Department of Electrical Engineering

Indian Institute of Technology (Indian School of Mines) Dhanbad

VIBHAV

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Message from HoD's Desk

By PROF. SUKANTA DAS

Dear All,
Greetings from IIT(ISM) Dhanbad!

With great pleasure, I am delighted to present the "September 2025" edition of the Department of Electrical Engineering's Monthly Newsletter: "VIBHAV"

The month of September 2025 was also marked by a significant milestone for our department with a few notable individual achievements.

I encourage you all to explore this issue and invite our students to contribute actively toward enhancing the quality and reach of our Monthly Newsletter. We also welcome your constructive feedback and suggestions, which may be forwarded to ee@iitism.ac.in for the improvement of forthcoming editions of "VIBHAV".

Thank you all.

Best wishes.

About the Department

The Electrical Engineering department was established in the year 2005. The four-year B.Tech. program in Electrical Engineering was started in the academic session 2006-07. Although the Department of Electrical Engineering is one of the latest of the existing departments of the Institute, the Electrical Engineering Section existed as a part of earlier Mining Machinery Engineering department from 1975. Apart from different B.Tech. programs, the department at present also offers M.Tech programs in Power System Engineering and Power Electronics & Electrical Drives. Through funded projects, consultancies, Doctoral, and postdoctoral programs, most of the research activities are being carried out in the department.

Patents

Kartick Chandra Jana, Gauri Shankar, Vedantham Lakshmi Srinivas, Khalid Raza Khan, Suryakant Kumar, and Ram Khelawan Saket, "Voltage Stabilization Control with Hybrid Renewable Power Sources in DC Microgrid,"
Indian Patent No. 571117,
Granted on Sept. 24, 2025.

Outreach Activities

- **Prof. Nitai Pal** evaluated Ph.D. Thesis of Research Scholar of MNIT, Jaipur as an External Examiner.
- **Prof. Nitai Pal** delivered expert lecture in the EDP Course on "Refresher Training Program for CIL Executives", organized by the Department of Management Studies & Industrial Engineering, IIT (ISM) Dhanbad during 01–15 September 2025.

Publications

Journals

- Anagha Rajendran K. P., **S. Barik**, S. Swain, and Bikash Das, "A Novel Combined KCL-KVL Based Zero Bus Distribution Load Flow with Pre-Defined Energy Contract Scenarios and Different Load Types," *e-Prime - Advances in Electrical Engineering, Electronics and Energy*, 2025.

Conferences

- Gulfshan and **Ashok Kumar**, "Application of Blockchain Technology in Modern Power Systems and Power Electronics- A Brief Review," *4th International Conference on Data, Decision and Systems*, Indian Institute of Information Technology, Dharwad, India, 2025. [Accepted for presentation]

Students' Corner

Energy Storage: The Silent Backbone of a Sustainable Future

Kavya Priyam – (22JE0468)

A New Era of Power

The way the world produces and uses energy is changing faster than ever before. As we move from fossil fuels to cleaner renewable sources, new questions arise about how to manage and distribute this power efficiently. Solar and wind energy are abundant, but they depend on natural conditions — the sun does not always shine and the wind does not always blow. This inconsistency creates a serious challenge for modern power systems. To bridge this gap between generation and demand, energy storage has emerged as one of the most important foundations of a sustainable and reliable grid.

Issue with Silicon (Si)

Silicon (Si) has been the backbone of the semiconductor industry for well over half a century. It is common, not too expensive to produce, and its properties have led it to become the go-to material for constructing billions of transistors, diodes, and microchips that drive everything from computers and smartphones to industrial motor drives and power converters. But now we're at a technology tipping point. Increasing demand for greater energy efficiency, higher-speed electronics, and smaller devices is taking silicon to the limits of its physical properties.

Understanding the Role of Storage

At its core, an energy storage system is designed to hold electrical energy temporarily and release it whenever needed. These systems help balance the grid by maintaining frequency, regulating voltage, and ensuring a consistent flow of electricity. When renewable plants generate more power than required, the excess is stored instead of wasted. Later, during high demand or low generation periods, that stored energy is fed back into the grid. This simple yet powerful concept enhances reliability, reduces energy loss, and makes large-scale renewable adoption truly practical.

