Department of Electrical Engineering

Indian Institute of Technology (Indian School of Mines) Dhanbad

VIBHAV

Vol.II, No.2 | August, 2025 | Monthly Newsletter

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 "August 2025" edition of the Department of Electrical Engineering's Monthly Newsletter: "VIBHAV"
The month of August 2025 was marked by a significant milestone for our department with several notable individual achievements, most prominently the successful organization of the 2nd GIAN course. The program, held in the area of Bioinformatics, witnessed enthusiastic participation from about 50 participants. We were also privileged to host Dr. Rohith Reddy from the University of Houston, Texas, who joined us in person as the expert speaker for this intensive 10-day program.
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

S. K. Sena and **A. Kumar**, "A single-stage single-phase non-isolated buck boost microinverter,"
Indian Patent No. 570016,
Filed Jan. 30, 2025,
Granted Aug. 25, 2025

Outreach Activities

- **Prof. Nitai Pal** evaluated Ph.D. Thesis of Research Scholar of NIT, Kurukshetra as an External Examiner.
- A 6-weeks summer research internship (SRIS–2025) has been completed successfully by Mr. Prakhar Pandey, B.Tech. 3rd year student, EEE Department, KIET Group of Institutions, Ghaziabad, Delhi NCR under the supervision of **Prof. Nitai Pal** in the Department of Electrical Engineering, IIT (ISM) Dhanbad.

Publications

Journals

- S. Singh and **P. K. Nayak**, "Protection of high voltage transmission line connected large scale solar photovoltaic plant using green anaconda optimized machine learning method," *Computers and Electrical Engineering*, Elsevier, vol. 127, pp. 110618, 2025.
- Preet Samanta, Sagar Babu Mitikiri, Pranay Krishna Sahay, **V. L. Srinivas**, "A comparative review of radial and axial Flux PMSMs: Innovations in topology, design, and control," *Franklin Open*, pp. 100341, ISSN 2773-1863, 2025.
- S. Kumar, K. R. Khan, **V. L. Srinivas**, G. Shankar, R. K. Saket and K. C. Jana, "Electric Vehicle Fast Charging Integrated with Hybrid Renewable Sources

for V2G and G2V Operation," *IEEE Transactions on Industry Applications*, 2025.

- Banerjee, S., **Maity, T**, "Wake dynamics and synergistic clustering-based power generation potential of a hybrid VAWT in a mine ventilation system," *Sādhanā*, vol. 50, no. 192, 2025.

Conferences

- Mitikiri Sagar Babu, Battula Amruth Raju, Dushyant Sharma, Mayukha Pal, **V. L. Srinivas**, "Eliminating Cascaded Control Loops: A Neural Network Approach for Grid-Forming Inverters," *IEEE North-East India International Energy Conversion Conference and Exhibition*, 2025.
- Tushita Das, Sagar Babu Mitikiri, Pranay Krishna Sahay,**V. L. Srinivas**, "Cyber-Induced Voltage Deviation Detection and Mitigation in DC Microgrids Under Operational Constraints," *IEEE North-East India International Energy Conversion Conference and Exhibition*, 2025.
- Pranay Krishna Sahay, Mitikiri Sagar Babu, Preet Samanta, Tushita Das, VL Srinivas, "SOGI based Three Phase G2V, V2G Technology," *IEEE North-East India International Energy Conversion Conference and Exhibition*, 2025.
- Somesh Ganguly, **Arijit Baral**, Sivaji Chakravorty, "Combined Effect of Thermal Stress and Moisture on Degradation of Nomex Paper-Based Dry Insulation," *24th International Symposium on High Voltage Engineering*, Karuizawa, Japan 2025.

