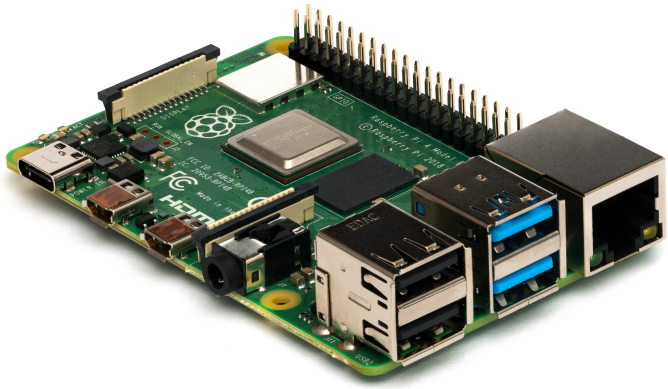
Tools in the box

Multimeter *(aka volt-ohm-milliammeter)*

- A measuring instrument that can measure multiple electrical properties, for example :
    - Voltage
    - Resistance
    - Current

- You can test open or closed/short circuit by using multimeter, fyi, open circuit = disconnected *(The multimeter value will be close to zero)* whereas closed/short circuit = connected *(The multimeter value will be 0L)*.

Raspberry Pi



- A small and affordable board
- There are 3 series of Raspberry Pi :
    - Raspberry Pi
    - Raspberry Pi Zero
    - Raspberry Pi Pico

- Most of the Raspberry Pi has *40 GPIO* pins which includes:
    - Eight (8) Ground (GND)
    - Two (2) 3.3V pins
    - Two (2) 5V pins
    - Twenty-eight (28) GPIO pins

Explanation for each GPIO pins

Ground (GND)

- Can be used to measure voltage and complete a circuit
- Zero voltage
- Mainly for safety purpose :
    - Lighting rod - It will provide low-resistance path to ground
    - Get rid of electric shock

3.3V

- Offers a stable 3.3V supply to power and test the LEDs

5V

- Give direct access to the 5v supply coming from your mains adaptor, less power than used by the Raspberry Pi itself.

I2C - Inter-Integrated Circuit

More info can found on the reference link

SPI - Serial Peripheral Interface

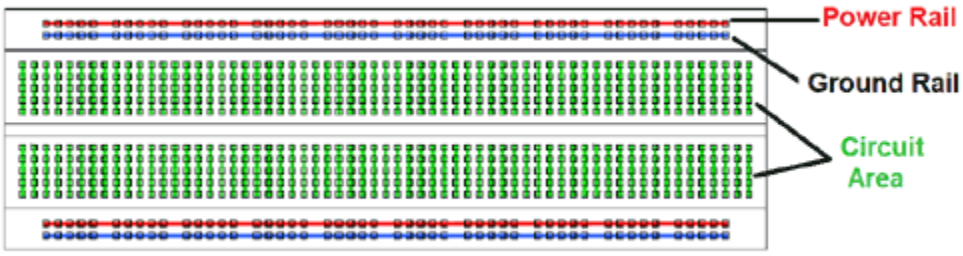
More info can found on the reference link

UART - Universal Asynchronous Receiver / Transmitter

More info can found on the reference link

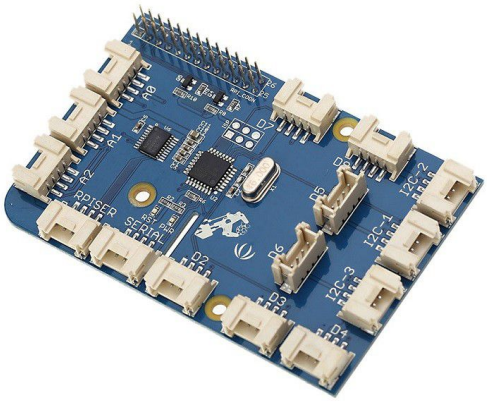
Reference link: https://www.tomshardware.com/reviews/raspberry-pi-gpio-pinout,6122.html

Breadboard



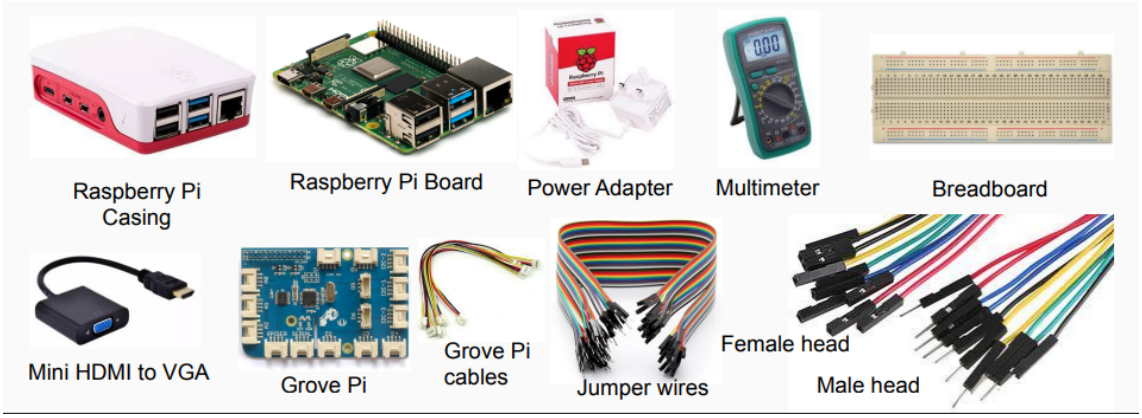
- A thin plastic board used to hold electronic components (transistors, resistors, chips, etc.) that are wired together
- A construction base for prototyping of electronics

Grove Pi Board

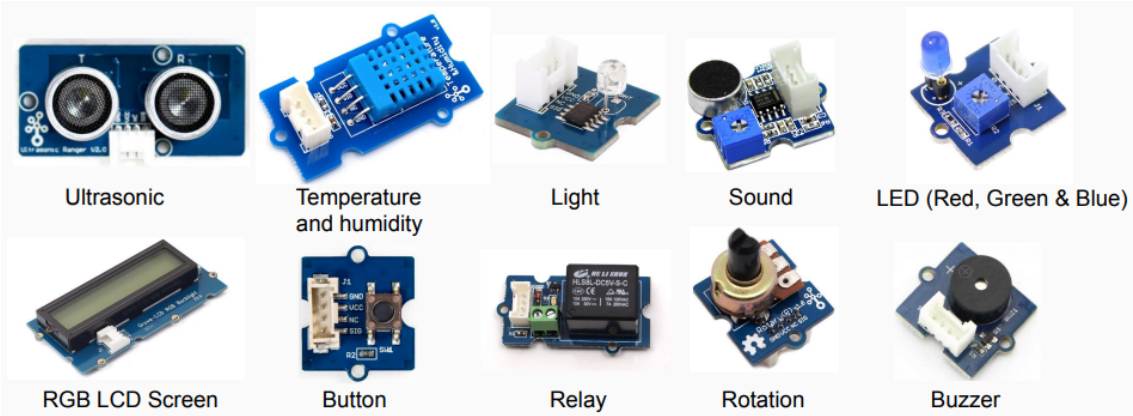


- Electronics board that can connect to hundreds of different sensors in which we can program them to monitor, control, and automate devices.

Other things in the box



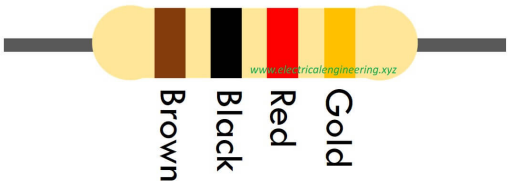
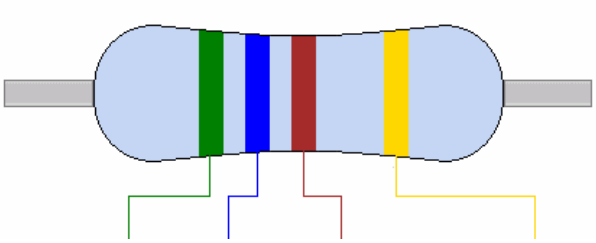
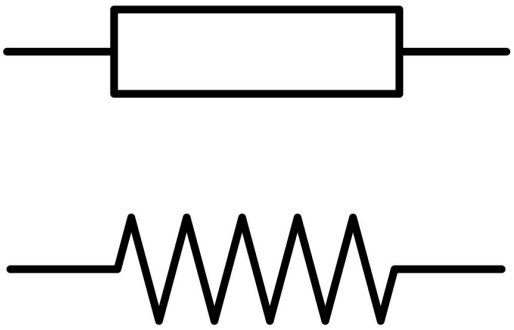
Sensor



Electronic components

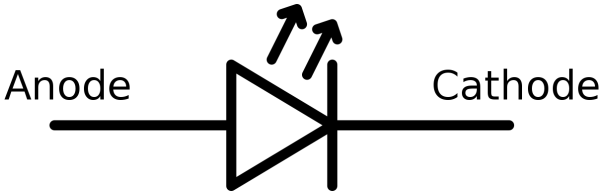
Resistor

- Resists the current flow

Common types of resistor	Electronic Symbol
Brown-black-red-gold : 1KΩ +-5%  Green-blue-brown-gold : 560Ω +-5%  brown-black-orange -gold : 10KΩ +-5% 	

LED

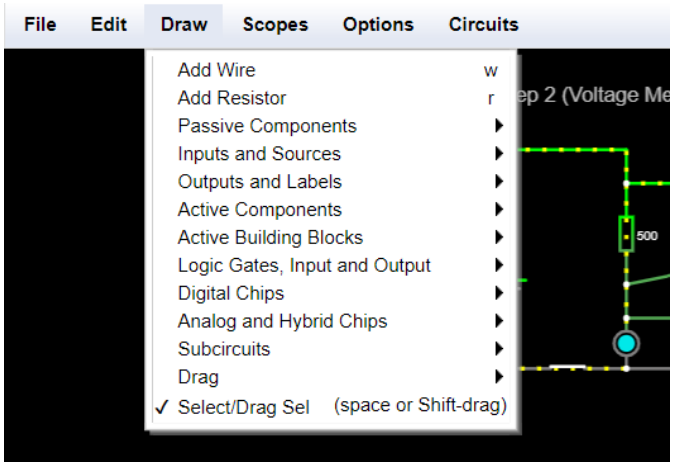
- Semiconductor light source that emits light when current flows through it

LEDs	Electronic Symbol
	

Falstah (Electronic Circuit Simulator)

- A simple circuit can be constructed and demo using Falstah

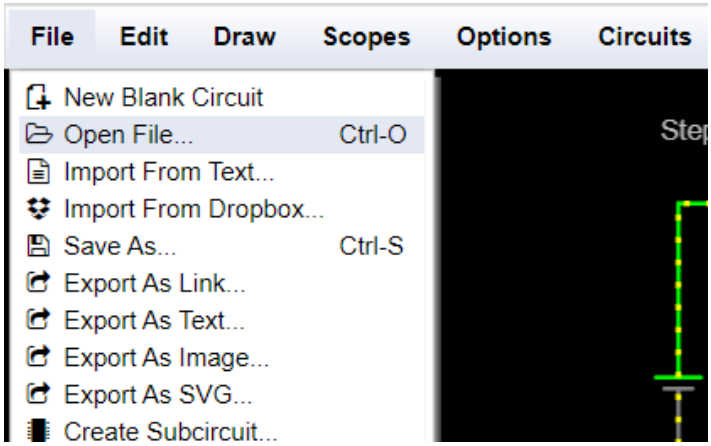
1. You can insert electronic components, wire, passive components, etc in the **`Draw`**



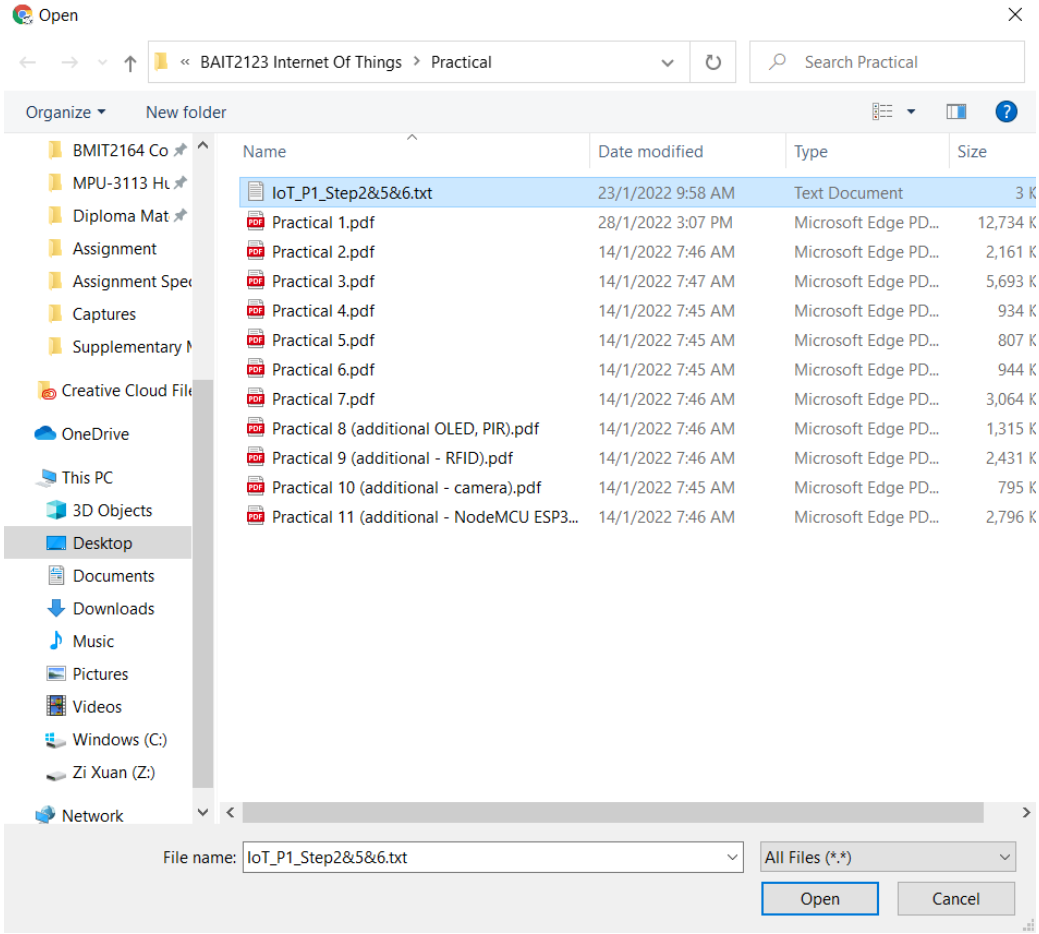
*** Alternatively, you can insert new electronic components by enter short form, for example, ‘w’ to add a wire into the circuit

2. You can open a text file that is saved from Falstah to your local PC. In my case, I open a txt file called *"IoT_P1_Step2&5&6.txt"* to open a pre-saved file.

