Analog Circuit Based Automatic Water Pumping System

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Contents:

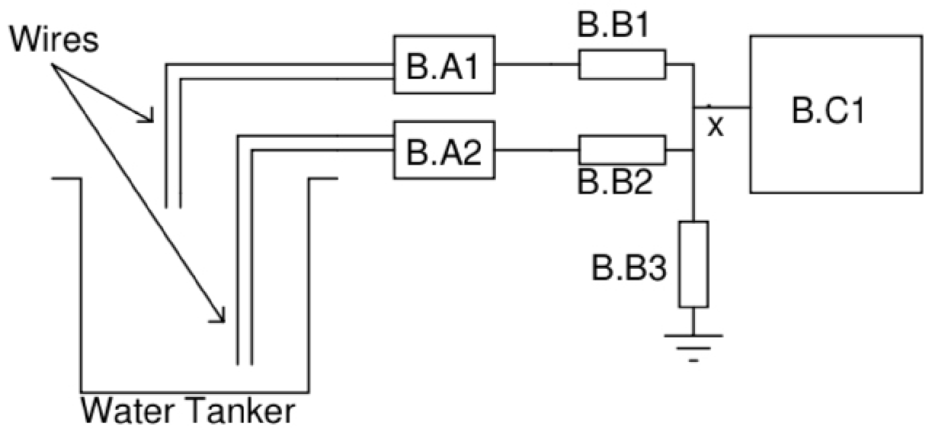
1.Overview of the project:

We have to design a circuit which can turn on and off your water pump automatically. The specification of this system like when water level is at 20% then motor will start automatically and fill pump water until water reaches to 90% level. And when water reaches at 90% level then motor must turn off automatically. It would remain off until water level reaches at 20%. This process should repeat over time.

1.2 Aim of the experiment:

An analog circuit automatically switches a water pump on/off to maintain water levels in a tank.

2. Block diagram:



Description:

I. The block diagram model of the Water level detection is shown in the block diagram. There are five main blocks can be needed to design a water level detection circuit. These blocks can be Resistors, Inductors, Capacitors, BJT, Mosfet or Opamps.

II. Block B.A1 and B.A2 sense the water levels. When water level is above of 20% then B.A2 will always supply current to block B.B2. Similarly when water reaches to 90% level then two wires which are connected with B.A1 will get short circuited and water level is sensed by B.A1. Thus, current flows B.A1 to B.B1.

III. The total current that are flowing through B.B1 and B.B2 will flow through B.B3 and no current will flow into B.C1. B.B1, B.B2 and B.B3 are taken such we can detect the water level in terms of voltage at node x and classify when to turn on and off the water pump.

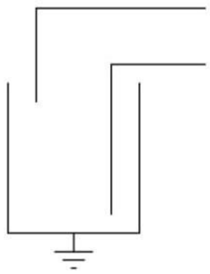
IV. When water level is below 20% then no current flow through B.B1 and B.B2 and hence voltage at node x will be zero. At this time motor must turn on. When motor start pumping the water into the tanker then water level reaches above 20% but less than 90%. At this time current flows through B.A2 to B.B2 and B.B3. This will result some voltage at node x and the value of the voltage we take as V1. But when water reaches above 90% then current will flow from B.A1 and B.A2 through B.B1 and B.B2 respectively. This total current will flow through B.B3 and create voltage V2 at node x. We have got three different voltage at three different levels. Now your task is to take this voltages and design B.C1 block such that it can take decision to turn the motor on and off.

V. When water is reached at 90% then motor gets turned off. At this time voltage at node x would be V2. After using water from tanker the water will get reduced from 90% and voltage at node x would be V1. Now at this time we do not want to turn on the motor. Motor will be turn on when water level is below than 20%. Taking this concept into consideration you have to design block B.C1.

