Department of Electrical and Electronic Engineering

Project Report Submission

Semester: *Spring 2023*
Course Code: *EEE283*
Course Title: *Digital Logic Design*
Section: *02*

Project Title: Plant Monitoring and Irrigation System

Group No.: 05

Group members:

Sl.	***Name***	***ID***	***Gsuite***
1.	Md. Reshad Al Muttaki	22121091	reshad.al.muttaki@g.bracu.ac.bd
2.	Mohammad Fasiul Abedin Khan	22121092	fasiul.abedin.khan@g.bracu.ac.bd
3.	Alvi Ibn Amzad Anil	21321098	alvi.ibn.amzad@g.bracu.ac.bd
4.	Yusuf Abdullah	22321077	yusuf.abdullah@g.bracu.ac.bd

Date of Submission: *13th December, 2023*

Contents

EEE283
Project

Project Title: Plant Monitoring and Irrigation System

Problem Statement: In the agricultural landscape of Bangladesh, manual plant monitoring practices prove time-consuming and often fail to provide timely insights into crucial environmental variables affecting crop health. The lack of an efficient and automated system hampers farmers' ability to respond promptly to changing conditions, impacting crop yield and overall productivity. To address this, the experiment "Plant Monitoring and Irrigation System" utilizing Proteus aims to introduce a technology-driven solution to enhance plant monitoring, enabling farmers in Bangladesh to optimize resource utilization, reduce manual labor, and improve agricultural outcomes.

Objectives: The objective of this experiment include the following:

- Monitoring soil temperature, environmental temperature and light intensity.
- Automatizing irrigation for plants.
- Observing the water level of the irrigation system.
- Alerting farmers for applying fertilizers and irrigation.
- Keep track of the plant harvest.

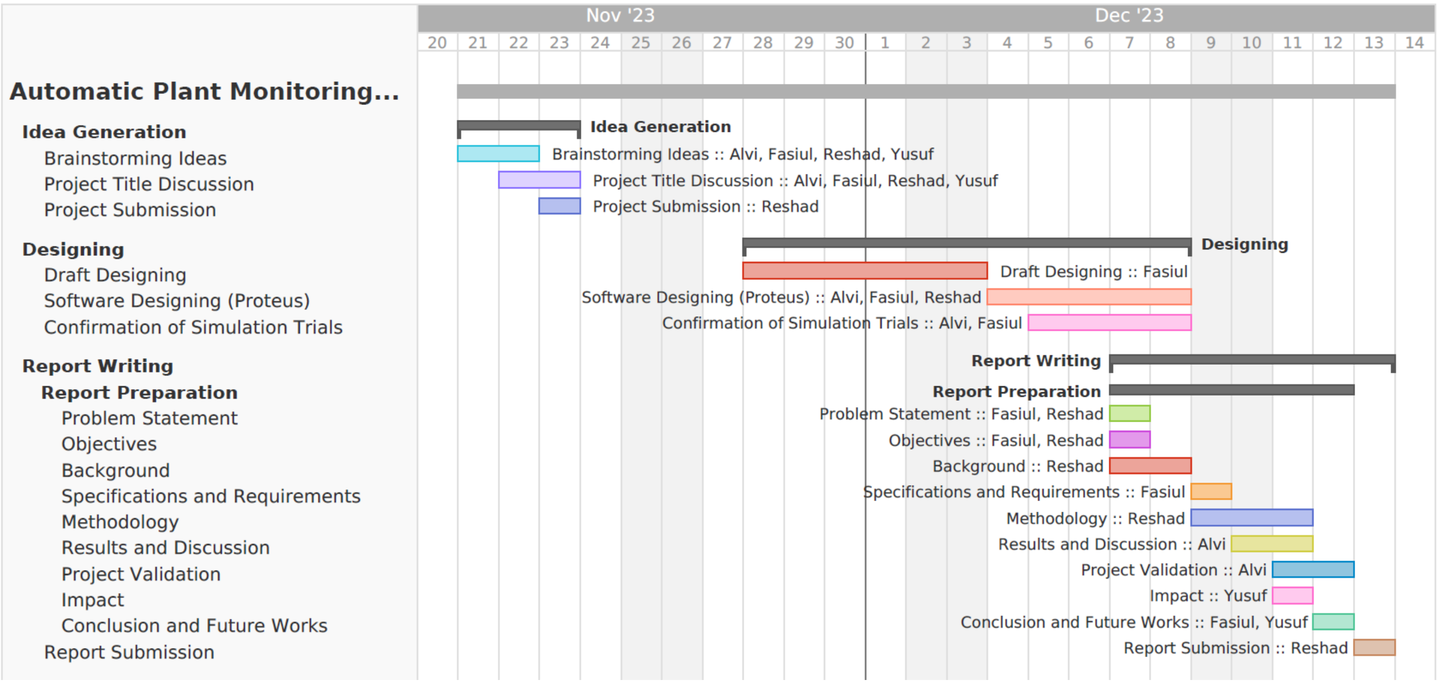
Background: In Bangladesh, agriculture is a significant sector, contributing to 14.2 percent of the country's GDP in 2017 and employing about 42.7 percent of the workforce (Raihan, 2012). Despite its importance, the agricultural sector in Bangladesh has remained largely subsistence-based, with uncertain crop yields and inefficient infrastructure limiting the ability of farmers to fully commercialize their production (*Bangladesh | FAO Regional Office for Asia and the Pacific*, n.d.).

The integration of electronics into agriculture can be a key enabler for delivering improved food supply and sustainable energy production without an increased burden on the limited fertile land (*Electronic Engineering for Agriculture*, n.d.). The use of digital technologies in agriculture, such as robotics, IoT and sensors, and blockchain, is transforming the industry. These technologies can help track produce and live animals, detect health issues, evaluate the environment inside the farm, and monitor the uptake of moisture from the soil in real time (Connolly, 2022).

In the context of the "Automatic Plant Monitoring System" experiment, the use of Proteus, a powerful design and simulation tool, can help address these challenges. The system can continuously monitor critical plant health parameters such as soil moisture, ambient temperature, light intensity, and nutrient levels in the soil. The system can alert the user when any of these parameters deviate from their optimal ranges, enabling timely intervention and care.

By leveraging the capabilities of Proteus and the power of electronics, this experiment can potentially revolutionize plant care methods in Bangladesh, leading to healthier crops, improved yields, and more sustainable agricultural practices. This could benefit not only individual farmers but also large-scale agricultural operations in the country.

Gantt Chart:

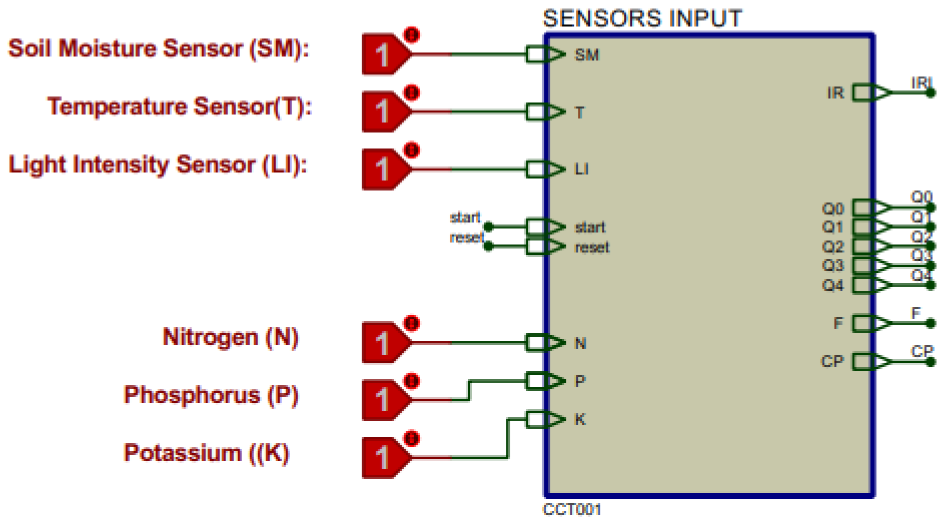


Specifications and Requirements:

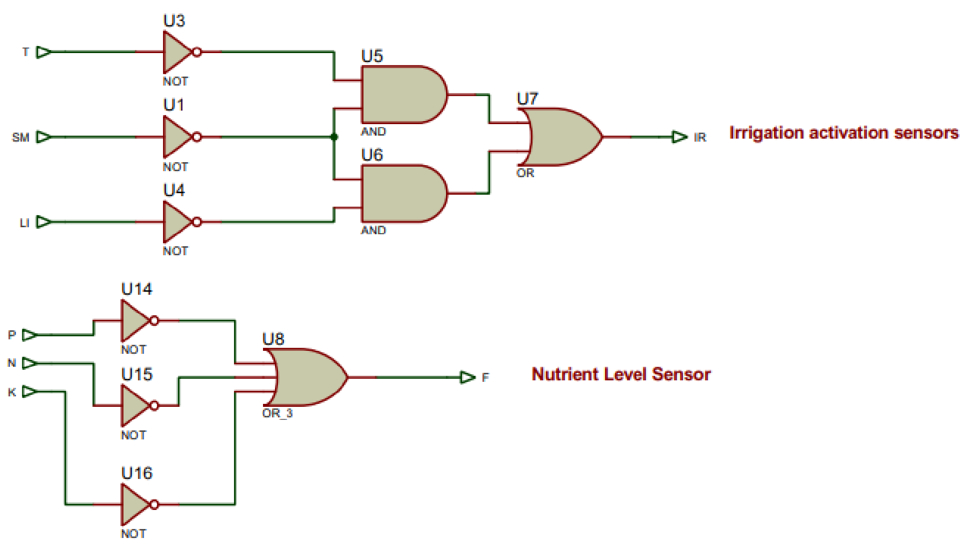
Components:

