IARE
INSTITUTE OF
AERONAUTICAL ENGINEERING

HIGH IMPACT PRACTICES (HIPS)

CORNERSTONE PROJECTS (CoPs)

INFORMATION PACKET

2025 - 2026

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25 YEARS
2000 2025

I appreciate your interest in the Cornerstone Project (CoP), Department of Electronics and Communication Engineering at the Institute of Aeronautical Engineering!

A **cornerstone project (CoP)** is typically introduced during the early or middle stages of an academic program at the Institute of Aeronautical Engineering. It focuses on helping students build foundational skills and understand how to apply basic concepts to real-world scenarios. These projects are usually smaller in scope, moderately complex, and designed to strengthen practical understanding of core subjects.

These projects encourage students to connect theoretical learning to data-centric applications, such as developing the data learning model, performing simple data analysis, or creating prototype engineering solutions. Emphasis is placed on learning by doing, helping students build confidence in applying methods like data preprocessing, statistical analysis, basic modeling, and reporting results. By working on these projects, students begin to understand how engineering and data science principles apply in real-world scenarios. Ultimately, cornerstone projects act as the foundation of experiential learning at IARE, transitioning students from passive learners to active problem-solvers, equipped with both technical skills and professional behaviors necessary for the challenges of advanced engineering education.

Cornerstone Project (CoP) teams are:

- Collaborative Project – This is an excellent opportunity for students who are committed to working towards social developments and emerging needs.
- Project Activity – The project coordinator listed current working areas for offering cornerstone projects with a team size of at least two students. The coordinator allotted mentors based on the work area and facilitated exclusive project laboratories for selected cornerstone project (CoP)students. This cornerstone project (CoP)bridges the gap between academic learning and real-world social applications. It helps enhance the professional development
- Short-term - Each undergraduate student may participate in a project for an assigned period.

The primary goal of cornerstone projects in Electronics and Communication Engineering is to provide a balanced platform of technical complexity, innovation, and interdisciplinary learning that allows students to gain hands-on experience across core ECE domains.

- **Simulate real-world engineering environments** – Familiarize students with the lifecycle of electronics and communication systems design, testing, and deployment, aligned with industry practices and standards.
- **Encourage cross-domain application of ECE concepts** – Promote the integration of electronics, signal processing, embedded systems, and communication principles into sectors like healthcare, transportation, automation, energy, and defense.
- **Promote responsible engineering and sustainability** – Instil a strong foundation in ethical engineering, safety standards, and environmentally conscious design throughout project execution.
- **Support data-driven and intelligent systems** – Encourage the use of AI, IoT, and real-time data processing techniques to design smart systems that enhance automation, monitoring, and decision-making.
- **Foster hands-on system-level project experience** – Engage students in projects involving the complete design flow: from circuit design, simulation, prototyping, to final validation using tools like MATLAB, LabVIEW, HDL, or Arduino/Raspberry Pi.
- **Build strong engineering portfolios** – Help students develop industry-ready portfolios showcasing innovation, practical skills in hardware/software co-design, and impactful solutions to engineering challenges.
- **Bridge theoretical learning with practical hardware/software integration** – Translate academic concepts into real-world applications through design, implementation, and testing of communication protocols, embedded systems, and VLSI circuits.
- **Incorporate emerging ECE technologies** – Encourage exploration of advanced topics such as 5G/6G, edge computing, software-defined radio, wearable electronics, and autonomous systems to remain aligned with future industry trends.

