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TRONICALS

COVER STORY

WATT THE FUTURE

AI'S GROWING ENERGY CRISIS

EDITORIAL TEAM

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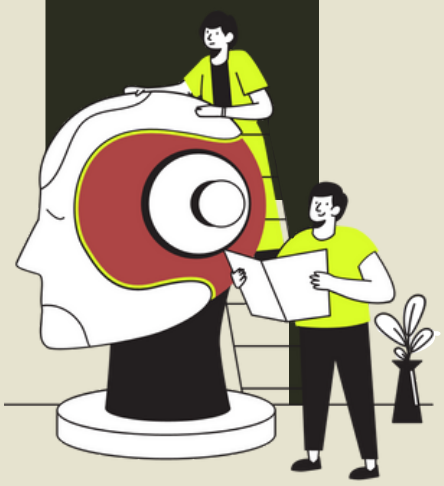


MESSAGE FROM THE EDITORIAL TEAM

Welcome to Tronicals 10.2, where we embark on an exciting exploration of the ever-evolving world of Electrical and Electronics Engineering. The EEE Association is a beacon of innovation, knowledge, and technological progress. We witness remarkable advancements each year, and this symposium is a tribute to those achievements.

We hope Tronicals is your guiding light in this universe of brilliant ideas and cutting-edge concepts. Our privilege is to unite EEE enthusiasts, foster collaboration, exchange insights, and inspire the future.

In a world driven by technology, EEE plays a pivotal role. It powers our devices, fuels connectivity, and drives progress. This symposium embodies the essence of EEE, providing a platform for discovery, discussion, and inspiration.

Join us on this electrifying journey as we explore the boundless possibilities of EEE. Engage, learn, and shape an electric, electronic, and extraordinary future!

MESSAGE FROM HOD
Dr. Sishaj P Simon

I am honored to be part of the second issue of the tenth volume of Tronicals, the biannual magazine of our department. The theme of this edition, “Watt the Future and AI’s Growing Energy Crisis,” is highly relevant and reflects the progressive direction of our department.

Dr. Sishaj P Simon
HOD EEE

We continue to progress by upholding our core values and rich legacy, ensuring alignment with the mission and vision of our department, institute, and nation. This commitment is evident in our QS World Subject Ranking of 501-550, reinforcing our global presence. Research in our department is dynamic and interdisciplinary, seamlessly integrating AI into various electrical engineering applications. With numerous sponsored projects in renewable energy and electric vehicles, our faculty have secured significant funding from various agencies, enabling state-of-the-art research facilities.

I strongly encourage both undergraduate and postgraduate students to engage not only in academics but also in these funded research projects and association activities, contributing to a holistic and enriching learning experience. Beyond placements, many of our students gain valuable industry exposure through internships, earning while they learn during their final semester. This flexibility in the academic schedule should be leveraged for better career opportunities.

I am pleased to share that our new annexure building, spanning a total area of 4,164 square meters, is nearing completion, marking a significant enhancement to our infrastructure. This addition will accommodate new curriculum and research laboratories, further strengthening our academic and research capabilities.

As I reflect on these remarkable developments, I am confident that our department is poised for a bright and promising future. I extend my heartfelt gratitude to the editorial team for their dedication and effort in bringing this edition to fruition. Wishing everyone continued growth and success.

MESSAGE FROM FACULTY ADVISOR

Dr. Josephine R. L.

Dr. Josephine R. L.
FACULTY ADVISOR, EEEA

Warm greetings to all EEE enthusiasts from the EEE Association (EEEA) and Tronicals. As the Faculty Advisor of the EEE Association, I am privileged to address you all.

Currents, our department's annual symposium, reflects our unwavering dedication to innovation and excellence within the department. With an exciting lineup of Guest Lectures from industrial experts, hands-on technical workshops, and thrilling competitions, we constantly strive to push the frontiers of technology and inspire the next generation of engineers. This edition of Currents focuses on Artificial Intelligence(AI) implementation in Electrical Engineering. The world has seen various stages of evolution in civilisation, and now it has reached the current stage - Automation using AI. Artificial Intelligence has garnered widespread attention and usage due to its versatile nature.

It is trained by human experts to think like a human.

We must be very cautious when implementing Artificial Intelligence and Machine Learning. We must ensure that we use it for the betterment of society and humankind. As Electrical engineers, we can use Artificial Intelligence tools to design circuits that can help society and the nation. Other applications include adaptation of supply changes, prevention of power outages, demand forecasts, AI assistance on healthcare and fitness equipment and much more. We cannot escape the modernisation using AI. However, we must ensure that AI does not create a negative impact.

Next, I would like to talk about Light Up 2.0 because "People learn from the good works we do. Lessons are not just classroom bounded. It is beyond that." Education is the biggest contribution and the greatest resource that we can give back to the society. I feel immensely proud that the Social Responsibility of the EEE Association has done exceptional work for rural children through Light Up 2.0. We donated JEE books and gave career guidance to the children. Our EEE students, faculty and staff have set an example to their juniors as well as our society. What's a more powerful message than being a good human. I am sure that our EEE students will set themselves as an example to everyone.

Good Luck to the entire team of the EEE Association. May the Almighty guide and protect all of us.

VISION AND MISSION OF THE DEPARTMENT

About

The department of Electrical and Electronics Engineering, NIT Tiruchirappalli was started in 1964. It offers one Under-Graduate programme (B.Tech.), two Post-Graduate programmes (M.Tech. in Power Systems and M.Tech. Power Electronics) and also research programmes (M.S. and Ph.D.) in the various fields of Electrical and Electronics Engineering. After the institute became NIT, the department has grown not only in terms of student and faculty strength but also in improving the laboratory facilities for teaching and research purposes. The department is recognised for excellence in research, teaching and service to the profession.

The faculty members have a strong sense of responsibility to provide the finest possible education for both graduate and undergraduate students. The academic strength of the faculty is reflected by the alumni, many of whom are in the top echelons of industry and academia both in India and abroad.

Vision

To be a centre of excellence in Electrical Energy Systems.

Mission

- Empowering students and professionals with state-of-art knowledge and Technological skills.
- Enabling Industries to adopt effective solutions in Energy areas through research and consultancy.
- Evolving appropriate sustainable technologies for rural needs

B. Tech Programme

Programme Educational Objectives

The major objectives of the B.Tech. programme in Electrical and Electronics Engineering are to prepare students:

- For graduate study in engineering
- To work in research and development organisations
- For employment in electrical power industries
- To acquire job in electronic circuit design and fabrication industries
- To work in IT and ITES industries

Programme Specific Outcomes

- Apply fundamental knowledge of Electrical , Electronics and Computer Engineering concepts to understand, analyse and solve complex problems in Power Engineering and allied areas.
- Analyse, design and develop Electronics circuits and systems
- Adapt to the changing needs for self and continuous learning, communicate effectively and practise professional ethics for societal benefits.

Programme Outcomes

The students who have undergone the B.Tech. programme in Electrical and Electronics Engineering (EEE):

- Will have an ability to apply knowledge of mathematics and science in EEE systems.
- Will have an ability to provide solutions for EEE problems by designing and conducting experiments, interpreting and analysing data, and reporting the results.
- Will have comprehensive understanding of the entire range of electronic devices, analog and digital circuits with added state-of-art knowledge on advanced electronic systems.
- Will have knowledge and exposure on different power electronic circuits and drives for industrial applications.
- Will have in-depth knowledge in transmission and distribution systems, power system analysis and protection systems to pursue a career in the power sector.
- Will have a good knowledge in microprocessors/microcontrollers, data structures, computer programming and simulation software.
- Will be able to develop mathematical modelling, analysis and design of control systems and associated instrumentation for EEE.
- Will be able to systematically carry out projects related to EEE.
- Will have an ability to participate as members in various professional bodies as well as multidisciplinary design teams.
- Will demonstrate the ability to choose and apply appropriate resource management techniques so as to optimally utilise the available resources.
- Will be proficient in English language in both verbal and written forms which will enable them to compete globally.
- Will have confidence to apply engineering solutions with professional, ethical and social responsibilities.
- Will be able to excel in their professional endeavours through self-education.
- Will be able to design and build renewable energy systems for developing clean energy and sustainable technologies.

M. Tech in Power Systems

Programme Educational Objectives

The major objectives of the M.Tech. programme in Power Systems are to equip the students with adequate knowledge and skills in Power Systems Engineering and to prepare them for the following career options:

- Research programmes in Power Systems Engineering
- Employment in power research and development organisations
- To work in electric power industries and energy sectors
- Faculty positions in reputed institutions

Programme Outcomes

A student who has undergone M.Tech. programme in Power Systems (PS) will:

1. Have an ability to evaluate and analyse problems related to Power Systems and be able to synthesise the domain knowledge and incorporate the principles in the state of art systems for further enrichment
2. Be able to critically investigate the prevailing complex PS scenarios and arrive at possible solutions independently, by applying the acquired theoretical and practical knowledge
3. Be able to solve PS problems such as load flows, state estimation, fault analysis and stability studies
4. Be able to develop broad-based economically viable solutions for unit commitment and scheduling
5. Be able to identify optimal solutions for improvising power transfer capability, enhancing power quality and reliability
6. Be able to evolve new schemes based on literature survey, and propose solutions through appropriate research methodologies, techniques and tools, and also by designing and conducting experiments
7. Be able to interpret power system data and work on well-defined projects with well defined goals to provide real time solutions pertaining to PS
8. Be able to develop, choose, learn and apply appropriate techniques, various resources including hardware and IT tools for modern power engineering, including prediction and modelling with an understanding of the limitations
9. Be able to develop dedicated software for analysing and evaluating specific power system problems
10. Be able to participate in collaborative-multidisciplinary engineering / research tasks and work as a team member in such tasks related to PS domain, giving due consideration to economic and financial intricacies, and lead the team in specific spheres
11. Be able to confidently interact with the industrial experts for providing consultancy
12. Be able to pursue challenging professional endeavours based on acquired competence and knowledge
13. Be a responsible professional with intellectual integrity, code of conduct and ethics of research, being aware of the research outcomes and serve towards the sustainable development of the society
14. Be capable of examining critically the outcomes of research and development independently without any external drive.

