LABORATORY MANUAL

SENSORS AND DEVICES LABORATORY (A35506)

II YEAR B.TECH II SEMESTER

(IoT)

GPCET
Pioneering Innovative Education

DEPARTMENT OF INTERNET OF THINGS

G.PULLAIAH COLLEGE OF ENGINEERING AND TECHNOLOGY
(AUTONOMOUS)

Accredited by NAAC with 'A' Grade and NBA Accredited (EEE, CSE & ECE)
Approved by AICTE, New Delhi & Permanently Affiliated to JNTUA, Ananthapuramu
(Recognized by UGC under 2(f) & 12(B) and ISO 9001:2008 Certified Institution)
Nandikotkur Road, Venkayapalli, Kurnool-518452

G. PULLAIAH COLLEGE OF ENGINEERING AND TECHNOLOGY, KURNOOL

COURSE STRUCTURE

A35506 – SENSORS AND DEVICES LABORATORY

LIST OF EXPERIMENTS

1. Connect an LED to GPIO pin 25 and control it through command line.
2. Connect an LED to GPIO pin 24 and a Switch to GPIO 25 and control the LED with the switch.
3. The state of LED should toggle with every press of the switch and Use DHT11 temperature sensor and print the temperature and humidity of the room with an interval of 15 seconds.
4. Use joystick and display the direction on the screen
5. Use Light Dependent Resistor (LDR) and control an LED that should switch-on/off depending onthe light.
6. Create a traffic light signal with three colored lights (Red, Orange and Green) with a duty cycle of5-2-10 seconds.
7. Switch on and switch of a DC motor based on the position of a switch.
8. Convert an analog voltage to digital value and show it on the screen.
9. Create a door lock application using a reed switch and magnet and give a beep when the door isopened.
10. Control a 230V device (Bulb) with Raspberry Pi using a relay.
11. Control a 230V device using a threshold temperature, using temperature sensor.
12. Create an application that has three LEDs (Red, Green and white). The LEDs should follow the cycle(All Off, Red On, Green On, and White On) for each clap (use sound sensor).
13. Create a web application for the above applications wherever possible with suitable modifications to get input and to send output.

BOOKS AND MATERIALS

Text Book(s)

1. Arshdeep Bahga and Vijay Madisetti, *Internet of Things - A Hands-on Approach*, Universities Press, 2015, ISBN: 9788173719547.
2. Matt Richardson & Shawn Wallace, O'Reilly (SPD), *Getting Started with Raspberry Pi*, 2014, ISBN: 9789350239759.
3. Simon Monk, O'Reilly (SPD), *Raspberry Pi Cookbook, Software and Hardware Problems andsolutions*, 2016, ISBN 7989352133895.

Reference Book(s)

1. Peter Waher, *Learning Internet of Things*, Packt Publishing, 2015 Editors Ovidiu Vermesan.
2. Peter Friess, *Internet of Things – From Research and Innovation to Market Deployment*, River Publishers, 2014.
3. N. Ida, *Sensors, Actuators and Their Interfaces*, SciTech Publishers, 2014.

Exp No: 1

Aim: Connect an LED to GPIO pin 25 and control it through command line.

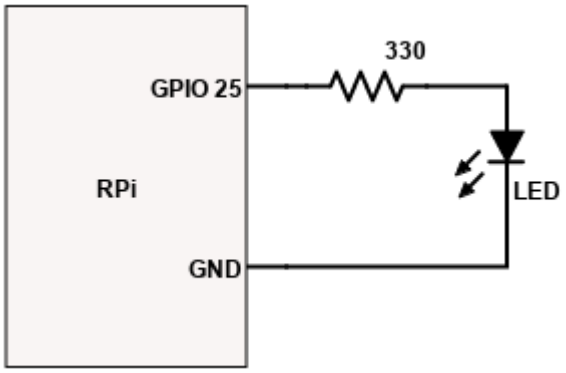
Components Required:

- Laptop installed with VNC Viewer
- Raspberry Pi installed with Raspbian OS
- LED
- Resistor 330 ohms
- Breadboard
- Connecting Wires

Procedure:

1) Make all connections as per the circuit diagram carefully.
2) To connect RPi to Laptop follow the below steps carefully.
3) Make sure laptop is connected to active Internet/WiFi connection.
4) Right click on mobile hotspot -> Go to settings -> Change "Network Name" and "Network Password" according to RPi credentials and turn on mobile hotspot.
5) Copy the IP address of RPi from connected devices section.
6) Open VNC Viewer on laptop and paste the copied IP address and click enter.
7) Enter The Login Credentials of RPi.
8) On home screen of RPi open "Thonny python IDE".
9) Type the program in the Thonny python IDE and save the program and click on "Run".
10) If there are any errors, debug the errors and "save" the program and "run" again.
11) Observe the output.

Circuit Diagram:



Program:

```
import RPi.GPIO as GPIO
import time

led = 25

GPIO.setmode(GPIO.BCM)
GPIO.setwarnings(False)     #It disables the Warnings
GPIO.setup(led,GPIO.OUT)    #Setting the led pin i.e 25 as ouput

while True:
    GPIO.output(led,True)
    time.sleep(0.5)
    GPIO.output(led,False)
    time.sleep(0.5)
```

Exp No: 2

Aim: Connect an LED to GPIO pin 24 and a Switch to GPIO 25 and control the LED with the switch.