Cornerstone Projects (CoPs) focuses on the challenges presented by the Sustainable Development Goals (SDGs)

Sustainability Development Goals (SDGs) for the Dept. of ECE, IARE	
SDG 4	Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
SDG 8	Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
SDG 9	Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
SDG 12	Ensure sustainable consumption and production patterns

Themes of Cornerstone Projects (CoPs) for the Electronics and Communication Engineering:

The following project domains are recommended for cornerstone projects (CoPs), and the students should frame the problem statements from any one of the following themes:

1. Design and Development of an IoT-Enabled Precision Agriculture Monitoring System for Real-Time Analysis of Soil Moisture, pH Levels, and Ambient Temperature Using Wireless Sensor Networks and Cloud Integration **(SDG #8, SDG #9, SDG #12)**

2. Implementation of an IoT-Based Smart Energy Meter for Real-Time Power Consumption Monitoring, Instant Usage Alerts, and Remote Load Control via GSM and Cloud Services **(SDG #9, SDG #12)**

3. Design and Deployment of a Smart Waste Bin Monitoring System Using IoT Sensors and GSM Communication for Real-Time Tracking, Overflow Alerts, and Optimized Municipal Waste Collection **(SDG #9, SDG #12)**

4. Design and Deployment of a Smart Agriculture System Using IoT and LoRaWAN Communication(**SDG #8, SDG #9, SDG #12)**

5. Design and Deployment of a Smart Urban Traffic Monitoring & Control System Using IoT and 5G**(SDG #9, SDG #12)**

In order to participate in cornerstone projects, you must formally apply and be accepted by the project coordinator. To proceed, please mail to the project coordinator, Dr. P Munaswamy (p.munaswamy@iare.ac.in), Head of Electronics and Communication Engineering (ECE). This will bring up all available open positions tagged as cornerstone projects.
Please note that participation by the cornerstone project (CoP)team requires registration for the accompanying project work from any of the specified domains. More information will be provided to all selected cornerstone project (CoP)applicants who have been offered a position.

If you have any questions about a particular team, please contact the faculty mentor.
We encourage you to contemplate this fascinating new opportunity. We look forward to receiving your application submission!

Design and Development of an IoT-Enabled Precision Agriculture Monitoring System for Real-Time Analysis of Soil Moisture, pH Levels, and Ambient Temperature Using Wireless Sensor Networks and Cloud Integration

Dr. V R Seshagiri Rao, Assistant Professor, ECE, Faculty Mentor

GOALS

The primary goal of this project is to develop a smart, IoT-enabled precision agriculture system capable of continuously monitoring key environmental and soil parameters such as soil moisture, pH levels, and ambient temperature. By integrating wireless sensor networks (WSNs), the system aims to collect real-time data from the field and relay it to a centralized cloud platform. This continuous flow of data enables farmers and agronomists to make informed decisions regarding irrigation, fertilization, and crop management, ultimately leading to improved productivity and resource efficiency.

A key objective is to reduce water and chemical usage by enabling data-driven practices through real-time analysis. The system will automate data acquisition and provide alerts or recommendations when soil conditions fall outside of optimal ranges. This not only helps prevent over-irrigation or under-fertilization but also enhances crop health by maintaining ideal soil conditions. The platform will be designed to be user-friendly and accessible via mobile or web applications to support remote monitoring and control.

Another important goal is to create a scalable and cost-effective solution that can be easily adapted to different crop types, land sizes, and climatic conditions. The modular design of sensors and wireless nodes will ensure flexibility and ease of maintenance. In the long term, the system can contribute to sustainable farming practices by conserving resources, reducing environmental impact, and enabling precision agriculture techniques even in rural and underserved farming communities.

METHODS & TECHNOLOGIES

Cornerstone Project (CoP) team will focus on IoT-Enabled Precision Agriculture Monitoring System for Real-Time Analysis of Soil Moisture, pH Levels, and Ambient Temperature Using Wireless Sensor Networks and Cloud Integration:

Sensor Deployment:

Utilizes soil moisture sensors, pH sensors, and temperature sensors to gather real-time data from the agricultural field.

Microcontroller Unit (MCU):

Employs microcontrollers such as Arduino, ESP32, or Raspberry Pi to collect, process, and transmit sensor data.

Wireless Communication:

Implements wireless protocols like Wi-Fi, Zigbee, or LoRa for transmitting data from sensors to the cloud platform, depending on range and power needs.