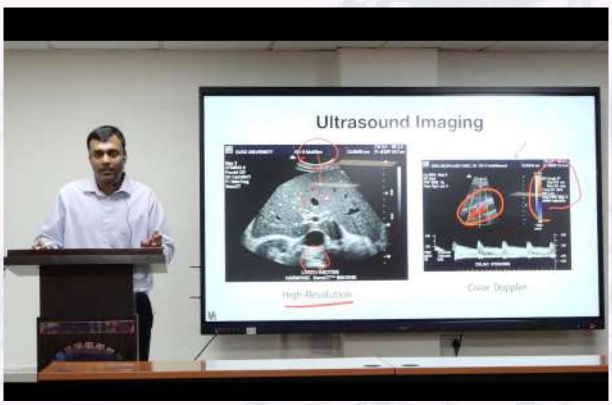
Executive Development Program (EDP) on "Electrical Safety and Precautionary Maintenance for Sustainable Mines"

Department of Electrical Engineering, IIT (ISM) Dhanbad has organized successfully an Executive Development Program (EDP) on "Electrical Safety and Precautionary Maintenance for Sustainable Mines" during 04–08 August 2025 [No. CONS/7520/E]: CI- **Prof. Nitai Pal**, Professor and Co-CI- **Prof. P. K. Sadhu**, Professor (HAG).
The program has been designed to keep in view the diverse aspects of electrical safety issues of the minors and preventive maintenance of machinery under operations in underground and open-cast mines. Besides the huge production, safety is the first and foremost choice for the miners as well as the preventive maintenance of machineries is the vaccine for Production. Also, the realization of the vast potential of its applications in various dimensions of its functioning has been considered. So, the topic is quite relevant nowadays for sustainable mines to increase productivity efficiently and effectively with safety.

Ten-days GIAN course on "Innovations in Infrared Imaging"

The Department of Electrical Engineering conducted a GIAN course on "Innovations in Infrared Imaging," from August 6th - 20th. The course was coordinated by **Dr. Haswanth Vundavilli**, who invited Dr. Rohith Reddy from University of Houston, Texas, to deliver the 10-day course.

Dr. Reddy delved into the integration of mid-infrared spectroscopy with microscopy to enable spectroscopic imaging, which maps biochemical composition across tissues, enabling applications in cancer diagnostics and renal pathology.

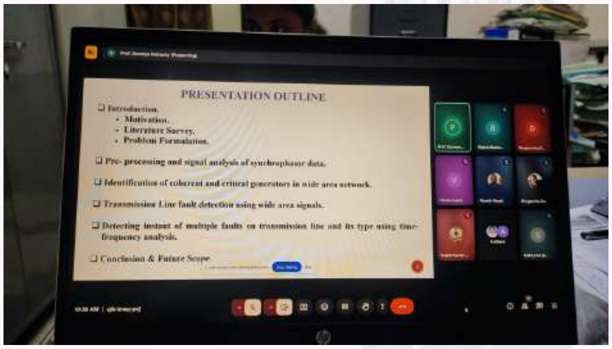


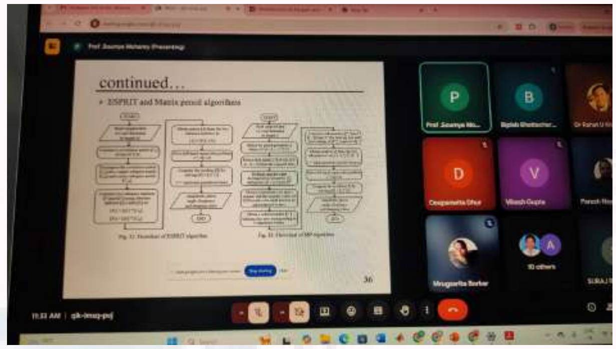
Three-day Centenary Webinar on "AI Applications for Intelligent Control, Monitoring of Industry Equipment and Protection of Renewable Integrated Power Systems"

The Webinar was conducted by **Prof. Biplab Bhattacharya** during 6-8 August 2025.

This three-day centenary webinar (total 12 lecture hours) on "AI Applications for Intelligent Control, Monitoring of Industry Equipment and Protection of Renewable Integrated Power Systems" explores Artificial Intelligence (AI) applications for intelligent control and monitoring of industry equipment. It also offers a platform to discuss the integration, control, and protection challenges and possible solutions for future renewable-dominated power systems.

