# IOT ENABLED ENERGY METER

**A MINOR PROJECT - II REPORT**

***Submitted by***


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| **SANJEEVADHARSH B R** | **927622BEC172** |
| **RANJITH S** | **927622BEC163** |
| **PRAAVIN O** | **927622BEC144** |


**BACHELOR OF ENGINEERING**

in

**DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING**

**M.KUMARASAMY COLLEGE OF ENGINEERING**

(Autonomous)

**KARUR – 639 113**

**MAY 2024**

# M.KUMARASAMY COLLEGE OF ENGINEERING, KARUR

## BONAFIDE CERTIFICATE

Certified that this 18ECP104L - **Minor Project II** report "**IOT ENABLED ENERGY METER**" is the bonafide work of **"SANJEEVADHARSH(927622BEC172), RANJITH(927622BEC163), PRAAVIN(927622BEC144),"** who carried out the project work under my supervision in the academic year 2023 -2024 - EVEN SEMESTER.

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|---|---|
| **SIGNATURE** | **SIGNATURE** |
| **Dr.A.KAVITHA B.E., M.E., Ph.D.,** | **Dr.R.KALAIARASAN M.E., Ph.D** |
| **HEAD OF THE DEPARTMENT,** | **SUPERVISOR,** |
| Professor, | Assistant Professor |
| Department of Electronics and | Department of Electronics and |
| Communication Engineering, | Communication Engineering |
| M.Kumarasamy College of Engineering, | M.Kumarasamy College of |
| Engineering, Thalavapalayam, | Engineering, Thalavapalayam, |
| Karur-639113. | Karur-639113. |

This report has been submitted for the **18ECP104L – Minor Project - II** final review held at M. Kumarasamy College of Engineering, Karur on _______________

**PROJECT COORDINATOR**

## INSTITUTION VISION AND MISSION

**Vision**

To emerge as a leader among the top institutions in the field of technical education.

**Mission**

**M1:** Produce smart technocrats with empirical knowledge who can surmount the global challenges.

**M2:** Create a diverse, fully -engaged, learner -centric campus environment to provide quality education to the students.

**M3:** Maintain mutually beneficial partnerships with our alumni, industry and professional associations.

## DEPARTMENT VISION, MISSION, PEO, PO AND PSO

**Vision**

To empower the Electronics and Communication Engineering students with emerging technologies, professionalism, innovative research and social responsibility.

**Mission**

**M1:** Attain the academic excellence through innovative teaching learning process, research areas & laboratories and Consultancy projects.

**M2:** Inculcate the students in problem solving and lifelong learning ability.

**M3:** Provide entrepreneurial skills and leadership qualities.

**M4:** Render the technical knowledge and skills of faculty members.

**Program Educational Objectives**

**PEO1: Core Competence:** Graduates will have a successful career in academia or industry associated with Electronics and Communication Engineering.

**PEO2: Professionalism:** Graduates will provide feasible solutions for the challenging problems through comprehensive research and innovation in the allied areas of Electronics and Communication Engineering.

**PEO3: Lifelong Learning:** Graduates will contribute to the social needs through lifelong learning, practicing professional ethics and leadership quality.

**Program Outcomes**

**PO 1: Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

**PO 2: Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

**PO 3: Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

**PO 4: Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

**PO 5: Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

**PO 6: The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

**PO 7: Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

**PO 8: Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

**PO 9: Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

**PO 10: Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

**PO 11: Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

**PO 12: Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Program Specific Outcomes**

**PSO1:** Applying knowledge in various areas, like Electronics, Communications, Signal processing, VLSI, Embedded systems etc., in the design and implementation of Engineering application.

**PSO2:** Able to solve complex problems in Electronics and Communication Engineering with analytical and managerial skills either independently or in team using latest hardware and software tools to fulfil the industrial expectations.

| Abstract | Matching with POs, PSOs |
|---|---|
| IOT, Smart Energy Meter | PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO8, PO9, PO10, PO11, PO12, PSO1, PSO2 |

# ACKNOWLEDGEMENT

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We offer our wholehearted thanks to our **Project Supervisor, Dr.R.Kalaiarasan,M.E., Ph.D., Assistant Professor,** Department of Electronics and Communication Engineering for his precious guidance, tremendous supervision, kind cooperation, valuable suggestions, and support rendered in making our project successful.

