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 pride, we present the March 2026 edition of the Department of Electrical Engineering's monthly newsletter, VIBHAV. Each issue of VIBHAV embodies the dynamic academic spirit of our department and its steadfast commitment to excellence.
The month of March 2026 has been marked by some remarkable individual achievements that highlight the dedication, perseverance, and collaborative ethos of our faculty, students, and staff. These milestones not only celebrate personal success but also contribute to strengthening the collective identity and reputation of our department.
As we move forward, we warmly invite our students to play an active role in enriching the quality, diversity, and reach of VIBHAV. Your thoughtful feedback and creative suggestions are always welcome and may be shared at ee@iitism.ac.in. Together, let us continue to make every edition of VIBHAV more engaging, inspiring, and impactful.
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.

Individual Achievement

Prof. Ashok Kumar (PI) received a project titled "Design and Development of a Hybrid AC–DC Multi-Port Converter for Intelligent and Sustainable EV Charging", from ANRF with the valuation of Rs. 62,66,071

Hearty Congratulations for his achievement !

Publications

Journals

- A. R, **P. Mahish**, H. Misra, B. S. T and M. K. P, "Thermal Analysis of EHV XLPE Cable Systems Using FEM During Pre-Qualification Assessment," *IEEE Transactions on Power Delivery*, doi: 10.1109/TPWRD.2026.3674824.
- 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*, vol. 62, no. 1, pp. 165-178, 2026.
- B. Das, **Soumyabrata Barik**, D. Das, "Towards the smarter microgrids: Startegic and optimized deployment of Electric Vehicle charging station along with DGs and SVCs," *Sadhana Journal*, Springer, 2026. [Accepted]

Conferences

- Sonu Kumar, **Ananda Shankar Hati** and Nishant Mishra, "Sensorless Direct Torque Control (DTC) Scheme for a Voltage Source Inverter (VSI) Fed Induction Motor Drive Using Space Vector Modulation (SVM)," *4th Odisha International Conference on Electrical Power Engineering, Communication and Computing Technology (ODICON-2026, Siksha' O' Anusandhan (Deemed to be University)*, Bhubaneswar, India, 20–21 February 2026.
- Pankaj Sarkar, **Nitai Pal**, Sudipta Chakraborty, Dinesh Mistri, Nimesh Kumar Singh, and Faizan A. Khan, "Prototyping of Structurally Optimized Four-wheeled EV for Rural Mobility," *Technical Conference on Bharat Electricity Summit (BES-2026)*, organized under the patronage of the Ministry of Power, Government of India, held at Dwarka, New Delhi during 19–22 March 2026.
- **Nitai Pal**, Prakhar Pandey, Promit Kumar Saha, Faizan A. Khan, Brijesh Singh, and Yaduvir Singh, "Performance Investigation of MPPT Controlled Boost Converter for Rural RE Applications," *Technical Conference on Bharat Electricity Summit (BES-2026)*, organized under the patronage of the Ministry of Power, Government of India, held at Dwarka, New Delhi during 19–22 March 2026.
- Anagha Rajendran K. P., **Soumyabrata Barik**, Sudarshan Swain, "Uncertainty-Aware Stochastic Assessment of Fully Integrated EV Charging Infrastructure in Distribution Networks Under Critical Load Conditions," *The International conference series: Power Electronics, Machines and Drives, 15th Edition*, London, UK, 2026. [Accepted]

Book/Book Chapter

- Heung Soo Kim, Salman Khalid, **Ananda Shankar Hati** and Prashant Kumar, "Recent Advances in Machine Learning and Deep Learning Theories Towards Intelligent Fault Diagnosis," MDPI, 2026 DOI: *https://doi.org/10.3390/books978-3-7258-5952-8*

Outreach Activities

- **Prof. Biplab Bhattacharyya** delivered a keynote speech on 26th March, 2026 in the IEEE AIEI 2026 (26-28 March) organized by NIT Jamshedpur.

Students' Corner

Future of Quantum Computing in Electrical Engineering

Saranshh Rastogi– (24JE0166)

Quantum computing revolutionises how we manage computations. It stands to change electrical engineering in ways we have never seen before. Classical computers work with binary bits that are just 0 or 1. Quantum computers use quantum mechanics instead. They rely on qubits that can be in superposition. This means they represent both 0 and 1 simultaneously. Qubits also get entangled. That creates links between them, regardless of their distance. Due to this fundamental difference, quantum computers can explore exponentially more options simultaneously compared to their classical counterparts. Quantum computing solves complex optimisation and simulation problems that were impossible before. Electrical engineering skills are required to build, maintain, and deploy these systems on a large scale. The field is rapidly transforming from theories to real products.

The Quantum Advantage

Quantum computing is faster than its classical equivalent because it can exploit the fundamentals of quantum mechanics. Classical computing power increments linearly. If you double the transistors, you get nearly twice the power. Quantum computing power grows exponentially. Each extra qubit boosts the capacity far beyond what classical machines can do. They manage exponentially more data, even with a linear increase in the number of qubits. This huge scaling comes from two main quantum principles: superposition and entanglement.