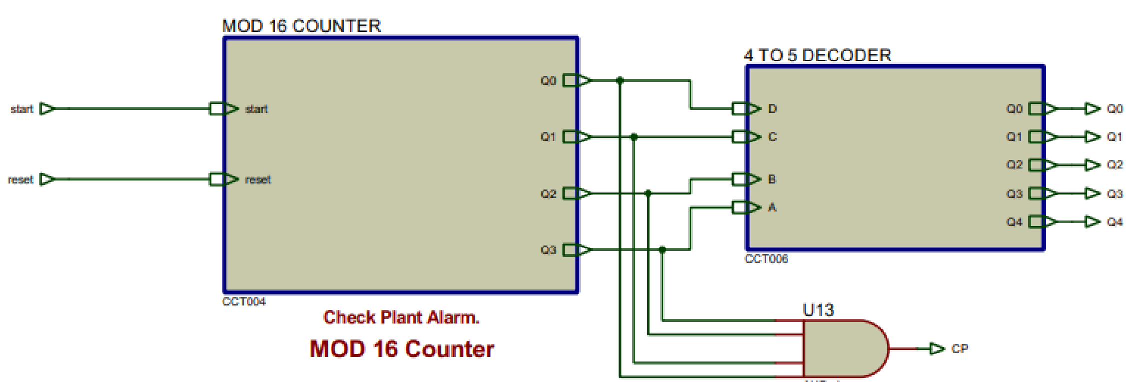
- 7 Segment Display
- Logic Toggle
- Motor
- Logic Gates (AND, OR, NOR, NAND, NOT)
- LED
- Resistor
- Capacitor
- 7474 (D- Flip Flop)
- Switch
- DClock
- Power
- Ground
- Wire

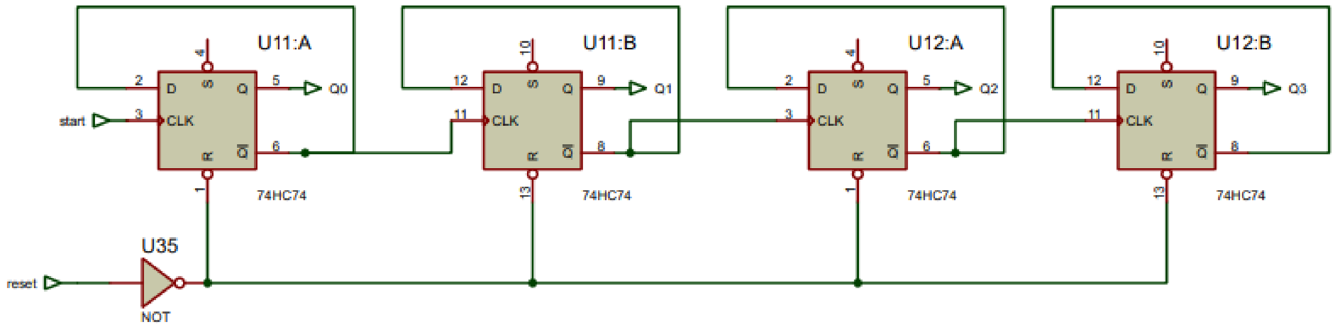
Sensor Input Circuit:

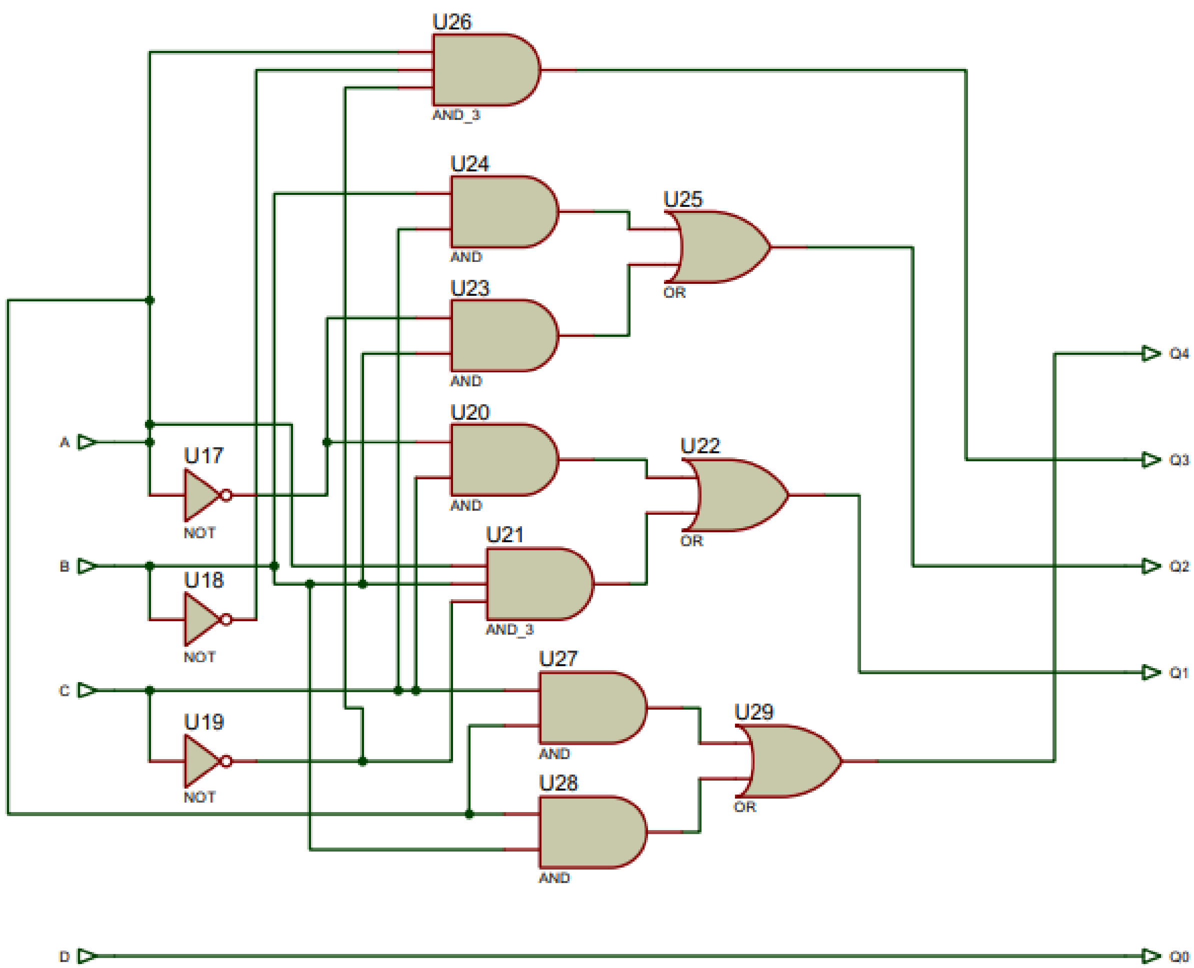


Sub Circuit:









4 TO 5 DECODER

For Irrigation

Truth Table

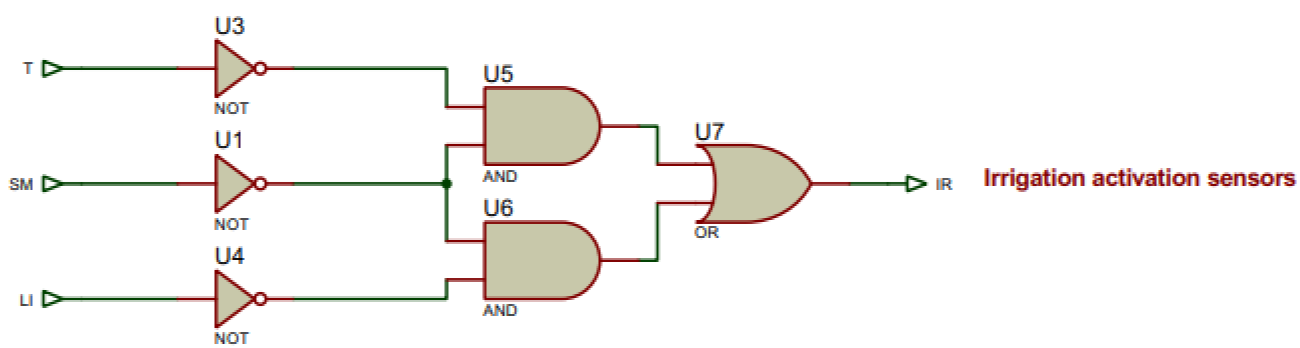
Input			**Output**
SM	**T**	**LI**	**Activate Alarm and Irrigation**
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	0

K Map

	LI’	LI
SM’T’	1	1
SM’T	1	0
SMT	0	0
SMT’	0	0

F = SM’T’ + SM’LI’

Circuit:



For Fertilizers

Truth Table

Input			**Output**
N	**P**	**K**	**Activate Alarm**
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	1

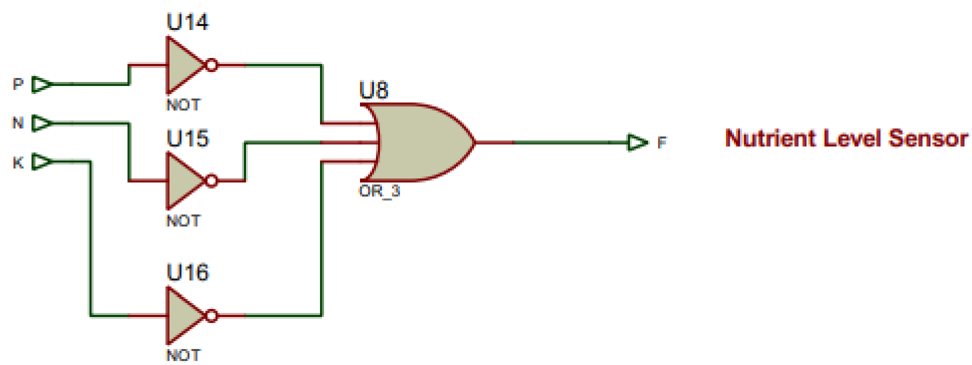
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0

K- Map

	K’	K
N’P’	1	1
N’P	1	1
NP	1	0
NP’	1	1

F = N’+P’+K’

Circuit:



MOD 16 Counter

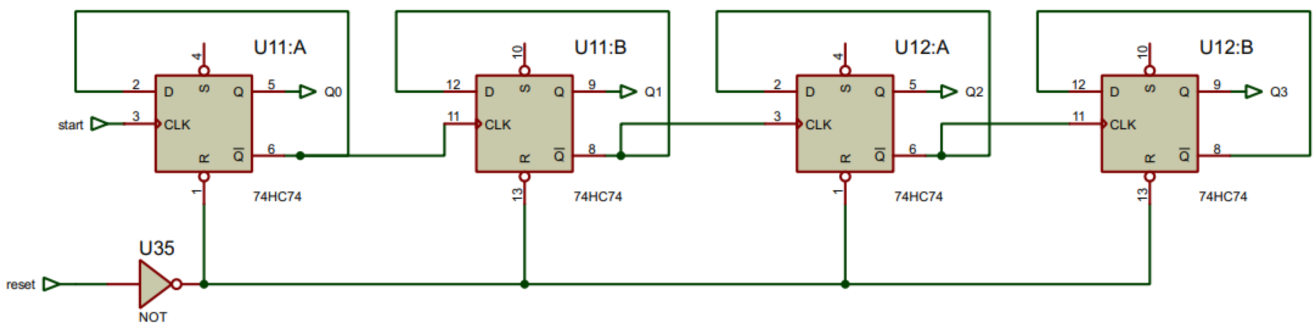
Truth Table

D	CLK	Q	Q’
0	0	0	1
0	1	0	1
1	0	0	1
1	1	1	0

Clk	D_3	D_2	D_1	D_0	
0	X	X	X	X	(No change)
1	0	0	0	0	Reset - 0
1	0	0	0	1	1
1	0	0	1	0	2
1	0	0	1	1	3
1	0	1	0	0	4
1	0	1	0	1	5
1	0	1	1	0	6

1	0	1	1	1	7
1	1	0	0	0	8
1	1	0	0	1	9
1	1	0	1	0	10
1	1	0	1	1	11
1	1	1	0	0	12
1	1	1	0	1	13
1	1	1	1	0	14
1	1	1	1	1	15

Circuit:



4 to 5 Decoder

Truth Table:

Input				**Output**				
A	**B**	**C**	**D**	**Q_4**	**Q_3**	**Q_2**	**Q_1**	**Q_0**
0	0	0	0	0	0	0	0	0
0	0	0	1	0	0	0	0	1
0	0	1	0	0	0	0	1	0
0	0	1	1	0	0	0	1	1
0	1	0	0	0	0	1	0	0
0	1	0	1	0	0	1	0	1
0	1	1	0	0	0	1	1	0
0	1	1	1	0	0	1	1	1
1	0	0	0	0	1	0	0	0
1	0	0	1	0	1	0	0	1
1	0	1	0	1	0	0	0	0
1	0	1	1	1	0	0	0	1
1	1	0	0	1	0	0	1	0
1	1	0	1	1	0	0	1	1
1	1	1	0	1	0	1	0	0
1	1	1	1	1	0	1	0	1

Q Map:

Q_0

	C'D'	C'D	CD	CD'
A'B'	0	1	1	0
A'B	0	1	1	0
AB	0	1	1	0
AB'	0	1	1	0

$Q_0 = D$

Q_1

	C'D'	C'D	CD	CD'
A'B'	0	0	1	1
A'B	0	0	1	1
AB	1	1	0	0
AB'	1	1	0	0

$Q_1 = A'C+ABC'$

Q_2

	C'D'	C'D	CD	CD'
A'B'	0	0	0	0
A'B	1	1	1	1
AB	0	0	1	1
AB'	0	0	0	0

$Q_2 = A'B+BC$

Q_3

	C'D'	C'D	CD	CD'
A'B'	0	0	0	0
A'B	0	0	0	0
AB	0	0	0	0
AB'	1	1	0	0

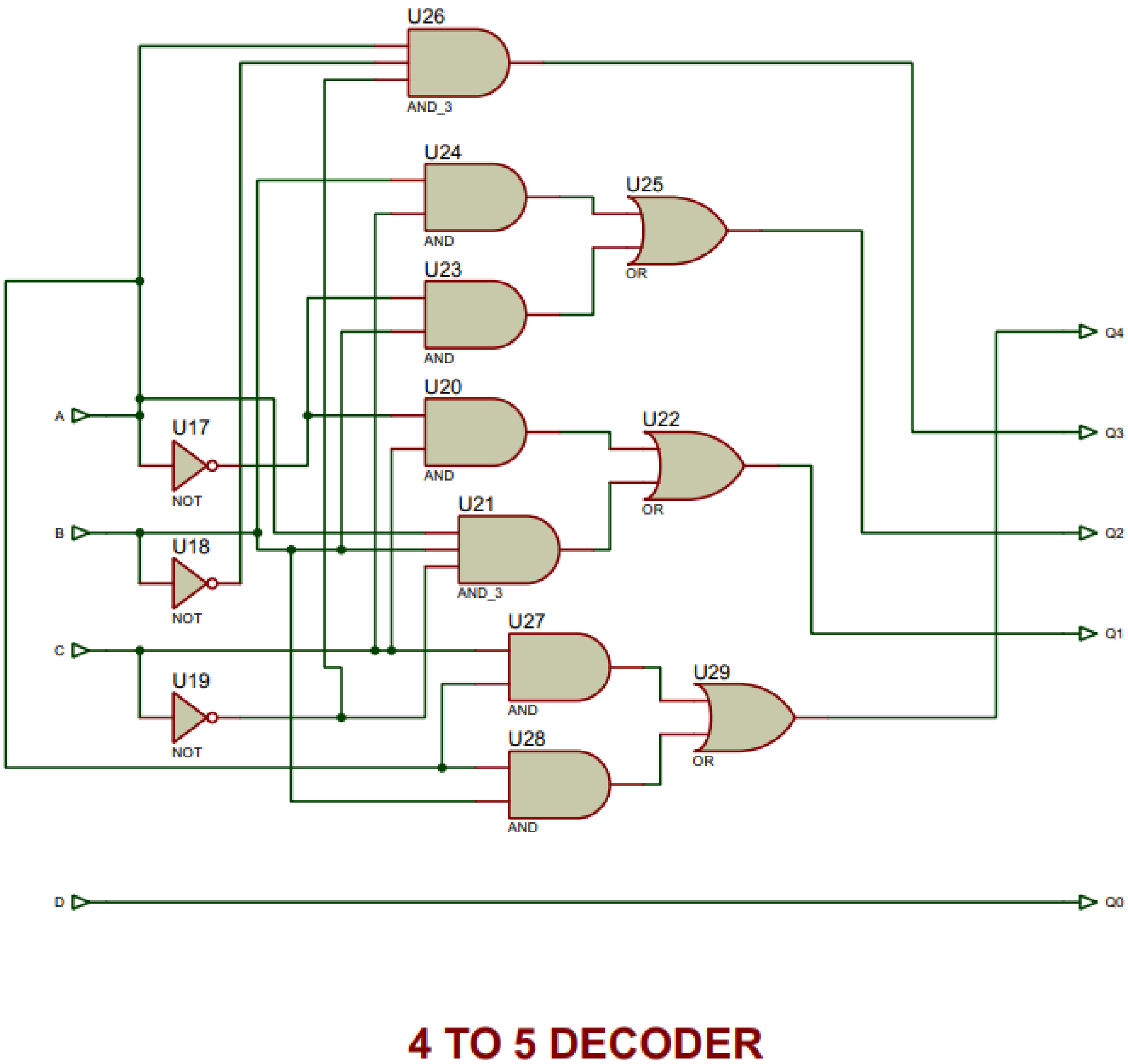
$Q_3= AB'C'$

Q_4

	C'D'	C'D	CD	CD'
A'B'	0	0	0	0
A'B	0	0	0	0
AB	1	1	1	1
AB'	0	0	1	1

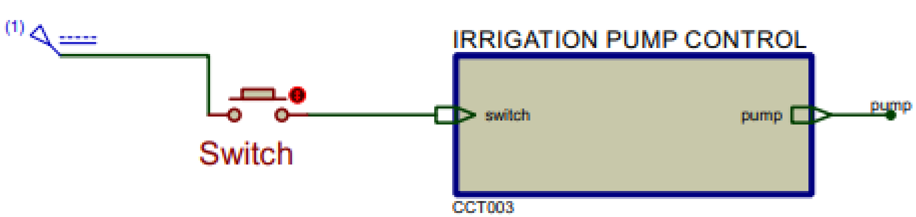
$Q_4= AC+AB$

Circuit:

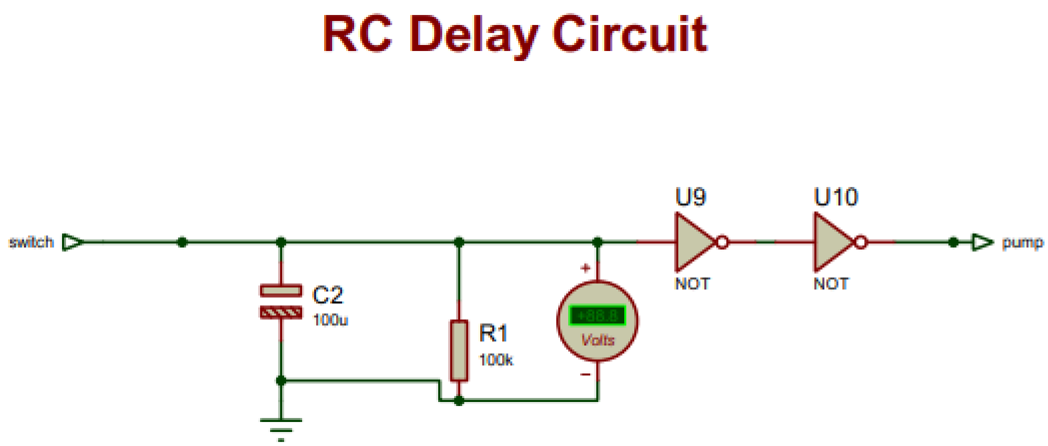


Irrigation Pump Control

Circuit:



Subcircuit:

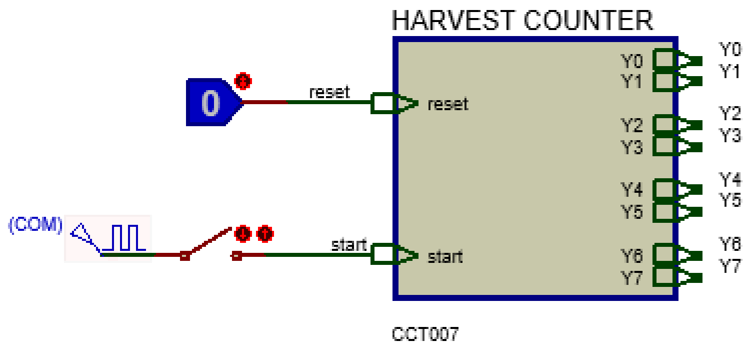


MOD256 Counter:

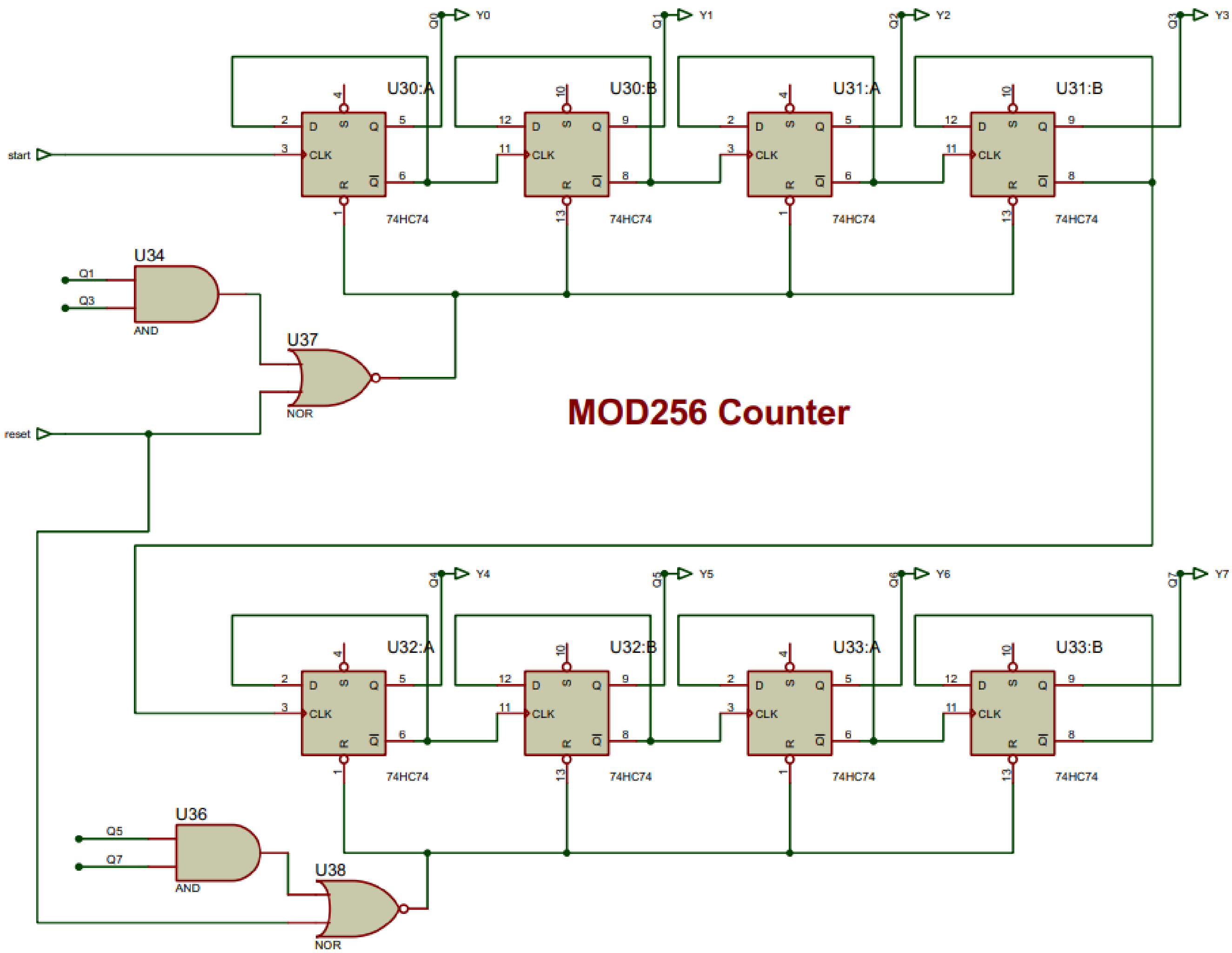
Truth Table:

Clk	D6	D5	D4	D3	D2	D1	D0
0	X	X	X	X	X	X	X
1	0	0	0	0	0	0	0
1	0	0	0	0	0	0	1
1	… (binary counting continues up to 99)						
1	0	1	1	0	0	1	1
1	0	1	1	0	1	0	0
1	0	1	1	0	1	0	1
1	0	1	1	0	1	1	0
1	0	1	1	0	1	1	1

Circuit:



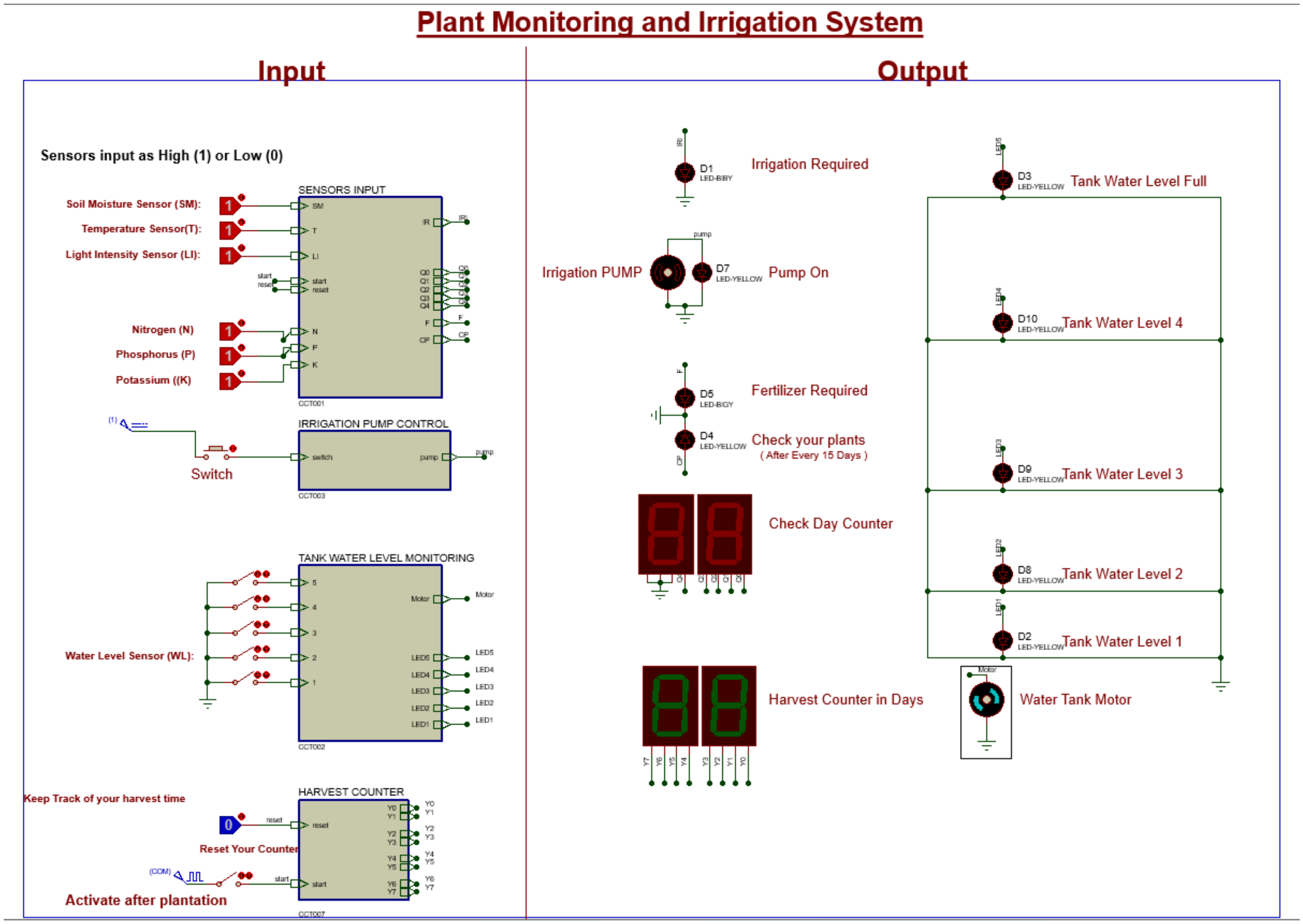
Subcircuit:



Methodology: Manual plant monitoring practices in Bangladesh's agricultural landscape are time-consuming, leading to delayed insights into critical environmental variables affecting crop health. The absence of an efficient and automated system impedes farmers' ability to respond promptly to changing conditions, negatively impacting crop yield and overall productivity.

Now, we will add upon some of the most critical factors revolving around our project.

1. System Architecture



1.1 Overview

The plant monitoring system is designed using a combination of logic gates, sequential and combinational circuits, and 7-segment displays. The system includes various monitoring various parameters in proper growth and development of a plant and sending alerts to the users if any of the parameters deviate from its natural or normal ranges.

1.2 Components

- Irrigation Sensory Unit: When the soil moisture goes below the recommended level and when the temperature and light intensity is low, this unit will give an irrigation alert. But if temperature or light intensity is high, the alert will not go through. This is because it is recommended not to water plants under intense sunlight.
- Fertilizer Alert Unit: To monitor plant fertilizer needs, three sensors detect the presence of essential nutrients—Nitrogen, Phosphorus, and Potassium—in the soil. Each sensor signals '1' for presence and '0' for absence. The “Fertilization Required” command activates if any

sensor signals '0', creating a logic system akin to a NOT gate, indicating the need for fertilization.

