SMART LOAD MANAGEMENT SYSTEM

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A Final Year Design Project (FYDP) submitted to the Department of Electrical and Electronic Engineering In partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering

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Declaration

It is hereby declared that

1. The Final Year Design Project (FYDP) submitted is my/our own original work while completing degree at Brac University.
2. The Final Year Design Project (FYDP) does not contain material previously published or written by a third party, except where this is appropriately cited through full and accurate referencing.
3. The Final Year Design Project (FYDP) does not contain material which has been accepted, or submitted, for any other degree or diploma at a university or other institution.
4. I/We have acknowledged all main sources of help.

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Approval

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Of Summer 2023 has been accepted as satisfactory in partial fulfillment of the requirement for the degree of Bachelor of Science in Electrical and Electronics Engineering on 26-08-2023.

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Ethics Statement:

All the project-based studies, research and field work have been done by us with proper supervision and done individually or in groups required as per the demand of that specific work. Moreover, all the data, information and resources have been taken from authentic and reliable sources and used and cited properly and carefully. Plagiarism and copying are something we were really careful and concerned about thus we carefully avoided them. Meanwhile no payment or extra benefits were to given to anyone related with the project as this is a voluntary work and our goal is to improve and benefit the mankind and the field of Electrical and Electronic Engineering. Also taking proper measures to avoid any environmental hazard was also our intention.

Abstract/ Executive Summary

The name of our project is Smart Load Management System. In our project, we are designing and constructing a smart load management system that can be effectively utilized to monitor power systems. We are monitoring power systems using real-time data. It also detects load mismatching between distributor and user. This smart load management system comes with theft control technique and is capable of notifying users about load-shedding through SMS to both distributor and consumer about any possible power theft or leakage.

Keywords: Smart Load Management; Load Shedding Management; Notification; Electricity Monitoring; GSM; Theft Control; Power Distribution; Power Monitoring.

Dedication:

We dedicate this project to the Almighty. We will be always grateful to the Almighty for His blessings. We would also like to thank our parents for their continuous love and support throughout this journey and dedicate this project to them. We sincerely thank our ATC panel for their support and their confidence in our project.

Acknowledgement:

We would like to express our sincere gratitude to our ATC panel members for their time and continuous contributions. The overwhelming support from the Department of EEE, Brac University made it possible to present this in front of such a big audience.

Table of Contents

Chapter 1: Introduction- [CO1, CO2, CO10]

1.1 Introduction

1.1.1 Problem Statement:

According to Annual Report (2020-2021) of Bangladesh Power Development Board (BPDB) the maximum peak generation (MW) of electricity was 13,792 MW and on the other hand maximum peak demand was 14,500 MW [1]. This clearly indicates that the Government of Bangladesh is failing to fulfill its population's demands and supply of electricity. As a result, on October 27, 2022, Bangladesh experienced 1,915 MW of load shedding [2].

The cause of the reason is many in numbers. If we read the news or even see the surroundings, we can see various load related issues are increasing at an alarming rate. In FY 2021, total duration of power interruption in the grid network was 167 hours 04 minutes [1]. Which was divided into many areas at various times. The main problem came from Partial Power failure due to trouble in grid S/S Equipment & Partial Power failure due to fault in transmission line which is nearly 95.8%. Now, to control the situation and maintain balance, the best way of dealing with the problem is to make a proper load management system. As the world is getting digital day by day the load management system is far behind modern solutions. Although they are trying to adapt to the new systems, these solutions are not well furnished according to the current requirements. Numerous energy producing stations have been saved or dismantled as a result of the deregulation of the energy market for financial reasons.

For a power system network with an overcurrent fault protection mechanism, a paper suggests an Internet of Things (IOT)-based Energy Management system that integrates source management, load automation and shedding, demand forecasting and internet communication. Using this form of operation, the sources are managed in accordance with changing demand [3]. After that, we discovered the implementation of smart and sustainable technology by modifying IoT-based techniques and employing smart plugs for data collection that is transmitted via wireless-gateway to the main database. The system is set up so that the Smart plugs can be turned on and off from the central server when not in use [4].

The MIT Auto-ID Center's Ashton initially suggested the IOT in the investigation of Radio-Frequency Identification (RFID) in 1999, and since then it has gained widespread recognition both domestically and overseas. The definition and scope of the IOT have altered and the coverage has been substantially enlarged, in the same-named study produced by the International Telecommunication Union (ITU) in 2005. It no longer refers to the IOT based on RFID technology [5]. Load Shedding is unreliable and inefficient because it is manually controlled

by assigning a person in charge to turn on and off the switch. The "Load Shedding Time Management System utilizing Microcontroller" can be created to automatically turn on or off the switch according to the command fixed into it using a real-time clock system run on an 8051 microcontroller [6]. To maintain track of the time and turn the loads ON/OFF automatically, a Real Time Clock (RTC) and microcontroller are employed. Push buttons are employed as the microcontroller's interface, from which it receives the required time when it matches the real time. Then, based on the commands, the microcontroller starts that specific relay, turning on or off the load [7].

Additionally, our system includes power theft control. In accordance with customization, the designs of all the components must be combined into a single design. The distributor box's design will include a GSM module and multiple ACS712 modules. The customized electric meter's simulation design will include the commercial electric meter's circuits and the customized electric meter's operation. Simulation designs can be obtained using Proteus software. Following a successful simulation, the design will facilitate electric meter-related simulation design, fabrication, licensing, and manufacturing. A digital conversion circuit should also be included in the simulation design. All of the users for the payment system, theft analytics, and a web-based mobile app will be developed with Android in such a way that the server of the app will contain the user's details and directions for theft.[8]

Due to a variety of factors, including the population's rapid growth, difficult geography, unfavorable environmental conditions, etc., problems related to traditional meter reading have gotten worse day by day. However, a lot of advancements have been made to lessen manual effects with the use of microcontrollers. In the old meter reading system, where utility usage is recorded on paper by employees, there are many opportunities for human error, which will raise costs for customers or businesses. Additionally, it's possible that consumers won't be around when utility workers arrive to read the meters. The billing process will still be in progress in these circumstances; therefore, employees will need to return to the customer's house. Sending employees to each and every customer's house to create the bill requires a lot of time and effort. Future obstacles will make it more difficult.

Furthermore, utility staff have a tough time manually identifying illicit connections or customer fraud. [9] Our initiative seeks to implement a system with the vision to help the general people as well as the management and administration behind load management. We want to create a solution which will let both the consumer and distributor side to know more about their load situation and act accordingly. Our main target is to use the proper and pristine data to manage the load timing and also keep track of electricity consumption. With the help of modern technology, we can combine all the scopes and make a better smart and sustainable automated system for load management which can also be monitored in real time. Through a machine learning-based method, we will forecast a load calculation for the entire year. As a result, we will be able to anticipate how much load will be required for the entire year. To correctly vary our load utilization, we are also attempting to control theft.

1.1.2 Background Study:

The maximum peak generation (MW) of energy was 13,792 MW, whereas the maximum peak consumption was 14,500 MW, according to Bangladesh Power Development Board's (BPDB) Annual Report (2020-2021) [1]. This demonstrates unequivocally that Bangladesh's government is unable to give electricity to its people in a timely manner. Bangladesh had 1,915 MW of load shedding as a result on October 27, 2022 [2]. There are numerous causes behind the reasons. We may notice that numerous load-related problems are spreading alarmingly whether we read the news or even look around. The grid network experienced power outages for a total of 167 hours 04 minutes in FY 2021[1]. It was at various points divided into a variety of sections. The main issue was a partial power outage caused by issues with the grid's S/S equipment and a partial power outage caused by a defect in the transmission line, which accounts for almost 95.8% of the problem.

Making a suitable load management system is now the best option to handle the issue in order to keep things under control and in balance.
As the world is getting digital day by day the load management system is far behind modern solutions. Although they are trying to adapt to the new systems, these solutions are not well furnished according to the current requirements. As a consequence of the liberalization of the energy market, many energy generation plants have been decommissioned or preserved for economic reasons.

For a power system network with an overcurrent fault protection mechanism, a paper suggests an Internet of Things (IOT)-based Energy Management system that integrates source management, load automation and shedding, demand forecasting and internet communication. Using this form of operation, the sources are managed in accordance with changing demand [3]. After that, we discovered the implementation of smart and sustainable technology by modifying IoT-based techniques and employing smart plugs for data collection that is transmitted via wireless-gateway to the main database. The system is set up so that the Smart plugs can be turned on and off from the central server when not in use [4]. The MIT Auto-ID Center's Ashton initially suggested the IOT in the investigation of Radio-Frequency Identification (RFID) in 1999, and since then it has gained widespread recognition both domestically and overseas. The definition and scope of the IOT have altered and the coverage has been substantially enlarged, in the same-named study produced by the International Telecommunication Union (ITU) in 2005. It no longer refers to the IOT based on RFID technology [5].

Load Shedding is unreliable and inefficient because it is manually controlled by assigning a person in charge to turn on and off the switch. The "Load Shedding Time Management System utilizing Microcontroller" can be created to automatically turn on or off the switch in accordance with the command fixed into it using a real-time clock system run on an 8051 microcontroller [6]. To

maintain track of the time and turn the loads ON/OFF automatically, a Real Time Clock (RTC) and microcontroller are employed. Push buttons are employed as the microcontroller's interface, from which it receives the required time when it matches the real time. Then, based on the commands, the microcontroller starts that specific relay, turning on or off the load [7]. Additionally, our system includes power theft control. In accordance with customization, the PCB designs of all the components must be combined into a single design. The distributor box's PCB design will include a GSM module and multiple ACS712 modules. The commercial electric meter's circuits and the customized electric meter's functionality will both be included in the PCB design of the customized electric meter. PCB design software may be used to obtain PCB designs. In the event that the simulation is successful, the PCB design will make PCB design, fabrication, licensing, and manufacture for electric meters easier. The PCB design should also have a digital conversion circuit. The web-based mobile app, theft analytics, and payment system will all be designed with Android in such a way that the server of the app will house the user's information and theft instructions.[8]

Traditional meter reading issues have become worse day by day as a result of a number of circumstances, such as the population's fast increase, challenging topography, bad environmental conditions, etc. However, a lot of advancements have been made to lessen manual effects with the use of microcontrollers. In the old meter reading system, where utility usage is recorded on paper by employees, there are many opportunities for human error, which will raise costs for customers or businesses.

There is also a possibility that customers won't be available when utility staff come to read the meters. In these situations, the billing procedure will still be in progress, and staff will need to go back to the customer's home. It takes a lot of time and effort to send workers to each and every customer's home to generate the bill. Future challenges will make it harder. Additionally, utility staff have a tough time manually identifying illicit connections or customer fraud. [9]

Our initiative seeks to implement a system with the vision to help the general people as well as the management and administration behind load management. We want to create a solution which will let both the consumer and distributor side to know more about their load situation and act accordingly. Our main target is to use the proper and pristine data to manage the load timing and also keep track of electricity consumption. With the help of modern technology, we can combine all the scopes and make a better smart and sustainable automated system for load management which can also be monitored in real time. Through a machine learning-based method, we will forecast a load calculation for the entire year. As a result, we will be able to anticipate how much load will be required for the entire year. To correctly vary our load utilization, we are also attempting to control theft.

Survey

We did a survey on our project. In order to assess the view of the stakeholders and the targeted users of our project, we conducted a survey which may provide us better insight to choose our optimal design solution.

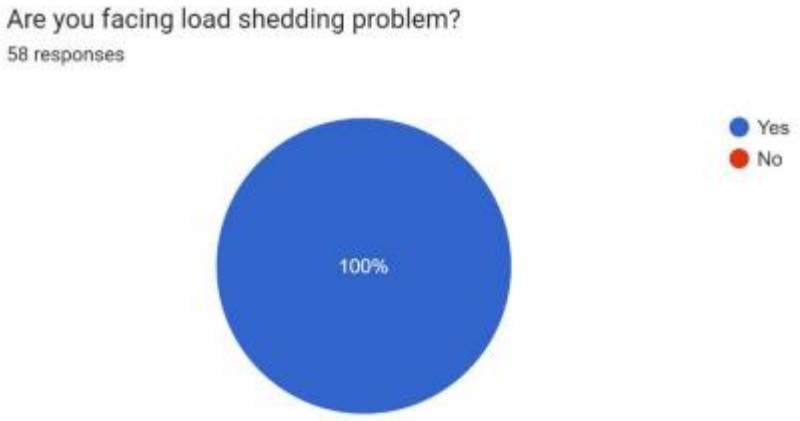

Figure 1.1.2.1: Pie Chart of Opinion About Load Shedding Problem.

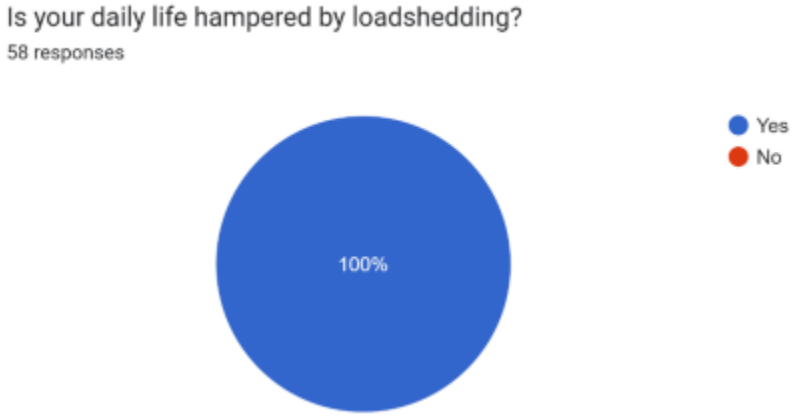

Figure 1.1.2.2: Pie Chart of Peoples Agreement About Daily Life Hassle.

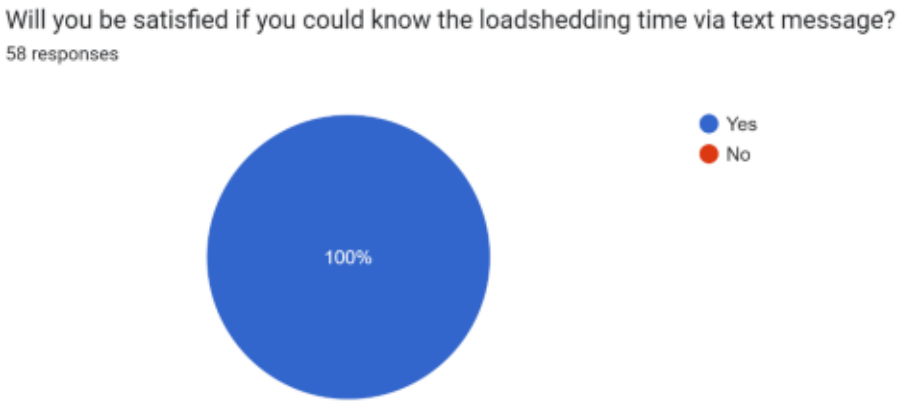

Figure 1.1.2.3: Pie Chart of About Peoples Notification Need.

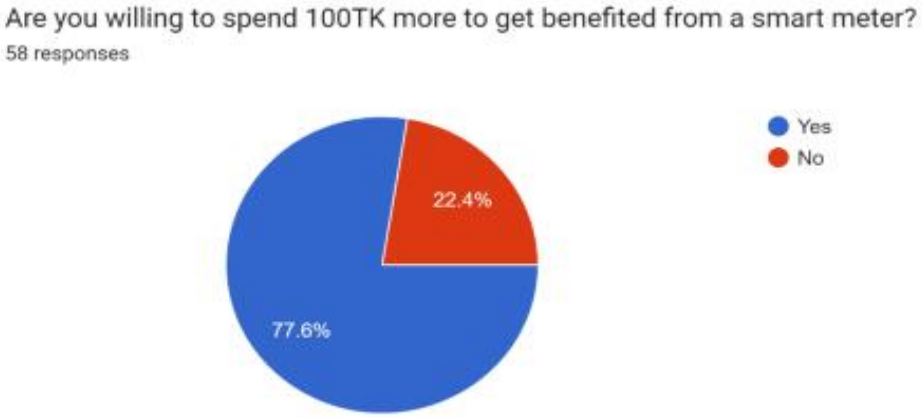

Figure 1.1.2.4: Pie Chart of People About Needing Smart Meter.

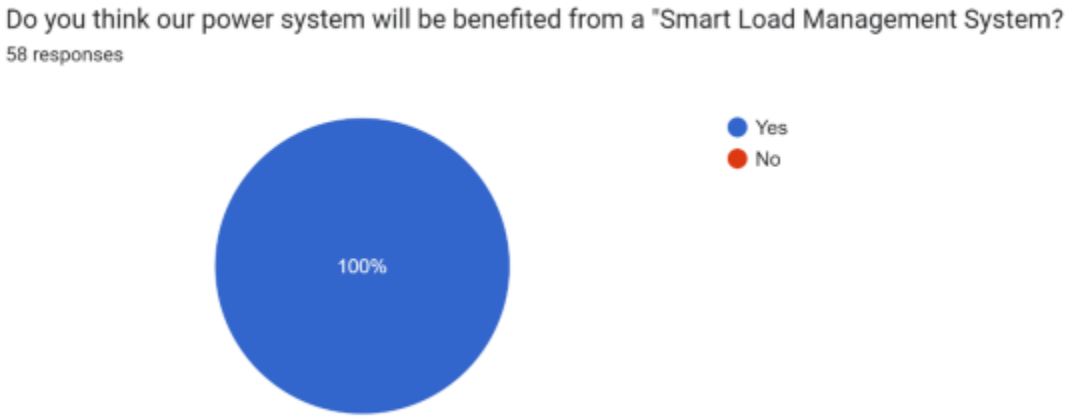

Figure 1.1.2.5: Pie Chart About Project Need.

1.1.3 Literature Gap

Numerous causes, such as the population's quick expansion, the region's challenging geography, the negative state of the environment, etc., have contributed to the problems with traditional meter reading, which have gotten worse every day. With the use of microcontrollers, numerous improvements have been developed to reduce the negative impacts of physical labor. There are several potentials for human mistakes in the outdated meter reading system, where utility usage is recorded on paper by personnel, which will increase rates for clients or enterprises. Our initiative seeks to implement a system with the vision to help the general people as well as the management and administration behind load management.

1.1.4 Relevance to current and future Industry

According to Annual Report (2020-2021) of Bangladesh Power Development Board (BPDB) the maximum peak generation (MW) of electricity was 13,792 MW and on the other hand maximum peak demand was 14,500 MW [1]. This clearly indicates that the Government of Bangladesh is failing to fulfill its population’s demands and supply of electricity. As a result, on October 27, 2022, Bangladesh experienced 1,915 MW of load shedding [2].

The cause of the reason is many in numbers. If we read the news or even see the surroundings, we can see various load related issues are increasing at an alarming rate. In FY 2021, the total duration of power interruption in the grid network was 167 hours (about 7 days) 04 minutes [1]. Which was divided into many areas at various times. The main problem came from Partial Power failure due to trouble in grid S/S Equipment & Partial Power failure due to fault in transmission line which is nearly 95.8%. Now, to control the situation and maintain balance, the best way of dealing with the problem is to make a proper load management system. As the world is getting digital day by day the load management system is far behind modern solutions. Although they are trying to adapt to the new systems, these solutions are not well furnished according to the current requirements. As a consequence of the liberalization of the energy market, many energy generation plants have been decommissioned or preserved for economic reasons.

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1.2 Objectives, Requirements, Specification and constant

1.2.1. Objectives:

- Implementation of “Smart Load management System”
- Notifying People About Load Shedding Schedule.
- Distribute Accurate Data and Information.
- Distributors will get an approximation of load calculation for a Month/Year based on users’ usage.
- Theft Control System. [13]
- Detection of load mismatching between distributor and user.

1.2.2 Functional and Nonfunctional Requirements

Functional Requirements:

1. Automated power system.
2. Monitoring power systems with real-time data.
3. Smart management system.
4. Theft Control. [13]
5. Load calculation prediction.
6. Real time data management.

Non-Functional Requirements:

1. Software Security
2. User Friendly System
3. Reliability of Wi-Fi System.
4. Smart Meter with display. [9]

1.2.3 Specifications

Table 1.2.3.1: Specification.

Sub System	Required Component	Description
Automatic Shedding.	Relay	Electric switches known as relays employ electromagnetism to transform weak electrical impulses into stronger currents.
	Transformer	Transformer usually plays the role of converting the voltage according to need. The need differs from consumer to consumer so does the size of a transformer. There are 2 main parts which does the work, named as primary side and secondary side.
	Sensor Unit	Voltage 2.1kVRMS Bandwidth 80KHz Internal conductor resistance 1.2 mΩ. Sensors are used to detect light; temperature also motion and sound. These detected signals are transferred in binary code. Then the binary code is processed by a computing unit.
Control Unit	Arduino	Operating Voltage: 5V Input voltage :7-12 V (recommended) Input Voltage :6-20 V Open-source hardware and software make up the foundation of the electronics platform known as Arduino.[10]
	Bread Board	Voltage 5V-15V Current .33A-1A It is mainly use in prototype design to check a circuit's working principle for better understanding of a simulated design
	Jumper Wire	Voltage 3.3V-5V A jumper wire in an electric wire widely used for closing down on distant placed circuit boards. By using a jumping wire to the circuit boards, we can short circuit in the board as well as jump to it

	LED Light	Input Voltage: 3.3V-5V LEDs emit light as electricity passes through them. Recombining semiconductor electrons and electron holes produces light.
Communication Component	GSM Module	GSM modems or modules employ GSM mobile phone technology to link to a network wirelessly.[11]
	Mobile	It can run software which we may need to use to receive data.
	GPS Module	The Global Positioning System (GPS) uses a network of satellites and ground stations to pinpoint an individual's location on Earth in real time.[12]

1.2.4 Technical and Non-technical consideration and constraint in design process:

Budget: As we are making a smart load system, we will need multiple devices. To make a project within a specific budget may be impossible to make as some devices are expensive.

Availability of Data: Data from Dhaka Power Distribution Company (DPDC) is being collected for this project. We went there and discussed our project with them. They consented to assist us. However, we are yet unsure just how much future data we can get from them**.**

Sensor Sustainability Problem: As we are using sensors across high voltage power lines. The sensors can be burnt.[14] Also we know sensors sometimes have durability issues.

Project Sustainability: Many impoverished or developing nations throughout the world that are having problems with loads can use our project. The countries with a focus on the Middle East and North Africa are the main victims of this. In the long run, they might employ our management systems. But because first-world nations don't have the same issue, it wouldn't really benefit them.

Environmental Damage Problem: As we are using many sensors and micro components the bad weather can be a problem. Also, internet connection gets hampered during rain.

1.2.5 Applicable compliance, standards, and codes:

Table 1.2.5.1: Applicable compliance, standards, and codes.

Codes	Description	Impact in our project
IEEE 1609.2a-2017	The Wireless Access in Vehicular Environments (WAVE) standard provides secure communication formats and processing for use by WAVE devices, including techniques for securing application messages and WAVE management messages. Additionally, it explains what duties are required to assist with the fundamental security operations.	In our project we are creating software to give notification to people. From these codes we can know how to protect and secure the functions of the software.
IEEE SA – IEEE C2-2023	The practical protection of people during the construction, use, or maintenance of electric supply stations, overhead supply and communication lines, and subterranean or buried supply and communication cables is covered by section. Furthermore, it outlines the procedures for using communication and power supply lines and equipment.	We need to protect our workers in a manner so that they don't get any harm in working conditions as we are going to implement this in high voltage supply stations.
IEEE SA – IEEE 1547.6-2011	Usually, this article is imposed if there is any work involve regarding distribution of secondary network system or any kind of architectural work, operation or component use. Which is under the work of a interfacing distributed resources (DR) System.	As our target is to manage load so we need to work with the distribution line and distribution site. This code provides us with the perfect guideline to do it correctly.

