End Project Report on

"Water Level Controller and Soil Irrigation System"

Course Code: EC256

Submitted for end project of IC Lab:

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Components Used:

Required for the Project:

NAME OF THE COMPONENT	QUANTITY	PRICE
• Soil Moisture Sensor	1	63/-
• 9 Volt DC Pump, Pipe	1	150/-
• Timer IC NE555	1	8.5/-
• 1 Channel 5V Relay Module	1	60/-
• 100k Ohm Potentiometer	1	35/-
• Resistors		
○ 1k ohm	2	2/-
○ 2.2M ohm	2	30/-
○ 100k ohm	1	2/-
• Transistor BC457	1	2/-
• Diode IN4148	2	4/-
• Relay 12V, 400ohm	1	40/-
• NAND IC4093	1	20/-

Required for the Power Supply Circuit:

NAME OF THE COMPONENT	QUANTITY	PRICE
• LM7805 Voltage Regulator	1	10/-
• Transformer 0 to 6VDLX12/21	1	129/-
• IN 4007 Diode	4	4/-
• 1000uF Capacitor	1	15/-

Introduction:

Agriculture is important to India's enormous population. Agricultural output and successful production have a significant impact on the country's economy. Irrigation becomes difficult in arid locations or when there is a shortage of rain. As a result, it may be machine-driven and managed remotely by the farmer. Because the system would give precisely the proper amount of water, it will also assist us in conserving water and energy which can reduce farmer’s expenses.

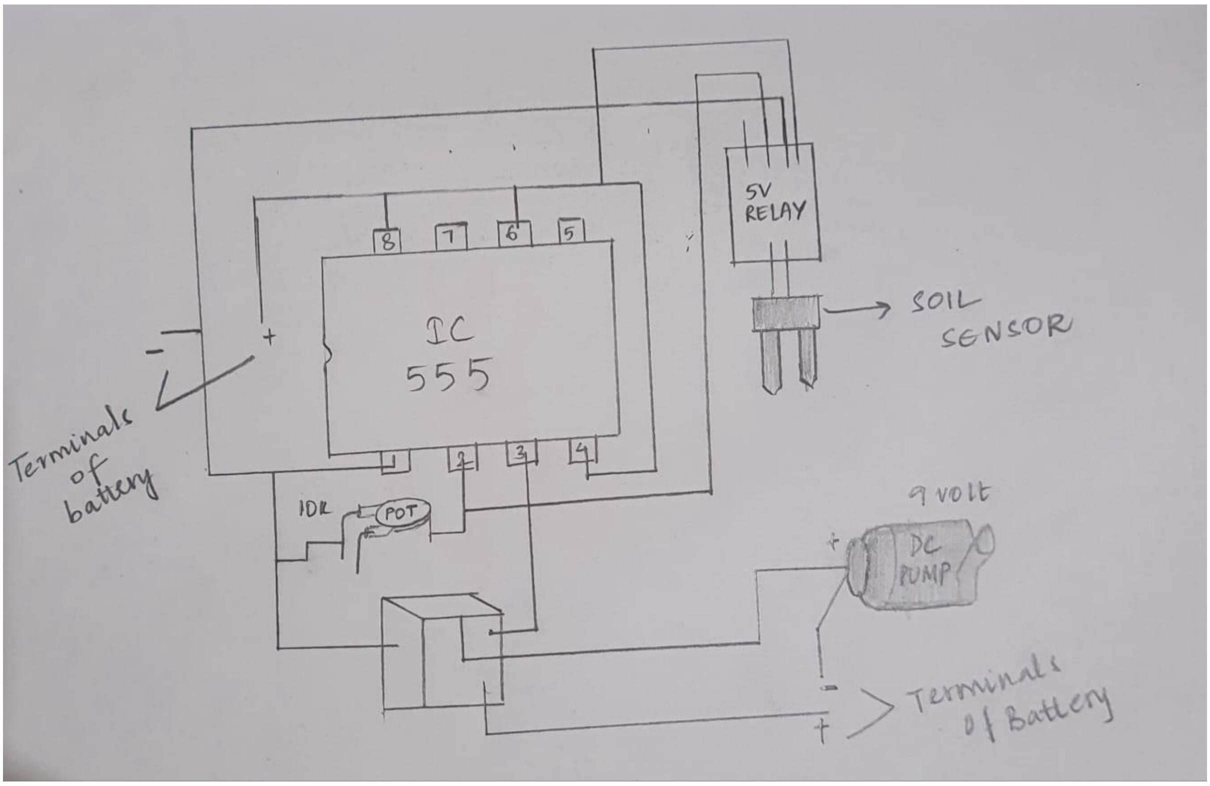
This invention is a clever way for making watering easier and for assisting plant lovers and farmers. It's difficult to remember to water our plants in our hectic lives. Some plants are highly sensitive, and they require a certain quantity of water only to survive, thus we required something to monitor the water requirements of plants and a solution for timely watering. This gadget will detect the humidity and temperature levels in the soil and will automatically turn on and off the water supply as needed. The right amount of water maintains the health of both soil and plants.

