Sheet 1
Micro Controllers

Question1:

Using the Arduino Uno, design a built-in Air Condition control board. Given the following

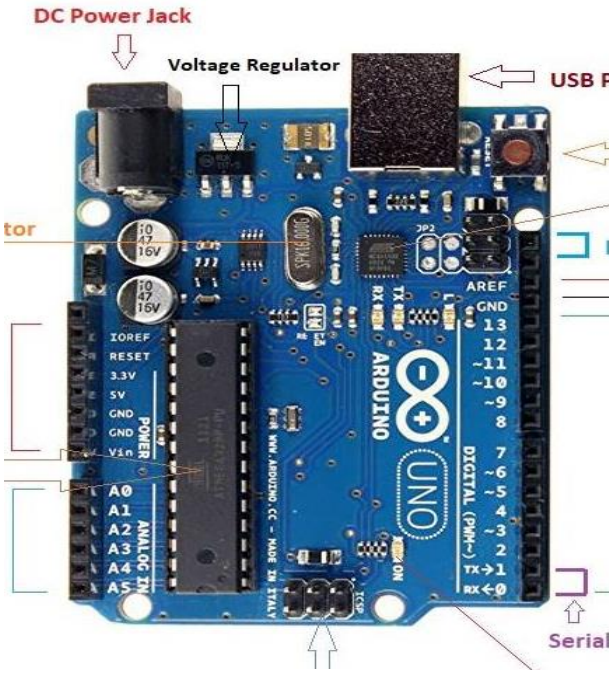
- Air Condition uses AC power from a wall socket to power the internal Compressor/ Fan.
- 2 x built push buttons to Increase / Decrease temperature
- 1 x built switch to enable/disable air swing servo/stepper motor
- 2 x Single Digit 7 Segment Display for Temperature Value
- 1 x Temperature Sensor(AD22100) { Output Voltage is Ranging from 0.25 V at −50°C to +4.75 V at +150°C } and it has linear response and the Temperature Coefficient of 22.5 mV/°C}, voltage at 0°C is 1.375

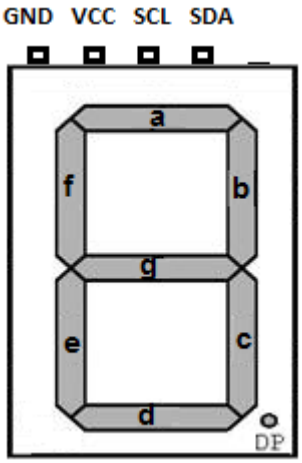
a. Show the wiring diagram of different devices and add any necessary components (active/passive) to ensure correct operations.
b. Write the main sketch functions calls to operate the AC when
   - Monitoring Temperature setting versus actual measured temperature to start / stop Compressor/Fan with delayed response 2 seconds
   - Read New Temperature Input Setting from push buttons ranging from 16°C to 28°C
   - Activate / Deactivate air swing servo (As in LAB)

Answer Guide

Needed Components

a. Arduino Uno
b. 2 push buttons
c. 1 input switch
d. 2 single digits seven segments
e. 1 servo/stepper for the swing
f. 1 input temperature sensor
g. Relay to control Power to Fan/compressor



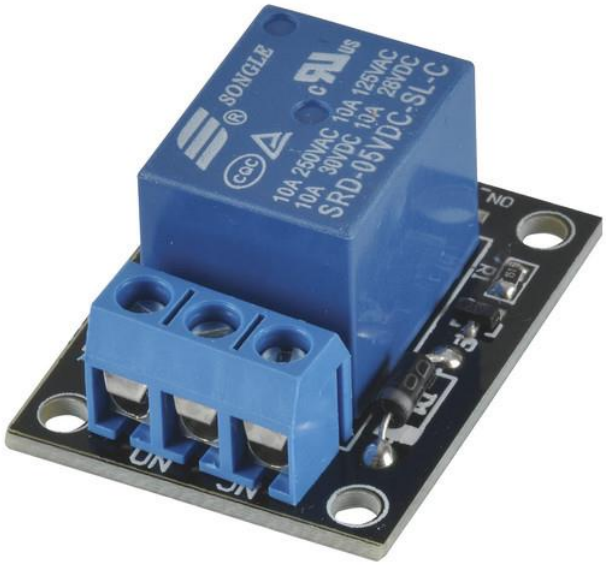


pin(A4)
pin(A5)

pin(4)
pin (7)

pin(A0)