Components Required:

- Laptop installed with VNC Viewer
- Raspberry Pi installed with Raspbian OS
- Switch
- LED
- Resistor 330 ohms
- Breadboard
- Connecting Wires

Procedure:

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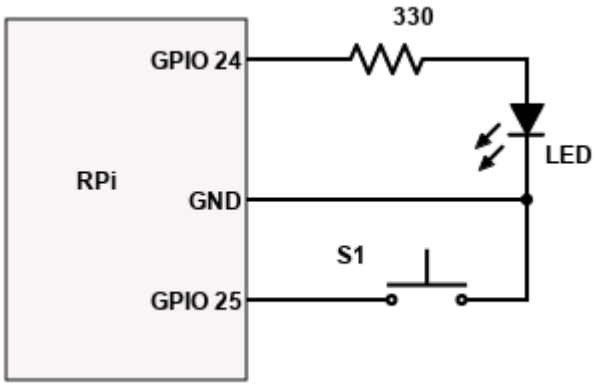

Program:

```
import RPi.GPIO as GPIO
import time

led = 25
sw = 24

GPIO.setmode(GPIO.BCM)
GPIO.setwarnings(False)      #It disables the Warnings
GPIO.setup(led,GPIO.OUT)  #Setting the led pin i.e 25 as ouput
GPIO.setup(sw, GPIO.IN,pull_up_down = GPIO.PUD_UP)  #Setting the
                                      #sw pin i.e 24 pin as input

while True:
 st = GPIO.input(sw)
 if st == 1:              #If sw is press
  GPIO.output(led,1)      # LED ON
 else:                    #If sw is release
  GPIO.output(led,0)      # LED OFF
```

Exp No: 3

Aim: Use DHT11 temperature sensor and print the temperature and humidity of the room with an interval of 15 seconds.

Components Required:

- Laptop installed with VNC Viewer
- Raspberry Pi installed with Raspbian OS
- DHT11
- Switch
- LED
- Resistor 330 ohms
- Breadboard
- Connecting Wires

Procedure:

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11) Observe the output.

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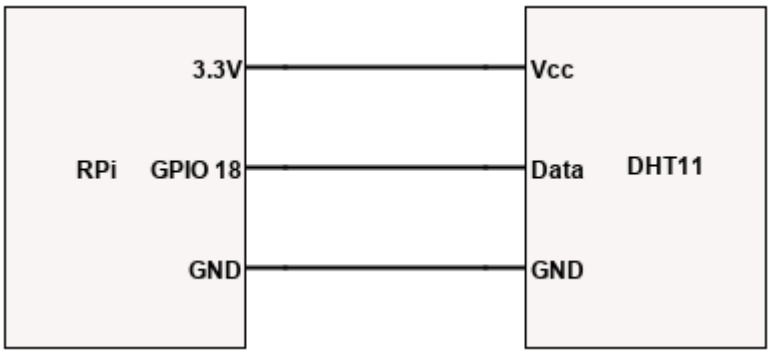

Program:

```
import sys
import adafruit_dht
from board import *
import time

dht = adafruit_dht.DHT11(D4, use_pulseio=False)

while True:
  try:
    temperature = dht.temperature
    humidity = dht.humidity
    temperature='{0:0.1f}'.format(temperature, humidity)+'C'
    humidity='{1:0.0f}'.format(temperature, humidity)+'%'
    print('Temp='+temperature, 'Humidity='+humidity)
    time.sleep(15)
  except RuntimeError as error:
    continue
```

Exp No: 4

Aim: Use joystick and display the direction on the screen.

Components Required:

- Laptop installed with VNC Viewer
- Raspberry Pi installed with Raspbian OS
- Joystick
- MCP3008 ADC IC
- Resistor 10k ohm
- Breadboard
- Connecting Wires

Procedure:

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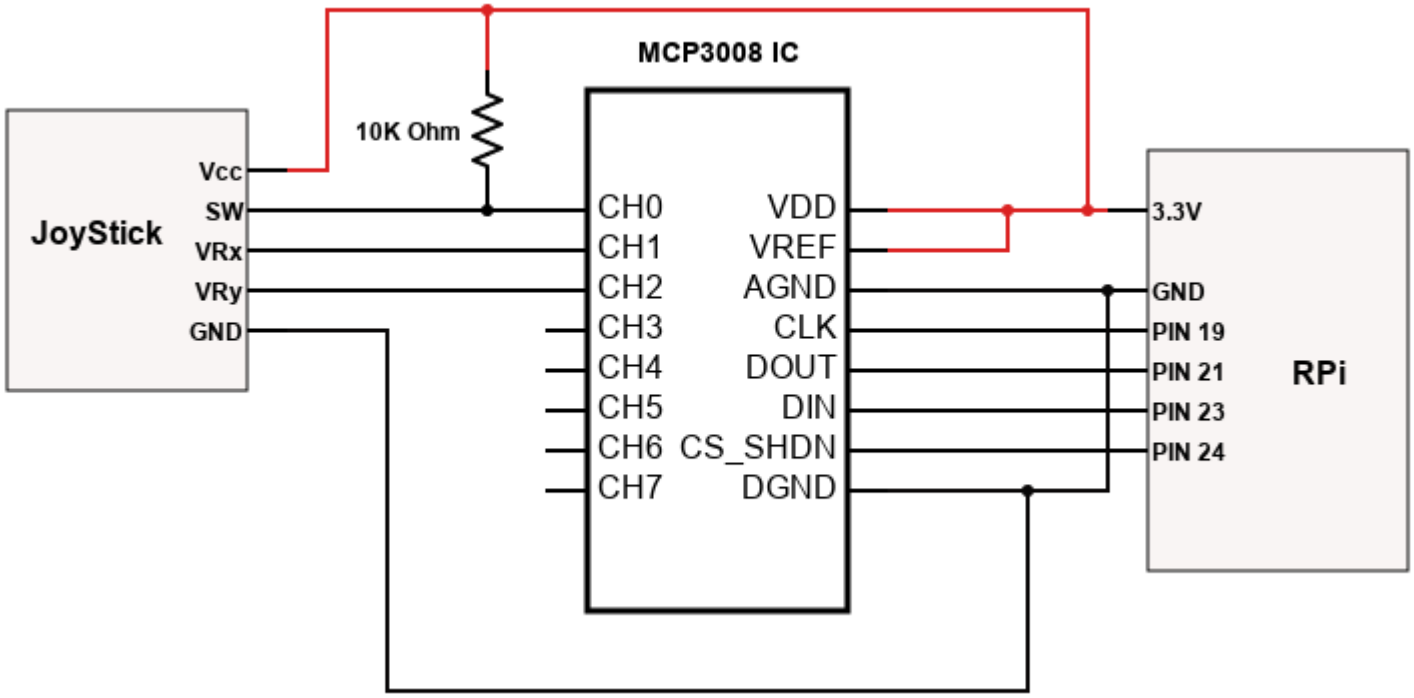