We would like to thank our **Minor Project Co-ordinator**, **Dr.K.Sivanandam, M.E., Ph.D., Associate Professor**, Department of Electronics and Communication Engineering for his kind cooperation and culminating in the successful completion of this project work. We are glad to thank all the Faculty Members of the Department of Electronics and Communication Engineering for extending a warm helping hand and valuable suggestions throughout the project. Words are boundless to thank our Parents and Friends for their motivation to complete this project successfully.

# ABSTRACT

The IoT-enabled Smart Energy Meter represents a cutting-edge solution for real-time monitoring and efficient management of energy consumption. Leveraging state-of-the-art Internet of Things (IoT) technology, this innovative device seamlessly integrates with various sensors and devices to capture comprehensive data on daily current usage. Notably, the system transcends traditional energy monitoring by establishing a dynamic connection to the cloud infrastructure. This connectivity facilitates the seamless transfer of data on a daily basis, empowering users with actionable insights into their energy usage patterns. Through the utilization of advanced cloud technology, our IoT-enabled Smart Energy Meter not only ensures accurate and timely data acquisition but also enables users to access and analyze their energy consumption trends with unparalleled convenience. This transformative solution heralds a new era in energy management, embodying efficiency, connectivity, and data-driven insights.

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## LIST OF ABBREVIATIONS

| ACRONYM | | ABBREVIATION |
|---|---|---|
| IOT | - | Internet Of Things |

# CHAPTER 1

## INTRODUCTION

### 1.1 BACKGROUND

The advent of the Internet of Things (IoT) heralds a transformative era, wherein uniquely identifiable objects are intricately interwoven into a sophisticated "internet-like" structure. This paradigm shift in technology has significantly impacted our daily lives, imbuing conventional objects with intelligence and automation. By fostering connectivity, IoT operates as an intelligent system, creating a universal global neural network of interconnected things.

As technology progresses, the influence of IoT extends into fundamental infrastructures such as electricity, gas, and water management systems, enhancing convenience for both individuals and organizations. This application aims to streamline control and management processes, effectively mitigating issues stemming from human error and manual efforts. In achieving this heightened level of sophistication, communication and networking play pivotal roles, tracking diverse connectivity among individual devices.

A specific area where this technological evolution proves is in the realm of electricity consumption monitoring. Currently, the manual reading and recording of meters present a laborious and time-consuming task. Recognizing this, the imperative is to transition towards automation, allowing users to effortlessly monitor energy meter readings. This paradigm shift not only simplifies the process but also ensures fair and accurate billing, aligning seamlessly with the evolving needs and expectations of customers.

# CHAPTER 2

## LITERATURE SURVEY

This system is designed for achieving complete automation in electricity billing. Its purpose is to gauge and oversee the electricity usage of consumers in a specific area, transmitting the consumption data to the station, and automatically generating the corresponding power consumption bill.

The implemented system that provides real-time pricing information for the electricity consumption of individual apartments in a complex. This approach has yielded improved outcomes, encouraging residents to use electricity more efficiently for economic reasons. The application utilizes analog meters to visualize power consumption.

Considerable effort was invested in developing a handheld, portable smart energy meter. The device employs wired digital meters to showcase the power consumption of individual compartments within the complex

# CHAPTER 3

## EXISTING SYSTEM

The existing system for the IoT-enabled energy meter involves conventional methods of energy monitoring and billing, typically reliant on manual meter reading practices. In this traditional framework, utility providers deploy electromechanical or digital energy meters to measure and record electricity consumption in residential and commercial buildings. These meters are periodically read by personnel who visit the premises, manually noting down the readings for billing purposes.

The manual nature of this process introduces several challenges. Firstly, it is time-consuming and labor-intensive, requiring frequent visits to various locations for meter readings. Additionally, human errors in data transcription can occur, leading to inaccuracies in billing. The lack of real-time data and communication capabilities further limits the ability to provide consumers with immediate insights into their energy usage patterns.

