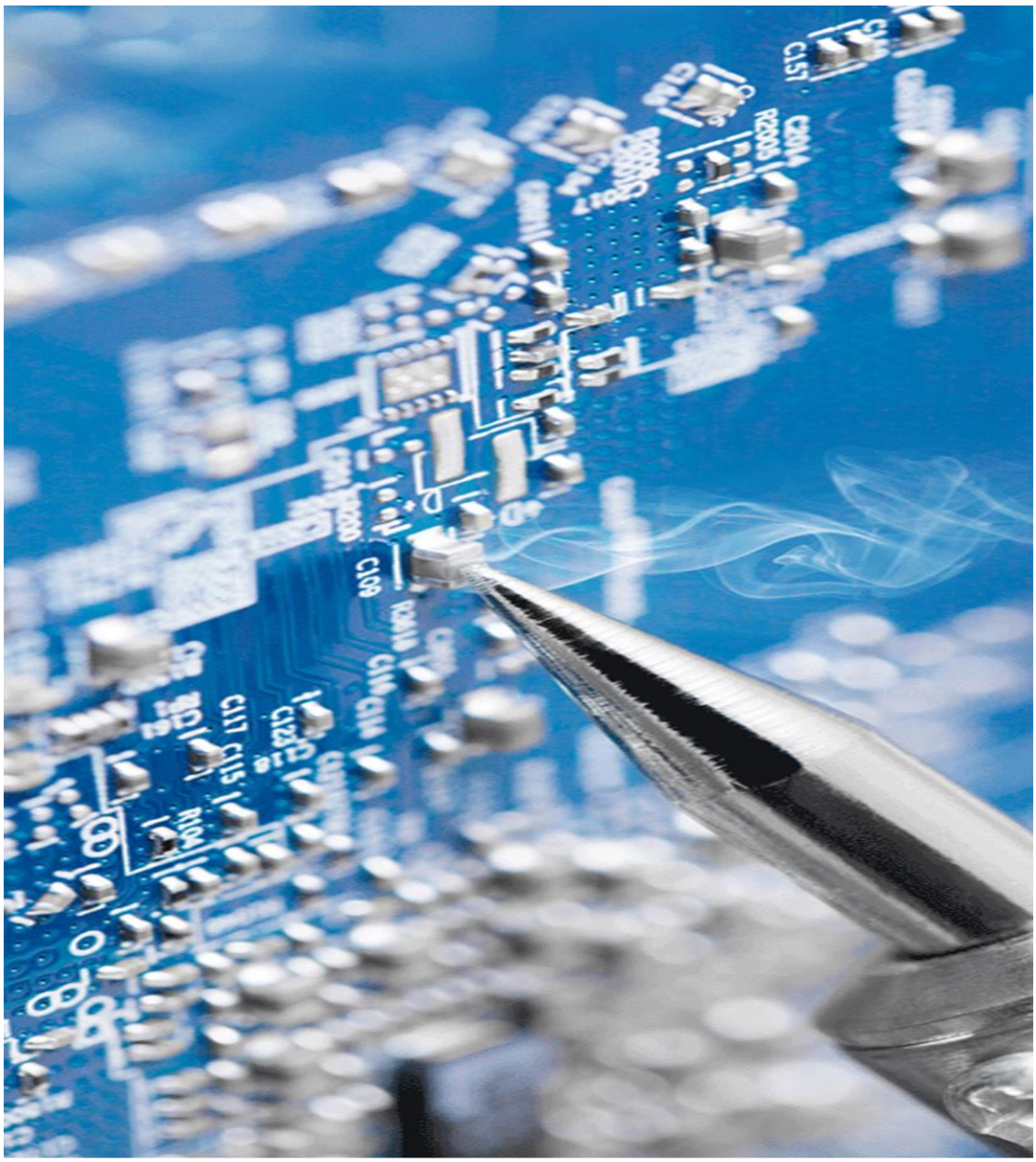


# PROJECT REPORT

## WATER-LEVEL-INDICATOR

**AYUSH JAIN** | **CAD-Laboratory** | **06-04-2018**

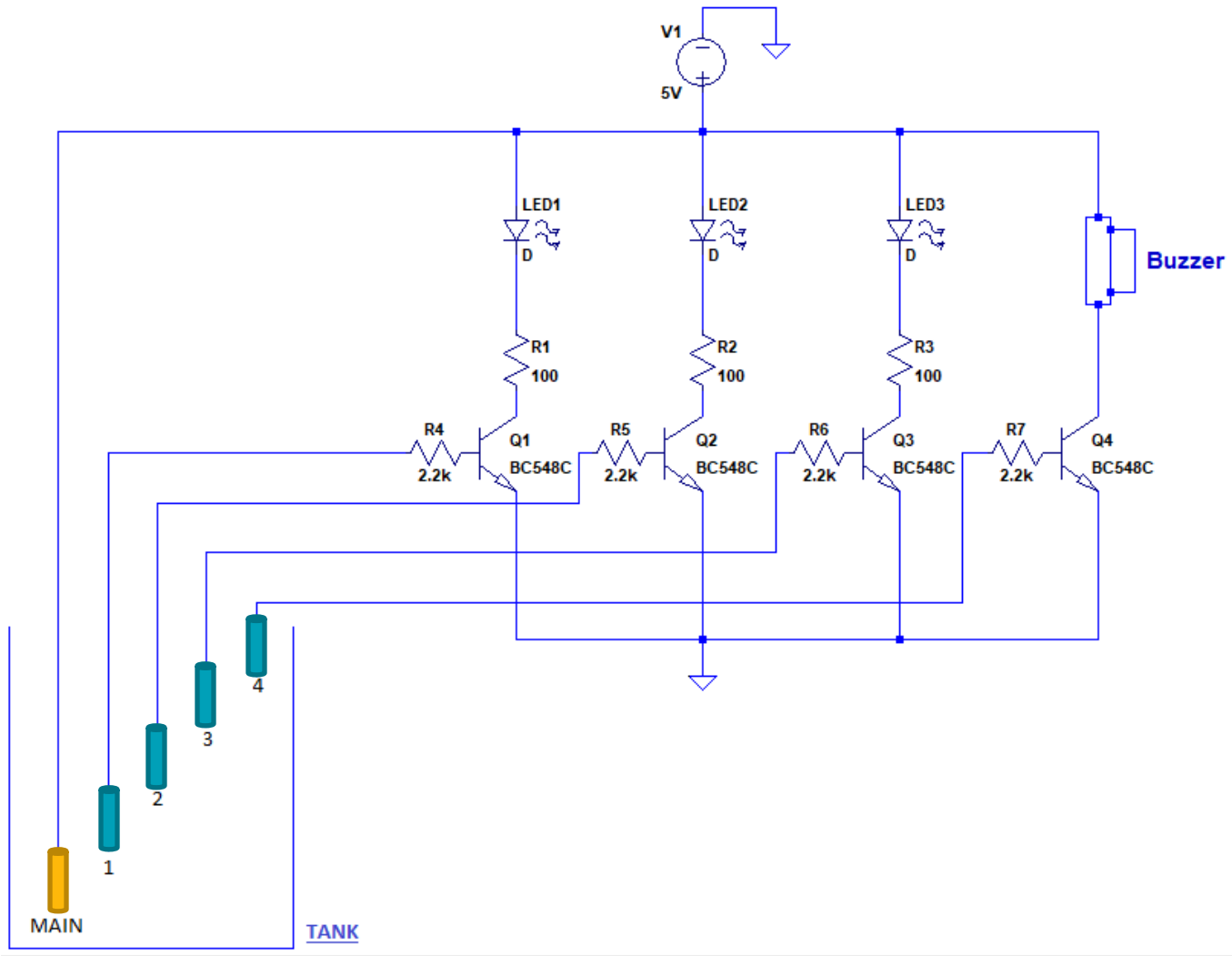
# WATER-LEVEL-INDICATOR

Introduction:- Today I am going to talk about a very useful project that I had taken up. It is called the Water Level Indicator Nowadays everybody has overhead tank at their homes. But everyone who has a water tank above knows the kind of problem that they face. Firstly there is no system to track the water in the tank. Then there comes a secondary problem that is when their water pump is started they have no idea when it gets filled up and sometimes there are situation where the pump keeps on pumping water to the tank and the water starts spilling out from the tank. There is wastage of energy as well as wastage of water.