Cloud Integration:
Uses IoT platforms such as Thing Speak, Blynk, or Firebase for real-time data storage, visualization, analysis, and alert generation.
Remote Monitoring Interface:
Provides a web or mobile dashboard to allow farmers to monitor field data, receive notifications, and make timely decisions from anywhere.
Power Supply Solutions:
Integrates solar panels or rechargeable battery modules to ensure continuous operation, especially in remote or rural locations.

RESEARCH, DESIGN, & TECHNICAL ISSUES

Cornerstone Project (CoP) team should be interested in the following majors or areas of interest: IoT-Enabled Precision Agriculture Monitoring System for Real-Time Analysis of Soil Moisture, pH Levels, and Ambient Temperature Using Wireless Sensor Networks and Cloud Integration

Sensor Calibration and Accuracy: Soil moisture, pH, and temperature sensors require frequent calibration to ensure accurate and reliable readings across different soil types and environmental conditions.
Wireless Communication Reliability: Long-range data transmission in large or remote farms can face signal interference, range limitations, or packet loss, especially with Wi-Fi or Zigbee.
Power Management:
Ensuring uninterrupted power supply using solar or battery solutions is a challenge in remote fields, especially during cloudy or rainy weather.
Cloud Connectivity and Downtime: System performance depends on stable internet access; cloud service outages or poor connectivity may disrupt data upload or user alerts.
Data Overload and Storage: Continuous data logging from multiple sensors can lead to large volumes of data, requiring efficient storage and processing strategies.

MAJORS & AREAS OF INTEREST

Cornerstone Project (CoP) team interested in from the following majors or areas of interest:
Relevant Disciplines and Core Competency Development
Electronics and Communication Engineering (ECE)
Computer Science and Engineering (CSE),Agricultural Engineering
Embedded Systems and IoT
Environmental and Resource Management

MENTOR CONTACT INFORMATION

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Implementation of an IoT-Based Smart Energy Meter for Real-Time Power Consumption Monitoring, Instant Usage Alerts, and Remote Load Control via GSM and Cloud Services.

Dr. V R Seshagiri Rao, Assistant Professor, ECE, Faculty Mentor

GOALS

The primary goal of this project is to design and implement an intelligent energy monitoring system that provides real-time insights into electrical power consumption. By using an IoT-enabled smart energy meter, users can continuously track electricity usage at home or in commercial spaces. This visibility helps in identifying energy usage patterns, detecting wastage, and promoting efficient energy management practices, ultimately leading to cost savings and better control over energy consumption.
Another important objective is to enable **instant alerts and remote access** through **GSM communication** and **cloud integration**.

The system is designed to send usage alerts when consumption exceeds set thresholds or when abnormalities are detected. These alerts can help users take timely action to prevent overload, reduce energy waste, and enhance electrical safety. Cloud services are used to store consumption data, generate usage reports, and support mobile or web-based dashboards for user interaction.

The project also focuses on enabling **remote load control**, allowing users to switch appliances on or off from a distance. This feature is especially useful in smart home applications or for managing unattended equipment in offices and industries. The system is built with scalability and low-cost deployment in mind, making it suitable for residential, commercial, and rural power management scenarios. It also serves as a foundation for advanced energy analytics and integration with smart grids in the future.

METHODS & TECHNOLOGIES

Cornerstone Project (CoP) team will focus on Tools and Techniques for an IoT-Based Smart Energy Meter for Real-Time Power Consumption

- **Current and Voltage Sensors (e.g., CT sensors, ACS712)**

Used to measure power consumption accurately in real time.

- **Microcontroller Unit (e.g., ESP32, Arduino, NodeMCU)**

Processes sensor data and handles wireless communication with cloud and GSM modules.

- **GSM Module (e.g., SIM800L or SIM900A)**

Enables remote alerting and control through SMS or mobile networks without internet dependency.