M. Tech Power Electronics

Programme Educational Objectives

The major objectives of the M.Tech. programme in Power Electronics are to equip the students with adequate knowledge and skills in Power Electronics and to prepare them for the following career options:

- Research programmes in Power Electronics and related areas
- Employment in R & D organisations related to sustainable technologies
- To work in power electronic circuit design and fabrication industries
- Faculty positions in reputed institutions

Programme Outcomes for Power Electronics

A student who has undergone M.Tech. programme in Power Electronics (PE) will:

1. Have an ability to evaluate and analyse problems related to Power Electronic Systems and incorporate the principles in the state of art systems for further improvement
2. Be able to investigate critical PE problems and to arrive at possible solutions independently, by applying theoretical and practical considerations
3. Be able to solve PE problems such as switching control, converter design, analysis and control of solid state drives and stability studies
4. Be able to develop appropriate power converters for sustainable energy technologies
5. Be able to identify optimal solutions for improvising power conversion and transfer capability, enhancing power quality and reliability through PE based solutions
6. Be able to evolve new power electronic topologies and control schemes based on literature survey and propose solutions through appropriate research methodologies, techniques and tools, and also by designing and conducting experiments
7. Be able to work on small, well-defined projects with particular goals to provide real time solutions pertaining to power electronics
8. Be able to develop, choose, learn and apply appropriate techniques, various resources including sophisticated digital controllers and IT tools for modern power electronic system simulation, including prediction and modelling with existing constraints
9. Be able to develop dedicated software for analysing and evaluating specific power electronics and control problems
10. Be able to participate in collaborative-multidisciplinary engineering / research tasks and work as a team member in such tasks related to PE domain, giving due consideration to ecological and economical intricacies, and lead the team in specific areas
11. Be able to confidently interact with the industrial experts for providing consultancy
12. Be able to pursue challenging professional endeavours based on acquired competence and knowledge
13. Be a responsible professional with intellectual integrity, code of conduct and ethics of research, being aware of the research outcomes and serve towards the sustainable development of the society
14. Be capable of examining critically the outcomes of research and development independently without any external drive.

EEEA'25 REPORT

Inauguration

The EEE Association conducted its very first inauguration on 18th October 2024. It had over 200 attendees, which is quite a remarkable achievement for our very first event of this edition. The inauguration was graced by the chief guest, Mr. R. D. Srinivasan, Senior Staff Performance Architect at Qualcomm. The event commenced with the prayer song dedicated followed by the lamp's lighting. The inauguration then began with the welcome address given by the chairperson of EEEA, Ms. Vallimayl, followed by the HOD, Dr M. P. Selvan, who was called upon to give an overview about our department and its achievements. Next was our faculty advisor, Dr Josephine R. L, who gave an overview of the EEE Association, and its activities followed by Dean (Academic) Dr. S. T. Ramesh giving the presidential address. A critical mark in the inauguration was the release of the biannual technical magazine, Tronicals. Tronicals is the technical magazine of the EEE association. The magazine hardcopies were distributed to the Dean (Academic), HoD EEE, Faculty Advisor EEEA, the Chief guest, Chairperson EEEA, Overall Coordinator EEEA and the softcopy was circulated to all the faculties and students. Finally, the chief guest was called upon to address the students. He gave a small talk which showed his work experience within the semiconductor industry and his endeavors as an engineer. The meeting then came to an end with the vote of thanks, delivered by the Overall Coordinator, Ms. Priya Darshini K, following it a photoshoot took place. Following the inauguration, these activities took place:

- A workshop on Long Short-Term Memory (LSTM) for load forecasting.
- An AI/ML event named "Bid-Genius."
- A guest lecture by Mr. R. D. Srinivasan on "Strategic Solutions in the System Architect's Journey: Shaping Interconnect and Memory Architecture."

Prior to the inauguration, we also planted a few saplings within our department soil space. WORD SPARK, an engaging essay competition on the topic "Towards a sustainable future: The role of engineers in shaping tomorrow" was conducted around February first week which received many submissions showcasing our students' interest on creative writing.

In the second week of February, a collaborative series of events was held by the Electrical Engineering (EE) societies of NIT Calicut, Surathkal, Warangal, and Trichy. This collaboration featured:

- A hackathon.
- A case study competition.
- A quiz.
- A guest lecture by Dr. Surender Reddy, a distinguished researcher recognized among the top 2% of scientists worldwide (Elsevier BV & Stanford University) and a member of IEEE and the IEEE Power Energy Society

In the first week of March, a special invited talk on "Civic Ethics in Community" was delivered by Dr. Prateep V. Philip, former DGP of Tamil Nadu. The event drew an audience of approximately 700 students. Following Dr. Prateep V. Philip's talk, an online guest lecture was given by Dr. Palaniappan J, a respected alumnus of NITT's 1983 batch in the same week. Dr. Palaniappan, with his expertise in computer networking and semiconductors, and his extensive experience as a Software Executive, provided invaluable industry insights.

Social Responsibility Event

Light Up 2.0, held on January 31st at MR Palayam Govt Higher Secondary School, was an incredible experience. We had the opportunity to interact with around 200 students, answer their questions and introduce them to various career opportunities. Their eagerness to learn and grow was truly inspiring. This initiative was more than just a session- it was about shaping young dreams. We hope our efforts will help them make informed choices for their future.

Association Events (AY 2024 - 25)

The EEE Association is excited to announce the 35th edition of Currents, our national-level technical symposium, scheduled for March 28th-30th, 2025. This three-day event will feature a diverse range of activities, including seminars, technical contests, quizzes, exhibitions, workshops, and paper presentations.

The inauguration ceremony, set for the afternoon of March 28th, will be graced by the HoD, faculty, director, EEEA members, and the student community. We are honoured to welcome Mr. Kuppuswamy, a 1983 batch EEE alumnus and former CPCL General Manager, as our guest of honour. Building on the success of previous editions, Currents'25 is planned to include 7 technical workshops, 6 engaging events, and 2 offline guest lectures. We anticipate a vibrant and enriching experience for all participants.

ALUMNI INTERVIEW

Find out what our alumni are up to now

Looking back, how would you describe your time at NIT Trichy, and how did it shape your career path?

My journey at NIT Trichy has played a crucial role in my professional as well as personal life. The decision to choose NIT Trichy itself was not easy to begin with. The year was 2018, and I was in Kolkata going through the anxious JOSAA counselling stage. Tiruchirappalli meant I would be 2000 kilometres away from home, in a new state with a completely different language and culture from what I knew. On the other hand, it also meant meeting people with different perspectives and an opportunity to gain a network of great minds. In hindsight, attending NIT Trichy was undoubtedly one of the wisest decisions of my life. My work on diverse projects and internships has provided me with a strong technical foundation and significantly advanced my career. Throughout my degree, I thoroughly enjoyed the carefully curated courses, worked on cutting-edge research, and collaborated with the brightest scholars in the country. Lastly, I found an amazing group of friends who made the journey memorable and made even the mess food palatable.

Sandipan Roy
Batch: 2018-22

Were there any specific professors or mentors at NIT Trichy who had a significant impact on your journey?

I consider myself lucky for the exceptional support and guidance I received from numerous professors and mentors, even after my graduation. Particularly, I am grateful towards Dr. MP Selvan for his continuous motivation and thought-provoking lectures. He has been my research guide, and mentor and took several courses around power engineering. I am also thankful to Dr. K. Sundareswaran for introducing me to the world of power electronics, where eventually I found my passion. Apart from professors, several seniors have also gone out of their way to help me, even beyond academics and research. Their experience and advice during internships and placements significantly impacted my professional career.

What critical areas within EEE and related fields should students prioritize to excel and succeed in today's evolving industry?

Several emerging fields like AI/ML, electric vehicles, and data science, along with innovative fields like control systems, power electronics and computer architecture, are relevant today. However, it is not possible to excel in everything; you must understand what you really want to do and look at the bigger picture. It is essential to know what you are doing rather than just doing it. Hands-on real-world experiences are a must and teach you through mistakes. The ability to critically analyse any problem statement and look for practical solutions is crucial. Strong communication abilities are essential in the current era. Always remember that you will never be out of the market if you are good at something relevant.

You have received the department gold medal by having the highest CGPA of your batch. What kept you motivated to achieve this milestone, and how did you manage your academics with co-curricular activities?

I feel consistency is the key to securing the Department Gold medal. It is a sign of perseverance and not merely a reflection of intelligence. Effective time management and being regular with your courses can help you in the long run. My motivation was to have a balance in life. While I achieved the highest grade, you would have also found me organising events for TEDxNITTrichy, participating in Pragyan, enjoying Festember as well as going on trips with my friends. One strategy I have always found essential is planning and prioritisation. One would find enough time for academics, personal pursuits, and co-curricular activities if one could plan well and realise when to do what.

You've had the unique experience of exploring international internships, which led to valuable research opportunities, followed by a corporate career, and now you're pursuing an MS at ETH Zürich. What guided your decisions to take on such varied roles, and how would you describe the experiences and key differences across these diverse paths?

My motivation to take on varied roles and responsibilities is to understand my passion and achieve my long-term goals. Academics, research and industry need completely different approaches. The objectives are significantly different; Courses are to build a technical foundation; Research promotes innovation whereas Industry rewards practicality and viability. In my four years of undergraduate study, followed by two years at Ola Electric, I have been part of multiple projects. Some of them eventually were published, while the others were functional and hands-on. I learnt beyond expectations in the last two years of the industry from my colleagues, and I was fortunate to work with stalwarts of the automotive industry. In the end, I could figure out what I actually enjoyed working on and how I could propel my career forward. At ETH Zürich, I am pursuing my Masters in EE with a focus on Power Electronics and Energy Systems, and I am amazed by the depth of courses and research going around. I believe my desire to learn new technologies, meet diverse people, and take on new challenges outside my comfort zone drives me forward.

What are your plans for the future after completing your MS?

I guess it is a little early to predict the future as I just started at ETH Zürich 4 months ago. But, after my MS, I envision myself doing things I love the most.

I would like to continue travelling, hiking, singing and learning new languages. Professionally, I would probably work on batteries, electric vehicles, control systems and high-power hardware design. I believe energy systems are becoming more complex and need innovative and practical solutions.

What message or final words of wisdom would you like to share with the NIT Trichy community and future engineers?