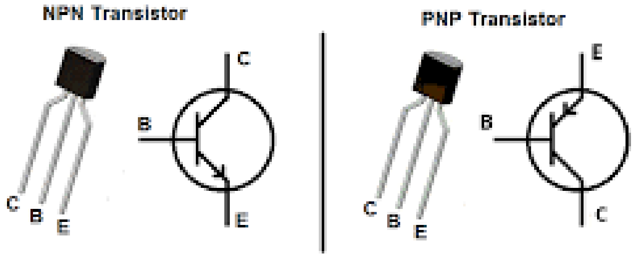
3.Design:

- From the block diagram we observe that block B.A1 and B.A2 are same components and B.B1, B.B2 and B.B3 are same components and B.C1 will be the schmitt trigger with positive feedback.
- So we take B.A1, B.A2 as transistors because to control the flow of current at different conditions. B.B1, B.B2, B.B3 we take resistors because to get voltages divided at X.
- B.C1 is schmitt trigger because it satisfies all the conditions for the voltages at X to turn on or off the motor.

Note: The water should be grounded always.

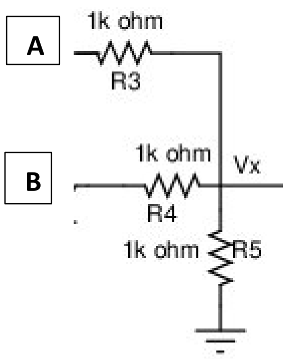


3.1 selection of transistors:



1) We have an option of selecting either NPN or PNP transistors.
2) First let us select NPN transistor, to measure the water level either emitter or base terminal should be in water i.e should be grounded.
3) If the base or emitter is grounded then the NPN transistor will be open so, no current flows through it.
4) So we select PNP transistor, for PNP transistor to be on Vb<Ve-Vth.
5) The base of the PNP transistor will be connected to the water and we give 5v supply to the emitter of the each PNP transistor.
6) So that Vb is always less than Ve and Vth so this PNP transistor allows current through post through it.
7) Both the basis of the PNP transistor are not grounded then in it it will not allow current to pass through it and the voltage at X=0If both the best terminals of a transistor are grounded then the voltage at X is V2.

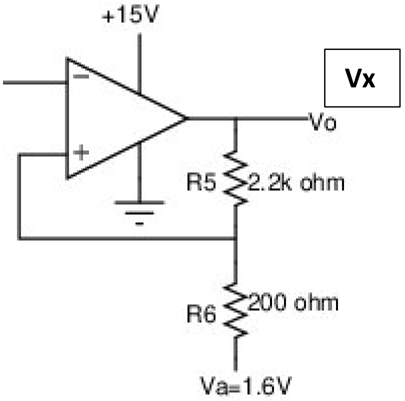
3.2 Selection of resistors:

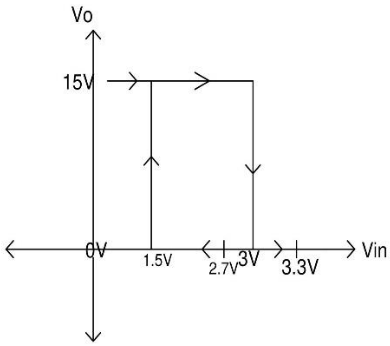


A and B are connected to the collector terminals of respective transistors

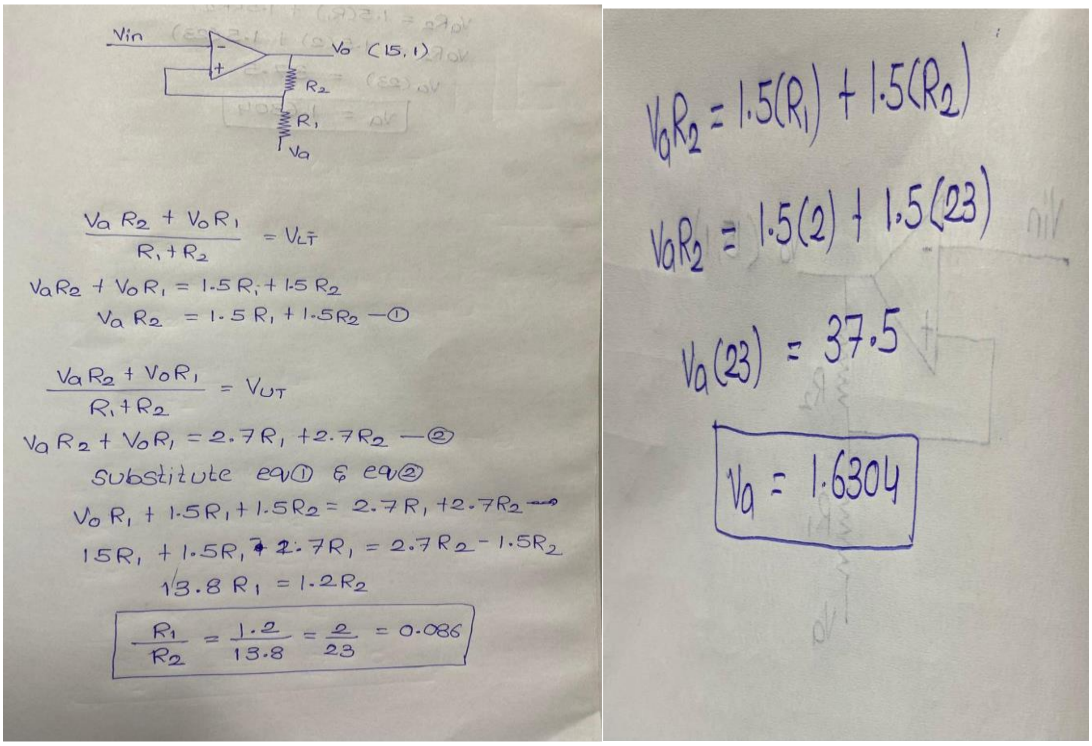
- Science we are dealing with small voltage we use resistors of 1k ohm.

3.3 selection of schmitt trigger:





For the resistor and Va values you can refer:



$$\frac{V_a R_2 + V_o R_1}{R_1 + R_2} = V_{LT}$$

$$V_a R_2 + V_o R_1 = 1.5 R_1 + 1.5 R_2$$

$$V_a R_2 = 1.5 R_1 + 1.5 R_2 \quad \text{— (1)}$$

$$\frac{V_a R_2 + V_o R_1}{R_1 + R_2} = V_{UT}$$

$$V_a R_2 + V_o R_1 = 2.7 R_1 + 2.7 R_2 \quad \text{— (2)}$$

Substitute eq(1) & eq(2)