   Step 1: Open file

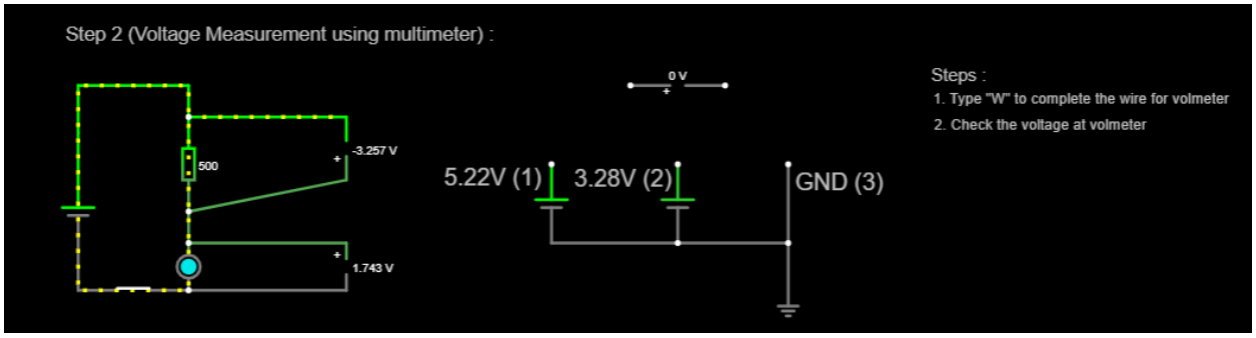


   Step 2: Select the text file and click open



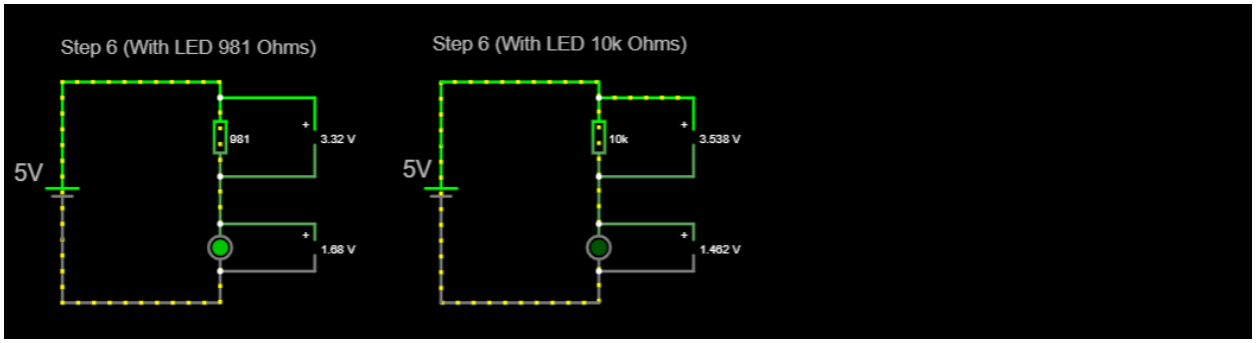
Overview of Practical 1 Simulation

Step 2 Learn to measure voltage using a multimeter



Step 5 Construct a resistor circuit without LED

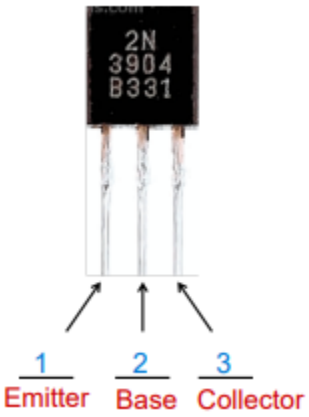
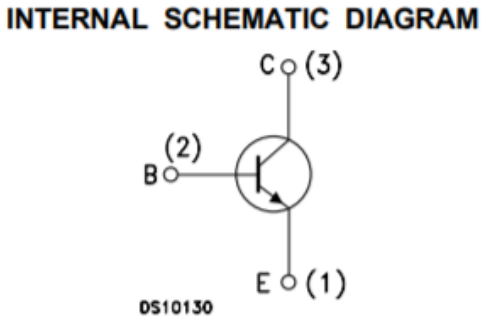
Step 6 Construct a resistor circuit with LED



Week 2: Basic electronic circuit 2

2.1 Transistor (SMALL SIGNAL NPN TRANSISTOR)

- If the voltage is not compatible or insufficient current to energize the relay's coil, we will use the driver which is a transistor
- It can act as conductor or insulator
- It turns low input current to high output current

Transistor	Electronic Symbol
 **bipolar junction transistor (BJT)	

1 - Emitter : The outlet for electrical supply (connected to GND)
2 - Base : The gate controller device for the largest electrical supply
3 - Collector : Larger electrical supply

How do transistors Act as Conductors or Insulators?

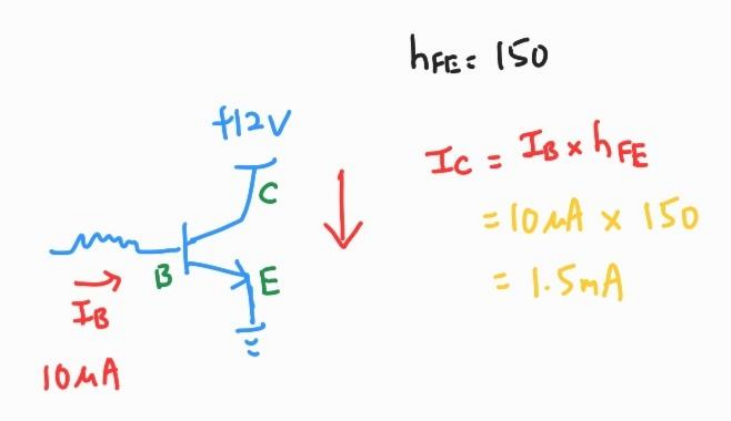
Important equation for transistor:

$I_C = I_B * h_{FE}$, true iff $V_{CE} > 0V$ // V_{CE} is the voltage measured between the collector and emitter

$h_{FE} = 150$ // It is fixed at this time

1. Transistor act as a *conductor* - It will amplify the current in the collector (C) by 150 times
   $I_B = 10\mu A$
   $I_C = 10\mu A * 150$
   $= 1.5mA$

Diagram Illustration:

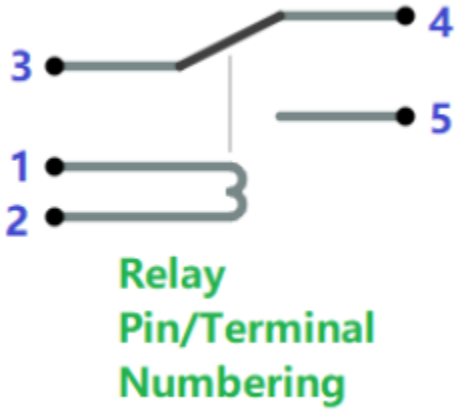


∴ 10μA input can amplified to 1.5mA

2. Transistor act as an *insulator*
   When I_B = 0, the I_C will also 0 (no current flow)
   ∴ It will become an insulator and is totally off

2.2 Relay (Electromechanical or Electrical Relay » Electronics Notes)

- With the relay, you can easily control the power going to a device with an Arduino, Raspberry Pi or other single-board computer or microcontroller.

Relay [1.1]	Electronic Symbol
	

Understand the relay connectivity and specification

**You can view the relay diagram[1.1] at above to gain necessary information

Output Control Rating Type	Voltage (V)	Current (I)	Pmax = VI
1	250VAC	10A	2.5KkW
2	125VAC	10A	1.25kW
3	30VDC	10A	0.3kW
4	28VDC	10A	0.28kW

The control voltage is **5VDC** which means the voltage required to energize the coil is only 5V, then it will generate a magnetic field, pull the switch metal and make a contact. Once it makes contact, it will be a closed circuit.

** Extra notes: 15mA 250V can kill a person.

Question included in Practical 2

1. Voltage required from a relay to control the household light bulb
   Malaysia : 250V
   America / Japan : 110 - 120V

2. To control the household light bulb (e.g., 20W one light bulb), what is the maximum number of light bulbs that the relay can control?
   Calculation:
   P = VI
   20 = 250(I)
   I = 20/250
   = 0.08A
   = 80mA

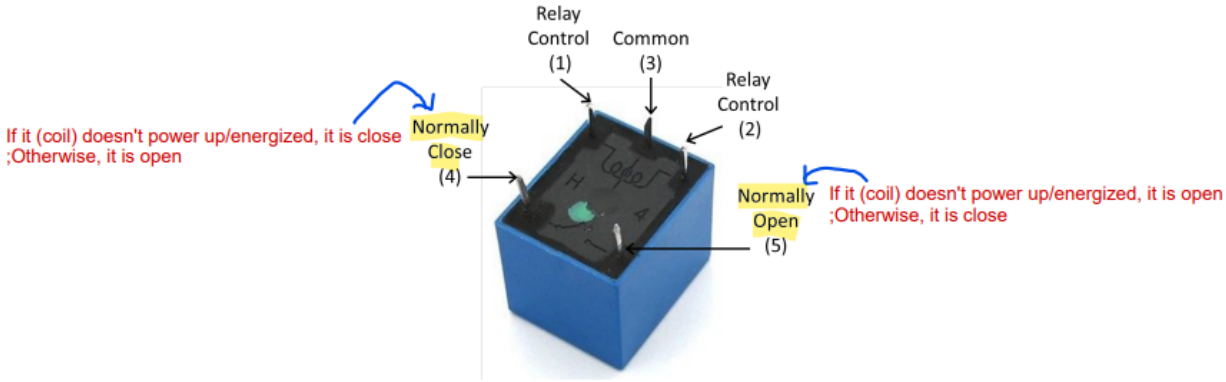
   ∴ Imax/Ibulb = 10A/0.08A = 125 light bulbs

   How to get Imax to substitute into the equation?
   We can look at the AC (normally the household connected plug is AC device)
   - All the figures in the relay [1.1] is the maximum voltage or current, which cannot exceed it, else it will malfunction.

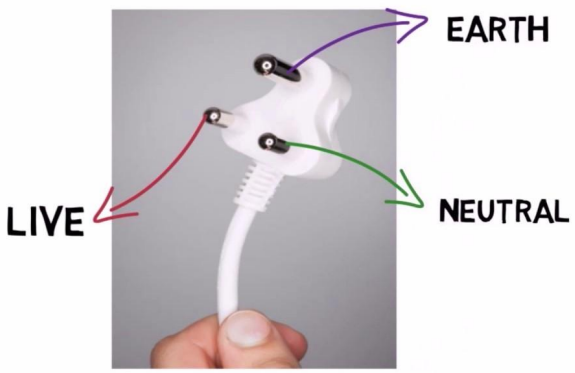
- For 250AC, 10A is the maximum and if exceed it, it might not function properly (i.e. burn or cause fire).

After calculating, we will know the safe number of lightbulbs to use so that we won't reach the limit. Otherwise it might burn and melt the metal inside the relay as it generates a lot of heat then burns the relay plastics as well as the rest of the system which will cause fire.

Relay Explanation



**** Extra Notes for socket** [1.2]



Earth (yellow green) - Protection so that we won't get electric shock, safe
Live (Brown) - You can feel the voltage, it is dangerous
Neutral (Blue) - Connected to earth so it is safe (*Sometimes it might connected to live, so have to be careful)

What should plug in the relay pin?

Input pin - Pin 1 & 2 - Either 1 put 5V and another put 0V as GND
Output pin - Pin 3, 4, 5

When connect to socket[1.2], we should connect high voltage to live - pin (4) or pin (5) while neutral connect to common pin (3)

Relay control coil resistance

Relay control coil resistance (Ω) = 72.3Ω

$\therefore$ The estimated current required to control the relay is 69mA

69mA is considered big to the microcontroller which normally provides up to 25mA or slightly bigger, hence it cannot drive the coil as it does not have enough power. It will then not make a contact or another case, it will make contact but we will hear the tik tak tik tak sound (it means connected then disconnected continuously). Furthermore, it will destroy the pin as well because it cannot source enough current but we're pulling that much current, it will burn the relay inside then it will spoil.