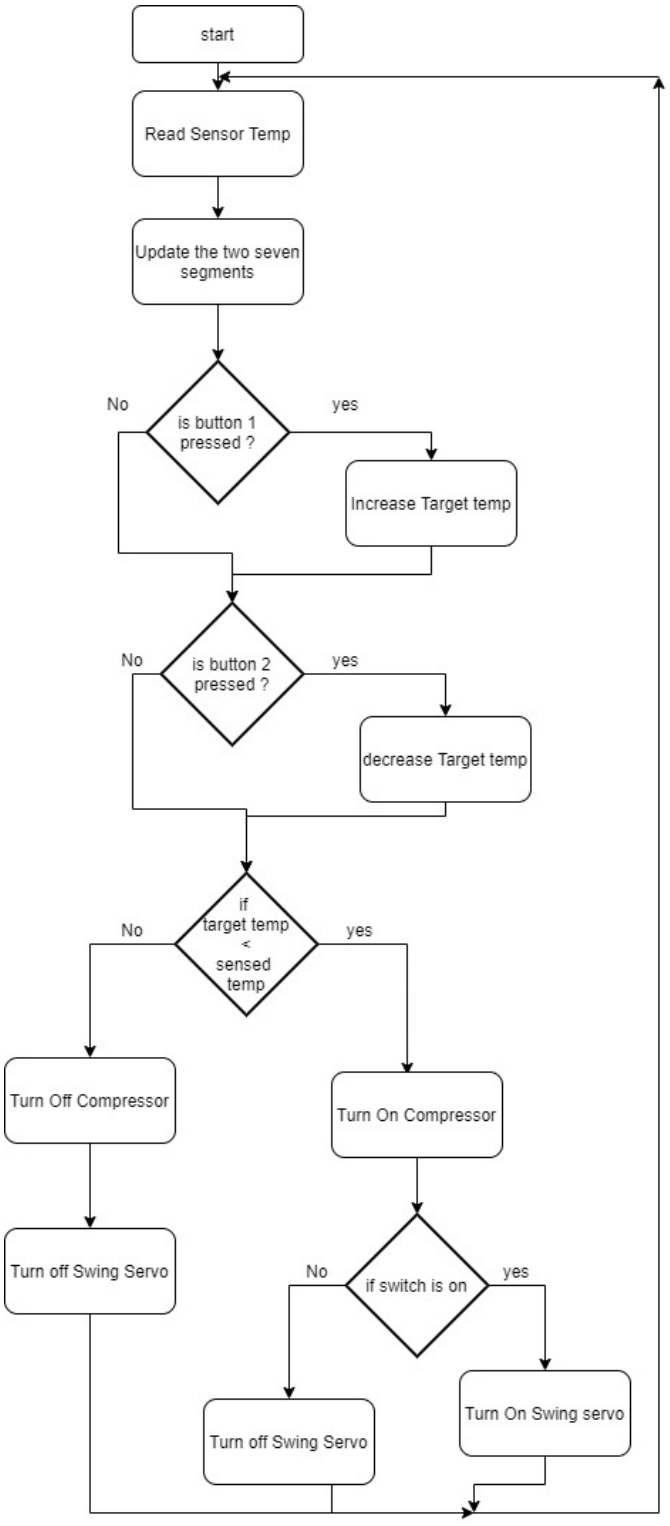
pin (2)



pin (8)

pin (9)

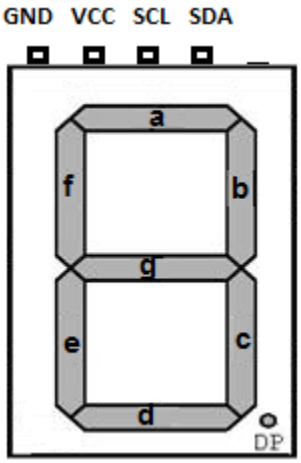
System Flow Chart



2 x 1 digit 7 Segment

Using a seven segment backpack, and I2C protocol

Operational Voltage 5V , Write Address for 1st 7 Segment is 53h , Write Address for 2nd 7 Segment is 43h