$$V_o R_1 + 1.5 R_1 + 1.5 R_2 = 2.7 R_1 + 2.7 R_2$$

$$15 R_1 + 1.5 R_1 - 2.7 R_1 = 2.7 R_2 - 1.5 R_2$$

$$13.8 R_1 = 1.2 R_2$$

$$\boxed{\frac{R_1}{R_2} = \frac{1.2}{13.8} = \frac{2}{23} = 0.086}$$

$$V_a R_2 = 1.5(R_1) + 1.5(R_2)$$

$$V_a R_2 = 1.5(2) + 1.5(23)$$

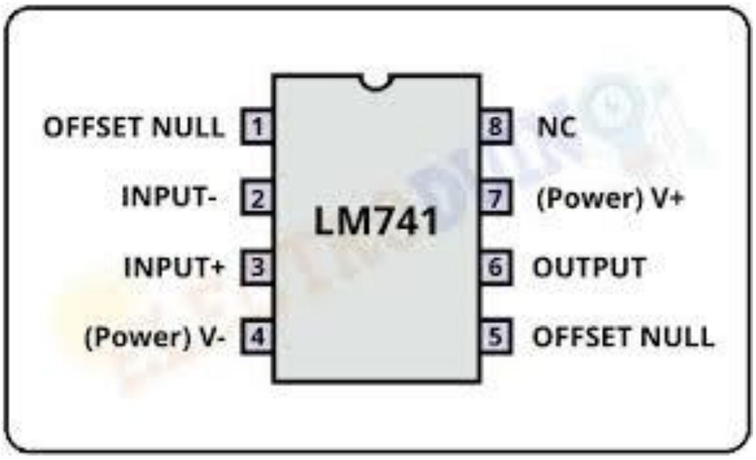
$$V_a(23) = 37.5$$

$$\boxed{V_a = 1.6304}$$

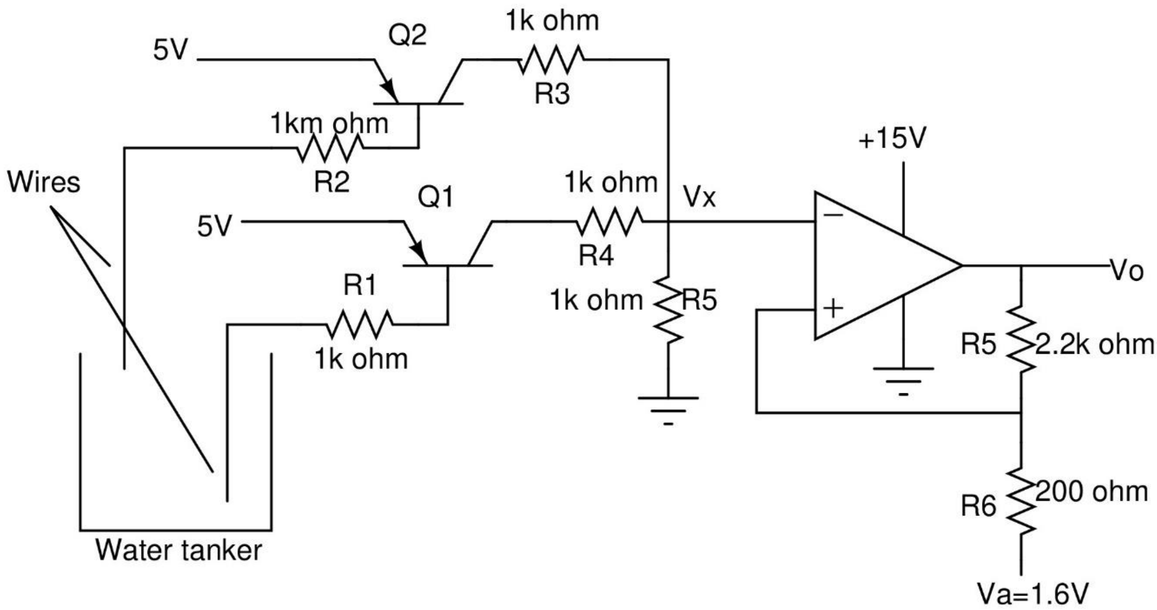
1) hear we select schmitt trigger with positive feedback because when the water is below 20% the motor should turn on until it reaches to 90% then it should turn off.
2) The report should remain turn off until it reaches below 20%
3) These all conditions will be satisfied by schmitt trigger so, we use it.

- This smith trigger will be designed by using OP AMP IC 714.

Pin diagram of IC 741



4)Circuit diagram:



When water is filling in tank:

- If both the base terminals of q1 and q2 are not connected to ground the motor will be on and it will pump the water (refer fig 1)
- If q1 base terminal is grounded and q2 base terminal is not grounded then also the motor is turn on. (refer fig 2)
- If both the base terminals are grounded the motor will turn off (refer fig 3).