Moreover, the existing system faces challenges in addressing issues such as energy theft and ensuring an equitable tariff structure. The absence of advanced communication systems hampers the implementation of dynamic pricing models and the establishment of a bidirectional communication network between the utility provider and the consumers.

In summary, the current system relies on traditional metering methods, presenting limitations in terms of efficiency, accuracy, and the provision of real-time information to consumers. The integration of IoT technology in the energy meter aims to address these shortcomings by enabling real-time monitoring, automation, and improved communication capabilities.

# CHAPTER 4

## PROPOSED SYSTEM

The proposed IoT-enabled energy meter system aims to revolutionize the traditional energy monitoring and billing approach. The core component of this system is an intelligent energy meter embedded with IoT capabilities. Real-time energy consumption data is collected by the meter and seamlessly transmitted to the cloud for storage and analysis. Leveraging cloud-based analytics tools, the system processes real-time data to provide meaningful insights into energy consumption patterns, enabling personalized recommendations for optimization.

A key feature of the proposed system is the introduction of a daily billing mechanism. By utilizing the real-time data stored in the cloud, consumers receive accurate and up-to-date bills on a daily basis. This approach enhances transparency, allowing users to monitor their energy expenses in near-real time and make informed decisions about their consumption habits. The user-friendly interface, accessible through web or mobile applications, facilitates easy access to energy data, billing details, and personalized insights directly on users' mobile devices.

Automated alert mechanisms notify users of any unusual spikes in energy consumption or potential issues, enhancing user awareness and enabling prompt action. Additionally, the system generates energy efficiency recommendations based on the analyzed data. These recommendations are tailored to individual consumption patterns, empowering users to adopt sustainable practices and reduce their overall energy consumption. Overall, the proposed IoT-enabled energy meter system integrates advanced technology, cloud computing, and real-time analytics to enhance accuracy, efficiency, and user empowerment in energy management, with the added convenience of mobile accessibility