IEEE SA – IEEE 1909.1-2014	Recommendations for the testing and installation of smart grid communication technology in electricity generating, transmitting, and distributing facilities, as well as in commercial and residential settings, are included in this regulation. Interoperability testing and verifying product conformity to its original performance specification are not part of the suggested process, but the safety, EMC, environmental, and mechanical battery tests is.	As we are trying to build a load management system this code is most important as it indicates directly to the smart grid system. This code helps us to understand our limitations.
IEEE C37.240-2014	Cybersecurity measures must combine technological and economic feasibility to meet substation hazards. Cybersecurity measures must be planned and executed so as not to inhibit lawful activities, especially during emergencies or restoration. This standard is balanced.	We are making it IoT based on cyber security is a must here. Also, we want to Collect data and that also requires permission.
Bangladesh Copy Right Act, 2000	The Copyright Act, 2000 protects literary, theatrical, musical, artistic, and cinematographic works. "Literary work" incorporates databases. Copying or distributing a computer database is a violation that can result in civil and criminal penalties. It is challenging to discern between database protection and copyright act data. The ingenuity and effort put into the gathering, validation, and presentation of databases are safeguarded by database protection. Data protection safeguards people's personal information.	As we are taking present data from DPDC for our project, copyright act 2000 is a must. We are making applications where we need data protection and to use present data for our project falls under database protection.

Bangladesh Digital Security Act, 2018	The Digital Security Act ensures national data security and develops data crime detection, prevention, suppression, trial, and other legislation. Under the Digital Security Act, any data or material published or disseminated in digital media that concerns data security can be removed or blocked by the Director General.	One of our goals for this project is to inform our users of the load time that DPDC will be providing. Therefore, we require their consent before using the data.,

1.4 Systematic Overview/summary of the proposed project

The name of our FYDP project is Smart Load Management System. The main reason we have chosen this project is to upgrade the load-shedding system in automation and also give notification to people before load-shedding and to keep the data of input and output load for both distributor side and consumer side. In this project to make smart loads we have gone through various sites and read articles about research papers. Through proper research we have initially agreed upon three approaches.

With the first method, communication between the power distribution authority, SLM device, and user is created using the authority identification number, device identity number of the device, and also the user identification number of a mobile network based on the GSM standard.

The second approach is based on machine learning to make predictions. The third approach is basically an IOT based smart system which contains details from power production to distribution to the user. We have provided all the three approaches in this report with a proper block diagram. Finally, while implementing the system, we have decided to work upon approach 2 and approach 3. In approach 2, we have incorporated the data which we got from DPDC in machine learning. For approach 3 we have used Proteus for complete simulation. There are some functional requirements and non-functional requirements in this report. We have also provided a budget and made a comparative analysis to know about the optimal solution. We have also got feedback about load shedding problems and if this project will be beneficial to people. Lastly, Ethical Consideration and Risk Management and Contingency Plan are also properly included in this report.

1.4 Conclusion

The FYDP project focuses on Smart Load Management System to upgrade load-shedding systems and notify people before load-shedding. Three approaches were considered: GSM-based mobile networks, machine learning, and an IoT-based smart system. The report provides a block diagram for each approach, with a focus on implementing approach 2 and 3. The report includes functional and non-functional requirements, budget, comparative analysis, feedback on load-shedding problems, and an Ethical Consideration and Risk Management and Contingency Plan. The project aims to provide notifications and data for both distributor and consumer sides.

Chapter 2: Project Design Approach [CO5, CO6]

2.1 Introduction

Multiple approaches or mixed method approaches are a recurrent topic of debate in academia. Scholars from different disciplines recommend the use of multiple methods to study complex engineering problem. Multiple approach techniques aid in getting complete answers and strengthen our comprehension. Using a variety of techniques may lead to a better and more thorough understanding of the phenomenon being studied by revealing information about its various facets. Researchers can broaden the focus of their investigation and investigate additional facets of the phenomena.

2.2 Identify multiple design approach

Initially for the project we had various approaches discussed within us. Over the time we reviewed and finalized three approaches to work on and find the optimal one. The three approaches are:

Approach 1: Data Based Load Management System
Approach 2: Machine Learning Based Load Management System.
Approach 3: Block Diagram Design of Smart Load Management System

2.3 Describe multiple design approach:

Approach 1:

In this approach we have implemented a smart system for load management. Our design contains details from power production to distribution to the user. To monitor the system in real time we plan to use IoT [3,20]. With the help of current sensors, we can also monitor the current generation, usage of areas. [21] We also like to use that information to control distribution according to need area wise. We connected four loads to the system. Through the microprocessor we can send data to the distributor via GSM module [9,10,22,23] so that they can provide actual time of load shedding to our users. Users will be able to get notification through the app. The design process is shown in figure 4.

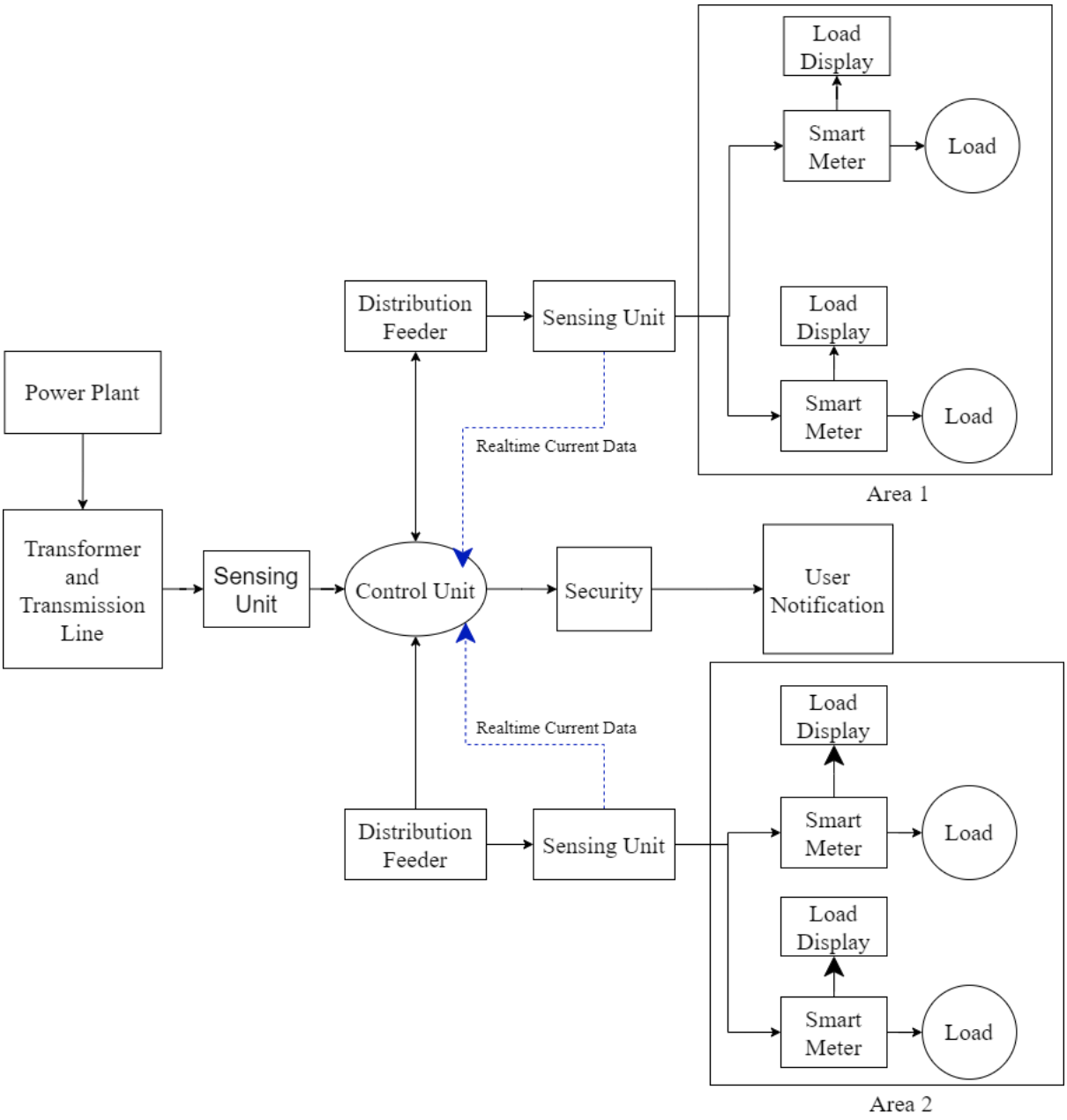

Figure 2.3.1: Data Based Load Management System.

Approach 2:

We've considered incorporating machine learning, which is really involved in this strategy. [19] Data from the past is used to make predictions about future energy usage, allowing the system to tailor power generation to meet local demands. Here we connected four loads through the distributor. We can see the visual representation below. Here, machine learning is an ongoing

process. It acquires new knowledge about regional habits every day and recommends changes to the distribution network so that regions may adjust their power consumption to match these patterns. [12] It progresses over the course of a week. However, it can regulate the power supply by anticipating where and when demand would be highest. Moreover, to control the power-theft we are going to use smart meter and we are going to connect with load-display. We can see all the data usage with that display and control the power-theft both distributors and consumer's side. Since our data processing can foresee when power will be needed, it will also send an SMS to every electric meter's owner before implementing load shedding.

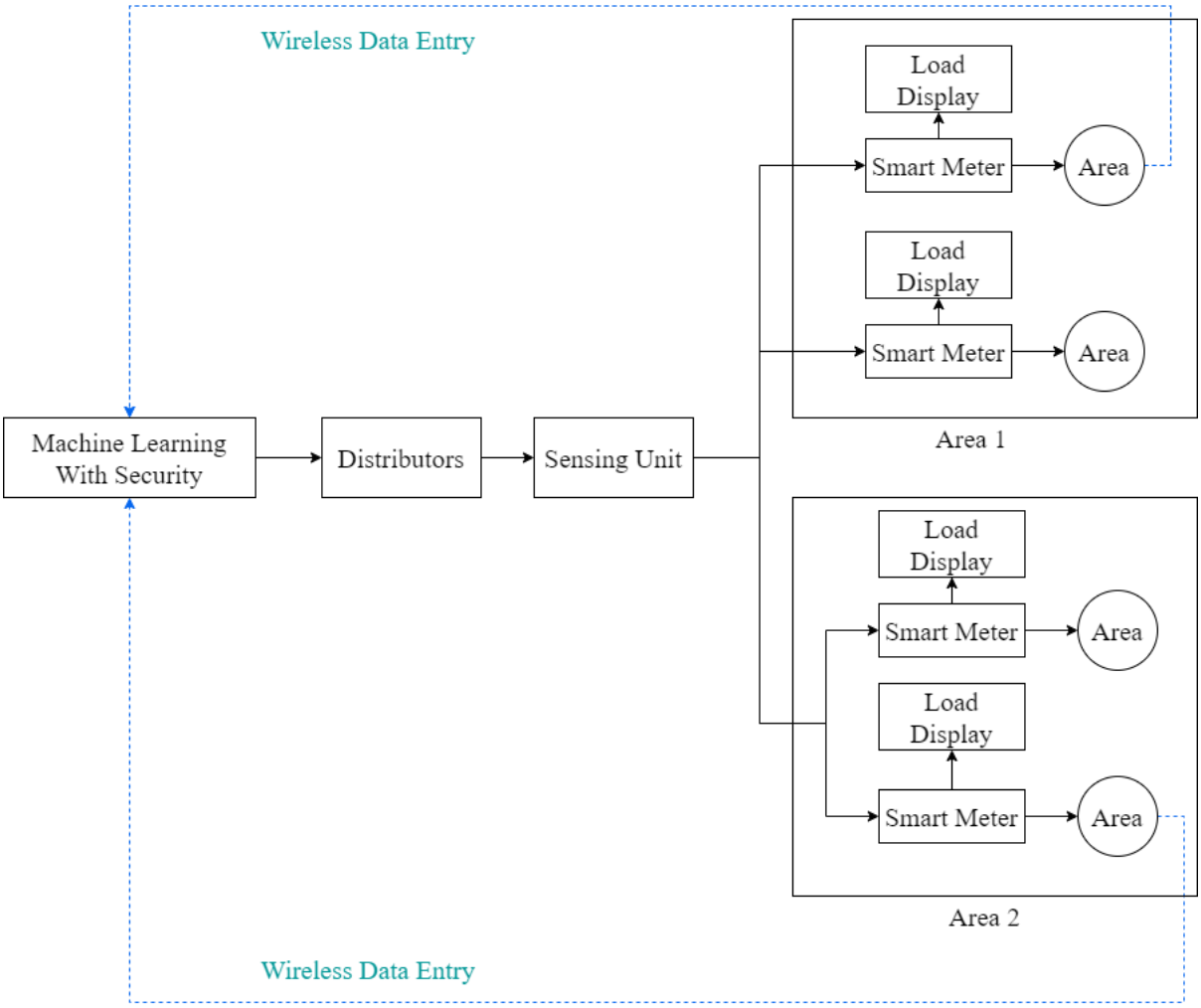

Figure 2.3.2: Machine Learning Based Load Management System.

Approach 3:

In this approach 1 which is figure 1 we propose, develop, and build a smart load management (SLM) system that may be used to efficiently meet customers' emergency demand for fans and lights when power generation is insufficient to meet demand [15]. Utilizing a GSM-based mobile network, the connectivity between the power distribution authority [16], SLM device, and user is established via the authority identification number, device identity number, and user identification number. Without changing hardware or software, the SLM device can be configured and reconfigured with just an SMS. The device will allow the power distribution authority to monitor the maximum authorized four loads as well as supply electricity for all consumers' emergency loads. SLM equipment enables switching from permissible load to emergency and vice versa depending on the availability of the power supply,[17] preventing total blackouts [18]. When the demand for electricity exceeds the supply, the SLM system can be used successfully.

Here,
SLM= Smart Load Management
SEM= Smart Energy Meter
EL= Emergency Load
AIN= Authority Identification Number
DIN= Device Identification Number
UIN= User Identification Number

Moreover, the control is going to also monitor the continuous electricity usage through the sensors that are connected through the smart meters of each load so that the users can get real time info about their usage. If there is any mismatch found in the sending end of the distributor and the receiving end of the smart meters, the system using the sensing unit in between can also detect any sort of electricity theft.[13]

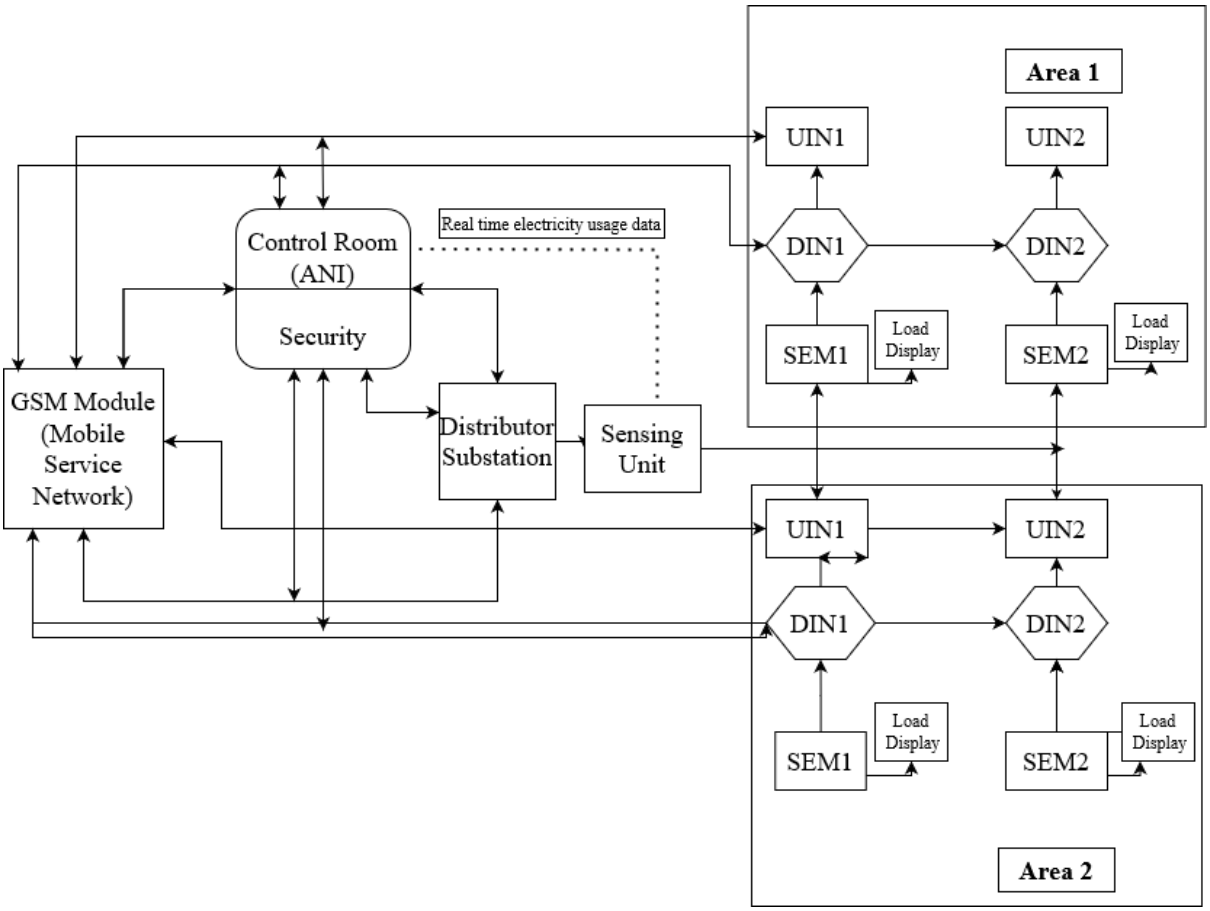

Figure 2.3.3: Block Diagram Design of Smart Load Management System.

Methodology of Approach 1:

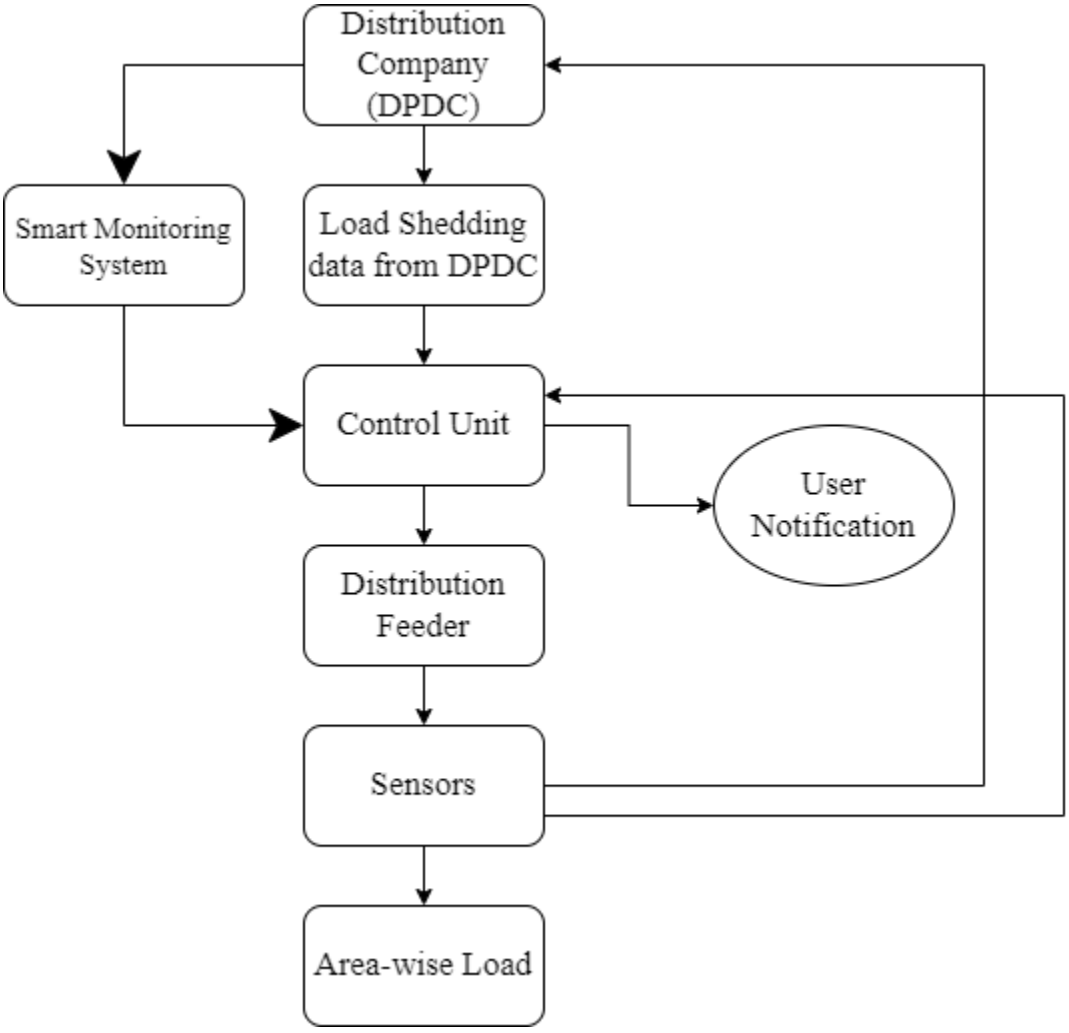

Figure 2.3.4: Data Based Load Management System Methodology.

For this method the main thing we have to do is to collect the load data from the distribution company and make proper use of it also from that data we can assume which area will need more electricity in what time and which area is less affected if there is a load shedding need to be done in an instant time.

The distributor company will manage the timing and send it to the control unit which will go to the control unit and be distributed accordingly to area needs. Also, every area will have a sensing unit which will send real time consumption data to the control unit and all areas will have this feature too, which will help us to monitor if there is a theft in the area or line.

Methodology of Approach 2:

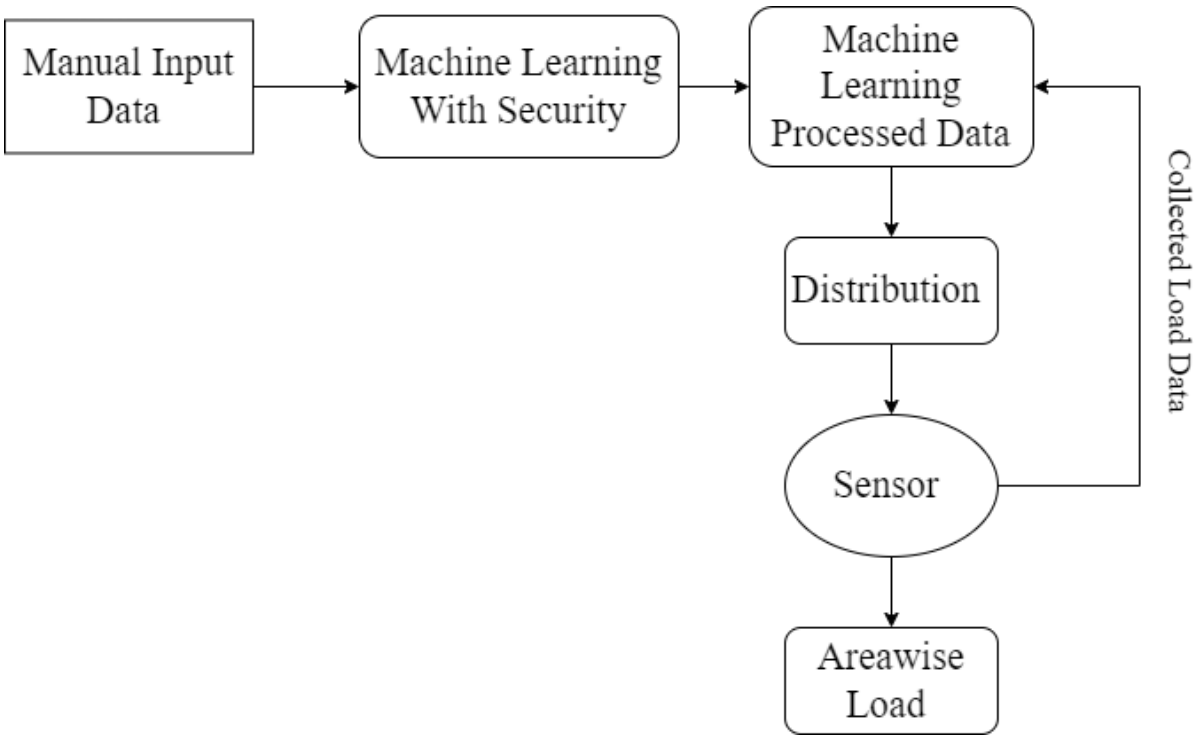

Figure 2.3.5: Machine Learning Based Load Management System Methodology.

