IARE
INSTITUTE OF
AERONAUTICAL ENGINEERING

HIGH IMPACT PRACTICES (HIPS)

INFRASTRUCTURE AND TECHNOLOGY ENGINEERING

INFORMATION PACKET

2025 - 2026

INSTITUTE OF AERONAUTICAL ENGINEERING

25 YEARS 2000 2025

I appreciate IARE students who are showing interest in the Civil Infrastructure and Technology Engineering (CITE) Project Program at the Institute of Aeronautical Engineering.

A CITE Project is undertaken during the final stage of an academic program at the Institute of Aeronautical Engineering and serves as the pinnacle of a student's learning journey. It challenges students to integrate and apply the concepts, skills, and professional practices acquired throughout their coursework to solve real-world, industry-relevant problems. These projects are larger in scope, more complex, and demand advanced technical expertise, innovation, and multidisciplinary collaboration.

Projects emphasize end-to-end solution development—from problem identification and research to design, implementation, testing, and professional reporting. Students gain hands-on experience with advanced tools and techniques such as simulation, AI/ML modelling, geospatial analysis, sustainable materials, and non-destructive testing. By completing these projects, students transition from learners to industry-ready professionals, equipped with technical proficiency, project management capability, ethical awareness, and the confidence to address complex engineering challenges.

Project teams are:

- Collaborative & Industry-Oriented – Projects are developed in partnership with industry or research organizations to ensure real-world relevance.
- Team-Based Execution – Students work in teams of 3–5 members, with dedicated mentors guiding technical, managerial, and ethical aspects of the project.
- State-of-the-Art Tools & Labs – Access to advanced civil engineering laboratories, GIS & remote sensing platforms, CFD workstations, AI & ML computing facilities, and NDT testing equipment.
- Extended Duration – Typically spanning two semesters, allowing for thorough research, experimentation, validation, and documentation.

The primary goal of CITE projects is to provide a level of moderate complexity, expertise, and diversity of thought in social data-centric areas that will allow them to gain hands-on experience with the TIPS projects.

- Develop Sustainable & Smart Infrastructure Solutions – Apply innovative technologies to design eco-friendly, cost-efficient, and resilient civil systems.
- Leverage Advanced Materials – Innovate with recycled aggregates, self-curing agents, and smart composites to improve durability and reduce environmental impact.
- Harness Digital Engineering Tools – Integrate GIS, Remote Sensing, CFD, AI, and Machine Learning for data-driven infrastructure design and performance optimization.
- Enhance Disaster Resilience – Design infrastructure systems that withstand climate extremes, urban flooding, landslides, and seismic events.
- Promote Non-Destructive & Real-Time Monitoring – Implement IoT-enabled, AI-assisted, and NDT-based evaluation methods for infrastructure health monitoring.
- Advance Water Resources & Urban Systems – Optimize urban water distribution, stormwater management, and hydrological forecasting using simulation and smart control systems.
- Foster Industry-Ready Skills – Prepare students with project management, documentation, technical communication, and professional ethics for their engineering careers.

The **CITE Project team** works as part of a research-driven group of students, research scholars, and faculty members to address innovative design and engineering challenges in domains such as sustainable construction, smart transportation systems, resilient infrastructure, and advanced structural monitoring.

By integrating civil engineering principles with advanced technologies such as Artificial Intelligence (AI), Machine Learning (ML), Building Information Modelling (BIM), Internet of Things (IoT), Remote Sensing, and Computational Modelling, students enhance capabilities in structural health monitoring, smart city infrastructure planning, non-destructive testing, and climate-resilient design. This interdisciplinary approach empowers the next generation of civil engineers to deliver data-driven, sustainable, and technologically advanced solutions for meeting the infrastructure demands of a rapidly changing world.