- Irrigation Pump Control: If the irrigation pump control switch is turned on, the water pump will start running and will stop after the water tank is fully filled.
- Water Level Sensor: This monitors the water level in the tank. When the tank is fully filled, the water tank motor will stop.

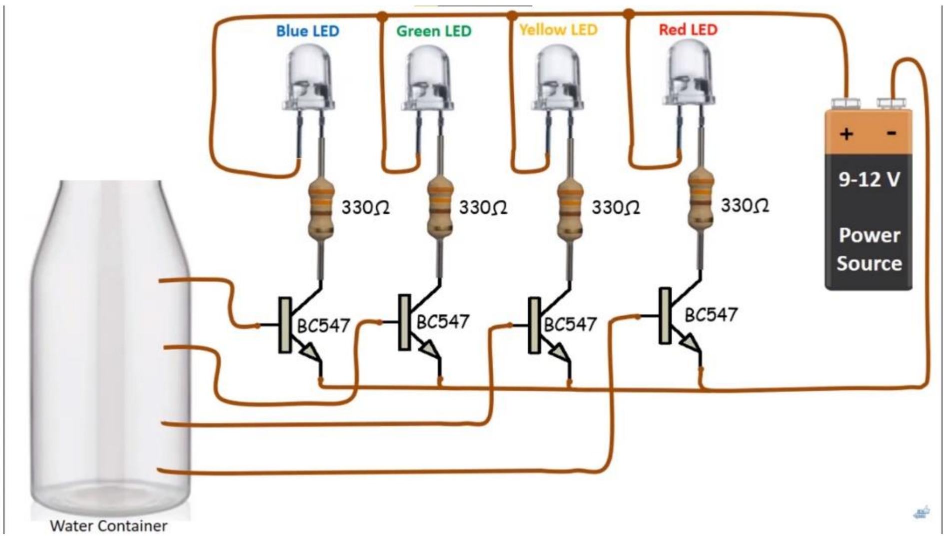


Figure: Practical implementation of Water Level Indicator.

- Harvest Tracker: The harvest tracker tracks the days of harvest.
- Plant Checking Alert: The plant checking alert is employed to inform the users to check their plants after every 15 days.

2. Methods of Research

The research methods primarily used by us during various stages of this project were a combination of primary and secondary research. We first collected relevant information regarding 'Automatic Plant Monitoring System' from various articles, research papers, websites and YouTube videos. The research involves a combination of literature review and practical experimentation. Relevant studies on plant monitoring systems, sensor technologies, and agricultural automation are reviewed to inform the design and development of the proposed system. After that, different components of our simulated circuit went through various trail and errors before settling to our final circuit.

3. Methods of Data Collection

Data on crucial environmental variables, such as soil moisture, temperature, and sunlight exposure, are collected using sensors integrated into the Automatic Plant Monitoring System. The relevant data are collected via simulation of our circuit.

4. Methods of Analysis

4.1 Data Preparation

Raw data collected by the Logic Toggles and switches is processed and formatted for input into the Proteus-based monitoring system.

4.2 Software Used

Proteus is employed as the primary software for designing, simulating, and testing the Automatic Plant Monitoring System. The software allows for a virtual representation of the system's components and functionalities.

5. Methodological Justification

5.1 Why this method?

Automatic Plant Monitoring System is conventionally made using various types of sensors, microcontrollers and Arduino Uno devices. But as these devices were not the topics of discussion in our Digital Electronics (EEE283) course, so, we did not use them during our designing. Rather we used various basic gates, combinational and sequential circuits. This made the circuit designing easy to grasp without the complexities of various sensors and microcontrollers.

5.2 Strengths and Weaknesses

Strengths:

- Utilization of proven basic gates, combinational and sequential circuits.
- Proteus facilitates thorough simulation and testing before real-world implementation.

Weaknesses:

- Limited to basic statistical analysis.
- Potential challenges in sensor calibration and maintenance.

The chosen approach aligns with the objectives of providing an accessible, technology-driven solution for plant monitoring in the agricultural context of Bangladesh. The methodology ensures practicality, affordability, and relevance to the local farming community.

6. Obstacles and Debugging Techniques

Our initial challenge involved designing the circuit without utilizing sensors due to their dependency on Arduino Uno or PIC microcontrollers in Proteus. Consequently, we opted for manual data input using logic toggles and buttons, generating outputs accordingly.

Subsequently, we encountered a need for automatic switching in the water level sensor to enable LEDs to illuminate automatically. Traditional switches and buttons proved ineffective, prompting us to address the issue by employing the switching action of a BJT (Bipolar Junction Transistor) as a substitute for automatic switches.

Additionally, for the irrigation pump controller, we faced the requirement for an automatic turn-off delay. To resolve this, we incorporated an RLC circuit to introduce the necessary delay within the pump controller.

Result and Discussion:

The Truth Table for Fertilizer Monitor:

N	**P**	**K**	**F.R**
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0

Verification of the Truth Table:

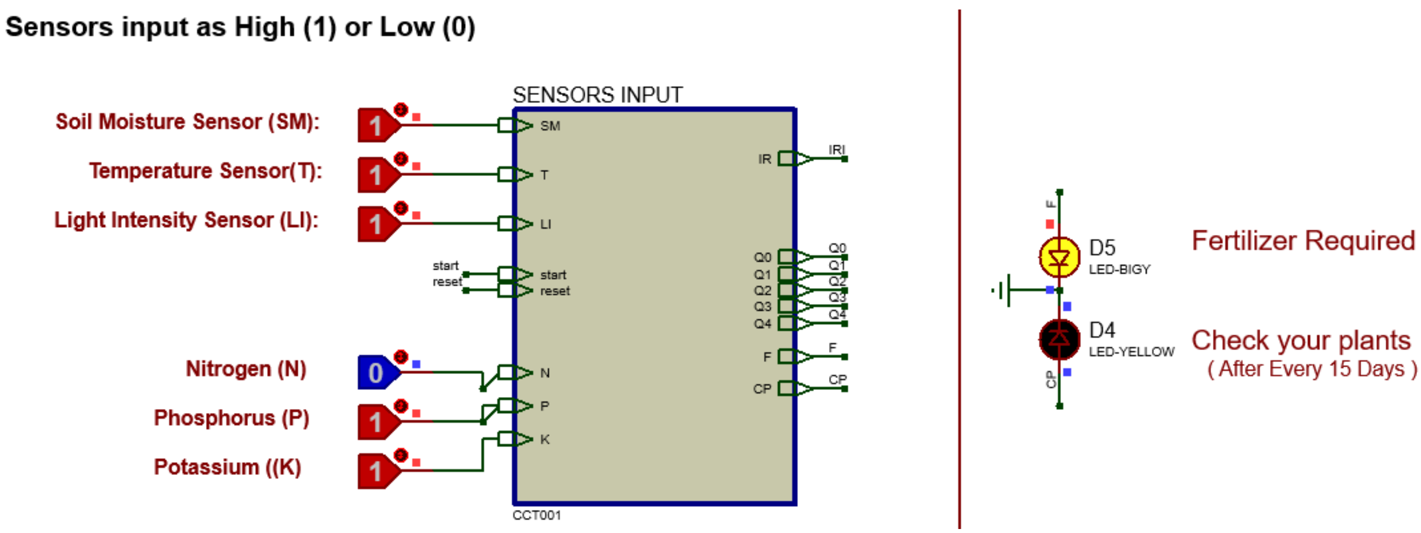


Figure: Nitrogen = 0, Phosphorous = 1, Potassium = 1; Fertilizer Alert (ON)

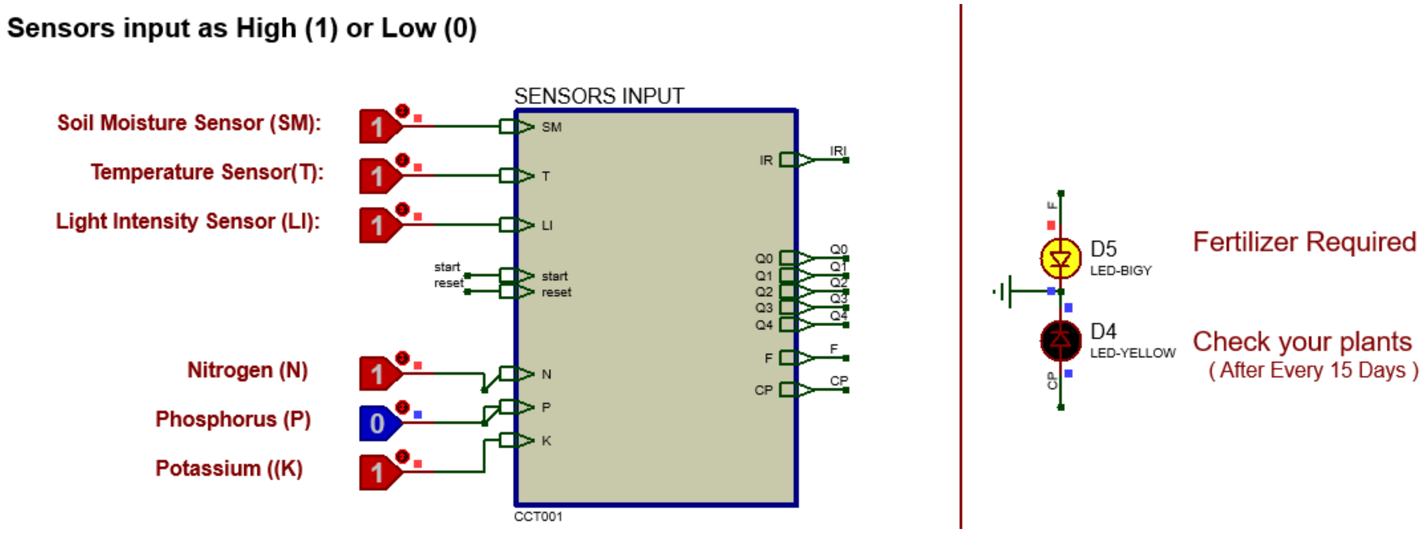


Figure: Nitrogen = 1, Phosphorous = 0, Potassium = 1; Fertilizer Alert (ON)