Superposition allows a qubit to exist in both 0 and 1 states simultaneously, effectively exploring multiple solution pathways at once. When a qubit is measured, it collapses into a definite state: 0 or 1, with probabilities determined by its quantum state. When two or more qubits become entangled, they form a special connection where the state of one qubit is instantly correlated with the state of another, enabling the quantum system to maintain coherence across these linked states and explore combinations of possibilities exponentially. These cascading uncertainties exponentially amplify computational power: while 256 classical bits represent a single discrete state, 256 qubits can simultaneously represent all 2^{256} possible states through superposition and entanglement.

Google's quantum chip, Willow, solved a complex problem in under five minutes, which would require the world's fastest classical supercomputer approximately ten quadrillion years to complete. In general, quantum computers can serve certain problems with greater speed, like factoring big numbers, optimising complex systems, or simulating molecules. The speed advantage of quantum computers over classical ones is between 100 million and 1 billion. To achieve this, quantum systems need a robust and precise hybrid quantum-classical architecture.

The Critical Role of Electrical Engineering

Electrical engineering sits at the core of constructing quantum hardware, supplying the key technology and expertise required to turn quantum theories into working systems. To understand why electrical engineers are so crucial, imagine trying to keep a soap bubble perfectly still in a hurricane—quantum computers face a similar challenge but far more extreme. Majority of quantum computers under the work utilize superconducting qubits. These need temperatures colder than outer space to retain their quantum properties. Outer space sits at about 2.7 Kelvin, which is roughly -270^0C. Quantum machines run at 15 millikelvin, around -273^0C, right above absolute zero. The first major challenge for electrical engineers is to achieve and maintain this temperature.

Creating this extreme cold involves dilution refrigerators, massive devices like sophisticated cooling systems, but more complex and precise. These systems must be carefully designed so they can cool the delicate quantum processor while also delivering control signals to it, it's like trying to communicate with someone inside a freezer without letting the warm air escape. Every wire, every connection, and every component must be engineered to minimise heat leakage while allowing information and control commands to flow reliably.

The signals controlling qubits themselves require specialised circuitry. Quantum computers manipulate their qubits using microwave pulses, the same technology that powers microwave ovens, but far more precise and controlled. These pulses must be generated with extraordinary accuracy and delivered through carefully engineered pathways to reach the qubits without losing their integrity. Recent breakthroughs have moved beyond external electronics to on-chip microwave pulse generators integrated directly into the quantum processor building tiny, ultra-efficient signal generators right alongside the qubits themselves.

Different companies pursue different approaches to building qubits. Some systems use trapped ions (individual charged atoms held in place by electromagnetic fields), others use photonic systems (light particles), and still others use silicon-based qubits (like traditional computer chips but operating at cryogenic temperatures). Each approach demands expertise in different areas: laser control systems, fiber optics, semiconductor physics, or electromagnetic field generation. This diversity means electrical engineers with various specializations, from power systems experts to signal integrity specialists to semiconductor designers; All play essential roles in building quantum computers.

Most importantly, today's quantum computers contain only hundreds of qubits, but practical systems will need millions. Imagine connecting hundreds of thousands of control wires to a system the size of a refrigerator while keeping everything cold, preventing electrical noise from corrupting quantum data, and managing enormous amounts of power, these engineering hurdles are formidable but solvable through continued innovation in system architecture, component design, and integration techniques.

Quantum Computing's Transformative Impact on Electrical Engineering Practice

While electrical engineers build quantum computers, these systems reciprocally revolutionise how electrical engineers solve problems across the discipline. Circuit design and simulation represent the most immediate application domain. Quantum computers can simulate electronic components and systems with unprecedented accuracy and speed, accelerating optimisation of circuit designs, power consumption minimisation, and discovery of novel architectures. Traditional circuit simulation tools like SPICE, while indispensable, become computationally expensive when analysing large, intricate circuits with complex interactions between components. Quantum simulators promise to model detailed interactions between electrons and electromagnetic fields at scales currently inaccessible.Large-scale electrical grids involve extraordinarily complex optimisation problems: optimally routing electricity flow to minimise transmission losses, ensuring stability amid fluctuating renewable energy supplies, and maintaining reliability across distributed networks with multiple variables and constraints. Classical optimisation methods often fail to identify efficient configurations when facing networks of this scale. Quantum algorithms, particularly the Quantum Approximate Optimisation Algorithm (QAOA) and quantum annealing approaches, can simultaneously evaluate vast numbers of potential system configurations, identifying optimal energy distribution routes that account for supply fluctuations, transmission losses, and grid stability constraints. Dubai has already demonstrated this potential with quantum-optimised grid management that improved solar energy utilisation, presaging widespread deployment of quantum optimisation in electrical infrastructure.