In this strategy, we use security-enhanced machine learning to predict data in the future. The manual collection of data from DPDC is the first step. Our machine learning model will be trained using the training dataset. After that, artificial intelligence will handle all of the information.

The processed data will be delivered to the distributor. The distributor company will control the timing and transmit it to the control unit. It will move through the control unit to reach various points. In addition, there is a sensor unit in each area that will send the distributors real-time data allocation. However, we will be able to control power theft with the assistance of a connected load display and smart meter. Machine learning will be able to update, foresee load-shedding ahead of time, and send notifications based on the feedback from the control unit.

Methodology of Approach 3:

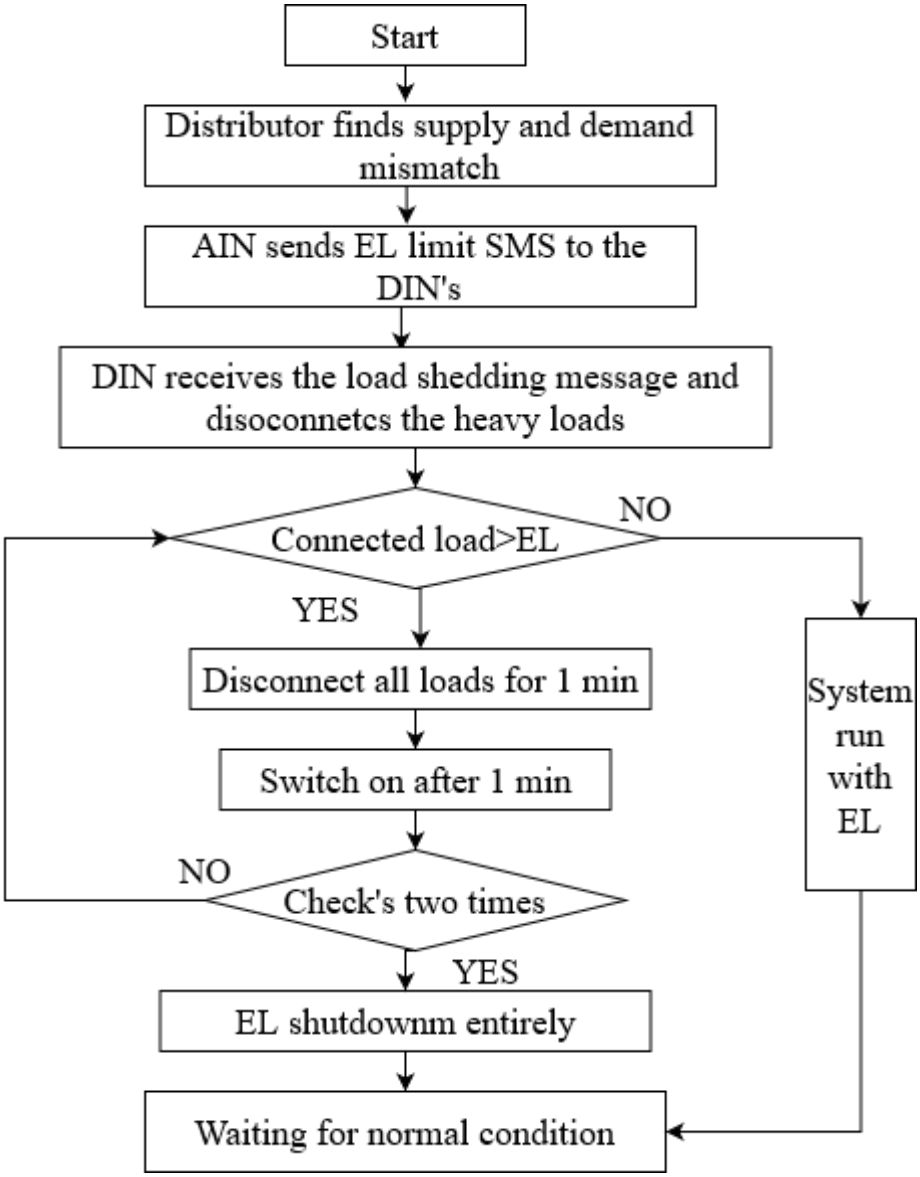

Figure 2.3.6: Flow diagram of Smart Load Management System technique.

In this method we are basically relying on an emergency load method. Here, the user will get notification about using only the emergency loads such as Fan, Light and refrained from using heavy loads like motor, this will help the distributor to manage the Area wise load as the supply demand mismatch will be mitigated and all the users can use their emergency loads. In case any user is not using the emergency loads only, he will get 2 warnings for doing so and if within the time the user does not respond the user will face load shedding for two hours.

2.4 Analysis of multiple design approach

Our main objective is to create a smart load management system that performs according to our objectives. As a result, we have chosen appropriate existing methodologies from our background research that we can evaluate to find the optimal one.

Existing Approach 1:

This is the first design approach that we have simulated in a software called Proteus and also for the function of a microcontroller we have used Arduino IDE.

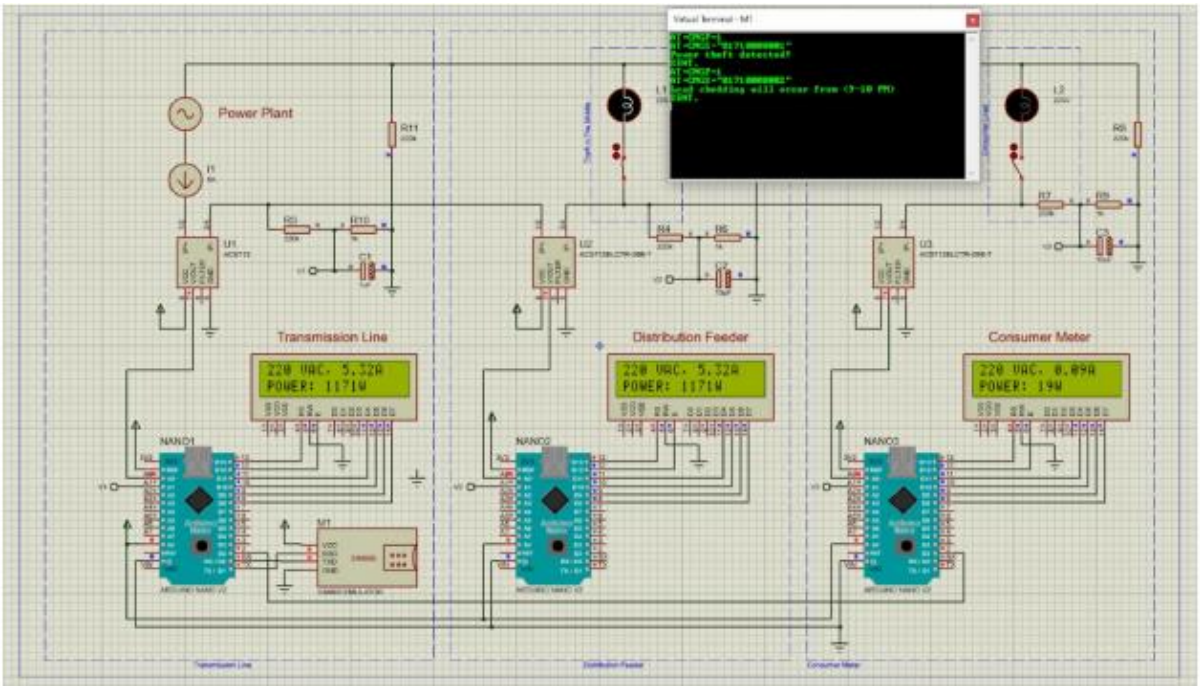

Figure 2.4.1: Schematic Diagram of full Smart Load Management System.

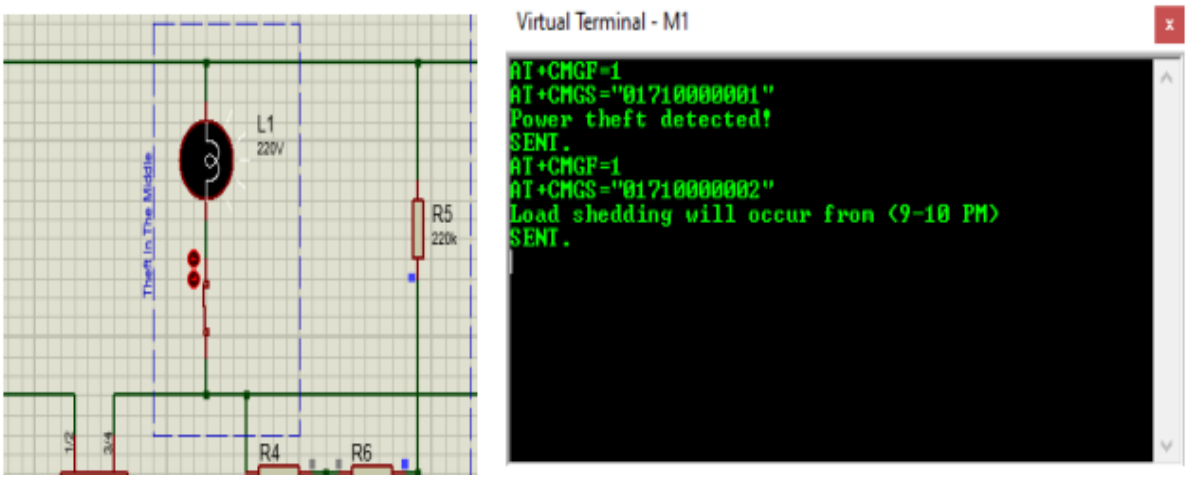

Figure 2.4.2: Theft control system and Sending notification via SMS to User and Distribution Feeder.

Here, we can see that the total system is divided into three different parts. The first one is Powerplant and transmission line the second one is Distribution Feeder and Distribution Line. In this part we have used no theft detection system as this is always well above the ground level and usually due to High Voltage this is not suitable for theft, that is why no theft detection system is present in between. After that there is the consumer meter section.

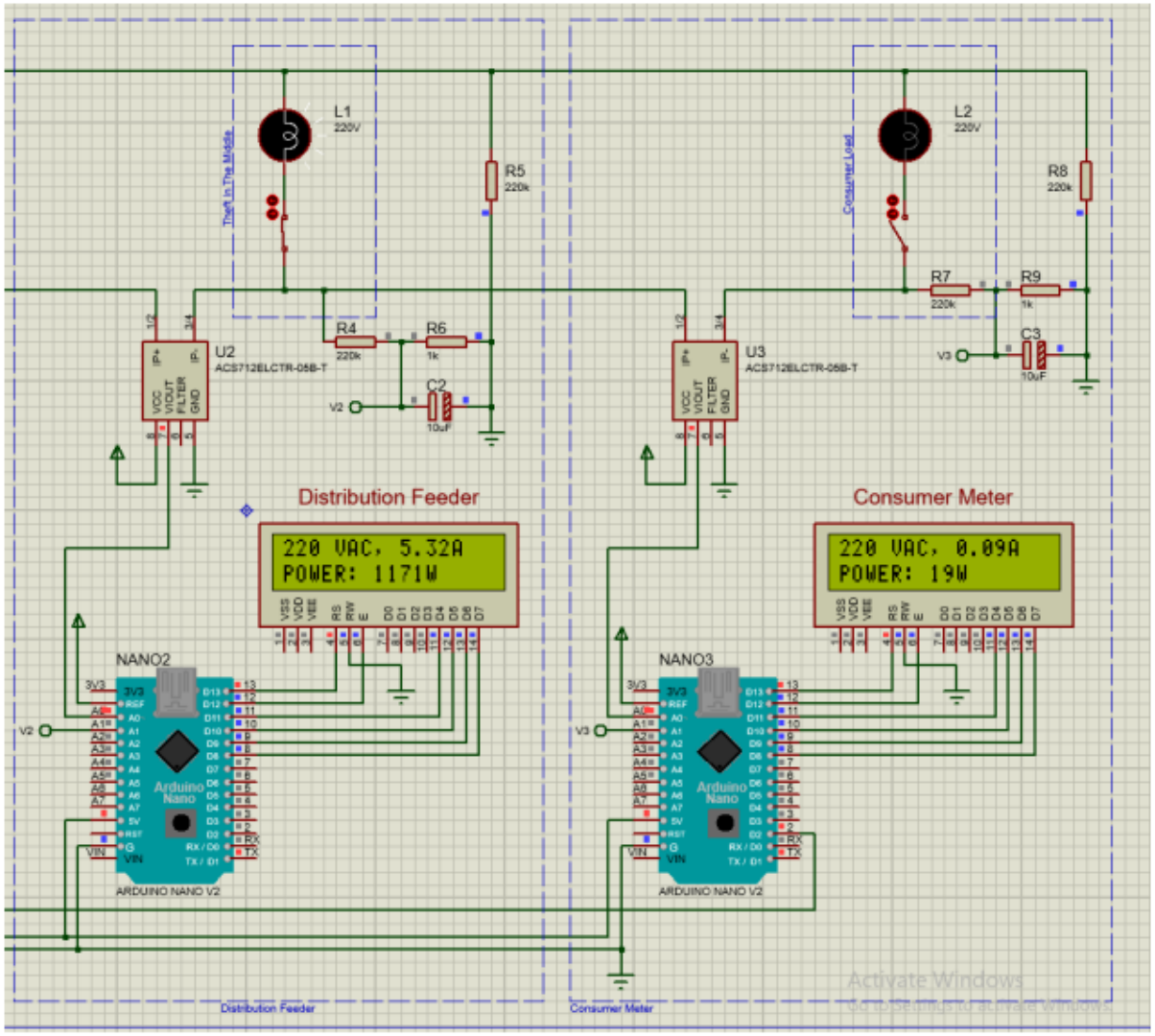

Figure 2.4.3: Despite the full power supply due to theft consumer getting very low power.

In between the distribution feeder and Consumer meter there is a theft detection system present which can detect the mismatch in any power between the feeder and consumer meter through the implementation of microcontrollers in our case which is Arduino NANO. This theft detection system can detect the power mismatch and can notify the Distribution feeder about the theft and simultaneously send the consumers about the tentative load shedding time

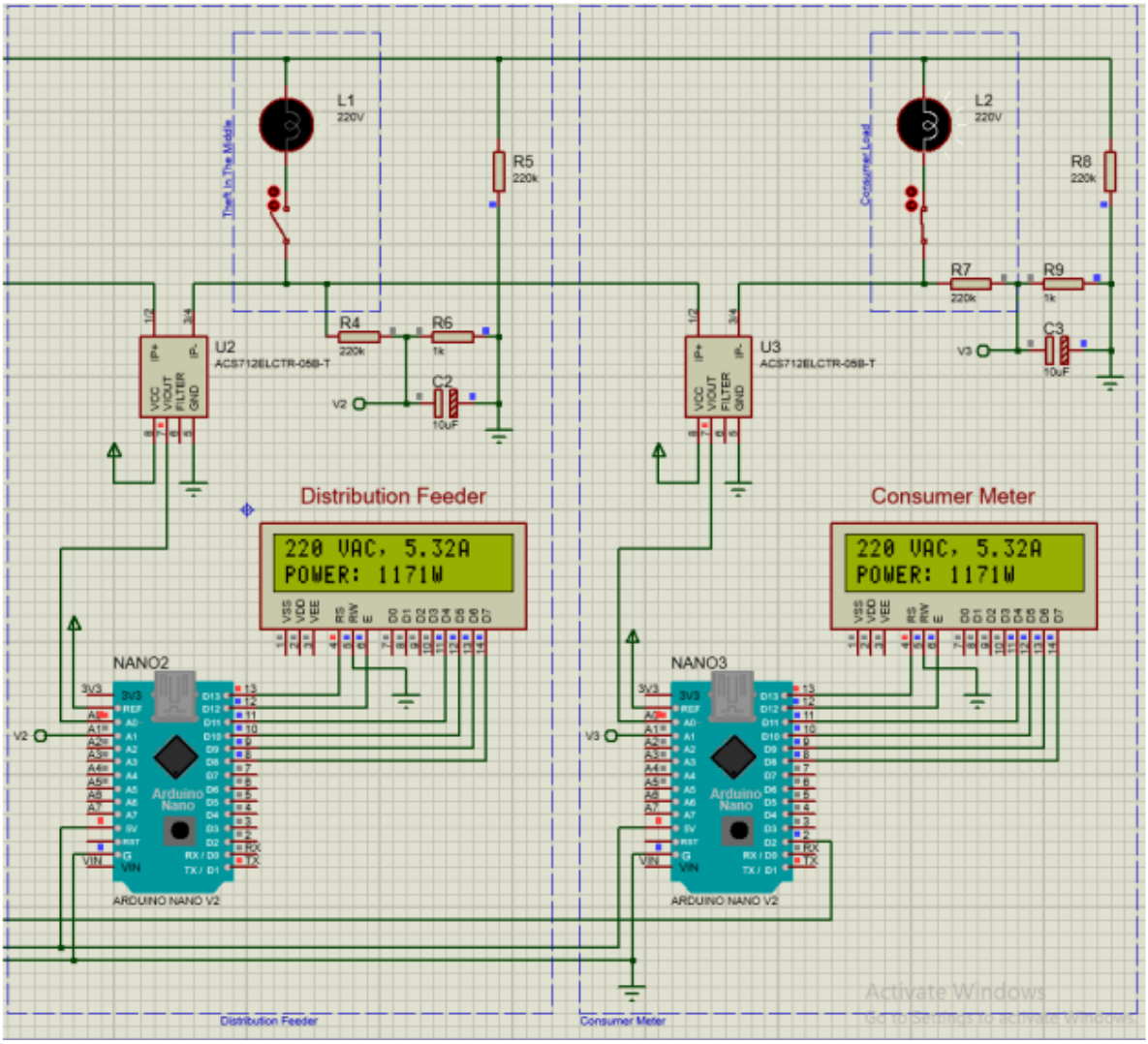

Figure 2.4.4: In no theft condition the consumer using the full load.

As we can already see this approach can already use the data and utilize it as per our required objectives and also represents a fully functional theft control system along with a user-friendly notification system like we saw that the consumer getting notified about the load shedding and the feeder getting notification about the theft also. This approach meets the objective of real time data monitoring also.

Existing Approach 2:

Authentic Value Management: To make the data more authentic we used the collected data from DPDC. We made the data digital with heading Date which carries date with hourly time and the Load section indicates how much electricity was being consumed in that particular hour which is in Mega Watt (MW). The load values also indicate the load shedding time.

	Date	Load
2	01-09-22 1:00	
3	01-09-22 2:00	
4	01-09-22 3:00	
5	01-09-22 4:00	
6	01-09-22 5:00	
7	01-09-22 6:00	
8	01-09-22 7:00	
9	01-09-22 8:00	
10	01-09-22 9:00	
11	01-09-22 10:00	10.17
12	01-09-22 11:00	7.27
13	01-09-22 12:00	7.77
14	01-09-22 13:00	7.75
15	01-09-22 14:00	4
16	01-09-22 15:00	8.95
17	01-09-22 16:00	10.17
18	01-09-22 17:00	8.94
19	01-09-22 18:00	
20	01-09-22 19:00	
21	01-09-22 20:00	9.34
22	01-09-22 21:00	
23	01-09-22 22:00	
24	01-09-22 23:00	
25	02-09-22 0:00	
26	02-09-22 1:00	
27	02-09-22 2:00	
28	02-09-22 3:00	
29	02-09-22 4:00	
30	02-09-22 5:00	

Figure 2.4.5: Data Plotting System.

So, the Load section does 2 jobs at the same time. Which is showing power consumption and load shedding time.

Data Plotting:

The data we digitized were plotted in Google Collab for visualization. The visual plot has some problem for missing data

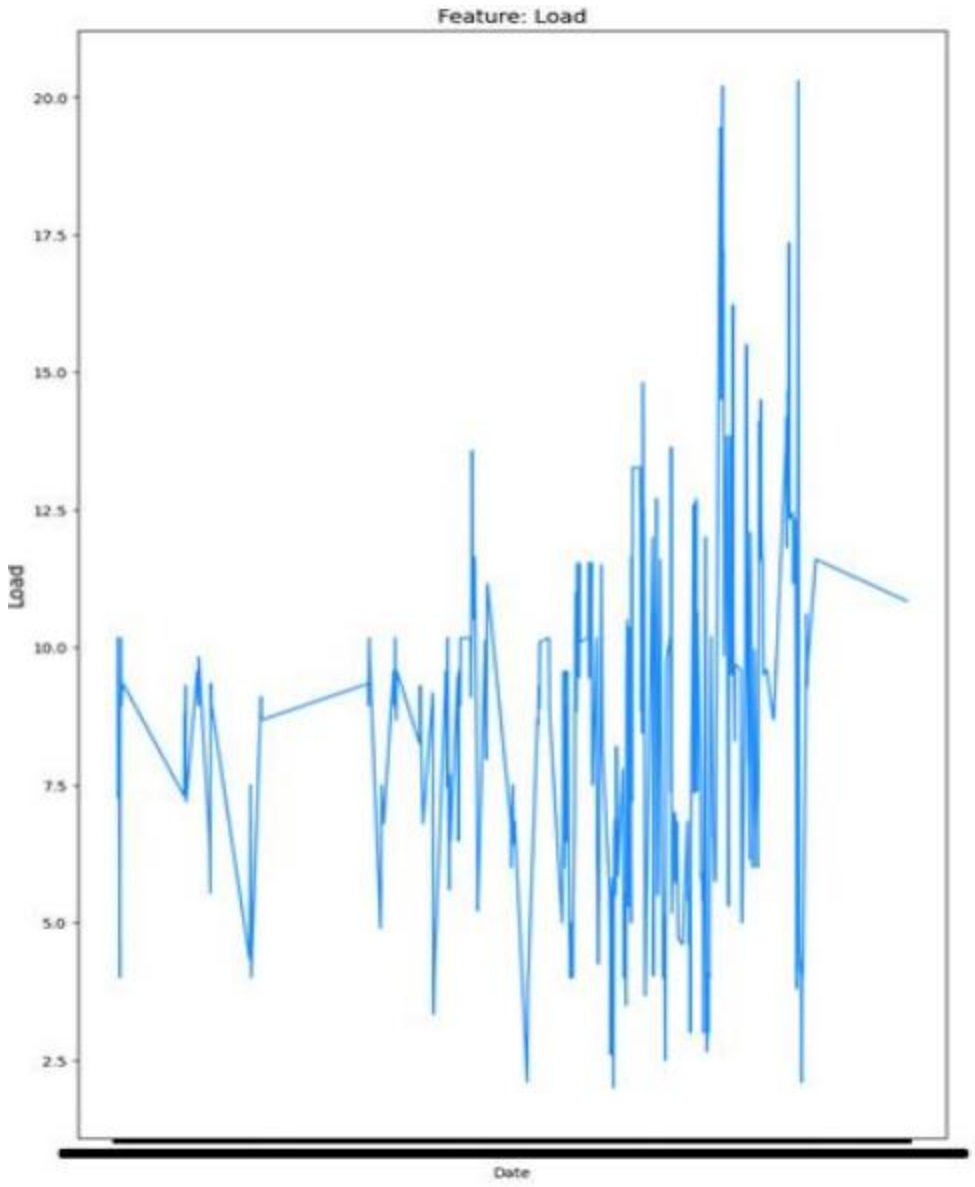

Figure 2.4.6: Data Plotting.

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For the missing load Value, we handled data in Collab's built- in library.