NIT Trichy has loads of opportunities to explore, and one should make the most of them. Four years is a lot of time, so make sure to work in different fields and use the existing tools – start with the internet, don't fear going out of your comfort zone, and figure out what works best for you. It is entirely alright to not follow traditional norms and pathways. If you are working diligently and smartly, things will definitely work out in the end. However, at the same time, balance is the key. Excelling in your professional career doesn't mean one has to abandon one's personal life. Remember to meet new people, make friends, take care of your family, and find a hobby that allows you to unwind. These things will enrich your life as you navigate your journey.

Interview With
Dr. M.P. Selvan

What initially sparked your interest in this profession?

I have always been passionate about teaching. My interest in power systems grew further during my Master's in Power Systems, largely influenced by the exceptional professors I had and the academic environment of our institute. Their guidance and dedication inspired me to pursue this field more deeply.

Research is a significant part of academia. What advice would you give to aspiring researchers?

The two most essential qualities for research are interest and patience. Research comes with its own set of challenges, including failures and setbacks. It can be difficult, especially when you see your peers opting for jobs while you are still working on your research.

However, if you are truly passionate, staying committed and persistent will eventually lead to success.

How does research in Electrical and Electronics Engineering (EEE) differ from other fields?

One of the key aspects of research in EEE is the vast number of choices available across different domains. A significant focus in EEE research revolves around improving the current design and efficiency of electrical machines and power systems. With constant technological advancements, there are always opportunities to enhance existing systems and develop innovative solutions.

Speaking of advancements, what are your thoughts on today's smart grids?

At our institution, we offer a course on smart grid technologies for postgraduate students. While smart grids are a promising technology, there is still a need to improve their technical and economic efficiency. A major area of focus should be on developing more resilient grid systems. In India, while the transmission system is well-operated, the distribution system still faces significant challenges. There are ongoing projects in Pondicherry working on smart grids, aiming to improve their implementation and effectiveness.

What are your thoughts on growing utilisation of SCADA (Supervisory Control and Data Acquisition) ?

SCADA is extremely important, particularly in power grid systems. However, one of its limitations is its slow time resolution, which affects its efficiency in certain applications. While automation through SCADA improves system operations, it also leads to concerns about job losses. Therefore, it is crucial to create alternative employment opportunities and provide specialized training. A common misconception is that SCADA is not relevant to electrical engineering students. While it is based on electronics, all its applications and aspects are fundamentally electrical.

What is your perspective on APFC (Automatic Power Factor Correction) switches?

APFC switches are relatively expensive but can achieve a power factor of nearly 0.9. For small industries, these switches help in balancing the power factor efficiently, making them a valuable investment despite their cost.

Reflecting on your journey, what have been the best moments of your life?

I strongly believe that everyone should experience hostel life at least once in their lifetime. Despite academic difficulties, the friendships and campus experiences provide immense support and unforgettable memories. As a faculty member, I am grateful for the guidance of senior professors of our department, particularly Prof. Nagamani Ma'am, who was heading the department when I joined. I learnt a lot from madam to shape my administrative role. Additionally, my time as a warden for Zircon C was filled with many cherished moments.

What are your future goals and aspirations?

My primary focus is on computer applications in power systems, particularly in utility and power grid optimization. Many of our projects have reached the lab implementation stage, but real-world field implementation is the next crucial step. I aim to work towards bridging this gap.

Many students today are opting for domains other than electrical engineering. What are your thoughts on this trend?

It is somewhat disappointing to see students choosing other fields over electrical engineering. However, I understand that attracting students to this domain requires updates in industry pay scales and a stronger focus on advanced technologies. The core electrical industry needs to evolve with emerging trends to make the field more appealing to future engineers.

Interview With
Dr. Sankaranarayanan

1. What inspired you to take up a career in teaching and research?
I initially planned to pursue research rather than teaching, as both my parents were teachers and my passion lies in research. However, the majority of researchers ultimately end up in academia, with only a small percentage transitioning to industry. Around 80–90% of researchers become teachers, as research significantly enhances one's ability to teach at a deeper level. This is how I naturally found myself in the field of teaching.

2. How has the field of Systems and Control Engineering changed since you started, and where do you think it's headed?
When I started, Systems and Control Engineering was already a mathematically intensive field with a strong foundation in core concepts like feedback control, modeling, and stability. Despite advancements, the fundamentals remain unchanged. While technologies such as AI and machine learning are now integrated into control systems, 80% of the field still relies on classical and modern control theories.
During my Ph.D. at IIT Bombay, I transitioned from Energy Engineering to Controls due to my personal interest. My supervisor, who had a robotics background, emphasized that mastering Controls equips one to understand any mathematical concept. Looking ahead, I see Systems and Control evolving with interdisciplinary applications in robotics, automation, and AI-driven optimization. However, the core principles will always remain fundamental.

Strong mathematical skills are essential to mastering this field, and those proficient in Controls can easily adapt to emerging technologies, making them valuable in both academia and industry.

3. If you were to start your career today, would you pursue the same path or explore something different?

People who work in Control Theory rarely leave the field. Even if they transition to a different job, they often apply the same principles in new ways. Control engineers have a deep mathematical understanding, which shapes their approach to problem-solving. While I might work in a different domain, I would still incorporate concepts from Control Theory into my work. This is a unique trait of control professionals. If you look at Control professors worldwide, they remain connected to the field. Even if they engage in other projects for funding or recognition, their core passion always lies in Controls.

4. What advice would you give to new academics who are just entering this profession?

For those entering Control Theory, it is important to understand its vast potential. Control concepts are everywhere, from small applications to advanced algorithms in high-end products. Expensive devices, like smartphones and earphones, rely more on control algorithms than just hardware.

Though often seen as challenging, learning is now easier with abundant online resources, including videos and demonstrations that simplify concepts. Earlier, limited books and teachers required self-learning, strengthening fundamentals. Today, the challenge is filtering vast information.

Despite this, Control Theory remains a promising field. A strong foundation unlocks diverse opportunities, and with dedication, anyone can master and apply it across industries. My advice to all students, including interdisciplinary Ph.D. candidates, is to focus on what they do, avoid distractions, and truly love their field of study.

5. What is the most important lesson you've passed on to your students over the years?

I often receive questions from second-year students about which field to choose for jobs or internships. I tell them it's too early to decide since they haven't explored all subjects yet. By the end of the second or early third year, they will have a better understanding of various courses and can make informed choices.

At the start, it is difficult to know about fields like power electronics, power systems, or control systems. Instead, students should focus on learning and gradually identify their interests. Once they choose a field, they should stay committed and explore it deeply.

Students today have access to vast resources but often lack focus. Unlike students 15 years ago, distractions from gadgets are common. Whatever field they choose, focus is key. Understanding deepens over time, so persistence is essential. With strong math fundamentals, they can excel in any chosen area through continuous learning and dedication.

6. If a sudent wants to pursue research in Systems and Control Engineering, what advice would you give them?

If a student wants to pursue research in Systems and Control Engineering, my primary advice is to build a strong foundation in the fundamentals.

Unlike other fields, Control Theory requires a deep understanding before tackling research problems. Before starting my research, I completed over 18 courses at IIT Bombay, many alongside B.Tech students. Competing in such an environment was challenging, as B.Tech students grasp concepts quickly and ask advanced questions. Discussions among Ph.D. scholars, M.Tech students, and even sharp B.Tech students were crucial for understanding complex topics.

For aspiring researchers, mastering the fundamentals is essential. Without a solid grasp of core concepts, solving research problems becomes extremely difficult. In Control Theory, you cannot simply dive into research without first understanding the mathematical and theoretical foundations. Patience, continuous learning, and a strong conceptual base are key to excelling in this field.

7. What do you think are the biggest challenges currently faced by researchers in this field?

Research in Control Theory presents challenges, especially in publishing papers. Unlike applied fields like power electronics, where designing a controller is enough, Control research requires developing new algorithms and validating them across multiple systems. This process takes time, often leading to delays and frustration.

Another challenge is the evolving landscape. Researchers must now integrate AI, machine learning, and deep learning for tasks like parameter tuning. Sticking strictly to classical methods increases competition and slows progress. To stay relevant, researchers should embrace modern techniques alongside fundamental concepts. Adapting to new advancements will make solving problems and publishing research easier.

8. What excites you most about the future of engineering?

The future of engineering is vast and unpredictable, especially with rapid advancements in technology like AI and machine learning. Ten years ago, we could imagine smartphones, but today's progress is beyond our expectations. While challenges increase, they also create immense opportunities for engineers. One example is the shift from large language models (LLMs) to smaller, more efficient models, driven by concerns over energy and resource consumption. Customizing models for specific tasks, like medical questions, reduces complexity and energy usage. Additionally, the demand for alternative energy sources is growing rapidly, as they are essential for sustaining technological advancements.

Interview With
Dr. Kumaresan

What inspired you to take up a career in teaching and research?

I had no idea about teaching and research during my undergraduate years. However, when I pursued my postgraduate studies at NIT Trichy in 1993–94, I was deeply influenced by the research work being carried out here. It was far more advanced and beneficial compared to what I had experienced during my undergraduate studies.
The professors were exceptional—especially Professor Subbaiah, who developed various power electronic controls from scratch and ensured they were fully functional. He would not only design and develop these models but also demonstrate them in the power electronics laboratory. Witnessing this hands-on approach, along with the excellent faculty and facilities in our department, inspired me to explore research and development as a career path.

How has the field of systems and control engineering changed since you started, and where do you think it is headed?

Before 2000, the facilities available to us were very minimal. Even for sophisticated equipment, the measuring devices were not as advanced as they are today. For instance, in microprocessor trainer kits, there was no memory to store data. Every time we conducted an experiment, we had to manually convert assembly language into machine code and enter it according to specific memory locations, which was highly complex.

