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Design and Development of NPN-Transistor Based Soil Moisture Analyzer

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ABSTRACT: Moisture content in the soil is an important factor for agriculture crops and development of plants. Plants grow easily due to moisture in the soil. To effectively measure the moisture present in the soil, many theoretical and experimental models have been given time to time by which the moisture present in the soil can be detected. In this project we, have developed BC-547-NPN transistor based moisture detection device by which, we can detect the moisture present in the soil under normal conditions. Transistor, resister, LED and power supply are used to construct the aforementioned detection device. This device mainly works on principal that in dry soil resistance becomes high so the conduction of current will be low but as the water contentment increases in the soil conduction of current becomes high due to low resistance and LED becomes glow. Device is very cost effective because we have not used any microcontrollers.

KEYWORDS: Soil Moisture, NPN Transistor, Sensor, Current conduction.

I. INTRODUCTION

In the last few years, various scientists have developed different types of instruments to measure the moisture present in the soil, by which the moisture present in the soil can be measured with great accuracy. Moisture of soil plays a significant in the development of plant, crop production in agriculture land and soil health. Monitoring soil moisture is crucial for effective water management, ensuring that crops receive the optimal water levels while preventing wastage. Our literature review gives details of the work published by various scientists. Kumar & Singh (2019) work on soil moisture sensing technologies for agricultural applications. Evett et al (2012) presented his work on soil water sensing for water balance, ET, and WUE. Kizito and his co-worker (2008) focus on Frequency, electrical conductivity, and temperature analysis of a low-cost capacitance soil moisture sensor. Muñoz-Carpena et al (2005) developed an automatic irrigation based on soil moisture for vegetable crops Zhang & Li (2005) proposed the Field applications of soil moisture sensors for agricultural water management. For precision and accuracy Czarnomski and his fellow researcher's et al (2005) developed three alternative instruments for measuring soil water content in two forest soils of the Pacific Northwest. Robinson and co-workers (2003) have discussed advances in dielectric and electrical conductivity measurement in soils using time domain reflectometry. Topp & Ferre (2002) discussed about soil moisture content. Soil water content and electrical conductivity Measurement on time domain Refractometer was introduced by Noborio (2001). Gaskin & Miller (1996) performed an experiment to measurement of soil water content using a simplified impedance measuring technique. Soil moisture plays an important role in the growth of plants and agricultural crop production because moisture is extremely essential for the growth of plants. Every plant or agricultural crop develops by absorbing the moisture present in the soil as per its requirement. Different types of soils have different moisture levels. The amount of moisture in different types of soils is different, which is very important to determine. In this project we have mainly used BC-547-NPN transistor, 1 k Ω register, LED light and 9 volt power supply. The design of soil moisture analyzer as shown in figure 1 was prepared with the help of Tincal-CAD software. The main objective of this work is to prepare low cost and highly effective soil moisture detection device.

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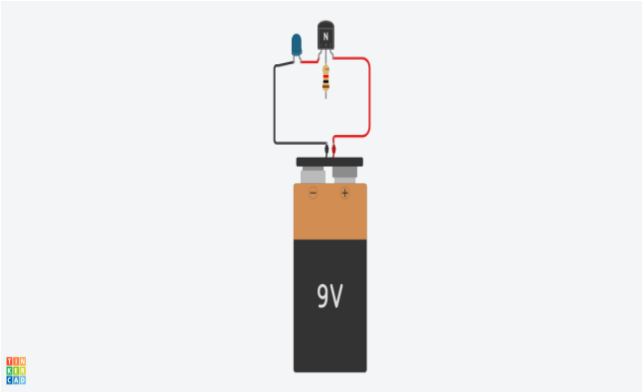

Figure 1: Connection soil moisture analyzer

II. THEORETICAL BACKGROUND OF SOIL DETECTOR ANALYZER

The efficiency of soil moisture analyzer is directly proportional to the moisture present in the soil. The higher the moisture in the soil, the higher will be the conductivity of the electric current. The conductivity of electric current mainly depends on the soil constant and volumetric moisture content. The relation between the conductivity of electric current and the amount of moisture content is shown as follows:

$$\sigma = k \cdot \theta^m \quad (1)$$

Where; σ= Conductivity of soil
k = Soil constant
θ = volumetric moisture content

III. CIRCUIT DESIGN OF SOIL MOISTURE ANALYZER AND THEIR COMPONENTS

- BC-547-NPN transistor,
- 1 k Ω register,
- LED light
- 9 volt power supply

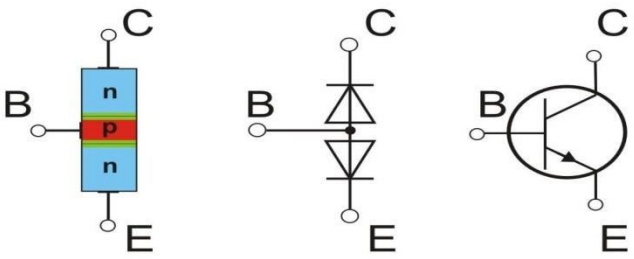

Figure 2: NPN- Transistor

Above components are arranged as shown in the figure 1. NPN transistor has mainly three pins which are called as emitter, base and collector as shown in figure 2. In which the positive pin of the LED was connected with the collector's pin of the transistor whereas the negative pin of LED was connected to the negative terminal of the battery.1 k Ω register was connected to the base pin of NPN-transistor. The other end of resistor was connected to the probe. Two wires were connected to emitter pin of BC-547-NPN transistor and other terminals of wire were connected to positive terminal of battery and second probe respectively.

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IV. RESULT AND DISCUSSION

The soil moisture analyzer basically works on conduction of current due to the moisture present in the soil. The different kind of soil shows different electrical conductivity, it is basically represented on the basis of conduction constant (K) as discuss above in equation 1.When the probe of soil moisture analyzer is inserting into the soil, if the soil is dry then it, is observed that

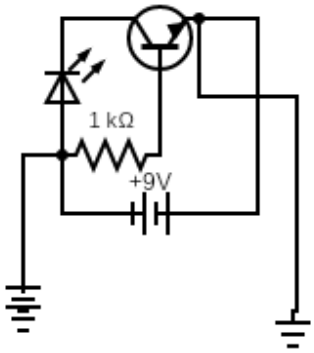

Figure 3: Schematic representation Soil moisture analyzer

No conduction of current will takes place and LED will not glow but as the moisture increases in the soil conduction of current start increasing due to low resistivity and LED glow brightly. The schematic representation of soil moisture analyzer is presented in figure 3. The efficiency of soil moisture analyzer is directly proportional to the moisture present in the soil. The higher the moisture in the soil, the higher will be the conductivity of the electric current. The conductivity of electric current mainly depends on the soil constant and volumetric moisture content. In our trial as shown in figure 4 LED is properly glowing that indicate the moisture in soil. This is the conformation of success of circuit design that is implemented in soil moisture analyzer.

Figure 4: Experimental trial of soil moisture analyzer

The results obtained from our experiments are excellent but still modification are needed to make it more fruitful and user friendly

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V. CONCLUSION

On the basis of above discussion, it can be concluded that the soil moisture analyzer is the best sensing device which can detect the moisture present in the soil very easily. This device is basically works on the principal of conduction of current in the moist soil. In case of dry soil the resistance is so high therefore no conduction of current will takes place indicating no moisture present in the soil. Soil moisture analyzer helps in development of various automated irrigation systems.

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