Abstract

Water is one of the most precious resources we have seeing that virtually every creature on this planet needs it to survive. Every drop counts, and every drop needs not to be wasted. Our project plays a role in conserving water by creating a rain alarm that detects water as its main task. This report contains a brief introduction on the project followed by the materials and methodology used to implement the project. The results are stated and then analysed in the discussion. Finally, the conclusion will show how the objectives have been achieved and what key findings have been uncovered throughout the project. The method we used to create the rain alarm is the by connecting two silicon transistors with a capacitor and a speaker. We reached to the conclusion that creating a rain alarm is applicable and can further be improved to serve many significant purposes. The project allowed us to work as a team and apply what we have learned throughout the course. It is recommended to use our project for other functions not just conserving water. An example of that is to protect people from great hazards when the presence of water is dangerous such as places with high voltages of electricity or chemicals. The project could also be further modified to detect water levels.

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1.0 Introduction

It is a principle skill for engineers to utilize acquired knowledge by applying it to everyday life. The course of Electrical Engineering Technology EE306 has served to teach that to students in addition to the ability to assemble and analyze multiple types of significant circuits. It has also provided students with the materials and technical skills that are meant to fill the gap between various courses. This mini project converts all of what has been taught into real life applications.

The most priceless and precious element Earth will always depend on is water; unfortunately, almost one billion people worldwide still lack access to clean water. It will always be our duty to conserve the clean water we have in any way possible. For this reason, we have chosen **Rain Alarm** as our project for this course. A rain alarm has a speaker that vibrates and releases a tone when in contact with water.

We have previously learned in EE306 about multivibrators and transistors. Our project can operate using either an a stable multivibrator, a common silicon transistor, or a sensor with a silicon-controlled rectifier. We have chosen to use the type with the components we are most familiar with which is the circuit with the silicon transistor. The team has come to the consent that our problem statement is the following:

The main objectives of our project are to develop a circuit that detects water, to work as a team cooperatively and collaboratively, and to convert the knowledge we have learned throughout the course into a beneficial application.

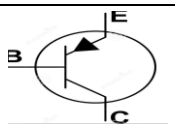
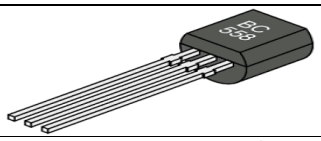
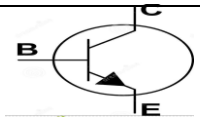
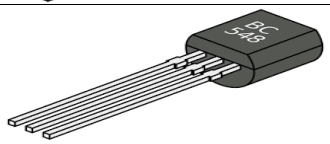
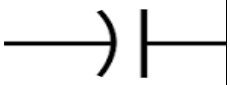
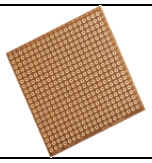
> To convert the knowledge, we learned throughout the course into a real life beneficial application by creating a rain alarm that can detect water.

2.0 Objective of the Project.

1- The main purpose is to develop an alarm circuit when rain falls.
2- Another objective is using it to conserve water, prevent groundwater and waterways pollution.

3.0 Materials

Table1 shows the project material clearly.

Table1: Project materials			
Materials	Symbols	Models	Quantity
1. Resistor 10 KΩ.			1
2. Resistor 330 KΩ.			1
3. Transistor BC558.			1
4. Transistor BC548.			1
5. capacitor 0.01 mF.			1
6. battery 3V.			1
7. Vero board.	-		1
8. Wires.	-		-
9- Speaker	-		1

10- Soldering iron	-		1
11- Soldering wires	-		-

4.0 Methodology

In this section, there will be a clear demonstration of both components and circuit diagram with detailed information. later, a set of tests to the components have been conducted.