## Components Required:-

1) BC 548C Transistors – **4pcs**
2) 2.2kΩ Resistors – **4pcs**
3) 100Ω Resistors – **4pcs**
4) LEDs (Red, Yellow, Green) – **3pcs**
5) Buzzer – **1pc**
6) Voltage Source – **5V**
7) Printed Circuit Board (PCB) – **1pc**
8) Wires

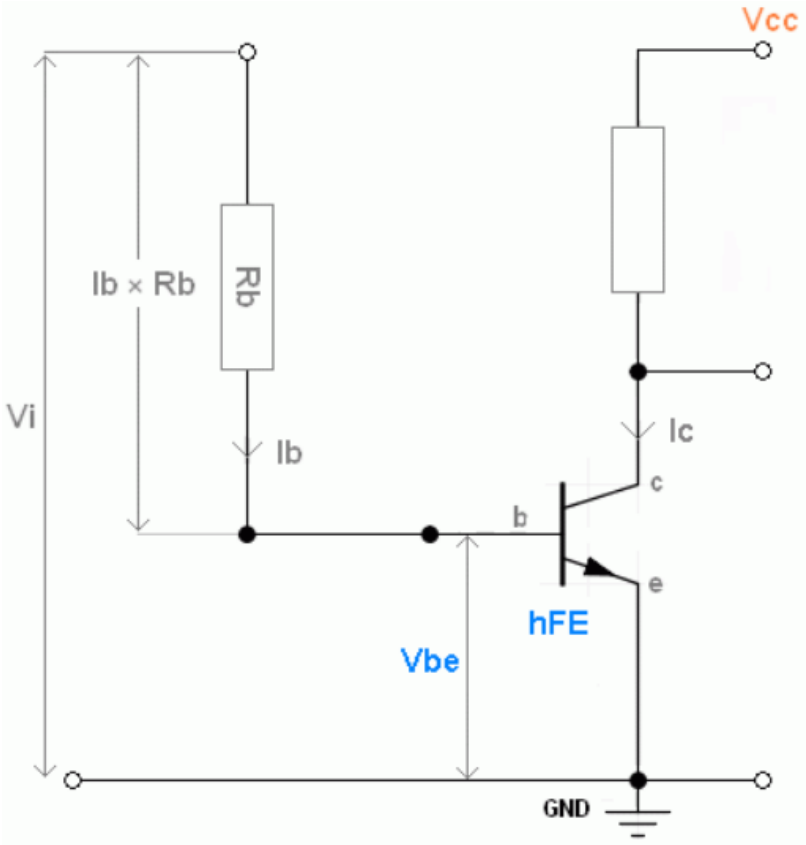
# Circuit – Diagram:-




Note:- Click on the image to view it.

**Description:-** We can consider this whole circuit as 4 small circuits, each one for indicating/alarming, when a particular level of water have been reached. When water level reaches to a particular level (Level 1, 2, 3) then the Led corresponding to that level (Green, Yellow, Red) will start glowing. And finally when tank gets full (Level 4), circuit with buzzer gets completed and buzzer starts beeping.

# Calculation for the Base resistor of the NPN transistor BC 548C:-




The voltage across the base resistor must be $I_b \times R_b$, this is simple Ohm's Law. The $V_{be}$ parameter is something we can easily find from the transistor datasheet.

$$V_i = (I_b \times R_b) + V_{be}$$

Therefore, with simple transposition of the above formula, the following formula provides the base resistance:

$$R_b = (V_i - V_{be}) / I_b$$

To guarantee that the transistor operates in the saturation region, we multiply the base current by a factor of six.

$$R_b = (V_i - V_{be}) / (6 \times I_b)$$

The base-emitter junctions of the bipolar transistor typically behave as a forward-biased diode with a 0.7 V drop across it.

$$V_b - V_e \approx 0.7$$

Now for calculating the value of $I_b$ we will use the following formula:

$$I_b = I_c / h_{FE}$$

As we know that, $h_{FE}$ is the DC gain, and $I_c$ is the collector current which is the same current flowing through the load.

Now from the datasheet of BC 548C we know that:-
$I_c = 10mA$, $h_{FE} \sim 430$ and $V_{be} = 0.7V$

Therefore,

$$I_b = I_c / h_{FE} \quad => I_b = (0.01 / 430)A$$

Also,

We are applying $V_i = 1V$

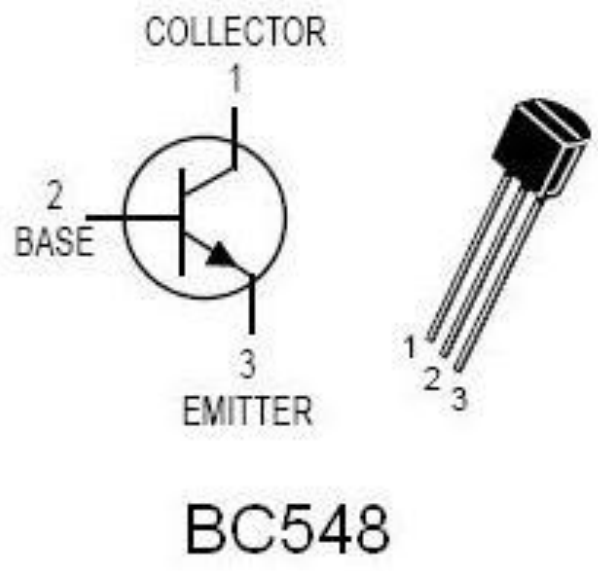
So, we get

$R_b = (V_i - V_{be}) / (6 \times I_b)$

=> $R_b = (1 - 0.7) / (6 \times 0.01/430)$

=> $R_b = 2150\ \Omega \sim$ **2.2 kΩ**

**Working:-** Here we are using transistor (of NPN type) as a switch. Initially there is no voltage applied to the base of the Transistors and the transistors are in OFF state and no current is flowing through collector and emitter so LEDs are also OFF.




When the water level reaches to Point 1 in the tank, the positive side of the battery gets connected to the base of the Transistor Q1 through the water. So when a positive voltage has been applied to the base of the Transistor Q1, it gets into ON state and current starts flowing from collector to emitter and LED-1 glows.

You can see resistors (R4, R5, R6, R7) at the base of each transistor, which is used to limit the maximum Base current. Generally a transistor gets its ON state fully when voltage of 0.7 V is applied to the base. There are also resistors (R1, R2, R3) with each of the LEDs, to drop the voltage across LEDs, otherwise LED may blow up.

Same phenomenon happens when water level reaches to Point 2. As soon as water level reaches to Point 2, a positive voltage gets applied to the Transistor Q2, it gets ON and current started flowing through LED-2, and LED-2 glows. With same principle, LED-3 glows when water level reaches to Point 3 and finally Buzzer beeps when water level reaches to 4.

**Note** -- Left most wire in the tank must be larger than other four wires in the tanks, because this is the wire which is connected to positive voltage.