- **Cloud IoT Platforms (e.g., Blynk, ThingSpeak, Firebase)**

Used for data storage, visualization, and remote monitoring of energy usage.

- **Mobile/Web Dashboard Interfaces**

Allow users to track consumption, receive alerts, and control loads via smartphones or browsers.

- **Relay Module or Smart Switch**

Used for remote load control—turning electrical appliances on/off through the IoT system.

- **Embedded Programming Tools (e.g., Arduino IDE, PlatformIO)**

Used for coding and uploading firmware to microcontrollers for data handling and device control.

RESEARCH, DESIGN, & TECHNICAL ISSUES

Cornerstone Project (CoP) team should be interested in the following majors or areas of interest: Challenges in IoT-Based Smart Energy Meter for Real-Time Power Consumption Monitoring, Instant Usage Alerts, and Remote Load Control via GSM and Cloud Services**.**

E**lectronics and Communication Engineering (ECE)**
Focuses on sensor interfacing, circuit design, analog-to-digital conversion, and GSM module integration for communication.

Computer Science and Engineering (CSE)
Involves cloud computing, IoT data management, backend dashboard development, and secure data transmission protocols.

Electrical Engineering
Addresses challenges in accurate power measurement, load switching mechanisms, and safety of electrical systems.

Embedded Systems and IoT
Centers on real-time data acquisition, firmware development, device-to-cloud communication, and system optimization.

MAJORS & AREAS OF INTEREST

Cornerstone Project (CoP) team interested in from the following majors or areas of interest: Technical Domains and Career-Aligned Skill Areas

Electronics and Communication Engineering (ECE)
Electrical and Power Engineering
Computer Science and Engineering (CSE)
Embedded Systems and Internet of Things (IoT)
Smart Energy Management and Automation

MENTOR CONTACT INFORMATION

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Design and Deployment of a Smart Waste Bin Monitoring System Using IoT Sensors and GSM Communication for Real-Time Tracking, Overflow Alerts, and Optimized Municipal Waste Collection

Dr. J Mohan, Professor, ECE, Faculty Mentor

GOALS

The primary goal of the *Smart Waste Bin Monitoring System* is to revolutionize urban waste management by leveraging IoT and GSM communication for real-time tracking, timely overflow alerts, and optimized collection schedules. Traditional waste collection systems often suffer from inefficiencies such as overflowing bins, irregular collection, and excessive resource usage. This project aims to address these challenges through automation, data-driven decision-making, and remote monitoring.

Using ultrasonic or infrared level sensors, the smart bin continuously monitors fill levels and transmits data via GSM modules to a centralized dashboard or mobile application. This enables real-time updates and alerts to municipal authorities or sanitation workers when bins are nearing capacity, reducing incidents of public littering and health hazards.

An equally critical goal is to enable route optimization for waste collection vehicles by identifying only those bins that need servicing. This results in reduced fuel consumption, lower operational costs, and minimal traffic disruption. The project also envisions integrating solar power for energy autonomy, ensuring functionality in areas with limited electricity access.

Additionally, the system promotes data analytics for waste generation trends, aiding urban planners in designing more sustainable waste infrastructure. Ultimately, this solution aligns with SDG 11 (Sustainable Cities and Communities) and SDG 9 (Industry, Innovation, and Infrastructure) by fostering cleaner, smarter, and more efficient urban environments.

METHODS & TECHNOLOGIES

Cornerstone Project (CoP) team will focus on core methods and technologies for the Smart Waste Bin Monitoring System Using IoT Sensors and GSM Communication:

- IoT Sensor Integration – Ultrasonic or infrared sensors for real-time bin fill-level detection and threshold-based overflow alerts.
- Microcontroller Platforms – Use of Arduino, ESP32, or Raspberry Pi for local data processing and sensor interfacing.
- GSM Communication – SIM800/900 modules for SMS-based or GPRS data transmission to central monitoring systems.
- Cloud Data Management – Firebase, AWS IoT Core, or ThingSpeak for data storage, remote access, and visualization.
- Real-time Alert Systems – Implementation of SMS or mobile push notifications to municipal workers upon overflow detection.
- Dashboard Interfaces – Web dashboards using Node-RED, Grafana, or Python Flask for live bin status monitoring and analytics.
- Route Optimization Algorithms – Greedy algorithms or Dijkstra's algorithm for planning shortest waste collection paths.
- Power Management – Integration of solar panels and low-power modes for sustainable and autonomous system operation.
- Enclosure Design – Weatherproof, vandal-resistant enclosures using 3D-printed or

recycled materials.
- Data Analytics & Reporting – Use of Python (Pandas, Matplotlib) or Power BI for tracking waste patterns and system performance over time.

RESEARCH DESIGN, & TECHNICAL ISSUES

Cornerstone Project (CoP) team interested in the following majors or areas of interest should consider these challenges and design aspects while building a Smart Waste Bin Monitoring System Using IoT Sensors and GSM Communication:

- Reliable Fill-Level Detection – Ensuring accurate measurement of waste levels using ultrasonic or IR sensors under varying waste types and conditions.
- Sensor Calibration and Maintenance – Addressing sensor drift, false readings, or sensor blockage due to irregular waste shapes or moisture.
- Power Management – Designing energy-efficient systems with long battery life or solar charging for continuous operation.
- Robust Enclosure Design – Creating weatherproof and tamper-resistant housings to protect electronics in outdoor, urban environments.
- GSM Network Coverage – Handling connectivity issues in areas with weak cellular signal and implementing fallback mechanisms.
- Data Synchronization and Latency – Minimizing delays in real-time data transmission and ensuring consistency across all monitored bins.
- Scalability and Load Management – Building architectures that support a growing number of bins across city zones without performance degradation.
- Secure Communication – Implementing encryption and authentication protocols to prevent tampering and ensure data integrity.

MAJORS & AREAS OF INTEREST

Cornerstone Project (CoP) team interested in the following majors or areas of interest will develop relevant skills and interdisciplinary expertise through the execution of the Smart Waste Bin Monitoring System Using IoT Sensors and GSM Communication project:

- Embedded Systems and IoT Engineering – Sensor integration, microcontroller programming (e.g., Arduino, ESP32), and real-time data acquisition.
- Telecommunication & Networking – GSM-based communication systems, SIM800 module interfacing, and low-power data transmission protocols.
- Environmental and Urban Engineering – Smart city infrastructure, waste management systems, and sustainable urban planning.
- Computer Science & Software Development – Backend logic, cloud database management, and full-stack web/dashboard development.
- Data Analytics & Visualization – Real-time monitoring, anomaly detection, trend analysis, and GIS-based bin location mapping.

MENTOR CONTACT INFORMATION

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Design and Deployment of a Smart Agriculture System Using IoT and LoRaWAN Communication

Dr. J Mohan, Professor, ECE, Faculty Mentor

GOALS

To develop a smart agriculture monitoring system that uses IoT sensors to track soil moisture, temperature, and humidity in real-time.To implement **LoRaWAN** (Long Range Wide Area Network) for wireless communication over large farmlands with minimal power usage.To reduce water wastage, improve crop health, and optimize resource usage through data-driven decisions.

METHODS & TECHNOLOGIES

Cornerstone Project (CoP) team will focus on core methods and technologies for the Smart Agriculture System Using IoT and LoRaWAN Communication

- **IoT Sensors**: DHT11 for temperature & humidity, capacitive soil moisture sensors.
- **Microcontrollers**: Arduino Uno/Nano or ESP32 (for integrated Wi-Fi).
- **LoRaWAN Modules**: RFM95 or SX1278 for low-power, long-range data transmission.
- **Gateway**: LoRa gateway connected to a cloud server via Wi-Fi/4G.
- **Cloud Platform**: Thingspeak, AWS IoT, or Firebase to store, visualize, and analyze data.
- **Mobile App/Web Interface**: Developed using Flutter or ReactJS for real-time monitoring.