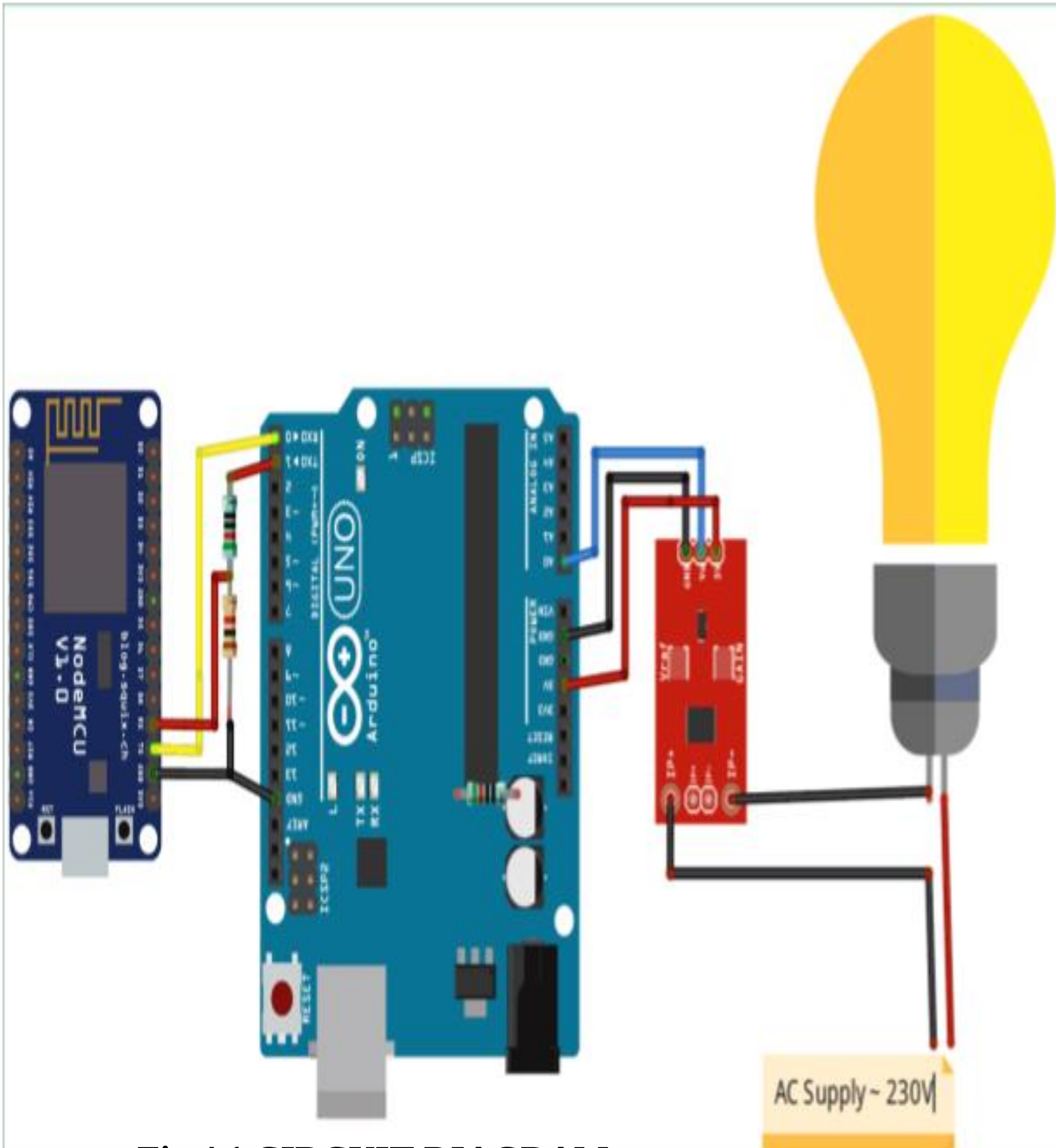



**Fig 4.1 CIRCUIT DIAGRAM**

# CHAPTER 5

## HARDWARE AND REQUIREMENTS

The hardware configuration for the IoT-enabled energy meter comprises essential components to enable real-time energy monitoring and data transmission. Key elements include the Arduino Uno microcontroller, ESP32 microcontroller, ZMPT101B voltage sensor, current sensor, and an I2C module with an integrated 16x2 display, with the address set at 0x27.

1. **ESP32 Microcontroller:**

   The ESP32 microcontroller serves a pivotal role in wireless communication, enabling seamless connectivity to the internet for cloud-based data storage and real-time transmission of energy consumption data.

2. **ZMPT101B Voltage Sensor**:

   The ZMPT101B voltage sensor precisely measures electrical potential difference in the system. Providing real-time voltage readings, this sensor is crucial for accurate power consumption calculations.

3. **Current Sensor:**

   The current sensor plays a key role in measuring the flow of electric current through the system, providing real-time current values for precise power consumption determination.

4. **I2C Module with 16x2 Display (Address: 0x27)**

The I2C module, combined with a 16x2 display, acts as the user interface for local data visualization. This display unit, set at address 0x27, offers immediate feedback to users by presenting relevant energy consumption metrics, enhancing user awareness and interaction with the system.

This comprehensive hardware configuration forms a robust foundation for the proposed IoT-enabled energy meter. The Arduino Uno and ESP32 microcontrollers collaborate to acquire, process, and transmit data. The ZMPT101B voltage sensor and current sensor contribute critical electrical parameters, while the I2C module with an integrated 16x2 display provides a user-friendly interface for on-the-spot data visualization. Together, these hardware components create an efficient platform for real-time energy monitoring, aligning with the objectives of the research paper

## 5ARDUINO UNO

The Arduino Uno microcontroller, a linchpin in the architecture of the IoT-enabled energy meter system, serves as the central intelligence unit for data acquisition, processing, and local display. Renowned for its versatility, ease of programming, and extensive community support, the Arduino Uno provides a solid foundation for interfacing with various sensors and modules crucial to energy monitoring.

With a rich set of features, including analog and digital input/output pins, the Arduino Uno seamlessly integrates with essential components like the ZMPT101B voltage sensor and current sensor. This integration is facilitated through pins such as A0 (analog input), allowing for precise measurement of electrical parameters. The analog pins, including A0, enable accurate analog voltage readings crucial for real-time energy consumption data.