Program:

```
import spidev
import time
import os

spi = spidev.SpiDev()
spi.open(0,0)
spi.max_speed_hz=1000000

def ReadChannel(channel):
  adc = spi.xfer2([1,(8+channel)<<4,0])
  data = ((adc[1]&3) << 8) + adc[2]
  return data

swt_channel = 0
vrx_pos_channel = 1
vry_pos_channel = 2

delay = 0.5

while True:

  vrx_pos = ReadChannel(vrx_pos_channel)
  vry_pos = ReadChannel(vry_pos_channel)

  swt_val = ReadChannel(swt_channel)

  if vrx_pos < 300:
      print('Foward...')
  elif vrx_pos > 700:
      print('Backward...')
  elif vry_pos < 300:
      print('Right...')
  elif vry_pos > 700:
      print('Left...')
  elif swt_val < 3:
      print('Switch Pressed...')
  else :
      print('Center...')

  time.sleep(delay)
```

Exp No: 5

Aim: Use Light Dependent Resistor (LDR) and control an LED that should switch-on/off depending on the light.

Components Required:

- Laptop
- Raspberry Pi installed with Raspbian OS
- LDR Sensor Module
- LED
- Resistor 330 ohms
- Breadboard
- Connecting Wires

Procedure:

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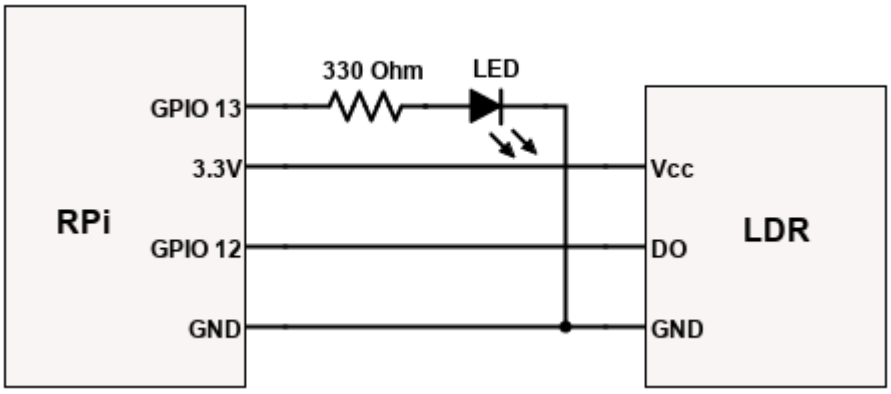

Program:

```
import RPi.GPIO as GPIO  #importing RPi.GPIO module as GPIO
import time              #impoting time module to create delay

ldr = 12                 #GPIO 12 to LDR sensor (Input Device)
led = 13                 #GPIO 13 to LED (Output Device)

GPIO.setmode(GPIO.BCM)   #Setting pin configuration mode as BCM
GPIO.setwarnings(False)  #Disabling warnings
GPIO.setup(ldr, GPIO.IN) #Setting ldr pin i.e 12 pin as input
GPIO.setup(led, GPIO.OUT)#Setting led pin i.e 13 pin as output
GPIO.output(led,False)   #Intialializing LED in OFF state

while True:
     ldrst = GPIO.input(ldr)
     if ldrst == 1:           #if no light
      GPIO.output(led, 1)     #LED ON
      print('Night, LED ON')
     else:                    #if there is light
      GPIO.output(led, 0)     #LED OFF
      print('Day, LED OFF')
     time.sleep(0.2)
```

Exp No: 6

Aim: Create a traffic light signal with three colored lights (Red, Orange and Green) with a duty cycle of 5-2-10 seconds.