The goals of CITE projects are,

1. **Develop Sustainable Construction Solutions**
   Design and implement eco-friendly materials, methods, and systems that reduce environmental impact while maintaining structural integrity and cost-effectiveness.
2. **Advance Structural Health Monitoring**
   Deploy IoT-enabled sensors, AI-based image analysis, and non-destructive testing techniques to assess and predict the condition of critical infrastructure such as bridges, buildings, and pavements.
3. **Optimize Urban Infrastructure Systems**
   Plan and manage transportation networks, utilities, and drainage systems using smart technologies to enhance efficiency, safety, and resilience.
4. **Leverage Remote Sensing and GIS for Civil Planning**
   Apply geospatial tools to map, monitor, and manage land use, infrastructure assets, and environmental changes for better decision-making.
5. **Enhance Disaster-Resilient Infrastructure**
   Model, design, and retrofit structures to withstand floods, earthquakes, landslides, and other climate-related hazards, improving public safety and service continuity.
6. **Innovate with Advanced Construction Materials**
   Research and apply high-performance materials such as self-curing concrete, recycled aggregates, and 3D-printed components to extend service life and promote circular economy practices.
7. **Enable Smart Decision Support Platforms**
   Create interactive dashboards and digital twins for planning, monitoring, and optimizing civil infrastructure projects in real time.
8. **Improve Transportation Infrastructure Performance**
   Use AI/ML and simulation tools to detect road damages, optimize traffic flow, and plan preventive maintenance schedules.
9. **Ensure Sustainable Water and Waste Management in Urban Areas**
   Design and integrate systems for stormwater harvesting, wastewater treatment, and solid waste recycling within smart city frameworks.
10. **Promote Community-Centric Infrastructure Planning**
    Use participatory planning tools and open data platforms to involve stakeholders, ensure transparency, and align infrastructure development with societal needs.

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

Sustainability Development Goals (SDGs) for the Dept. of CSE (DS), IARE	
SDG #6	Ensure availability and sustainable management of water and sanitation for all
SDG #9	Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
SDG #11	Make cities and human settlements inclusive, safe, resilient and sustainable
SDG #13	Take urgent action to combat climate change and its impacts
SDG #15	Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

Themes of CITE projects for the CE:

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

1. **Smart and Resilient Infrastructure Systems – SDG 9, SDG 11, SDG 13**
2. **Sustainable Construction Materials and Technologies – SDG 9, SDG 12**
3. **Water and Wastewater Infrastructure Innovation – SDG 6, SDG 9, SDG 14**
4. **Transportation Engineering and Smart Mobility – SDG 9, SDG 11, SDG 13**
5. **Sustainable Building and Construction Materials – SDG 9, SDG 13, SDG 14**
6. **Water and Wastewater Infrastructure Innovation – SDG 9, SDG 11, SDG 13**
7. **Energy-Efficient Buildings and Infrastructure – SDG 7, SDG 11, SDG 13**
8. **Disaster Risk Reduction and Infrastructure Resilience – SDG 11, SDG 13**
9. **Digital Civil Engineering (BIM, GIS, and AI Applications) – SDG 9, SDG 11, SDG 17**

In order to participate in TIPS projects, you must formally apply and be accepted by the project coordinator. To proceed, please email the project coordinator, Dr. N Sri Ramya (n.sriramya@iare.ac.in), Assistant Professor of CE. This will bring up all available open positions tagged as CITE projects.
Please note that participation by the CITE project team requires registration for the accompanying project work from any of the specified domains. More information will be provided to all selected CITE project 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!

Smart and Resilient Infrastructure Systems

Dr. R Ramya Swetha, Associate Professor, Civil Engineering _ Faculty Mentor

GOALS

The goal of this project is to introduce students to the principles of designing smart and resilient civil infrastructure that can adapt to changing urban demands and climate challenges. Students will focus on identifying vulnerabilities in existing infrastructure systems—such as roads, bridges, stormwater drains, and public utilities—and propose innovative solutions that enhance resilience, sustainability, and adaptability.

By integrating smart technologies, renewable energy considerations, and climate-resilient design practices, students will learn how infrastructure can withstand natural disasters, support sustainable urbanization, and improve community safety. The project emphasizes early-stage innovation, design-based problem solving, and the practical application of civil engineering foundations for building future-ready infrastructure.

METHODS & TECHNOLOGIES

The project team will apply a combination of observational studies, digital modeling tools, and resilience-focused design practices.