## Simulation Using LTspice :-

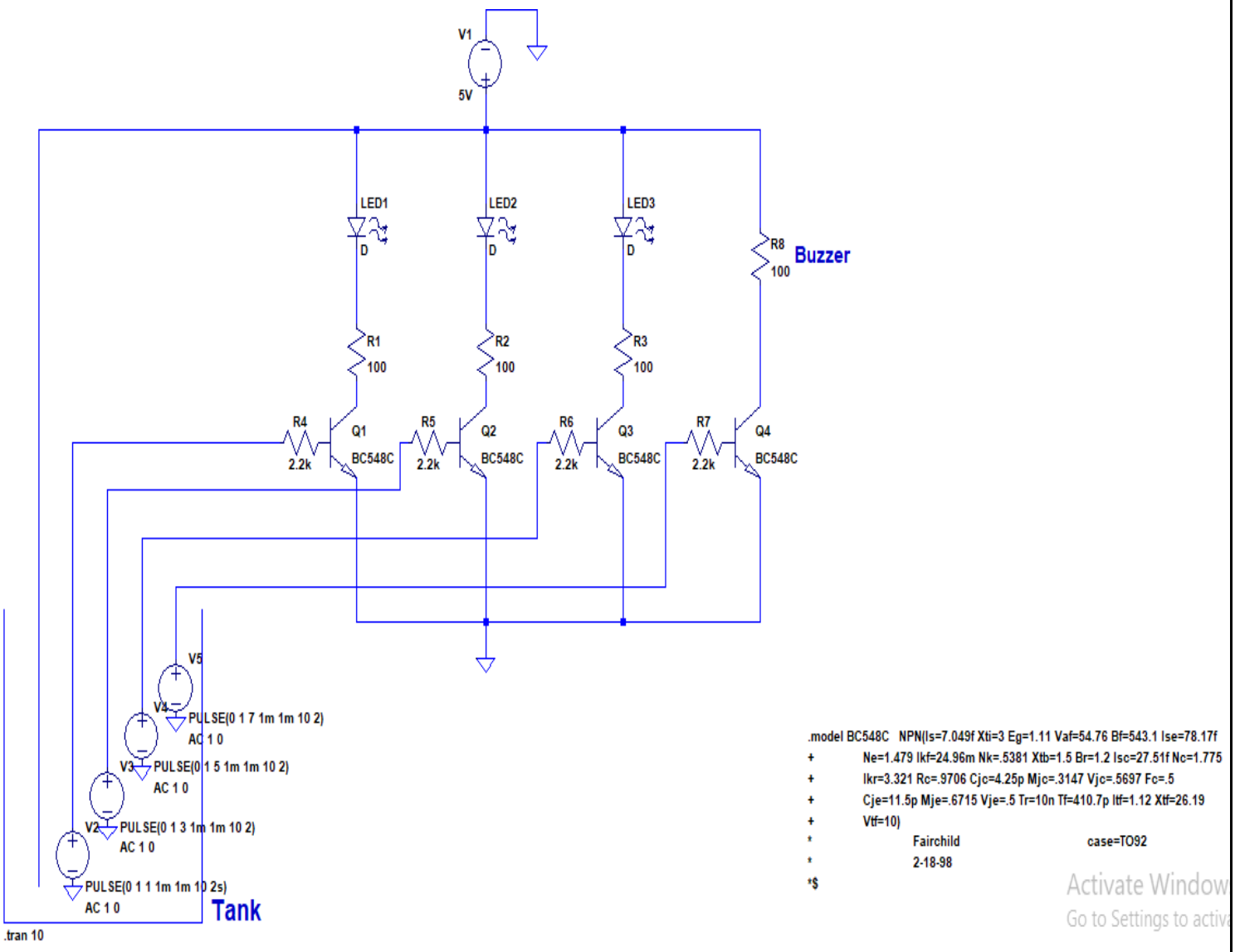
I have performed the transient analysis for a stop time of 10 sec. using LTspice.
I have used 4 ac-pulse voltage sources each having a time delay of 2 sec with respect to the previous one to indicate the water level in the tank.
For the simulation of Buzzer, I have used a 100 Ω resistor.
The main power supply voltage is 5V.
Also to get the BC-548C transistor I have downloaded the .mod (model file) and used it during simulations.

### Model File for BC-548C Transistor :-

```
.model BC548C NPN(Is=7.049f Xti=3 Eg=1.11 Vaf=54.76 Bf=543.1 Ise=78.17f
+             Ne=1.479 Ikf=24.96m Nk=.5381 Xtb=1.5 Br=1.2 Isc=27.51f Nc=1.775
+             Ikr=3.321 Rc=.9706 Cjc=4.25p Mjc=.3147 Vjc=.5697 Fc=.5
+             Cje=11.5p Mje=.6715 Vje=.5 Tr=10n Tf=410.7p Itf=1.12 Xtf=26.19
```

```
+             Vtf=10)
*             Fairchild            case=TO92
*             2-18-98
*$
```

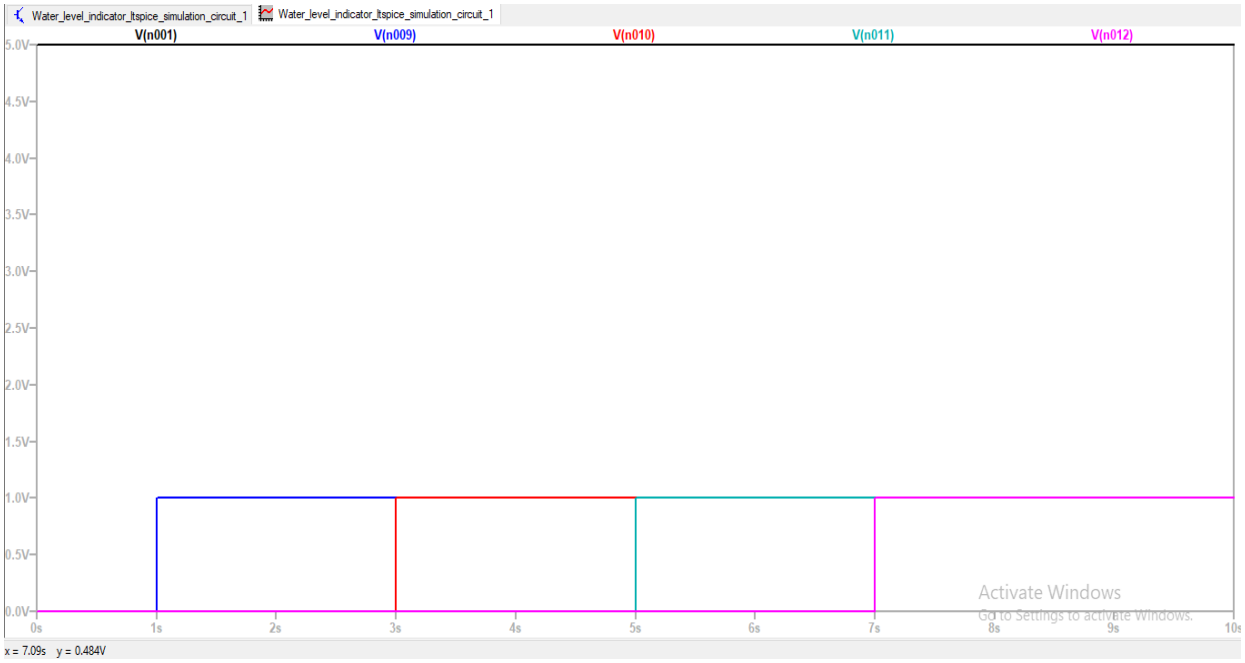
# Circuit used for Simulation :-




Note:- Click on the image to view it.