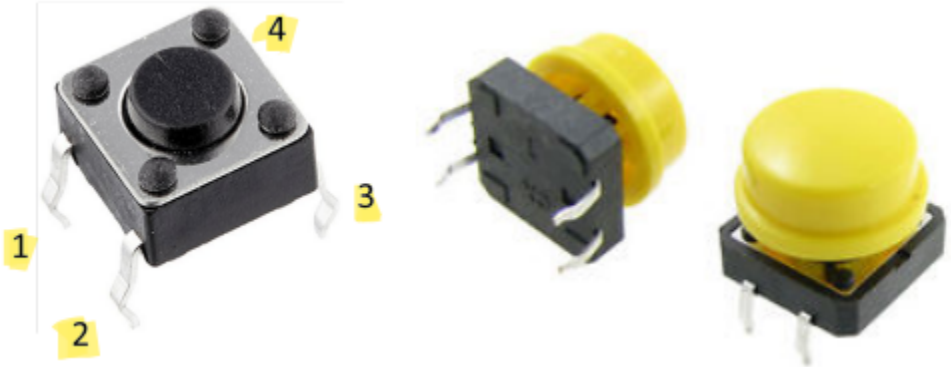
Hence, the relay will need a driver (transistor) to turn the low current input to high current output.

Connectivity among Relay's lead

Lead	Lead	Short (Just tick "✓")	Open (Just tick "✓")
3	4	✓	
3	5		✓
4	5		✓

(When coil is energized, normally close (4) will become open circuit while normally open (5) will become short circuit)

2.3 Push Button Switch



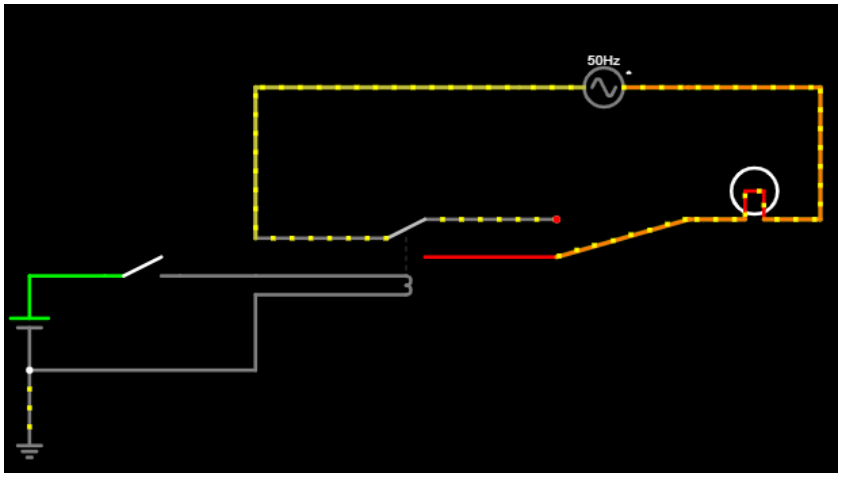
Push Button Lead Testing (When didn't press the push button switch)

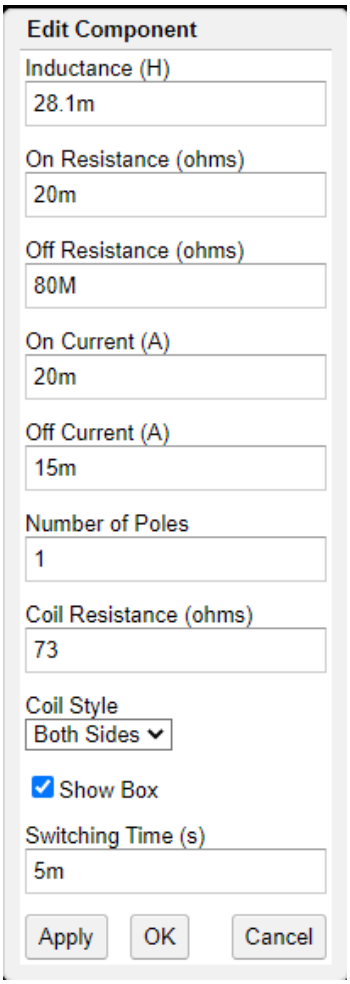
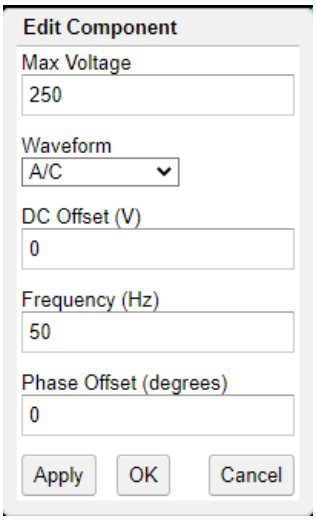
Lead	Lead	Short Circuit	Open Circuit
1	2	✔	
2	3		✔
3	4	✔	
4	1		✔
1	3		✔
4	1		✔

Push Button Lead Testing (When press the push button switch)

All leads will be connected.

Falstad Simulation for Relay (Practical 2 Part 3 Video)

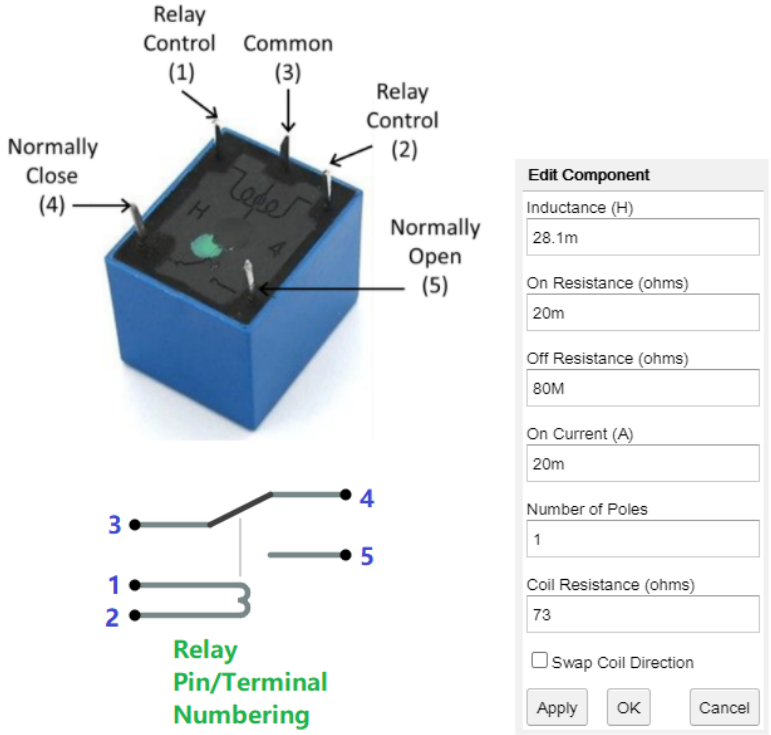


Settings for Relay	Settings for A/C sources (2 terminal)
	

The schematic relay symbol may appear differently. This is because its appearance can be edited. Below is the many different appearances:

Appearance changes do not affect its electrical properties.

Below is the pin numbering of the relay to help you sketch the schematic diagram for answering Practical Quiz 2



Week 3: Programming with Python

Python Library Reference link: Python Library Documentation - Dexter Industries

How to run in the Thorny Python

Test on LED Blink: *led_blink.py (test01.py)*

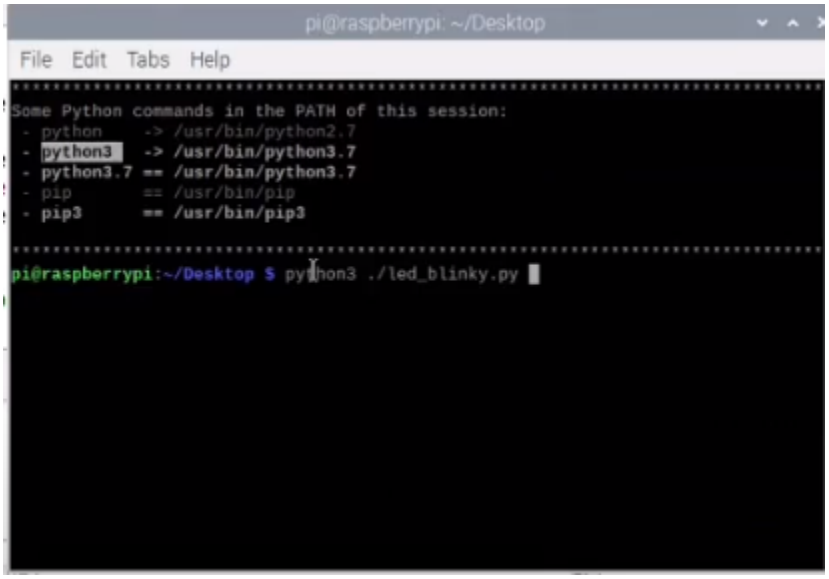
Python Command	Explanation
import time	To delay some action in order to see the effect (i.e turn on, delay for a while, vice versa)
from grovepi import *	Import everything inside Grovepi
led = 4	The led is connected to D4 (Digital 4) port
pinMode(led, "OUTPUT")	Configure the pin number 4 (D4) as an output
while True:	Loop forever when it is true
try:	Try function
time.sleep(1)	Sleep for 1 second
digitalWrite(led, 1)	Write high to the LED to turn on it
time.sleep(1)	Sleep for another 1 second
digitalWrite(led, 0)	Shut off the LED
except KeyboardInterrupt:	Same like catch function Catch the keyboard interrupt, we can use it to escape the loop (i.e ctrl c, ctrl z)
digitalWrite(led, 0)	Shut off the LED
break	Break out of this while loop and back to main function and then stop the program
except IOError:	The raspberry pi communicates with GrovePi to do the action (i.e write the led to 1, write the led to 0, etc), it communicates using i2c. Sometimes, the communication fails, when it fails, it will generate this error which indicates raspberry pi failed to communicate with the GrovePi board. One of the reasons might be you unplug/detached the GrovePi board from the raspberry pi which causes them to not communicate.

print("I/O error occurs")	Display I/O error message
break	Break out of this while loop and back to main function and then stop the program

How to run in the console

1. Click "Tools"
2. Click "Open System Shell"
3. In the shell, type python3 ./led_blink.py
4. Press enter, the led will blinking
5. Press ctrl c, the led will turn off (due to keyboard interruption)

Diagram Illustration



Test LED Fade: *(test02.py)*

Python Command	Explanation
import time	To delay some action in order to see the effect (i.e turn on, delay for a while, vice versa)
import grovepi	Import grovepi library
rotaryangle = 2	Connect rotaryangle sensor to port 2 of analogy which is A2
led = 5	Connect the LED to D5 which is digital pin 5
grovepi.pinMode(rotaryangle, “INPUT”)	Set the pin mode of the rotaryangle as input because the rotaryangle is reading the signal
grovepi.pinMode(led, “OUTPUT”)	Configure the pin number 4 (D4) as an output
val = 0	This val will carry the value read from rotaryangle
while True:	Loop forever when it is true
try:	Start try block
time.sleep(1)	Sleep for 1 second
val = grovepi.analogRead(rotaryangle)	Read the analog from the rotaryangle through the grovepi library and store it in val
print(val)	Print out the val so that we can see the value from the console
grovepi.analogWrite(led, val//4)	Set the LED but this setting is different from what we did before. In the previous program, we will digital write the LED to high or low. This analog is a special function which will take in the value from 0 to 255, and then will generate a square wave. The LED will switch on and off very quickly but at different duty cycles, and therefore produce varying intensity. Notes: analogRead values go from 0 to 1023, analogWrite values from 0 to 255
except KeyboardInterrupt:	Same like catch function Catch the keyboard interrupt, we can use it to escape the loop (i.e ctrl c, ctrl z)
digitalWrite(led, 0)	Shut off the LED

break	Break out of this while loop and back to main function and then stop the program
except IOError:	The raspberry pi communicates with GrovePi to do the action (i.e write the led to 1, write the led to 0, etc), it communicates using i2c. Sometimes, the communication fails, when it fails, it will generate this error which indicates raspberry pi failed to communicate with the GrovePi board. One of the reasons might be you unplug/detached the GrovePi board from the raspberry pi which causes them to not communicate.
print("I/O error occurs")	Display I/O error message
break	Break out of this while loop and back to main function and then stop the program

test03.py

Python Command	Explanation
import time	To delay some action in order to see the effect (i.e turn on, delay for a while, vice versa)
import math	Import math library
from grovepi import *	Import all the functions inside Grovepi
buzzer = 2	Connect the buzzer to D2
button = 4	Connect the button to D4
pinMode(buzzer, "OUTPUT")	Set the pin mode of buzzer to output as we gonna buzz the buzzer
pinMode(button, "INPUT")	Set the pin mode of button to input as we need to read the button statement whether it is low (0V) or high (3.3V)
while True:	Loop forever when it is true
try:	Start try block
time.sleep(0.25)	Sleep for 0.25 seconds
bStatus = digitalRead(button)	Read the button using digitalRead and place the value inside the bStatus (0=>not pressed, 1=>pressed)

if(bStatus):	If the button has been pressed, enter inside that statement
digitalWrite(buzzer, 1)	Write 1 to buzzer (Turn on the buzzer)
else :	If the button hasn't been pressed
digitalWrite(buzzer, 0)	Write 0 to buzzer (Turn off the buzzer)
except KeyboardInterrupt:	Same like catch function Catch the keyboard interrupt, we can use it to escape the loop (i.e ctrl c, ctrl z)
digitalWrite(buzzer, 0)	Turn off the buzzer
break	Break out of this while loop and back to main function and then stop the program
except IOError:	The raspberry pi communicates with GrovePi to do the action (i.e write the led to 1, write the led to 0, etc), it communicates using i2c. Sometimes, the communication fails, when it fails, it will generate this error which indicates raspberry pi failed to communicate with the GrovePi board. One of the reasons might be you unplug/detached the GrovePi board from the raspberry pi which causes them to not communicate.
print("I/O error occurs")	Display I/O error message
break	Break out of this while loop and back to main function and then stop the program

Task 1: Modify the code to make the buzzer sound like a warning siren / ambulance.