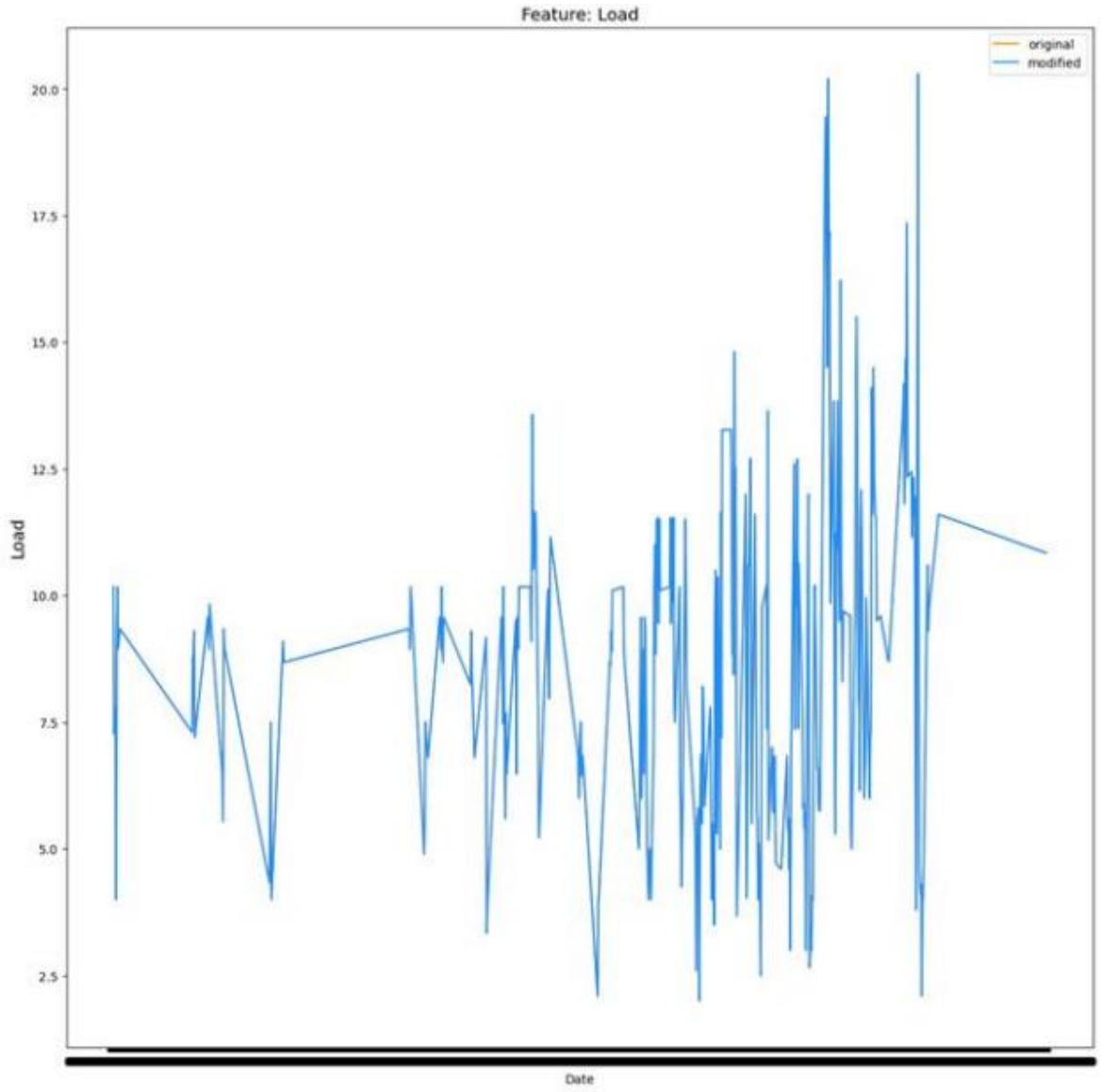

Figure 2.4.7: Missing Value Handling.

Missing Load Value Handling:

On the data sheet we had many missing load values. To fill those missing values, we have tried to predict it with mean value, but it was not a desirable load value.

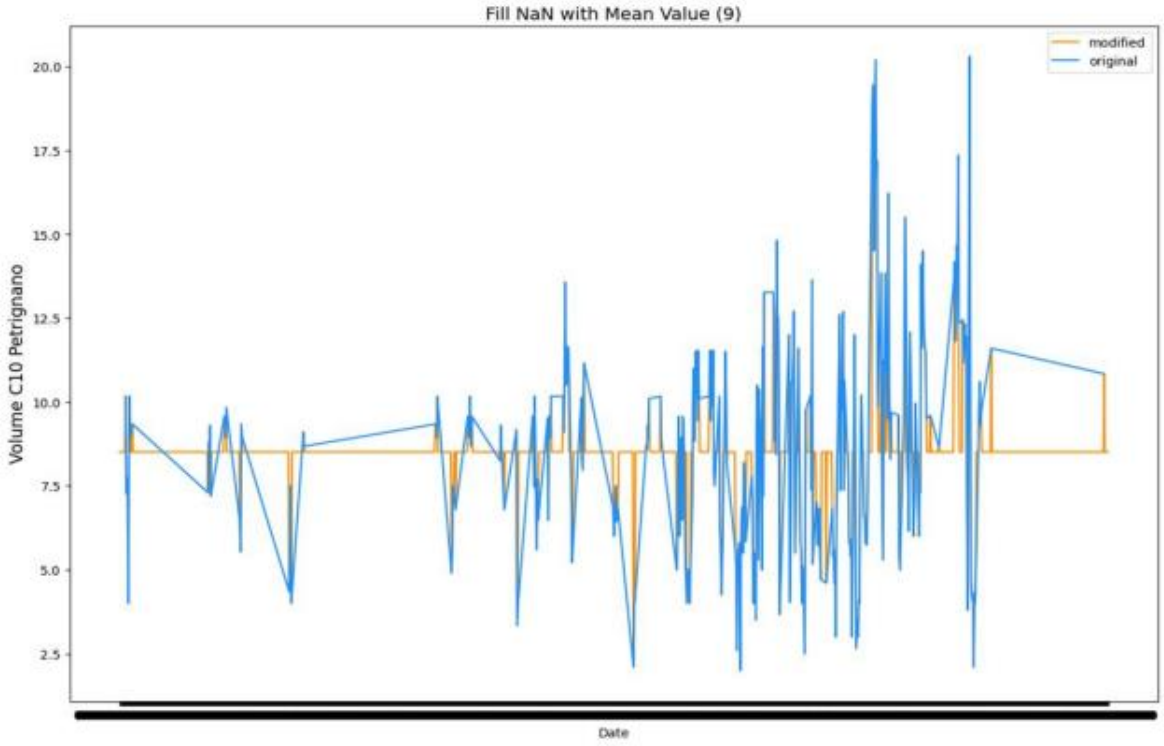

Figure 2.4.8: Handling Missing value with Mean.

To make the data more accurate we plotted the load data value with linearly interpolated values. Which was more accurate.

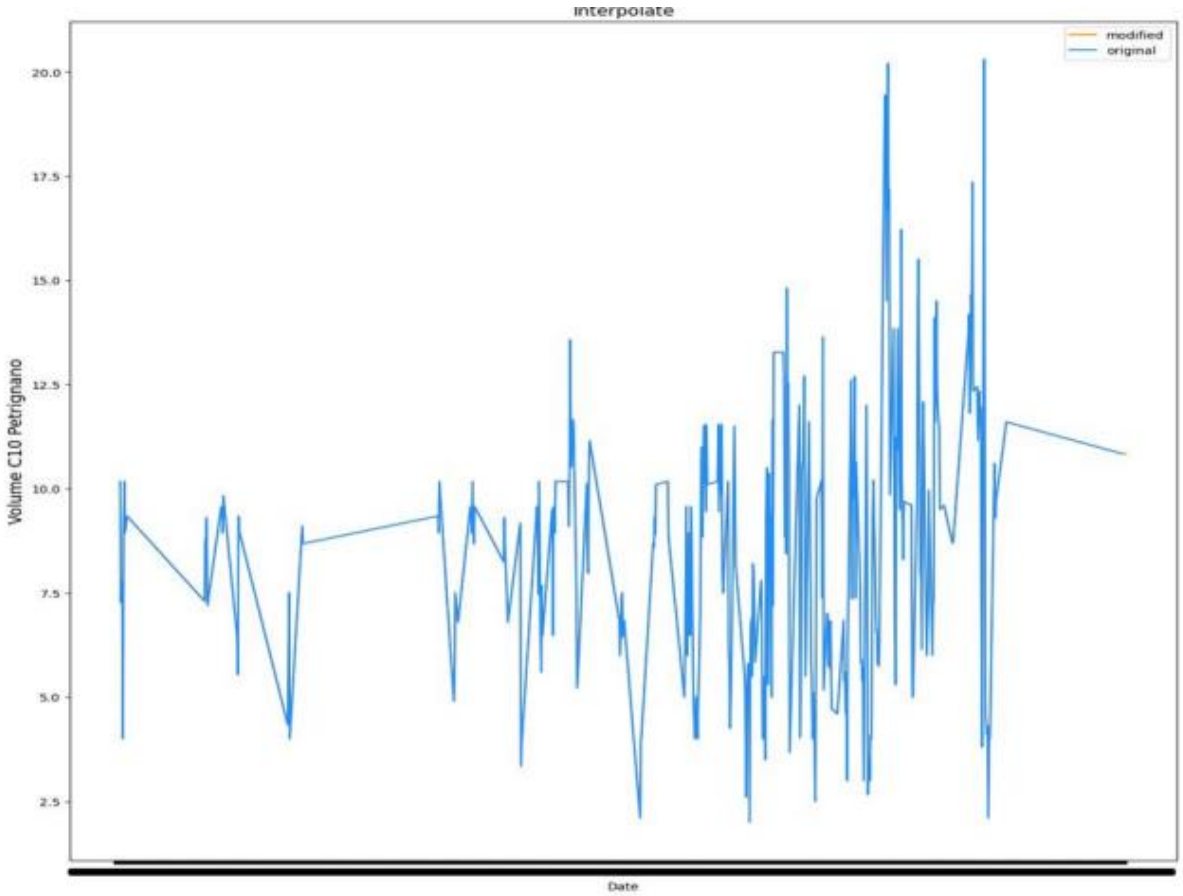

Figure 2.4.9: Handling missing value with linearly interpolated value.

For training the data we have generated some stationary test results which was ideal for many cases

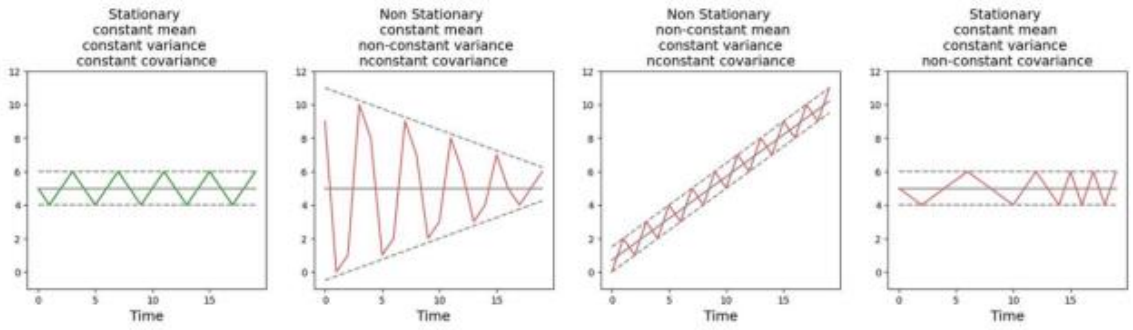

Figure 2.4.10: Stationary Test.

Here, we have tested our load value for non-stationary non-constant mean & non-constant variants. The plotted load data resembles rolling mean and rolling standard curve values. Which also can be compared with our load values.

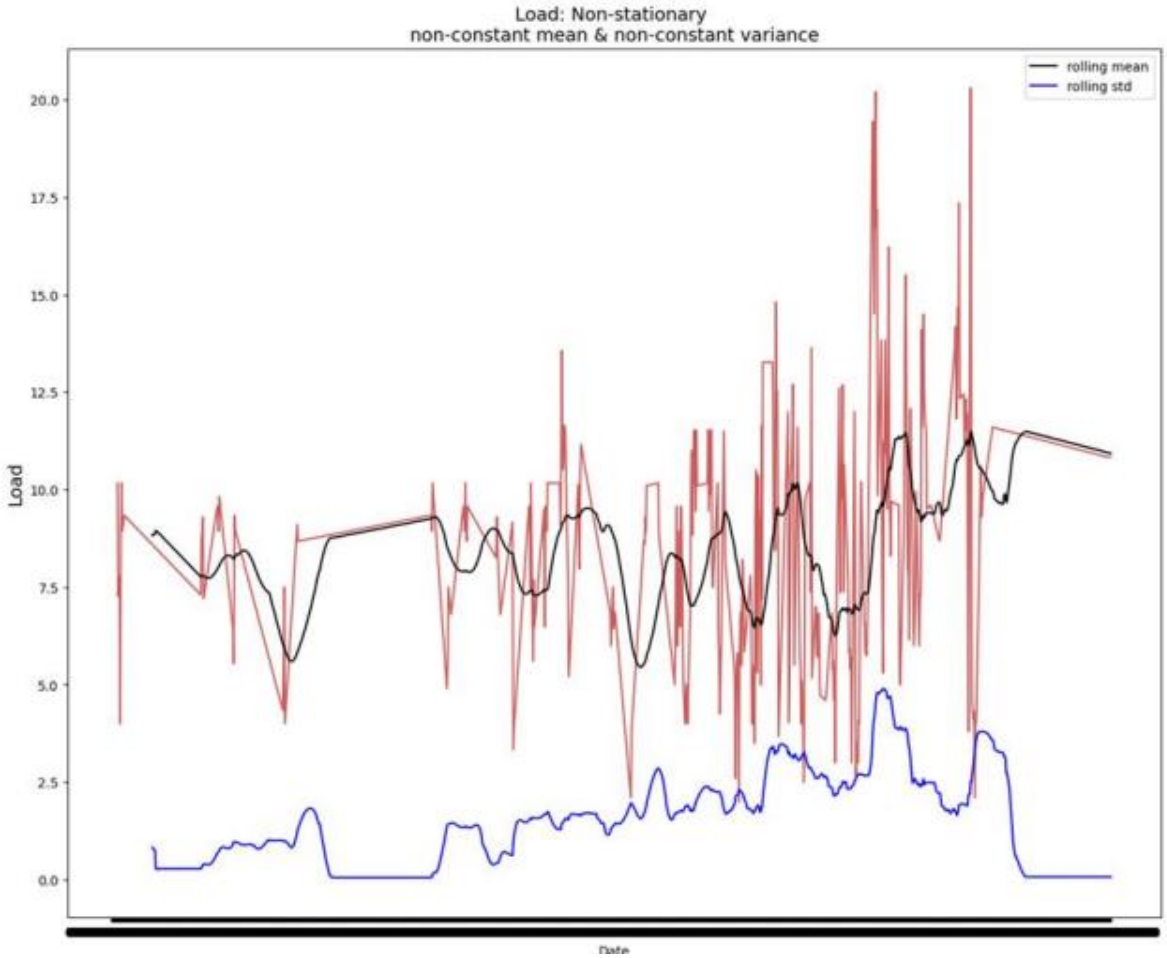

Figure 2.4.11: Stationary Visual Check.

Existing Approach 3:

This is the third design approach that we have simulated in a software called Proteus and also for the function of a microcontroller we have used Arduino IDE.

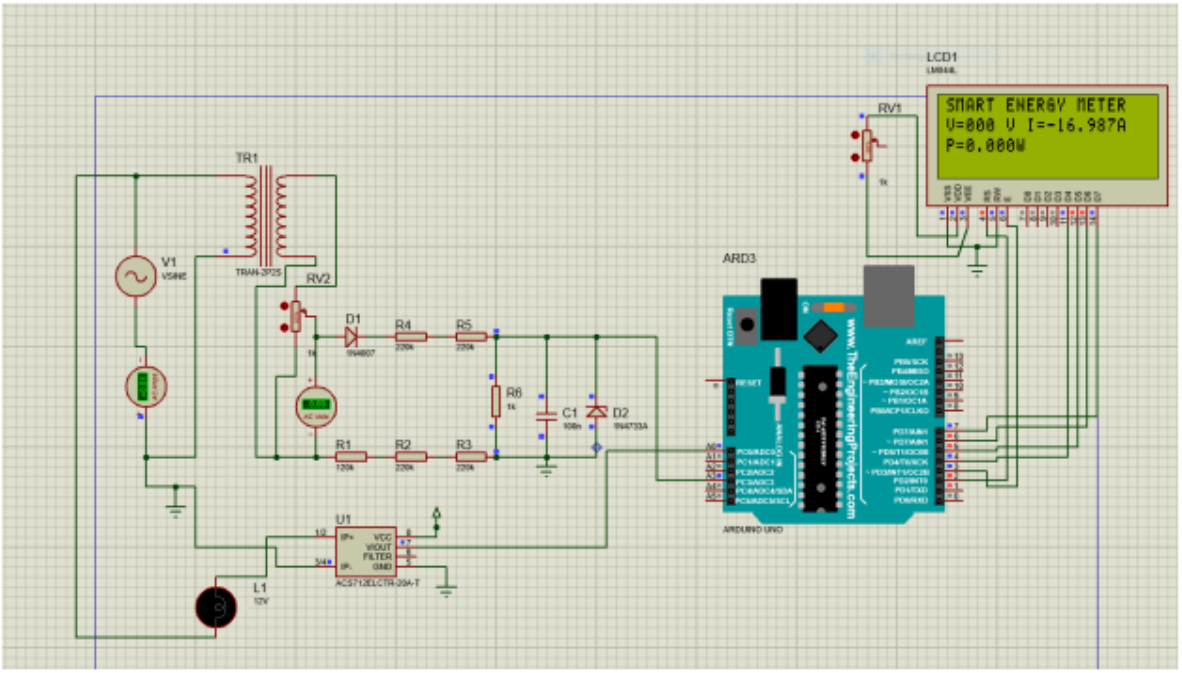

Figure 2.4.12: Smart Energy Meter.

Smart meters, as opposed to standard meters that require manual readings, automatically report energy use data to the utility provider over a wireless network. Customers may monitor their energy usage in real time, allowing them to find areas where they can cut consumption and save money on their bills. Additionally, smart meters help utilities to better manage the energy grid by providing accurate and timely information about energy demand and usage patterns. Verifying that the current readings correspond to the expected values based on the load current and the sensitivity of the sensor. If the readings are not accurate, we may need to calibrate the sensor or adjust the scaling factor in the sketch.

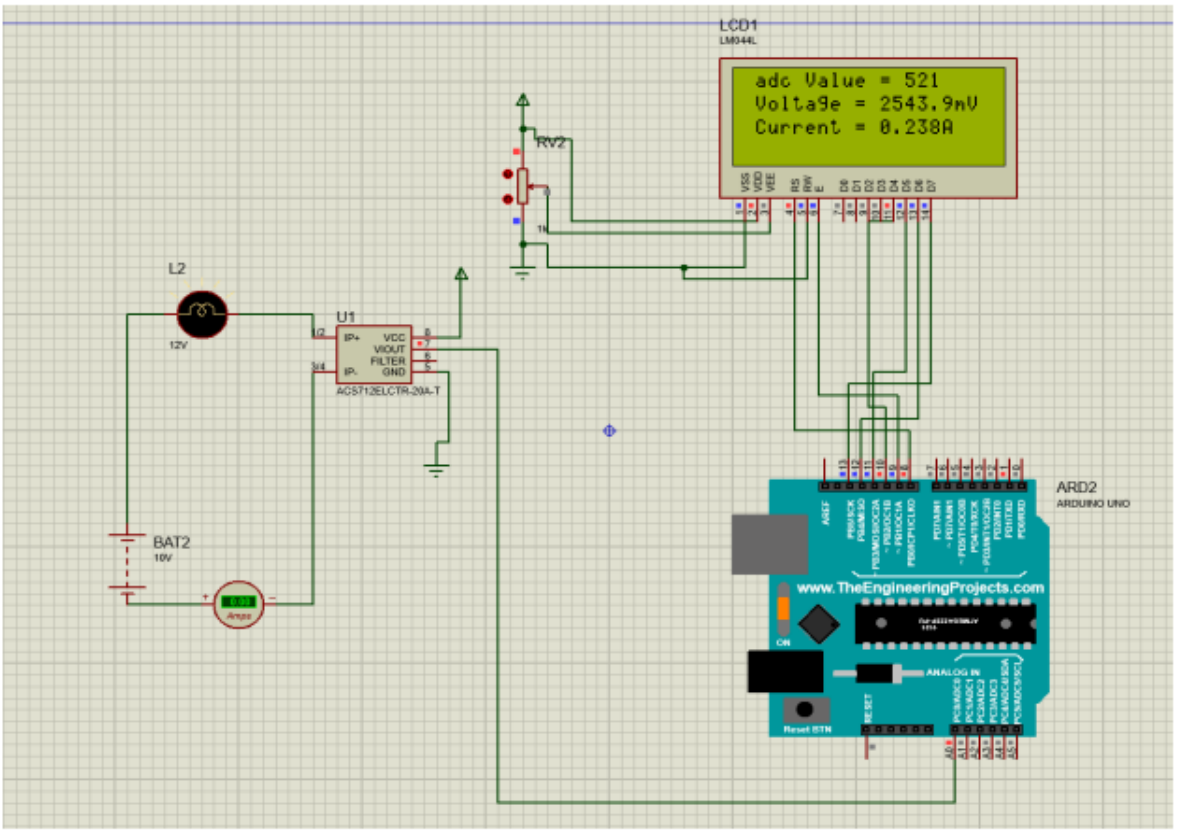

Figure 2.4.13: ACS712 Current Sensor Testing.

Connect the ACS712 sensor to an Arduino board. Upload the sketch to the Arduino board and open the serial monitor to see the current readings. After connecting a load, such as a light bulb or motor, to the sensor and observe the current readings as the load is turned on and off. Verifying that the current readings correspond to the expected values which is based on the load current and also the sensor's sensitivity. If the readings are not accurate, we may need to calibrate the sensor or adjust the scaling factor in the sketch.

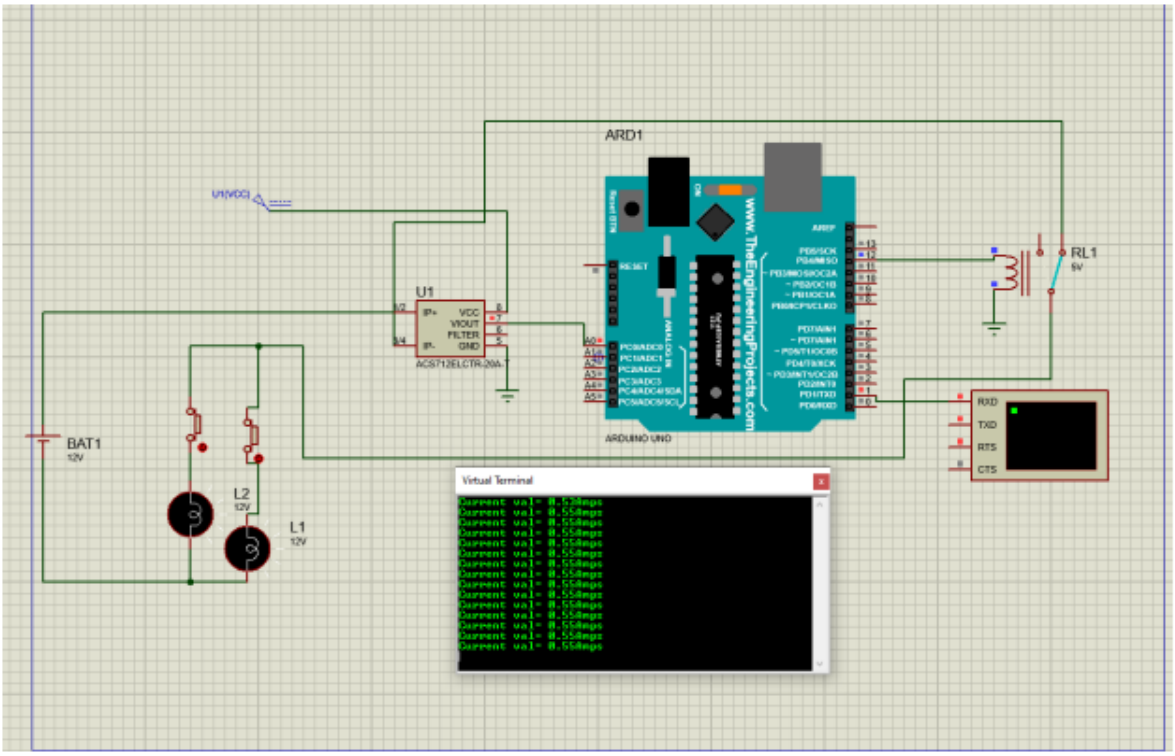

Figure 2.4.14: Overload testing through current sensor.