First and Second 7 Segments attached

Connections on Arduino

Uno A4 (SDA), A5 (SCL)

Communication Functions

Wire.begin() // Master Joining Bus

Wire.beginTransmission(0x53)

Wire.write(0x3) // Write 3 to 1st 7 Segment

flag = Wire.endTransmission()

AD22100 Temperature Sensor

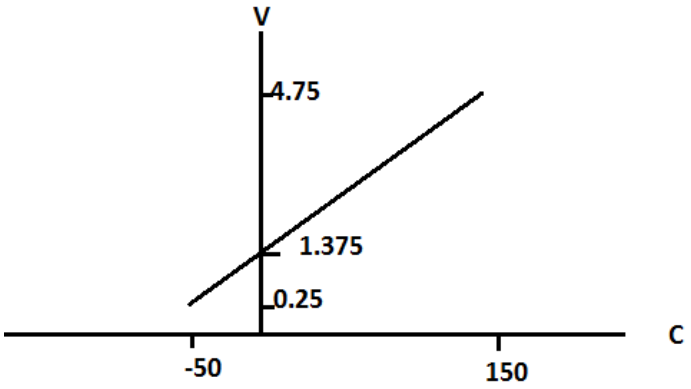
[note that this solution does not use a pull up resistor , this addition is left to the student to try on their own]

Output V0 Ranging from 0.25 V at −50°C to +4.75 V at +150°C

Assume linear response(i.e linear function) and Temperature Coefficient of 22.5 mV/°C (i.e volt=22.5 (temp)+c) , then the voltage at 0°C is 1.375

But take care that the actual readings from the sensor ranges from 0 to 1023 not from 0 to 5 volt,

So first convert the readings from 0 to 1023 range to 0 to 5 v range, then map the voltage to the according temperature degree as shown in the diagram.



The line equation: Volt=m C+p

Volt=22.5 C + 1.375

Volt=22.5(temperature)+1.375

Temperature= (Volt-1.375)/22.5

so you find a temperature degree X , given a voltage Y

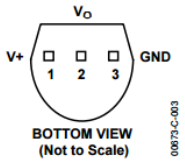


Figure 3. 3-Lead TO-92

Table 4. 3-Lead TO-92 Pin Function Descriptions

Pin No.	Mnemonic	Description
1	V+	Power Supply Input.
2	V_O	Device Output.
3	GND	Ground Pin Must Be Connected to 0 V.

Connections on Arduino

Any of A0 to A5

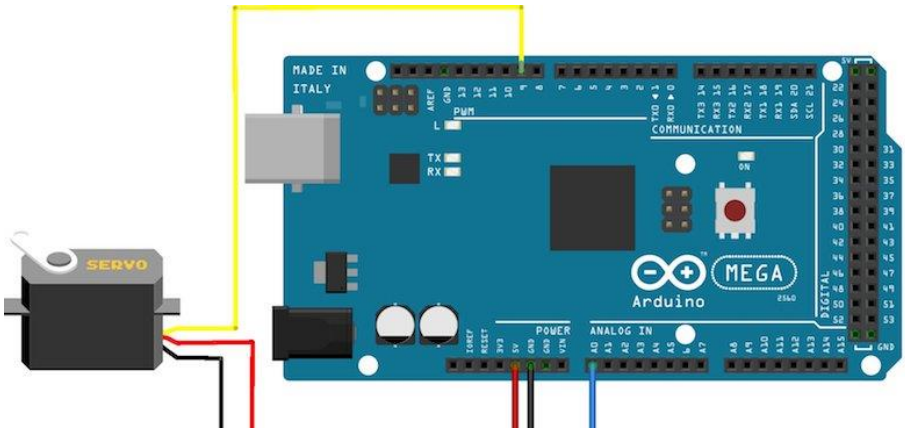
Temperature Calculation

int sensorValue = analogRead(A0);

float voltage= sensorValue * (5.0 / 1023);

temperature = (voltage -1.375) / 22.5

Servo motor



Code servo Arduino

```
Servo servo1;
servo1.attach(9);
while (swing)
for(angle = 0; angle < 180; angle += 1) // command to move from 0 degrees to 180 degrees
{ servo1.write(angle); //command to rotate the servo to the specified angle
delay(15); }
```