An irrigation system is an important part of contemporary agriculture because it guarantees efficient and effective water delivery to crops. The IC555 timer integrated circuit is used to build an irrigation system in this project. The system comprises of a water pump, a soil moisture sensor, and an IC555 timer-based control circuit. The IC555 timer is set to astable mode to create a fixed-frequency pulse train that operates a relay to turn on and off the water pump. The system has been tested and optimised to guarantee that it operates reliably and consistently. The IC555 timer provides a simple and cost-effective option for managing irrigation systems and increasing agricultural yields.

Electricity waste is a serious issue in a variety of industrial and household applications, resulting in higher energy costs and a negative impact on the environment. To overcome this issue, we may create an automated system that can properly manage the fluid level while preventing power waste. In this project, we will create a circuit that will manage the fluid level and prevent electricity waste using the 4093 NAND gate IC and basic components. The project will make use of a variety of electrical components, including sensors, resistors, capacitors, and diodes. When the appropriate fluid level is attained, the circuit will automatically turn off the motor.

In order to automate particular duties, this project will create two electronic circuits utilising various ICs. In the first circuit, a 555 timer IC is used to measure the soil moisture content and turn on or off the device in accordance with the moisture level. The second circuit will regulate the fluid level in a tank using a 4093 NAND gate IC, diodes, and a transistor. When the tank is empty, the circuit will automatically turn off the motor. Both circuits are easy to build and may be used in a variety of commercial and domestic applications. The report will include a thorough analysis of the circuit design, components utilised, operating concept, and outcomes.

Circuit Diagram Soil Irrigation System:



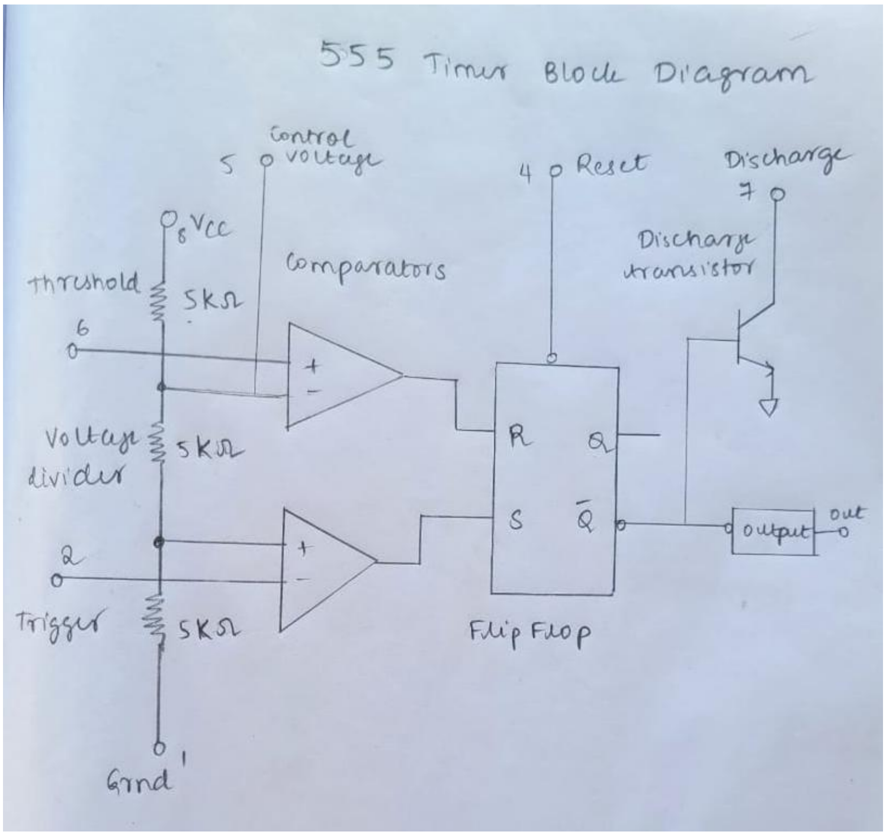
Working of Soil Irrigation System:

The device is made up of a PCB, a relay, a DC water pump, a 10k variable resistor, an LED, a 555 timer IC, a soil moisture sensor, and other components. The soil moisture sensor is used to measure the soil's moisture content.

The sensor alerts the 555 timer IC when the soil is dry. When utilised as an astable multivibrator, the 555 timer IC produces a square wave output at a set frequency. The settings of the resistor and capacitor connected to the timer IC define the frequency of the square wave output. The relay, which is used to operate the DC water pump, is linked to the output of the 555 timer IC.

When the 555 timer IC's output is high, the relay activates and electricity may flow to the water pump. The relay shuts off when the output is low, cutting off power to the water pump. To show the system's state, the LED is linked to the 555 timer IC's output. The LED is turned on when the 555 timer IC's output is high and off when the output is low. The frequency of the square wave output of the 555 timer IC, which in turn regulates the flow of water to the soil, is changed using the 10k variable resistor.

Circuit Diagram of 555 Timer IC:



Working of IC 555 Timer in Soil Irrigation System:

In the soil irrigation system circuit, the 555 timer IC is used as an astable multivibrator to generate a square wave output at a fixed frequency. The frequency of the square wave output is determined by the values of the resistor and capacitor connected to the timer IC.

The 555 timer IC consists of two comparators, a flip-flop, and an output stage. The comparators compare the voltage at the threshold and trigger inputs to the voltage at the control input. When the voltage at the trigger input is less than 1/3 of the control voltage, the flip-flop is set, and the output of the IC goes high. When the voltage at the threshold input is greater than 2/3 of the control voltage, the flip-flop is reset, and the output of the IC goes low.