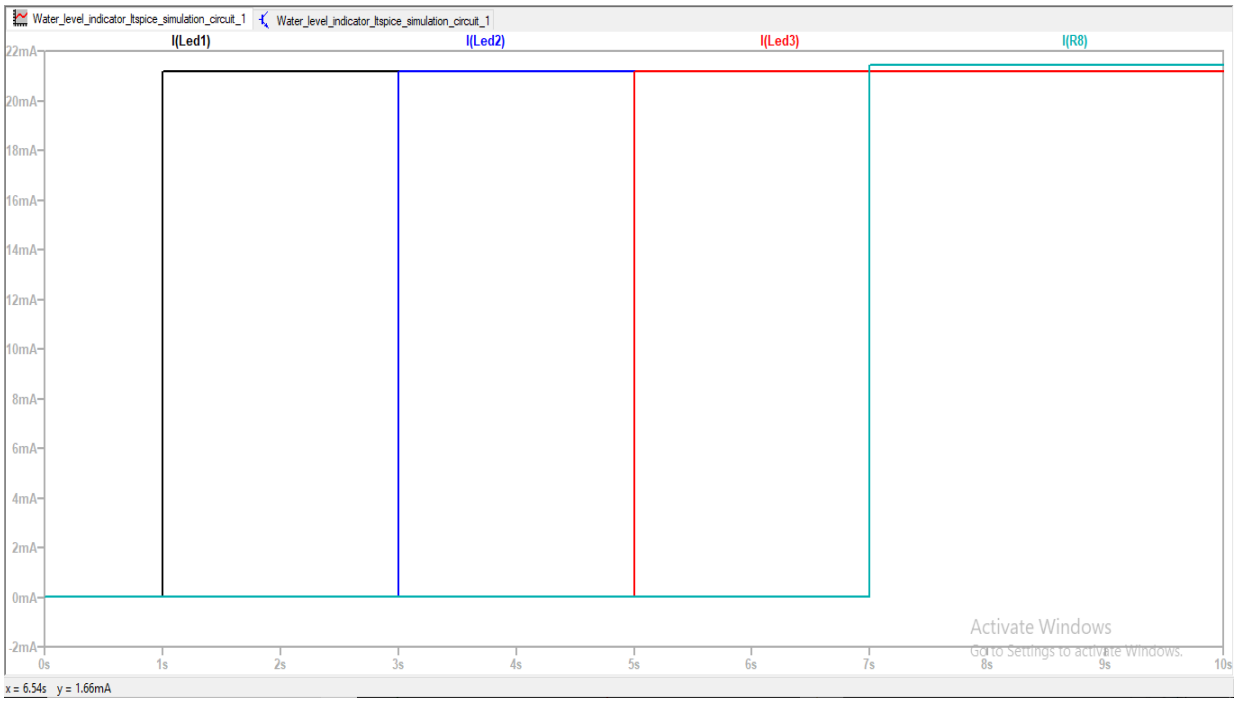
# Simulation Waveforms :-

## a) Voltage waveforms:-

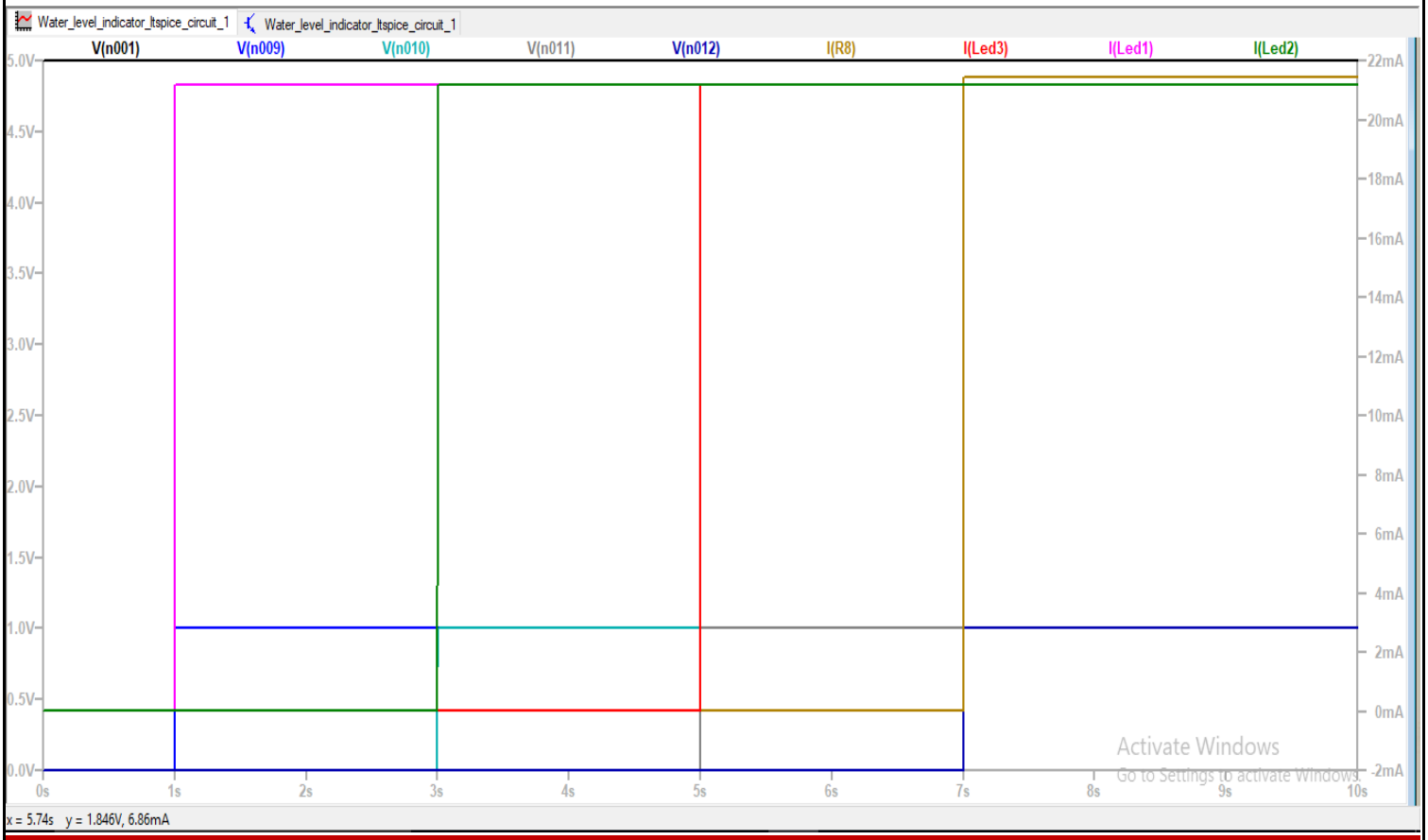



Note:- Click on the images to view them.

## b) Current waveforms:-



# Combined waveform:-




Note:- Click on the image to view it.

This displays that as the water reaches at each level after a fixed interval of 2 seconds each the current begins to flow through the LED belonging to that particular level, and therefore it starts glowing.

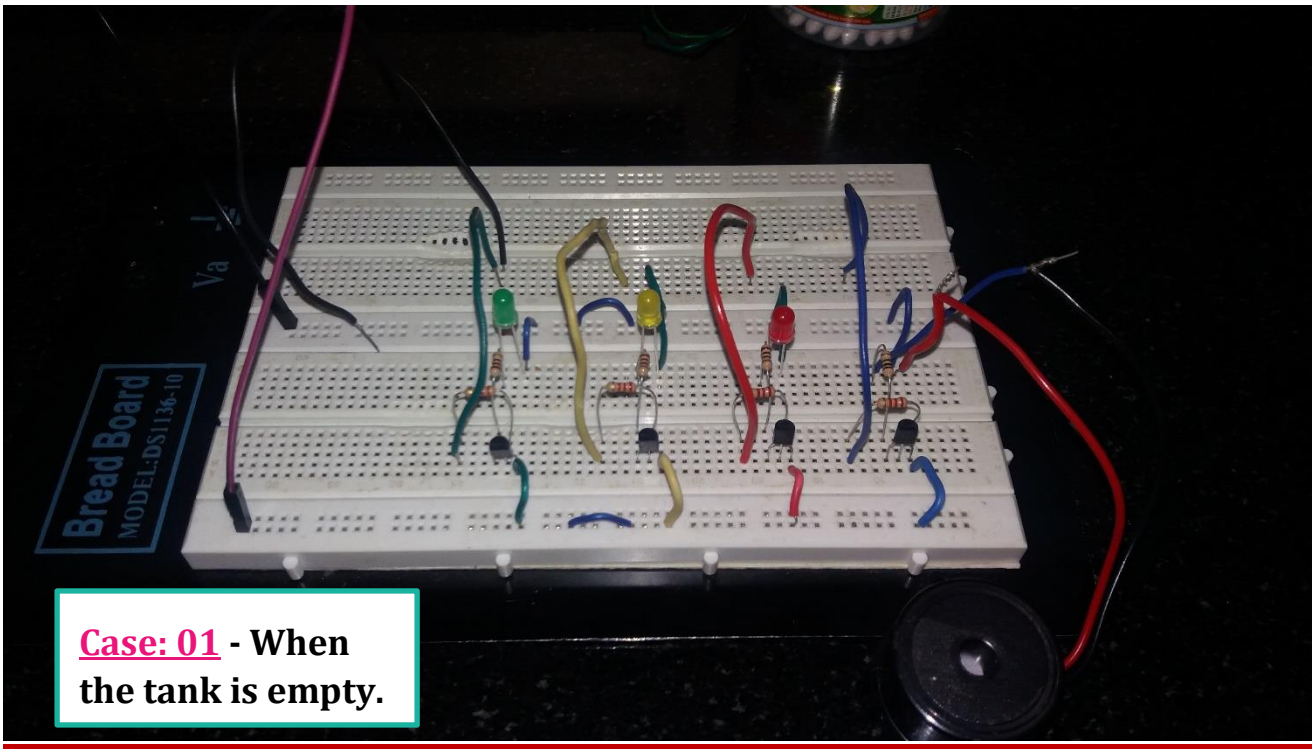
Finally after 7 seconds when water reach to the top level the branch having buzzer becomes conducting and as a result the buzzer starts beeping.