Components Required:

- Laptop
- Raspberry Pi installed with Raspbian OS
- Traffic Light Signal Module
- Breadboard
- Connecting Wires

Procedure:

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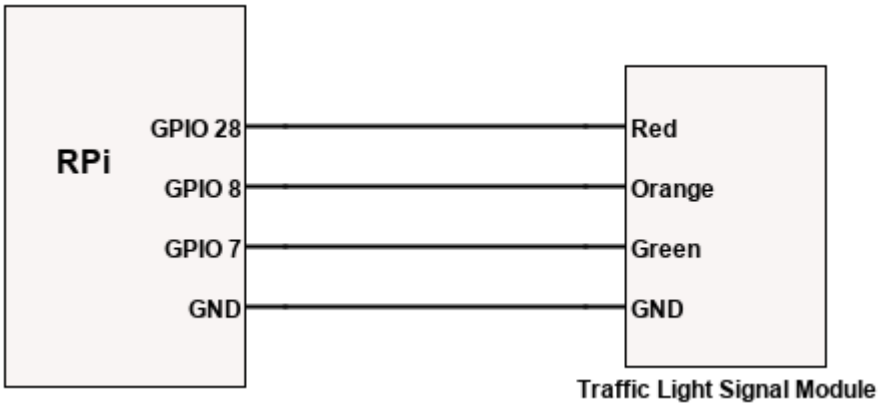

Program:

```
import RPi.GPIO as GPIO
import time

r = 25          #GPIO 25
y = 8           #GPIO 8
g = 7           #GPIO 7

GPIO.setmode(GPIO.BCM)
GPIO.setwarnings(False)
GPIO.setup(r, GPIO.OUT)
GPIO.setup(y, GPIO.OUT)
GPIO.setup(g, GPIO.OUT)
GPIO.output(r, False)
GPIO.output(y, False)
GPIO.output(g, False)

while True:
    GPIO.output(r, True)
    print('RED')
    time.sleep(5)
    GPIO.output(r, False)
    GPIO.output(y, True)
    print('YELLOW')
    time.sleep(2)
    GPIO.output(y, False)
    GPIO.output(g, True)
    print('GREEN')
    time.sleep(10)
    GPIO.output(g, False)
```

Exp No: 7

Aim: Switch on and switch of a DC motor based on the position of a switch.

Components Required:

- Laptop
- Raspberry Pi installed with Raspbian OS
- L293D Motor Driver Module
- DC Motor with Propeller FAN
- Slide Switch
- Breadboard
- Connecting Wires

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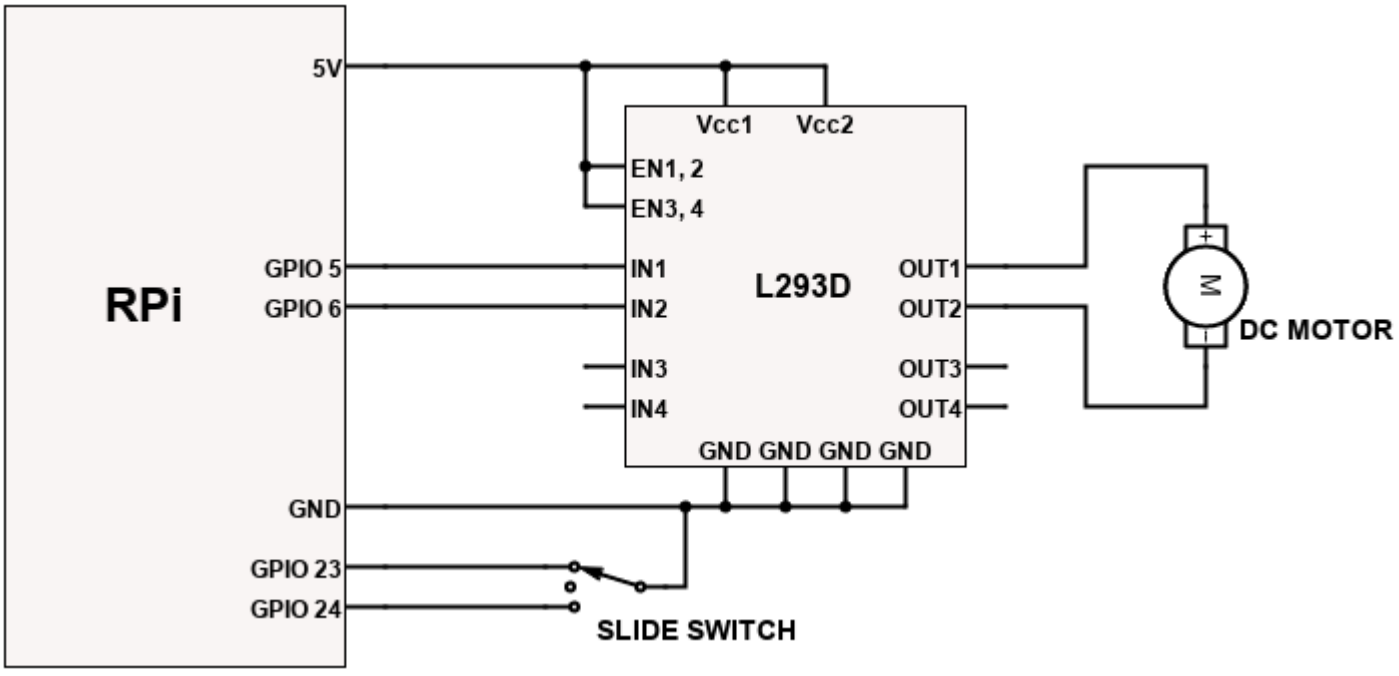