- **Field Observation & Risk Identification** – Studying local infrastructure systems and identifying risks due to floods, heatwaves, or traffic congestion.
- **GIS & Mapping Tools** – Using geographic information systems for spatial analysis and urban vulnerability mapping.
- **BIM (Building Information Modeling**) – Exploring the basics of 3D modeling for resilient design planning.
- **Smart Technology Integration** – Exploring IoT sensors for structural health monitoring, flood detection, or energy optimization.
- **Scenario Planning** – Designing solutions considering different hazard scenarios (floods, storms, traffic surges).
- **Sustainable Materials & Energy Use** – Integrating recycled materials, solar lighting, and passive design strategies.
- **Design Communication** – Presenting ideas through digital models, storyboards, and concept posters.

DESIGN & TECHNICAL ISSUES

Students will explore the following challenges and design considerations:

- Identifying weak points in local infrastructure (roads, drainage, power supply).
- Translating hazard data into actionable design improvements.
- Understanding interconnectivity of systems (transport, energy, water).
- Balancing cost, sustainability, and resilience in design solutions.
- Applying drafting and modeling conventions for clear communication.
- Incorporating community needs and accessibility into resilient planning.
- Exploring multi-hazard design (e.g., both earthquake and flood resilience).

- Ensuring designs are scalable, practical, and adaptable for future needs.

MAJORS & AREAS OF INTEREST

This Cornerstone Project (CoP) develops interdisciplinary skills by connecting civil foundations with resilience thinking and smart technologies:

- **Resilient Structural Design** – Understanding load resistance, redundancy, and robustness.
- **Sustainable Urban Systems** – Linking transport, drainage, and housing to urban sustainability.
- **Digital Civil Engineering Tools** – Exposure to GIS, BIM, and sensor technologies.
- **Smart Cities & IoT Integration** – Exploring applications of sensors for infrastructure monitoring.
- **Climate-Resilient Planning** – Designing systems that withstand floods, storms, or heat stress.
- **Collaborative Team Design** – Working in teams to integrate technical, social, and environmental dimensions.
- **Civil Engineering Foundations** – Applying drafting, site planning, and basic design principles.

MENTOR CONTACT INFORMATION

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PARTNERS & SPONSORS
None

Sustainable Construction Materials and Technologies

Dr. M Venu, Professor, Civil Engineering, _ Faculty Mentor

GOALS

The project aims to introduce students to innovative and sustainable construction materials and techniques that reduce environmental impact while maintaining structural performance. Students will evaluate the environmental footprint of traditional materials such as cement, steel, and aggregates, and explore alternatives like geopolymer concrete, recycled aggregates, fly ash bricks, bamboo, and bio-based composites.

The broader goal is to train students in designing construction practices that minimize waste, optimize resource use, and ensure durability while promoting responsible consumption. By applying both theoretical knowledge and experimental exploration, students will understand how sustainable materials can transform the construction industry for a greener future.

It contributes directly to SDG 6 (Clean Water and Sanitation), SDG 12 (Responsible Consumption and Production), and SDG 15 (Life on Land) by ensuring sustainable land and water conservation interventions at the watershed level.

METHODS & TECHNOLOGIES

Students will employ both hands-on and digital approaches to study and design sustainable material solutions:

- **Material Testing & Characterization** – Simple lab-scale testing (compressive strength, durability, permeability).
- **Comparative Life Cycle Assessment (LCA)** – Evaluating carbon footprint and embodied energy of materials.
- **Case Study Analysis** – Reviewing real-world green building projects and material applications.
- **Experimental Mix Design** – Designing sustainable concrete mixes using industrial by-products.
- **3D Printing with Green Materials** – Exploring additive manufacturing in sustainable construction.
- **Digital Tools** – BIM-based sustainability simulations and material tracking.
- **Standards & Codes Review** – Understanding IS codes and international sustainability guidelines.

MAJORS & AREAS OF INTEREST

This project provides students with exposure to the future of sustainable construction:

- **Green Building Materials** – Exploration of fly ash bricks, bamboo, geopolymer concrete, hempcrete.
- **Circular Economy in Construction** – Material reuse, recycling, and resource optimization.
- **Construction Waste Management** – Innovative solutions to minimize site waste.
- **Life Cycle Analysis (LCA)** – Tools for measuring carbon footprint and sustainability.

- **Energy-Efficient Construction** – Low-embodied energy and thermally efficient materials.
- **Digital Tools for Sustainability** – Integration of BIM for material management and green certifications.
- **Civil & Environmental Integration** – Linking structural design with environmental sustainability.
- **Future-ready Skills** – Innovation in eco-materials and sustainable technologies for industry adoption.