## Observations at definite intervals:-

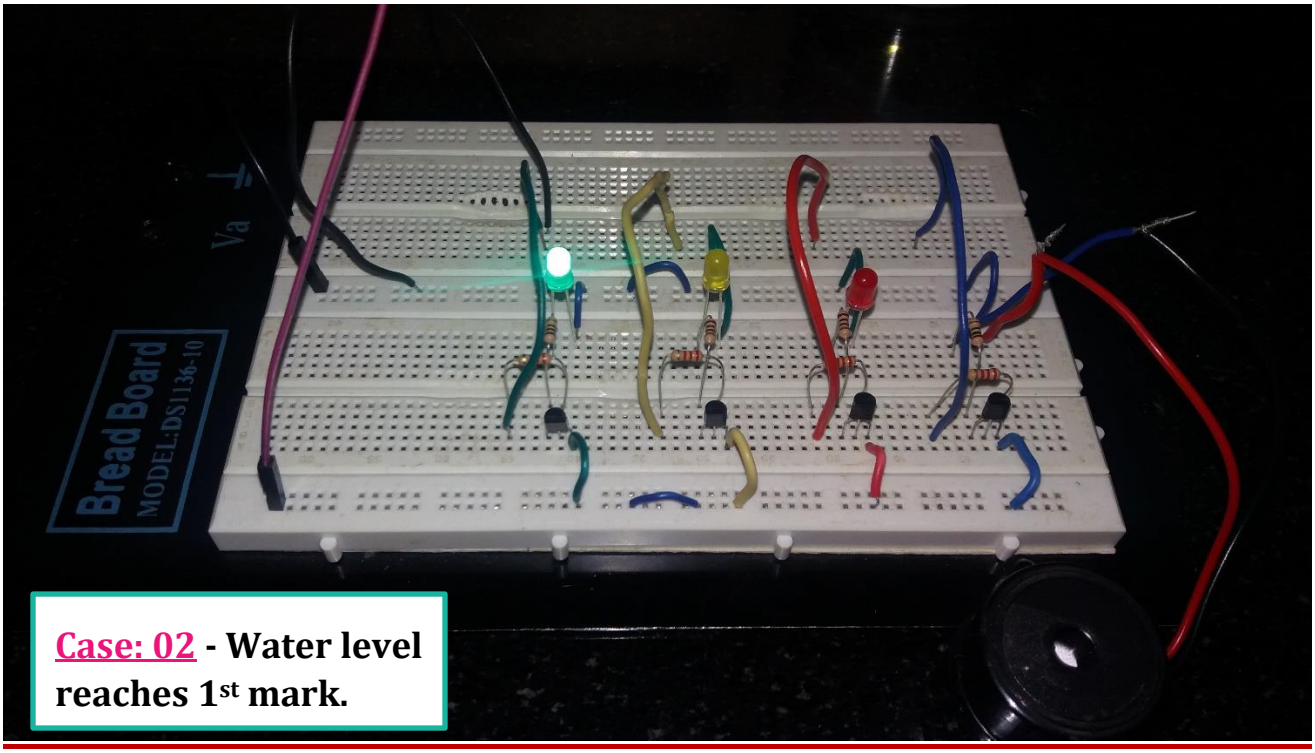
1) **At t = 0 seconds:**
   - Water level starts rising in the tank.
2) **At t = 1 seconds:**
   - Water level reaches the 1st mark. So LED1 (Green) starts glowing.
3) **At t = 2 seconds:**
   - Water level continues to rise.
4) **At t = 3 seconds:**
   - Water level reaches the 2nd mark. So LED2 (Yellow) also starts glowing.
5) **At t = 4 seconds:**
   - Water level continues to rise.
6) **At t = 5 seconds:**
   - Water level reaches the 3rd mark. So LED3 (Red) also starts glowing.
7) **At t = 6 seconds:**
   - Water level continues to rise.
8) **At t = 7 seconds:**
   - Water level reaches up to the brim. So buzzer starts beeping.

The buzzer beeps continuously until the water level reduces or the power supply is switched off.

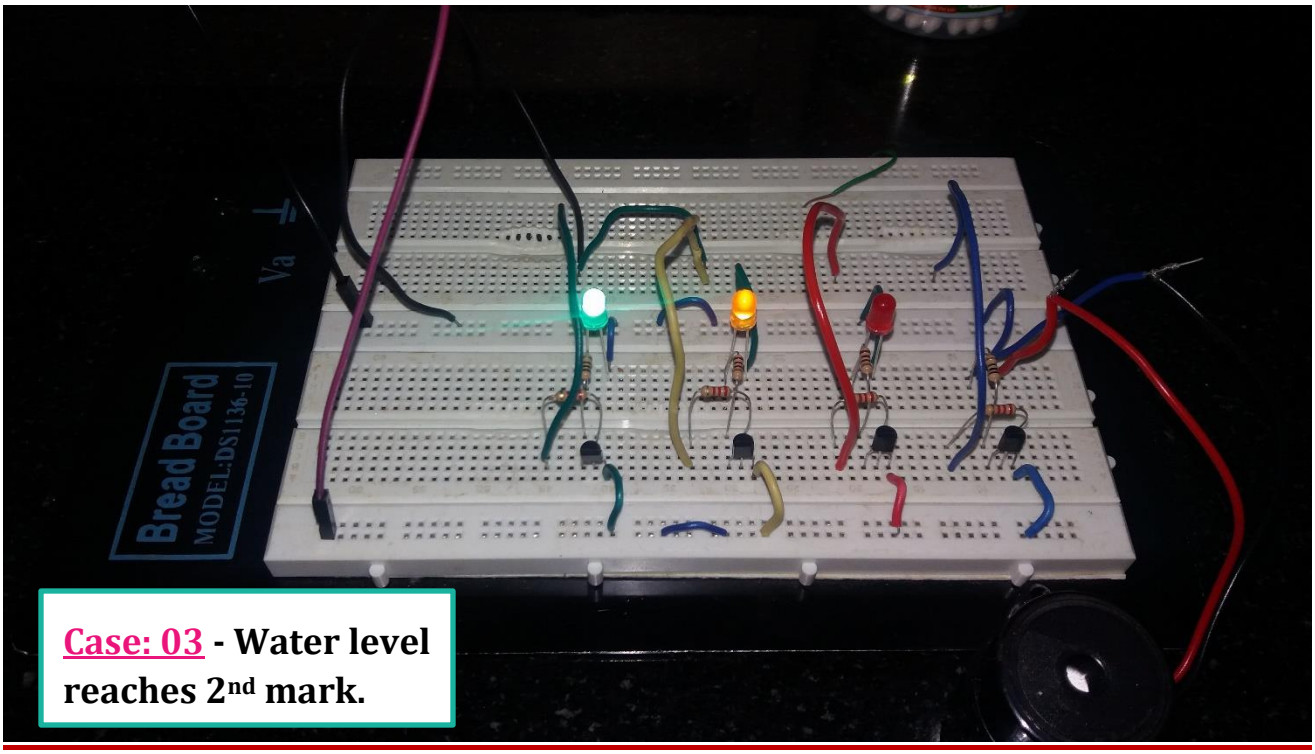
# Images of the Circuit on the breadboard:-