Code stepper Arduino

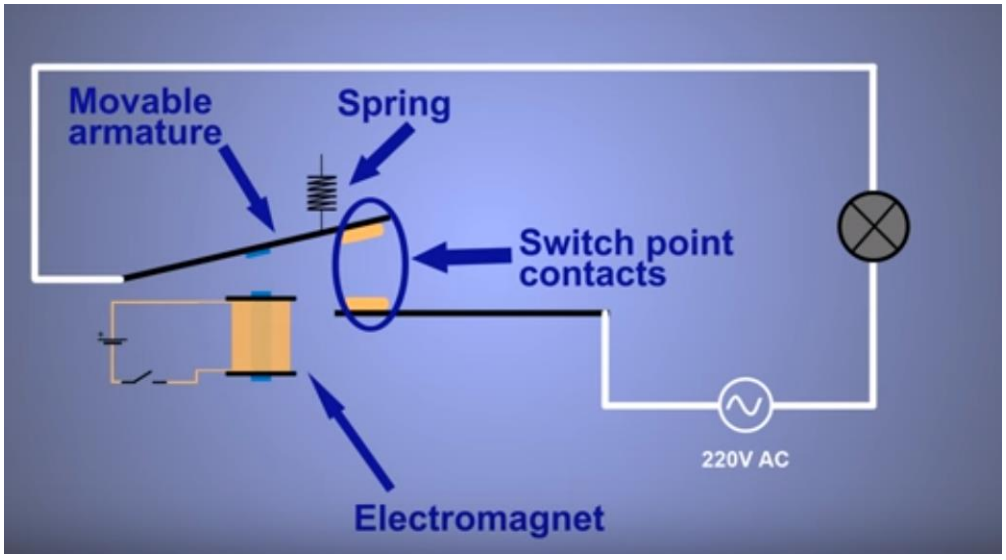
```
Stepper mystepper(steps per revolution, four pins)
mystepper.setspeed(20);
while (swing)
mystepper.step(0); //command to rotate the stepper to the specified angle delay(15);
mystepper.step(180); //command to rotate the stepper to the specified angle delay(15);
```

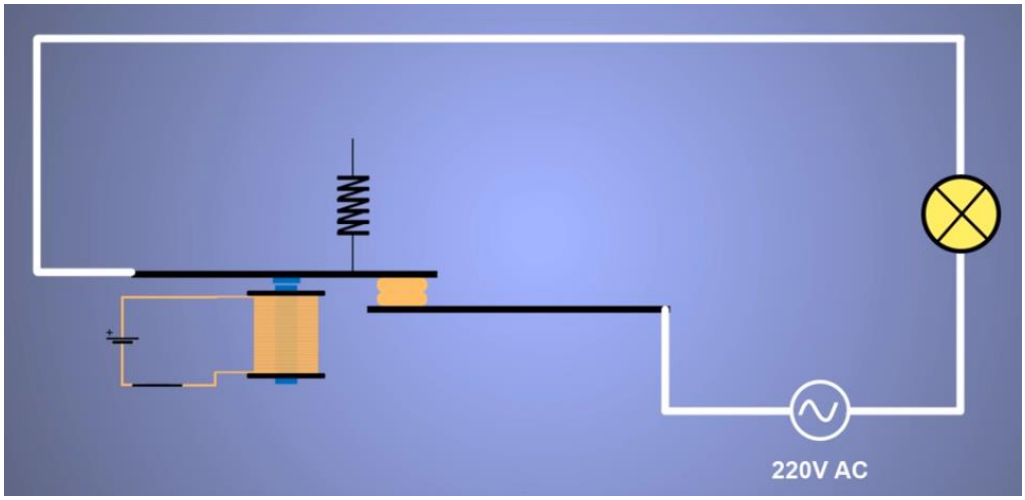
Fan and Compressor Connections and Relay

Relay:

An electrical device, typically incorporating an electromagnet, which is activated by a current or signal in one circuit to open or close another circuit.

