Department of Electrical Engineering

Indian Institute of Technology (Indian School of Mines) Dhanbad

VIBHAV

Vol.I, No.3 | November, 2024 | Monthly Newsletter

Message from HoD's Desk

By PROF. SUKANTA DAS

Dear All,
Hope you are doing well!
With a great pleasure, I hereby introduce the third edition of the Monthly Newsletter of the Department of Electrical Engineering: "VIBHAV".
This edition of the Newsletter primarily focuses to report the achievements of the department for the month of November-2024. Apart from the contributions of teaching fraternity, the students' contributions in technical report writing are the other key highlights in this version.
I invite you to go through this edition of our Monthly Newsletter. I also request our students to engage themselves actively for the betterment of the Monthly Newsletter. All of you are requested to forward your constructive comments at ee@iitism.ac.in. The Editorial Team is committed to publish much improved versions in the forthcoming editions of "VIBHAV".
Merry Christmas in advance!
Thank you all.
Best regards.

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. Though, 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 the Ph.D. and Post-Doctoral Programs majority of the research activities are being carried out in the department.

Individual Achievement

Prof. Kalyan Chatterjee has been enrolled as Fellow by the Institution of Engineers (India). *Hearty Congratulations for his achievement !*

Prof. Kalyan Chatterjee

Publications

Journals

- S. Ganguly, **A. Baral**, S. Chakravorti, "Effect of Charges Freed from Shallow and Deep Traps on Dielectric Response and Associated Insulation Diagnosis," *IEEE Transactions on Dielectrics and Electrical Insulation*, in press, 2024.
- Mondal, M., Lahiri, A., **Vundavilli, H.**, Del Priore, G., Reeves, N. P., Datta, A. (2024). "A Computational Study of Efficient Combinations of FDA-approved drugs and dietary supplements in Endometrial Cancer". *IEEE Access*.
- S. K. Mohanty, **P. K. Nayak**, P. Siano, and A. Swetapadma, "Intelligent protective relaying for the series compensated line with high penetration of wind energy sources," *International Journal of Electrical Power and Energy Systems*, 163 (2024) 110362.
- G. Goswami and **S. Das**, "Inherently robust loss model controller for energy efficient operation of indirect rotor field oriented induction motor drives," *IEEE Transactions Power Electronics*, vol. 39, no. 11, pp. 14951-14960, Nov. 2024. (issued in Nov 2024)

Conferences

- S. Ganguly, **A. Baral** and S. Chakravorti, "Effect of Variation in Measurement Temperature on the Uniqueness of Time-Varying Insulation Model and Associated Diagnosis," *IEEE 7th International Conference on Condition Assessment Techniques in Electrical Systems (CATCON)*, Kolkata, 2024

- S. Banerjee, **T. Maity** and M. Sharma, "Enhanced MPPT for PMSG-Based VS-WECS: Adaptive Step-Size Perturb and Observe Algorithm with Single Current Sensor," *2024 IEEE International Conference on Smart Power Control and Renewable Energy (ICSPCRE)*, Rourkela, India, 2024, pp. 1-5.
- S. Banerjee, P. Kumari and **T. Maity**, "Development of MQTT Protocol-Based Sensor Data Subscription Using Raspberry-Pi as a Server Mode for IIoT Application," *2024 IEEE International Conference on Smart Power Control and Renewable Energy (ICSPCRE)*, Rourkela, India, 2024, pp. 1-5.
- **A. Kumar** and S. K. Sena, "Small Signal Modelling of Open Loop Single Mode Inverter Using Circuit Averaging Technique," *2024 International Conference on Emerging Frontiers in Electrical and Electronic Technologies (ICEFEET)*, Patna, India, 2024. *(Best Paper Award)*
- Suraj S, Subramaniyan P J, N. Manjarekar, **S. Barik** and S. Swain, "Time of the Day based Charging of Electric Vehicles along with V2G and Solar Photovoltaic System for Indian Electricity Demand Scenario," *2024 International Conference on Modeling, Simulation & Intelligent Computing (MoSICom)*, BITS Pilani Dubai, Dubai, 2024.
- Anagha Rajendran K P, **S. Barik** and S. Swain, "Logic OR Based Forward Backward Load Flow Method for DG Placement and Sizing with Modified Fuzzy Max-Min Principle for Different Load Types," *2025 Fourth International Conference on Power, Control and Computing Technologies (ICPC2T*, NIT Raipur, India, 2024.