When water is discharging in tank:

- If both the base terminals are grounded the motor will turn off (refer fig 1)
- If q1 base terminal is grounded and q2 base terminal is not grounded then also the motor is turn off.(refer fig 4)
- If both the base terminals of q1 and q2 are not connected to ground the motor will be on and it will pump the water (refer fig 1)

Experimental results:

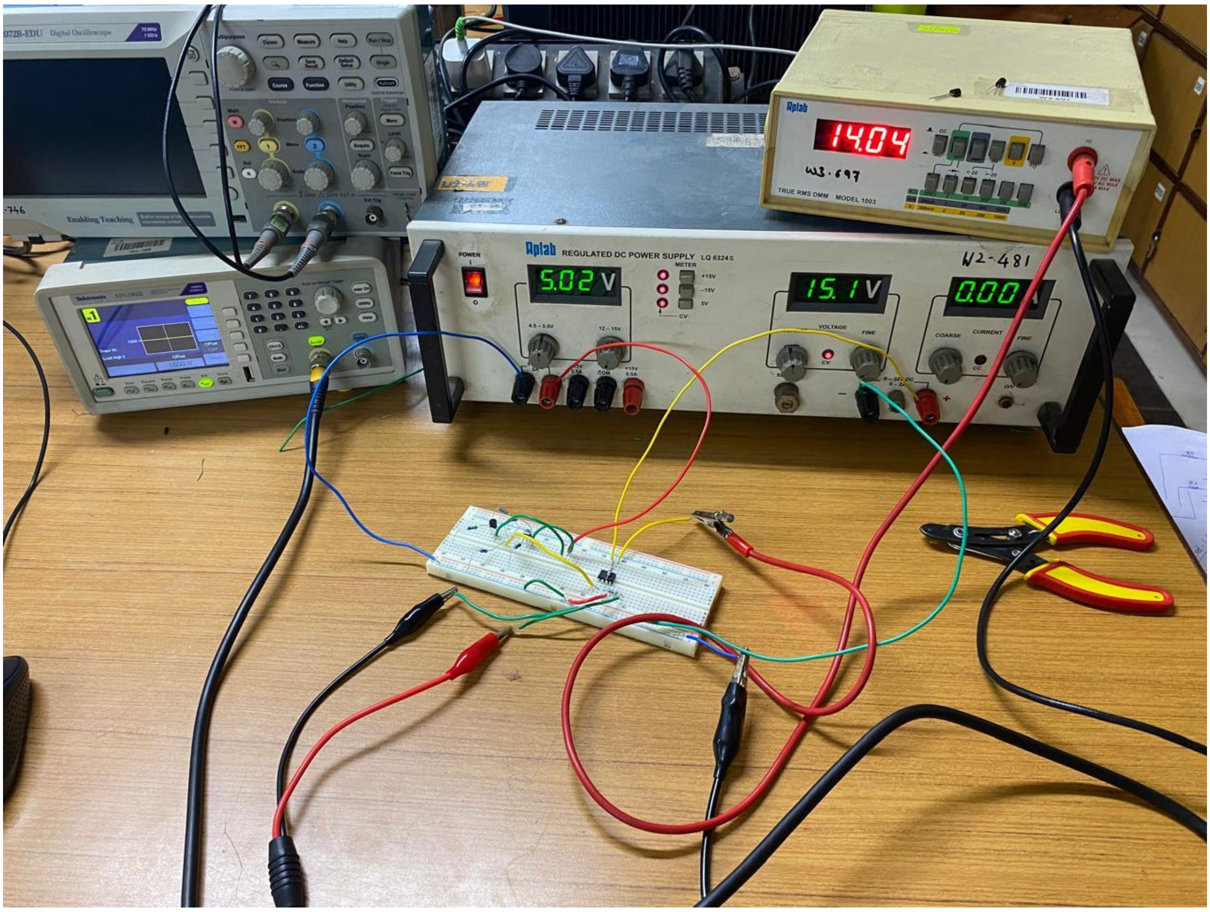


Fig 1

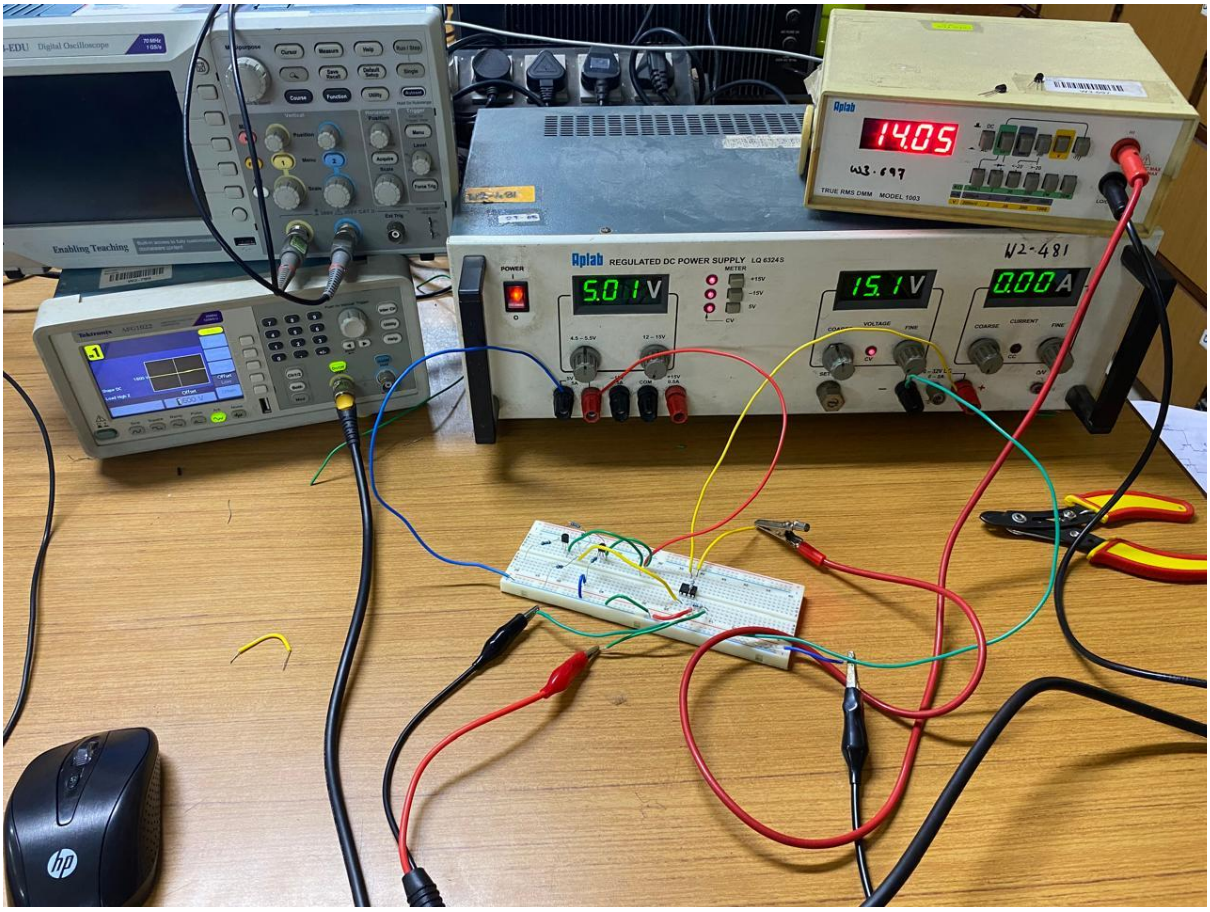

Digital Oscilloscope
Enabling Teaching
Aplab
REGULATED DC POWER SUPPLY LQ 6324 S
5.01 V
15.1 V
0.00 A
14.05
TRUE RMS DMM MODEL 1003
W2-481
W3-697