Connecting the current sensor to a load that you want to test. We have Make sure that the load is within the range of the sensor and does not exceed its maximum current rating. Connecting the sensor output to a microcontroller that can measure and record the current readings in real-time. Applying a gradually increasing load to the system until it reaches the maximum current rating of the sensor. Observe the current readings as the load increases.

2.5 Conclusion

Multiple approaches or mixed method approaches are widely debated in academia for studying complex engineering problems. They provide comprehensive answers, enhance comprehension, and reveal various facets of the phenomenon, allowing researchers to broaden their investigation. In our case we believe this improved our outcome to a great extent.

Chapter 3: Use of Modern Engineering and IT Tool. [CO9]

3.1 Introduction

An ability to employ the methods, abilities, and contemporary engineering tools required for engineering practice is a requirement for an engineer to meet ABET outcome k. Technology is changing. Nowadays, internet data storage sites, simulation tools, and large data books are replacing hand-drawn diagrams, computations, and calculations. As a result, since they produce more effective results, new engineering tools must be used by engineers to finish projects.

Engineering is all about finding answers to issues and making them practical. We are knowledgeable about all the equipment, methods, and abilities required for process engineering procedures. We've included all the tools we could incorporate into this process.

3.2 Select appropriate engineering and IT tools:

These tools are used to bring a visual life of the real project. We used different tools for different categories. There are mainly two parts.

1. Simulation
2. Coding

3.3 Use of modern engineering and IT tools

Simulation:

For the simulation part we have used “Proteus” as the components we need are all available in the proteus library. An exclusive tool set for automating electrical design is called the Proteus Design Suite. The majority of the components may be easily located in the most recently updated software because our project is based on the Arduino. If a component is needed but not already present in the library, it is simple to gather it and upload it.

We need to perform circuit design using code and evaluate the outcome for real-world simulation experience. It is simple to upload code from an Arduino onto a circuit, which was required for this project. Additionally, we are already familiar with this software from a variety of lab exercises from previous courses. As a result, we chose Proteus software.

Coding:

For coding we have used “Arduino IDE” as it is user friendly. Also, the most popular platform is the Arduino IDE. It features a sizable number of component libraries, and a sizable community is

accessible to assist in the event that an issue is found. There are a ton of tutorial sessions accessible because there are so many people. Learning will therefore be simpler. This one is ideal for this project overall.

3.4 Conclusion

Engineering is all about finding answers to issues and making them practical. We are knowledgeable about all the equipment, methods, and abilities required for process engineering procedures. We've included all the tools we could incorporate into this process.

Chapter 4: Optimization of Multiple Design and Finding the Optimal Solution. [CO7]

4.1 Introduction

In order to get the optimal solution for our project we must compare the three approaches and find the optimal one. For this we went through an evaluation process that we are going to describe here.

4.2 Optimization of multiple design approach

To get the perfect point of view and what things we need to reach our final decision we can analyze the table of these three designs and match our requirements.

Approach 1:

Table 4.2.1: Approach 1 Optimal Solution.

Requirements	**Expected Outcome**	**Validation**
Automated Power System	The electrical system will be digitized. For it, we employed a relay.	Validated
Monitoring Power Systems with Real Time Data.	It will monitor the supplied data in accordance with what is offered via DPDC in our sensor system's display.	Validated
Smart Management System	Our system will handle all of the jobs automatically, which will enable smart system administration.	Validated
Theft Control	Our system will do every task automatically, allowing for wise system administration.	Validated
Load Calculation Prediction	It will be available to calculate the future load from the past load data we got from DPDC.	Not Validated
Real time Data management	The real time data that we got from DPDC will be integrated through machine learning for collecting future data.	Not Validated
Smart Meter with Display	The system will have a smart meter with a display to show the usage of load from both distributor and consumer side.	Validated
Measure Load Estimation	As the system has a smart meter it will show the estimation of load.	Validated

Approach 2:

Table 4.2.2: Approach 2 Optimal Solution.

Requirements	**Expected Outcome**	**Validation**
Automated Power System	The electrical system will be digitized. For it, we employed a relay.	Validated
Monitoring Power Systems with Real Time Data.	It will monitor the supplied data in accordance with what is offered via DPDC in our sensor system's display.	Validated
Smart Management System	Our system will handle all of the jobs automatically, which will enable smart system administration.	Validated
Theft Control	Our system will do every task automatically, allowing for wise system administration.	Not Validated
Load Calculation Prediction	It will be available to calculate the future load from the past load data we got from DPDC.	Validated
Real time Data management	The real time data that we got from DPDC will be integrated through machine learning for collecting future data.	Validated
Smart Meter with Display	The system will have a smart meter with a display to show the usage of load from both distributor and consumer side.	Not Validated
Measure Load Estimation	As the system has a smart meter it will show the estimation of load.	Validated

Approach 3:

Table 4.2.3: Approach3 Optimal Solution.

Requirements	**Expected Outcome**	**Validation**
Automated Power System	The electrical system will be digitized. For it, we employed a relay.	Validated
Monitoring Power Systems with Real Time Data.	It will monitor the supplied data in accordance with what is offered via DPDC in our sensor system's display.	Validated
Smart Management System	Our system will handle all of the jobs automatically, which will enable smart system administration.	Validated
Theft Control	Our system will do every task automatically, allowing for wise system administration.	Validated
Load Calculation Prediction	It will be available to calculate the future load from the past load data we got from DPDC.	Not Validated
Real time Data management	The real time data that we got from DPDC will be integrated through machine learning for collecting future data.	Not Validated
Smart Meter with Display	The system will have a smart meter with a display to show the usage of load from both distributor and consumer side.	Validated
Measure Load Estimation	As the system has a smart meter it will show the estimation of load.	Validated

4.3 Identify optimal design approach

Qualitative Assessment:

Table 4.3.1: Comparison.

Category	**Weightage**	**Approach 1**	**Scoring (Out of 10)**	**Approach 2**	**Scoring (Out of 10)**	**Approach 3**	**Scoring (Out of 10)**
Budget	15%	The usage of the Arduino Nano in approach 1 will lower the project's overall cost. It is hence affordable.	8.5	Since we used machine learning in approach 2, it is also cost effective.	8.5	Using more Arduino and energy meters is required in approach 3, which will increase the project's cost. Thus, it is prohibitively costly.	6
Efficiency	20%	The system is simpler and thus more effective in our initial approach, from distribution to area load distribution.	8	In the second approach we are integrating data through machine learning, so this approach has good efficiency.	7	The third approach has a bit of a complex design and the whole integration of circuit can’t be properly done so it has less efficiency.	6.5
Reliability	15%	More Reliable	8	More Reliable	7	Less Reliable	6

Accuracy	15%	We will input the load and time here after gathering all of our data from DPDC so that it will provide more accurate results.	8	Our second approach, which is primarily machine learning-based, will forecast the data from the previous data sheet and provide customers with the most recent time. The data will give us the projected value as it predicts the data.	6	Less Accurate	7
Availability of Components	15%	More Available	9	Available	8	less Available (as some components aren't available in our country)	7
Theft Detection	20%	Applicable	9.5	Not Applicable	0	Applicable	8
Total	100 %		8.525		5.582		6.8

4.4 Performance evaluation of developed solution

We have compared our three existing designs through multiple parameters and qualitative assessments. As we can already see from the comparison that our Existing approach 1 is the most scoring one with the highest score in almost every parameter.

If we think about the budget and availability of components our approach 1 is the optimal one as this one is both budget friendly along with the ease of getting components within the vicinity. Secondly, Efficiency and reliability this approach one is more efficient and reliable compared with the other two approaches. In terms of accuracy approach 2 and 3 are doing great but the unavailability of sufficient data can harm the output, on the other hand approach 1 has no such

issues. Finally, the theft detection is a big edge for approach 1 compared to the other two approaches because even though approach 3 also has theft detection it lags behind in other parameters.

So, it is safe to declare that approach 1 is the optimal one for the next phase of the project, FYDP C.

4.5 Conclusion

After thoroughly analyzing three design approaches using a variety of criteria and taking stakeholder needs as well as data from actual testing into account, we have come to the conclusion that the third design approach we suggested not only satisfies but also surpasses the targeted objectives.

Chapter 5: Completion of Final Design and Validation. [CO8]

5.1 Introduction:

A thorough process that spans the spectrum from ideation to realization culminates in the Completion of Final Design and Validation phase. We will dissect the complex web of actions, choices, and assessments that make up this crucial stage of the project lifecycle in the context of this report. As we begin this exploration, it quickly becomes clear that the Final Design and Validation stage is the foundation upon which the overall project's success and viability depend. The transition from a conceptual plan to a concrete reality occurs at this phase. When the vision reaches this stage, it has been perfected and brought to life in a way that not only meets but frequently exceeds expectations. As a result of rigorous validation processes that put the final design to the ultimate test of usability, dependability, and safety, it also signifies the shift from theoretical conjecture to empirical evidence.

It is impossible to exaggerate the significance of the Final Design and Validation phase completion. Here, we make sure that the project complies with the original specifications as well as more general industry norms, legal constraints, and user expectations. The results of this phase have repercussions for market competitiveness, user satisfaction, and stakeholder confidence in addition to the immediate project aims. We will explore the many facets of this phase throughout this paper, from the rigorous validation procedures used to fine-tune design elements. In order to shed light on best practices that result in effective project outputs, we will investigate the tools and approaches used by experts across a variety of fields. We'll also talk about how important it is for multidisciplinary teams to work well together, as well as how important accurate documentation and reporting are for maintaining project transparency and accountability.

In order to fulfill our needs as presented, our final design is finished and integrates the project's functioning and the implementation of our desired features. Executing the project as planned with minimal to no deviation is of the utmost significance. To evaluate the performance of the project, the output must also be validated, and feedback must be evaluated.

5.2 Completion of final design:

The final design is built upon all the initial ideas that came through our mind from various research performed on our topic before. This design took a long session of multiple discussion as we were thinking about developing a system that could perform on the weather and economical perspective of Bangladesh. Being a country with relatively lower power supply than required which is now

improving a lot of day by day our aim was to build a system that can perform in the present scenario as well as in the future also.

Learning from various design failures and design faults we made sure that we solve each and every problem with precision and accuracy. Whenever we try to make a design, we use a lot of systems and subsystems integrated with the whole system, so you have to make sure that each of the subsystems is closely knitted with the main system and they are performing accordingly. But often it happens that the subsystems are just not working properly. Integrating those various real systems together in a working form of a big system was one of the biggest challenges that we faced in our project.
We had to rethink the real-life components that we are going to use in our project. During the simulation phase of our project, we used various simulation tools available in our vicinity but whenever we tried to integrate them together in the real-life various issues like not finding them in the nearby Markets and when integrating them in the real life they don't perform simply like the simulation. The weather performance in simulation and real life are quite different. With different scenarios we had to rethink all the components because in real life some components are not really suitable to work with.

That sensors used in our projects we had to recalibrate them as per our design specifications and our project requirements. Based on the need of a project we had to recalibrate all sorts of sensors that we got from the nearby market. We even had to integrated two or multiple sensors together so sure that we can get our desired output from the sensors.

5.2.1 Methodology:

The conclusion of the final design phase is a crucial milestone in the worlds of project management and product development. It symbolizes the point at which every inventive idea, painstaking preparation, and iterative design effort coalesces into a concrete and polished blueprint. In this stage, ideas are transformed into executable plans that span the gap between imagination and implementation.

5.2.1.1 Display Test for Saturation

As in our design we are using a 16x2 lcd display we faced two major challenges. The main major problem was the backflow of current as we were using AC current in our project. The problem was fixed by using diodes. the second main problem was controlling the saturation of the display which we solved by using a potentiometer according to need.

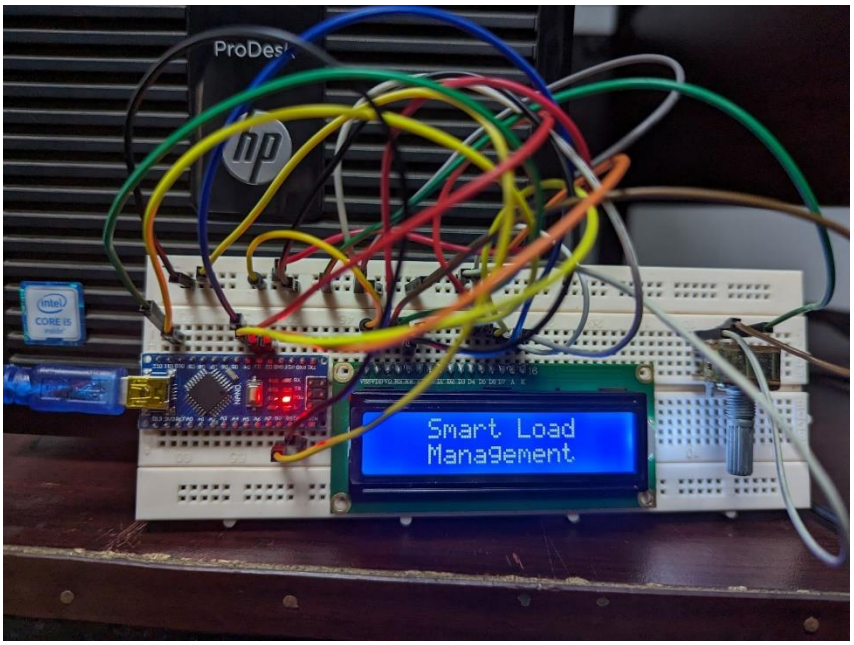

Figure 5.2.1.1.1: Display Test with Arduino nano.

5.2.1.2 Current Sensor Calibration

As the current sensor was measuring the AC current the fluctuation was high, and every sensor also stored some current from their previous test. To solve the fluctuation problem, we had to take the average data of every 5 seconds. Also, for the stored current problem we have to minus the stored value in the Arduino code.

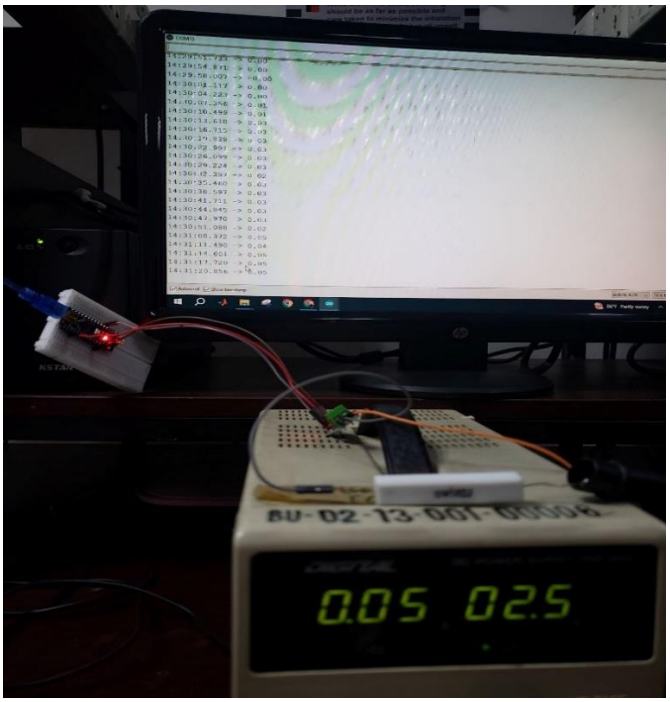

Figure 5.2.1.2.1: Current Sensor Test Via Arduino Nano.

5.2.1.3 GSM Module Test

As one of our main focuses was to send notifications to our users and providers, the flawless working of a GSM module was much needed. To achieve our goal, we used a module which has more coverage and also supports a modern 3G network. For an undisturbed network we used an extended antenna for our module.

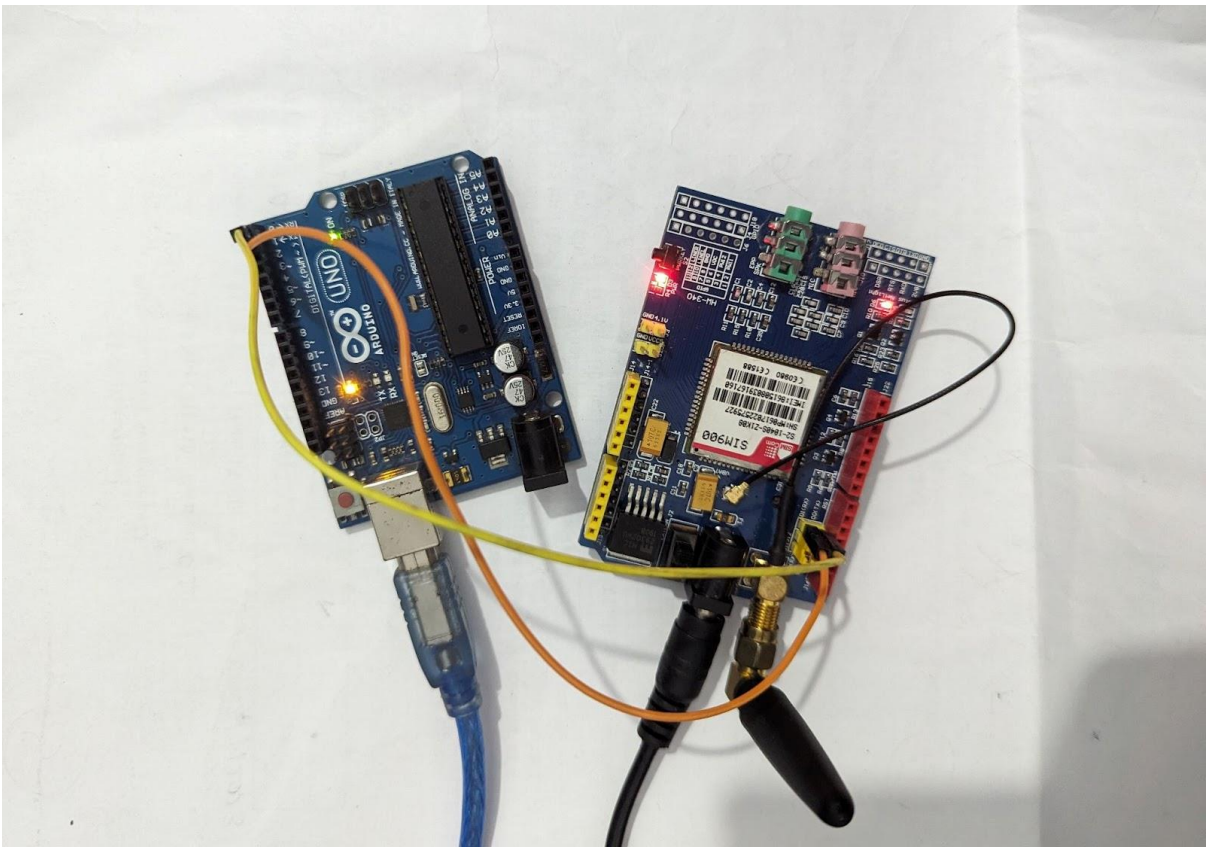

Figure 5.2.1.3.1: GSM Module Test.

5.2.2 Developed Prototype

The completion of the final design denotes a thorough procedure that goes beyond only aesthetic considerations. It includes a whole strategy for tackling issues, where functionality, security, effectiveness, and user experience are all thoroughly evaluated and maximized. This stage takes the initial concept and turns it into a thorough collection of blueprints, schematics, or specifications that direct the project's next stages.

As we have presented a power plant in our initial design, to achieve that, we used a power socket to mimic the power plant. To get more accurate values and make an understanding of the situation, we have used multiple bulbs on the consumer side. Also, to establish communication among the Arduino, we have connected all the Arduino through jumper wire and coded in the Arduino IDE accordingly. Also, in the design of the display we used or with full saturation but in real life we have to control the saturation for which we have used potentiometer.

The GSM module also needed an external power source because in the GSM module the power burst while transmission is nearly 2A.

To give power to all the Arduino nano we have connected all the nano with jumper wire in the power port of the nano which is a 5V connection port and powered by only one nano.

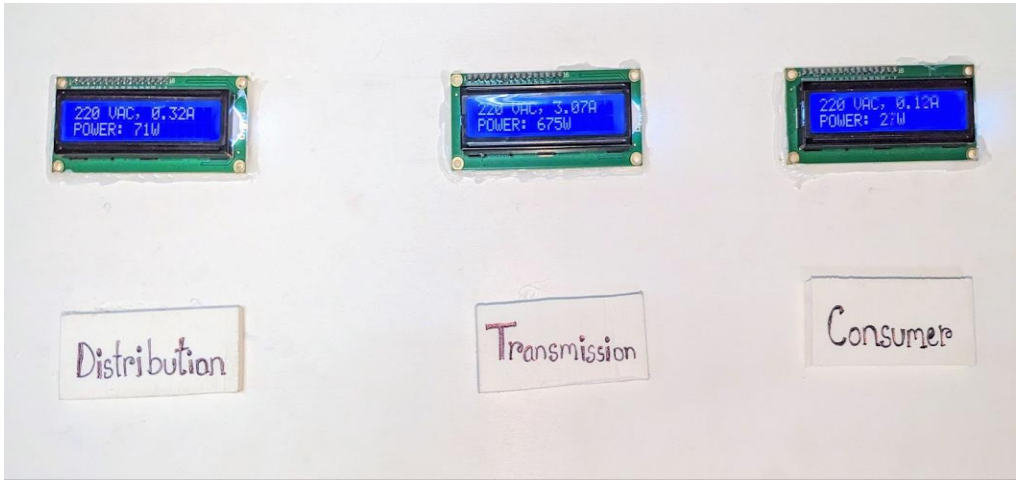

Figure 5.2.2.1: Display of the system

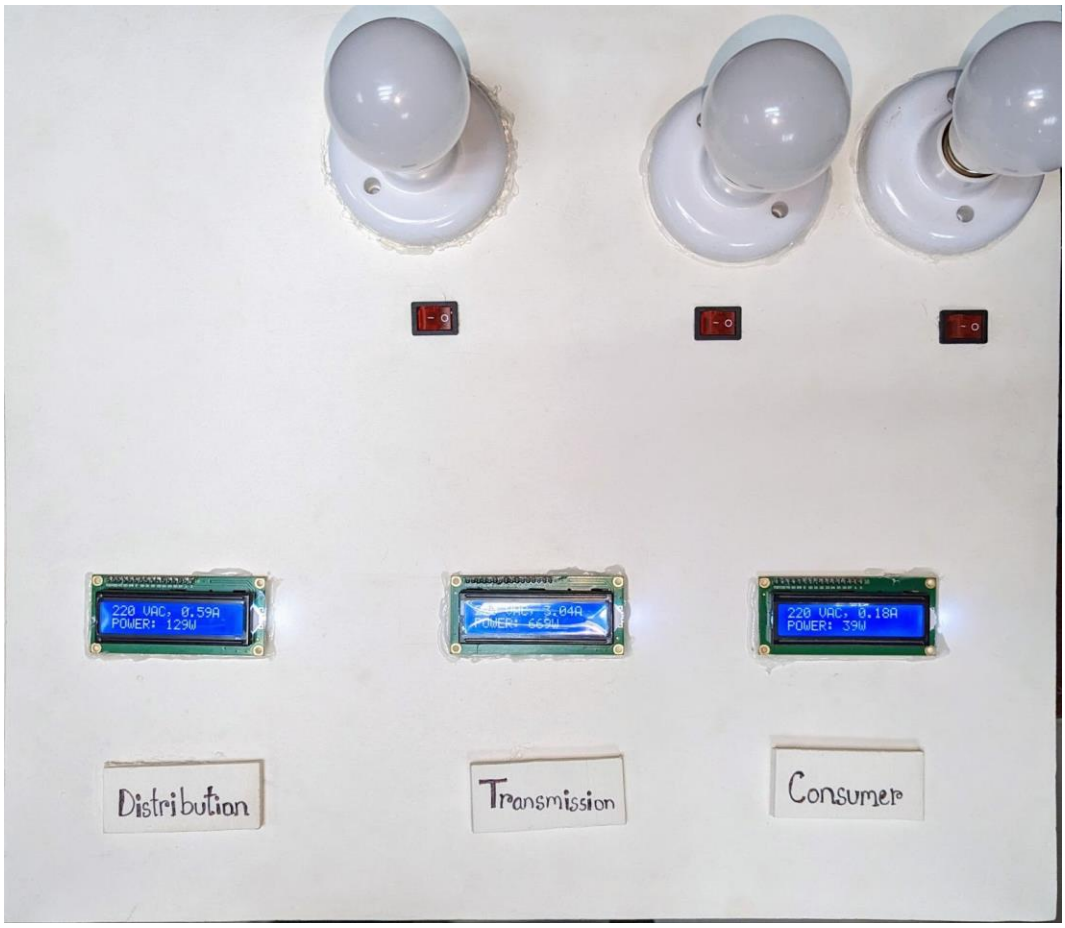

Figure 5.2.2.2: Load connected as LED bulb.