Book/Book Chapter

- Promit Kumar Saha and **Nitai Pal**, "Comprehensive investigation of the architectures of single-stage switched-boost inverters," *Recent Advancements in Computational Intelligence and Design Engineering*, CRC Press, 2024, chapter 47, pp. 304-317.

Patents

Patent filed no. 202431093206, Dated 28^{th} Nov. 2024, "A multi-level switched-capacitor-based single source inverter generating boosted output voltage," Bikramaditya Chandan, Pradipta Kumar Pal, and **Prof. Kartick Chandra Jana** to Indian Patent Office on 28th November 2024.

Outreach Activities

Innovation, Design, and Entrepreneurship (IDE) Bootcamp, for school teachers under Innovation Cell, Ministry of Education, Government of India held on 29-30 November 2024 at IIT (ISM) Dhanbad.

Faculty Coordinators of organizing committee: **Prof. Nitai Pal, Prof. Pradip K. Sadhu**

Upcoming Events

First *IEEE International Conference on Smart and Sustainable Developments in Electrical Engineering (SSDEE)* from 28^{th} Feb. to 2^{nd} Mar. 2025.

Link to Access: https://people.iitism.ac.in/ ssdee-2025/

Five-day Executive Development Program entitled "Preventive Maintenance and Electrical Safety in Mines" to be organized by the Department of Electrical Engineering, IIT (ISM), Dhanbad from 20^{th} Jan. to 24^{nd} Jan. 2025.

Coordinators: **Prof. Nitai Pal** and **Prof. Pradip K. Sadhu**

Link to Access: https://www.iitism.ac.in/ announcement

Students' Corner

The Role of Quantum Computing In Electrical Engineering

Sriram Ryali – (23JE0834)

WHAT ?

Quantum Computing is an emerging fleld that's based on the principles of Quantum Mechanics. It differs completely from classical computing in the way that it processes information and has a different range of applications and usages. It plays a key role in areas like power systems, material discovery and circuit design.

WHY ?

Quantum computation isn't really just a faster or upgraded version of classical computation. It is studied with a different aspect in mind, to solve an entirely new world of problems. Yes, it might not solve the existing operations such as addition as quickly as normal computers do, But it is meant to do a different job, accessing the information on quantum levels, where each bit is called **Qubit**. The name Qubit comes from Quantum Bit, representing the quantum levels. It helps us to tackle problems involving tonnes of data, where classical computers could take over a sep-

tillion years (10^{24} years!!!), longer than the age of the universe itself!!!

ANALOGY !

Consider that we are on an expedition on an island; now note the mode of expedition; suppose the initial computers from the 50's represent us walking there, the computers that we use represent bikes, and supercomputers represent F1 cars, then quantum computers can be treated as ships. Here, a car and a ship can't be compared directly. Similarly, classical and quantum computing can't be directly comparable because they have different fields of work.

HOW ?

Quantum computing works on the three core principles of quantum mechanics, namely Superposition, Interference and Entanglement of quantum particles. Superposition allows the simultaneous existence of Qubits in multiple states, enabling parallel computation. Quantum Entanglement explains the correlation between particles, leading to faster data transfer and problem-solving. Interference helps refine computations by amplifying correct solutions.

The major contributions of Quantum computing to electrical engineering are :

Power System Optimisation: Quantum algorithms optimize energy flow in grids by minimizing losses and enhancing stability. They are capable of dynamically balancing the load distribution to prevent blackouts. Electronics' Material Discovery : They are very helpful in identifying and testing new materials for semiconductors and superconductors, improving efficiency and performance.

Advanced Circuit Simulation: With its precise simulations of complex electrical circuits, including nanoscale circuits and electromagnetic fields, More efficient components can be designed with higher precision and accuracy.

One of the real-world applications of quantum computing is grid management. Quantum-enhanced algorithms are being used to enhance power distributions in grids, especially in Smart grids.

Material Science: Quantum simulations are driving advancements in broader fields like semiconductors and superconductors.

Battery Optimization: They can be very helpful in improving the efficiency of batteries by improving battery chemistry. IBM and Google are leading the race in Quantum computing.

Interesting Resources:

"Meet Willow, our state-of-the-art quantum chip"- Google

"Announcements from IBM Quantum Developer Conference 2024" - IBM

Challenges: Building and maintaining Quantum computers require highly efficient resources and cooling systems. For example, the one built by IBM has a cooling system that maintains a temperature of " 15 mK " - the lowest in the entire universe. Also, these quantum computers are very limited in size; larger ones are needed for more complex problems. Finally, linking Quantum technology with existing electrical systems is a huge task yet to be done.