This is a great tutorial on how it works : https://www.youtube.com/watch?v=1_YfuH_AcxQ





NC: Normally closed 120-240V terminal

NO: Normally open 120-240V terminal

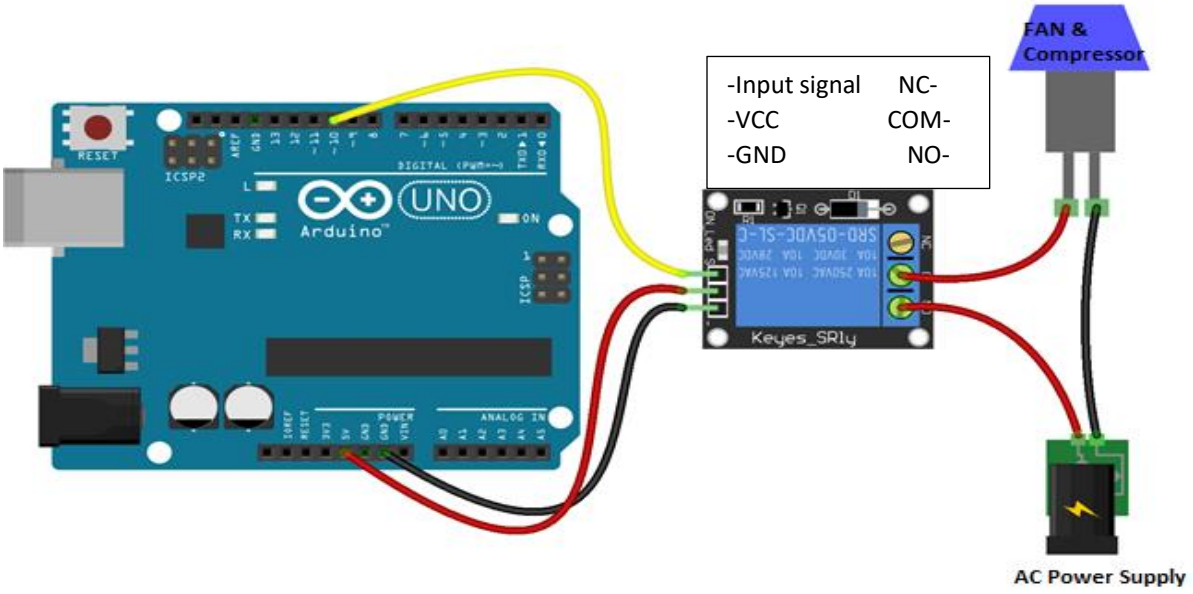
C: Common terminal

Ground: Connects to the ground pin on the Arduino

5V Vcc: Connects the Arduino's 5V pin

Input Signal: Carries the trigger signal from the Arduino that activates the relay

Inside the relay is a 120-240V switch that's connected to an electromagnet. When the relay receives a HIGH signal at the signal pin, the electromagnet becomes charged and moves the contacts of the switch open or closed.



Code

```
delay(2000)  // recover from user input increase / decrease by 2 seconds
             // could be added after reading the input from the buttons
If (Input_Temperature < Sensor_Temperature) // Condition Check
digitalWrite(10,HIGH);  // Turns ON Relay Control PIN for Fan and compressor

else
digitalWrite(10,LOW);  // Turns Off Relay Control PIN for Fan and compressor
```

To Do(1):

write a full Arduino code for the system as a whole, use unit functions and comments in your implementation so that the answer is clean.

Question2:

Using the Arduino Uno, design a plant watering/sprinkler system to take care of your plant pots while you are away.

a. Write the code required to operate the sprinkler with 1 liter of water when moister level is less than 30%. make sure that during the watering process, the readings of the sensor don't stop the watering operation until the amount of water is poured. Make sure that the watering process doesn't repeat within at least 12 hours even if the moister level gets less than 30%.
b. Extend the moister conditions when having 2 types of plants; one that requires watering when moister level is less than 30% with 1 liter of water and another type that requires watering when the moisture level is below 5% with half liter of water. Note that if it is the time to water any of the plants and you didn't for more than half an hour the plant will die.