Here, on the figure 5.2.2.2 we can see three displays which indicates main part of our power distribution system which is transmission, distribution and consumption. The led light bulb indicates the load of a system.

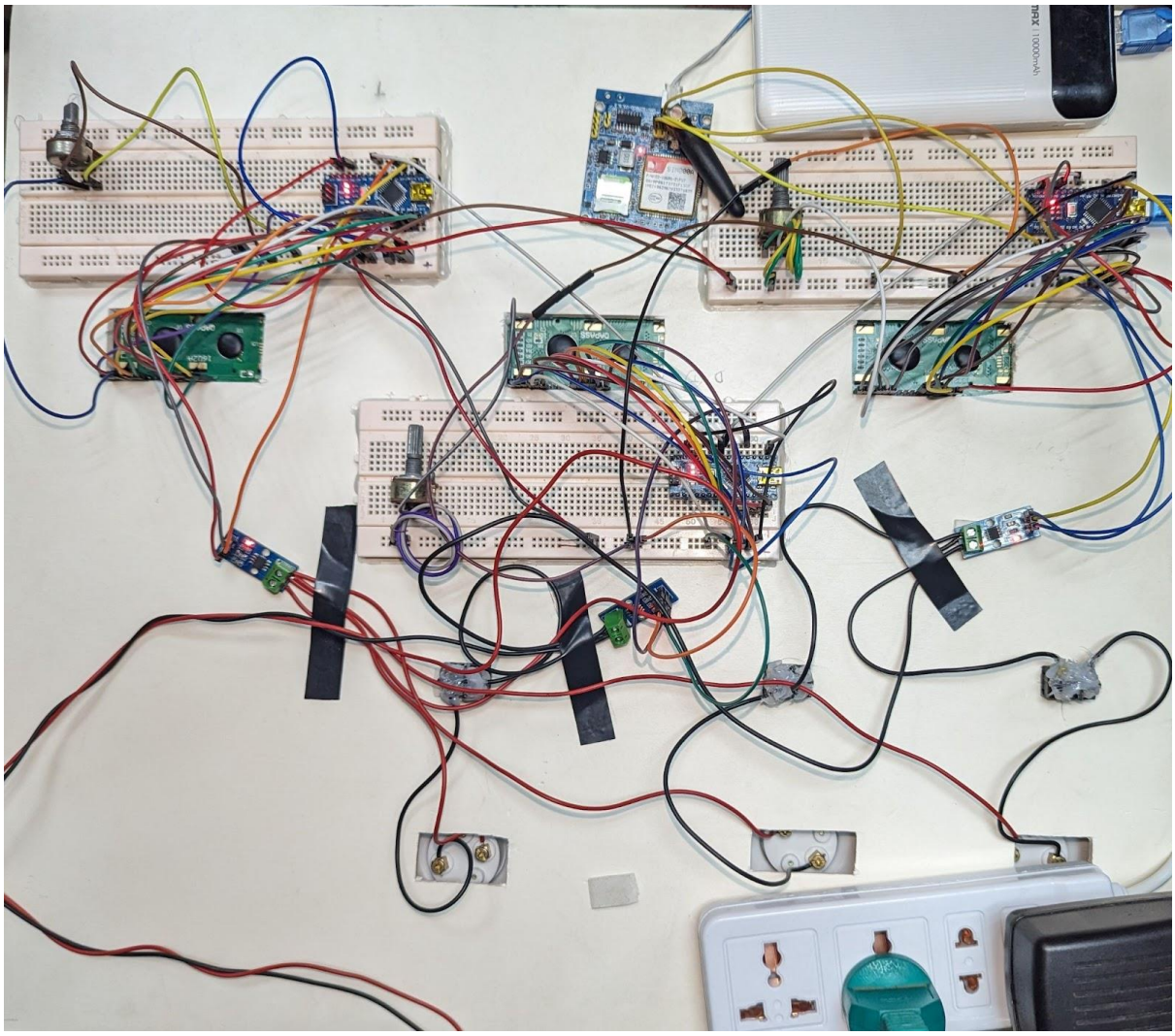

Figure 5.2.2.3: Back part of the system

Figure 5.2.2.3 shows the main setup of the whole project. The connection of our system and AC line. Also, the processing unit connection is shown here for better understanding.

5.3 Evaluate the solution to meet desired need

An essential part of the analysis in this report is determining how well the solution meets the desired needs. The suggested solution's compatibility with the project's original objectives, requirements, and stakeholder expectations must be thoroughly evaluated. In order to ensure that the original goal has been authentically kept or even improved during implementation, the solution's alignment with the project objectives should first be carefully examined. Second, a thorough assessment of the solution's ability to satisfy the given requirements is essential, identifying any deviations or gaps and determining the significance of each. Furthermore, it is crucial to thoroughly assess the solution's functionality, performance, and dependability to make sure that it runs smoothly and effectively. We can assess how well the solution meets the required goals, identify areas for development, and provide guidance for future projects to ensure greater success by conducting a thorough review that takes into account these dimensions.

5.3.1 Functional & Non-functional verification of the prototype

As in our functional requirements we wanted to monitor the data in real time which can be done by looking at the display of every part. As shown in the figure above we can monitor the data in real time.

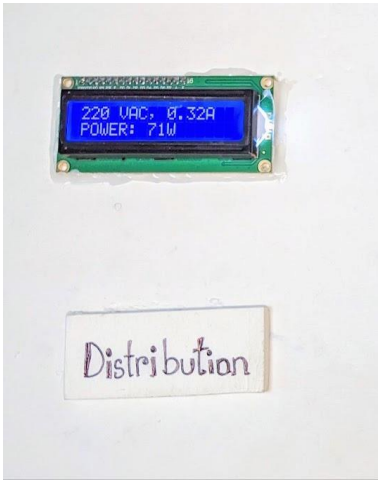

Figure 5.3.1.1: Distribution Sending Power Display.

Figure 5.3.1.2: Transmission Sending Power Display.

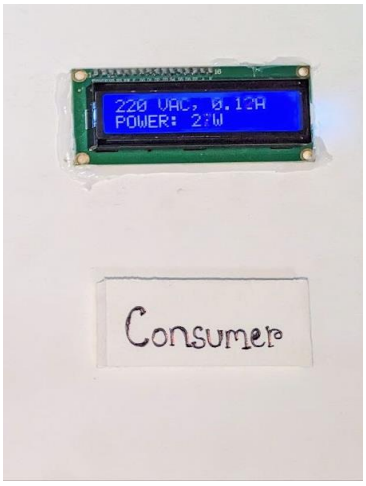

Figure 5.3.1.3: Consumer Consumption Power Display.

Secondly, we wanted to maintain the data and send notification to our stakeholders which was made possible by using the GSM module. Our main target was the distributors and consumers.

Figure 5.3.1.4: Distribution Company Notification

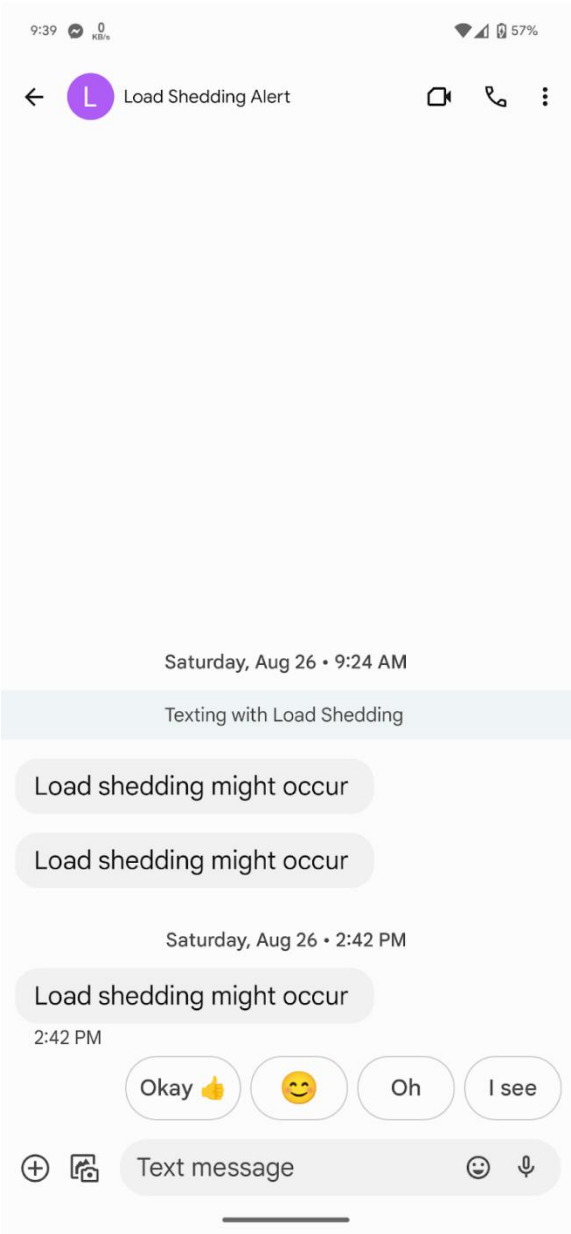

Figure 5.3.1.5: Consumer Load Shedding Alert.

As we can see on figure x the distribution company gets a notification via SMS when there is a power transmission gap in the line even after deducting the technical loss and transmission loss. Also, the consumers get a SMS if the loss is too much and there could rise a possibility of power cut.

For the non-functional requirement part, we wanted to make our system secure which can be seen as the SMS gets over 3G network via our modern GSM module where the network is more secure than the usual 2G network. Other than that, we also wanted to make our consumers a friendly system which we have accomplished by creating a smart display for the users about how much they are consuming power in their household.

5.4 Conclusion:

In conclusion, implementing the final design is an important step in fulfilling the demands of the proposed project. It's crucial to carry out your design exactly as intended in order to reduce variation and guarantee top performance. The project can fulfill required needs and goals with the help of effectively implemented design elements and functions.

Additionally, it is crucial to verify project outputs, assess input, and assess performance. This procedure offers perception into the project's effectiveness, indicates areas for development, and makes possible essential adjustments to maximize project functioning. The final design's implementation, followed by the verification and evaluation process, enables the project team to provide results that are successful and meet project goals. The intended outcomes of the final product are guaranteed by adherence to the suggested specifications and exact implementation of the design. The final step in ensuring that project performance meets or exceeds stakeholder expectations is the verification and evaluation of feedback.

Chapter 6: Impact Analysis and Project Sustainability. [CO3, CO4]

6.1 Introduction

To ensure that a project has a good influence on the environment, society, and economy in which it will be implemented, impact and sustainability assessments should be used.
This is typically done to prevent any negative results that might hurt anything while trying to achieve the desired goals. Not to add, the analysis must conclude that the product can be used and distributed in the future, as well as in the present.

6.2 Assess the impact of solution

Load management is anticipated to play a critical function in future power control systems. In our project we are building an automated load shedding with a software notification system. There could be some potential issues, and we've provided some solutions to resolve them. This project includes the following legal, social and cultural health and safety impacts: All four of these effects of this solution are discussed below.

Legal Impact:
The system we are building for this project includes many devices and components that we need to use, such as smart meters and smart sensors. Many components may not be available in the country itself. We have to import them from abroad or export them to other countries. It must be ensured that no components or devices are purchased illegally or secondhand from the black market. If any components or devices are sold illegally, the production company could file a lawsuit, which could hinder or stop the project altogether. We are collecting data from DPDC and extracting personal information for software use from consumers. It is our responsibility to protect the confidentiality of data from both parties.

Social and Cultural:
The smart charging system that we plan to build is a relatively new concept for our country. The whole system will be fully automated with many integrated devices. Until now, load shedding control was done manually. If we can successfully deploy the smart charging system, in the future it will take a lot of engineers to control the system, and also create many job opportunities for many people. Over the past few months, load-shedding has created many problems for the people of this country. In the software systems, we'll be able to give notice before actual offloading, and people can take action if they have significant commitments or reviews.

Health:
Electricity is essential for medical facilities. An unstable power supply can be fatal for emergency, surgical, and intensive care patients. The alternator is programmed to start automatically in the event of a power failure. This immediate start ensures that there is no negative impact on life support equipment during a power outage. However, Medicines that must be kept in the refrigerator can be damaged or lose their effectiveness in the absence of a generator or when offloading lasts several hours. Thus, automatic offloading can increase the efficiency of the whole situation, and through the notification system, the authorities of healthcare facilities can devise a more alternative.

Safety:
Maintaining safety protocols in the construction of any electrical system is of utmost importance. In our project, some of the components we use are transformers, smart meters, smart sensors etc. All have high voltages. In addition, electrical safety is important because hazards such as electric arcs and electric shocks can lead to death if someone comes into contact with them. Control measures to prevent these hazards require careful management, meticulous, and technical skill. Therefore, it’s necessary to know about proper electrical safety management systems so that unexpected failures do not occur.

6.3 Evaluate the sustainability

The SWOT analysis matrix is a form of collectively calculating the Strength, Weakness, Opportunities and Threats to measure the sustainability of a project and assess the various aspects of the project. Now we will talk about the SWOT analysis's variables presently.

Table 6.3.1: SWAT Analysis.

Analyzing the Sustainability of "Smart Load Management System"	
Strength	**Weakness**
• Reduction of untimely Load Shedding • Authentic schedule from Power Distribution Company • Power Company can achieve higher capacity factor. • Feed-wise Load Management System	• Load data collection during political instability • Arranging frequently workshop for Distribution Company Employee • Budget Constraints
Opportunities	**Threats**
• Resulting in lower Price Per Unit • Collaboration with Power Companies • Instant action by the Disciplinary committee if theft if power is detected	• Slow adoption Rate • Possibility of customer Data Breach • Insufficient load generation due to natural calamities

Strengths:

The ultimate goal of our project is to create a sustainable Smart Load Management system which can be useful for the users of the distribution companies. The main objective is the first thing we are focusing on which is reducing the untimely Load Shedding that users face from the distribution companies. This project addresses the issue of untimed load shedding and makes sure that the users are getting the authentic time of their load shedding directly from the feeders of the electricity provider company.

Additionally, as the distribution companies can better manage their load data, they can know about the demand of the user's area wise and can also better understand the usage of each and every area which results in achieving a much better and greater capacity factor. Capacity factor is basically measuring how often a plant is running at maximum power. Moreover, as our country's main distribution is controlled from the area wise feeder, we made sure that our systems are working from the feeders, otherwise it might be possible that a technical issue from a particular feeder is collapsing our whole management system.

Weaknesses:

The flaws are also an important aspect in every project as this helps us to work with our project more efficiently in future. One of the main weaknesses is that most of the power distribution companies in our country are government owned such as Dhaka Power Distribution Company Limited (DPDC), Dhaka Electric Supply Company Limited (DESCO), West Zone Power Distribution Company Ltd (WZPDCL). All these companies are controlled by the Government of Bangladesh which means during a political crisis in our country, it may hamper the smooth transition of collecting data from the Power Distribution Companies.

Moreover, in order to make sure that the employees of distribution companies are well aware about the Smart Load Management System we might have to arrange frequent workshops. Additionally, a budget to build our project we might face many budgets related issues

Opportunities:

The Bangladesh Energy Regulatory Commission (BERC) has made a decision responding to a review petition filed by the Bangladesh Power Development Board (PDB) to increase the electricity price at the wholesale level. As our project focuses on increasing the Capacity factor, it shows that the price per unit of electricity can be reduced overtime if our system is used from the root level of power distribution. An idea about the demand can easily help the distributors to work closely with the power generator companies.

Moreover, as time passes by, we believe there are many opportunities for us to work with the distribution companies existing throughout the country to implement this system and both parties to be benefited from such opportunities.

Threats:

The greatest challenge for this project is its slow adoption rate. As we have already mentioned that most of the power distribution companies in our country are government owned, this is really time consuming to work with the government officials as this requires multiple layers of permissions. Moreover, as we will be using data from KPI zones of the Bangladesh Government, the breach of such confidential information is always a risk for us, so we have to be extremely careful. Additionally, the load generation which will be hampered due to natural calamities might not be something the load management system can detect and act accordingly. Finally, as users get messages via GSM or the internet, all privacy-related aspects must be verified and safeguarded.

6.4 Conclusion

In order to assess a project's potential effects on the environment, society, and economy and to make sure that it is created and implemented in a safe and responsible manner, impact analysis and sustainability evaluations are highly valued. As a result, stakeholders are better equipped to not only act with more caution but also to develop methods for more effective mitigation.

Chapter 7: Engineering Project Management. [CO11, CO14]

7.1 Introduction

The Smart Load Management System (SLMS) project exemplifies the essence of addressing these difficulties with advanced engineering solutions. This project focuses on the design and implementation of a sophisticated system that optimizes the distribution and consumption of electrical energy within a particular infrastructure, hence promoting efficiency, dependability, and cost-effectiveness.

7.2 Define, plan and manage engineering project

The engineering project Smart Load Management System intends to create an innovative system for improving energy distribution and consumption. This project aims to develop a cutting-edge system that dynamically balances power demand, improves energy efficiency, and reduces waste through diligent planning, effective resource allocation, and rigorous risk management. The project team will assure timely delivery of a dependable and scalable solution that tackles the pressing concerns of modern energy management by utilizing interdisciplinary collaboration, rigorous testing, and constant monitoring. Effective project management will lead to successful implementation, which will result in increased sustainability, cost savings, and a positive impact on both the environment and end users**.**

7.3 Evaluate project progress:

The implementation phase of the smart load management system project has seen significant progress. The system's prototype has been constructed and tested, and key milestones such as hardware and software design have been completed. In terms of scheduling and budget, the project is currently on track. Integration challenges with existing infrastructure were efficiently handled, and stakeholder feedback has been constructive. The coordination and efficient resource allocation of the project team have contributed to the achieved progress. With the completion of these essential stages, the project is ready to enter the final testing and deployment phases, exhibiting significant promise for accomplishing its objectives.

7.4 Conclusion

Finally, our engineering project successfully created a complex smart load management system that optimizes energy use, improves efficiency, and lowers expenses. We produced a solution that matches with modern environmental aims while addressing actual industrial demands through painstaking design, rigorous testing, and collaborative effort. This initiative demonstrates our

commitment to creative problem solving and the power of technology to transform energy utilization. We foresee greater uses and continued advancements in this field as we move forward, contributing to a more energy-efficient and environmentally conscientious future.

Chapter 8: Economical Analysis. [CO12]

8.1 Introduction

The foundation of any project analysis and evaluation is economic analysis. It is designed to determine a project's total national impact. It is a gauge for the social costs and gains of a project. In our project we have also analyzed economical aspects.

8.2 Economic analysis

In our project we have done both a tentative budget and a tentative budget.

Table 8.2.1: Prototype of Project Budget Table.

Tentative Sub System	Tentative Required Component	Quantity	Tentative Price (BDT)	Description
Automatic Shedding	Relay	4-5	120-150	12 V
	Transformer	12-13	2700-3000	110-220V
	Power Supply	1	600-800	12 V
	Sensors	5-6	900-1100	Voltage 2.1kV RMS Bandwidth 80KHz
Control Unit	Arduino	1	5500-6000	Operating Voltage: 5V Input voltage: 7-12 V
Connection of Subsystem	Bread Board	10-12	800-1000	Voltage 5V-15V Current .33A-1A

	Jumper Wire	120-150	400-500	Voltage 3.3V-5V
	LED Light	25-30	50-60	Input Voltage: 3.3V-5V
Communication Subsystem	GSM Module	3	2000-2500	Mobile phone technology to link to a network wirelessly.
	GPS Module	3	3200-3500	A network of satellites and ground stations to pinpoint an individual's location on Earth in real time.
Estimated Total (BDT)			16270-18610	

8.3 Cost benefit analysis:

1. Time and Cost Saving:

Power distribution companies will have easier time to manage the load-shedding issues and theft-control issues. Also, the power consumption data can be monitored and stored digitally. Which previously took time to make in digital. The sensors are expensive but can run for a ling time and gives perfect values and with protection circuit it can run for a long time.

2. Sustainability:

Our project's smart load management system is very durable. To achieve the project's objective, we utilized a variety of components. The system's components are all reasonably priced and efficient. However, we have made an effort to employ every resource that will be useful in the long term in order to fulfill the Sustainable Development Goals (SDGs).

3. Improved Efficiency:

Using the smart load management system, we also have a feature of sending notifications that people can be aware before the load-shedding and can think of any alternative. Theft control can also help people realize if their electricity is being stolen and they can take necessary measures accordingly.

8.4 Evaluate economic and financial aspects:

As the project we are building is more sustainable and budget friendly If it can be implemented it can save more money from the government as with the automation system manual people and giving the salary with them.

8.5 Conclusion

Overall, the economic study emphasizes the importance of adopting new solutions such as smart load management systems, not only for the financial well-being of individual enterprises, but also for the larger objective of developing a more sustainable and efficient energy landscape. Substitution of metals and plastics, conserving foreign reserve cash, and lowering environmental effect by reducing plastic production.

Chapter 9: Ethics and Professional Responsibilities CO13, CO2

9.1 Introduction

A project's development must take ethics and professional obligations seriously in order to ensure that the project is handled ethically, legally, and responsibly. The main factors taken into account are moral standards, legal obligations, and potential effects on all prospective parties.

9.2 Identify ethical issues and professional responsibility

All of our data was obtained from DPDC. We have their load shedding schedule, so we know when the load shedding happens and when it stops. We are unable to exploit their sensitive data for our own purposes. The information is designed to be kept confidential. We must ensure that all of the data we use is concentrated on that. They were formally gathered by us, and we have their consent to use such information for project-related purposes. Even though we are using the data, we are unable to share it with anyone else because our use of it was the only one allowed. Therefore, we must guarantee that their data is completely secure with us.

We must make sure that licensing and labeling are done correctly and in accordance with the law. We must make sure that each one is taken into account as we maintain IEEE standards. We must think about and aim for that designation for each rule. We are maintaining the Bangladesh copyright act and security act.

We are thinking about the security of every piece of information that has been given to us. They gave us the information knowing that it would be kept private. We'll resolve it and protect their privacy. Since data is a valuable resource that each business develops, acquires, stores, and exchanges. A corporation can avoid financial loss, reputational damage, a decline in consumer trust, and brand erosion by safeguarding it from internal and external malfeasance and unauthorized access. So, we will keep that in our mind while working on our project.
Considering that we are using various electronic parts here. Based on the project, we will use them. Using them properly is something we need to keep in mind. It is necessary to recycle and reuse some of the parts we'll be using. Working with those will be less difficult for us.

9.3 Apply ethical issues and professional responsibility

Authorization Letter:

Date: 24 October, 2022

To,

Engineer Bikash Dewan

Managing Director,

Dhaka Power Distribution Company (DPDC).

Subject: Requesting to provide load management information for Final Year Design Project.

Dear Sir,

We are a group of Final Year Design Project (FYDP) students doing our project under the supervision of Mr. Tasfin Mahmud, Lecturer, Department of EEE, Brac University seeking your permission to provide us with next 6 months load management data of areas controlled by DPDC.

Our project is titled "Smart Load Management System". We are going to make software for the consumers and manage this in a smart way to make their life easier for load management, billing and other sort of important stuff. We will be also designing a programmable interface for load management in power distribution plants.

The reason we need the data of the upcoming 6 months of load management is, we want to integrate the data in our software for making a proper and real time prototype of our software which will accurately inform us about electricity off time, total billings and many more. We cannot just assume some data and make this project as this is a real time project and we need pristine data for our project to be a successful one.

This is not possible without your support. I want to assure you that the instructions that will be given from your end will be properly followed. Any important information you offer will be utilized solely for academic reasons. We would be immensely grateful to you if you could please allow us to access those data and thereby allow us to successfully complete the project.