This domain contributes to sustainable rural development, climate-smart agriculture, and conservation of natural resources through AI-driven insights, directly supporting SDG 6, SDG 12, and SDG 15.

MENTOR CONTACT INFORMATION

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PARTNERS & SPONSORS
None

Urban Water and Wastewater Management Systems

Dr. Nanna Sri Ramya, Assistant Professor, Civil Engineering, _ Faculty Mentor

GOALS

Explainable AI for Water Quality and Hydrological Risk Analysis is an emerging research area that combines AI-powered prediction models with interpretability techniques to enhance transparency, accountability, and reliability in Hydro-Informatics systems. Traditional hydrological models and water quality monitoring systems often produce complex outputs that are difficult for decision-makers and non-technical stakeholders to interpret. With the growing adoption of AI models in flood forecasting, pollution detection, and hydrological hazard prediction, ensuring explainability and traceability of AI-generated results has become a crucial priority.

This research domain aims to develop explainable AI frameworks that not only predict water quality anomalies, flood risks, and drought events but also justify the reasoning behind those predictions. By providing clear insights into the factors influencing AI model outcomes, these systems build trust among water managers, policymakers, and the public. They also help identify hidden risk factors, data inconsistencies, and operational vulnerabilities within water management systems.

The goal is to create AI-based risk analysis platforms capable of real-time decision support, while maintaining high levels of interpretability and transparency. This domain contributes directly to SDG 6 (Clean Water and Sanitation), SDG 9 (Industry, Innovation and Infrastructure), and SDG 16 (Peace, Justice and Strong Institutions) by promoting fair, responsible, and transparent water governance practices.

METHODS & TECHNOLOGIES

Students will use both analytical and practical approaches to design effective systems:

- **Water Quality Analysis** – Monitoring physical, chemical, and biological parameters.
- **GIS & Remote Sensing** – Mapping water distribution networks and wastewater flows.
- **Hydraulic Modeling Software** – EPANET, SWMM, or MIKE URBAN for simulating water supply and drainage.
- **Wastewater Treatment Technologies** – Constructed wetlands, MBBR, SBR, and decentralized systems.
- **Rainwater Harvesting Models** – Designing rooftop collection and recharge systems.
- **IoT-based Smart Monitoring** – Sensors for real-time water quality and leak detection.
- **Case Study Evaluation** – Smart city water management and sustainable urban drainage systems (SUDS).
- **Field Surveys & Lab Work** – Collecting samples and testing treatment efficiency.

MAJORS & AREAS OF INTEREST

This project provides students with interdisciplinary exposure across civil, environmental, and urban planning domains:

- **Water Supply Engineering** – Network design, distribution, and leak detection.

- **Wastewater Treatment** – Advanced biological, chemical, and natural systems.
- **Urban Drainage & Stormwater Management** – Sustainable drainage and flood mitigation.
- **Smart City Water Systems** – IoT, SCADA, and AI integration.
- **Circular Water Economy** – Recycling, reuse, and resource recovery from wastewater.
- **Climate-Resilient Infrastructure** – Designing systems adaptable to climate change.
- **GIS & Data Analytics** – Mapping and analyzing urban water infrastructure.
- **Policy & Regulation Studies** – Water governance, sustainability policies, and SDG alignment.

MENTOR CONTACT INFORMATION

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PARTNERS & SPONSORS
None

Transportation Systems and Smart Mobility

Dr. Praveena Rao, Assistant Professor, Civil Engineering, _ Faculty Mentor

GOALS

This project aims to design sustainable and smart urban transportation systems that reduce congestion, enhance mobility, and lower carbon emissions. Students will explore innovative approaches to improve public transportation, promote non-motorized modes, and integrate digital technologies for efficiency and safety. The goal is to build solutions that foster green, resilient, and intelligent mobility systems, making cities more connected, inclusive, and environmentally sustainable.

It contributes significantly to SDG 3 (Good Health and Well-being), SDG 6 (Clean Water and Sanitation), and SDG 14 (Life Below Water) by ensuring the safety of water resources for human use and preserving aquatic ecosystems through data-driven, anticipatory water quality management systems.