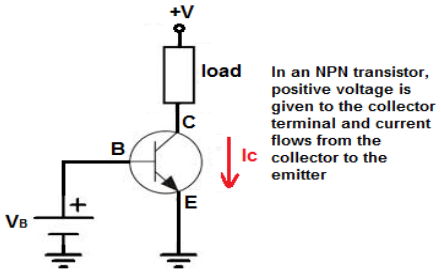
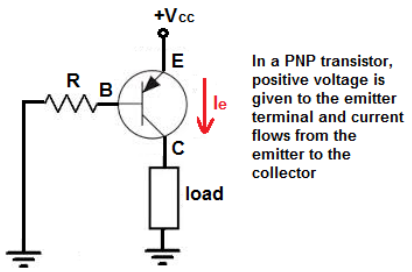
4.1 Components Demonstration

Rain Alarm is a device which will generate the signal (the tone of the speaker) when the rain falls on the two probes (which is the sensor). The frequency of the tone of the speaker will be more when the rain is heavy and the frequency is very less when the rain will be little. It all means that the frequency will depend upon the rain. So, the circuit will generate tone whenever the rain starts.

Before starting to explain the circuit, diagram there must be a clear understanding about the components specially transistors as it's the main part of the circuit. And in order to that a simple comparing table have been constructed as shown in (table 2) below [1], [2]. They used because of their low operating voltages for greater safety and lowest cost

Table2. The difference between NPN and PNP transistors

	NPN Transistor	**PNP Transistor**
Similarities	Both NPN and PNP are bipolar junction transistors (BJTs). BJTs are current-controlled transistors that allow for current amplification. Which means they provide amplification and/or switching capability.	
Flowing of current	current flows from the collector to the emitter	current flows from the emitter to the collector.

Turning on the transistor	It turns on when a sufficient current is supplied to the base of the transistor.	It turns on when a sufficient current is supplied to the emitter of the transistor and no current at the base.
Illustrated figures		

Second important component is the speaker which produces sound based on reverse of the piezoelectric effect. The generation of pressure variation or strain by the application of electric potential across a piezoelectric material is the underlying principle. It consists of piezo crystals between two conductors and when a potential is applied across these crystals, they push in one conductor and pull on the other and this push and pull action, results in a sound wave.

4.2 Circuit Diagram Demonstration

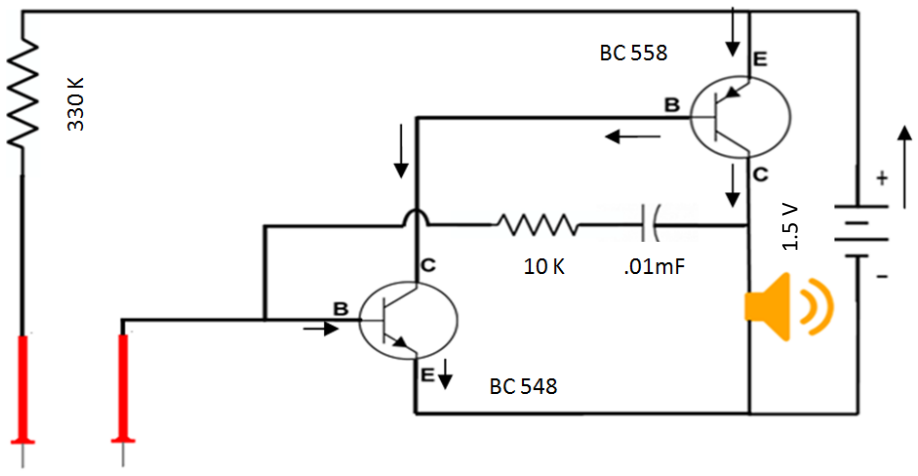


Figure1. The schematic diagram of the rain alarm.

the explanation of the circuit diagram shown above (figure 1) is:

Initially, when there is no rain outside, the circuit will be open and so no current will flow so the transistor will be off then the speaker will not beep.

However, when it rains outside and water is in contact with the prob(sensor) the circuit will be closed as water is a conductor of electricity, some current will pass throw the base of NPN transistor (BC548) and this will turn it on and let current flow throw its emitter. On the other side, current is flowing from the battery to the emitter of the PNP transistor (BC558) so it will be turned on and current flow from emitter to the collector to the speaker and an oscillation is created in the circuit thus, it will start beeping.