Buzzer.py

Python Command	Explanation
import time	To delay some action in order to see the effect (i.e turn on, delay for a while, vice versa)
from grovepi import *	Import all the functions inside Grovepi
buzzer = 3	Connect the buzzer to D3
pinMode(buzzer, “OUTPUT”)	Set the pin mode of buzzer to output as we gonna buzz the buzzer
while True:	Loop forever when it is true
val = input(“Enter a value between 0 - 255: ”)	User input for a value between 0 -255 and assign to val
val = int(val)	Convert the val to integer
if val > 255:	If the val value is greater than 255
val = 255	The value of val will be 255
elif val < 0:	Else if the val value is lesser than 0
val = 0	The value of val will be 0
analogWrite(buzzer, val)	Write the val value to the D3 pin **In this case, buzzer is 3 which is D3*

Notes: D3, D5 and D6 pin allows us to write 8 bits value which is from 0 - 255 using analogWrite

Result:

255
50
255
50
can make the buzzer sound like a warning siren / ambulance

Practical 3 Quiz

Why do we need i//4 at line 16? * 4/4

test02.py

```
1  import time
2  import grovepi
3
4  rotaryangle = 14
5  led = 6
6
7  grovepi.pinMode(rotaryangle, "INPUT")
8  grovepi.pinMode(led, "OUTPUT")
9  i = 0
10
11 while True:
12     try:
13         time.sleep(1)
14         i = grovepi.analogRead(rotaryangle)
15         print(i)
16         grovepi.analogWrite(led, i//4)
17     except IOError:
18         print("IO Error occurs")
```

- [ ] To ensure the i value in return of 4 decimal points from LED.
- [x] To ensure the value assigned to LED (output) is divided by 4.
- [x] To ensure led brightness act according to the rotary angle value.
- [ ] To ensure the analog read in return of 4 decimal points from rotary angle.
- [x] To ensure 10 bits values converted to 8 bits value.
- [ ] To ensure 8 bits value converted to 10 bits value.
- [x] To ensure the correct value is assigned to the LED (output).

Feedback

Well done.

To let the LED blink faster (on and off time consistently), we should modify the code to become: * 4/4

test01.py *

```
import time
from grovepi import *

led = 4
pinMode(led, "OUTPUT")
while True:
    try:
        time.sleep(1)
        digitalWrite(led, 1)
        time.sleep(1)
        digitalWrite(led, 0)
    except KeyboardInterrupt:
        digitalWrite(led, 0)
        break
    except IOError:
        print("IO Error occurs")
```

- ○ Line 8 : time.sleep(1.5) Line 10: time sleep (1.5)
- ○ Line 8 : time.sleep(0.5) Line 10: time sleep (1.5)
- ○ Line 10: time.sleep(0.5)
- ○ Line 8: time sleep (1.5)
- ◉ Line 8 : time.sleep(0.5) Line 10: time sleep (0.5)
- ○ Line 10: time sleep (1.5)
- ○ Line 8 : time.sleep(1.5) Line 10: time sleep (0.5)
- ○ Line 8 : time.sleep(0.5)

Feedback

Modify the sleep time to 0.5 (shorter sleeping time) consistently for on and off time, to blink faster.

What is the purpose of having time.sleep(1) at line 8 and 10 ? * 4/4

test01.py *

```
1  import time
2  from grovepi import *
3
4  led = 4
5  pinMode(led, "OUTPUT")
6  while True:
7      try:
8          time.sleep(1)
9          digitalWrite(led, 1)
10         time.sleep(1)
11         digitalWrite(led, 0)
12     except KeyboardInterrupt:
13         digitalWrite(led, 0)
14         break
15     except IOError:
16         print("IO Error occurs")
17
```

- ○ To have sufficient time (one second) to rest and clear memory before the next task.
- ◉ To hold on for one second and follow by turning on / off LED for the blinking effect.
- ○ To have one second for initializing the LED light before it turns on / off.

Feedback

For human to sense the one second blinking time.

Week 4: Programming with Python

Step 1: Test Ultrasonic and Relay

ultrasonic_with_relay.py

Python Command	Explanation
from time import *	Import all the functions in the time library
from grovepi import *	Import all the functions inside Grovepi
ultrasonic_port = 3	Set the ultrasonic port to D3
relay_port = 2	Set the relay port to D2
pinMode(relay_port, “OUTPUT”)	Set the relay port as output *Important as if you didn’t specify it as output, you will not be able to control it *While for the ultrasonic port, it is handled by library, so we don’t have to specify it as input or output
while True:	Loop forever
try:	Try block
sleep(0.5)	Sleep for 0.5 seconds
distance = ultrasonicRead(ultrasonic_port)	Read from the ultrasonic D3 port and return the distance Notes: ultrasonicRead(pin) is a grove specific function that used to Read the distance reading from the Grove Ultrasonic ranger
print(‘Distance : ’, distance, ‘cm’)	Print the distance on the terminal
if distance <= 10:	If the distance is less than 10
digitalWrite(relay_port, 1)	Turn on the relay / Write the HIGH value to relay_port (D2 pin)
else:	otherwise;
digitalWrite(relay_port, 0)	Turn off the relay / Write the LOW value to relay_port (D2 pin)
except KeyboardInterrupt:	Same like catch function Catch the keyboard interrupt, we can use it to escape the loop (i.e ctrl c, ctrl z)
digitalWrite(relay_port, 0)	Turn off the relay

break	Break out of this while loop and back to main function and then stop the program
except TypeInterrupt:	None of the function being called within this try block, this error will occur
print("Type error occurs")	Display Type error message
break	Break out of this while loop and back to main function and then stop the program
except IOError:	The raspberry pi communicates with GrovePi to do the action (i.e write the led to 1, write the led to 0, etc), it communicates using i2c. Sometimes, the communication fails, when it fails, it will generate this error which indicates raspberry pi failed to communicate with the GrovePi board. One of the reasons might be you unplug/detached the GrovePi board from the raspberry pi which causes them to not communicate.
print("I/O error occurs")	Display I/O error message
break	Break out of this while loop and back to main function and then stop the program

Step 2: Test RGB LCD Display and DHT (Digital Humidity and Temperature)

dht_with_lcd.py

Python Command	Explanation
from time import *	Import all the functions in the time library
from grovepi import *	Import all the functions inside Grovepi
from grove_rgb_lcd import *	Import all the functions to control the lcd
DHT11 = 0	Specify DHT11 as DHT module type that we want to communicate
dht_sensor = 3	Connect dht sensor to D3
pinMode(dht_sensor, "INPUT")	Configure the pin mode of DHT sensor as input
setRGB(5, 15, 10)	Set the rgb to color cyan
while True:	Loop forever

try:	Try block
sleep(0.5)	Sleep for 0.5 seconds
[temp, hum] = dht(dht_sensor, DHT11)	Read from the dht sensor which will return 2 parameters/array of 2 floats (temperature and humidity)
print('Temp: ', temp, '\u00b0', 'Hum: ', hum, '%')	Print the temperature and humidity on the console
t = str(temp)	Convert the temperature from integer to string * When we want to display text on LCD, it must be in string format
h = str(hum)	Convert the humidity from integer to string
setText('Temp: ', t, '\331, 'Hum: ', h, '%')	Print the text on lcd
except KeyboardInterrupt:	Same like catch function Catch the keyboard interrupt, we can use it to escape the loop (i.e ctrl c, ctrl z)
setText("Program Exited")	Set the text of lcd to "Program Exited"
break	Break out of this while loop and back to main function and then stop the program
except TypeInterrupt:	None of the function being called within this try block, this error will occur
print("Type error occurs")	Display Type error message
break	Break out of this while loop and back to main function and then stop the program
except IOError:	The raspberry pi communicates with GrovePi to do the action (i.e write the led to 1, write the led to 0, etc), it communicates using i2c. Sometimes, the communication fails, when it fails, it will generate this error which indicates raspberry pi failed to communicate with the GrovePi board. One of the reasons might be you unplug/detached the GrovePi board from the raspberry pi which causes them to not communicate.

print("I/O error occurs")	Display I/O error message
break	Break out of this while loop and back to main function and then stop the program

Test RGB Color

rgb.py

Python Command	Explanation
from grove_rgb_lcd import *	Import all the functions to control the lcd
while True:	Loop forever
val = input("Enter RGB values: ")	Get user input and store inside the val
rgb = val.split(',')	Split the val using comma(,)
num = len(rgb)	Return the length of the list (e.g 1, 2, 3 …)
if num < 3 or num > 3:	If the length of the list is more than or less than 3
print('Three values needed, but you gave {}', format(len(rgb)))	It will print the message to alert user to input exact 3 values
continue	The continue statement rejects all the remaining statements in the current iteration of the loop and moves the control back to the top of the loop
setRGB(int(rgb[0], int(rgb[1], int(rgb[2]))))	Set the rgb based on the user input
text = "R:{},G:{},B:{}".format(rgb[0], rgb[1], rgb[2])	The rgb value will be stored on text variable
setText(text)	Print out the text inside the text variable

Sample Output from LCD

Red

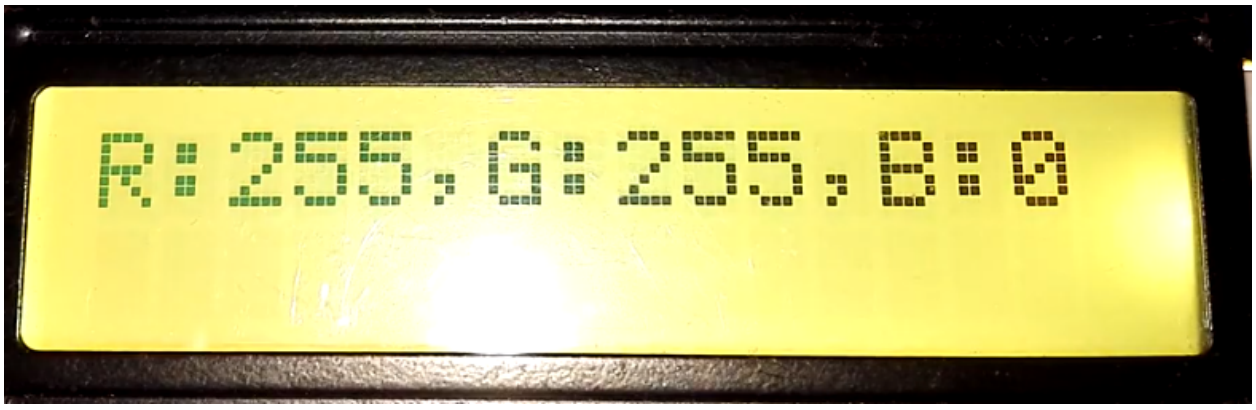
Blue

Cyan

Cyan

Pink

Yellow



Magenta

Question for Practical 4 Worksheet

1. **Can the fake device library emulate a relay?**
   There is no virtual relay. But you can see visually the state of the pin (connected to the relay). If the pin is set to high (then by right the relay should turn on). Similarly, if the pin is set to low (then the relay should be off). You have to imagine that the state of the pin you see is the state of the relay you are controlling.

2. **How to emulate a buzzer controlled from a relay?**
   You can emulate a buzzer by configuring the launcher script to beep when a pin is set to high. Although there is no relay in between the pin and the buzzer, the effect is the same with the physical setup. Just that you will not be hearing the click-clack sound generated by the relay.

3. **Can we use analogWrite(.) instead of digitalWrite(.) to sound the buzzer?**
   Yes, by right both can generate sound. The sound generated by digitalWrite(.) is only a single tone. If you use analogWrite(.), you can produce different, though limited, numbers of tones. You can watch me demonstrate this in this 2-minute video. The tones are not the best tones you get from a perfect tone generator. This is true only when you use real Grove Pi. But, in the fake device, I did not emulate this. So at the moment you *cannot* use analogWrite(.) under the fake device library.

4. **Can we use analogWrite(.) to control the sound volume of a buzzer?**
   No, the analogWrite(.) works differently from the actual analog output. Grove Pi generates a high frequency square wave on the output pin to create the illusion that controls the brightness of an LED connected to the pin. It works on the LED. But it does not work the same for a speaker or buzzer.