METHODS & TECHNOLOGIES

Students will employ both conventional planning tools and cutting-edge digital technologies:

- **Traffic Simulation Software** – VISSIM, AIMSUN, SYNCHRO for modeling traffic flow.
- **GIS-Based Transportation Planning** – Mapping routes, congestion zones, and accessibility.
- **IoT & Sensor Networks** – Smart traffic lights, congestion monitoring, and adaptive signaling.
- **Big Data Analytics** – Predicting traffic demand and optimizing routes.
- **Electric & Hybrid Vehicle Integration** – Infrastructure planning for EV charging.
- **Smart Ticketing & Mobility-as-a-Service (MaaS)** – Unified travel apps and digital fare systems.
- **Sustainable Design Practices** – Bike lanes, pedestrian pathways, and low-emission zones.
- **Field Surveys & Case Studies** – Assessing current urban mobility systems and identifying gaps.

MAJORS & AREAS OF INTEREST

This project cuts across civil, mechanical, electrical, and IT disciplines, offering a multidisciplinary scope:

- **Transportation Engineering** – Highway design, traffic flow modeling, safety studies.
- **Urban Planning** – Smart mobility planning, TOD (Transit-Oriented Development).
- **Mechanical/Automotive Engineering** – Electric and autonomous vehicle systems.
- **Electrical Engineering** – Smart grids and EV charging infrastructure.
- **Computer Science & IT** – AI, IoT, big data, and smart apps for traffic management.
- **Environmental Engineering** – Low-carbon mobility and pollution reduction.
- **Policy & Governance Studies** – Smart mobility regulations and urban transport policy.

The domain directly addresses community health protection and sustainable water management by embedding AI-driven, preventive measures into public infrastructure systems, thereby supporting SDG 3, SDG 6, and SDG 14.

MENTOR CONTACT INFORMATION

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PARTNERS & SPONSORS
None

Sustainable Building and Construction Materials

Dr. U Vamsi Mohan, Professor, Civil Engineering, _ Faculty Mentor

GOALS

The project seeks to explore, design, and implement eco-friendly and innovative construction materials that reduce the environmental footprint of the built environment. The focus is on minimizing resource depletion, lowering embodied energy, and ensuring long-term sustainability while maintaining structural strength, durability, and cost-effectiveness. The goal is to contribute toward a circular economy in construction through material reuse, recycling, and innovative design approaches.

By leveraging cloud infrastructure, these systems ensure scalability, remote accessibility, and continuous data synchronization from telemetry sensors, mobile apps, and satellite feeds. The ultimate goal is to empower decision-makers with actionable insights for sustainable watershed management, soil and water conservation, and rural development projects. This domain directly supports SDG 6 (Clean Water and Sanitation), SDG 9 (Industry, Innovation and Infrastructure), and SDG 15 (Life on Land) by promoting resilient, technology-enabled watershed development frameworks.

METHODS & TECHNOLOGIES

Students will employ both laboratory experiments and advanced digital tools:

- **Material Characterization Tests** – Strength, durability, thermal resistance, and lifecycle performance.
- **Green Cement Alternatives** – Fly ash, GGBS, geopolymer concrete.
- **Recycled Aggregates & Plastic Waste Utilization** – Substitution in concrete and asphalt.
- **Bamboo & Natural Fibers** – Low-carbon and locally available materials.
- **3D Printing in Construction** – Additive manufacturing for efficient use of materials.
- **Building Information Modeling (BIM)** – Sustainable material selection and lifecycle analysis.
- **Life Cycle Assessment (LCA)** – Evaluating embodied energy and carbon footprint.
- **Nanotechnology** – Use of nano-additives for strength, durability, and self-healing properties.

MAJORS & AREAS OF INTEREST

This project spans across multiple disciplines in engineering and design:

- **Civil Engineering** – Structural analysis and material testing.
- **Materials Science & Nanotechnology** – Development of advanced eco-materials.
- **Mechanical Engineering** – Testing mechanical properties and durability.
- **Architecture & Urban Planning** – Sustainable design integration.
- **Environmental Engineering** – Waste management and pollution control.
- **Industrial Engineering** – Supply chain optimization for sustainable materials.
- **Policy & Economics** – Cost-benefit analysis and green construction policies.