The Arduino Uno is programmed to execute sophisticated algorithms for real-time data analysis, interpreting sensor data received through pins like A0 and others. These algorithms contribute to the local processing of information before transmission to the ESP32 microcontroller, enhancing overall system responsiveness and computational efficiency.

Furthermore, the Arduino Uno orchestrates the integration with the I2C module and the 16x2 display, set at address 0x27. The various pins, including VIN (voltage input), GND (ground), and the analog pins, facilitate the connection and communication between the microcontroller and the display unit.

In collaboration with the ESP32 microcontroller, the Arduino Uno establishes seamless communication protocols using pins like TX (transmit) and RX (receive), ensuring the efficient exchange of data between the local processing unit and the cloud-based storage system. Its firmware is meticulously developed and optimized to handle tasks related to sensor interfacing, data processing, and communication protocols.

In summary, the Arduino Uno stands as a cornerstone in the IoT-enabled energy meter system, providing the computational power, flexibility, and interface capabilities essential for accurate, real-time energy monitoring. Its rich array of pins, including VIN, GND, A0, TX, and RX, contribute to the success of the proposed energy management solution, making it an indispensable component in the pursuit of efficient and sustainable energy consumption practices

**5.1. ARDUINO UNO**

# CHAPTER 6

## WORKING PRINCIPLE

The IoT-enabled energy meter system operates on a sophisticated yet user-friendly working principle, seamlessly integrating hardware components, microcontrollers, and cloud-based technologies. The following steps elucidate the system's working mechanism:

**1. Data Acquisition:**

The process begins with the Arduino Uno, equipped with analog and digital pins, interfacing with the ZMPT101B voltage sensor and current sensor. These sensors, connected to specific pins like A0 (analog input), precisely measure electrical parameters such as voltage and current.

**2. Sensor Calibration:**

The Arduino Uno executes calibration routines to fine-tune the readings from the ZMPT101B voltage sensor and the current sensor. This ensures accurate and reliable measurements, aligning the system with real-world electrical values.

**3. Local Processing and Display:**

Using its computational capabilities, the Arduino Uno processes the acquired sensor data in real-time. Algorithms interpret the information, generating energy consumption metrics. The processed data is then displayed on the 16x2 display, providing users with immediate insights into their energy usage patterns.

**4. Communication with ESP32:**

The Arduino Uno collaborates with the ESP32 microcontroller, establishing seamless communication protocols through pins like TX (transmit) and RX (receive). The ESP32 acts as the bridge between the local processing unit and the cloud-based storage system.

**5. Wireless Data Transmission:**

Leveraging its integrated Wi-Fi capabilities, the ESP32 securely transmits processed energy consumption data to a cloud platform for storage and analysis. This enables real-time monitoring and historical tracking of energy usage patterns.

**6. Cloud-Based Analytics:**

In the cloud, the energy consumption data undergoes further analysis using advanced algorithms. Cloud-based analytics provide comprehensive insights, revealing consumption patterns, identifying trends, and facilitating personalized recommendations for energy optimization.