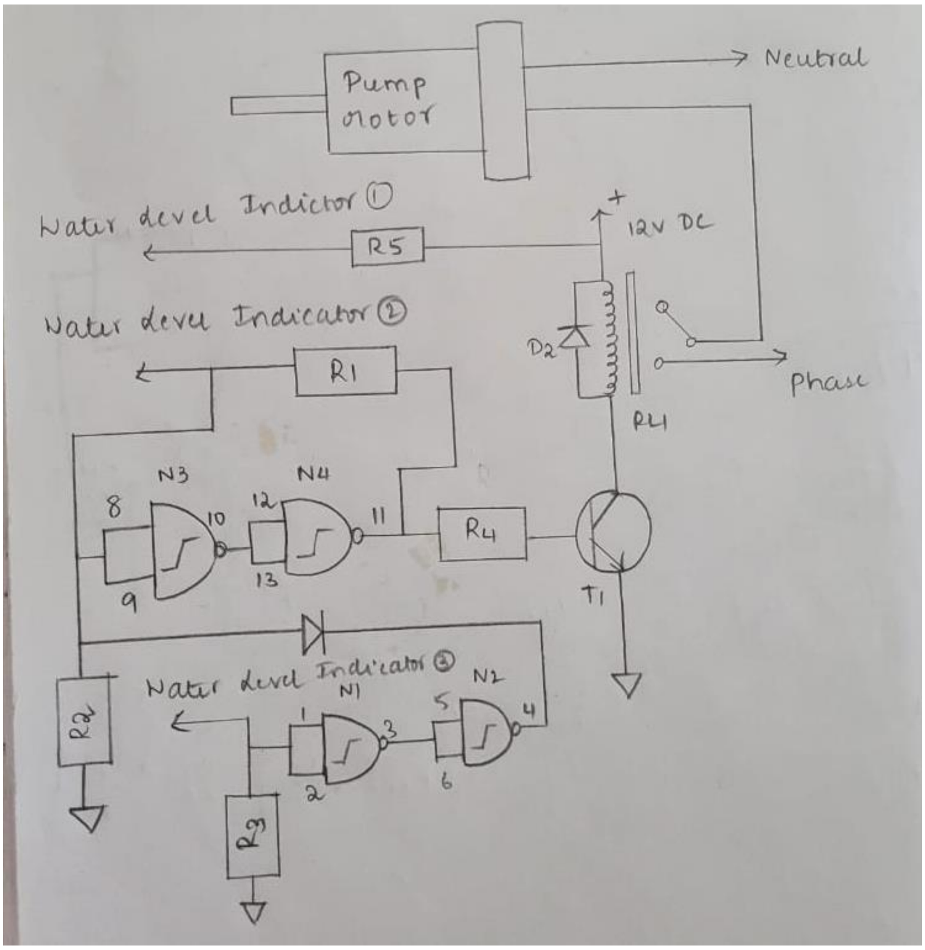
In the astable multivibrator configuration, the control voltage is connected to the timer IC through a resistor and a capacitor. The resistor and capacitor form a timing circuit, which determines the frequency of the output square wave. When the voltage at the control input is between 1/3 and 2/3 of the supply voltage, the output of the timer IC oscillates between high and low states, producing a square wave output.

In the soil irrigation system circuit, the square wave output of the 555 timer IC is connected to the relay, which controls the DC water pump. When the output of the 555 timer IC is high, the relay turns on, allowing current to flow to the water pump. When the output is low, the relay turns off, stopping the flow of current to the water pump.

The 10k variable resistor is used to adjust the frequency of the square wave output of the 555 timer IC, which in turn controls the flow of water to the soil. When the soil is dry, the soil moisture sensor sends a signal to the 555 timer IC, which generates a high-frequency square wave output, turning on the relay and activating the DC water pump. As the soil gets wet, the soil moisture sensor detects the change in moisture level and sends a signal to the 555 timer IC, which generates a low-frequency square wave output, turning off the relay and stopping the flow of water to the soil.

In summary, the 555 timer IC works as an oscillator to generate a square wave output at a fixed frequency, which is used to control the relay and DC water pump in the soil irrigation system circuit. The frequency of the output square wave is determined by the values of the resistor and capacitor in the timing circuit. The 10k variable resistor is used to adjust the frequency of the square wave output, which in turn controls the flow of water to the soil.

Circuit Diagram of Water Level Controller:



Working of Water Level Controller:

A water level controller using IC 4093, diodes, resistors, pump, relay, and transistor works on the principle of maintaining a constant water level in a tank or reservoir by controlling the pump automatically. The circuit consists of an IC 4093 which is a quad NAND gate Schmitt trigger, diodes, resistors, pump, relay, and transistor. The IC 4093 has four NAND gates, and each gate has a Schmitt trigger input that provides hysteresis to the input signal.

The circuit is designed in such a way that two probes are placed in the tank or reservoir to measure the water level. The probes are connected to the input of two Schmitt trigger gates of IC 4093. When the water level reaches the level of the probes, the gates switch states, and their outputs change. The output of one gate is connected to the input of the other gate through a diode. This creates a latch circuit that maintains the output states of the gates until the water level changes. The output of the latch circuit is connected to the base of a transistor, which acts as a switch to control the relay. The relay is used to turn on and off the pump, which pumps water from a source to the tank or reservoir.