Program:

```
import RPi.GPIO as GPIO
import time

s1 = 23
s2 = 24
m1 = 5
m2 = 6

GPIO.setmode(GPIO.BCM)
GPIO.setwarnings(False)        #It disables the Warnings
GPIO.setup(s1, GPIO.IN, pull_up_down=GPIO.PUD_UP)
GPIO.setup(s2, GPIO.IN, pull_up_down=GPIO.PUD_UP)
GPIO.setup(m1, GPIO.OUT)
GPIO.setup(m2, GPIO.OUT)
GPIO.output(m1, False)
GPIO.output(m2, False)

while True:
    s1State = GPIO.input(s1)
    s2State = GPIO.input(s2)
    if s1State == 0:
        GPIO.output(m1, True)
        GPIO.output(m2, False)
        print('Forward...')
    elif s2State == 0:
        GPIO.output(m1, False)
        GPIO.output(m2, True)
        print('Revesre...')
    else:
        GPIO.output(m1, False)
        GPIO.output(m2, False)
        print('Stop')
```

Exp No: 8

Aim: Convert an analog voltage to digital value and show it on the screen.

Components Required:

- Laptop
- Raspberry Pi installed with Raspbian OS
- Potentiometer 10K ohms
- MCP3008 ADC IC
- Breadboard
- Connecting Wires

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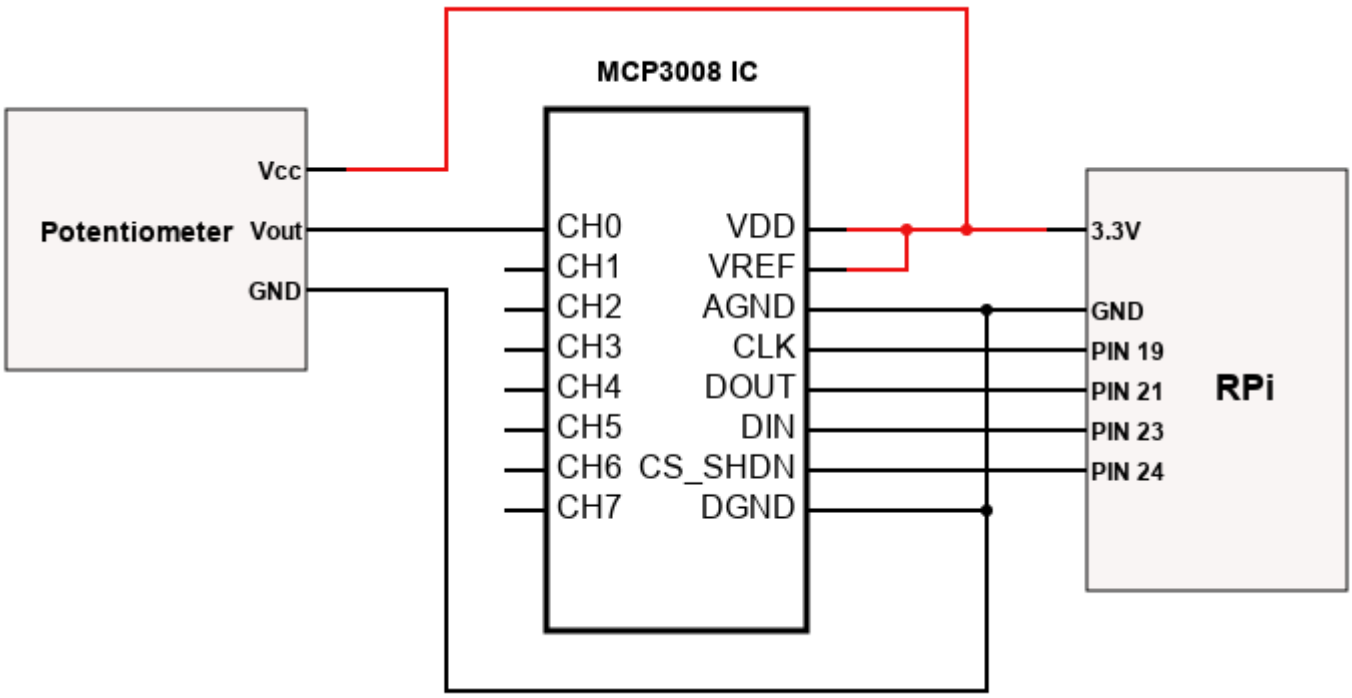

Program:

```
import spidev
import time
import os

spi = spidev.SpiDev()
spi.open(0,0)
spi.max_speed_hz=1000000

def ReadChannel(channel):
  adc = spi.xfer2([1,(8+channel)<<4,0])
  data = ((adc[1]&3) << 8) + adc[2]
  return data

pot_channel = 0

delay = 0.5

while True:

  pot = ReadChannel(pot_channel)

  print("POT VALUE :", pot)

  time.sleep(delay)
```

Exp No: 9

Aim: Create a door lock application using a reed switch and magnet and give a beep when the door is opened.