Practical 4 Quiz

How to set the LCD display to have Red background? * 4 points

test05.py

```
from time import *
from grovepi import *
from grove_rgb_lcd import *

dhtsensor = 7

pinMode(dhtsensor, "INPUT")

while True:
    try:
        sleep(0.5)
        [temp, hum] = dht(dhtsensor, 0)
        print("Temp = ", temp, '\u00b0C', " Hum = ", hum, " %")
        t = str(temp)
        h = str(hum)
        setRGB(0, 255, 0)
        setText("Temp = " + t + '\337'+ "C   Hum = " + h + " %")
    except KeyboardInterrupt:
        setText("Program Exited")
        break
    except TypeError:
        print("Type Error occurs")
    except IOError:
        print("IO Error occurs")

```

- ○ At line 16, change to setRGB(0, 255, 255)
- ○ At line 16, change to setRGB(255, 0, 255)
- ○ At line 16, change to setRGB(255, 255, 0)
- ◉ At line 16, change to setRGB(255, 0, 0)
- ○ At line 16, change to setRGB(0, 0, 255)

The maximum and minimum GrovePi Ultrasonic sensors value is... * 4 points

test04.py

```
from time import *
from grovepi import *

ultrasonic = 3
relay = 2

pinMode(ultrasonic, "INPUT")
pinMode(relay, "OUTPUT")

while True:
    try:
        sleep(0.5)
        distance = ultrasonicRead(ultrasonic)
        print(distance, 'cm')
        if distance <= 10:
            digitalWrite(relay, 1)
        else:
            digitalWrite(relay, 0)
    except KeyboardInterrupt:
        digitalWrite(relay, 0)
        break
    except TypeError:
        print("Type Error occurs")
    except IOError:
        print("IO Error occurs")
```

- ○ max = 50, min = 10
- ○ max = 100, min = 10
- ○ max = 65535, min 5
- ◉ max = 500, min = 0
- ○ max = 255, min = 10

Notes: This prototype GrovePi Ultrasonic sensor able to measure distance from 0 mm to 500 mm (some says 0 - 350mm), depends on the quality / specification of ultrasonic sensor

Referring the the following code, what are the steps to set the buzzer sounds like a warning siren ? * Answers (in steps) are indicated continuously. *

4 points

```
10  while True:
11      try:
12          time.sleep(0.25)
13          bStatus = digitalRead(button)
14          if bStatus:
15              digitalWrite(buzzer,1)
16          else:
17              digitalWrite(buzzer,0)
18      except KeyboardInterrupt:
19          digitalWrite(buzzer, 0)
20          break
21      except IOError:
22          print("IO Error occurs")
```

- [ ] Replace the function from digitalWrite to analogRead at line 15, 17, 19.
- [x] Replace the function from digitalWrite to analogWrite at line 15, 17, 19.
- [ ] Change the button pinMode to "OUTPUT" at line 8
- [ ] Change the assigned value from 1 to 0, at line 15.
- [x] Change the assigned value from 1 to 255, at line 15.
- [ ] Increase the time.sleep from 0.25 to 5 at line 12.
- [ ] Add a new line: time.sleep(0.25) in between 18 and 19.
- [x] Add a new line: time.sleep(0.25) in between 14 and 15.
- [ ] Add two new lines: time.sleep(0.25) ; analogWrite(buzzer, 100) in between 21 and 22.
- [x] Add two new lines: time.sleep(0.25) ; analogWrite(buzzer, 100) in between 15 and 16.

Improved Code to set the buzzer sounds like a warning siren:

```
while True:
      try:
         time.sleep(0.25)
         bStatus = digitalRead(button)
         if(bStatus):
            time.sleep(0.25)
            analogWrite(buzzer, 255)
            time.sleep(0.25)
            analogWrite(buzzer, 100)
      except KeyboardInterrupt:
          analogWrite(buzzer, 0)
          break
      except IOError:
          print("IO Error occurs")
```

Notes: D3, D5 and D6 pin allows us to write 8 bits value which is from 0 - 255 using analogWrite

Notes: A0, A1 and A2 pin (aka D14, D15, D16) allows us to read 10 bits value which is from 0 - 1023 using analogRead

Week 5 Working with Firebase

Step 1: Register an account at https://firebase.google.com/, refer to *Setup - Firebase.pdf*

* *Do not use TAR UC student gmail account as it doesn't come with Google Firebase features.*
* *Recommend to create a **new** Gmail account to be used among team members (gmail password is used as part of log in procedure to be shown in your python code)*

Reference: Setup - Firebase.pdf

Step 2: There are many ways to establish connection to Google Firebase.

We use Pyrebase, that is a simple python wrapper for the Firebase API, pre-installed in our Raspberry Pi module

* If you are using your own Raspberry Pi, do install Pyrebase by typing:

  sudo pip3 install Pyrebase

* Reference: https://github.com/thisbejim/Pyrebase

Reference: Pyrebase - A simple python wrapper for the Firebase API.

Step 3: Open Thonny Python (IDE) - open a new file - save as test06.py - code the following *test06.py* (test06.py)

```
from time import *
from grovepi import *
from grove_rgb_lcd import *
from pyrebase import pyrebase

dhtsensor = 7
pinMode(dhtsensor, "INPUT")

config = {
    "apiKey": "AIzaSyBkGe8rwXaekDyGa68SN5BndPlN-6XYY-g",
    "authDomain": "bait2123-iot-12d48.firebaseapp.com",
    "databaseURL":
"https://bait2123-iot-12d48-default-rtdb.firebaseio.com/",
    "storageBucket": "gs://bait2123-iot-12d48.appspot.com"
}

firebase = pyrebase.initialize_app(config)
auth = firebase.auth()
user = auth.sign_in_with_email_and_password("zixuan2001711@gmail.com",
"loozx123")
db = firebase.database()

while True:
    try:
        sleep(1.5)
        [temp, hum] = dht(dhtsensor, 0)
        print("Temp = ", temp, '\u00b0C', " Hum = ", "%")
```

```
        t = str(temp)
        h = str(hum)
        setRGB(0,255,0)
        setText("Temp = " + t + '\337' + "C Hum = "+ h + "%")
        data1 = {"temperature":t}
        data2 = {"humidity":h}
        results = db.child("PI_001").push(data1, user['idToken'])
        results = db.child("PI_001").push(data2, user['idToken'])
    except KeyboardInterrupt:
        setText("Program Exited")
        break
    except TypeError:
        print("Type error occurs")
        break
    except IOError:
        print("I/O error occurs")
        break
```

You have to replace the "text" in **red color in order to suit your case (based on configuration that you had done in your Firebase)*

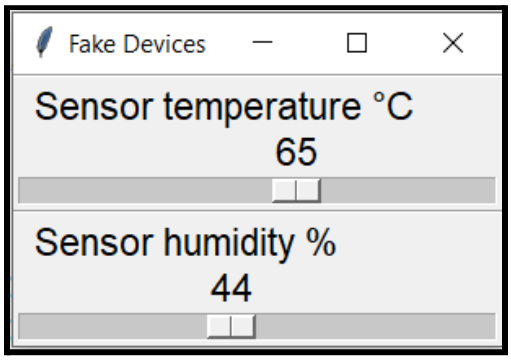
Step 4: Open a new file - save as *test06_launcer.py* - code the following.

Note that you will run the code using this python file (test06_launcher.py) not test06.py.

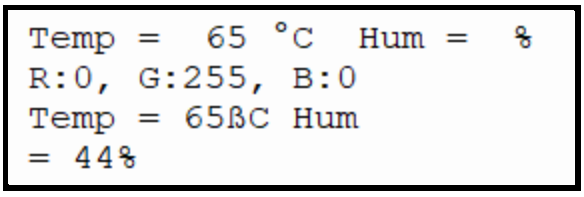
test06_launcher.py (test06_launcher.py)

```
from FakeDevices import *
import logging

log = logging.getLogger(__name__)

try:
    gui = Gui()
    gui.add(DHT(7, 'Sensor'))

    from test06 import *
except:
    log.exception('----------------Log----------------')
```

Step 5: Run the test06.py and adjust the fake device's sensor value.



Adjust the value by swipe right or left



Console Output in Thonny Python

You can see the temperature and humidity that was set in the console.

Now, let's go into ***Firebase - Realtime Database***. Here, you can see the data (Temp = 65ßC Hum = 44%) is being inserted into the real time database.

My Firebase link

https://console.firebase.google.com/u/0/project/bait2123-iot-12d48/database/bait2123-iot-12d48-default-rtdb/data/~2FPI_001

Extra Task for Practical 5

Task 1: Test your temperature and humidity sensor by facing it with a few breaths and show it in your firebase's database (Since I am using the fake device, thus I can't demonstrate this part, but basically the humidity and temperature will increase when you breathe through the dht sensor). Modify the code to display the values without adding a new "child" (updating the same child values for every 2 seconds).

test06.py

```
from time import *
from grovepi import *
from grove_rgb_lcd import *
from pyrebase import pyrebase

dhtsensor = 7
pinMode(dhtsensor, "INPUT")

config = {
    "apiKey": "AIzaSyBkGe8rwXaekDyGa68SN5BndPlN-6XYY-g",
    "authDomain": "bait2123-iot-12d48.firebaseapp.com",
    "databaseURL": "https://bait2123-iot-12d48-default-rtdb.firebaseio.com/",
    "storageBucket": "gs://bait2123-iot-12d48.appspot.com"
}

firebase = pyrebase.initialize_app(config)
auth = firebase.auth()
user = auth.sign_in_with_email_and_password("zixuan2001711@gmail.com",
"loozx123")
db = firebase.database()

while True:
    try:
        sleep(2)
        [temp, hum] = dht(dhtsensor, 0)
        print("Temp = ", temp, '\u00b0C', " Hum = ", "%")
        t = str(temp)
        h = str(hum)
        setRGB(0,255,0)
        setText("Temp = "+ t + '\337'+ "C Hum = "+ h + "%")
        data1 = {"temperature":t}
        data2 = {"humidity":h}

        # Updating same child values for every 2 seconds
        results = db.child("PI_001").set({
            'Sensor Values': {
                'temperature': data1,
                'humidity': data2
            }
        })
    except KeyboardInterrupt:
        setText("Program Exited")
        break
```

```
    except TypeError:
        print("Type error occurs")
        break
    except IOError:
        print("I/O error occurs")
        break
```

test06_launcher.py

```
from FakeDevices import *
import logging

log = logging.getLogger(__name__)

try:
    gui = Gui()
    gui.add(DHT(7, 'Sensor'))

    from test06 import *
except:
    log.exception('----------------Log----------------')
```

Useful link for firebase

https://firebase.google.com/docs/database/admin/save-data#python_2

Pyrebase/README.md at master

Practical 5 Quiz

At line 25 and 29, what is the indication for 'u00b0' and '\337' ? Why do we need to have line 26 and 27 ? * 4/4

test06.py

```
1  from time import *
2  from grovepi import *
3  from grove_rgb_lcd import *
4  from pyrebase import pyrebase
5
6  dhtsensor = 7
7  pinMode(dhtsensor, "INPUT")
8
9  config = {
10   "apiKey": "[API_KEY]",
11   "authDomain": "[PROJECT_ID].firebaseapp.com",
12   "databaseURL": "https://[DATABASE_NAME].firebaseio.com",
13   "storageBucket": "[PROJECT_ID].appspot.com"
14 }
15 firebase = pyrebase.initialize_app(config)
16 auth = firebase.auth()
17 user = auth.sign_in_with_email_and_password([EMAIL_USERNAME], [EMAIL_PASSWORD])
18 db = firebase.database()
19
20 while True:
21     try:
22         # adjust the sleep time if you have succesfully push data to your firebase
23         sleep(5)
24         [temp, hum] = dht(dhtsensor, 0)
25         print("Temp = ", temp, '\u00b0C', " Hum = ", hum, " %")
26         t = str(temp)
27         h = str(hum)
28         setRGB(0, 255, 0)
29         setText("Temp = " + t + '\337'+ "C   Hum = " + h + " %")
30         data1 = {"temperature":t}
31         data2 = {"humidity":h}
32         results = db.child("PI_001").push(data1, user['idToken'])
33         results = db.child("PI_001").push(data2, user['idToken'])
34         # remove the break if you have succesfully push data to your firebase
35         break
36     except KeyboardInterrupt:
37         setText("Program Exited")
38         break
39     except TypeError:
40         print("Type Error occurs")
41     except IOError:
42         print("IO Error occurs")
43
```

- ○ Secret code for reading temperature. Change the temp and hum variable to machine readable text.
- ◉ Symbol for certain character. Convert temp and hum variable to string data type.
- ○ "Celcius" symbol indicator. Casting for temp and hum variable to integer data type.

Feedback

Yes. \u00b0 and \337 are Unicode and Octal value (LCD character table) for (Degree, °) symbol. str(xxx) is to convert the object xxx to string data type.

At line 35, "break" means: * 4/4

test06.py

```
from time import *
from grovepi import *
from grove_rgb_lcd import *
from pyrebase import pyrebase

dhtsensor = 7
pinMode(dhtsensor, "INPUT")

config = {
  "apiKey": "[API_KEY]",
  "authDomain": "[PROJECT_ID].firebaseapp.com",
  "databaseURL": "https://[DATABASE_NAME].firebaseio.com",
  "storageBucket": "[PROJECT_ID].appspot.com"
}
firebase = pyrebase.initialize_app(config)
auth = firebase.auth()
user = auth.sign_in_with_email_and_password([EMAIL_USERNAME], [EMAIL_PASSWORD])
db = firebase.database()

while True:
    try:
        # adjust the sleep time if you have succesfully push data to your firebase
        sleep(5)
        [temp, hum] = dht(dhtsensor, 0)
        print("Temp = ", temp, '\u00b0C', " Hum = ", hum, " %")
        t = str(temp)
        h = str(hum)
        setRGB(0, 255, 0)
        setText("Temp = " + t + '\337'+ "C   Hum = " + h + " %")
        data1 = {"temperature":t}
        data2 = {"humidity":h}
        results = db.child("PI_001").push(data1, user['idToken'])
        results = db.child("PI_001").push(data2, user['idToken'])
        # remove the break if you have succesfully push data to your firebase
        break
    except KeyboardInterrupt:
        setText("Program Exited")
        break
    except TypeError:
        print("Type Error occurs")
    except IOError:
        print("IO Error occurs")

```

- ( ) Program will pause until user press "space bar" to continue the program flow.
- (•) Program will exit the while loop
- ( ) Program will break (branch out) and perform exception case (run the code in except KeyboardInterrupt)
- ( ) Program will pause and continue with setText("Program Exited")

Feedback

I'm sure you listen to the practical classes. Yes, we don't need this line if we have confirmed our coding "push" data properly to the firebase, to ensure it runs continuously.