When the water level in the tank or reservoir drops below the probes, the output of the latch circuit changes, and the transistor turns on. This activates the relay, which turns on the pump, and water is pumped from the source to the tank or reservoir until the water level reaches the probes again. The resistors in the circuit are used to control the sensitivity of the probes, and the diodes are used to create the latch circuit.

The pump is connected to the relay, and its power is controlled by the transistor. In summary, the circuit works by monitoring the water level in a tank or reservoir and automatically activating the pump when the water level drops below the probes. This helps to maintain a constant water level in the tank or reservoir and ensures that the pump only operates when necessary.

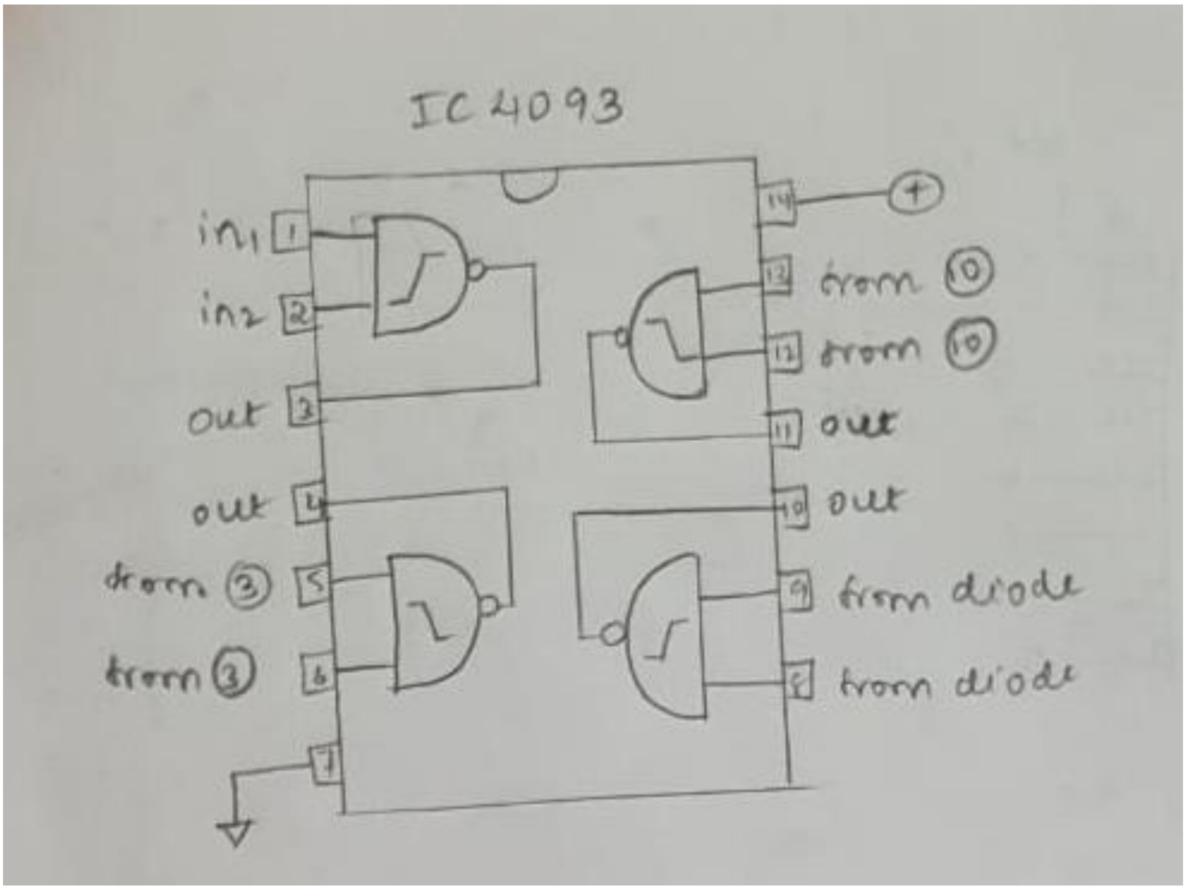
The above passage describes the working principle of a water tank level controller circuit that is based on a simple logic circuit using NAND gates and a few other components. The circuit is designed to control the water level in a tank and automatically switch on and off a water pump as required. The circuit consists of four NAND gates (N1 to N4), a relay, a water pump, a few resistors, a diode, and three points A, B, and C. The points A and C are connected to the top and bottom sections of the tank, respectively, while point B is located somewhere in the bottom section of the tank.

Initially, when there is no water in the tank, points A and C are at ground level, and the inputs of NAND gates N1 and N3 are at logic low levels. The outputs of NAND gates N2 and N4 are also at logic low levels, which keeps the relay and water pump switched off. As water starts filling the tank, it reaches point B, which connects point C and B, making the input of NAND gate N1 high. This, in turn, makes the output of NAND gate N2 high. However, the presence of diode D1 prevents the positive output of N2 from affecting the preceding circuit.