Fig 2

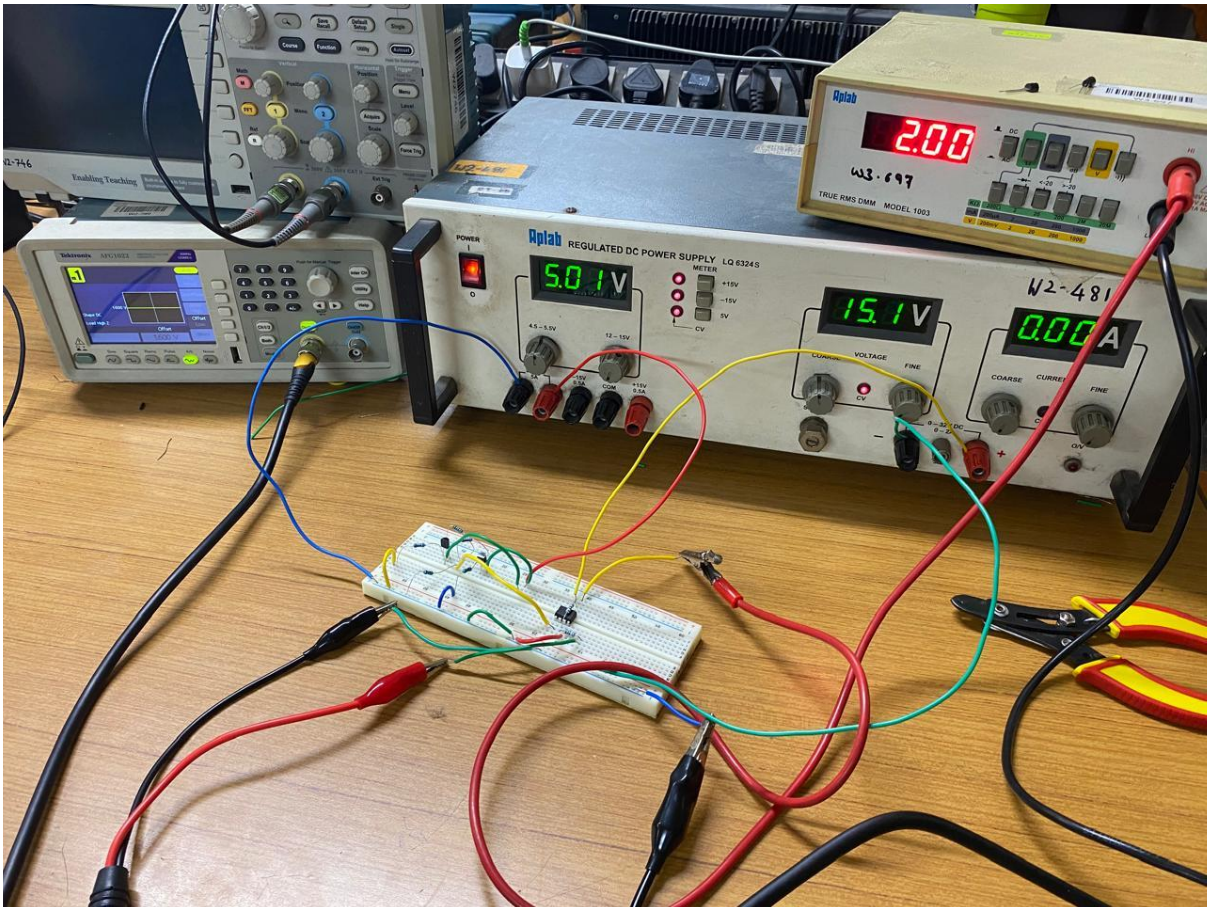

2.00
W3·697
TRUE RMS DMM
MODEL 1003
Aplab
REGULATED DC POWER SUPPLY
LQ 6324 S
5.01V
15.1V
0.00A
W2-481
POWER
METER
VOLTAGE
COARSE
FINE
Enabling Teaching