At line 10 to 13, API_KEY, PROJECT_ID, DATABASE_NAME are keys for ... * 4/4

test06.py

```
from time import *
from grovepi import *
from grove_rgb_lcd import *
from pyrebase import pyrebase

dhtsensor = 7
pinMode(dhtsensor, "INPUT")

config = {
  "apiKey": "[API_KEY]",
  "authDomain": "[PROJECT_ID].firebaseapp.com",
  "databaseURL": "https://[DATABASE_NAME].firebaseio.com",
  "storageBucket": "[PROJECT_ID].appspot.com"
}
firebase = pyrebase.initialize_app(config)
auth = firebase.auth()
user = auth.sign_in_with_email_and_password([EMAIL_USERNAME], [EMAIL_PASSWORD])
db = firebase.database()

while True:
    try:
        # adjust the sleep time if you have succesfully push data to your firebase
        sleep(5)
        [temp, hum] = dht(dhtsensor, 0)
        print("Temp = ", temp, '\u00b0C', " Hum = ", hum, " %")
        t = str(temp)
        h = str(hum)
        setRGB(0, 255, 0)
        setText("Temp = " + t + '\337'+ "C   Hum = " + h + " %")
        data1 = {"temperature":t}
        data2 = {"humidity":h}
        results = db.child("PI_001").push(data1, user['idToken'])
        results = db.child("PI_001").push(data2, user['idToken'])
        # remove the break if you have succesfully push data to your firebase
        break
    except KeyboardInterrupt:
        setText("Program Exited")
        break
    except TypeError:
        print("Type Error occurs")
    except IOError:
        print("IO Error occurs")

```

- [x] Set up the connection between python code and Google Firebase.
- [x] Authentication for any user to access the Google Firebase.
- [x] Application layer for updating or retrieving data to / from the Google Firebase.
- [ ] Retrieve Google services like Google Maps, Gmail, etc.
- [ ] Access to Google Drive for updating and retrieving sensors data.
- [ ] Access to TAR UC servers for updating and retrieving sensors data.

Week 6 Working with Thinkspeaks & Beebotte

PART 1: Connecting to the cloud (internet) - thinkspeaks.com

Step 1 : Setup your thingspeak by following these steps in the pdf (Setup - Thingspeak.pdf)

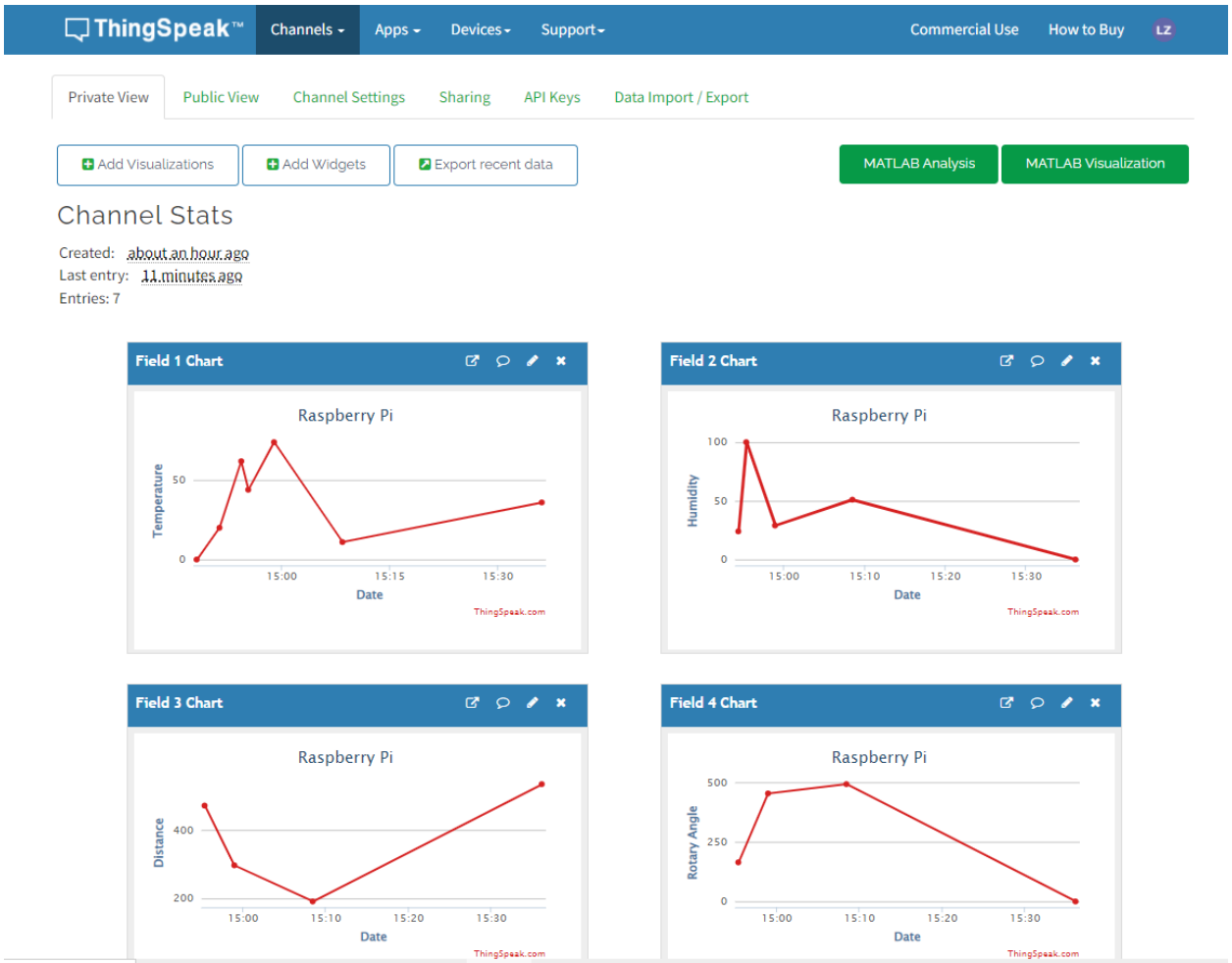
Step 2 : Create new python file called *test07.py* & *test07_launcher.py* and retype the codes given below

- test07.py
- test07_launcher.py

*Note that you have to use your **own Write API key** in order to push the data onto your thingspeak successfully.

Step 3 : Run the code in test07_launcher.py

Step 4 : You can view the data if you have successfully push data to your thingspeak



Example the data that have been successfully push onto thingspeak

PART 2: Connecting to the cloud (internet) - Beebotte.com

Step 1 : Setup your thingspeak by following these steps in the pdf (Setup - Beebotte.pdf)

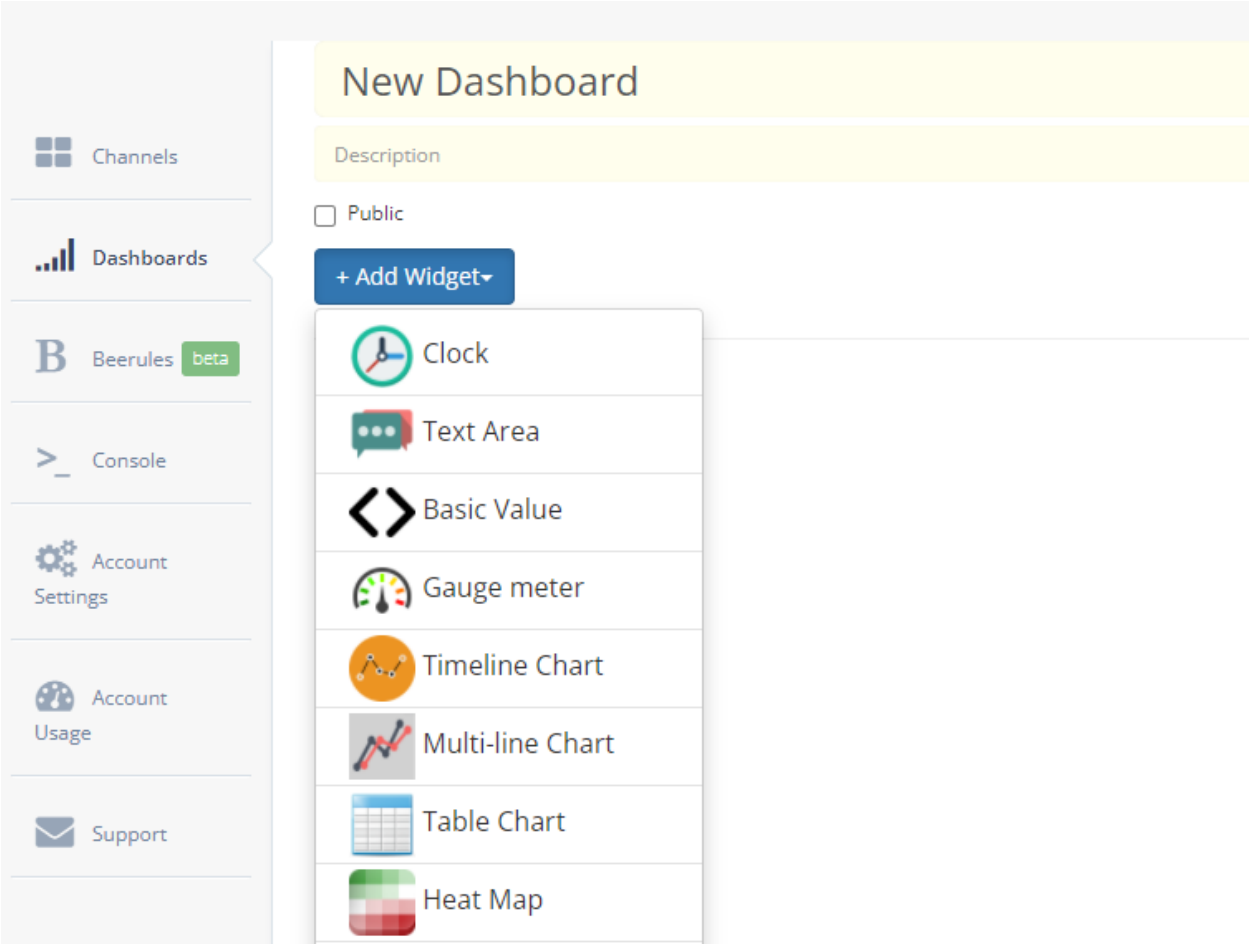
Step 2 : Create new python file called *test08.py* & *test08_launcher.py* and retype the codes given below

- test08.py
- test08_launcher.py

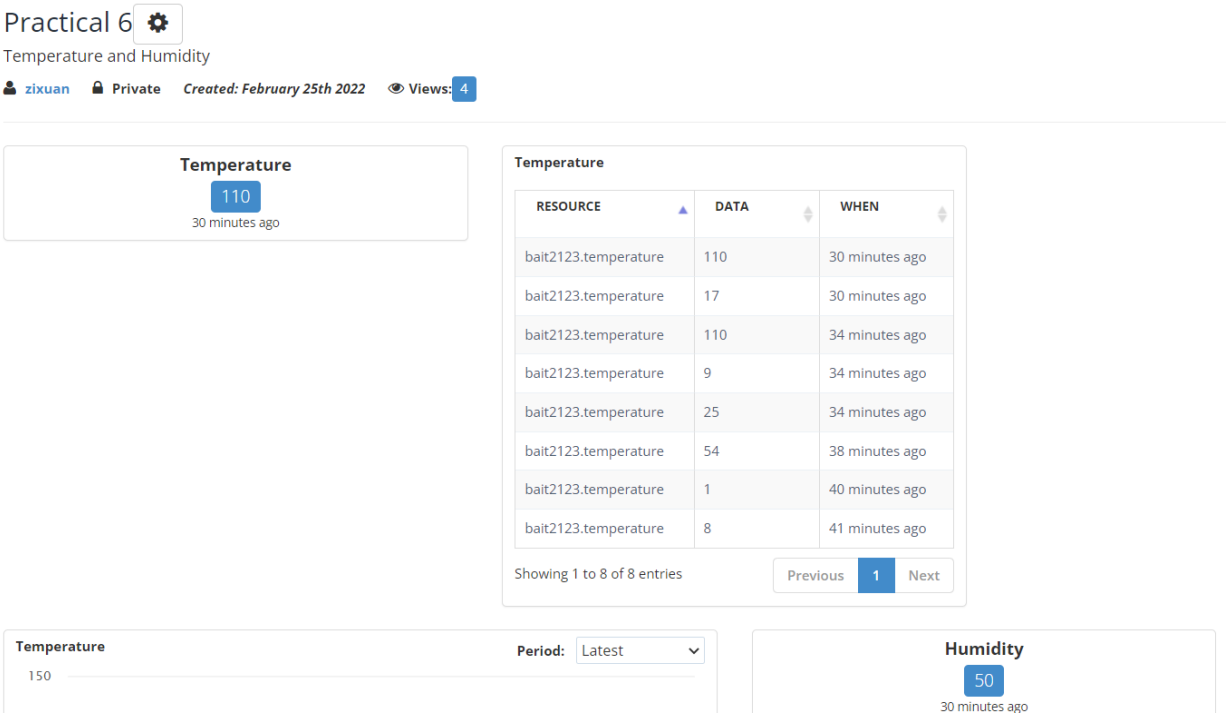
*Note that you have to use your **own API key and secret key** in order to push the data onto your thingspeak successfully.

Step 3 : Run the code in test08_launcher.py

Step 4 : You can view the data if you have successfully push data to your beebotte
Before you can view the data, you have to enter beebotte website and click on the Dashboard > Create Dashboard > Add Widget

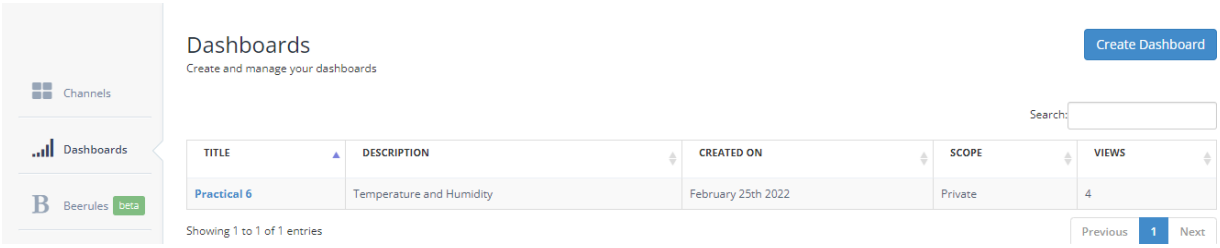


Then, select the widget and resource you want to be displayed and click Done.