Now, developing modern controllers has become much easier with the availability of DSPs (Digital Signal Processors) and FPGAs (Field-Programmable Gate Arrays) that allow for parallel processing. We also have highly accurate voltage and current sensors, whereas earlier, we had to build voltage sensors ourselves. Measuring current used to involve using a known resistance value, measuring the voltage drop, and converting it into current.
In electrical engineering, storing waveforms was another challenge. We used to rely on CROs (Cathode Ray Oscilloscopes), where the waveform would move continuously, making it difficult to capture and analyze data. There were only two CROs in our lab, making them extremely precious—we would often have to compete for access to conduct our experiments. Today, we have DSOs (Digital Storage Oscilloscopes) that make waveform storage much easier.
Our department now has more sophisticated equipment, such as power harmonic analyzers, which were not available back then. Computers were also much slower; simply switching them on would take 2–3 minutes, and their processing speed was significantly limited. With the excellent facilities available today, the only challenge left is updating our technical knowledge. Any complex system can now be implemented with ease, opening up immense possibilities for research and development in the field of systems and control engineering.

If you could pick your career again, would you choose the same path?

During my B.Tech, I had no idea that I would pursue teaching. It was only during my master's degree that I joined here, and my journey into teaching began. At that time, we had a part-time B.E. program, and one of the professors asked me to handle a subject. I did okay, but I noticed that the attention level of the students was not very high. Since most of them worked in industries during the day and attended classes in the afternoon, they were often too tired to focus. Still, we had to teach, regardless of whether they listened or not. In the beginning, I struggled to understand how students think. I also conducted laboratory classes, which were a better experience because students would complete their assigned work within the given time. Over time, I learned that every student has a different level of understanding, and as teachers, we must recognize and address their difficulties. My real interest in teaching grew from the professors I had—they were systematic, sincere, and incredibly supportive. They not only guided us academically but also helped us during research and experimental work. I still remember how they would bring refreshments for us while we worked in the lab. Their dedication left a deep impression on me.
After completing my master's, I got placed in a company. However, when I joined, I realized that my master's degree had little relevance there—the work was mostly repetitive. I felt there wasn't much scope for learning or growth, so I decided to leave and pursue higher studies. I rejoined this institute, and that decision shaped my career. The kind of training and academic environment we receive here is unparalleled—you won't find it anywhere else.
Understanding students and their challenges took me nearly ten years. When I became the Dean of Student Welfare, I had the opportunity to interact with students more closely. I realized that everyone who comes to this institute arrives with a plan. For 70–80% of them, things go smoothly, but the remaining students need mentorship and guidance to help them find their way. As educators, it is our responsibility to support them in that journey.

What advice would you give to people who are new to this profession?

When I joined here, Sudha ma'am and I joined together, though she had been here longer than I was. At that time, everyone around me was my teacher, so I had to maintain the mindset of an obedient student while transitioning into my role as a faculty member.
One important thing I have learned is that teaching is just one component of a faculty member's responsibilities—it is a multidimensional role. Apart from teaching, we are also responsible for mentoring, guiding, and counseling students. In addition, we are involved in research and development activities, administrative duties, and other responsibilities that keep the department running smoothly. If faculty members don't take up these roles, then who will manage the entire department?

My advice to new faculty members is to view teaching as just one part of their role. It is equally important to engage with students beyond academics and provide the support they need. However, there is a fine line between being friendly with students and becoming their friend. Faculty must be approachable and supportive, but maintaining professionalism is essential. Understanding this balance is crucial for effectively helping students and guiding them toward success.

What advice would you give to people joining fields other than teaching, such as industries?

Be straightforward and honest in whatever you do. Nothing comes overnight—you have to work for it. While learning shortcuts for efficiency is important, there is no shortcut to hard work. Perseverance is the key to long-term success.
It's also crucial to be open about any challenges you face. If something is bothering you, don't hesitate to talk to your parents, friends, or faculty members. Seeking guidance and support can make a significant difference in how you navigate your career.
Additionally, developing essential skills like self-learning and effective communication happens naturally when students involve themselves in various activities. Engaging in extracurriculars, teamwork, and real-world projects helps build confidence and adaptability—qualities that are valuable in any profession.

What is the most important lesson you have passed on to your students over the year?

Be simple and polite. Over the years, I have learned the importance of listening to students, especially after my time as the Dean of Student Welfare. I now make a conscious effort to teach them the value of listening to others—it is a skill that can make a big difference in both personal and professional life.
Another key lesson I emphasize is the importance of completing work on time. In lab classes, for instance, I insist that students finish their work within the allotted class hours. This helps instill discipline, efficiency, and a sense of responsibility, which are crucial qualities for success in any field.

What advice would you give to someone in your area of work?

Research and development (R&D) is something our students must actively take up. The students who come to our institute are already strong in mathematics and physics, and they also have good language skills. The only thing some of them lack is clarity about what they truly want to pursue.
For those interested in R&D, patience is essential. Results take time, and in the initial stages, there will be more failures than successes. However, every failed experiment is an opportunity to learn. It is crucial to document the results of all experiments, including the unsuccessful ones. If something is not working, take note of it and analyze why. Without proper documentation, you may end up repeating the same mistakes over and over again.
This kind of patience and systematic approach is necessary for anyone looking to build a career in R&D

BLOCKCHAIN IN ELECTRONICS SUPPLY CHAIN

- by Tejasvini G

What is Blockchain technology?

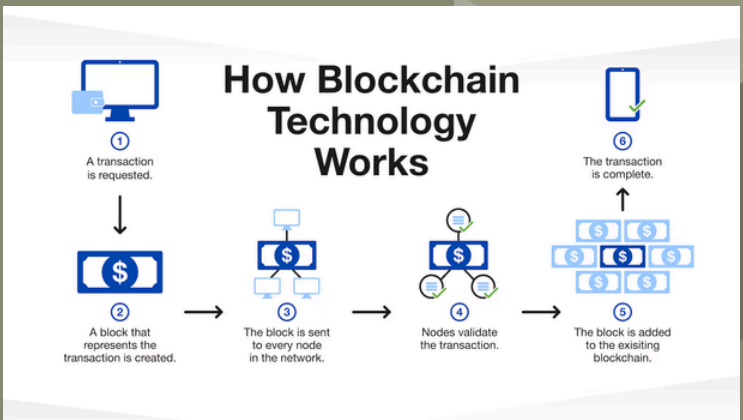
A Blockchain is a digitally distributed, decentralized, public ledger that exists across a network. In simple words, it is a collection of records linked with each other, strongly resistant to alteration and protected using cryptography. Cryptography being the process of encoding information so that only the intended receipt can read it. Blockchain is used to make transactions secure and track assets in the network. Introduced in market since 2008, this technology has potential applications including supply chain tracking, fund transfers, tokenization, sustainability at the present.

What is electronics supply chain?

The electronics supply chain is a complex process that involves multiple stages and participants. It starts with the IP owner, who designs the integrated circuits (ICs) or sources them from multiple vendors to create a complete system-on-chip (SoC).

Next, the foundry takes the design files and manufactures the ICs or printed circuit boards (PCBs). The foundry also tests and sorts the manufactured components, assigning them a physical identity like an electronic chip ID (ECID) and marking. The PCB assemblers use the ICs and PCBs to build board-level products. System integrators, like original equipment manufacturers, use these board-level products to create complete electronic systems.

Distributors act as the transportation channel between the different stages, facilitating the supply of components between foundries, PCB assemblers, and system integrators. Finally, electronics recyclers handle e-waste, which includes end-of-life electronic components and systems. The purpose of the electronics supply chain is to transform an electronic design into a physical entity, like an IC or PCB, and deliver it to the end user.



Why electronics supply chain needs blockchain technology?

The traditional electronics supply chain faces several security threats, such as the introduction of counterfeit components, which can jeopardize the quality, reliability, and trustworthiness of electronic products. Blockchain technology offers a promising solution to to enhance the integrity of the electronics supply chain.

Reasons being:

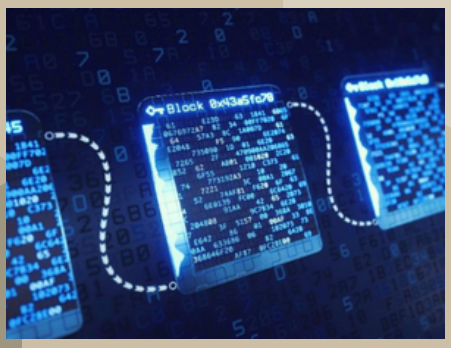
- Lack of Transparency and Trust: The electronics supply chain often lacks transparency, making it hard to verify the origin and authenticity of components. Blockchain provides a decentralized, transparent platform where every transaction is recorded, fostering trust and accountability.
- Counterfeit Components: Counterfeit parts like recycled, defective, or cloned components pose

risks to system performance and safety. Blockchain's immutable ledger tracks each part's history, flagging suspicious activities, such as reintroducing marked "E-waste" into the supply chain.

- Data Security and Tamper Resistance: Centralized databases are prone to manipulation and breaches. Blockchain's distributed, tamper-resistant system ensures data integrity with cryptographically secured, verifiable transactions.
- Streamlined Verification Process: Verifying components in a complex supply chain can be time-consuming. Blockchain simplifies this by enabling quick checks of a component's authenticity through its unique ID, benefiting PCB assemblers, system integrators, and end users.

How can this technology be integrated into electronics supply chain?

Integrating blockchain technology into the electronics supply chain establishes a secure and transparent system for tracking and verifying the authenticity of electronic components. The proposed framework leverages a consortium blockchain, called the Certificate Authority (CA) network, which acts as a trusted third party to manage electronic chip identification (ECID) information throughout the supply chain.



Each electronic component is assigned a unique identifier, such as an ECID or a package marking, enabling tracking across the supply chain. The process begins with the IP owner enrolling chip details, including marking, ECID, grade (e.g., military or commercial), and optionally PUF CRPs (Physical Unclonable Functions –challenge response pairs) for added security, into the CA network. Upon successful registration, the CA network issues an "enrollment certificate." When the IP owner sells the chips, they request an ownership release from the CA network. After verification, the network provides an ownership release token, which is transferred to the buyer, such as a PCB assembler or distributor. Before using the chips, the PCB assembler verifies their authenticity with the CA network using the token and public marking information. The CA network conducts a two-step verification process: a quick database search (semi-verification) and a deeper intrinsic ID match using PUF CRPs (full-verification). Upon successful verification, the PCB assembler requests ownership, and the CA network issues an "ownership certificate," updating the chip's stage to "PCB Assembly."