This domain directly strengthens rural sustainability, climate adaptation, and integrated water management strategies through AI-powered, cloud-based solutions, addressing SDG 6, SDG 9, and SDG 15.

MENTOR CONTACT INFORMATION

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PARTNERS & SPONSORS
None

Water and Wastewater Infrastructure Innovation

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GOALS

AI-Based Smart Hydrological Forecasting and Decision Support Systems is an emerging interdisciplinary research domain within Hydro-Informatics that focuses on integrating artificial intelligence and machine learning techniques into water resources management and hydrological prediction systems. Traditionally, hydrological forecasting and water resource decision-making have relied heavily on manual data interpretation, statistical models, and physical hydrological simulations. These approaches, though effective, are often time-consuming, data-limited, and sensitive to uncertainties in climatic and land-use changes.

This domain leverages AI to automate and enhance the collection, analysis, prediction, and visualization of hydrological data for applications such as flood forecasting, drought monitoring, reservoir operation, and watershed prioritization. The primary goal is to build intelligent systems capable of generating reliable, real-time forecasts and decision recommendations based on multi-source data — including remote sensing, telemetry, and historical records.

These AI-enhanced systems aim to improve early warning capabilities, minimize water-related disaster risks, and optimize resource allocation in water-scarce and climate-vulnerable regions. AI-driven Hydro-Informatics frameworks also contribute to sustainable urban water management by supporting smart water distribution, demand prediction, and anomaly detection. This domain directly supports SDG 6 (Clean Water and Sanitation), SDG 11 (Sustainable Cities and Communities), and SDG 13 (Climate Action) by enabling climate-resilient, data-driven water management and disaster mitigation strategies.

METHODS & TECHNOLOGIES

The core enabling technologies for this domain include advanced machine learning models and AI-powered big data analytics platforms capable of handling large spatiotemporal hydrological datasets.

Key techniques include:

- **Time Series Forecasting Models**: LSTM, ARIMA, Prophet, and hybrid CNN-LSTM models for rainfall-runoff and streamflow forecasting.
- **AI-Based Flood Prediction Systems**: Real-time flood forecasting models using telemetry and remote sensing data, combined with AI-based anomaly detection algorithms.
- **Geospatial AI (GeoAI)**: AI-enhanced remote sensing, GIS analytics, and land-use change detection for watershed prioritization and flood risk mapping.
- **Hydro-Informatics Decision Support Systems (DSS)**: AI-integrated DSS platforms that combine hydrological models with predictive analytics for operational decision-making in reservoirs, irrigation, and water distribution networks.

- **Cloud Computing and IoT-based Data Acquisition**: Integration of AI models with cloud-based platforms for real-time telemetry data handling from IoT sensors and meteorological stations.

These systems employ AI libraries and tools such as TensorFlow, Keras, Scikit-learn, and cloud services like AWS IoT and Google Earth Engine, along with Hydro-Informatics tools like HEC-RAS, MIKE SHE, and SWAT integrated into AI workflows.

MAJORS & AREAS OF INTEREST

This research domain is highly relevant for students and professionals in Hydraulic Engineering, Civil Engineering, Remote Sensing & GIS, Environmental Engineering, and Computer Science (for AI integration). It also intersects with Climate Informatics, Data Science, and Smart Infrastructure Planning.

Key areas of research and practical application include:

- AI-based rainfall-runoff forecasting and hydrological disaster early warning systems.
- AI-enhanced water demand prediction and distribution optimization.
- Real-time AI-based anomaly detection in urban water networks.
- AI-assisted hydrological risk analysis and climate resilience planning.
- Sustainable watershed prioritization and AI-powered erosion control planning.
- Integration of AI-based decision support systems for smart cities and rural water management schemes.

The domain promotes climate-smart water governance and contributes to Sustainable Development Goals like SDG 6, SDG 11, and SDG 13 by embedding AI innovation into core water resource management strategies.