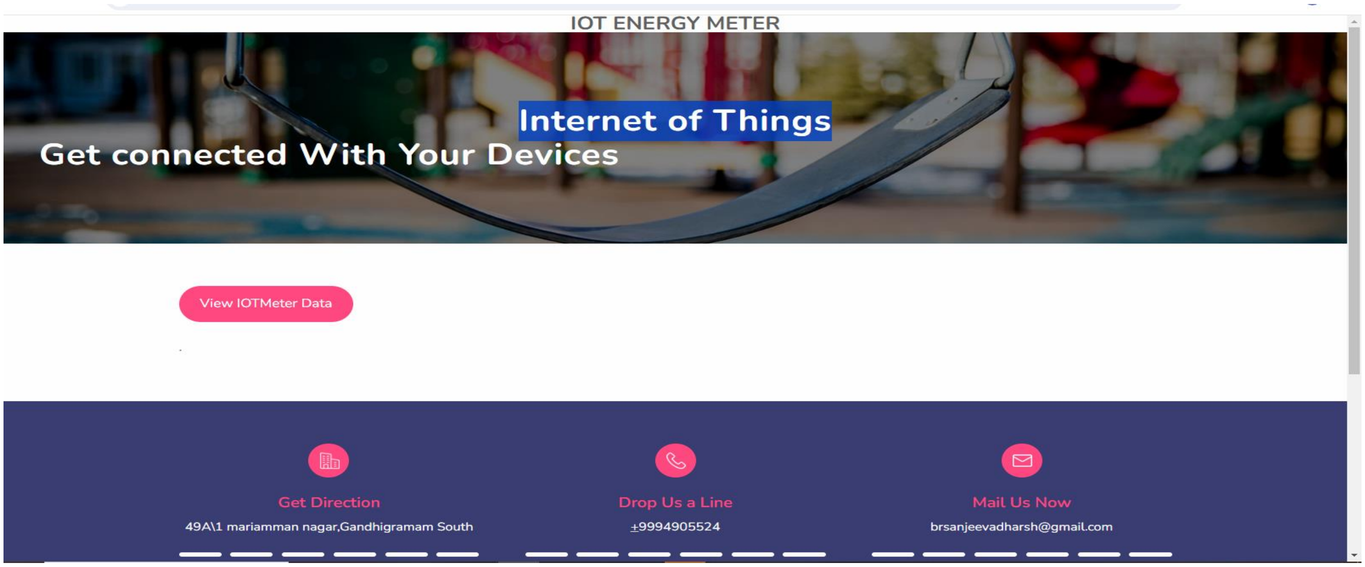
**7. User Interaction and Alerts:**

Users can interact with the system through mobile or web applications, accessing real-time energy consumption data. Automated alerts notify users of unusual spikes in usage, enabling prompt actions to optimize energy consumption.

In summary, the working principle of the IoT-enabled energy meter system involves precise sensor data acquisition, local processing, wireless transmission, cloud-based analytics, and user interaction. This integrated approach provides a comprehensive solution for real-time energy monitoring and optimization.

# CHAPTER 7

# RESULTS AND DISCUSSION




Our cutting-edge website, designed using the versatile WordPress platform, serves as the central hub for monitoring and managing IoT-enabled energy systems. Seamlessly integrating the robust capabilities of Firebase, Google's premier cloud service, the site provides real-time data visualization and analytics, empowering users with actionable insights into their energy consumption patterns. Leveraging WordPress's extensive customization options ensures a user-friendly interface, while Firebase's cloud infrastructure guarantees secure, scalable, and efficient data storage and retrieval. This fusion of technologies not only enhances the user experience but also ensures the reliability and performance essential for modern energy management solutions. The website's responsive design ensures accessibility across all devices, making it a pivotal tool for both individual users and large-scale energy providers looking to optimize their energy efficiency.

The infusion of IoT technology into the energy meter landscape introduces advanced functionalities that transcend conventional capabilities. These include dynamic load scheduling, adept overcurrent detection mechanisms, and the establishment of seamless communication channels among interconnected devices. This confluence of features positions IoT-based smart energy meters at the forefront of innovation, amplifying their impact on energy management

# CONCLUSION AND FUTURE SCOPE

In conclusion, the implementation of IoT-enabled energy meters signifies a remarkable stride toward a future characterized by heightened energy awareness and optimized consumption practices. The real-time monitoring capabilities and remote accessibility provided by these smart meters empower users, fostering a culture of informed and efficient energy usage.

Anticipating the road ahead, the integration of machine learning into IoT energy meter systems holds tremendous potential. The synergy between IoT and machine learning technologies is poised to elevate energy management to unprecedented levels of sophistication. Machine learning algorithms, delving into intricate patterns within energy consumption data, promise nuanced insights beyond the reach of traditional monitoring systems.

As we peer into this visionary future, the amalgamation of IoT and machine learning in energy meters is expected to revolutionize not only how we monitor but also how we optimize and predict energy usage. The convergence of these technologies will facilitate adaptive learning, enabling systems to evolve and provide tailored recommendations based on individual consumption patterns.

