"*Sustainable Energy Systems: A Data-driven Approach*"

under QIP PG Certification Program

1. Course Objectives

- To build foundational computing skills among faculty participants through the concepts of problem-solving, logic building, and Python programming, enabling them to integrate computational thinking into engineering education.
- To introduce the fundamental principles and technologies behind conventional and renewable energy systems, with an emphasis on their real-world applications and sustainability considerations.
- To develop competency in data science and analytics, equipping participants with tools and techniques for data-driven decision-making in the context of energy systems and sustainability challenges.
- To explore specialized renewable energy systems such as solar and wind, focusing on their design, analysis, and integration into sustainable energy solutions.
- To engage participants in project-based learning, encouraging interdisciplinary collaboration and the application of computational techniques for addressing complex issues related to energy sustainability and climate change.
- To foster a curriculum development mindset, enabling faculty members to create or enhance academic courses that integrate energy engineering with computational and data science methodologies.

2. Rationale for the Course

The pressing global demand for sustainable energy solutions, coupled with the accelerating transition toward digitalization, calls for a new generation of educators who are not only well-versed in energy systems but are also capable of leveraging computational and data- driven methods. This QIP PG Certificate Programme is designed to address this critical need by equipping faculty members with interdisciplinary competencies at the intersection of energy engineering, data science, and sustainability.

The course structure reflects a carefully designed blend of computing fundamentals, domain expertise, and analytical tools. Beginning with **"Joy of Computing"**, the programme introduces participants to logic building and Python programming - essential skills for modern engineers and educators. This is followed by core modules on "**Energy Systems Fundamentals"** and "**Renewable Energy Technologies"**, including focused content on "**Solar, and Wind Energy Systems"**, offering a well-rounded exposure to diverse sustainable energy sources.

The inclusion of **"Data Science for Engineers"** ensures that faculty are equipped with tools to handle, interpret, and extract insights from energy-related data - an increasingly vital skill

in today's industry and research. The open-ended **project component** further enables participants to apply their learning in a practical, interdisciplinary context, encouraging innovation and problem-solving on real-world energy and climate-related challenges.

By the end of the programme, participants will be capable of not only integrating these concepts into their own teaching and research but also contributing to the development of future-ready curricula that reflect the demands of a data-informed, sustainability-focused energy landscape.

3. Course Structure

Course Component	Content
CS Core 1	The Joy of Computing using Python
Domain Core	Energy Systems: Fundamentals & Applications
CS Core 2	Data Science for Engineers
Domain Specialized	Renewable Energy Engineering: Solar, Wind and Biomass Energy Systems
Project	Energy Sustainability & Climate Change

4. Learning Outcomes

- Demonstrate proficiency in problem-solving and programming using Python, applying computational thinking to engineering problems and pedagogical tasks.
- Explain the working principles and key components of conventional and renewable energy systems, including solar and wind energy technologies.
- Analyse energy systems using fundamental engineering principles, considering efficiency, sustainability, and environmental impact.
- Apply data science tools and techniques to collect, visualize, interpret, and analyse datasets related to energy systems and sustainability challenges.
- Design and evaluate renewable energy systems, integrating solar, and wind energy solutions into feasible and efficient configurations for diverse scenarios.
- Undertake interdisciplinary, project-based investigations that explore real-world issues in energy and climate, using computational and data-driven methods to derive solutions.
- Develop or enhance curricula and academic content that embed energy systems education with computing and sustainability, suitable for undergraduate and postgraduate engineering students.

5. Infrastructure and Resources Available

- **Smart Classrooms & Seminar Halls:** Equipped with projectors, internet connectivity, and audio-visual tools to facilitate interactive teaching and learning.

- **Computer Labs:** High-performance systems installed with Python, data science libraries (such as NumPy and Pandas), and relevant engineering software to support computational tasks.
- **Energy Laboratories:** Well-equipped facilities for solar PV/thermal systems, wind energy setups, real-time monitoring, and energy system analysis.
- **Library & E-Resources:** Extensive access to physical and digital resources, including databases like ScienceDirect, IEEE Xplore, and Springer.
- **Learning Management System:** Used for distributing course content, managing assignments, and providing access to recorded sessions.
- **Expert Faculty Pool:** A multidisciplinary team of experienced faculty members from energy, computing, and engineering backgrounds, supported by research and industry collaborations.

6. Expected Outcomes of the Course

- Contribute to the training of 40 - 50 faculty members nationwide in emerging areas of energy systems and sustainability.
- Develop computational thinking and basic programming skills for engineering applications.
- Understand key concepts in conventional and emerging renewable energy systems.
- Analyse energy systems using data-driven methods and relevant software tools.
- Evaluate and integrate renewable technologies into sustainable energy solutions.
- Design and deliver undergraduate/postgraduate elective modules in energy systems at their home institutions.
- Implement mini projects and case studies for effective classroom engagement.
- Collaborate across disciplines to address real-world sustainability challenges.
- Initiate project proposal development with mentoring support.
- Guide undergraduate, postgraduate, and PhD students in energy-related research, in line with NEP 2020.
- Participate in academic exchanges and foster long-term collaborative research.

7. Other Relevant Information

- Industry engagement: guest talks from industry personnel and visit to couple of industries during their visit to IIT Guwahati
- Faculty will access curated NPTEL content alongside in-person instruction
- Course designed to support NEP goals on interdisciplinary, tech-driven education
- Supports integration with existing B.Tech/M.Tech energy programs

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