This webinar aims to enhance the knowledge and technical skills of research scholars, student participants, faculty members, and industry professionals in the domain of AI applications for intelligent control and monitoring of industrial equipment. This program provides an opportunity to discuss the impacts of integrating inverter-based resources (IBRs) such as solar and wind on bulk power system dynamics and shortcircuit performance as well as the protection challenges and solutions associated with IBR-integrated power distribution and transmission networks.





STUDENTS' CORNER

Revolutanizing Power Electronics: Wide Band Gap Semi Conductors

Samiksha Biswas – (24JE0164)

Role of Power Semiconductors

Power electronics is the key technology to efficient power conversion, control, and management of electric power, a role that is central to nearly every contemporary electrical system and infrastructure. Lying at the core of this technology are power semiconductor devices, which are transistors and diodes that are highly specialized and serve as active devices able to carry out tasks such as amplification, rectification, and switching in a circuit. Power semiconductors differ from other types of semiconductors that deal with low-level signals in that they are designed to work at much higher voltages and currents and are largely responsible for the world's electrical infrastructure.

These devices serve mostly as on/off switches for power control circuits, for example, in a switch-mode power supply. Although conventional signal devices are more geared towards higher switching frequencies, power devices are designed for high-performance operation under harsh conditions. Their basic purpose of controlling and guiding the flow of electrical energy is mostly invisible to the consumer. This backroom role as the "enablers" is why power semiconductors advances are so important; they are not components but the unseen architects that control the efficiency and ability of the entire power domain, from a charger to an electric vehicle powertrain.

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.

Switching speed constraints:

Switching devices between on and off quickly is critical in power electronics to manipulate energy flow with minimum losses. Silicon devices, however, suffer more from switching losses owing to lower mobility of charge carriers and recombination times. Silicon transistors generate a lot of heat with higher switching frequency, which affects efficiency. This lowers their potential in the use of next-generation high-frequency DC–DC converters, on-board electric vehicle charging, and advanced radar systems, where highly fast switching is a requirement.

Temperature limitations:

Silicon has a bandgap of only 1.1 eV, which means it deteriorates under high electric fields and does not function reliably above around 150–175°C. Under practical conditions, this requires oversized cooling hardware (heat sinks, fans, liquid cooling) to maintain devices within a safe range. The cooling hardware not just adds bulk and expense, but also compromises overall system energy efficiency. This is a severe bottleneck in applications such as aerospace or electric cars, where weight, thermal management, and efficiency are everything.

Low power density:

Silicon just can't efficiently deal with high currents and voltages, so systems must make up for this with more heavy-duty transformers, inductors, and passive filters. This makes equipment both heavy and big ; remember how big old laptop power supplies or industrial motor drives used to be. In today's applications, where small energy-dense solutions are required, silicon just can't fit enough power capability into a small space.

In short, whereas silicon was the workhorse material of the 20th century, driving the computer revolution and facilitating the microelectronics boom, it is increasingly viewed as a constraint in the 21st century's quest for faster, smaller, and greener technologies.

Wide Band Gap (WBG) Semiconductors

Whereas silicon (Si) has dominated electronics for decades, it's now finally getting challenged by a new generation of materials: wide-bandgap (WBG) semiconductors. The most well-known among these are Silicon Carbide (SiC) and Gallium Nitride (GaN).

Imagine the bandgap of a semiconductor as a barrier that electrons must surmount in order to carry electricity. Silicon has a narrow bandgap, so electrons have it easy to jump the barrier, but this also makes the material prone to electrical breakdown with high voltages and temperatures. WBG semiconductors, by their name alone, have a significantly greater bandgap. This translates to it requiring a much larger amount of energy to get an electron to hop, making SiC and GaN devices capable of dealing with much higher voltages and temperatures without breakdown. This underlying property gives them a resounding advantage over conventional silicon.