Components Required:

- Laptop
- Raspberry Pi installed with Raspbian OS
- Reed Switch
- Magnet
- Buzzer
- Breadboard
- Connecting Wires

Procedure:

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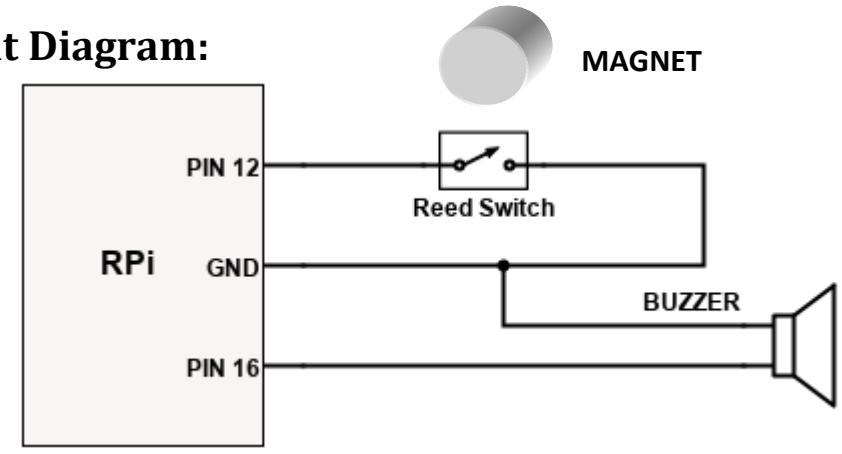

Program:

```
import RPi.GPIO as GPIO
import time

reedSwitch = 12
buzzer = 16

GPIO.setmode(GPIO.BOARD)
GPIO.setup(reedSwitch, GPIO.IN, pull_up_down=GPIO.PUD_UP)
GPIO.setup(buzzer, GPIO.OUT)
GPIO.output(buzzer, False)
while True:
  doorState = GPIO.input(reedSwitch)

  if doorState == 1:
     GPIO.output(buzzer, True)
     print('Door Opened')
  else:
     GPIO.output(buzzer, False)
     print('Door Closed')
  time.sleep(0.2)
```

Exp No: 10

Aim: Control a 230V device (Bulb) with Raspberry Pi using a relay.

Components Required:

- Laptop
- Raspberry Pi installed with Raspbian OS
- Relay Module
- AC Bulb
- Bulb Holder
- AC 2Pin Power Cable
- Connecting Wires

Procedure:

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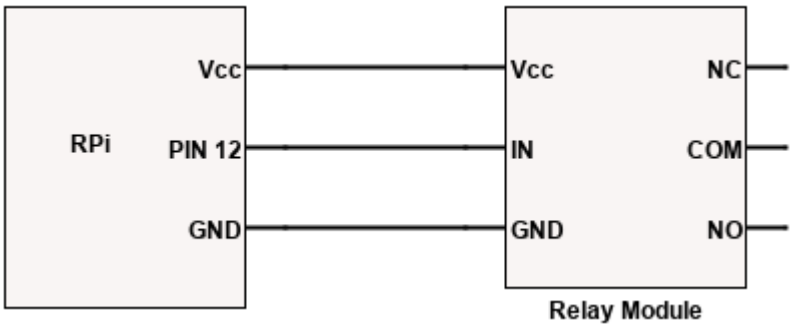

Program:

```
import RPi.GPIO as GPIO
import time

relay = 12

GPIO.setmode(GPIO.BOARD)
GPIO.setup(relay, GPIO.OUT)
GPIO.output(relay, True)

while True:
   cmd = input(">")
   if cmd =='ON':
      GPIO.output(relay, False)
      print('Light ON')
   elif cmd =='OFF':
      GPIO.output(relay, True)
      print('Light OFF')
   else:
      print('Wrong Command')
```

Exp No: 11

Aim: Control a 230V device using a threshold temperature, using temperature sensor.

Components Required:

- Laptop
- Raspberry Pi installed with Raspbian OS
- LM35 Temperature Sensor
- Relay Module
- AC Bulb
- Bulb Holder
- AC 2Pin Power Cable
- Breadboard
- Connecting Wires

Procedure:

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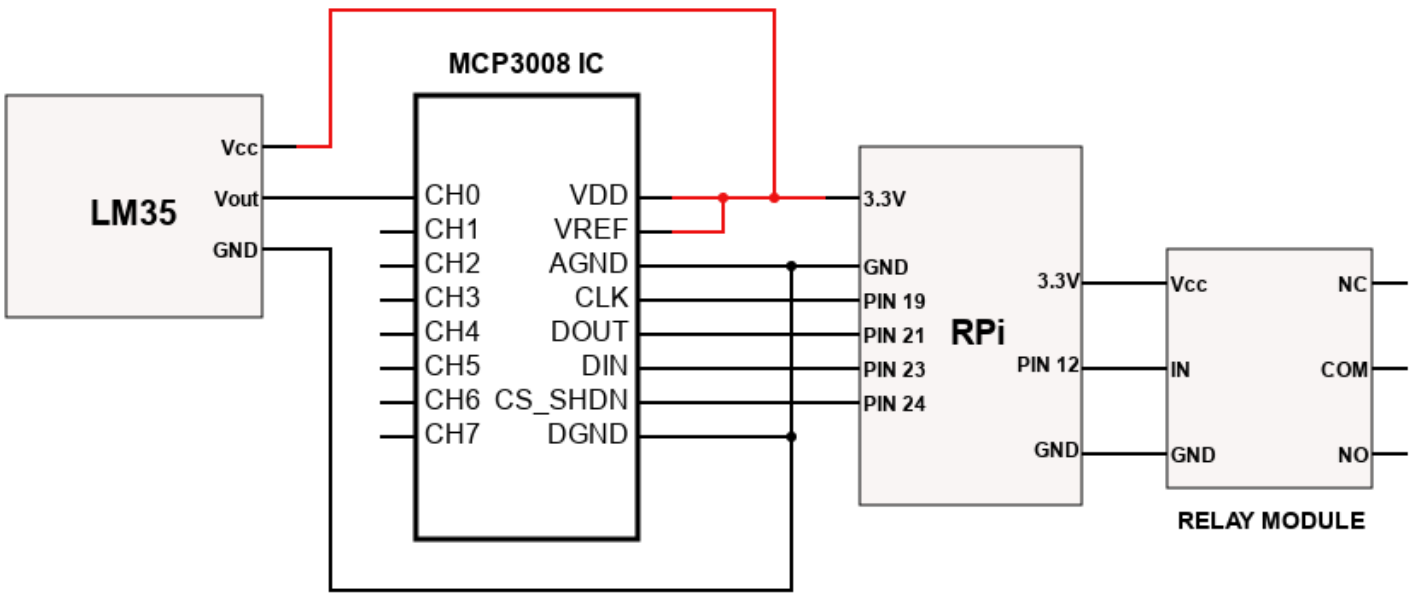