When the current flow through the capacitor, the capacitor will fully charge and act in the circuit as a battery. The benefit having a capacitor in the circuit is when the density of the rain is low, the connection between terminals of the probe will be weak and accordingly the current will be also weak and as a result of that the speaker will produce a choppy and weak alarm. So, when the capacitor is fully charge it will act as a battery and prevent the sound of the speaker to be choppy when the density of the rain is low. In the speaker, there is an inductive coil that causes the motion in one direction and because of that the induced current will be produced, which is in opposite direction to the flow of the current. The form of the induced current is a pulse. The induced current will flow through the capacitor, resistor and makes the NPN transistor off to reach to the previous state. This process will be repeated again and again since there is a water in the probe. To sum up, as have stated above when the rain falls on the probe the current will flow in the circuit through the components and make the speaker vibrates and gives a tone.

4.3 Conducted Tests

The components of the circuit must be tested before, during and after construction the circuit, to be sure that the components and the circuit will work correctly. Also after construction the circuit the output voltage must be tested to chick if the results were expected or there are any errors. In the following sections, there will be a brief explanation of the tests have been conducted.

4.3.1 Resistor Test

This test aimed to check if the values of resistors are true and close to its rated value using digital multimeter.

4.3.2 Capacitor Test

This test aimed to check if it is good or bad before construction the circuit when it is fully discharged and to insure its value using digital multimeter.

4.3.3 The Output Voltage Test

There were three tests, the first one was conducted to check if the BC548 is working as a switch when the circuit is closed as there will be small amount of current passing through its base and approximately no voltage from its collector to emitter. Also, to check the amount of voltage across Bc585 that allows current to flow to the speaker so we can hear sound. And last test is the output voltage across speaker to check if it is working correctly. All of these tests were carried out using DMM.

4.3.4 The Output Current Test

This test was conducted to see the amount of current output it from the circuit.

5.0 Results

In this section, the measured values tests above were implemented as follows.

5.1 Results of the Resistors Test

This test was conducted to insure the values of the resistors as mentioned above in the tests section. Table 3 shows the readings of resistors test.

Table 3. Readings of resistors test

No. of Reading	Experimental value of resistance (Ω)	Theoretical value of resistance (Ω)	Error (%)
1	10004 Ω	10,000 Ω	$\left\|\frac{10000-10004}{10000}\right\| \times 100 = 0.04\%$
2	329 K Ω	330 K Ω	0.3%

5.2 Results of the Capacitor Test

Firstly, the capacitor was tested when it is fully discharge to check if it is defective or effective using DMM as shown in figure 2. Digital meter shows some numbers for a second and then it is turned to (OL).

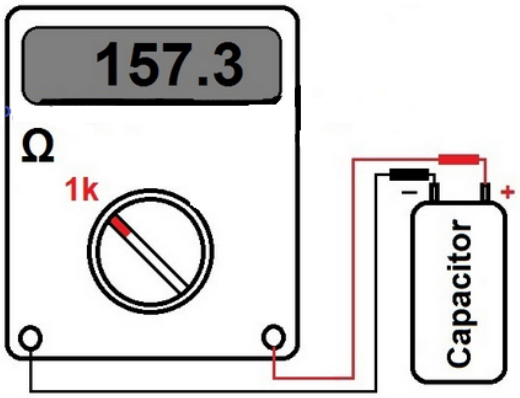


Figure 2. The Result of testing uncharged capacitor.