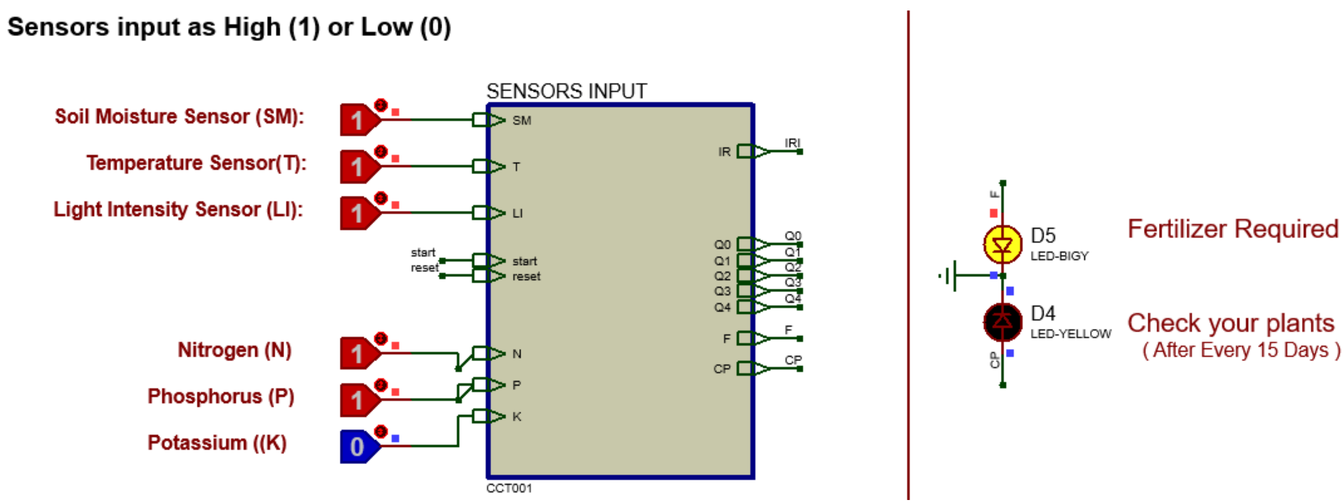


Figure: Nitrogen = 1, Phosphorous = 1, Potassium = 0; Fertilizer Alert (ON)

Truth Table for Irrigation Alerts:

Input			**Output**	
SM	**T**	**LI**	**Activate alarm for Irrigation**	**Pump**
0	0	0	1	ON
0	0	1	1	ON
0	1	0	1	ON
0	1	1	0	OFF
1	0	0	0	OFF

1	0	1	0	OFF
1	1	0	0	OFF
1	1	1	0	OFF

Verification of Truth Table:

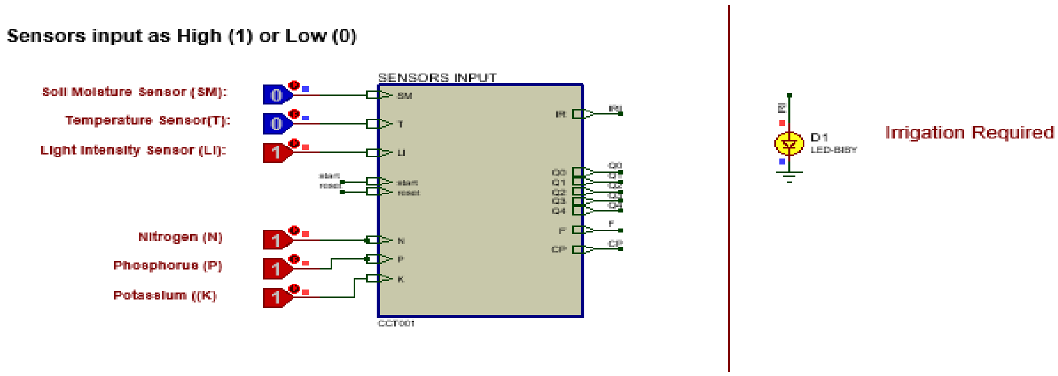


Figure: Soil Moisture = 0, Temperature = 0, Light Intensity = 1, Irrigation Alert (ON)

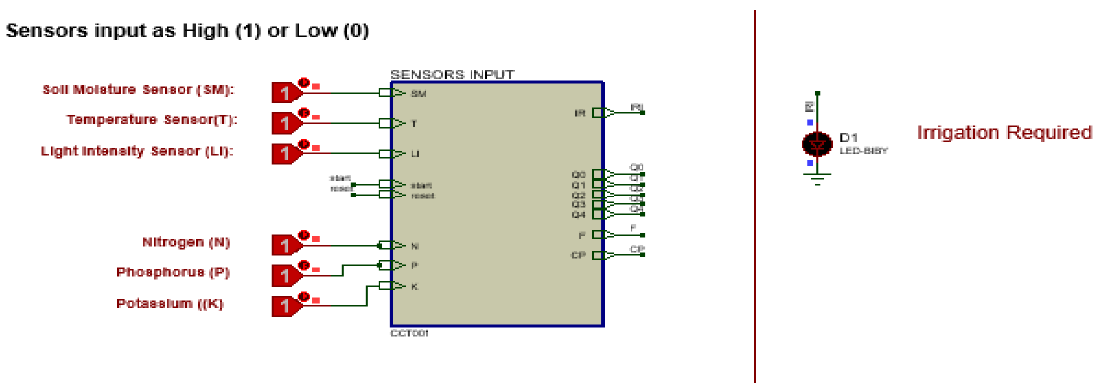


Figure: Soil Moisture = 1, Temperature = 1, Light Intensity = 1, Irrigation Alert (OFF)

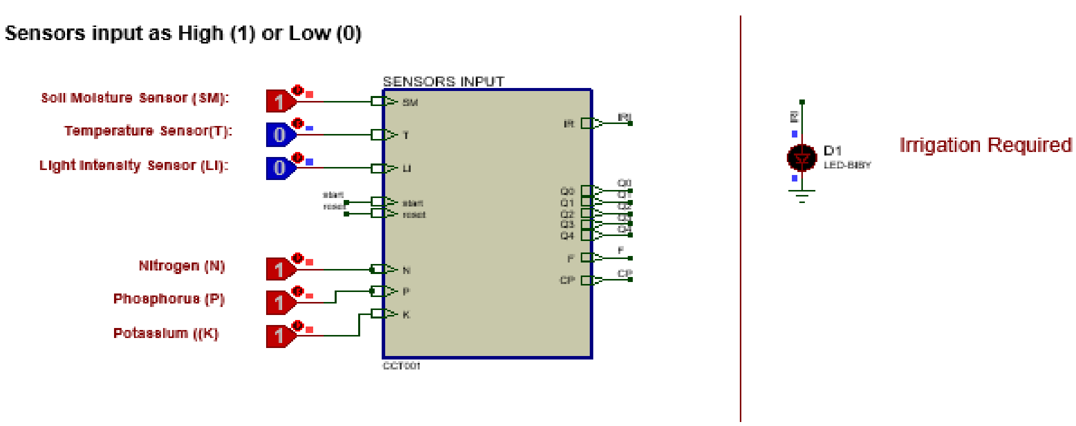


Figure: Soil Moisture = 1, Temperature = 0, Light Intensity = 0, Irrigation Alert (OFF)

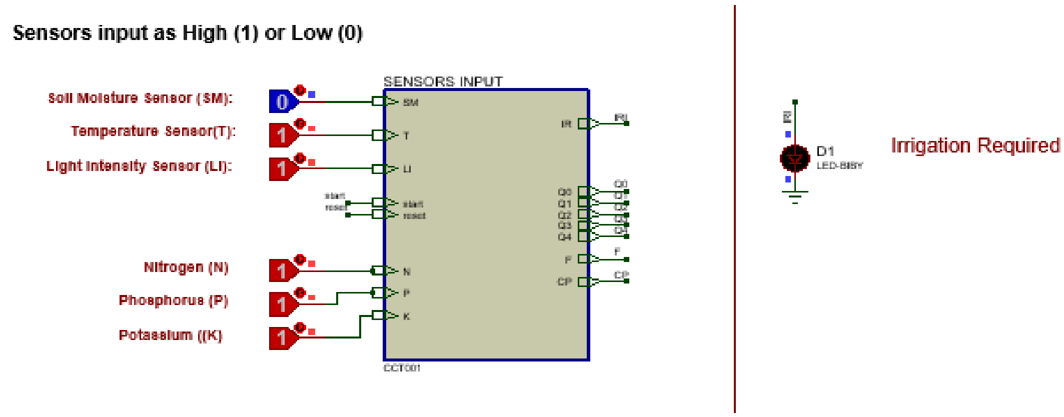


Figure: Soil Moisture = 0, Temperature = 1, Light Intensity = 1, Irrigation Alert (OFF)

<u>Truth Table for Irrigation Pump Control</u>:

Switch	Pump
ON	ON
OFF	OFF

Verification of Truth Table:

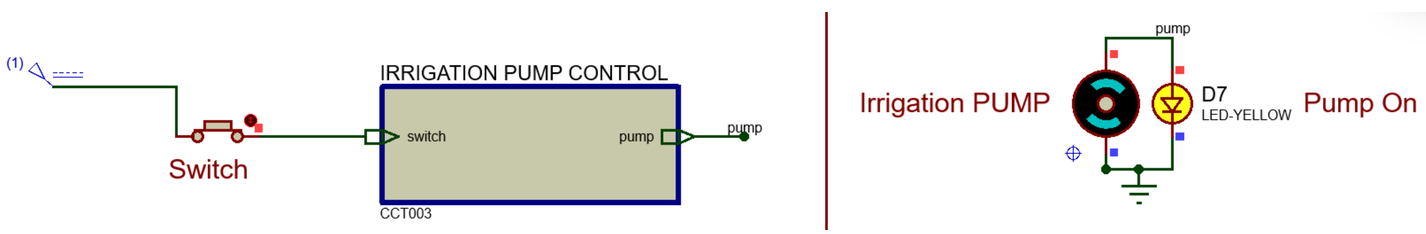


Figure: Irrigation Pump ON when switch is ON

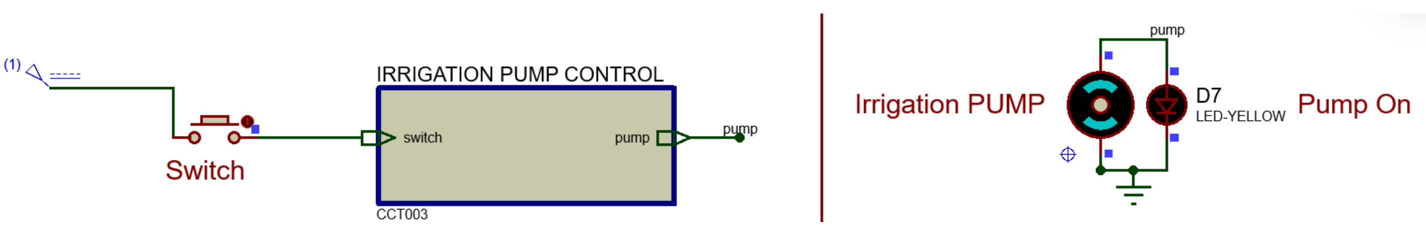


Figure: Irrigation Pump OFF when switch is OFF

<u>Truth Table for Water Level Sensor</u>:

Input					**Output**					
S1	**S2**	**S3**	**S4**	**S5**	**L1**	**L2**	**L3**	**L4**	**L5**	**Water tank**
0	0	0	0	0	0	0	0	0	0	ON

0	0	0	0	1	0	0	0	0	1	ON
0	0	0	1	0	0	0	0	1	0	ON
0	0	0	1	1	0	0	0	1	1	OFF
0	0	1	0	0	0	0	1	0	0	ON
0	0	1	0	1	0	0	1	0	1	OFF
0	0	1	1	0	0	0	1	1	0	ON
0	0	1	1	1	0	0	1	1	1	OFF
0	1	0	0	0	0	1	0	0	0	ON
0	1	0	0	1	0	1	0	0	1	OFF
0	1	0	1	0	0	1	0	1	0	ON
0	1	0	1	1	0	1	0	1	1	OFF
0	1	1	0	0	0	1	1	0	0	ON
0	1	1	0	1	0	1	1	0	1	OFF
0	1	1	1	0	0	1	1	1	0	ON
0	1	1	1	1	0	1	1	1	1	OFF
1	0	0	0	0	1	0	0	0	0	ON
1	0	0	0	1	1	0	0	0	1	OFF
1	0	0	1	0	1	0	0	1	0	ON
1	0	0	1	1	1	0	0	1	1	OFF
1	0	1	0	0	1	0	1	0	0	ON
1	0	1	0	1	1	0	1	0	1	OFF
1	0	1	1	0	1	0	1	1	0	ON
1	0	1	1	1	1	0	1	1	1	OFF
1	1	0	0	0	1	1	0	0	0	ON
1	1	0	0	1	1	1	0	0	1	OFF

1	1	0	1	0	1	1	0	1	0	ON
1	1	0	1	1	1	1	0	1	1	OFF
1	1	1	0	0	1	1	1	0	0	ON
1	1	1	0	1	1	1	1	0	1	OFF
1	1	1	1	0	1	1	1	1	0	ON
1	1	1	1	1	1	1	1	1	1	OFF

Verification of Truth Table:

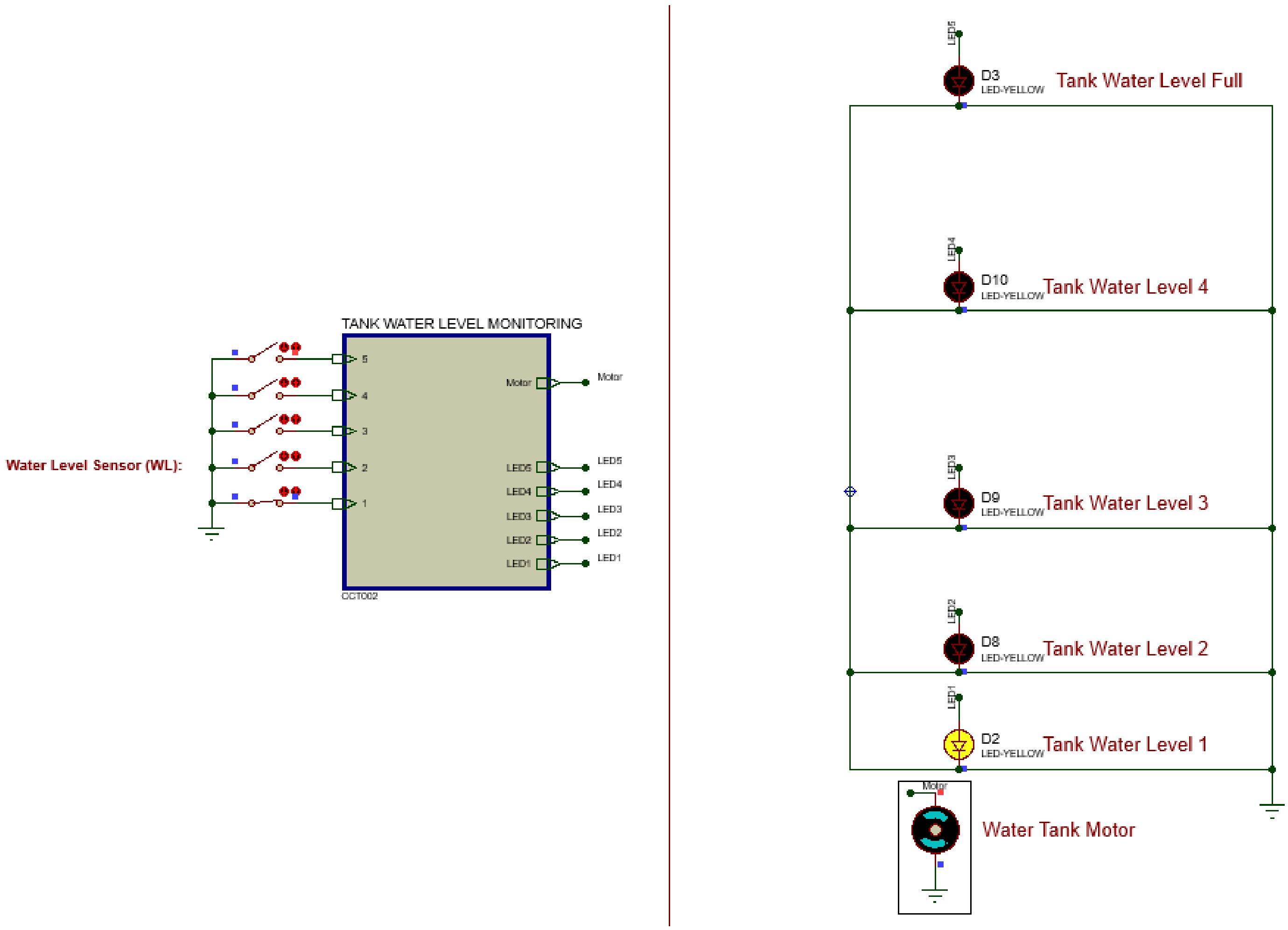


Figure: Switch 1: ON, Water Tank Motor: ON

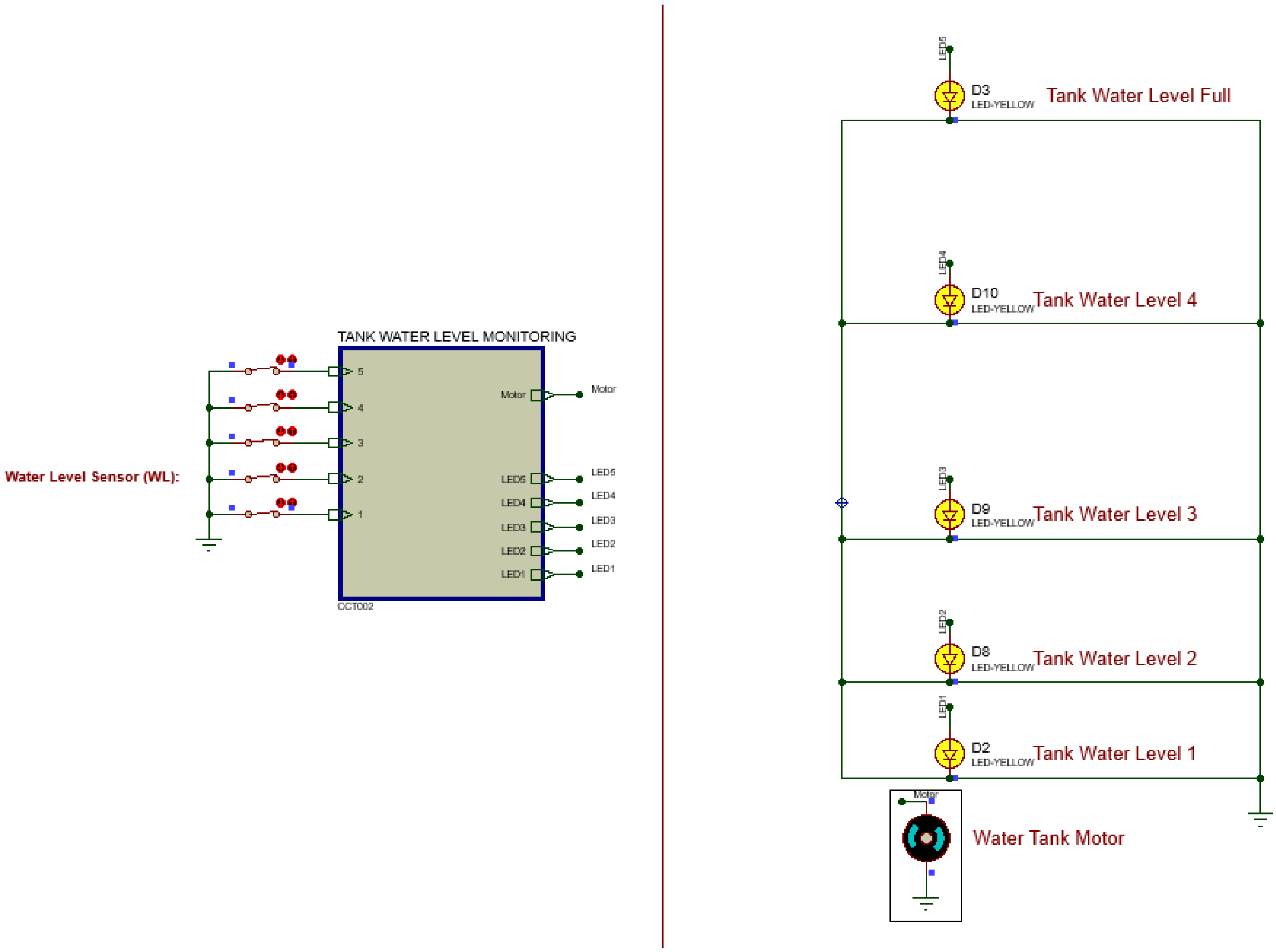


Figure: Switch 1, 2, 3, 4, 5: ON, Water Tank Motor: OFF

Besides these, the harvest counter keeps a track off the days of harvest. The “Check Day Counter” sends an alert to the user to check the plants after every 15 days.

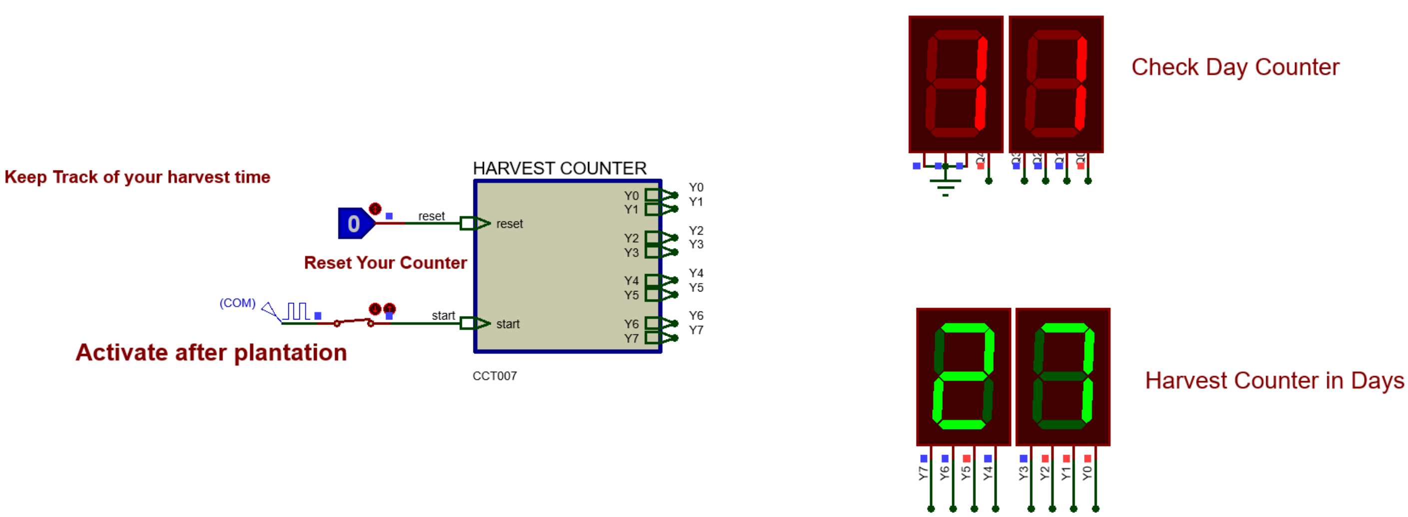


Figure: Functions of Harvest Counter and Check Day Counter

Project Validation: From the above results, we can safely conclude that, our project was a success and every part of the system runs as intended. The designed project satisfies the complex engineering criteria set in the class. The project touches on the 'Range of diverse resources', 'Level of interactions', 'Consequence to society and environment', and 'Familiarity' criteria quite well. We used various types of circuit elements learnt during this course and our previous courses. We discussed each and every step of our project with all our groupmates and we could relate to the designed circuits. The consequence and impact of our project on society and environment is also immense (which is discussed on the following paragraph). Finally, we tried to use the familiar circuit components in a complex and sophisticated form in various components of our project.

Impact: The "Automated Plant Monitoring System" we designed has profound impacts across various aspects of life, including societal, cultural, legal, safety, and health contexts. These impacts are as follows:

Socio-cultural impacts:

- The automated system contributes significantly to the formation of a smart society and facilitates social modernization.
- As a smart system, it simplifies human life by reducing daily hassles and saving valuable time.
- The system ensures effective care and maintenance of plants, positively impacting the agricultural sector and improving the economic conditions of farmers.
- The growth of the agricultural sector due to the system will also stimulate related industries, leading to visible socio-economic growth (Ariyaratne et al., n.d.).
- Observing the benefits of the automated system, people will be encouraged to plant and maintain trees, contributing to forest growth. It also enables easy home gardening, reducing vegetable costs and enhancing social elegance.

Impacts on health and safety issues:

- The system contributes to food security by ensuring a good harvest.
- By increasing the demand for agricultural products and reducing the use of inorganic materials, the system benefits both the environment and human health (Slippers et al., 2020).
- The system's accurate monitoring and care of plants result in fresh and healthy foods that can improve human health (Buja, 2021).
- The system ensures the appropriate use of fertilizers, preventing plant damage from insects and thus reducing various forms of pollution (*Development of an Automatic Plant Monitoring System*, 2014).

Legal and benevolent impacts:

- The automated system allows the owner to supervise the plants without the need for many laborers, ensuring the privacy and security of the property.
- The reduction in labor demand due to automation can benefit other sectors by providing them with more workable laborers.
- The automated plant monitoring system reduces water wastage by ensuring the exact amount of water irrigation to the plants.

Future Works: As a future enhancement to our project, "Automatic Plant Monitoring and Irrigation System", we plan to develop an Internet of Things (IoT) based mobile application. This app will allow users to monitor and control their irrigation systems remotely, providing real-time updates and notifications about the health and needs of their plants.

Built using Proteus, our system already automates the process of plant care. By integrating it with a mobile application, we aim to make this process even more user-friendly and accessible. Users will be able to adjust settings, receive alerts, and even automate responses to certain plant conditions directly from their smartphones.

This IoT-based mobile app will not only enhance the functionality of our existing system but also contribute to the broader goal of promoting smart and sustainable agriculture. We believe that this integration of technology with agriculture can revolutionize the way we care for plants and manage resources.

Conclusion: The "Automatic Plant Monitoring and Irrigation System" project signifies a significant breakthrough in Bangladesh's agriculture, leveraging technology, specifically Proteus for simulation, to address manual monitoring challenges. The methodology, opting for basic gates and circuits over traditional sensors and microcontrollers, aligns strategically with the educational context, prioritizing simplicity and affordability while recognizing potential weaknesses in statistical analysis and sensor calibration. The project demonstrates adaptability and innovative problem-solving to overcome obstacles, with system validation showcasing extensive impacts on socio-cultural, health, safety, and legal aspects. Future work involves the development of an IoT-based mobile app, enhancing user-friendliness and accessibility for smart and sustainable agriculture. In summary, driven by Proteus and a digital electronics approach, the project holds promise for positive transformation in Bangladesh's agricultural practices, automating plant care for a more sustainable and efficient future.

References:

Ariyaratne, U.H.D. T. N., Vitharana, V. D. Y., Deelaka, L.H. D. R., & Herath, H.M. S. M. (n.d.). *IoT Smart Plant Monitoring, Watering and Security System.*

Bangladesh | FAO Regional Office for Asia and the Pacific. (n.d.). Food and Agriculture Organization of the United Nations. Retrieved December 8, 2023, from https://www.fao.org/asiapacific/perspectives/agricultural-statistics/global-strategy/results-in-the-region/bangladesh/en/

Buja, I. (2021, March 18). *Advances in Plant Disease Detection and Monitoring: From Traditional Assays to In-Field Diagnostics.* MDPI. Retrieved December 13, 2023, from https://www.mdpi.com/1424-8220/21/6/2129

Connolly, A. (2022, April 26). *10 Digital Technologies That Are Transforming Agriculture*. Forbes. Retrieved December 8, 2023, from https://www.forbes.com/sites/forbestechcouncil/2022/04/26/10-digital-technologies-that-are-transforming-agriculture/

Development of an automatic plant monitoring system. (2014, August 14). IIUM Repository (IRep). Retrieved December 13, 2023, from http://irep.iium.edu.my/37656/

Electronic engineering for agriculture. (n.d.). Department of Electrical and Electronic Engineering. Retrieved December 8, 2023, from https://www.eee.manchester.ac.uk/research/themes/electronic-engineering-for-agriculture/

Raihan, S. (2012). *Economic Reforms and Agriculture in Bangladesh: Assessment of Impacts Using Economy-wide Simulation Models.* International Labour Organization.

Slippers, B., Roux, J., & Visser, M. (2020, June 10). *Why it's so critical to continuously monitor and manage plant diseases.* The Conversation. Retrieved December 13, 2023, from https://theconversation.com/why-its-so-critical-to-continuously-monitor-and-manage-plant-diseases-139423

Working Principle of BJT Transistor with Water Level Circuit Example. (2021, March 1). YouTube. Retrieved December 13, 2023, from https://www.youtube.com/watch?v=pAZ2EtxFiVg

Proteus File

https://drive.google.com/drive/folders/1dwR491erd196yLcE3LWq96aAHttUmwSN?usp=drive_link