The assembler then generates a PCB ID (PID) by combining the ECIDs of the assembled chips, often using a hash tree like a Merkle tree, and enrolls it into the CA network. At the system integration stage, a system ID (SID) is generated from PIDs and similarly enrolled, creating a hierarchical ID structure that facilitates efficient tracking and management of components at different supply chain levels. End users can verify the authenticity of the final product by sending a request to the CA network. Once verified, the product's stage is updated to "End User." Additionally, when electronic products reach the end of their lifecycle, recyclers enroll their details into the CA network, marking them as "E-waste." This ensures that recycled components cannot re-enter the supply chain as new.
The blockchain-based framework also offers strong resistance to counterfeiting. Recycled chips are detected via their recorded stages, overproduced chips without enrollment or with conflicting stages are flagged, and any discrepancies in markings are identified. Furthermore, the use of PUFs enhances security by verifying the unique physical characteristics of chips, making cloning nearly impossible.

This comprehensive solution minimizes counterfeiting risks and enhances the reliability and security of the electronics supply chain, ensuring a trusted system for all stakeholders.

Challenges in inculcating this technology

Blockchain technology holds immense potential for securing the electronics supply chain. However, its widespread adoption faces several significant roadblocks. One major concern is Data Privacy. Companies are often hesitant to share sensitive information, such as chip IDs and production volumes, fearing the loss of proprietary advantages. Striking the right balance between transparency and confidentiality remains a critical challenge.

Another key obstacle is the Complex Implementation of blockchain systems across global supply chains. The integration of hardware, software, and secure communication protocols demands significant technical expertise and logistical coordination, posing a steep barrier to entry.

The Scalability and Efficiency of blockchain solutions also present challenges. The sheer volume of transactions in the electronics industry requires a system capable of handling massive data flows without compromising speed or performance. Finally, the High Costs associated with blockchain adoption cannot be ignored. From investments in infrastructure to personnel training, the financial burden can be overwhelming, especially for smaller enterprises.

Overcoming these hurdles will require industry-wide collaboration, the development of cost-effective solutions, and a focus on maintaining both transparency and data privacy. Only then can blockchain truly revolutionize the electronics supply chain.

Current use and Future Aspect

While the research on proposing a blockchain-based framework for electronics supply chain integrity is still ongoing , specific examples of its current use in practical industries are not found yet. However, here are some initiatives and trends that suggest growing interest and potential adoption of blockchain in supply chain management:

- Walmart's Blockchain Pilot: Walmart is mentioned as testing blockchain technology for supply chain management, specifically tracking produce in the U.S. and pork in China. This example showcases the potential of blockchain to improve transparency, traceability, and efficiency in large-scale food supply chains.
- IBM and Everledger: IBM's development of a blockchain-based tracking service for Everledger to record the movement of diamonds from mines to jewelry stores. This demonstrates blockchain's applicability in tracking high-value items and ensuring their authenticity in a complex supply chain.

These examples, while not directly related to the electronics industry, suggest that blockchain is gaining traction in various sectors for enhancing supply chain integrity and transparency. The principles and benefits of blockchain discussed as in the above, such as decentralization, immutability, and enhanced security, are applicable across industries, indicating the potential for wider adoption in the electronics supply chain in the near future.

NANOTECHNOLOGY IN ELECTRICAL ENGINEERING

- by Harsha Pradeep

Introduction

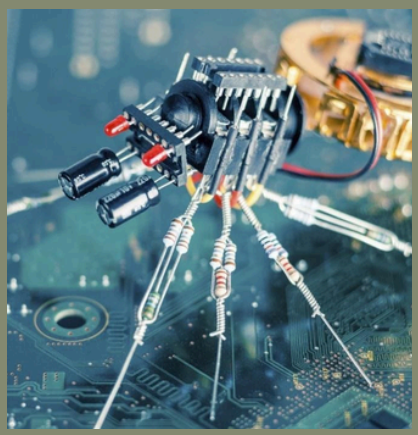
Nanotechnology is revolutionizing the field of electrical engineering by enabling the development of devices and systems at the molecular and atomic levels. It deals with the manipulation and control of matter at the nanoscale, typically below 100 nanometers. This transformative technology is opening new frontiers in electronics, power systems, and communication technologies. By improving the efficiency, size, and power consumption of electrical devices, nanotechnology is expected to have a lasting impact on the future of engineering and technology.

Applications in Electrical Engineering

Nanoelectronics: The miniaturization of transistors using nanomaterials like carbon nanotubes and graphene has led to the development of faster, more efficient, and smaller electronic devices. Nanoelectronics allows for ultra-dense memory storage and faster processors, significantly improving computational power. Additionally, nanotechnology is enabling the creation of neuromorphic computing systems that mimic the human brain, leading to advancements in artificial intelligence and machine learning. This has potential applications in robotics, automation, and data processing, making electronic devices smarter and more adaptive.

Nanomaterials in Semiconductors: Advanced materials like quantum dots and nanowires are enhancing the performance of semiconductors, enabling better conductivity and energy efficiency. These materials improve thermal management in microchips, ensuring higher reliability and durability in extreme conditions. Nanotechnology is also playing a critical role in reducing energy consumption in processors and enhancing semiconductor reliability, leading to longer-lasting and more efficient electronic devices.

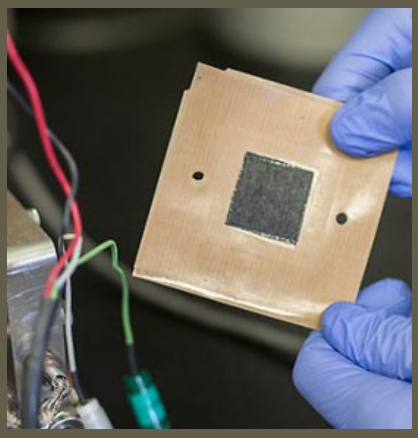
Nanosensors: Nanoscale sensors offer high sensitivity and accuracy in detecting electrical, thermal, and mechanical changes. These sensors are crucial in industrial automation, biomedical devices, and environmental monitoring. Nanosensors are also making significant strides in wearable healthcare devices, enabling continuous health monitoring and early disease detection. In industries such as aerospace and automotive, nanosensors help monitor structural integrity, improving safety and performance. Furthermore, nanosensors are being integrated into smart homes and cities to provide real-time environmental monitoring and security enhancements.



Nanotechnology in Energy Systems: Nanomaterials are being integrated into batteries, supercapacitors, and solar cells to improve energy storage and efficiency. Nano-enabled power transmission systems reduce energy loss and enhance the reliability of electrical grids. Furthermore, research in nanostructured catalysts is enhancing fuel cell efficiency, leading to cleaner energy solutions. Advances in nanocoatings and nanofilms are also helping improve the efficiency of wind and hydroelectric energy systems, promoting the development of greener, more sustainable energy sources.

Flexible and Wearable Electronics: Nanotechnology supports the development of flexible, lightweight, and wearable electronic devices, expanding applications in healthcare and consumer electronics. The advent of nanomaterial-based electronic textiles (e-textiles) is further driving innovation, allowing for the seamless integration of electronics into fabrics for real-time monitoring and communication. Flexible displays, smart fabrics, and implantable medical devices are becoming more widespread due to the unique properties of nanoscale materials, allowing for greater durability, efficiency, and adaptability in modern electronics.

Future Directions

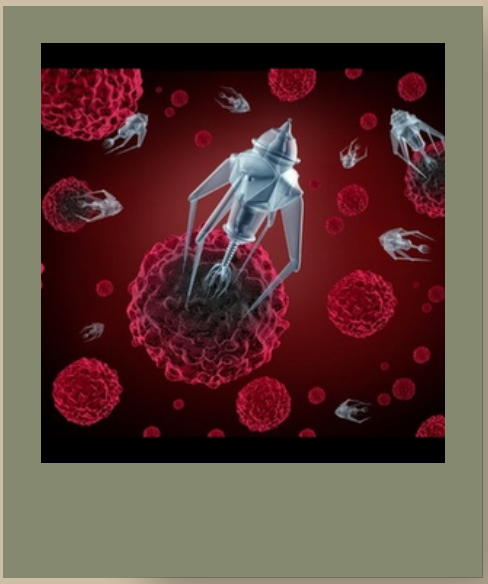


Quantum Computing: The fusion of nanotechnology with quantum mechanics is paving the way for quantum computers capable of performing complex computations at unprecedented speeds. This will revolutionize data encryption, material simulations, and problem-solving across various fields. Nanotechnology plays a key role in the development of quantum dots, superconducting circuits, and qubit stabilization, making quantum computing more practical and commercially viable.

Nano-Integrated Smart Grids: Future smart grids will integrate nanosensors and nanodevices to enhance real-time monitoring, fault detection, and power efficiency. These grids will help optimize electricity distribution, reducing energy waste and improving overall sustainability. By incorporating nanotechnology, power networks will become more resilient, adaptive, and efficient, ensuring stability even during fluctuations and peak demand periods.

Advanced Energy Harvesting: Nanotechnology will facilitate the development of self-powered devices through nanogenerators that convert mechanical vibrations and thermal energy into electrical power. This has the potential to revolutionize the Internet of Things (IoT) by enabling energy-autonomous sensors and communication devices. This technology can lead to the widespread use of self-sustaining wearable devices, remote sensors, and other applications that require long-term operation without the need for battery replacements.

3D Nanoelectronics: The advancement of 3D nanostructures will further increase circuit density and processing capabilities, enabling next-generation electronic systems. These structures will help overcome the limitations of traditional silicon-based chips, leading to more powerful and compact electronic devices. The development of 3D nanoscale architectures will also contribute to higher computational efficiency, paving the way for faster and more compact computing systems.



Nanophotonics: Combining nanotechnology with photonics can lead to faster optical data transmission, minimizing latency in communication networks. Nanophotonic circuits are expected to play a critical role in the development of ultra-fast internet and high-performance computing systems. This technology has implications for telecommunications, data centers, and satellite communication, leading to higher data transmission speeds and more reliable connectivity.

Biomedical Applications in Electrical Engineering: The intersection of nanotechnology and electrical engineering is contributing to bioelectronics, where nanoscale electronic devices are used for medical diagnostics, neural interfaces, and drug delivery systems. Implantable nanoelectronic devices are advancing prosthetics, brain-machine interfaces, and precision medicine. Furthermore, nanotechnology is helping develop advanced imaging systems, biosensors, and nano-robots that can perform targeted treatments at a cellular level, making personalized medicine more effective and accessible.