In essence, the journey doesn't culminate here; it extends into a realm where IoT energy meters, enriched by machine learning capabilities, become not just tools for monitoring but indispensable companions in our pursuit of sustainable and intelligent energy consumption. The future is poised for innovation, and the incorporation of IoT and machine learning in energy management will undoubtedly be a cornerstone of that transformative evolution

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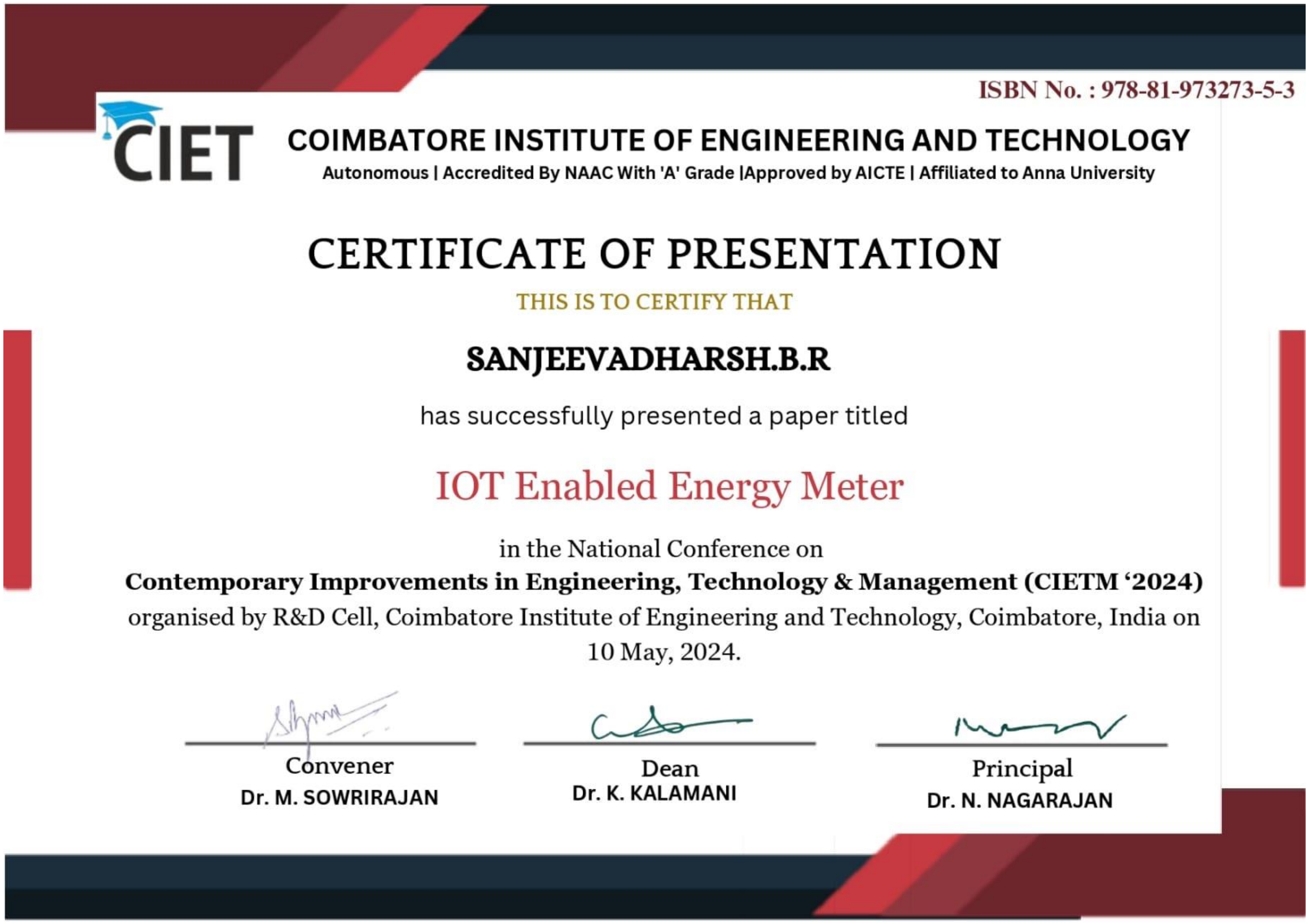