In this system:

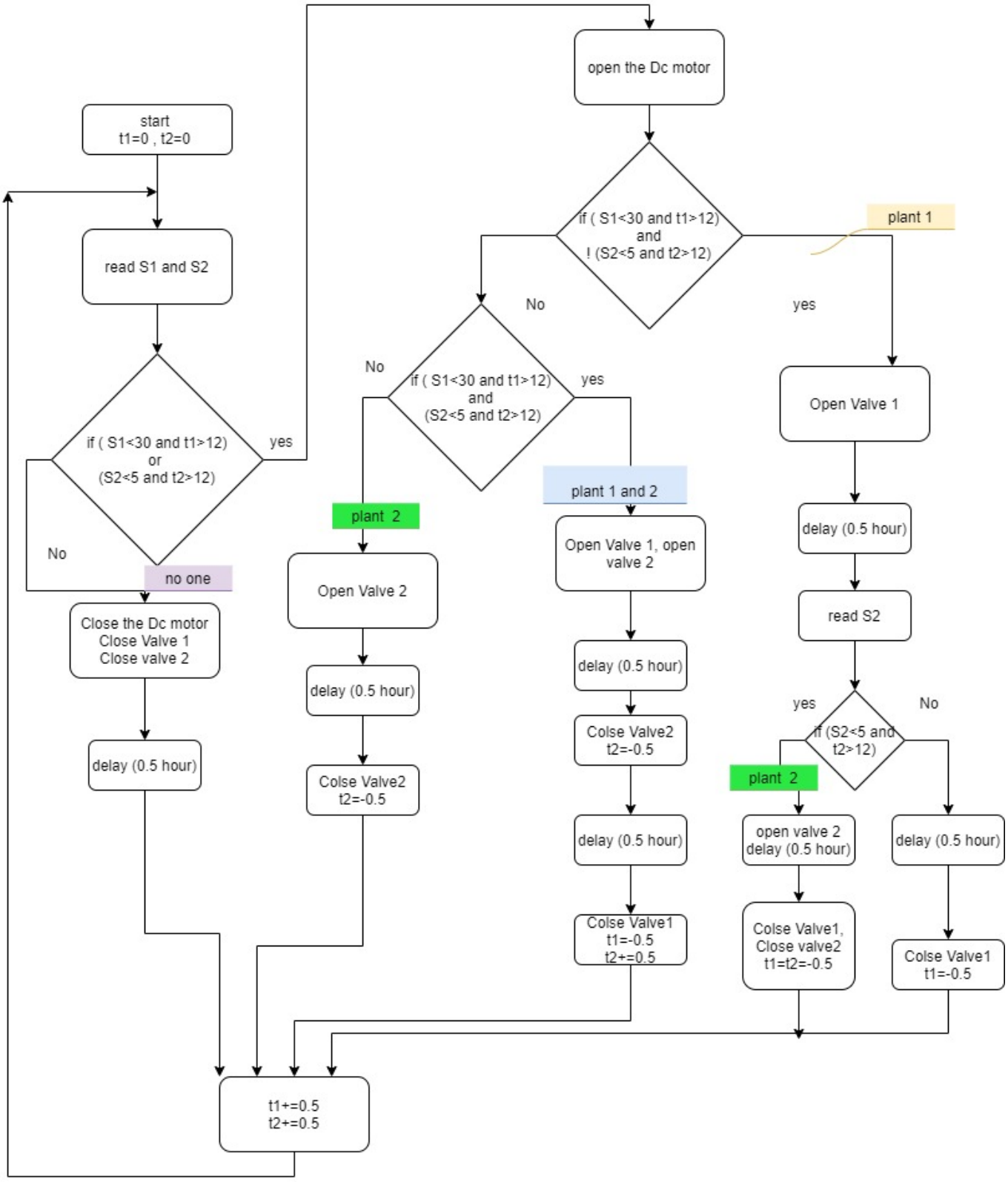
- The water is provided by a water pump, the water pump is derived by a DC motor works on 12 volts.
- Each plant pot has an electric valve that allows or prevents the water from the pump to pass to the plant, and each valve also needs 12 volts to operate properly.
- For the moister sensor, the output voltage ranges from 0 V at 0 moisture level to 4.2 V at 100 moisture level].
- Assume that the water system takes one hour to pour 1 liter of water.