As the water level continues to rise and reaches point A, the input of NAND gate N3 becomes high, making the output of NAND gate N4 also high. The feedback resistor between the output of N4 and the input of N3 causes the gates to latch, which switches on the relay and starts the water pump to empty the tank. Even if the water level goes below point A, the circuit remains latched due to the feedback resistor. However, once the water level drops below point B, the input of NAND gate N1 reverts to logic low, which makes the output of NAND gate N2 also low. Here, the diode gets forward biased and pulls the input of NAND gate N3 to logic low, which makes the output of NAND gate N4 low as well, switching off the relay and the water pump.

In summary, the circuit works based on the principle of logical gates and feedback to control the water level in a tank and switch on/off the water pump as required. The circuit is simple, cost-effective, and can be easily implemented with a few components.

Circuit Diagram of IC4093 Dual Input Quad NAND Gate:



Working of IC4093 Dual Input Quad NAND Gate:

The 4093 IC is a CMOS quad NAND Schmitt trigger. It contains four independent NAND gates, each with a Schmitt trigger input. The Schmitt trigger input provides hysteresis, which means that the input signal must rise above a certain threshold voltage to switch the output state, and the input signal must fall below a lower threshold voltage to switch back the output state. This hysteresis allows the 4093 IC to provide stable and reliable output signals even in the presence of noise or other disturbances.

The internal structure of the 4093 IC consists of several transistors, resistors, and capacitors, arranged in a way that creates the NAND gate with a Schmitt trigger input. The input signal is first passed through a buffer stage, which amplifies and shapes the signal. The output of the buffer is then fed into a Schmitt trigger, which provides the hysteresis. The 4093 IC is based on CMOS (complementary metal-oxide-semiconductor) technology, which uses both p-type and n-type transistors to achieve low power consumption and high noise immunity. The resistors and capacitors used in the Schmitt trigger and other circuits are implemented using MOS (metal-oxide-semiconductor) transistors in a way that minimizes their size and power consumption.

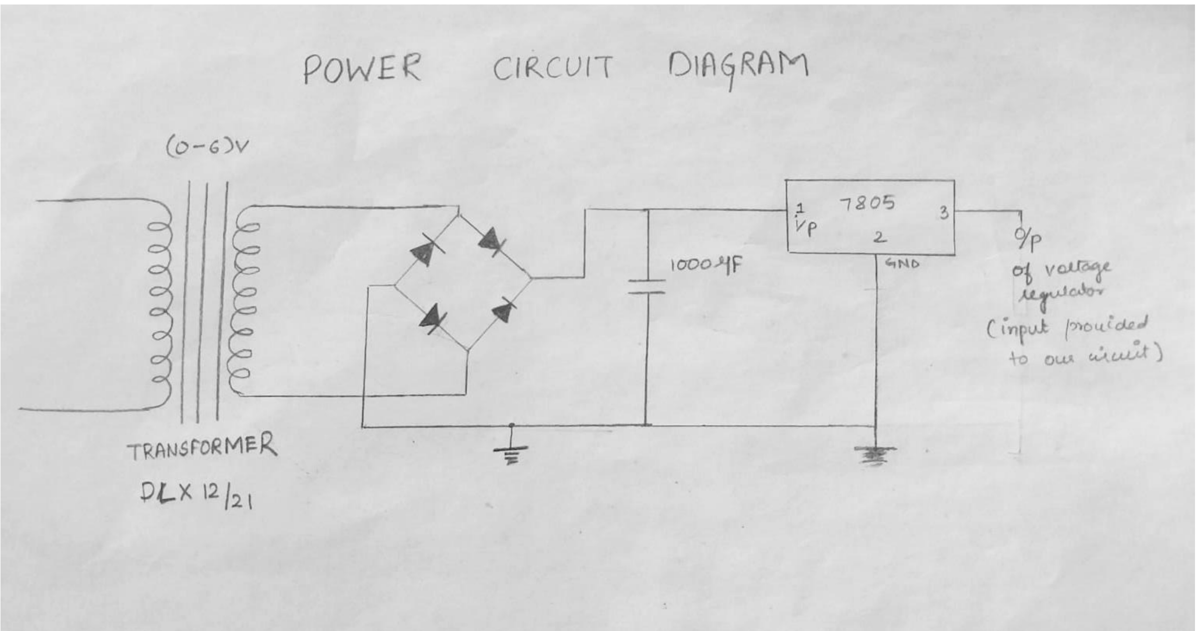
The Schmitt trigger consists of a positive feedback loop that includes a resistor and a capacitor. When the input signal rises above a certain threshold voltage, the output of the Schmitt trigger switches from low to high, and the capacitor begins to charge through the resistor. When the input signal falls below a lower threshold voltage, the output of the Schmitt trigger switches back to low, and the capacitor begins to discharge through the same resistor. This charging and discharging of the capacitor create the hysteresis effect, which makes the output of the Schmitt trigger less sensitive to noise or other disturbances.

The 4093 IC is widely used in digital circuits due to its reliability, low power consumption, and ease of use. Its quad NAND gate configuration allows multiple logic functions to be implemented with a single IC. The Schmitt trigger input provides noise immunity and hysteresis, making the IC ideal for applications where the input signal may be subject to noise or other disturbances. The Schmitt trigger also allows the IC to act as a simple signal conditioner, shaping and amplifying weak or noisy input signals.