Environmental and Safety Considerations: As nanotechnology advances, it is essential to address potential environmental and safety concerns associated with nanomaterials. Research is ongoing to understand the long-term effects of nanomaterials on human health and ecosystems. Regulations and safety protocols must be established to ensure responsible use of nanotechnology in electrical engineering, balancing innovation with sustainability and safety.

Conclusion

Nanotechnology is transforming electrical engineering by driving innovation across various domains, from nanoelectronics to energy systems. As the technology continues to evolve, it promises to revolutionize the way we design, produce, and utilize electrical systems, paving the path toward smarter, more efficient, and sustainable solutions. The integration of nanotechnology with AI, IoT, and renewable energy systems will further amplify its impact, making it a key enabler of next - generation technological advancements. Embracing nanotechnology will be essential in meeting the future demands of the rapidly advancing electrical engineering industry. As research continues to expand, engineers and scientists must work together to harness the full potential of nanotechnology while addressing ethical, environmental, and safety concerns to create a sustainable and innovative future.

WATT THE FUTURE: AI'S GROWING ENERYGY CRISIS

by Kartik Aashish

The advent of AI is making waves all across the world. Since OpenAI released its generative AI Chat-GPT into the wild, humanity has not looked back. Better models are turning up every other day, to the pleasure of some and to the misfortune of others. From doing mundane tasks like writing an email to your boss to performing high speed computations in a matter of seconds, AI is impacting us one way or the other.

This democratization has given everyone the potential to write code, make paintings, write novels and so on. One only needs to write a few lines of prompt. But all these fascinating aspects have a common issue that companies are grappling with: Energy. AI, specifically GenAI has huge computational requirements, which in turn means higher energy needs. Training a large language model like OpenAI's GPT-3, for example, uses nearly 1,300 megawatt-hours (MWh) of electricity, the annual consumption of about 130 US homes. Producing a single image using an AI image generator can consume as much energy as fully charging a smartphone, according to research from Hugging Face and Carnegie Mellon University. Even less energy intensive tasks like text generation adds up, with 1,000 outputs consuming about 16 percent of a smartphone charge.

The Glaring Problem

AI energy consumption refers to the electricity required to train, deploy and operate artificial intelligence systems, particularly resource- intensive ones that involve machine learning and deep learning. These systems often require a substantial amount of computational power, both during the training phase — when vast amounts of data are processed — and during everyday use. Most deep learning applications designed to analyse large large datasets to perform operations such as computer vision, natural language processing, GenAI are power intensive. Training an AI model involves billions of calculations that are done on GPUs (graphics processing units) or TPUs (Tensor processing units) housed in servers maintained in huge datacentres.

These datacentres require significant amounts of electricity- not just for the large computations, but also for maintaining the cooling systems required to keep the hardware operation efficient.

All over the US, data centres are springing up. Countries like China, Saudi Arabia and Malaysia are slowly progressing in terms of installation of datacentres. According to a report by the International Energy Agency (IEA), data centres accounted for approximately 1% of global electricity demand in 2020, and this figure is expected to rise as AI adoption expands. It also predicts that data centres alone could account for 3 to 4 percent of global electricity consumption by 2030, driven in large part by the rapid proliferation of AI.

Most of this energy guzzling can be attributed to the reliance of these models on huge databases and the process of moving data in and out of chips. For example, a model that needs to be trained to identify fruits must be shown as many pictures as possible. The movement of large amounts of data to and from GPUs is a problem that has to be solved.

What about the Powergrid?

All across the US, the data centre boom is distorting the flow of power to domestic consumers of electricity. Cities in and around Chicago and "data centre alley" in Northern Virginia are experiencing distorted power above acceptable levels. This is threatening already aging electrical equipment. An exclusive Bloomberg analysis shows that more than three-quarters of highly-distorted power readings across the US are within 50 miles of significant data centre activity. Power quality issues can lead to flickering, blackouts and brownouts. Voltage surges in the grid can also cause electrical fires endangering residential consumers.

Prior planning of generation is also being outpaced by the speed at which these city sized data centres are being installed. The rise in power demand due to population increases over the years pales in comparison to the expected number of installations of these facilities to power AI in the coming years. This could impact other areas of electrification in our daily life. EV adoption could be impacted if the grid is not fortified enough to sustain this huge demand.

And the environment?

Alphabet-the parent company of Google, marked an unsavoury milestone-its GHG emissions are up 48 per cent since 2019. Around the same time, Microsoft announced that its emissions are up 29 per cent since 2020. Both companies cite this to increasing workloads of AI. Due to this the decommissioning of several coal-based power plants has been put on hold. Microsoft even went so far as to secure a deal to reopen Three Mile Island- the site of the worst nuclear accident in American history.

Predictions that AI will help solve climate change by analysing emissions and forecasting environmental processes are now being upended by AI's insatiable

hunger for energy. Not just that, data centres require huge amounts of water for cooling, most of which is potable. Cooling towers, which are commonly used for AI data centres, require "continuous clean freshwater replenishment," as they can only recycle water a handful of times. This is stressing the already burgeoning water scarcity across the world. AI also produces solid toxic waste, which has been found to consist of Mercury and Lead.

So.... The solution?

Among all this brouhaha over data centres, there is a ray of hope. Many companies are still pursuing sustainability goals among the AI boom. Nearly 45% of S&P companies have made net zero commitments. Marrying the ceaseless ambition of improving AI while making good on a greener future will be a challenge. Experts all around the world are working on a number of solutions. Some of these are listed below:

- Smaller models:

Not every company requires large models such as ChatGPT. Specific use cases can be catered to by smaller models that are less energy hungry, more affordable and thus more efficient.

- Renewables:

All companies should look at setting up data centres near regions with abundant renewable energy sources. Green data centres are a significant step towards this.

- Hardware improvements:

Power-capping hardware has been shown to decrease energy consumption by up to 15%, while only increasing the time it takes to return a result by a barely noticeable 3%. Chips designed to be more energy efficient are already under development.

- Smarter model training:

Existing methods of training models often involve running previous models, which is quite energy intensive. Rather than this, early identification and removal of underperforming models can cut power consumption.

- Open Source:

Sharing tips and tools with public at large can help future developers provide energy efficient solutions to the problem.

One of the most recent advancements in opensource AI, DeepSeek, claims to be a leaner model requiring less energy for training. Although the veracity of these claims is yet to be established, this new entry has prompted discussions about energy efficiency in the AI industry. Measures to combat the growing energy use of AI are needed in a grid made fragile by increasing DERs (Distributed Energy Resources), EVs and power electronic loads. The halted decommissioning of thermal power plants to meet energy demands poses a threat to global climate sustainability goals. The onus of dealing with this issue also falls on the numerous utilities. Grid fortification against such disturbances must take the highest priority. Regulating AI development in will only backfire as AI can also be used to develop climate-based strategies and enhance emissions analysis. In conclusion, any emerging technology has faced resistance from the masses. AI finds itself in a similar situation. Only sheer human ingenuity can find an answer for all these problems and help advance a technology still in its infancy.

INTERNSHIP EXPERIENCE

Vinay's internship experience at Oracle

I interned as a Software Developer at NetSuite-Oracle, Hyderabad, for a duration of two months, from May 29th to June 23rd. My interest in web development began after my third semester, when I completed several projects in this domain. This experience solidified my passion for web technologies and motivated me to prepare for Software Development, Data Structures and Algorithms (DSA), and core computer science subjects. My enthusiasm for this field was further reinforced when I was selected for The Spotlight Program in IT by Procter & Gamble (P&G). Through this program, I gained exposure to how AI is transforming industries and the potential of software-driven solutions. During the internship season, I was drawn to Oracle because it is a global leader in software development and is renowned for its cloud services expertise. Additionally, Oracle's recent collaborations with NVIDIA and OpenAI highlighted its forward-looking vision, making it an ideal place to learn, grow and contribute.

During my internship at NetSuite-Oracle, I worked on developing "Spasso - An Automation App", designed to streamline the organization of a corporate game event. The app automated processes like user and game registrations, game rule management, and match scheduling while providing real-time analytics. It supported multiple roles with customized permissions to ensure efficient event management. The project utilized NetSuite's platform for backend and frontend integration. This automation reduced manual effort, enhanced participant engagement, and ensured smooth execution of the event. The experience allowed me to work through all phases of development, improving my skills in web development and learning about testing techniques such as Unit Testing & Automation Testing. We had daily stand-up meetings with our mentor to brief him on our progress and challenges. We developed a timeline chart where we wrote about the entire end-to-end development process, we also thought about possible edge cases in the beginning itself.

As a group of four interns, we primarily collaborated among ourselves, focusing on the development and refinement of the project. While we didn't directly collaborate with other teams in a developmental capacity, we engaged with various teams throughout the internship, and they also used to give us feedback on the project. We also had learning sessions with teams.

Going to a new city and exploring food there is something which I like a lot. Apart from this, I enjoyed interacting with fellow interns and some of the team members. Playing carrom and TT after lunch were also quite fun.

I studied Data Structures & Algorithms, OOPS & Operating Systems. I practiced questions of DSA on various platforms such as leetcode, codeforces and codechef.

I gained hands-on experience with SuiteScript on the NetSuite platform for backend development and UIF for frontend design in TypeScript. I also learned unit testing with Jest and automation testing with Selenium. Additionally, I got familiar with agile methodologies, especially task prioritization and daily stand-ups.

Varun's Internship experience at Qualcomm

I had the opportunity to intern at Qualcomm, Bangalore, as a Hardware Engineer in the Camera Hardware Design team for two months. This experience was particularly exciting as it aligned with my passion for the Electronics domain, specifically Digital Design. The internship, which I secured through the on-campus Summer Internship Program (SIP), allowed me to work at the forefront of semiconductor innovation. During my time at Qualcomm, I explored the team's work in Camera IP Design and Image Processing.

My project involved designing an efficient integer division module to replace existing solutions, with the potential to improve performance across Qualcomm's System-on-Chip (SoC) products, not just within the Camera team. This hands-on project, combined with knowledge transfer sessions, recommended readings, and discussions with team members, enhanced my technical and analytical capabilities. I deepened my knowledge of HDLs (Hardware Description Languages), gained hands-on experience with EDA tools like Design Compiler, and learned about mathematical simulation and functional coverage techniques, which are essential in hardware verification. Alongside technical growth, the internship honed my soft skills, such as delivering effective presentations and conducting feasibility analyses to evaluate design choices.