Example the widget data that have been successfully push onto beebotte

If you exit the dashboard accidentally, you can click on Dashboard at the sidebar > title (i.e *Practical 6* in my case) to view back your widget data.



Practical 6 Quiz

In Beebotte cloud service, updated data are show in the cloud database. Which coding line act as authenticating connection to beebotte cloud service and updating the code respectively ? * 4/4

test08.py *

```
1  from time import *
2  from grovepi import *
3  from grove_rgb_lcd import *
4  from random import *
5  from urllib.request import *
6  from beebotte import *
7
8  led = 3
9  soundsensor = 14
10 lightsensor = 15
11 dhtsensor = 16
12 pinMode(led, "OUTPUT")
13 pinMode(soundsensor, "INPUT")
14 pinMode(lightsensor, "INPUT")
15 pinMode(dhtsensor, "INPUT")
16 apikey = [YOUR_API_KEY]
17 secretkey = [YOUR_SECRET_KEY]
18 bclient = BBT(apikey, secretkey)
19
20 while True:
21     try:
22         # adjust the sleep time if you have succesfully push data to your beebotte
23         sleep(5)
24         [temp, hum] = dht(dhtsensor, 0)
25         light = analogRead(lightsensor)
26         sound = analogRead(soundsensor)
27         print("Temp = %.2f, hum = %d, light = %d, sound = %d" %(temp, hum, light, sound))
28         setText("Temp = " + t + '\337'+ "C   Hum = " + h + " %")
29         bclient.write('test', 'temperature', temp)
30         bclient.write('test', 'humidity', hum)
31         # remove the break if you have succesfully push data to your beebotte
32         break
33     except KeyboardInterrupt:
34         setText("Program Exited")
35         break
36     except TypeError:
37         print("Type Error occurs")
38     except IOError:
39         print("IO Error occurs")
40
```

- ○ Line 16 and 17; Line 29 and 30
- ○ Line 18; Line 28
- ◉ Line 18; Line 29 and 30
- ○ Line 6 ; Line 29 and 30
- ○ Line 6 and 16; Line 28

At line 21 and 22, we use analogRead function because... * 4/4

test07.py

```
from time import *
from grovepi import *
from grove_rgb_lcd import *
from random import *
from urllib.request import *

led = 3
soundsensor = 14
lightsensor = 15
dhtsensor = 16
pinMode(led, "OUTPUT")
pinMode(soundsensor, "INPUT")
pinMode(lightsensor, "INPUT")
pinMode(dhtsensor, "INPUT")
apikey = [YOUR_API_KEY]

while True:
    try:
        # adjust the sleep time if you have succesfully push data to your thingspeak
        sleep(5)
        [temp, hum] = dht(dhtsensor, 0)
        light = analogRead(lightsensor)
        sound = analogRead(soundsensor)
        print("Temp = %.2f, hum = %d, light = %d, sound = %d" %(temp, hum, light, sound))
        t = str(temp)
        h = str(hum)
        setText("Temp = " + t + '\337'+ "C   Hum = " + h + " %")
        r = randint(0, 255)
        g = randint(0, 255)
        b = randint(0, 255)
        setRGB(r, g, b)
        content = urlopen("https://api.thingspeak.com/update?api_key=" + apikey + "&field1=" + t).read()
        if (content):
            print("Updated Thingspeak")
        # remove the break if you have succesfully push data to your thingspeak
        break
    except KeyboardInterrupt:
        setText("Program Exited")
        break
    except TypeError:
        print("Type Error occurs")
    except IOError:
        print("IO Error occurs")
```

- [ ] light sensor gives us a value of 0 and 1
- [x] sound sensor gives us a value more than two levels
- [ ] digitalRead will not able to read the value from light and sound sensor.
- [x] digitalRead will give us an inappropriate value from light and sound sensor.
- [ ] analogRead will give us a value from 0 to 255
- [x] analogRead will give us a value from 0 to 1023
- [ ] analogRead will give us a value from 0 to 2047

To update the cloud storage / service with multiple type of sensor data at the same time, we can ... * 4/4

test07.py

```
1  from time import *
2  from grovepi import *
3  from grove_rgb_lcd import *
4  from random import *
5  from urllib.request import *
6
7  led = 3
8  soundsensor = 14
9  lightsensor = 15
10 dhtsensor = 16
11 pinMode(led, "OUTPUT")
12 pinMode(soundsensor, "INPUT")
13 pinMode(lightsensor, "INPUT")
14 pinMode(dhtsensor, "INPUT")
15 apikey = [YOUR_API_KEY]
16
17 while True:
18     try:
19         # adjust the sleep time if you have succesfully push data to your thingspeak
20         sleep(5)
21         [temp, hum] = dht(dhtsensor, 0)
22         light = analogRead(lightsensor)
23         sound = analogRead(soundsensor)
24         print("Temp = %.2f, hum = %d, light = %d, sound = %d" %(temp, hum, light, sound))
25         t = str(temp)
26         h = str(hum)
27         setText("Temp = " + t + '\337'+ "C   Hum = " + h + " %")
28         r = randint(0, 255)
29         g = randint(0, 255)
30         b = randint(0, 255)
31         setRGB(r, g, b)
32         content = urlopen("https://api.thingspeak.com/update?api_key=" + apikey + "&field1=" + t).read()
33         if (content):
34             print("Updated Thingspeak")
35         # remove the break if you have succesfully push data to your thingspeak
36         break
37     except KeyboardInterrupt:
38         setText("Program Exited")
39         break
40     except TypeError:
41         print("Type Error occurs")
42     except IOError:
43         print("IO Error occurs")
```

- (●) Modify the url string at line 32
- ( ) Add lines in between line 32 and 33 to call more urlopen funtions for updating multiple data.
- ( ) Add more if else condition statement to check multiple data updates at line 33
- ( ) Remove break at line 36 to allow multiple updates on sensor data.

Feedback

Yes. We can add on the URL string by putting more parsing parameters and value (e.g., ...&field2=data2&field3=data3...)

Week 7 Mosquitto MQTT on Windows 10

Notes from Dr Poh Tze Ven

For practical 7, the MQTT on Windows 10 document (document) shows how to *install* and *configure* Mosquitto MQTT on Windows 10. It is complicated because Windows 10 enforces IP access security by default, so we have to disarm the security on Mosquitto MQTT. Otherwise, any client trying to access the broker through TCP/IP will be blocked by the Windows OS. Note that if the broker is not properly set up, the MQTT client Python program (using the Paho library) will not work. To run the program given in Practical 7, you need to install the Paho library:

```
pip3 install paho-mqtt
```

If you want to know the *return code* by the MQTT client, it can be found in the last page of this document. Please watch the video (Practical 7: Part 2) on why you might need to know the *return code* by the MQTT. In the video, I encountered a connection issue with one of the MQTT brokers on the Internet because the network was temporarily down.

There is a new section in Practical 7 regarding **NodeRED**. Please try that on your own. At the moment, I don't have a video covering that topic.

For those who are trying the **MQTT on the Raspberry Pi OS running on the real Raspberry Pi** (or under a VirtualBox in Windows), you can change the MQTT broker's configuration by editing the `mosquitto.conf` file. For example you might want to change the MQTT broker to listen on a specific IP address and port of your Raspberry Pi, do the following:

```
$ sudo thonny /etc/mosquitto/mosquitto.conf &
```

Add the following lines and save:

```
listener 1883 [YOUR_IP_ADDRESS]
listener 1883 127.0.0.1
allow_anonymous true  #This line is needed for "Bullseye" OS to work correctly
```

Restart the MQTT broker:

```
$ sudo systemctl stop mosquitto
$ sudo systemctl start mosquitto
```

Or simply just:

```
$ sudo systemctl restart mosquitto
```

On the "Bullseye" version of Raspberry Pi OS, you will need the **`allow_anonymous true`** command (see above). Otherwise, `Connection Refused, not authorized` error (error code 5) will be returned.

Self-note-taking for Practical 7

Part 1 Test the MQTT process using cmd

First, you have to follow this document to set up a Mosquitto MQTT on Windows 10 .

- Note that I was currently learning from home in which I don't have access to the Raspberry Pi to develop the MQTT program, hence I'm using this document **written by Dr Poh Tze Ven** to set up a Mosquitto MQTT in my laptop.
- If you follow the document properly, it will be no issue for you to demonstrate the MQTT process by setting up a Mosquitto MQTT and demonstrating it solely using cmd.

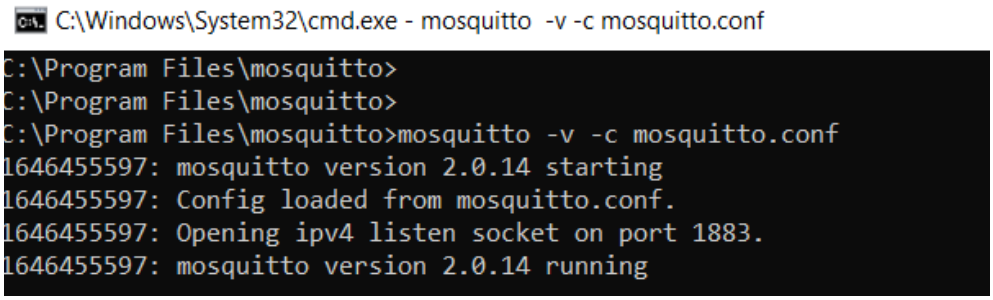
Special Notes for above section

If you are still facing this error even after extending MQTT service to accept external requests - Error: No connection could be made because the target machine actively refused it, it might be you accidentally closed the broker cmd [1]. Note that you cannot close this cmd as it acts as a BROKER that enables MQTT clients to communicate.

There are 3 command prompts needed in order to make the MQTT process successful.

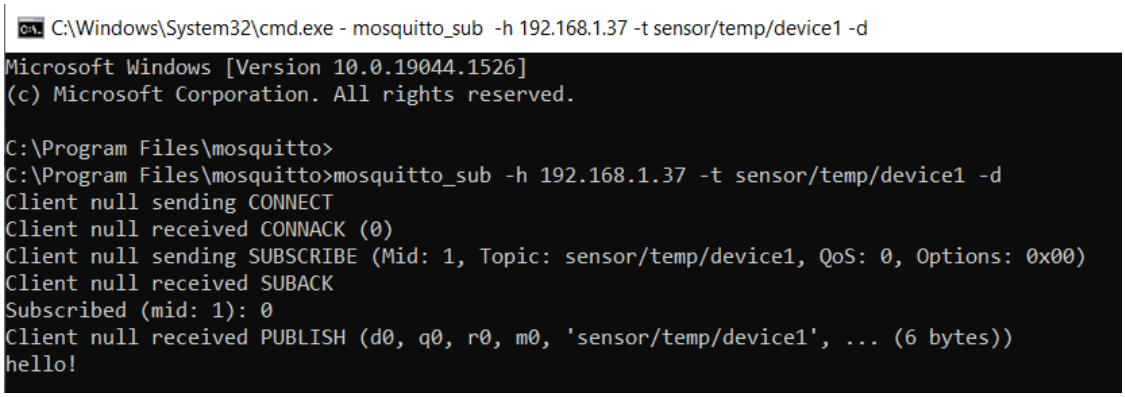
[1] **1st cmd** - Start the MQTT broker service using the configurations in the mosquitto.conf file

```
mosquitto -v -c mosquitto.conf
```



2nd cmd - Act as a Subscriber

mosquitto_sub -h 192.168.1.37 -t sensor/temp/device1 -d



3rd cmd - Act as a Publisher
mosquitto_pub -h 192.168.1.37 -t sensor/temp/device1 -m “hello!” -d

Part 2 Test the MQTT process using Thonny Python (ID)

Step 1

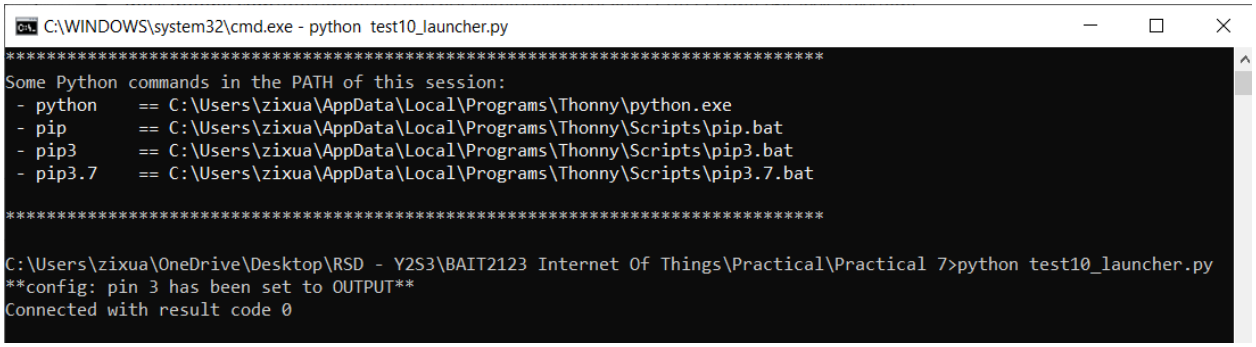
In **Thonny Python (ID)**, click “New” to create a new python file and Save As “test09.py”. Type the following codes for subscriber(test10.py & test10_launcher.py) and publisher(test09.py).

Step 2

As Thonny Python (ID) restricts only one program running at one time, in this case, we will use Tools > Open System Shell (1) and Run current script (2) in Thonny Python to demonstrate the MQTT process.