Materials science and semiconductor design will undergo a fundamental transformation through quantum computing. Many materials' electrical properties are fundamentally governed by quantum mechanical behaviour at atomic scales, effects that classical simulation tools cannot accurately model. Quantum computers can simulate materials at the atomic level with high fidelity, accelerating the development of semiconductors with superior properties: better conductivity, lower energy dissipation, and enhanced performance for power electronics. For advanced battery materials essential for electric vehicles and renewable energy storage, quantum simulations have already identified materials that improve battery performance beyond lithium-ion technologies.

Cryptography and security form yet another domain where quantum computing creates both challenges and opportunities for electrical engineers. Quantum algorithms like Shor's algorithm can factor large numbers exponentially faster than classical methods, posing fundamental threats to current encryption infrastructure that protects electrical grid control systems, communications networks, and industrial systems. This threat has spawned an entire subfield, post-quantum cryptography, requiring electrical engineers to develop and implement quantum-resistant algorithms in hardware and embedded systems before quantum computers reach the scale necessary to break current encryption standards. Simultaneously, quantum communication systems enabled by quantum key distribution protocols promise theoretically unbreakable encryption, requiring electrical engineers to develop quantum repeaters, quantum networks, and hybrid systems integrating quantum and classical communications infrastructure.

Current Developments: The Industry's Rapid Evolution Toward Practical Systems

IBM's quantum roadmap provides the most comprehensive view of how quantum systems will scale from the laboratory toward industrial deployment. IBM plans to deliver its Starling system by 2029 the first large-scale, fault-tolerant quantum computer, featuring two hundred logical qubits capable of executing one hundred million error-corrected operations. IBM's intermediate milestones illuminate the engineering challenges: the Loon processor (2025) will demonstrate robust storage of errorcorrected information; Kookaburra (2026) will incorporate both storage and computation in a multichip configuration; and Cockatoo (2027) will link two Kookaburra modules, validating a scalable modular architecture.

Atom Computing and Microsoft have demonstrated complementary progress with neutral atom platforms, announcing a commercial quantum system featuring twenty-four logical qubits inNovember 2024,the largest number of entangled logical qubits ever demonstrated, with commercial availability expected in 2025.

These developments reveal electrical engineering's central role: every announced milestone involves hardware advances requiring expertise in cryogenics, RF engineering, signal integrity, power delivery, thermal management, and integrated circuit design. The shift toward modular quantum-classical architectures particularly demands electrical engineers skilled in heterogeneous systems integration, synchronisation across distributed processors, and hybrid computing platforms.

Toward Fault Tolerance: Future Goals and Engineering Challenges

The near-term future of quantum computing centres on achieving fault-tolerant quantum computing (FTQC) systems that detect and correct errors automatically, enabling reliable operation at scales needed for practical applications. Current quantum computers are fundamentally limited by noise and decoherence: quantum states are extremely fragile, collapsing when exposed to environmental disturbance, and error rates in quantum gates remain substantial typically 0.1This means that without error correction, quantum circuits with more than a few hundred operations become unreliable.

Quantum error correction will depend on elegant theoretical codes, surface codes, LDPC codes, repetition codes, but implementation of these codes represents a massive electrical engineering challenge. This demands ultra-low-noise qubit readout circuits, fast classical processing integrated cryogenically with quantum processors, and synchronisation between quantum operations and error detection spanning microsecond timescales. Recent work on cryogenic CMOS circuits enabling onchip classical processing and control at millikelvin temperatures represents critical progress but scaling these systems to control millions of qubits while maintaining power budgets and thermal performance remains unsolved.

Beyond error correction, future quantum systems will require quantum networking, linking quantum computers across distances through quantum repeaters and quantum communication channels, enabling distributed quantum processing for problems exceeding individual system capabilities. Recent demonstrations of cryogenic microwave links coherently connecting superconducting qubits in spatially separated cryogenic systems represent first steps, but scaling to networks spanning data centres and across cities demands that electrical engineers develop quantum routers, quantum memories, and hybrid optical-electrical systems maintaining quantum coherence across macroscopic distances. Scaling to practical problem sizes represents the ultimate engineering frontier.

Conclusions

Quantum computing represents both an extraordinary challenge and opportunity for electrical engineering. The discipline provides the fundamental expertise, cryogenics, RF design, semiconductors, power delivery, signal integrity, necessary to transform quantum computing from laboratory curiosity to practical technology. Simultaneously, quantum computers will revolutionise how electrical engineers design circuits, optimise power systems, develop materials, and secure communications infrastructure. The rapid transition from theoretical concepts to deployed systemswith hundreds of qubits demonstrates that quantum advantage is no longer speculative; electrical engineers now entering the field will lead the industry toward fault-tolerant quantum computers with transformative capabilities across society. The road ahead demands sustained innovation in hardware, integration, and systems architecture, work that positions electrical engineering at the very forefront of computing's next revolution.

Mr. Goutam Mandal has fulfilled all the requirements for the award of Ph.D. degree under the guidance of **Prof. Sanjoy Mandal**. His thesis title is "characterization of Electromagnetic Force Compensation Technology for Improving the performance of Electronic Weighing Balances".

Hearty Congratulations for his achievement !