The Core Technologies

There are many different ways to store energy, each suited to specific needs. Electrochemical storage — mainly batteries — is the most common today. Lithium-ion batteries lead the market because they combine high energy density with long life and fast response times. However, next-generation systems like sodium-ion and solid-state batteries are gaining attention. They use safer, more abundant materials and offer better stability at higher temperatures. On the utility side, mechanical storage methods such as pumped hydro and flywheels play a major role. Pumped hydro is still the largest form of energy storage worldwide, capable of handling massive loads and providing long discharge durations ideal for balancing national grids.

Emerging Innovations

Innovation in this field is constant. Flow batteries, for instance, store energy in liquid electrolytes and allow independent scaling of capacity and power, which is perfect for flexible grid applications. Hydrogen-based storage takes surplus electricity and converts it into hydrogen through electrolysis, which can later be used for electricity generation or as a clean fuel. Thermal energy storage, where heat is stored in materials like molten salts, supports concentrated solar power plants by extending their operation beyond daylight hours. These emerging technologies are expanding the boundaries of what a renewable-driven grid can achieve.

The Core Technologies

Hybrid Systems and Smart Control Modern systems are increasingly hybrid in nature. Engineers are combining batteries with supercapacitors or fuel cells to balance quick response with long-term endurance. These hybrid setups are coordinated by advanced control algorithms that distribute energy according to changing load conditions. Intelligent Battery Management Systems, equipped with sensors and AI-based analytics, can now monitor cell health, predict aging, and prevent failures. This smart coordination allows storage systems to communicate seamlessly with the grid and adapt to real-time conditions — something unimaginable a decade ago.

The Role of Power Electronics

Behind every efficient storage system lies the silent contribution of power electronics. Devices like inverters, converters, and controllers regulate how energy flows between storage units and the grid. They manage voltage levels, control current direction, and ensure smooth transitions between charging and discharging. Recent advances in wide-bandgap semiconductors such as silicon carbide and gallium nitride have made these systems faster, smaller, and more energy-efficient. For electrical engineers, this intersection of storage and power electronics represents one of the most promising and rapidly growing research areas today.

Challenges on the Road Ahead

Despite the exciting progress, large-scale deployment of energy storage still faces challenges. Battery systems remain expensive, and the global supply of raw materials like lithium and cobalt is limited. Heat management, fire safety, and the recycling of used cells also require careful attention. To address these issues, researchers are developing new chemistries such as zinc-air, iron-flow, and aluminum-ion batteries that rely on cheaper and more sustainable materials. Improving recy-

clability and designing circular-economy frameworks will be key to making energy storage cleaner and more affordable in the long run.

India's Path Toward Energy Independence

India has set ambitious renewable energy targets, and energy storage is central to achieving them. The National Energy Storage Mission aims to promote domestic manufacturing, advanced research, and deployment of storage solutions across the country. Projects combining lithium-ion and flow batteries with large solar and wind farms are already taking shape. Institutes like IITs are conducting pioneering research on solid-state batteries, advanced battery management systems, and power-electronics interfaces optimized for Indian climatic conditions. These developments are paving the way for a grid that is not only green but also self-reliant and resilient.

The Future Engineers' Frontier

Energy storage has evolved from being a supporting technology to becoming an active, intelligent part of the power ecosystem. For future electrical engineers, it represents an exciting blend of power systems, control theory, materials science, and data intelligence. The ability to design, optimize, and integrate storage systems will define the next era of electrical innovation. The silent backbone of the energy revolution is, in truth, a story of engineering brilliance — one where precision and creativity work together to power a cleaner, more dependable future.

Mr. Soumyadip Banerjee has fulfilled all the requirements for the award of Ph.D. degree under the guidance of **Prof. Tanmoy Maity**. His thesis title is "Development and deployment of hybrid vertical axis wind turbines for urban and industrial exhaust energy recovery".
Hearty Congratulations for his achievement !

Upcoming Events

Executive Development Program (EDP) on "Electrical Safety and Smart Maintenance for Sustainable Mines" to be held during 05th – 09th January 2026 at Seminar Room (No. 113), 1st Floor, New Academic Complex, Department of Electrical Engineering, IIT(ISM) Dhanbad: CI- **Prof. Nitai Pal**, Professor and Co-CI- **Prof. P. K. Sadhu**, Professor (HAG), Department of Electrical Engineering. Links: https://www.iitism.ac.in/seminar-1 https://www.iitism.ac.in/electrical-engineering

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