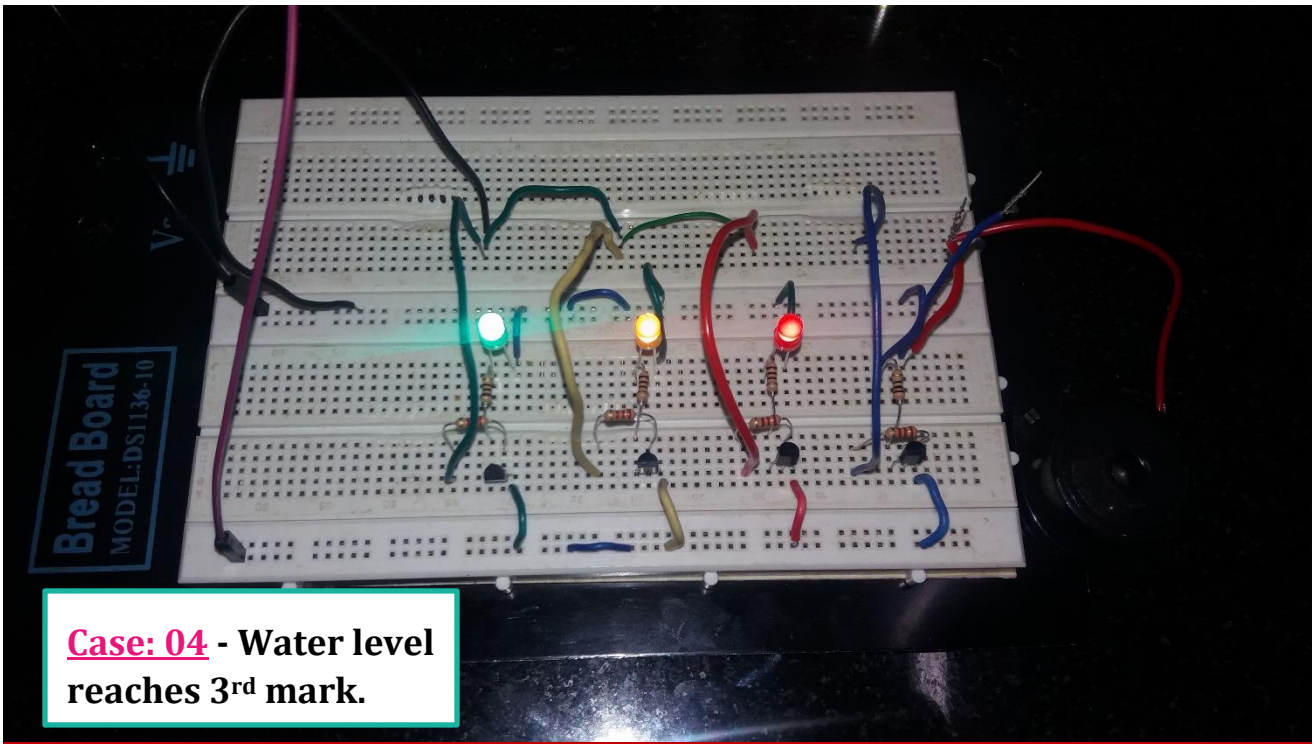

**Case: 01 - When the tank is empty.**




**Case: 02 - Water level reaches 1st mark.**

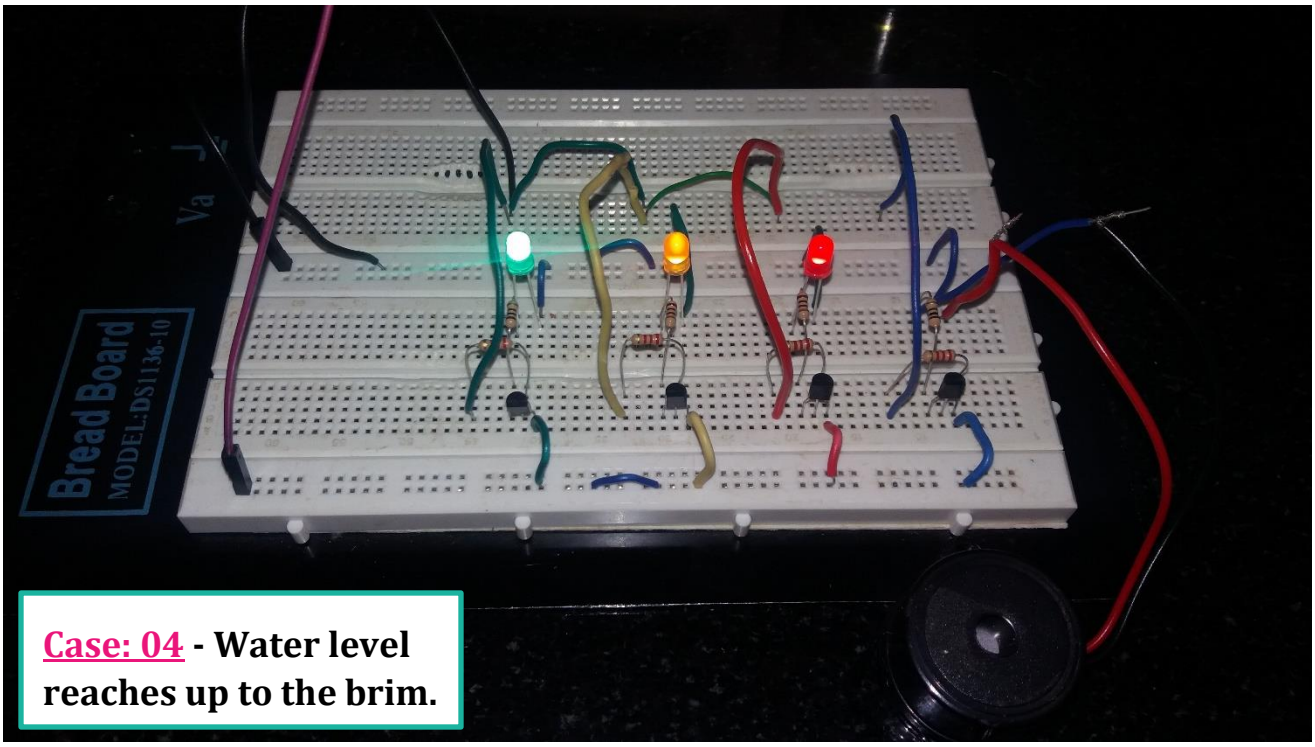



**Case: 03 - Water level reaches 2nd mark.**



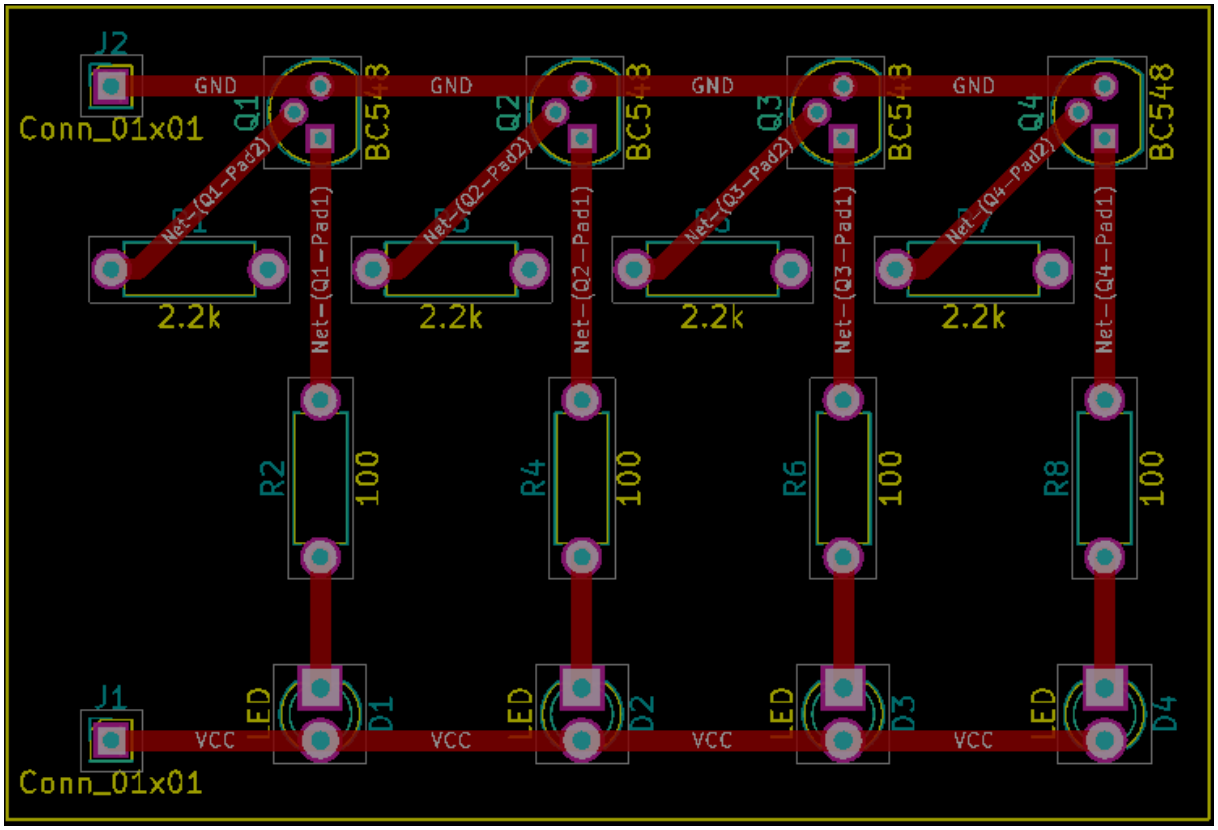

**Case: 04 - Water level reaches 3rd mark.**

Note:- Click on the images to view them.

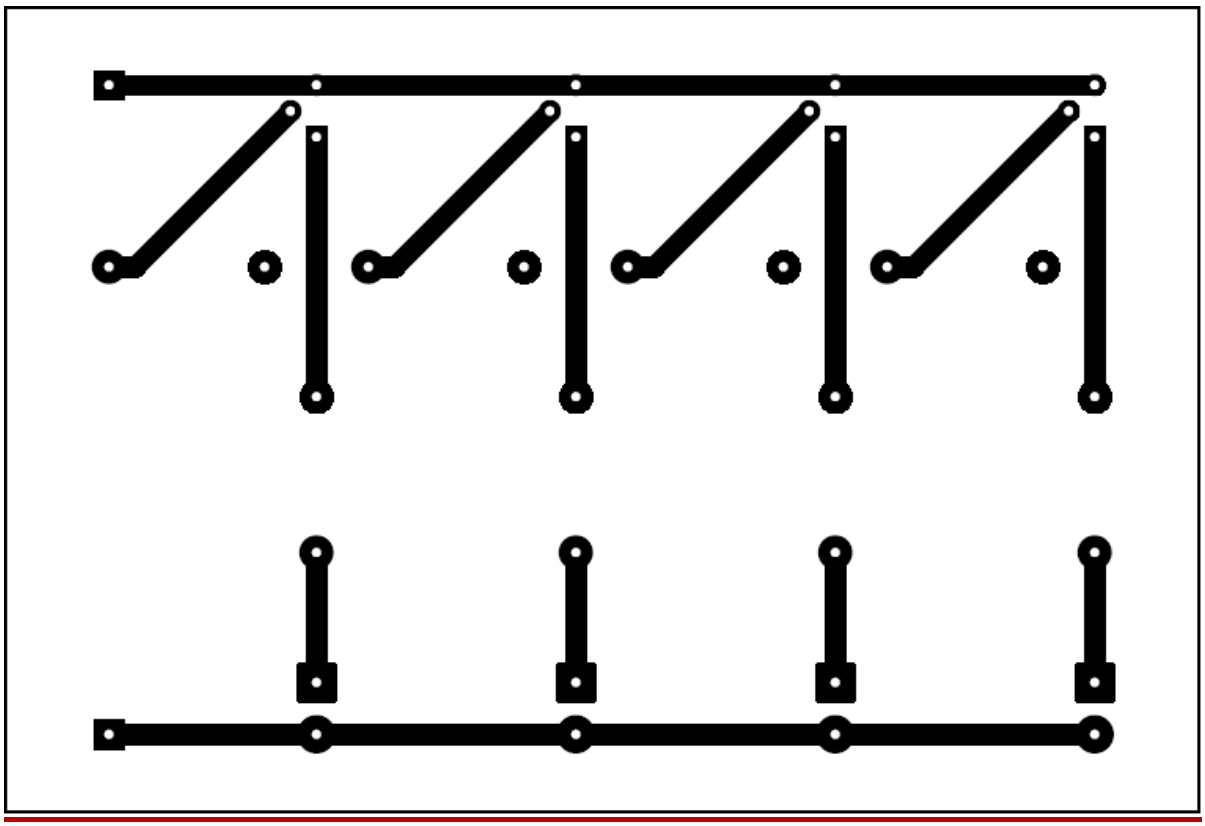



**Case: 04 - Water level reaches up to the brim.**

# Kicad Auto-Routing:-



# Kicad Layout:-



## Procedure for Toner Transfer :-

1) Paste the printed glossy sheet on the Cu board (printed-side facing Cu board).
2) Transfer the printed layout on the Cu board by pressing the printed glossy sheet on the Cu board, using an iron box.
3) Subsequently, place the Cu board in a dish containing water, in order to remove the glossy paper from the Cu board. Take care not to scratch the surface of the Cu board.

## Note:-

- Before transferring the toner on the PCB, clean it with acetone to remove the dust and dirt particles.
- Do not do pressing with iron for more than 1 to 2 minutes.
- Also, apply enough pressure as required to get the exact print on the PCB.

## Procedure for Etching of Cu :-

Etch Cu from the unmasked portions of the board (that is, portions not covered by toner ink). To this end, use a mixture of 30% HCl (further diluted by water; HCl:$H_2O$ = 1:2) and 30% $H_2O_2$ (further diluted by water; $H_2O_2$:$H_2O$ = 1:1).

## Note:-

- Before etching, you must ensure that the toner is completely transferred on the PCB. If toner is missing in some portions, then apply whitener to that region as whitener remains unaffected during etching, and thus protects the copper below it.