Managing my time was critical to my success, and I ensured clear communication with my manager to set realistic goals and deadlines, breaking tasks into daily targets for consistent progress. Collaboration was another key aspect of my internship; although I primarily worked with my immediate team, these interactions taught me the value of teamwork and professional communication, whether it was setting up virtual machines (VMs), brainstorming research ideas, or refining my final presentation. The professional environment at Qualcomm was result-oriented yet collaborative, and my manager's support made adapting to the corporate culture easier. I learned to maintain professional boundaries while embracing the team's balance of hard work and celebrations after milestones.

The freedom to explore Camera Hardware Design, combined with personal highlights like spending time with friends in Bangalore, made the experience even more fulfilling. Preparing for the internship required a strong foundation in electronics coursework, active participation in the IPMP process, and guidance from seniors, all of which helped me adapt quickly.The internship also enhanced my skills in System Verilog, running EDA tools using VMs, creating compelling presentations, and utilizing the UNIX command-line interface (CLI) for efficient workflows.

It reignited my passion for computer architecture and system design, reinforcing my goal to work in cutting-edge hardware technologies. If I were to offer advice to future interns, I would stress the importance of prioritizing health and maintaining a positive mindset, as things tend to work out with proper planning and focus.

Abdul Basith's Internship experience at Siemens

I did my 3-month technical summer internship at Siemens Bangalore in cybersecurity and automation under the technology division. It was an On-Campus Summer Internship Offer. There was an aptitude and core examination on the Mettl examination portal after which I had an online technical interview with the team lead. My resume was relevant to a few of the job descriptions about which I spoke in my interview. This resulted in me landing the internship. I also showed my interest in Siemens by mentioning various industry trends and the role played by the company in it.

My project dealt with the integration of cybersecurity into electrical systems. I had to build a messaging framework between factories that triggered automation systems all while communicating cryptographically, securely contributing to enterprise resource management. I had to develop an emulation of the secure network system and a miniature working prototype displaying the process. It was a blend of Software (Cybersecurity) and Electrical (Industrial Automation). I got to learn about Industry Standards, Siemens PLC modules, CORE Network Emulator, cryptography, and various other communication protocols. Siemens had very flexible working hours leading to a great work-life balance and a stress-free environment. Saturdays and Sundays were strictly off. I mostly caught up with my friends who were in Bangalore for their respective internships. You would feel as though half of NIT-T is in Bangalore during the summer internship season.

Since it was my second time interning in Bangalore, I didn't feel like roaming the city. Instead, I took my leisure time participating in the annual technology hackathon in Siemens while contributing to the development of a digital twin of a power plant with various seniors from my team.

We also had a great team retreat to Nandi Hills in Karnataka. It was a great trekking experience that helped us engage with industry leaders from the various teams in Siemens. Although it sounds generic, it is the mantra: Actively engage in activities related to your interests and commit yourself to various things you love doing. Building on your confidence is the key. Talent goes to waste without proper soft or people skills. Learn to sell yourself through your resume and introductions. Focus on what makes you stand out from the other candidates. It is not always about being the best. It is about being unique. If things don't go the way you want them, believe that better opportunities are coming your way. Always look out for networking opportunities and practice aptitude daily. Consistent efforts are all that matter at the end of the day.

Ansh Bhatia's Internship experience at P&G

I had the opportunity to intern at P&G's Femcare plant in Goa in a techno-managerial role. Before that, I had a research internship at IISc Bangalore, where I worked on developing a swarm of drones to assist visually impaired individuals. This experience gave me a brief yet impactful introduction to research and robotics. It also played a key role in securing my P&G internship, as it stood out during the personal interview. Another thing which struck up with the interviewers was my project at e-Yantra (a national robotics competition hosted at IIT Bombay) where we developed an autonomous robot to fill potholes. The experience taught me valuable lessons about teamwork.

During my internship at P&G, I worked on two major projects. The first was the automation of the Contract Manufacturing (CM) site. The plant I worked at manufactures Whisper sanitary pads, and the packaging at the CM site was done manually. This led to high operational costs and dependencies on external factors. My task was to automate the site, which involved evaluating available packaging machines, assessing the site from an electrical and layout perspective, and conducting a detailed NPV and ROR analysis to justify the automation investment.

Through this project, I gained a deep understanding of both technical and business aspects, ensuring that the final solution provided maximum efficiency and cost savings.

The second project involved designing a plant layout to integrate two Optima packaging machines. Typically, these machines are placed parallel to each other, but due to space constraints, that wasn't an option in our case. I proposed an innovative solution—placing the two machines at a 90-degree angle and connecting them via a diverter. This was a novel layout and required extensive discussions with various stakeholders to finalize the best layout.

To be honest, my internship at P&G was one of the most memorable experiences of my life. I worked hard, met incredible people, and learned from experts across different departments. It truly broadened my perspective. The interview process at P&G usually has 2-3 rounds. In the first round, I was asked behavioral questions on how I would handle certain situations or problems. I prepared for this by speaking to seniors and watching preparation videos, particularly those by Bahroz Abbas on YouTube. The interview felt more like a conversation, where the interviewers tried to understand my problem-solving approach rather than seeking a "right" or "wrong" answer. The second round was resume-based. The key was to effectively showcase my strengths and domain expertise. P&G values leadership, communication skills and strong spikes in a resume, and I believe that apart from my projects and internships, my experience as the Head of Events at LEAP and my work in Pragyan Media Relations played a crucial role in my selection. Having the support of family and good friends (namaste gang, elites and beryl boys to name a few) makes all the difference. Their motivation helped me push through ups and downs, and I was fortunate to have them by my side.

I'd like to share a thought with juniors—take the time to figure out what truly excites you (it's never too late; I'm still figuring it out myself). Once you do, go all in and make the most of it!

T Sivachidambaram's Internship experience at Mitacs

Last summer, I undertook a research internship within the Sustainable Design Engineering Department at the University of Prince Edward Island, Canada. This opportunity was part of the Mitacs Globalink Research Internship program, which I first learned about through my seniors. I applied because it offered an excellent platform to gain international research exposure. The Mitacs application process typically opens around August to September each year and is relatively straightforward. It requires submission of your resume, academic details, a Statement of Purpose (SOP), research experience, and Letters of Recommendation (LORs). After submitting my application, I received an interview invitation from my host professor in late December, where we discussed the research title and my previous projects. I finally received the selection result in late January. Anyone considering applying should focus on projects that align with their academic background, which can significantly enhance their chances of success.

During my internship, I worked on a project titled "Optimization of Battery Energy Storage on a Community Scale" under the guidance of Prof. Kuljeet Grewal. The project focused on developing MATLAB-based scripts to model various battery technologies using electrical circuit models based on mathematical equations. These models were integrated with year-long hourly data of solar and wind energy generation and load demand.
I implemented a Genetic Algorithm optimization technique in MATLAB to determine the optimal combination of solar, wind, and battery energy storage. The goal was to maximize the utilization of renewable energy and contribute to achieving net-zero electricity. This project played a significant role in advancing sustainable development by optimizing the use of clean energy.

I lived in downtown Charlottetown, just 2 km from the shoreline, and enjoyed daily walks on Confederation Trails. On weekends, my fellow interns and I explored Prince Edward Island, visiting stunning beaches like Cavendish, Tracadie, and Brackley. We also had fun at an amusement park near Cavendish Beach and tried kayaking at Tracadie Beach.

I also explored local attractions like Anne of Green Gables, the Charlottetown Farmers Market, Victoria Park, Queen Elizabeth Park, and chocolate factories.

I recommend that juniors focus on internships and projects aligned with their interests from 2nd year onwards while also prioritizing CGPA. A solid foundation and relevant experience will be invaluable but don't stress too much about grades. International internships like Mitacs Globalink clarify whether to pursue corporate roles or further studies. They are excellent stepping stones, especially for those planning to pursue a master's right after undergrad.

Gayathri Rajesh's Internship experience at IUSSTF-Viterbi

Last summer, I had the opportunity to pursue a research internship at the University of Southern California (USC) in Los Angeles. This internship was a part of the IUSSTF-Viterbi program jointly sponsored by the Indo-US Science and Technology Forum, Government of India and the Viterbi School of Engineering, USC. So yes, you get a fully sponsored trip to the US! I learnt about the IUSSTF-Viterbi program from my seniors and hence decided to apply for the same. All students with CGPA > 8.5 are eligible to apply for this program. The applications generally open in the second week of October and the deadline is around November 30th. The process is fairly straightforward - you need to submit your resume, three essays and two letters of recommendation. The selection committee reviews your application and the results are released in early February. This program is a great opportunity for anyone interested in research, particularly those who aim to pursue graduate studies in the future! I worked in the area of Large Language Models and Robotics under the guidance of the most incredible Prof Daniel Seita. My project involved the use of pre-trained foundation models to obtain a robot policy for fabric manipulation tasks such as folding and smoothing. A lot of work in the area of deformable object manipulation (such as ropes, cloth and plastic bags) involves the use of data-driven techniques such as imitation learning or reinforcement learning. As an alternative to these laborious data-driven methods, my project aimed to leverage the knowledge of Large Language Models like GPT for robotic manipulation tasks. Thus, I used GPT to output low-level pick-and-place actions. USC is located in the vibrant city of Los Angeles, so I had the opportunity to visit several iconic landmarks like the Griffith Observatory and the Santa Monica Pier (GTA V fans know better).