What are They?

Silicon Carbide (SiC) is a silicon-carbon compound. Gallium Nitride (GaN) is a gallium-nitrogen compound. Both are extremely hard, robust materials with excellent properties that make them the best fit for high-power applications.

Why are They Better?

Greater Efficiency:

There is less waste of energy as heat when in operation. This equates to devices operating cooler, with smaller cooling systems needed, and essentially using less power.

Faster Switching Speeds:

WBG devices switch from an "on" to an "off" much more quickly than silicon. Designers can then employ higher operating frequencies, which enables smaller and more compact parts like inductors and capacitors. The device thus becomes much smaller and lighter.

Increased Voltage and Temperature Endurance:

These materials can function satisfactorily under extreme conditions that would destroy a silicon-based device. This renders them ideal for rugged applications such as electric vehicles and industrial power systems.

SiC vs GaN

Even though Silicon Carbide (SiC) and Gallium Nitride (GaN) are from the same wide bandgap semiconductor group, they are not vying for the same throne. They excel in different areas of power electronics, each doing something that the other cannot. It is this "friendly competition" that has led to a healthy division of labor in contemporary technology, with both materials occupying a niche.

Silicon Carbide (SiC) would be the best described as the workhorse of the two. Its virtue is its capability to process very high voltages and high amounts of power without failing. Being a material with great thermal conductivity, SiC can withstand huge stress and heat while remaining dependable. This makes it the default option for applications like electric vehicle drivetrains, renewable energy inverters, locomotive applications, and high-voltage power grid—essentially, anywhere more concern about ruggedness and reliability outweighs concern about small size. Put simply, SiC is a sturdy, stable truck: designed to deliver heavy payloads over long distances, slow and steady but extremely reliable.

At the same time, Gallium Nitride (GaN) is a speedster designed for acceleration. GaN performs well for applications with high frequencies, lower-to-medium voltages where agility and efficiency are the utmost priority. GaN switches at lightning speeds with its high electron mobility, enabling power supplies and converters to be miniaturized, lightweight, and lightning-fast. Such agility makes GaN ideal for fast chargers, miniature power adapters, high-speed data centers, and radio frequency communication applications such as 5G and satellite electronics .As a quick racing car, GaN covers distances in small steps at blistering velocities with precision and flair.

The two materials complement each other rather than duplicating themselves. SiC dominates where muscle and endurance are needed, while GaN dominates where velocity and rapidness are needed. The balanced combination ensures that we benefit from the best of both worlds:heavy-duty high-voltage systems driving our green grid and electric vehicles, and thin high-frequency solutions driving our chargers, consumer devices, and wireless networks.

Conclusion

Power semiconductors are the behind-the-scenes cornerstone of contemporary power electronics, making possible efficient conversion, control, and distribution of electric energy. Silicon has been the backbone of this field for decades, yet it is increasingly being held back by its physical and thermal limits. The advent of wide bandgap semiconductors, including Silicon Carbide (SiC) and Gallium Nitride (GaN), represents a revolutionary transition. With their capacity to withstand higher voltages, temperatures, and switching frequencies, these materials set the stage for smaller, faster, lighter, and more efficient power systems. SiC offers the rugged reliability required for high-voltage, heavy-duty applications, and GaN offers unparalleled performance in high-frequency, compact designs. In combination, they are not just substitutes for silicon, but facilitators of a whole new generation of energy-saving technologies. As we proceed towards electrified transportation, integration of renewable energy, and state-of-the-art communication systems, wide bandgap semiconductors will be at the center of power electronics transformation, fueling innovation and sustainability for the decades ahead.

Mr. Goutam Goswami has fulfilled all the requirements for the award of Ph.D. degree under the guidance of **Prof. Sukanta Das**. His thesis title is "Robust Energy Efficient Operating Strategies for High Performance Induction Motor Drives"

Hearty Congratulations for his achievement !