## Removal of Toner :-

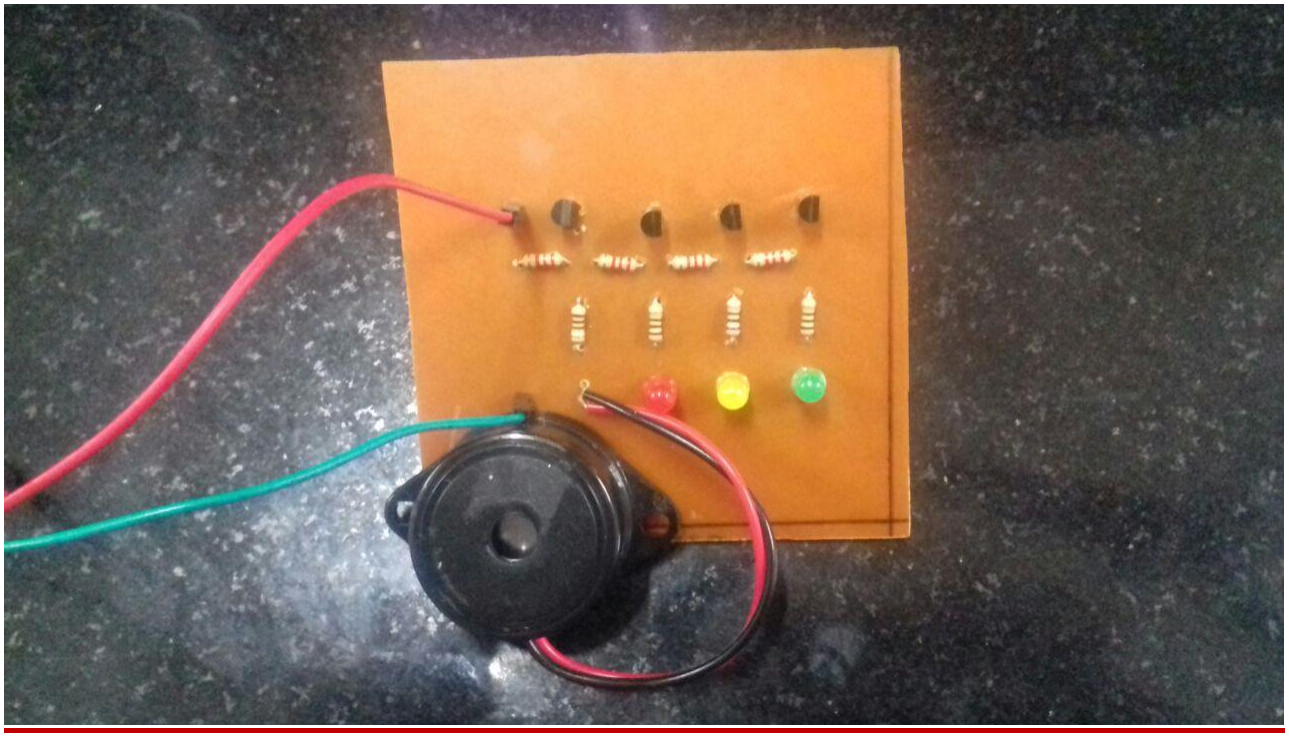
After complete etching of Cu from the unmasked portions of the board, remove the toner ink by immersing the board in acetone. The toner ink is

removed, to reveal the underlying Cu layer. **Take care not to scratch the surface of the Cu board in the process**. The acetone will remove whitener ink also.

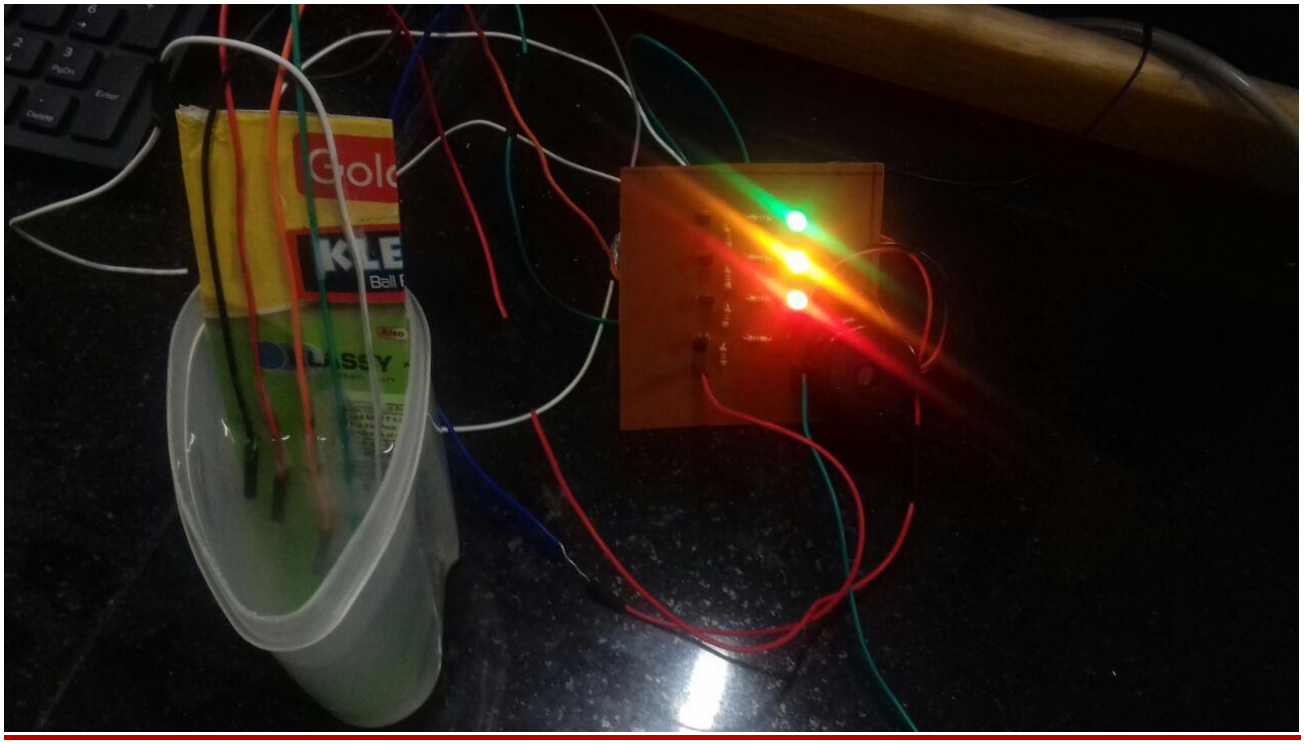
Now, drill holes at appropriate places, so that components can be placed/soldered properly on the PCB.
Finally, Solder all the components.

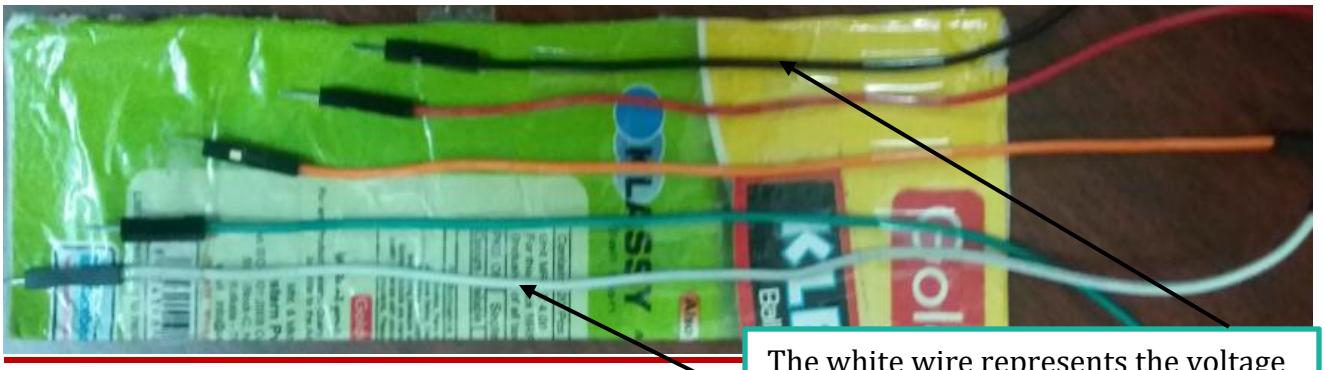
## PCB Design and Soldering:-

## Circuit on PCB:-



## Demo of the Circuit :-





The white wire represents the voltage line, while every other wire represents the different levels of water in the container. (Green – the bottom level while Black represents the top level.)

# Conclusion:-

From this lab I learnt:

- Designing circuits using breadboard.
- About **LT Spice** simulation software and to design circuits using various components in the **LT Spice.**
- How to simulate circuits using **LT Spice** simulation software and understanding its characteristics.
- About **Kicad** software and how to create layout for PCB using it.
- To construct circuits on the PCB (Printed Circuit Board).
- About Water Level Indicator and its construction.