Thank you for your time and support.

Sincerely yours,

Imamul Mursalin Imamul Mursalin 24-10-22

On Behalf of,

FYDP Group Members:

1. Imamul Mursalin ID: 19121121
2. Nur E Tasniya ID: 19121066
3. Ananya Sen Gupta ID:19121055
4. Anam Al Ahad ID:19321006

Approved by:

Md. Mosaddequr Rahman, PhD

Professor and Chairperson

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Tel: +880-2-9844051-4 (Ext: 4196), Rankstel: 09617445066 Ext. 5066, Email: mosaddeq@bracu.ac.bd

Mosaddeq 24.10.22

Md. Mosaddequr Rahman, PhD

Dr. Md. Mosaddequr Rahman
Professor and Chairperson
Department of Electrical & Electronic Engineering
Brac University

Figure 9.3.1: Authorization Letter From DPDC.

9.3.1 Risk Management and Contingency Plan:

9.3.1.1 Identification of Risks:

In this project we are building a system. While working on building a system there are some risk factors involved which if not addressed can be dangerous. These dangers are mainly divided into four groups. The whole situation may be summarized as follows.

Risks of Electric Shock:

One of the first risks for this project could be the potential of getting electric shock. There could be any faulty grounds from the transmission and distribution line which anyone who's working may come into contact if not careful. Many electrical devices have high voltages and without proper precautions if someone accidentally touches it that person may get the shock. There is also a high chance of being electrocuted with two energized bus terminals while working in the power station.

Risk of System Crash:

System crash is another type of risk we may have to handle while working on this project. As we are using multiple subsystems in our project there is a high possibility that one sub system can affect another sub system which will ultimately result in a full system crash.

Risk of Component Failure:

A component is a smaller, independent part of a larger system, though there are other possible definitions as well. Instability of some form is typically the cause of component failure, which is a common phenomenon in a sub system. Component failure can mean many things such as in our project we are using various sensors which can be affected by many causes such as mechanical failure or over current or voltage.

Risk of Power System Failure:

These general causes of power system failure could apply, Grid failure: This may occur as a result of an abrupt trip of a major power source, such as a power plant, an upstream transformer, an upstream transmission line, or an issue with an upstream circuit breaker. These could occur because of internal power plant issues, improper power management at the RLDC (Regional Load Dispatch Center), thunderstorms, etc. Failures of the transmission and distribution lines, power cables, power transformers, and other components of the local power system (Normally HT cable of medium and high voltage grade). As this project is closely related to the power system this is also a concern for this project.

9.3.1.2 Risk Matrix

Table 9.3.1.2.1: Risk Matrix Table.

	Likelihood & Consequences						
	1	2	3	4	5		
	Rarely	Unlikely	Possible	Likely	Almost Certain		
Power Station	4	8	12	16	20	Catastrophic	4
Transmission line	3	6	9	12	15	Major	3
Distribution Line	2	4	6	8	10	Moderate	2
Electric Component	1	2	3	4	5	Minor	1

Table 9.3.1.2.2: Table of Risk of System Crash

	Likelihood & Consequences						
	1	2	3	4	5		
	Rarely	Unlikely	Possible	Likely	Almost Certain		
Triangulation Failure	4	8	12	16	20	Catastrophic	4
Data Program Lost	3	6	9	12	15	Major	3
Interference	2	4	6	8	10	Moderate	2
Software Update delay	1	2	3	4	5	Minor	1

Risk Level:

1. Low =1-5
2. Moderate =5-10
3. High =11-15
4. Extreme =16-20

9.3.1.3 Risk Response Matrix

Table 9.3.1.3.1: Risk Response Matrix with Contingency Plan.

Risk Event	Response	Contingency	Trigger	Responsibility
Electric Shock	i) The current flow will be reduced by adding a lot of insulation. ii) Aiming to prevent any parts from coming into contact with water. iii)There should always be sufficient footing.	As soon as there is substantial current flow, the main switch ought to be a relay.	Faulty ground and water coming in contact with the electrical components	Ahad, Tasniya
Component Failure	i) Proper sensors to detect the system ii) Components should be used in the proper direction to verify each and every problem.	There should be sensors in every load system. must be able to feel them and act accordingly.	Detection of any change inside the system.	Ananya, Imamul
Power System Failure	To identify the primary issue, each sensor will be connected to an LED.	A lot of maintenance is required over time.	Voltage drops or sudden shutdown of the whole system.	Tasniya, Imamul
System Crash	i) If we notice any systemic disturbance, we will restart the system. ii). Use of updated software is required to prevent process latency.	Getting in touch with a service representative to inquire about the software's status.	Data collection becomes unresponsive	Imamul, Ahad

9.4 Conclusion

In order to ensure that the project is carried out in a responsible and ethical manner, these factors are crucial to keep in mind during the project development lifecycle. In conclusion, professional and ethical obligations are essential parts of every project since they help to ensure that it is carried out in an ethical and responsible manner. Project managers can advance the welfare of the community and guarantee the success and sustainability of the project by taking stakeholders' potential affects into account and upholding legal and ethical standards.

Chapter 10: Conclusion and Future Work.

10.1 Project summary

The name of our FYDP project is Smart Load Management System. The main reason we have chosen this project is to upgrade the load-shedding system in automation and also give notification to people before load-shedding and to keep the data of input and output load for both distributor side and consumer side. In this project to make smart loads we have gone through various sites and read articles about research papers.

Through proper research we have initially agreed upon three approaches. The first approach is using a GSM-based mobile network with the connectivity between the power distribution authority, SLM device, and user is established via the authority identification number, device identity number, and user identification number. The second approach is based on machine learning to make predictions. The third approach is basically an IOT based smart system which contains details from power production to distribution to the user. We have provided all the three approaches in this report with a proper block diagram. Finally, while implementing the system, we have decided to work upon approach 2 and approach 3. In approach 2, we have incorporated the data which we got from DPDC in machine learning. For approach 3 we have used Proteus for complete simulation.

There are some functional requirements and non-functional requirements in this report. We have also provided a budget and made a comparative analysis to know about the optimal solution. We have also got feedback about load-shedding problems and if this project will be beneficial to people. Lastly, Ethical Consideration and Risk Management and Contingency Plan are also properly included in this report.

10.2 Future work

Collaboration with government and Private power generation and distribution companies. As a result, using it on a massive scale can even reduce the production costs more. Implementing this can save power on a massive scale and revolutionize the Power Industry.

Chapter 11: Identification of Complex Engineering Problems and Activities.

11.1: Identify the attribute of complex engineering problem (EP) and Provide reasoning how the project address selected attribute (EP)

Attributes of Complex Engineering Problems (EP) mentioned in the table:

Table 11.1.1: Attributes of Complex Engineering Problems.

	Attributes	**Put tick (√) as appropriate**
P1	Depth of concept	**(√)**
P2	Range of conflicts	**(√)**
P3	Depth of Analysis	**(√)**
P4	Familiarity of issues	
P5	Extent of applicable codes	
P6	Extent of stakeholder involvement and needs	**(√)**
P7	Interdependence	**(√)**

11.2: Provide reasoning how the project address selected attribute (EP)

Depth of concept: We require wide knowledge of load management systems and how they operate with various loads. Our system will employ several sensor patterns; thus, we must accurately distribute them.

Range of conflicts: As we are using various Internet of things and GSM Modules, this triggers the concerns of "IT enabled systems versus data protection" Secondly, Fair distributions of energy

versus Distributors system performance is another concern for our project as our SLM is going to heavily interact with the Distributors. Their machinery might require more frequent and precise maintenance.

Depth of Analysis: We have read numerous papers and articles on our system and analyzed them in light of it, how other systems operate, and how our system will operate.

Extent of stakeholder involvement and needs: Users and distributors comprise the majority of our investors.

Interdependence: We employed a variety of parts in our system, including a microprocessor, sensors, relays, and more.

11.3 Attributes of Complex Engineering Activities (EA)

Table 11.3.1: Attributes of Complex Engineering Activities (EA).

	Attributes	**Put tick (√) as appropriate**
A1	Range of resource	**(√)**
A2	Level of interaction	**(√)**
A3	Innovation	

A4	Consequences for society and the environment	**(√)**
A5	Familiarity	

11.4 Provide reasoning how the project address selected attribute (EA)

Range of resource: To develop this project, a wide variety of financing, materials, equipment knowledge, and personnel needs are required.

Level of interaction: A broad breadth of expertise is necessary from Electronics, design, and networking to successfully make this project.

Consequences for society and the environment: The initiative intends to bring a change in the power sector by automation load-shedding and helping the consumers by giving earlier notification about load shedding.

References

1. Directorate of Public Relations, BPDB, “ANNUAL REPORT 2020-21” Bangladesh Power Development Board, Dhaka, Bangladesh, 2020-2021. Accessed Oct. 1, 2022. [Online]. Available:

https://bdcom.bpdb.gov.bd/bpdb_new/resourcefile/annualreports/annualreport_16407 56525_Annual_Report_2020-2021_latest.pdf

2. UNB, D. (2022) Scheduled power-cuts: Bangladesh experienced 1915 MW load shedding on Day 1, The Daily Star. Available at:

https://www.thedailystar.net/environment/natural-resources/energy/news/scheduled power-cuts-bangladesh-experiences-1915-mw-load-shedding-day-1-3074516 (Accessed: October 27, 2022).

3. Y. Gupta, S. P. Bajoria, R. K. Singh and O. V. Gnana Swathika, "IOT based energy management system with load sharing and source management features," 2017 4th IEEE Uttar Pradesh Section International Conference on Electrical, Computer and Electronics (UPCON), 2017, pp. 169-177, Doi: 10.1109/UPCON.2017.8251042.

4. A. Srinivasan, K. Baskaran and G. Yann, "IoT Based Smart Plug-Load Energy Conservation and Management System," 2019 IEEE 2nd International Conference on Power and Energy Applications (ICPEA), 2019, pp. 155-158, Doi:

10.1109/ICPEA.2019.8818534.

5. M. A. Rahman, I. Rahman and N. Mohammad, "Demand Side Residential Load Management System for Minimizing Energy Consumption Cost and Reducing Peak Demand in Smart Grid," 2020 2nd International Conference on Advanced Information and Communication Technology (ICAICT), 2020, pp. 376-381, Doi: 10.1109/ICAICT51780.2020.9333451.

6. M. A. Rahman, I. Rahman and N. Mohammad, "Demand Side Residential Load Management System for Minimizing Energy Consumption Cost and Reducing Peak Demand in Smart Grid," 2020 2nd International Conference on Advanced Information and Communication Technology (ICAICT), 2020, pp. 376-381, Doi: 10.1109/ICAICT51780.2020.9333451

7. M. U. Saleem, M. R. Usman and M. Shakir, "Design, Implementation, and Deployment of an IoT Based Smart Energy Management System," in IEEE Access, vol. 9, pp. 59649-59664, 2021, Doi: 10.1109/ACCESS.2021.3070960.

8. N. K. Mucheli et al., "Smart Power Theft Detection System," 2019 Devices for Integrated Circuit (DevIC), 2019, pp. 302-305, Doi: 10.1109/DEVIC.2019.8783395. 9. A. S. Metering, S. Visalatchi and K. K. Sandeep, "Smart energy metering and power

theft control using Arduino & GSM," 2017 2nd International Conference for Convergence in Technology (I2CT), 2017, pp. 858-961, Doi: 10.1109/I2CT.2017.8226251.

10. Y. A. Badamasi, "The working principle of an Arduino," 2014 11th International Conference on Electronics, Computer and Computation (ICECCO), 2014, pp. 1-4, Doi: 10.1109/ICECCO.2014.6997578.

11. M. Yuchun, H. Yinghong, Z. Kun and L. Zhuang, "General Application Research on GSM Module," 2011 International Conference on Internet Computing and Information Services, 2011, pp. 525-528, Doi: 10.1109/ICICIS.2011.137.

12. H. A. Abdallah Dafallah, "Design and implementation of an accurate real time GPS tracking system," The Third International Conference on e-Technologies and Networks for Development (ICeND2014), 2014, pp. 183-188, Doi: 10.1109/ICeND.2014.6991376.

13. M. Anas, N. Javaid, A. Mahmood, S. M. Raza, U. Qasim and Z. A. Khan, "Minimizing Electricity Theft Using Smart Meters in AMI," 2012 Seventh International Conference on P2P, Parallel, Grid, Cloud and Internet Computing, 2012, pp. 176-182, Doi: 10.1109/3PGCIC.2012.42.

14. S. Ziegler, R. C. Woodward, H. H. -C. Iu and L. J. Borle, "Current Sensing Techniques: A Review," in IEEE Sensors Journal, vol. 9, no. 4, pp. 354-376, April 2009, Doi: 10.1109/JSEN.2009.2013914.

15. Labib, M. Billah, M. R. Islam and G. M. S. M. Rana, "Design and construction of smart load management system: An effective approach to manage consumer loads during power shortage," 2015 International Conference on Electrical Engineering and Information Communication Technology (ICEEICT), 2015, pp. 1-4, Doi: 10.1109/ICEEICT.2015.7307346.

16. A. Mahmood, N. Javaid, M. A. Khan, and S. Razzaq, “An overview of load management techniques in smart grid,” International Journal of Energy Research, vol. 39, no. 11, pp. 1437–1450, 2015.

17. R. Petrichenko and V. Chuvychin, "Smart load shedding system," 2012 3rd IEEE International Symposium on Power Electronics for Distributed Generation Systems (PEDG), 2012, pp. 64-71, Doi: 10.1109/PEDG.2012.6253981.

18. M. Abrar, M. A. Tahir, R. Masroor and H. M. U. Hamid, "Real time smart grid load management by integrated and secured communication," 2018 International Conference on Innovative Trends in Computer Engineering (ITCE), 2018, pp. 253- 257, Doi: 10.1109/ITCE.2018.8316634.

19. S. Angra and S. Ahuja, "Machine learning and its applications: A review," 2017 International Conference on Big Data Analytics and Computational Intelligence (ICBDAC), 2017, pp. 57-60, Doi: 10.1109/ICBDACI.2017.8070809.

20. X. Bin, C. Qing, M. Jun, Y. Yan and Z. Zhixia, "Research on a Kind of Ubiquitous Power Internet of Things System for Strong Smart Power Grid," 2019 IEEE Innovative Smart Grid Technologies - Asia (ISGT Asia), 2019, pp. 2805-2808, Doi: 10.1109/ISGT-Asia.2019.8881652.

21. M. M. Eissa, S. M. Wasfy, and M. M. Sallam, “Load Management System using intelligent monitoring and control system for commercial and industrial sectors,” Energy Efficiency - The Innovative Ways for Smart Energy, the Future Towards Modern Utilities, 2012.

22. Vishal V. Mehtre , Utkarsh Chaurasia, Nikhil Sundram, Prince Kumar "Automation in Load Shedding Using Microcontroller" Iconic Research and Engineering Journals, 5(12)

23. A. Arif, M. Al-Hussain, N. Al-Mutairi, E. Al-Ammar, Y. Khan and N. Malik, "Experimental study and design of smart energy meter for the smart grid," 2013 International Renewable and Sustainable Energy Conference (IRSEC), 2013, pp. 515- 520, Doi: 10.1109/IRSEC.2013.6529714.

Appendix

Code:

Transmission:

```
#include <LiquidCrystal.h>

LiquidCrystal lcd(13, 12, 11, 10, 9, 8);

char number1[] = "01745083888";
char number2[] = "01798289657";
char msg1[] = "Power theft detected!";
char msg2[] = "Load shedding will occur";

#define AVG_NUM 20
#define CURRENT_ADJ 0.026393581
#define VOLTAGE_ADJ 0.474137931

int voltage, watt;
float current;
long pms;
bool isSent;

void setup() {
  Serial.begin(9600);
  lcd.begin(16, 2);
  pinMode(2, INPUT);
```

```
}

void loop() {
  voltage = readAdc(A1) * VOLTAGE_ADJ;
  current = abs(readAdc(A0) * CURRENT_ADJ - 13.6);
  watt = voltage * current;
  if (current < 0) current = 0;

  if (digitalRead(2) && !isSent) {
    sendSMS(number1, msg1);
    sendSMS(number2, msg2);
    isSent = true;
  }
  if (!digitalRead(2)) isSent = false;

  if (millis() - pms >= 500) {
    lcd.setCursor(0, 0);
    lcd.print((String)voltage + " VAC, " + current + "A  ");
    lcd.setCursor(0, 1);
    lcd.print((String)"POWER: " + watt + "W  ");
    pms = millis();
  }
}

void sendSMS(char num[], char msg[]) {
  Serial.print(F("AT+CMGF=1\r\n"));
  delay(100);
  Serial.print("AT+CMGS=\"");
```

```
  Serial.print(num);
  Serial.print("\"\r\n");
  delay(100);
  Serial.print(msg);
  Serial.write(0x1A);
  Serial.print("\r\n");
  delay(100);
  Serial.println(F("SENT."));
}

int readAdc(int channel) {
  int i, temp, sum = 0;

  for (i = 0; i < AVG_NUM; i++) {
    temp = analogRead(channel);
    sum += temp;
    delayMicroseconds(50);
  }
  if (channel == A1) return 464;
  return (sum / AVG_NUM);
}
```

Distribution:

```
#include <LiquidCrystal.h>

LiquidCrystal lcd(13, 12, 11, 10, 9, 8);
```

```
#define AVG_NUM 20
#define CURRENT_ADJ 0.026393581
#define VOLTAGE_ADJ 0.474137931

int voltage, watt;
float current;
long pms;

void setup() {
  Serial.begin(9600);
  lcd.begin(16, 2);
}

void loop() {
  voltage = readAdc(A1) * VOLTAGE_ADJ;
  current = abs(readAdc(A0) * CURRENT_ADJ - 13.6);
  watt = voltage * current;
  if (current < 0) current = 0;

  if(millis() - pms >= 500) {
    lcd.setCursor(0, 0);
    lcd.print((String)voltage + " VAC, " + current + "A  ");
    lcd.setCursor(0, 1);
    lcd.print((String)"POWER: " + watt + "W  ");
    pms = millis();
  }
}
```

```
int readAdc(int channel) {
  int i, temp, sum = 0;

  for (i = 0; i < AVG_NUM; i++) {
    temp = analogRead(channel);
    sum += temp;
    delayMicroseconds(50);
  }
  if(channel == A1) return 464;
  return (sum / AVG_NUM);
}
```

Consumer:

```
#include <LiquidCrystal.h>

LiquidCrystal lcd(13, 12, 11, 10, 9, 8);

#define AVG_NUM 20
#define CURRENT_ADJ 0.026393581
#define VOLTAGE_ADJ 0.474137931

int voltage, watt;
float current;
long pms;

void setup() {
  Serial.begin(9600);
```

```
  lcd.begin(16, 2);
  pinMode(2, OUTPUT);
}

void loop() {
  voltage = readAdc(A1) * VOLTAGE_ADJ;
  current = abs(readAdc(A0) * CURRENT_ADJ - 13.6);
  watt = voltage * current;
  if (current < 0) current = 0;

  if(watt > 500 && watt < 600) digitalWrite(2, 1);
  else if(watt < 100) digitalWrite(2, 1);
  else digitalWrite(2, 0);

  if(millis() - pms >= 500) {
    lcd.setCursor(0, 0);
    lcd.print((String)voltage + " VAC, " + current + "A  ");
    lcd.setCursor(0, 1);
    lcd.print((String)"POWER: " + watt + "W  ");
    pms = millis();
  }
}

int readAdc(int channel) {
  int i, temp, sum = 0;

  for (i = 0; i < AVG_NUM; i++) {
    temp = analogRead(channel);
```

```
    sum += temp;
    delayMicroseconds(50);
  }
  if(channel == A1) return 464;
  return (sum / AVG_NUM);
}
```

Logbook:

Group Member Details:			
Student Details	**NAME & ID**	**EMAIL ADDRESS**	**PHONE**
Member 1	Anam Al - Ahad	anam.al.ahad@g.bracu.ac.bd	01745083888
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Member 3	Ananya Sen Gupta	ananya.sen.gupta@g.bracu.ac.bd	01933034142
Member 4	Imamul Mursalin	imamul.mursalin@g.bracu.ac.bd	01722621386
ATC Details:			
ATC 1			
Chair	Dr. A.H.M. Abdur Rahim		
Member 1	Tasfin Mahmud	tasfin.mahmud@bracu.ac.bd	
Member 2	Md. Mehedi Hasan Shawon	mehedi.shawon@bracu.ac.bd	
Member 3	Dr. Saifur Rahman Sabuj	srsabuj@bracu.ac.bd	

FYDP (P) Fall 2022 Summary of Team Logbook/ Journal

Date/Time/Place	Attendee	Summary of Meeting Minutes	Responsible	Comment by ATC
11.10.2022 09:00 PM Google Meet	1.Ahad 2.Tasniya 3.Ananya 4.Imamul	1. Did some research in many topics 2. Read many papers individually 3. Took some meeting minutes	Task 1: Everyone Task 2: Everyone Task 3: Tasniya	
12.10.2022 08:20 PM Google Meet	1.Ahad 2.Tasniya 3.Ananya 4.Imamul	1. Selected 6 topics 2. Did more research on those topics	Task 1: Everyone Task 2: Everyone	
13.10.2022 12:30 PM On Campus	1.Ahad 2.Tasniya 3.Ananya 4.Imamul	1. ATC called a meeting upon request 2. Introduced our topics 3. Got comments on all topics	Task 1: ATC Panel Task 2: Ahad Task 3: ATC Panel	Advised to do more research on load management topics.. Encouraged to gather real data from DPDC.
18.10.2022 12:50 PM On Campus	1.Ahad	1. Discussed about load management. 2. Got some ideas about multiple design approaches.	Task 1: Ahad Task 2: Ahad	Advised to do more research.