MENTOR CONTACT INFORMATION

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PARTNERS & SPONSORS

None

Energy-Efficient Buildings and Infrastructure

Ms. B Bhavani, Assistant Professor, Civil Engineering _ Faculty Mentor

GOALS

Energy-Efficient Buildings and Infrastructure is a multidisciplinary research domain focused on reducing energy consumption, minimizing carbon footprints, and promoting sustainable construction practices. Traditional building design and infrastructure planning often rely on conventional energy-intensive materials and mechanical systems, which contribute significantly to global greenhouse gas emissions and climate change. This domain emphasizes integrating renewable energy, smart building technologies, and green construction practices to achieve high-performance, low-carbon infrastructure.

The primary goal is to design intelligent and adaptive building systems that optimize energy usage through passive design strategies, advanced insulation, energy-efficient HVAC (heating, ventilation, and air conditioning) systems, renewable energy integration, and smart grid connectivity. By leveraging digital twin technologies, IoT-based energy monitoring, and AI-driven optimization, energy efficiency can be maximized throughout the building lifecycle — from construction to operation and maintenance. These advancements directly contribute to **SDG 7 (Affordable and Clean Energy)**, **SDG 11 (Sustainable Cities and Communities)**, and **SDG 13 (Climate Action)** by fostering sustainable urbanization, reducing operational costs, and mitigating climate impacts.

METHODS & TECHNOLOGIES

The implementation of energy-efficient buildings and infrastructure relies on a synergy of smart design principles, digital technologies, and renewable energy integration.
Key techniques include:

- **Passive Design and Green Architecture:** Optimization of natural ventilation, daylighting, and thermal insulation to reduce energy demand.
- **Smart Building Systems:** IoT-enabled energy monitoring, AI-driven HVAC optimization, and adaptive lighting systems.
- **Renewable Energy Integration:** Use of solar PV panels, wind turbines, and geothermal systems to reduce reliance on fossil fuels.
- **Building Information Modeling (BIM) and Digital Twins:** Simulation-based design for energy optimization and lifecycle energy management.
- **Advanced Building Materials:** Use of high-performance concrete, phase-change materials, and reflective coatings for thermal efficiency.
- **Smart Grids and Energy Storage:** Integration of smart grids with battery storage and demand-side management for efficient energy use.

Enabling technologies include IoT sensors, AI optimization algorithms, cloud-based energy management platforms, and simulation tools such as EnergyPlus, TRNSYS, and DesignBuilder.

MAJORS & AREAS OF INTEREST

This domain is highly relevant to Civil Engineering, Architecture, Environmental Engineering, and Urban Planning, with strong intersections with Computer Science and Electrical Engineering for smart technologies.

Key areas of research and practical application include:

- Smart energy-efficient building design and retrofitting.
- AI and IoT-enabled building energy management systems.
- Life-cycle energy assessment of construction materials.
- Net-zero energy buildings (NZEB) and green infrastructure.
- Integration of renewable energy systems into building design.
- Digital twin-based simulation and real-time energy optimization.
- Smart cities infrastructure with sustainable energy planning.

The domain promotes resilient and sustainable infrastructure by embedding energy efficiency at the heart of construction and urban planning, thereby supporting **SDG 7, SDG 11, and SDG 13**.

MENTOR CONTACT INFORMATION

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PARTNERS & SPONSORS
None

Disaster Risk Reduction and Infrastructure Resilience

Dr. M Madhusudhan Reddy, Assistant Professor, Civil Engineering _ Faculty Mentor

GOALS

Disaster Risk Reduction (DRR) and Infrastructure Resilience is an emerging interdisciplinary domain that emphasizes designing, planning, and managing infrastructure systems to withstand and rapidly recover from natural and human-induced hazards. Traditional civil engineering practices primarily focused on strength and serviceability; however, climate change, rapid urbanization, and the increasing frequency of disasters demand resilient, adaptive, and sustainable solutions.

The primary goal of this domain is to integrate disaster risk management strategies into infrastructure planning, enabling communities to anticipate, absorb, and recover from disasters such as floods, earthquakes, cyclones, and landslides. Resilience-driven approaches ensure critical lifeline systems (water, power, transport, and healthcare facilities) remain functional during and after disasters. This domain directly contributes to **SDG 11 (Sustainable Cities and Communities)** and **SDG 13 (Climate Action)** by promoting resilient infrastructure, adaptive urban planning, and climate-smart construction practices.