Program:

```
import RPi.GPIO as GPIO
import spidev
import time
import os

relay = 12

GPIO.setmode(GPIO.BOARD)
GPIO.setup(relay, GPIO.OUT)
GPIO.output(relay, True)

spi = spidev.SpiDev()
spi.open(0,0)
spi.max_speed_hz=1000000

def ReadChannel(channel):
  adc = spi.xfer2([1,(8+channel)<<4,0])
  data = ((adc[1]&3) << 8) + adc[2]
  return data

lm35_channel = 0

delay = 0.5

while True:

  tempvalue = ReadChannel(lm35_channel)
  print("Digital Value = ",tempvalue)
  volts = (tempvalue * 5) / 1024    #Volts = (DigitalValue in dec
                                    #* 5v)/1024(2^10bits)
  temperature = volts / (10.0 / 1000)  #Temperature = volts/10mV
  print("Temperature = " + temperature + "°C")
  if temperature > 30:
 GPIO.output(relay, False)
          print('FAN ON')
  else:
      GPIO.output(relay, True)
      print('FAN OFF')
  time.sleep(delay)
```

Exp No: 12

Aim: Create an application that has three LEDs (Red, Orange and Green). The LEDs should follow the cycle (All Off, Red On, Orange On, and Green On) for each clap (use sound sensor).

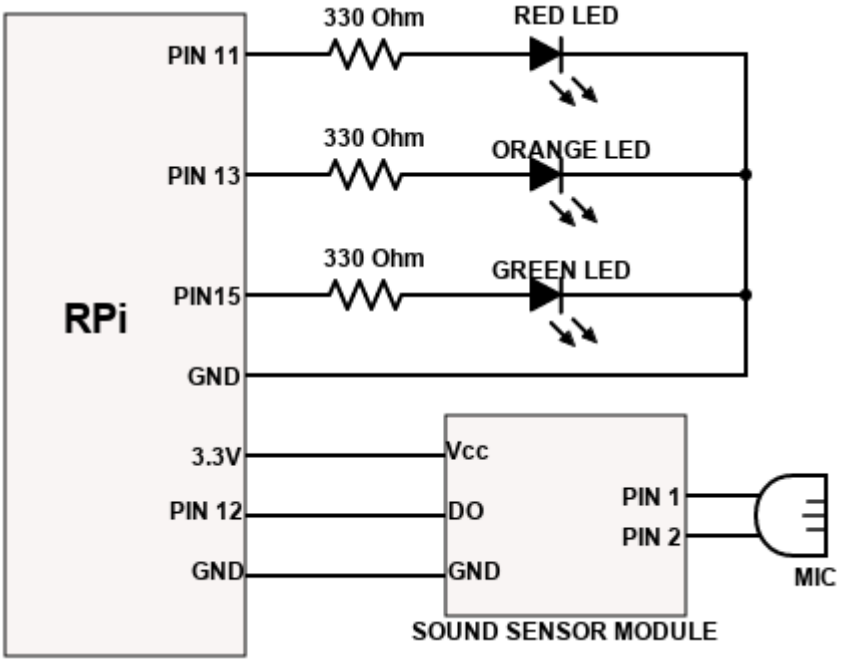
Components Required:

- Laptop
- Raspberry Pi installed with Raspbian OS
- Sound Sensor Module
- LEDs (Red, Orange and Green)
- Resistor 330 ohms
- Breadboard
- Connecting Wires

Procedure:

1) Make all connections as per the circuit diagram carefully.
2) To connect RPi to Laptop follow the below steps carefully.
3) Make sure laptop is connected to active Internet/WiFi connection.
4) Right click on mobile hotspot -> Go to settings -> Change "Network Name" and "Network Password" according to RPi credentials and turn on mobile hotspot.
5) Copy the IP address of RPi from connected devices section.
6) Open VNC Viewer on laptop and paste the copied IP address and click enter.
7) Enter The Login Credentials of RPi.
8) On home screen of RPi open "Thonny python IDE".
9) Type the program in the Thonny python IDE and save the program and click on "Run".
10) If there are any errors, debug the errors and "save" the program and "run" again.
11) Observe the output.