The output of the Schmitt trigger is then fed into a NAND gate, which performs the logical operation of a NOT-AND (NAND) gate. The NAND gate consists of several transistors that are arranged in a way that allows the output to be low only when both inputs are high. When one or both inputs are low, the output is high. The 4093 IC also includes several protection features, such as a power-on reset circuit that ensures that all outputs are in a known state when power is first applied to the IC. The IC also includes internal clamping diodes that protect against overvoltage and ESD (electrostatic discharge) events.

In summary, the 4093 IC is a CMOS quad NAND Schmitt trigger that contains four independent NAND gates, each with a Schmitt trigger input. The internal structure of the IC includes several transistors, resistors, and capacitors that create the NAND gate with a Schmitt trigger input, providing hysteresis to the input signal and making the output more reliable and less sensitive to noise or other disturbances.

Circuit Diagram of Power Supply Circuit:



Working of Power Supply Circuit:

The circuit you are referring to is a power supply circuit that uses a 6V transformer and a 7805-voltage regulator IC to provide a stable 5V DC output. The circuit works by first stepping down the AC voltage from the transformer to a lower AC voltage, which is then rectified and filtered to produce a stable DC voltage. The voltage regulator IC then regulates this DC voltage to the desired output voltage.

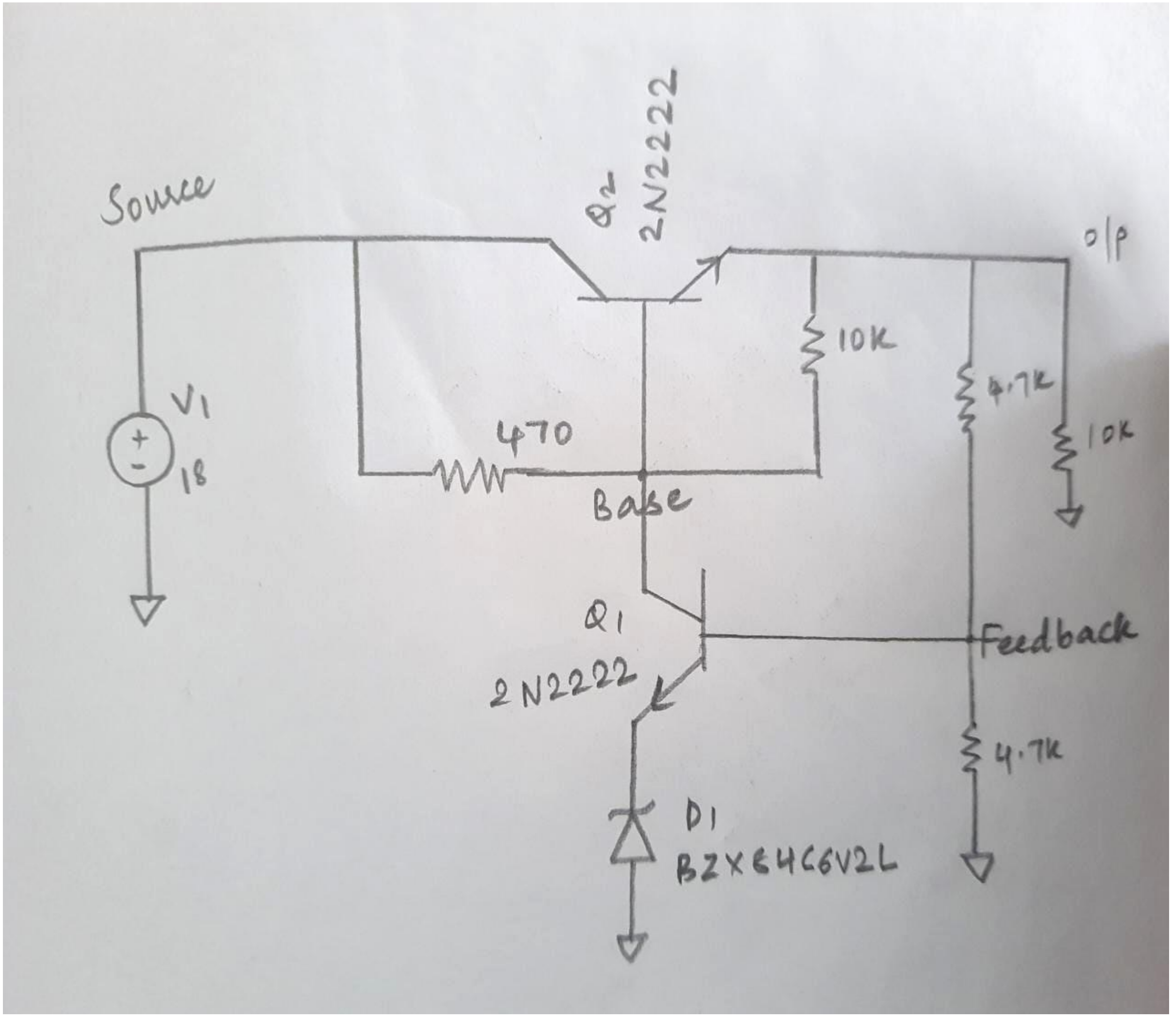
The 6V transformer used in the circuit is a step-down transformer that reduces the input AC voltage to a lower voltage suitable for use in the circuit. The transformer has two primary windings and two secondary windings, each with a centre tap. The two primary windings are connected in parallel to the input AC voltage, while the two secondary windings are connected in series to produce a 12V AC output.