Fig 3

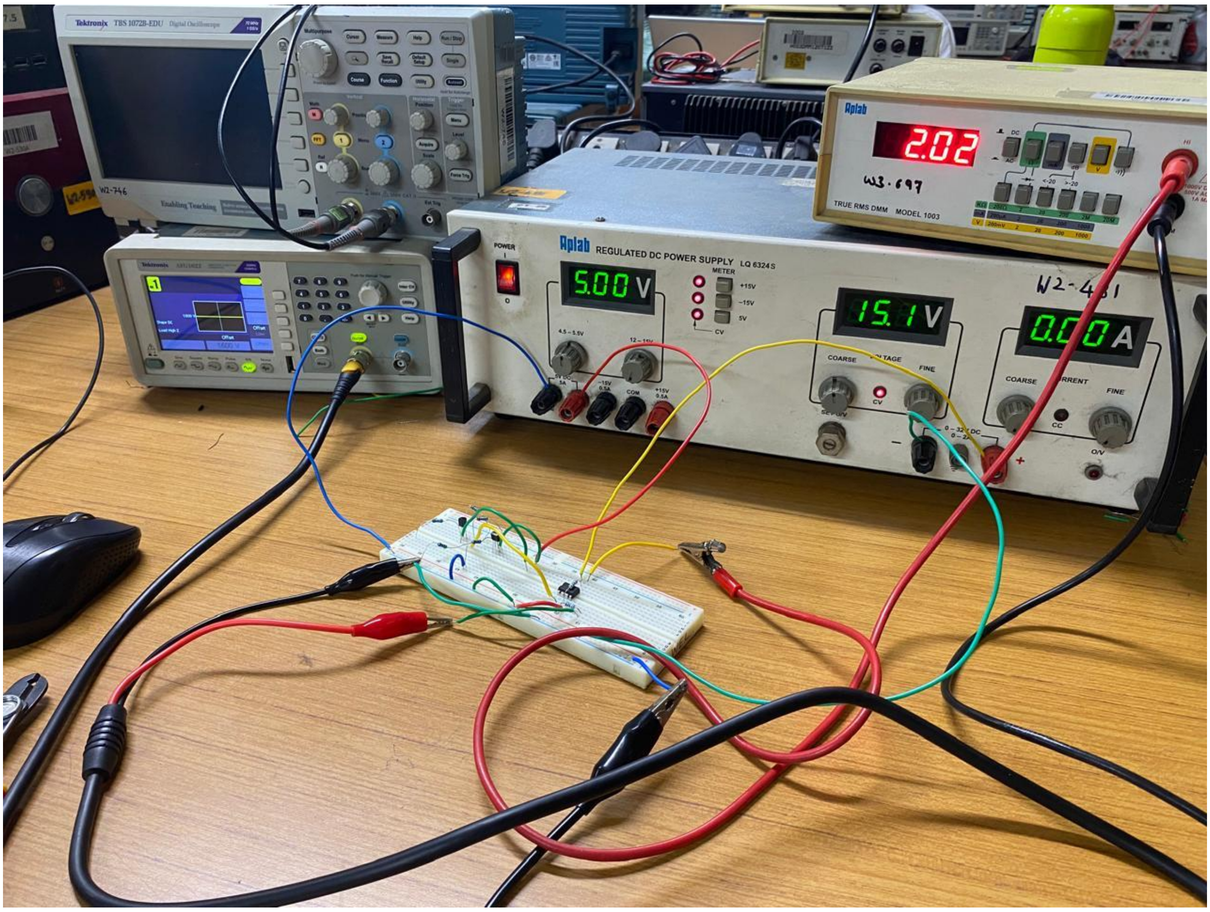


Fig 4

Conclusion: We conclude that designing an automated water pumping system involves several complex considerations and potential points of confusion. Here are some key aspects and potential inferences that need to be addressed.