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has successfully presented a paper titled

IOT Enabled Energy Meter

in the National Conference on

**Contemporary Improvements in Engineering, Technology & Management (CIETM '2024)**

organised by R&D Cell, Coimbatore Institute of Engineering and Technology, Coimbatore, India on 10 May, 2024.

| Convener | Dean | Principal |
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| **Dr. M. SOWRIRAJAN** | **Dr. K. KALAMANI** | **Dr. N. NAGARAJAN** |

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in the National Conference on

**Contemporary Improvements in Engineering, Technology & Management (CIETM '2024)**

organised by R&D Cell, Coimbatore Institute of Engineering and Technology, Coimbatore, India on 10 May, 2024.

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**PRAAVIN.O**

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in the National Conference on
**Contemporary Improvements in Engineering, Technology & Management (CIETM '2024)**
organised by R&D Cell, Coimbatore Institute of Engineering and Technology, Coimbatore, India on 10 May, 2024.

| Convener | Dean | Principal |
|---|---|---|
| **Dr. M. SOWRIRAJAN** | **Dr. K. KALAMANI** | **Dr. N. NAGARAJAN** |

## IOT ENABLED ENERGY METER

Sanjeevadharsh B, R,Kalaiarasan, R,Ranjith, S,Praavin O
Electronics and Communication Engineering Department,
M. Kumarasamy College of Engineering,
Karur

**Abstract**—A critical aspect in achieving this objective lies in the precise absence of full duplex transmission capability. To surmount this Efficient energy utilization within the power system access and analysis by both producers and consumers, facilitating challenge, this study proposes an Internet of Things (IoT)-enabled collected data is subsequently transmitted to the cloud for facile current sensors in conjunction with an ESP8266 12E Wi-Fi employed, supplemented by FRAM as the storage medium. This energy meter technologies encounter constraints, notably the holistic approach presents a robust solution for efficient energy is imperative for the advancement of the smart grid paradigm. management within the smart grid infrastructure. module for data management and energy usage computation. The monitoring and control of energy consumption. However, extant smart energy meter system. This system integrates voltage and streamlined energy consumption analytics. Moreover, to augment the system's capabilities, an Arduino Uno microprocessor is Index

**Keyword** —Smart grid,Energy utilization,Energy meter,Fullduplex transmission,Internet of Things (IoT)

## AI FOR STUDENT PERFORMANCE PREDICTION: A COMPARATIVE ANALYSIS

Mr. Shakthivel, Assistant Professor
Department of Computer Science and Engineering
Erode Sengunthar Engineering College Thudupathi, Tamilnadu

Ms. K. Sobiya Agneeshwari, Ms. M. Rithikadevi
Department of Computer Science and Engineering
Erode Sengunthar Engineering College Thudupathi, Tamilnadu

**Abstract** - In recent years, the application of artificial intelligence (AI) in education has gained significant attention due to its potential to revolutionize student learning outcomes. One crucial aspect of AI in education is its ability to predict student performance, which can helpeducators identify at-risk students early and provide personalized interventions. This paper presents a comparative analysis of different AI techniques used for student performance prediction. The study reviews several AI models, including machine learning algorithms such as decision trees, random forests, support vector machines, and neural networks, applied to student performance datasets. Various features such as demographics, past academic records, and behavioural data are considered to train and evaluate these models. Key findings highlight the effectiveness of certain AI methods over others in accurately predicting student outcomes. Factors influencing prediction accuracy, such as dataset quality, feature selection, and model complexity, are discussed. Additionally, the study explores the ethical implications of using AI for student performance prediction and suggests guidelines for responsible implementation Overall, this research contributes to the growing body of knowledge on AI applications in education and provides insights into best practices for leveraging AI to enhance student success. This abstract captures the essence of a research paper focused on the use of AI for predicting student performance in educational settings.

**Keywords** - Student performance prediction, Machine learning, predictive modeling Educational data mining,