The 12V AC output from the transformer is then fed into a bridge rectifier circuit, which consists of four diodes that are arranged in a bridge configuration. The rectifier circuit converts the AC voltage into a pulsating DC voltage, which contains both positive and negative voltage swings. The pulsating DC voltage is then filtered using a capacitor connected across the output of the rectifier circuit. The capacitor smoothes out the voltage fluctuations and produces a more stable DC voltage.

The filtered DC voltage is then fed into the input of the 7805-voltage regulator IC. The 7805 IC is a three-terminal voltage regulator that regulates the input voltage to a stable 5V DC output. The IC contains a voltage reference, an error amplifier, and a power transistor, which work together to regulate the output voltage. The voltage reference sets the desired output voltage, while the error amplifier compares the actual output voltage to the reference voltage and adjusts the power transistor accordingly to maintain a constant output voltage.

In summary, the power supply circuit using a 6V transformer and a 7805-voltage regulator IC works by first stepping down the AC voltage from the transformer, rectifying and filtering the voltage to produce a stable DC voltage, and then regulating the DC voltage to the desired output voltage using the 7805 IC. The circuit provides a stable and reliable 5V DC output that can be used to power a variety of electronic devices.

Circuit Diagram of IC 7805:



Explanation of the project:

In this combined circuit, both the water level controller circuit and the soil irrigation system circuit are connected to the same motor. The relay outputs of both circuits are connected in parallel to the motor. When either circuit is triggered, its corresponding relay switches on and provides power to the motor.

The output of the 555 timer IC is connected to the relay, which is used to control the DC water pump. When the output of the 555 timer IC is high, the relay turns on, allowing current to flow to the water pump. When the output is low, the relay turns off, stopping the flow of current to the water pump.

When the water level in the tank is below point B, the input of gate N1 is low, keeping the output of N2 low, and the relay and motor switched off. Similarly, the input of N3 is low, keeping the output of N4 low, and the motor switched off. As a result, the soil irrigation system does not operate and the tank remains empty.

When the water level in the tank rises and reaches point B, point C and the input of N1 become high, causing the output of N2 to become high as well. However, due to the presence of diode D1, the high output from N2 does not affect the preceding circuit.

When the water level reaches point A, the input of N3 becomes high and the output of N4 switches high as well. This high output from N4 switches on the relay and the motor starts running, emptying the tank and simultaneously irrigating the soil.

As the tank gets emptied, the water level eventually goes below point A, but since N3 and N4 are latched, the motor continues running. However, once the water level goes below point B, point C and the input of N1 revert to logic low, causing the output of N2 to become low. This triggers diode D1 to become forward biased, pulling the input of N3 to logic low as well. As a result, the output of N4 also becomes low, switching off the relay and the motor.

For example, if the water level controller circuit is triggered, its relay output switches on and provides power to the motor, which will start emptying the tank. Similarly, if the soil irrigation system circuit is triggered, its relay output switches on and provides power to the motor, which will start the irrigation process.

It is important to note that the motor should be compatible with both circuits in terms of voltage and power ratings. Additionally, the combined circuit should be properly wired and tested to ensure safe and reliable operation.

Therefore, with a common motor, both the water level controller and the soil irrigation system operate in tandem. When the water level is low, the motor remains off, and both systems remain idle. When the water level rises, the motor starts running, and the soil irrigation system operates in parallel with the water level controller, until the water level goes below point A, at which point the motor is switched off, and both systems are deactivated.

Applications of the Project:

The combined project of water level controller and soil irrigation system using 4093 IC and 555 timer IC respectively has a wide range of applications in various fields. Some of the major applications of this project are as follows:

- Agriculture: The combined project can be used for the automation of irrigation systems in agriculture. It can help farmers to manage their crops efficiently by ensuring proper water levels and soil moisture content. The system can be programmed to water the plants at regular intervals and maintain a consistent soil moisture level, which can lead to higher crop yields and reduced water wastage.
- Residential and Commercial Buildings: The project can be installed in residential and commercial buildings for managing the water supply and drainage systems. The system can monitor the water levels in tanks and sumps, and automatically turn on/off the pumps to maintain the desired water levels. This can help to reduce water wastage and prevent damage due to water overflow.
- Industrial Applications: The combined project can be used in various industrial applications, such as water treatment plants, chemical industries, and food processing plants. The system can be programmed to maintain a specific water level and ensure proper irrigation or cleaning of the equipment. It can also be used for automatic filling of tanks and containers.
- Smart Cities: The project can be used in smart city applications for efficient management of water resources. The system can be used to monitor the water levels in lakes, rivers, and reservoirs, and provide real-time data to the concerned authorities. This can help in effective water management and conservation.
- Aquaculture: The project can be used in fish farms and aquaculture systems for efficient management of water levels and oxygen levels. The system can be programmed to monitor the water levels, temperature, and oxygen levels, and provide the necessary input to the pumps and aerators for maintaining the desired conditions. This can help to improve the growth and survival rate of the fish and reduce water wastage.
- Greenhouses: The project can be used in greenhouses for efficient management of water and nutrient supply to the plants. The system can be programmed to maintain the desired soil moisture level and provide the necessary nutrients to the plants at regular intervals. This can help to improve the growth and yield of the plants.