METHODS & TECHNOLOGIES

Key enabling frameworks and technologies include:

- **Disaster Risk Modeling and Simulation:** Use of seismic hazard models, flood inundation models, and cyclone impact models for vulnerability assessment.
- **Remote Sensing and GIS Applications:** Real-time hazard monitoring, early warning, and risk mapping.
- **Resilient Design Standards:** Earthquake-resistant building codes, flood-resilient foundations, and cyclone-proof shelters.
- **Digital Twin and AI-Powered Simulations:** Predictive resilience assessment of urban systems.
- **Nature-Based Solutions (NbS):** Green infrastructure, mangrove restoration, and bioengineering for hazard mitigation.
- **IoT and Smart Sensors:** Real-time structural health monitoring of bridges, dams, and critical infrastructure.

MAJORS & AREAS OF INTEREST

The integration of Artificial Intelligence (AI) with Remote Sensing (RS) and Geographic Information System (GIS) technologies has revolutionized groundwater potential zonation, particularly in water-scarce regions. This interdisciplinary topic spans Civil Engineering, Environmental Engineering, Geology, and Geoinformatics, offering advanced tools for water resource planning, watershed management, and hydrogeological analysis.

- Multi-hazard risk assessment and resilient urban infrastructure planning.

- Seismic-resistant structures and earthquake retrofitting.
- Smart flood control infrastructure and early warning systems.
- Infrastructure resilience in climate-vulnerable regions.
- Integration of DRR strategies into smart cities and rural development.
- Community-based resilience planning and governance frameworks.

This domain supports climate-resilient infrastructure development and strengthens global disaster preparedness frameworks in line with SDG 11 and SDG 13.

MENTOR CONTACT INFORMATION

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PARTNERS & SPONSORS
None

Digital Civil Engineering (BIM, GIS, and AI Applications)

Mr. K Anand Goud, Assistant Professor, Civil Engineering _ Faculty Mentor

GOALS

Digital Civil Engineering represents the transformation of traditional civil engineering practices through the adoption of Building Information Modeling (BIM), Geographic Information Systems (GIS), and Artificial Intelligence (AI) technologies. Traditionally, infrastructure planning and construction relied heavily on manual drafting, isolated datasets, and static design methods. With digital transformation, civil engineering projects are now more data-driven, collaborative, and intelligent.

The goal of this domain is to create smarter, more sustainable, and efficient infrastructure by integrating digital technologies across the lifecycle of projects — from planning, design, and construction to operation and maintenance. It aligns with SDG 9 (Industry, Innovation, and Infrastructure), SDG 11 (Sustainable Cities and Communities), and SDG 17 (Partnerships for the Goals) by promoting innovative, technology-enabled collaboration in infrastructure delivery.

METHODS & TECHNOLOGIES

The goal of this domain is to create smarter, more sustainable, and efficient infrastructure by integrating digital technologies across the lifecycle of projects — from planning, design, and construction to operation and maintenance.

- **Building Information Modelling (BIM):** 3D/4D/5D modelling for planning, design optimization, cost estimation, and lifecycle management.
- **GIS and Remote Sensing**: Spatial data analytics for urban planning, site selection, and infrastructure monitoring.
- **AI and Machine Learning:** Predictive modelling for construction delays, maintenance scheduling, and risk analysis.
- **Digital Twins:** Real-time virtual replicas of infrastructure systems for performance monitoring.
- **IoT and Cloud Computing:** Smart sensors integrated with cloud-based platforms for asset management.
- **Augmented Reality (AR) & Virtual Reality (VR):** Immersive visualization for design review and safety training.

MAJORS & AREAS OF INTEREST

Traditionally, infrastructure planning and construction relied heavily on manual drafting, isolated datasets, and static design methods. With digital transformation, civil engineering projects are now more data-driven, collaborative, and intelligent.BIM-based smart project management and cost optimization.

- AI-driven predictive maintenance for infrastructure systems.
- GIS-based smart city planning and urban sustainability analysis.
- Integration of digital twins for resilient infrastructure.
- Collaborative construction using cloud-enabled BIM platforms.

- Smart transportation, water supply, and energy infrastructure design.

This domain empowers future engineers with the digital skillset required to lead infrastructure innovation, enhance project sustainability, and strengthen global collaborations, directly contributing to SDGs 9, 11, and 17.

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