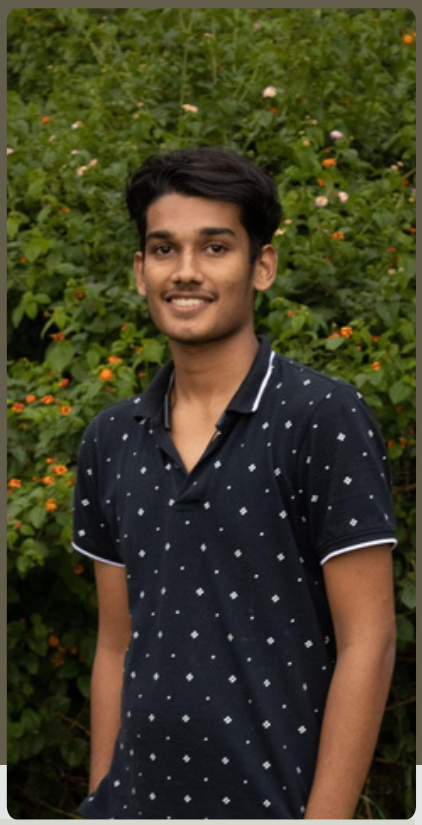
My friends and I also went on a 10-mile hike to the Hollywood Sign. I had the chance to visit Disneyland Park and Universal Studios Hollywood. As a Potterhead, sipping butter beer, standing on Platform 9 ¾ and clicking pictures in front of Hogwarts was truly a dream come true. I started preparing for these internships in my fourth semester. I was keen on applying to both the DAAD-WISE fellowship and the IUSSTF-Viterbi scholarship. Hence, I decided to pursue an internship at IIT Madras during my summer break after my second year. This internship gave me a lot of clarity about my research interests. I am also a part of RMI (Robotics and Machine Intelligence) and the projects I did as a part of the club helped me greatly. A key component of the application process is your essays. Of the three essays required for the IUSSTF-Viterbi application, one essay focuses on your prior research experience. The second essay talks about your research ideas and which professors you want to work with at USC. This essay gauges your research aptitude and your ability to comprehend the work done in academia. The final essay talks about your career goals. The application for any research internship (not just Viterbi) is a very holistic one. Hence, I strongly recommend that those interested in preparing for such internships should start preparing early. Make sure to work on projects in your area of interest. Rather than building toy projects, participate in hackathons (like Transfinitte) and tech-fest competitions (like Pragyan and Sastra by IITM) to build your profile. Pursue internships and projects with professors in your area of interest during the summer break after your fourth semester. This will help you understand how research works and explore your interests. If everything goes well, you may even have the chance to publish your work! Most importantly, focus on your CGPA. In short, those aiming for research (and graduate studies) should work towards building a solid profile right from the start. I am sure that with the right effort, you will secure great opportunities.

My suggestion to anyone writing an application essay would be to tell your story unabashedly. Talk about the highs and lows of your journey and how you stood strong in the face of adversity.

[Note: Since the DAAD-WISE scholarship has been discontinued, I recommend juniors to look at ThinkSwiss, Summer@EPFL and Charpak fellowships].

Vishal's Internship experience at Swiss Re

II completed my internship at Swiss Re, one of the world's largest reinsurance companies, where I worked in the Risk Management IT division as a Data Science Intern. I secured this opportunity through my on-campus summer internship program. The selection process had three stages:
Stage 1: An online assessment that tested high school-level math, statistics, probability, quantitative aptitude, and some machine learning concepts.
Stage 2: Two technical interviews. The first focused on my computer science fundamentals, while the second delved deeper into my projects and previous internship experiences.
Stage 3: An HR interview. The number of technical interviews varied for some candidates, but the typical process involved two technical rounds followed by HR.
I developed a configurable data quality framework from scratch to automate data quality checks at the data source level. This framework streamlined the validation process, significantly reducing manual intervention and enabling seamless daily assessments of data quality.

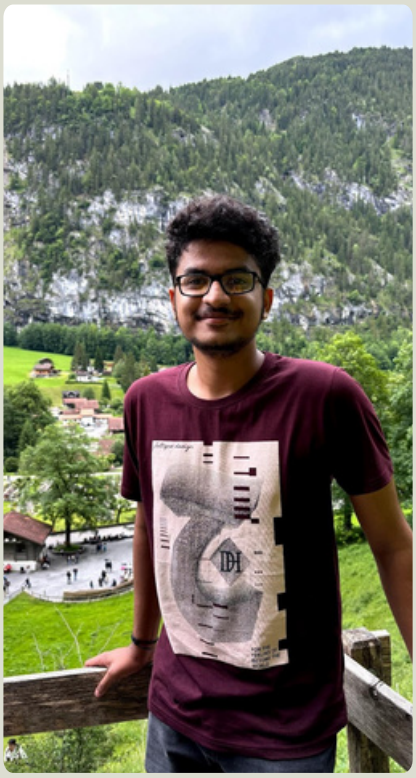


As this was my first time in Bangalore, I spent most of my leisure time exploring the city. I also enjoyed hanging out with colleagues and friends. Additionally, I participated in various sports activities, as the office organized a sports event during my internship. Preparing and practicing with my colleagues made my leisure time both enjoyable and memorable.
I believe I secured this internship because of my strong grasp of the fundamentals, which is something they highly value. I consistently stayed updated with the latest trends in AI and built small projects to reinforce my learning. For juniors aspiring to follow a similar path, my advice is:

- Focus on building a strong foundation in your field.
- Stay informed about new trends and technologies.
- Work on small, meaningful projects as you learn.

This approach not only enhances your skills but also prepares you for such opportunities.

Sundaram's Internship experience at DAAD-WISE



With the help of the DAAD WISE scholarship, I finished my internship in the Chair of Circuit Design at Technische Universität München (TU Munich), Germany. I started the process by first getting in touch with German professors to ask about internship possibilities. I was chosen for an analog circuit design project, which matched my interests, following a few online interviews. After being accepted, I had to send in more paperwork via the DAAD portal and by post, including a letter of recommendation, a statement of purpose, transcripts, a No Objection Certificate (NOC), and a letter of approval from the German university. My application for the DAAD scholarship was accepted a few months later.

The Chair of Circuit Design at TU Munich developed a tactile stress sensor chip featuring a 12-bit analog-to-digital converter in 180nm technology. Using Cadence Virtuoso, I completed the layout and conducted post-layout simulations by building various testbenches to analyse the ADC's performance, along with implementing design modifications to minimise delay, noise, and offset in the comparator and the overall ADC.

I worked five days a week and had my weekends off. Having free weekends is one of the greatest perks in Germany. I utilized my free time to explore various destinations. I had the opportunity to travel to many countries and stunning locations in Europe, including Switzerland and Italy. The best aspect was that the stipend was sufficient to take care of my travel costs. Some of my colleagues and I were even able to set aside some savings.

I had a solid grasp of my fundamentals and relevant project and internship experience in my area of interest. These proved to be extremely beneficial during the interview process. Selecting a professor, researching their work, and crafting a tailored email for each one can be quite time-intensive, but it pays off. Dedicating careful time and effort to cold emailing is essential. Regarding research scholarships, especially those abroad, having a strong CGPA, typically above 9.2, is highly advantageous and provides an edge.

Aritra Maity's Internship experience at ITC Limited

I completed my internship in the Foods Business Division of ITC Limited. I secured the internship through an On-campus drive in my 3rd year. The selection process involved a resume shortlist, games assessment, GD, and then followed by two PIs. In the GD round, 8-10 students were provided with a situational case question for which they had to come up with a conclusion. The GD round was followed by PI-1 (technical), where the students were tested on their core subject knowledge. After clearing PI-1, PI-2 (technical + HR) revolved around the applications of the core subject knowledge in industries and general HR questions. You secure the internship once you clear the PIs.

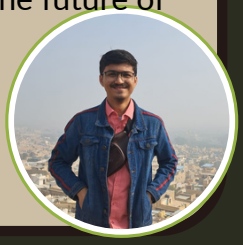
My project was on Waste Reduction and Automation of certain machinery used to produce Mad Angles chips. Due to confidentiality purposes, I am unable to provide a detailed account of the project. However, it involved lots of discussions with multiple stakeholders, live/sustained trials on production lines, quality testing of raw and final products, automation, etc. All projects are done individually within 2 months.

Since my internship was located far away from any metro city, I didn't have much to do during the weekends. My co-interns and I would go shopping, have good food in cafes, and spend time watching movies/web series. There was hardly any leisure time, and completing the project within two months was very challenging.
I didn't prepare much for the internship. I ensured that I had good electrical and analytics related projects. I had also practiced a few GD topics to improve my confidence and communication skills. For PIs, knowing the basics of core electrical subjects is very essential. Since very few companies come for techno-managerial/supply chain/managerial roles for internship it is essential to have several good projects and PORs. An internship during 4th semester winter break will be an added plus point. Also, these companies test your core knowledge during PIs so it is essential to keep in touch with those subjects. Just be confident during the process and all will go well.

WORDS PARK ARTICLES

"Engineers are not just problem-solvers; they are architects of the future, shaping a world where technology and sustainability go hand in hand. From integrating renewable energy into smart systems to developing AI-driven solutions for efficiency and conservation, their role is pivotal in building a greener tomorrow. Ethical responsibility, transparency, and interdisciplinary collaboration must guide every innovation, ensuring sustainability benefits all, not just a privileged few. The future of engineering lies in creating solutions that are intelligent, inclusive, and environmentally conscious. With innovation and integrity, engineers can craft a world that future generations will be proud to inherit."

- Atharva Rathi

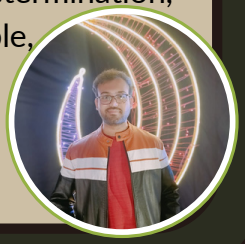


"Engineers, with their unique ability to envision and create, hold the key to transforming challenges into opportunities. In a world driven by technology, they bridge the gap between progress and sustainability, designing solutions that balance human needs with environmental responsibility. From clean energy innovations to climate-resilient infrastructure, their role is pivotal in shaping a greener, more equitable future. A sustainable tomorrow cannot be built on shortcuts—it demands integrity, diligence, and a commitment to excellence. The time to act is now, and the responsibility is ours to shoulder. By embracing innovation with a conscience, engineers can truly become the architects of a better world."

-Abdul Basith

"Engineers are at the forefront of building a sustainable future, turning challenges into opportunities with innovation and technical prowess. From renewable energy to smart cities, they design solutions that balance progress with environmental responsibility. Whether it's clean transportation, efficient water management, or greener industries, their work directly shapes the world we live in. Sustainability isn't just about fixing problems—it's about preventing them in the first place. With creativity, determination, and a vision for a better tomorrow, engineers are redefining what's possible, one breakthrough at a time. The future isn't just something we enter—it's something engineers create with every innovation."

- Ansh Bhatia



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