Future Scope of the Project:

The water level controller and soil irrigation system project have significant future scope, as it can be improved and expanded in several ways. Some possible future developments are:

1. Remote monitoring and control: The system can be integrated with IoT (Internet of Things) technology to allow remote monitoring and control of the water level and soil moisture levels. This would enable farmers and gardeners to check the status of their irrigation system from anywhere, and make adjustments as needed.
2. Smart scheduling: The system can be made more intelligent by using weather data and other inputs to schedule watering times and adjust watering amounts. This can help reduce water waste and optimize plant growth.
3. Automatic pump control: The system can be enhanced with automatic pump control, which would turn the pump on and off as needed to maintain the desired water level in the tank.
4. Integration with other sensors: The system can be combined with other sensors, such as temperature and humidity sensors, to create a more comprehensive and automated plant monitoring and irrigation system.
5. Energy-efficient design: The system can be optimized for energy efficiency by using low-power sensors, solar panels, and other energy-saving techniques.
6. Multi - zone irrigation: The system can be expanded to include multiple zones of irrigation, each with its own soil moisture sensor and valve. This would allow for more targeted watering and better management of water resources.
7. Water quality monitoring: The system can be integrated with water quality sensors to monitor the quality of the irrigation water and adjust watering accordingly. This can help prevent damage to plants caused by poor water quality.
8. Fertilizer management: The system can be combined with a fertilizer management system to automatically deliver the right amount of fertilizer to each plant based on its individual needs.
9. Machine learning: The system can be enhanced with machine learning algorithms that learn from historical data to predict the water and fertilizer requirements of each plant. This can help optimize plant growth and minimize water and fertilizer waste.
10. Mobile application: A mobile application can be developed to provide users with a convenient way to monitor and control the system from their smartphones. The application can also provide alerts and notifications to users based on the status of the system.
11. Integration with precision farming: The system can be integrated with precision farming techniques, such as GPS mapping and yield monitoring, to create a more comprehensive and efficient farming system.

Overall, the water level controller and soil irrigation system project have the potential to be an important tool for sustainable agriculture and gardening, and there are many opportunities for further development and improvement.

Conclusion:

The water level controller and soil irrigation system project are a highly useful and effective system for managing water resources and ensuring proper irrigation of plants. The system uses advanced sensors and control circuits to maintain optimal water levels in a storage tank and monitor soil moisture levels, and it can be customized and expanded in a number of ways to suit specific needs.

The project has significant future scope, with possibilities for integrating with other technologies such as IoT, machine learning, and precision farming. By incorporating these technologies, the system can be further optimized for improved plant growth, reduced water waste, and more efficient use of resources.

Overall, the water level controller and soil irrigation system project have immense potential to transform the way we manage water and grow crops, making it an important tool for sustainable agriculture and gardening. The system has several benefits, including:

1. Water conservation: By monitoring soil moisture levels and controlling water levels in the storage tank, the system helps prevent overwatering and water waste, thus conserving water resources.

2. Increased plant growth: By ensuring that plants receive the right amount of water and nutrients, the system can help promote healthy growth and increase crop yields.

3. Cost-effective: The system is relatively inexpensive and easy to build, making it accessible to farmers and gardeners of all budgets.

4. Low maintenance: The system requires minimal maintenance and can be easily customized to suit specific needs.

In addition, the water level controller and soil irrigation system project can also be used in a variety of settings, including farms, gardens, and indoor plant cultivation. With its versatility, affordability, and efficiency, the system has the potential to significantly improve agricultural practices and help meet the growing demand for sustainable food production.

In summary, the water level controller and soil irrigation system project are a valuable and innovative solution to the challenges of water management and crop production. By incorporating advanced sensors and control circuits, the system can be optimized for increased efficiency and improved plant growth, making it a highly promising technology for sustainable agriculture.

Limitations and Issues Faced while doing Project:

As with any project, there are always limitations and issues that arise during the process. Here are some limitations and issues that may be faced while doing the water level controller and soil irrigation system project.

1. Component availability: One of the main limitations of this project is the availability of components. Some components, such as the 4093 IC and 555 timer IC, may not be readily available in certain regions. This can make it difficult to source the necessary parts for the project.
2. Power supply: Another limitation is the power supply required for the project. The project requires a stable DC power supply, which can be difficult to obtain in certain areas. This may require additional components or modifications to the circuit.
3. Calibration: The water level controller circuit relies on accurate calibration of the sensors to ensure that the system operates correctly. Any errors in calibration can lead to incorrect water level measurements and improper operation of the system.
4. Sensitivity: The soil irrigation system circuit is sensitive to changes in soil moisture levels. This can lead to false triggering of the system, which can waste water and damage the plants.
5. Maintenance: Like any system, the water level controller and soil irrigation system require periodic maintenance to ensure proper operation. This may include cleaning and calibration of the sensors, as well as replacement of any worn or damaged components.
6. Cost: The project can be relatively expensive, depending on the components used. This may make it difficult for some hobbyists or students to undertake the project.
7. Complexity: The project requires a certain level of skill and knowledge to complete, including an understanding of electronics and circuit design. This may make it challenging for beginners or those with limited experience in electronics.

Despite these limitations and issues, the water level controller and soil irrigation system project can be a rewarding and educational project for those interested in electronics and automation. With careful planning and attention to detail, it is possible to overcome these limitations and build a functional system that can save water and improve plant growth.

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