(1)

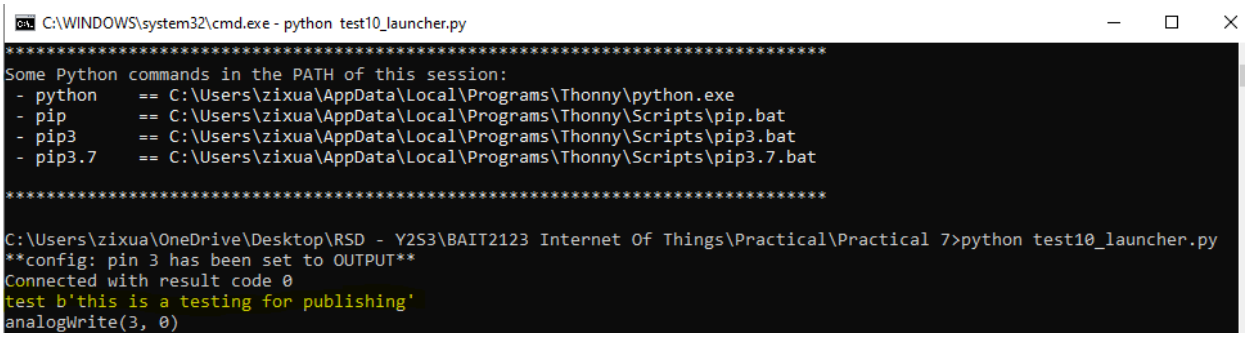
Issue “python test10_launcher.py” to run this program - it will act as subscriber



(2)

Run test09.py by clicking Run current script or F5. - it will act as publisher

Next, you can see the text "this is a testing for publishing" appear on the system shell (1) that acts as the subscriber.



A simple MQTT process demonstrated.

Extra

Except using your [own IP address], you can also modify the value of the MQTT_BROKER variable (i.e `MQTT_BROKER = "broker.emqx.io"`) to one of the public MQTT brokers as what I comment in the test09.py and test10.py.

One of the example for public MQTT broker: Free Public MQTT 5 Broker Server | EMQ

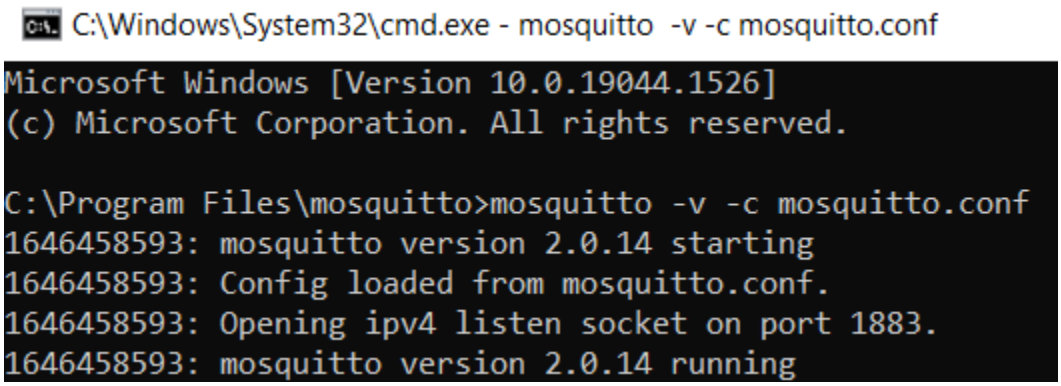
∴ You can search more public MQTT Broker via online

Testing MQTT Service (with Username and Password)

After setting up username and password (last part of the document),

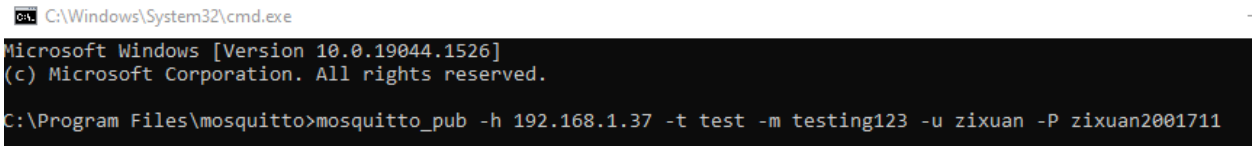
Save it and restart the mosquitto MQTT broker using the following command (Note: Ensure the previous running MQTT broker has been terminated first):

```
mosquitto -v -c mosquitto.conf
```



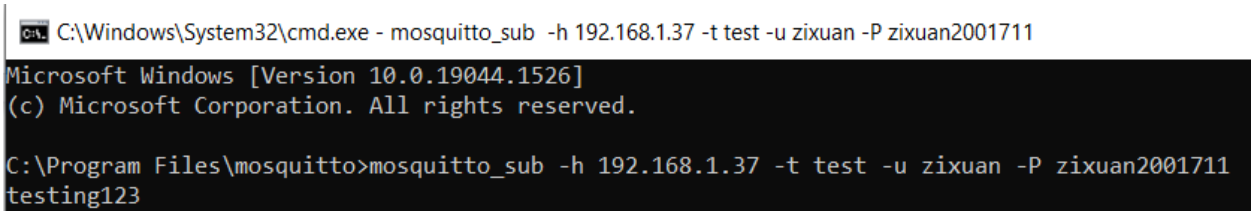
For subscriber,

mosquitto_sub -h [*YOUR_IP_ADDRESS*] -t [TOPIC] -u [USERNAME] -P [PASSWORD]



For publisher,

mosquitto_pub -h [*YOUR_IP_ADDRESS*] -t [TOPIC] -m [DATA] -u [USERNAME] -P [PASSWORD]



If either or both username and password is/are wrong or were not given, the broker will refuse connection.

Part 3

Task 1 - Modify the code to cross control other sensors / devices with another raspberry pi.
I had modified the code to cross control the buzzer to on or off by using digitalWrite(buzzer,0) / digitalWrite(buzzer,1).

Code can be found on my Google Drive:

- test09_task1.py
- test10_task1.py
- test10_task1_launcher.py

Practical 7

In MQTT Protocol, the important element to distinguish between clients who send a message to who act on the message sent by the client, is ... * 4/4

- ○ Client IP address
- ○ Message length
- ◉ Topic
- ○ Client networking port

Feedback

We define topic to be send by publisher and received by subsriber.

In MQTT protocol, Broker serves two type of clients, which are: * 4/4

test11.py

```
from time import *
from grovepi import *
from paho.mqtt.client import *

buzzer = 6
pinMode(buzzer, "OUTPUT")

MQTT_SERVER = "localhost"
MQTT_PATH = "buzzer"

def on_connect(client, userdata, flags, rc):
    print("Connected with result code " + str(rc))
    client.subscribe(MQTT_PATH)

def on_message(client, userdata, msg):
    print(msg.topic + " " + str(msg.payload))
    i = int(msg.payload)
    if i > 0 & i < 256:
        analogWrite(buzzer,i)
    else:
        analogWrite(buzzer,0)

client = Client()
client.on_connect = on_connect
client.on_message = on_message

client.connect(MQTT_SERVER, 1883, 60)

client.loop_forever()
```

```
from time import *
from grovepi import *
from paho.mqtt import publish

MQTT_BROKER = "[PUT YOUR PI IP ADDRESS HERE]"   # Change l
MQTT_TOPIC = "buzzer"

def on_connect(client, userdata, flags, rc):
    print("Connected with result code " + str(rc))
    client.subscribe(MATT_PATH)

def on_message(client, userdata, msg):
    print(msg.topic + " " + str(msg.payload))

publish.single(MQTT_TOPIC, "120", hostname=MQTT_BROKER)
```

- ○ Sender and Receiver
- ◉ Publisher and Subscriber
- ○ Transmitter and Receiver
- ○ Server and Client

In this MQTT communication test code, the left hand side serves as receiver to perform action, and the right hand side serves as sender to give commands. What is the different between MQTT_SERVER and MQTT_BROKER ? * 4/4

test11.py

```
from time import *
from grovepi import *
from paho.mqtt.client import *

buzzer = 6
pinMode(buzzer, "OUTPUT")

MQTT_SERVER = "localhost"
MQTT_PATH = "buzzer"

def on_connect(client, userdata, flags, rc):
    print("Connected with result code " + str(rc))
    client.subscribe(MQTT_PATH)

def on_message(client, userdata, msg):
    print(msg.topic + " " + str(msg.payload))
    i = int(msg.payload)
    if i > 0 & i < 256:
         analogWrite(buzzer,i)
    else:
         analogWrite(buzzer,0)

client = Client()
client.on_connect = on_connect
client.on_message = on_message

client.connect(MQTT_SERVER, 1883, 60)

client.loop_forever()
```

```
from time import *
from grovepi import *
from paho.mqtt import publish

MQTT_BROKER = "[PUT YOUR PI IP ADDRESS HERE]"   # Change l
MQTT_TOPIC = "buzzer"

def on_connect(client, userdata, flags, rc):
    print("Connected with result code " + str(rc))
    client.subscribe(MATT_PATH)

def on_message(client, userdata, msg):
    print(msg.topic + " " + str(msg.payload))

publish.single(MQTT_TOPIC, "120", hostname=MQTT_BROKER)
```

- (●) No difference.
- ( ) MQTT_BROKER is for our own IP address; MQTT_SERVER is for a server IP address.
- ( ) MQTT_BROKER is for broker IP address; MQTT_SERVER is for a server IP address.
- ( ) MQTT_BROKER is for our own IP address; MQTT_SERVER is for localhost IP address.

Practical 8

Get the code from my Github - https://github.com/loozixuan/Degree-RSD-Materials

In the practical, we use python coding and include luma-oled library with SH1106 driver to communicate with Grove - OLED Display 1.12" module. Select the following parameters that required for establishing this communication: * 1/1

- [ ] Using Serial Peripheral Interface protocol
- [ ] Using Universal Asynchronous Receiver / Transmitter protocol
- [x] Using Inter-Integrated Circuit protocol
- [ ] With module address of 0x04
- [x] With module address of 0x3C
- [ ] With module address of 0x01

OLED stands for * 1/1

- (•) Organic Light-Emitting Diode
- ( ) Original Light-Emitting Diode
- ( ) Original Liquid Crystal Display
- ( ) Operational Light-Emitting Diode

By using Python Image Library (PIL), we can resize an image with the following codes / functions (assume that there is a "testing.jpg" file in "C:\". *** Only CHECK the necessary lines, without these CHECKED lines, program will prompt error(s). *** * 2/2

- [ ] import matplotlib.image as mpimg
- [x] from PIL import Image
- [x] img = Image.open(r"C:\testing.jpg")
- [ ] print(img.format)
- [x] newsize=(64, 64)
- [ ] print(newsize)
- [x] img = img.resize(newsize)
- [ ] img = img.save(r"C:\testing_resized.jpg")

The following(s) are CORRECT description for Grove - Passive InfraRed (PIR) motion sensor usage: * 4/4

- [x] The motion detector is triggered and the sensor outputs as HIGH on its SIG (signal) pin.
- [ ] The motion detector is triggered and the sensor outputs as LOW on its SIG (signal) pin.
- [x] The response speed is from 0.3s - 25s, and max 6 meters of detecting range.
- [ ] Read the motion sensor value by checking i = grovepi.digitalWrite(pir_sensor, 1)
- [ ] Read the motion sensor value by checking i = grovepi.analogWrite(pir_sensor, 255)
- [x] Read the motion sensor value by checking i = grovepi.digitalRead(pir_sensor)
- [ ] If i = 128, motion is triggered
- [x] If i = 0, no motion is triggered
- [ ] If i = 255, no motion is triggered

Practical 9

Get the code from my Github - https://github.com/loozixuan/Degree-RSD-Materials

RFID stands for * 1/1

- (●) Radio Frequency IDentification
- ( ) Response Fault IDdentifier
- ( ) Reduced Fraud IDentification
- ( ) Randomise Frequency IDentification
- ( ) Radio Fidelity IDentification

The following are essential elements for a complete and function-able RFID system: * 4/4

- [ ] A screen protector, to protect the RFID card surface from scratch
- [ ] A card holder, that can hold the card when it is read by embedded system
- [x] A reader, that is connected to (or integrated with) embedded system
- [x] An antenna, that sends out / receives in a radio signal
- [ ] A printer, that can print a label on the RFID card surface.
- [x] A tag (or transponder) that returns the signal with information added
- [x] An algorithm that is coded / programmed in an embedded system for specific features.
- [ ] A ring, to hold / tagged the RFID card with a keychain (with your name)

Which of the following statement is CORRECT ? * 3/3

- [x] Our Malaysia Identity Card RFID feature is running on 13.56MHz frequency.
- [ ] Our Bank credit card RFID feature is running on 125kHz frequency.
- [ ] RFID Scanner (13.56MHz) requires Grove Pi module
- [x] RFID Scanner (125kHz) requires Grove Pi module
- [x] RFID that run under 125kHz transmit only 14 bytes of data.
- [x] RFID that run under 13.56MHz transmit more than 14 bytes of data.
- [ ] RFID that run under 125kHz is more secured than 13.56MHz.
- [ ] RFID that run under 13.56MHz is less secured that 125kHz.

Practical 10

By using Raspberry Pi, in order to ensure the Camera device (either USB or Pi Camera) function-able, we MUST do take the following step(s) * 0/4

- [x] Ensure the camera device is properly connected to Pi.
- [ ] Ensure the audio jack is connected properly.
- [ ] Ensure the Pi casing is closed.
- [ ] picamera library is installed for accessing USB webcam in Python programming
- [x] fswebcam library is installed for accessing Pi camera in Python programming
- [x] Turn on Raspberry Pi power.

The circle in green color should be the correct answer.

To stream a video camera, these elements are important, EXCEPT: * 2/2

- ( ) Network connectivity
- ( ) IP address of sender
- (•) IP address of receiver
- ( ) Port for video stream at sender's IP

We can stream the input video to multiple viewers via network using http (web browser). * 2/2

- (•) True
- ( ) False