Circuit Diagram:



Program:

```
import RPi.GPIO as GPIO
import time

soundPin = 12
r = 11
o = 13
g = 15

GPIO.setmode(GPIO.BOARD)
GPIO.setwarnings(False)
GPIO.setup(soundPin, GPIO.IN)
GPIO.setup(r, GPIO.OUT)
GPIO.setup(o, GPIO.OUT)
GPIO.setup(g, GPIO.OUT)
GPIO.output(r, False)
GPIO.output(y, False)
GPIO.output(g, False)
clap = 0

def callback(soundPin):
        global clap
        if GPIO.input(soundPin):
                print("Sound Detected!")
                clap += 1
        else:
                print("Sound Detected!")
                clap += 1
        if clap == 1:
            print('1st Clap')
            GPIO.output(r, True)
        elif clap == 2:
            print('2nd Clap')
            #GPIO.output(r, False)
            GPIO.output(o, True)
        elif clap == 3:
            print('3rd Clap')
            #GPIO.output(o, False)
            GPIO.output(g, True)
        elif clap == 4:
            print('4th Clap')
            GPIO.output(r, False)
            GPIO.output(o, False)
            GPIO.output(g, False)
            clap = 0

GPIO.add_event_detect(soundPin, GPIO.BOTH, bouncetime=300)
# let us know when the pin goes HIGH or LOW
GPIO.add_event_callback(soundPin, callback)  # assign function
to GPIO PIN, Run function on change

while True:              # infinite loop
   time.sleep(1)
```

Exp No: 13

Aim: Create a web application for the above applications wherever possible with suitable modifications to get input and to send output.

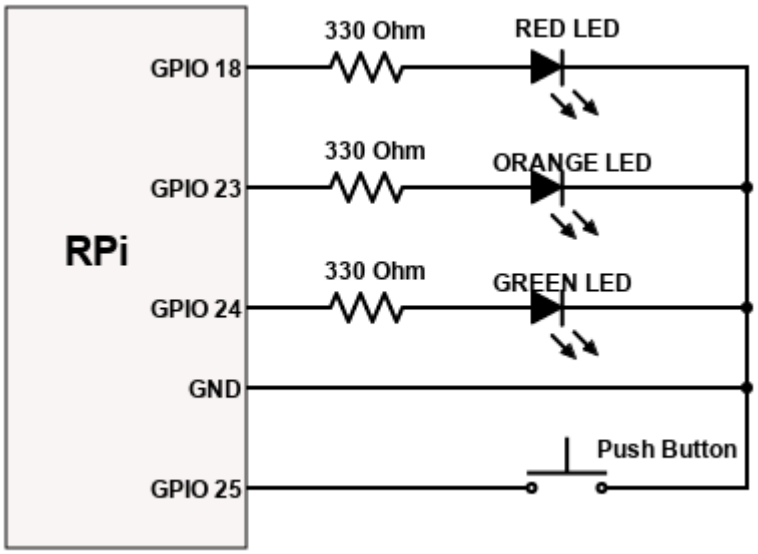
Components Required:

- Laptop
- Raspberry Pi installed with Raspbian OS
- Push Button
- LEDs – 3 No's
- Resistor 330 ohms – 3 No's
- Breadboard
- Connecting Wires

Procedure:

1) Make all connections as per the circuit diagram carefully.
2) To connect RPi to Laptop follow the below steps carefully.
3) Make sure laptop is connected to active Internet/WiFi connection.
4) Right click on mobile hotspot -> Go to settings -> Change "Network Name" and "Network Password" according to RPi credentials and turn on mobile hotspot.
5) Copy the IP address of RPi from connected devices section.
6) Open VNC Viewer on laptop and paste the copied IP address and click enter.
7) Enter The Login Credentials of RPi.
8) On home screen of RPi open "Thonny python IDE".
9) Type the program in the Thonny python IDE and save the program and click on "Run".
10) If there are any errors, debug the errors and "save" the program and "run" again.
11) Observe the output.

Circuit Diagram:



Program:

```
from bottle import route, run
import RPi.GPIO as GPIO

GPIO.setmode(GPIO.BCM)
GPIO.setwarnings(False)
led_pins = [18, 23, 24]
led_states = [0, 0, 0]
switch_pin = 25
GPIO.setup(led_pins[0], GPIO.OUT)
GPIO.setup(led_pins[1], GPIO.OUT)
GPIO.setup(led_pins[2], GPIO.OUT)
GPIO.setup(switch_pin, GPIO.IN, pull_up_down=GPIO.PUD_UP)

def switch_status():
    state = GPIO.input(switch_pin)
    if state:
        return 'Up'
    else:
        return 'Down'

def html_for_led(led):
    l = str(led)
    result = " <input type='button' onClick='changed(" + l + ")'
value='LED " + l + "'/>"
    return result

def update_leds():
    for i, value in enumerate(led_states):
        GPIO.output(led_pins[i], value)

@route('/')
@route('/<led>')

def index(led="n"):
    if led != "n":
        led_num = int(led)
        led_states[led_num] = not led_states[led_num]
        update_leds()
    response = "<script>"
    response += "function changed(led)"
    response += "{"
    response += " window.location.href='/' + led"
    response += "}"
    response += "</script>"
    response += '<h1>GPIO Control</h1>'
    response += '<h2>Button=' + switch_status() + '</h2>'
    response += '<h2>LEDs</h2>'
    response += html_for_led(0)
    response += html_for_led(1)
    response += html_for_led(2)
    return response
run(host='localhost', port=8080)
```