Secondary to insure its value, DMM was used as shown in figure 3 below

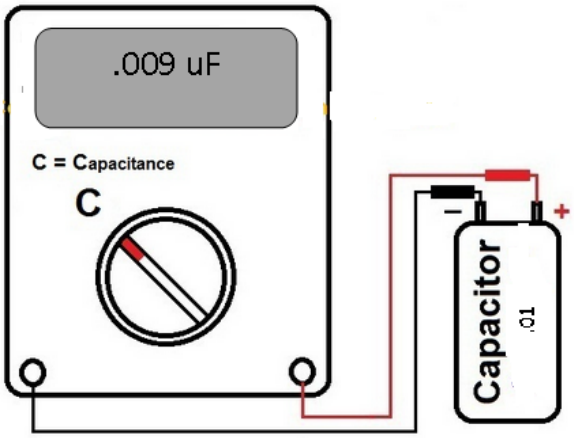


Figure 3. The Result of testing the capacitor value

5.3 Results of the Output Voltage and Current

The following table (table 4) shows the readings for BC 585 and BC 548 transistors output voltage also the speaker voltage before and after the switch closed.

Table 4. Readings of the output voltage		
Component	**Voltage (v)**	
BC 585	.002	
BC 548	1.38	
Speaker	Before	0.00
	After	0 .11

The value of current in the output terminal of the circuit was 1.041 A

6.0 Discussion

The purpose of doing this project is to develop an alarm circuit when rain falls. A rain alarm has a speaker that vibrates and releases a tone when in contact with water. Several tests have been conducted to check the circuit efficiency and in this section the discussion of the results will be showed.

Firstly, in the resistors test to measure its value. the way to know the accuracy of measuring it, is by looking for the tolerance color which was (gold) and it should be in the range of (-5% - +5%). If it was out of this range then the reason would be due to the measurement or temperature changes. Therefore, the error of this part is due to the tolerance of the resistors.

Secondary, in the capacitor test was used to check its quality and its experimental value using DMM. As the digital mustimeter shows numbers it's mean that capacitor is in Good Condition. However, if there is no change, then capacitor is dead. There was a little difference between the actual and experimental values with 10% error due to temperature conditions.

The last part which is measuring the output voltages, first of all transistor (BC548) which is turned on when a small amount of current has passed through its base thus, it has

observed that 1.38 volt coming from the battery across its collector and emitter when the probe is in contact with water. Secondary, (BC585) behaves as a switch, it operates in a saturated condition and this was proved by measuring the output voltage from collector to emitter and it was approximately 0 volt so, this means that a voltage coming from the battery has passed from its emitter to collector and turned the transistor on. Secondary, through it to turn on the speaker. About the speaker has observed that is have a small amount of voltage and that is because of the (10K) series resistor thus the voltage coming from battery will divided on the components which is a good manner to save them from defect.

At the end, the objective of the project has been achieved which is successfully developing a rain alarm circuit that releases a tone when rain falls.

The circuit can be used in verity of application, it's used to prevent diseases damage and nutrient loss also, using a rain alarm prevents unnecessary wear and tear of the lawn irrigation system since it minimizes the amount of time that lawn irrigation is in operation specially in rainy seasons. Moreover, to prevent groundwater and waterways pollution.

Conclusion

In conclusion, a circuit that detects water was successfully created. We had difficulties in soldering the elements seeing that it was the first time we solder, and not all members were able to attend the soldering class with Dr. Khawa. We solved this problem by distributing the work among members and teaching each other skills that some members had and others lacked. This has given us the opportunity to work as a team cooperatively and collaborative. We also faced problems with connecting the circuit which allowed us to revise everything we learned throughout the course to figure out the problem. The problem turned out to be at first with the bread board and then with the connection of the capacitors. By that, all three objectives of the project were achieved. We found out that when the water touches the probes of the circuit, it sounds the alarm; however, all other wires must not touch each other during after soldering because it causes the circuit to close and thus makes a continuous beeping sound. The project can be improved by adding multiple probes to detect water levels. It could also be further improved by collecting water in a dam or a storage unit. Also, the project can be applied in situation where the presence of water jeopardizes the safety of people such as places with high voltages, open wires, or chemical lab tests.

References

[1] http://www.learningaboutelectronics.com/Articles/Difference-between-a-NPN-and-a-PNP-transistor

[2] http://www.electronics-tutorials.ws/transistor/tran_3.html