Answer Guide

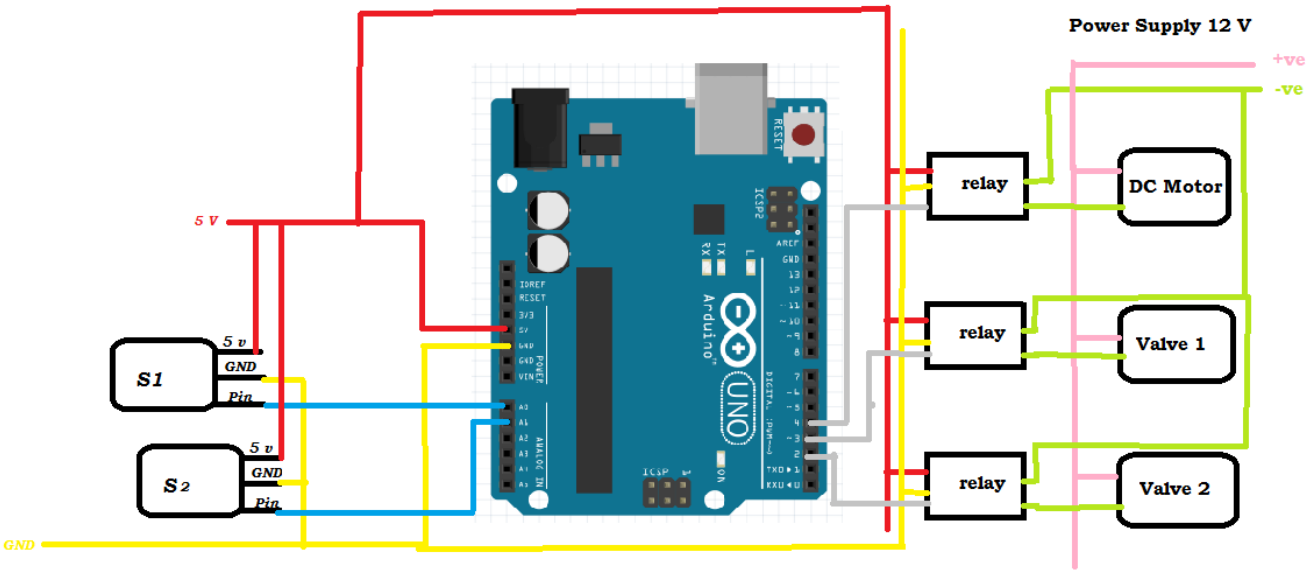
Needed Components

a. Arduino Uno
b. 2 moisture sensors
c. 1 DC motor for the pump
d. 1 relay for the DC motor
e. 2 relays for the two valves

System diagram



Wiring diagram



Moisture Sensor calculations

Firstly The analog reading levels [0 -1023] -> mapped to voltage levels [0-5].

Then The voltage levels [0-4.2] mapped to moister levels [0 – 100].

SO if you have input analog reading of 200 what is the moister level ?

Volt=200*5/1023=0.97.

Slope=100/4.2=23.8

Moist=0.97*23.8=23.1

Arduino code

int sensorValue1 = analogRead(A0);

*float voltage= sensorValue1 * (5.0 / 1023);*

*moisture = (voltage)** 23.8

final note about the blocking and non blocking systems:

1. if you use delay(msec) function then your system is blocking system , which can work but not desired.

   In this case the code will halt till the watering is done or till 12 hours are passed.

2. A better solution is to use functions like millis() or micros() that returns the number of miliseconds/ microseconds from the start of the program.

   In this case the code will check continuously for the passed time .

To Do (2) :

Write a full Arduino code for the system as a whole, use unit functions and comments in your implementation so that the answer is clean.