Conclusion: Quantum Computing is poised to change the future of electrical engineering by solving complex and tough problems that were previously thought impossible. More of this is yet to come, but potential work has already begun. Quantum computing paves the way for an advanced and sustainable future.

The Evolution of Microprocessors: Revolutionizing Computing

Arjun Ashok Kumar Bhandary – (23JE0147)

In recent times, one could say the most notable development of human technology has come through the rise of artificial intelligence and machine learning. Through the power of statistics and simple mathematics, one could now go from creating a simple spam email classifier to omniscient Large Language Models. Ironically, to train and run these magical models, we did not have neither the convenient hardware nor strong enough computing power. Hence, the rise of artificial intelligence ended up catalyzing the evolution of microprocessors. This article would be covering how the computing strength has evolved in the last 20 years through the help of microprocessors.

To start this topic, one must discuss what CPUs are and their role in computing. CPUs, or Central Processing Units, are the core components of a computer responsible for executing instructions from programs and managing tasks. Often called the "brain" of the computer, it performs basic arithmetic, logic, control, and input/output operations. Over the last 20 years, CPUs have experienced groundbreaking advancements in architecture, manufacturing processes, and functionality. Here are few of the notable changes made:

1. Transition to Multi-Core Architectures: The most game-changing innovation made was to change the architecture from single-core to multi-core processors. All of a sudden, a single CPU chip had two or more independent cores which led to parallelism. Traditional single-core processors, while powerful, reached a point where increasing clock speeds led to diminishing returns due to heat generation and power consumption. Multi-core designs address these challenges by distributing workloads across multiple cores, allowing for parallel processing without significantly increasing energy usage or heat.

2. The Impact of Transistor Scaling on CPU Advancement: It is clear that there's been an exponential increase in the performance and efficiency of the CPU which largely relied on Moore's law which forecasts that chips have the number of transistors increasing in an exponential fashion roughly every two years. Transistor scaling has been the primary contributor towards such progress.

Transistors are created based on a specific manufacturing process technology node which mostly ranges between a specification of 130nm to 3nm for CPUs in 2024. Furthermore, this growth can be attributed to various technological innovations such as EUV lithography which leads to faster response and cut down usage of energy. A very significant example to this would be how a Pentium 4 which was developed in the early 2000's CPU's used about 55 million transistors operating in the nanoscale while modern M3 Apple chips with 3 nano technology have an astonishing almost around hundred billion.

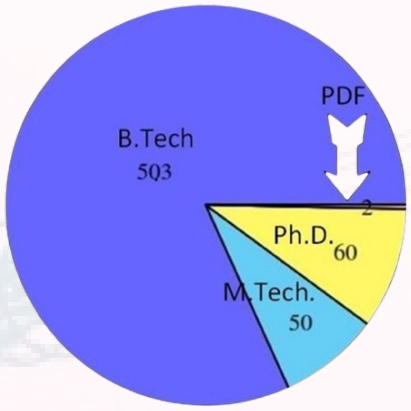
3. AI Accelerators and Security Enhancements: Today CPUs have extended beyond the original broad purpose of computation by adding certain features that specifically deal with the requirements of advanced computing applications. One of the main factors furthering this advance is the addition of AI accelerators and neural processing units, as well as more secure technologies such as Intel's SGX or AMD's SEV. These breakthroughs make it possible for CPUs to perform delicate operations and computations with secured confidentiality the computing environment. As the demand for artificial intelligence (AI) continues to rise, AI accelerators and NPUs have come to be integrated within modern CPUs and are crucial in offloading machine learning (ML) workloads, mainly in directions of inference and real-time analytics. Here's how these technologies work:

a) AI Accelerators: These are AI specific circuits embedded in the CPU meant to perform certain AI routines that may involve the use of vector and matrix arithmetic as is the case with convolutional neural networks architectures. Tasks that require computation but do not require AI algorithms to run are better handled in general purpose cores, therefore offloading them increases performance and saves energy as well.

b) Neural Processing Units (NPUs): NPUs are parts of the computer that are solely devoted to the matrix computations involving deep networks, they are also good at inference which essentially is the getting of an output from a pre-trained model.

Aniket Vatsa was honored with the Best PhD Thesis Award for the year 2024.

Hearty Congratulations to him!



Student Strength