RESEARCH DESIGN & TECHNICAL ISSUES

Cornerstone Project (CoP) team interested in the following majors or areas of interest should consider these challenges and design aspects while building a Smart Agriculture System Using IoT and LoRaWAN Communication

- **Sensor Deployment**: Install sensors across different zones of the field.
- **Node Communication**: Use LoRa-enabled nodes to collect and transmit data to a central gateway.
- **Cloud Storage**: Data from the gateway is pushed to the cloud platform for analysis.
- **Decision System**: Based on thresholds (e.g., low moisture), trigger irrigation or send alerts.
- **User Interface**: Dashboard for farmers to view data and receive actionable recommendations.
- **Power Management**: Ensuring long battery life for remote sensor nodes**.**
- **Data Integrity**: LoRa has low data rates; may cause delays or packet losses.
- **Range Limitations**: Terrain and obstacles may reduce signal quality.
- **Sensor Calibration**: Environmental factors may affect sensor accuracy over time.

MAJORS & AREAS OF INTEREST

Cornerstone Project (CoP) team interested in the following majors or areas of interest will develop relevant skills and interdisciplinary expertise through the execution of the Smart Agriculture System Using IoT and LoRaWAN Communication

- **Majors**: Electronics & Communication Engineering, IoT Engineering, Agricultural Technology.
- **Areas**: Wireless sensor networks, embedded systems, sustainable farming, precision agriculture, cloud computing.

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Design and Deployment of a Smart Urban Traffic Monitoring & Control System Using IoT and 5G

Dr. J Mohan, Professor, ECE, Faculty Mentor

GOALS

To design a real-time traffic monitoring and control system for smart cities using IoT and high-speed 5G communication.To reduce traffic congestion, manage emergency vehicle routes, and improve urban mobility.

METHODS & TECHNOLOGIES

- **IoT Devices**: Cameras, IR vehicle counters, RFID readers at intersections.
- **Edge Computing**: NVIDIA Jetson Nano or Raspberry Pi 4 for real-time video processing at intersections.
- **Communication**: Use **5G** or **NB-IoT** for ultra-low latency transmission of traffic data.
- **Cloud Integration**: Azure or AWS for big data processing, analytics, and AI predictions.
- **AI Algorithms**: YOLO (You Only Look Once) for vehicle detection, CNNs for traffic pattern analysis.
- **Dashboard**: Real-time traffic status visualization with alert features.

DESIGN,&TECHNICAL ISSUES

Cornerstone Project (CoP) team interested in the following majors or areas of interest should consider these challenges and design aspects while building a Smart Urban Traffic Monitoring & Control System Using IoT and 5G

- **Smart Node Setup**: Install smart cameras and IR counters at major junctions.
- **Data Capture**: Real-time vehicle detection and traffic flow measurement.
- **Data Transmission**: Use 5G to send high-speed data to cloud servers.
- **Processing & Response**: AI-based algorithm decides traffic light durations and emergency vehicle prioritization.
- **Control Feedback**: Signal controllers are dynamically updated based on analytics.
- **Bandwidth Requirements**: High data demand due to real-time video streaming.
- **Latency Constraints**: Requires extremely low delay for traffic signal decisions.
- **Edge AI Challenges**: Limited computing power in edge devices may limit accuracy.
- **Infrastructure Costs**: High cost for deploying 5G and smart nodes at city scale.

MAJORS & AREAS OF INTEREST

Cornerstone Project (CoP) team interested in the following majors or areas of interest will develop relevant skills and interdisciplinary expertise through the execution of the Smart Urban Traffic Monitoring & Control System Using IoT and 5G

- **Majors**: Computer Science, Electrical Engineering, AI & Data Science, Communication Systems.
- **Areas**: Smart cities, vehicular networks, real-time systems, machine learning, 5G technologies.

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