19.10.2022 01:10 PM On Campus	1.Ahad 2.Tasniya 3.Ananya 4.Imamul	1. Discussed multiple design approaches. 2. Asked to brainstorm more	Task 1: Everyone Task 2: Tasfin Mahmud	
19.10.2022 09:10 PM Google Meet	1.Ahad 2.Tasniya 3.Imamul	1. Showed us some relevant research papers. 2. Discussed more about multiple approaches.	Task 1: Tasfin Mahmud Task 2: Tasfin Mahmud	
20.10.2022 11:30 AM On Campus	1.Ahad 2.Tasniya 3.Imamul	1. Explained about the topic more elaborately. 2. Advised about rethinking Topic Headline.	Task 1: Ahad Task 2: MD. Mehedi Hasan Shawon	
22.10.2022 07:40 PM Google Meet	1.Ahad 2.Tasniya 3.Ananya 4.Imamul	1. Did more discussion and research about the management system. 2. Came up with more multiple approach's ideas.	Task 1: Everyone Task 2: Everyone	
23.10.2022 12:45 PM On Campus	1.Ahad 2.Tasniya	1.Discussed about the new multiple approaches.	Task 1: Ahad, Tasniya	Advised to start writing on the concept note

24.10.2022 8:25 PM Google Meet	1.Ahad 2.Tasniya 3.Ananya 4.Imamul	1. Preparing writing on concept note.	Task 1: Everyone	
27.10.2022 11:30 AM On Campus	1.Ahad 2.Tasniya 3.Imamul	1. Preparing Block Diagram of multiple design approach 2. Started Writing on the concept note	Task 1: Everyone Task 2:Everyone	
27.10.2022 8:35 PM Google meet	1.Ahad 2.Tasniya 3.Imamul	1.Writing concept note	Task 1: Ahad, Tasniya, Imamul	
28.10.2022 11:40 PM Google meet	1.Ahad 2.Tasniya	1. Writing concept note.	Task 1: Ahad, Tasniya,	
30.10.22 9:00pm Google Meet	1.Ahad 2.Tasniya 3.Ananya 4.Imamul	1.Finalizing the approaches	Task 1: Everyone	
31.10.22 8:00pm Google Meet	1.Ahad 2.Tasniya	1.Writing Concept Note (Complete (Ready for checking))	Task 1:Everyone	

	3.Ananya 4.Imamul			
1.11.22 12:30 PM On Campus	1.Ahad 2.Tasniya 3.Ananya	1.Concept note checking	Task 1: MD. Mehedi Hasan Shawon, MD Rakibul Hasan	
1.11.22 9:30 PM Google Meet	1.Ahad 2.Tasniya 3.Ananya 4.Imamul	1.Preparing the slides	Task 1:Everyone	
2.11.22 11:30AM Google Meet	1.Ahad 2.Tasniya 3.Ananya	1.Correcting the prepared slides 2.Showed correction	Task 1:Everyone Task 2:MD.Rakibul Hasan	
3.11.22 8:00AM On Campus	1.Ahad 2.Tasniya 3.Ananya 4.Imamul	1.Presentation day	Task 1:Everyone :	
20.11.22 12:00 PM DPDC	1.Ananya 2.Imamul	1.Going for the collection of the load-shedding data	Task 1:everyone	
21-11-2022 9:00pm Google Meet	1.Imamul	1 Completion of some formalities.	Task 1:Everyone	

24-11-2022 12:00pm DPDC	1..Tasniya 2.Ananya 3.Imamu 4.Ahad	1.Collecting the data	Task 1:Everyone	
29-11-2022 8:00pm Google Meet	1.Ahad 2.Tasniya 3.Ananya 4.Imamul	1.Started preparing the slides	Task 1:Everyone	
11-12-2022 1:00am Google Meet	1.Ahad 2.Tasniya 3.Ananya 4.Imamul	1.Completed the slides for mock presentation	Task 1:Tasfin Ahmed,Md.Mehedi Hasan Shawon	
12-12-2022 2:00pm On Campus	1.Ahad 2.Tasniya 3.Ananya 4.Imamul	1.Gave mock presentation	Task 1:Tasfin Ahmed,Md.Mehedi Hasan Shawon	
14-12-2022 2:00pm On Campus	1.Tasniya 2.Ahad 3.Ananya 4.Imamul	1.Showed slides and got correction for final presentation	Task 1:Tasfin Ahmed,Md.Mehedi Hasan Shawon	
14-12-2020 9:00pm	.Tasniya 2.Ahad	1.Corrected the error in slides	Task 1:Tasfin Ahmed,Md.Mehedi Hasan Shawon	

Google Meet	3.Ananya 4.Imamul			
15-12-2022 8:00pm On Campus	1.Tasniya 2.Ahad 3.Ananya 4.Imamul	1.Gave final presentation for 400p	Task 1:Everyone	
15-12-2022 9:00pm Google Meet	1.Tasniya 2.Ananya 3.Ahad	1.Started discussion for final Project Proposal Report	Task 1:Everyone	
16-12-2022 12:30pm Google Meet	1.Ananya 2.Ahad	1.Started preparing the Project Proposal Report	Task 1:Everyone	
16-12-2022 9:00pm Google Meet	1.Ananya 2.Tasniya 3.Ahad 4.Imamul	1.Preparation for the Project Proposal Report	Task 1:Everyone	
20-12-2022 2:00pm On Campus	1.Ananya 2.Tasniya 3.Ahad 4.Imamul	1.Taking suggestions and ideas.	Task 1:Md.Mehedi Hasan Shawon	
20-12-2022 11:00pm Google Meet	1.Ananya 2.Tasniya 2.Ahad 4.Imamul	1. Preparing the project proposal report draft	Task 1:Everyone	

21-12-2022 6:OOPM On Campus	1.Ananya 2.Tasniya 2.Ahad	1.Showing the prepared draft	Task 1:Tasfin Ahmed	
21-12-2022 11:00pm Google Meet	1.Ananya 2.Tasniya 2.Ahad 4.Imamul	1.Correcting the error	Task 1:Everyone	

FYDP (D) Spring 2023 Summary of Team Logbook/ Journal

Date/Time/Place	Attendee	Summary of Meeting Minutes	Responsible	Comment by ATC
28.01.2023 12:00 AM Offline Campus	1.Ucchas 2.Tasniya 3.Ahad 4.Ananya	1.Regarding the time for consultation of 400D.	Task 01:Everyone	
2.02.2023 10:00 AM Offline Campus	1,Ananya 2.Tasniya 2.Ahad	1.Consulting the next to-do for 400D.	Task 01;Tasfin Mahmud	
4.02.2023 10:30 PM Google Meet	1.Tasniya 2.Ananya 3.Ahad 4.Ucchas	1.Rearching for software to implement the design for a project.	Task 01:Everyone	
6.02.2023 9:00pm Google Meet	1.Tasniya 2.Ananya 3.Ahad 4.Ucchas	1.Rearching for software to implement the design for a project.	Task 01:Everyone	
8.02.2023 2:30 pm Offline Campus	1.Ahad	1.Regarding the progress update of the project.	Task 01:Everyone	

10.02.2023 8:00pm Offline Campus	1.Tasniya 2.Ananya 3.Ahad 4.Ucchas	1.Discussion about our simulation.	Task 01:Everyone	
16.02.2023 2:00pm Offline Campus	1.Ucchas 2.Tasniya	1.A small consultation to make understanding of our project to new ATC members.	Task 01:Tasfin Mahmud, Mehedi Hasan Shawon	
17.02.2023 11:00pm Google Meet	1.Ahad 2.Tasniya 3.Ucchas	1.Further research for our implementation of the project.	Task 01:Everyone	
19.02.2023 10:00pm Google Meet	1.Ahad 2.Tasniya 3.Ucchas 4.Ananya	1.Searching papers for certain software implementations.	Task 01:Everyone	
23.02.2023 4:30pm Offline Campus	1.Ananya 2.Tasniya 3.Ahad 4.Ucchas	1.Consultation regarding workload distribution. 2.Meeting with new ATC members.	Task 01:Tasfin Mahmud Task 02:Everyone	
25.02.2023 10:00pm Google Meet	1.Ananya 2.Tasniya 3.Ahad 4.Ucchas	1.Working on a GSM module.	Task 01:Everyone	
27.02.2023 8:00pm Google Meet	1.Ananya 2.Tasniya 3.Ahad 4.Ucchas	1.Current sensor proteus simulation.	Task 01:Everyone	
28.02.2023 9:00pm Google Meet	1.Ananya 2.Tasniya 3.Ahad 4.Ucchas	1.Working on slides for powerpoint presentations.	Task 01:Everyone	
1.03.2023 8:00pm GoogleMeet	1.Ananya 2.Tasniya 3.Ahad 4.Ucchas	1.Preparation for progress presentation.	Task 01:Everyone	
2.03.2023 11:30pm Offline Campus	1.Ananya 2.Tasniya 3.Ahad 4.Ucchas	1.Day of progress presentation..	Task 01:Everyone	
3.03.2023 10:00pm Google Meet	1.Ananya 2.Tasniya 3.Ahad 4.Ucchas	1.Researching about simulation.	Task 01:Everyone	
7.03.2023 9:00pm Google Meet	1.Ananya 2.Tasniya 3.Ahad 4.Ucchas	1.Reading journal papers.	Task 01:Everyone	
10.03.2023	1.Ananya	1.Reading journal papers.	Task 01:Everyone	

8:00pm Google Meet	2.Tasniya 3.Ahad			
13.03.2023 2:00pm Offline Campus	1.Ananya 2.Tasniya 3..Ucchas	1.Simulation on current sensor.	Task 01:Everyone	
15.03.2023 1:00pm Offline Campus	1.Ananya 2.Tasniya 3.Ahad 4.Ucchas	1.Watching videos on machines. Learning.	Task 01:Everyone	
16.03.2023 10:00am Offline Campus	1.Ananya 2.Tasniya 3.Ahad 4.Ucchas	1.Trying to learn about time series machine learning .	Task 01:Everyone	
22.03.2023 8:00pm Google Meet	1.Ananya 2.Ahad 3.Ucchas	1.Working on software implementations.	Task 01:Everyone	
27.03.2023 8:00pm Google Meet	1.Ananya 2.Tasniya 3.Ahad 4.Ucchas	1.Implementing software as part of a project.	Task 01:Everyone	
1.04.2023 10:00am Offline Campus	1.Ananya 2.Tasniya 3.Ahad 4.Ucchas	1.Searching about proper hardware.	Task 01:Everyone	
4.04.2023 7:00pm Offline Campus	1.Ananya 2.Tasniya 3.Ahad 4.Ucchas	1.Discussing about different hardwares.	Task 01:Everyone	
10.04.2023 5:00pm Offline Campus 8:00pm Google Meet	1.Ananya 2.Tasniya 3.Ahad 4.Ucchas	1.Went to show our progressions to ATC. 2.Worked on the suggestions.	Task01:Md.Mehedi Hassan Shawon Task 02:Everyone	
12.04.2023 4:00pm Offline Campus	1.Ananya 2.Tasniya 3.Ahad 4.Ucchas	1.Talked with tasfin sir about our work.	Task 01:Tasfin Mahmud	
14.03.2023 10:00pm Google Meet	1.Tasniya 2.Ahad 3.Ucchas	1.Started Working on simulation.	Task 01:Everyone	
16.04.2023 11:00pm Google Meet	1.Tasniya 2.Ahad 3.Ucchas 4.Ananya	1.Properly connecting our simulation.	Task 01:Everyone	
17.04.2023 10:00pm Google Meet	1.Tasniya 2.Ahad 3.Ucchas	1.Working on simulation.	Task 01:Everyone	

18.04.2023 11:00pm Google Meet	1.Tasniya 2.Ahad 3.Ucchas	1.Completing our simulation of our project.	Task 01:Everyone	
19.04.2023 9:00pm Google Meet	1.Tasniya 2.Ahad 3.Ucchas 4.Ananya	1.Started distributing parts for working on project reports.	Task 01:Everyone	
20.04.2023 10:00pm Google Meet	1.Tasniya 2.Ahad 3.Ucchas 4.Ananya	1.Started working on reports.	Task 01:Everyone	
23.04.2023 10:00pm Google Meet	1.Tasniya 2..Ananya	1.Working on reports.	Task 01:Everyone	
25.04.2023 9:30pm Google Meet	1.Tasniya 2.Ahad 3.Ucchas 4.Ananya	1.Completing the reports and starting the slides.	Task 01:Everyone	
26.04.2023 10:00am Google Meet	1.Tasniya 2.Ahad 3.Ucchas 4.Ananya	1.Completing the slides.	Task 01:Everyone	
27.04.2023 12:45pm Offline Camus	1.Tasniya 2.Ucchas 3.Ananya	1.FYDP-DFinal presentation day.	Task 01:Everyone	
30.04.2023 11:00pm Google Meet	1.Tasniya 2.Ahad 3.Ucchas 4.Ananya	1.Submitting the reports.	Task 01:Everyone	

FYDP (C) Summer 2023 Summary of Team Logbook/ Journal

Date/Time/Place	**Attendee**	**Summary of Meeting Minutes**	**Responsible**	**Comment by ATC**
31.05.2023 11.00pm Offline Campus	1.Ucchas 2.Tasniya 3.Ahad 4.Ananya	1.Attendending FYDP C class and meeting with tasfin sir.	Task 01: Everyone	

2.06.2023 12.00pm Offline Campus	1.Ucchas 2.Tasniya 3.Ahad 4.Ananya	1.Meeting with Tasfin sir regarding FYDP C work.	Task 01: Tasfin Mahmud.	
3.06.2023 8:00pm Google Meet	1.Ucchas 2.Tasniya 3.Ahad 4.Ananya	1.Discussing about components.	Task 01: Everyone	
4.06.2023 9:00pm Google Meet	1.Ucchas 2.Tasniya 3.Ahad 4.Ananya	1.Searching and listing about components.	1.Task 01: Everyone	
6.06.2023 12:00pm Offline Campus	1.Ucchas 2.Tasniya 3.Ahad	1.Finalizing components.	1.Task 01: Everyone	
7.06.2023 8:00pm Google Meet	1.Ucchas 2.Tasniya 3.Ahad 4.Ananya	1.Talking about hardware components and publishing papers regarding the project.	1.Task 01: Everyone	
8.06.2023 1:00pm Offline campus	1.Ucchas 2.Tasniya 3.Ahad 4.Ananya	1.Meeting with Tasfin sir about our hardware part.	1.Task 01: Tasfin Mahmud	
10.06.2023 9:00pm Google Meet	1.Ucchas 2.Tasniya 3.Ahad 4.Ananya	1.Discussing about component buying places and the connection way.	1.Task 01: Everyone	
12..06.2023 1:00pm Offline Campus	1.Ucchas 2.Tasniya 3.Ahad	1.Meeting with both tasfin sir and shown sir.	1.Task 01: Md.Mehedi Hasan Shawon, Tasfin Mahmud.	1.Sir told us the ways we can improve.
13.06.2023 2:00pm Offline Campus	1.Ucchas 2.Tasniya 3.Ahad 4.Ananya	1.Ordering all of our components.	1.Task 01: Everyone	

14.06.2023 5.00pm Offline campus	1.Ucchas 2.Tasniya 3.Ahad 4.Ananya	1.Meeting with all ATC Panel.	1.Task 01: Everyone	
15.06.2023 1:00pm Offline Campus	1.Ucchas 2.Tasniya 3.Ahad 4.Ananya	1.Collecting all the components and starting testing.	1.Task 01: Everyone	
17.06.2023 2:00pm Offline Campus	1.Ucchas 2.Tasniya 3.Ahad	1.Testing the components.	1.Task 01: Everyone	
19.06.2023 1.00pm Offline Campus	1.Ucchas 2.Tasniya 3.Ahad 4.Ananya	1.Testing the components.	1.Task 01: Everyone	
20.06.2023 5.00pm Offline Campus	1.Ucchas 2.Tasniya 3.Ahad 4.Ananya	1.Meeting with Tasfin sir and showing our progress.	1.Task 01: Tasfin Mahmud	1.Tasfin sir gave some suggestions.
21.06.2023 3.00pm Offline Campus	1.Ucchas 2.Tasniya 3.Ahad 4.Ananya	1.Solving some difficulties regarding component testing.	1.Task 01: Everyone.	
23.06.2023 1.00pm Offline Campus	1.Ucchas 2.Tasniya 3.Ahad 4.Ananya	1.Meeting with Tasfin sir and showing our progress.	1.Task 01: Everyone	
25.06.2023 5:00pm Offline Campus	1.Ucchas 2.Tasniya 3.Ahad 4.Ananya	1.Meeting with sir to solve some difficulties regarding component testing.	1.Task 01: Tasfin Mahmud	1.Sir told us the things we can improve.
27.06.2023 9:00pm Google Meet	1.Ucchas 2.Tasniya 3.Ahad 4.Ananya	1. Talking about our next plan regarding incorporating the components.	1.Task 01: Everyone	

28.06.2023 10:00pm Google Meet	1.Ucchas 2.Tasniya 3.Ahad 4.Ananya	1.Starting incorporation of the components.	1.Task 01: Everyone	
29.06.2023 9:00pm Google Meet	1.Ucchas 2.Tasniya 3.Ahad 4.Ananya	1.Starting incorporation of the components.	1.Task 01: Everyone	
30.06.2023 10:00pm Google Meet	1.Ucchas 2.Tasniya 3.Ahad 4.Ananya	1.Starting incorporation of the components.	1.Task 01: Everyone	
1.07.2023 10:00pm Google Meet	1.Ucchas 2.Tasniya 3.Ahad 4.Ananya	1.Starting incorporation of the components. 2.Discussion with the ATC about some problems that we are facing.	1.Task 01: Everyone 2.Task 01: Tasfin Mahmud	1.Sir told us the things we can improve overall.
2.07.2023 10:00pm Google Meet	1.Ucchas 2.Tasniya 3.Ahad 4.Ananya	1.Starting incorporation of the components.	1.Task 01: Everyone	
4.07.2023 10:00pm Google Meet	1.Ucchas 2.Tasniya 3.Ahad 4.Ananya	1.Starting incorporation of the components.	1.Task 01: Everyone	
6.07.2023 10:00pm Google Meet	1.Ucchas 2.Tasniya 3.Ahad	1.Starting incorporation of the components.	1.Task 01: Everyone	
8.07.2023 1:00pm Offline Campus	1.Ucchas 2.Tasniya 3.Ahad 4.Ananya	1.Meeting with Tasfin sir on some suggestions.	1.Task 01: Tasfin Mahmud	1.Tasfin sir gave some suggestions on the current sensor.
10.07.2023 1:00pm Offline Campus	1.Ucchas 2.Tasniya 3.Ahad 4.Ananya	1.Starting incorporation of the components.	1.Task 01: Everyone	

12.07.2023 1:00pm Offline Campus	1.Ucchas 2.Tasniya 3.Ahad 4.Ananya	1.Preparing the PowerPoint presentation.	1.Task 01: Everyone	We have shown tasfin sir our progress work and how all the sensors and components work.
13.07.2023 1:00pm Offline Campus	1.Ucchas 2.Tasniya 3.Ahad 4.Ananya	1.Progress presentation	1.Task 01: Everyone	
15.07.2023 1:00pm Offline Campus	1.Ucchas 2.Tasniya 3.Ahad	1. Incorporating finally all the components.	1.Task 01: Everyone	
17.07.2023 1:00pm Offline Campus	1.Ucchas 2.Tasniya 3.Ahad 4.Ananya	1. Incorporating finally all the components.	1.Task 01: Everyone	
18.07.2023 1:00pm Offline Campus	1.Ucchas 2.Tasniya 3.Ahad 4.Ananya	1. Incorporating finally all the components.	1.Task 01: Everyone	
19.07.2023 1:00pm Offline Campus	1.Ucchas 2.Tasniya 3.Ahad 4.Ananya	1. Incorporating finally all the components.	1.Task 01: Everyone	
20.07.2023 1:00pm Offline Campus	1.Ucchas 2.Tasniya 3.Ahad 4.Ananya	1. Incorporating finally all the components.	1.Task 01: Everyone	
21.07.2023 1:00pm Offline Campus	1.Ucchas 2.Tasniya 3.Ahad 4.Ananya	1. Incorporating finally all the components.	1.Task 01: Everyone	

23.07.2023 1:00pm Offline Campus	1.Ucchas 2.Tasniya 3.Ahad 4.Ananya	1. Incorporating finally all the components.	1.Task 01: Everyone	
24.07.2023 1:00pm Offline Campus	1.Ucchas 2.Tasniya 3.Ahad 4.Ananya	1. Incorporating finally all the components.	1.Task 01: Everyone	
25.07.2023 1:00pm Offline Campus	1.Ucchas 2.Tasniya 3.Ahad 4.Ananya	1. Incorporating finally all the components.	1.Task 01: Everyone	
26.07.2023 1:00pm Offline Campus	1.Ucchas 2.Tasniya 3.Ahad 4.Ananya	1. Incorporating finally all the components.	1.Task 01: Everyone	
27.07.2023 1:00pm Offline Campus	1.Ucchas 2.Tasniya 3.Ahad 4.Ananya	1. Incorporating finally all the components.	1.Task 01: Everyone	
28.07.2023 1:00pm Offline Campus	1.Ucchas 2.Tasniya 3.Ahad 4.Ananya	1. Meeting with Tasfin sir.	1.Task 01: Everyone	1.Sir gave some feedback.
30.07.2023 1:00pm Offline Campus	1.Ucchas 2.Tasniya 3.Ahad 4.Ananya	1. Incorporating finally all the components.	1.Task 01: Everyone	
1.08.2023 1:00pm Offline Campus	1.Ucchas 2.Tasniya 3.Ahad 4.Ananya	1. Incorporating finally all the components.	1.Task 01: Everyone	
2.08.2023 1:00pm Offline Campus	1.Ucchas 2.Tasniya 3.Ahad	1. Incorporating finally all the components.	1.Task 01: Everyone	

3.08.2023 1:00pm Offline Campus	1.Ucchas 2.Tasniya 3.Ahad 4.Ananya	1. Incorporating finally all the components.	1.Task 01: Everyone	
5.08.2023 1:00pm Offline Campus	1.Ucchas 2.Tasniya 3.Ahad 4.Ananya	1. Incorporating finally all the components.	1.Task 01: Everyone	
8.08.2023 1:00pm Offline Campus	1.Ucchas 2.Tasniya 3.Ahad 4.Ananya	1. Incorporating finally all the components.	1.Task 01: Everyone	
10.08.2023 1:00pm Offline Campus	1.Ucchas 2.Tasniya 3.Ahad 4.Ananya	1. Incorporating finally all the components.	1.Task 01: Everyone	
11.08.2023 1:00pm Offline Campus	1.Ucchas 2.Tasniya 3.Ahad 4.Ananya	1. Incorporating finally all the components.	1.Task 01: Everyone	
13.08.2023 1:00pm Offline Campus	1.Ucchas 2.Tasniya 3.Ahad 4.Ananya	1. Completing Incorporating the components.	1.Task 01: Everyone	
15.08.2023 1:00pm Offline Campus	1.Ucchas 2.Tasniya 3.Ahad 4.Ananya	1.Incorporation complete and showing sir.	1.Task 01: Tasfin Mahmud.	1.Sir gave the satisfactory remark
17.08.2023 1:00pm Offline Campus	1.Ucchas 2.Tasniya 3.Ahad 4.Ananya	1.Starting the poster preparation.	1.Task 01: Everyone	
19.08.2023 1:00pm Offline Campus	1.Ucchas 2.Tasniya 3.Ahad 4.Ananya	1.Doing the poster preparation.	1.Task 01: Everyone	

20.08.2023 1:00pm Offline Campus	1.Ucchas 2.Tasniya 3.Ahad 4.Ananya	1.Doing the poster preparation.	1.Task 01: Everyone	
21.08.2023 1:00pm Offline Campus	1.Ucchas 2.Tasniya 3.Ahad 4.Ananya	1.Doing the poster preparation work.	1.Task 01: Everyone	
22.08.2023 2:00pm Offline Campus	1.Ucchas 2.Tasniya 3.Ahad 4.Ananya	1.Starting the poster preparation	1.Task 01: Everyone	
23.08.2023 3:00pm Offline Campus	1.Ucchas 2.Tasniya 3.Ahad 4.Ananya	1.Starting the poster preparation	1.Task 01: Everyone	
24.08.2023 3:00pm Offline Campus	1.Ucchas 2.Tasniya 3.Ahad 4.Ananya	1.Completing the poster and showing Tasfin sir. 2.Printing the poster.	1.Task 01: Tasfin Mahmud.	1.Sir gave some changes like alignment issues, picture adding.
25.08.2023 3:00pm Offline Campus	1.Ucchas 2.Tasniya 3.Ahad 4.Ananya	1.Reviewing the last-minute preparations.	1.Task 01: Everyone	

Mapping of CO-PO-Taxonomy Domain & Level- Delivery-Assessment Tool

Sl.	CO Description	PO	Bloom's Taxonomy Domain/Level	Assessment Tools
CO7	**Evaluate** the performance of the developed solution with respect to the given specifications, requirements and standards	d	Cognitive/ Evaluate	• Demonstration of working prototype • Project Progress Report on working prototype
CO8	**Complete** the final design and development of the solution with necessary adjustment based on performance evaluation	c	Cognitive/ Create	• Project Final Report • Final Presentation • Demonstration at FYDP Showcase
CO9	**Use** modern engineering and IT tools to design, develop and validate the solution	e	Cognitive/ Understand, Psychomotor/ Precision	• Project Final Report
CO10	**Conduct** independent research, literature survey and learning of new technologies and concepts as appropriate to design, develop and validate the solution	l	Cognitive/ Apply	• Project Final Report
CO11**	**Demonstrate** project management skill in various stages of developing the solution of engineering design project	k	Cognitive/ Apply Affective/ Valuing	• Project Final Report • Project Progress presentation at various stages
CO12	**Perform** cost-benefit and economic analysis of the solution	k	Cognitive/ Apply	• Project Final Report
CO13	**Apply** ethical considerations and professional responsibilities in designing the solution and throughout the project development phases	h	Cognitive/ Apply Affective/ Valuing	• Peer-evaluation, • Instructor's Assessment • Final Report
CO14**	**Perform** effectively as an individual and as a team member for successfully completion of the project	i	Affective/ Characterization	• Peer-evaluation • Instructor's Assessment

CO15**	**Communicate** effectively through writings, journals, technical reports, deliverables, presentations and verbal communication as appropriate at various stages of project development	j	Cognitive/ Understand Psychomotor/ Precision Affective/ Valuing	• Project Final Report • Progress Presentations, • Final Presentation • Demonstration at FYDP Showcase

Note: The double star (**) marked CO will be assessed at various stages of the project through indirect deliverables.