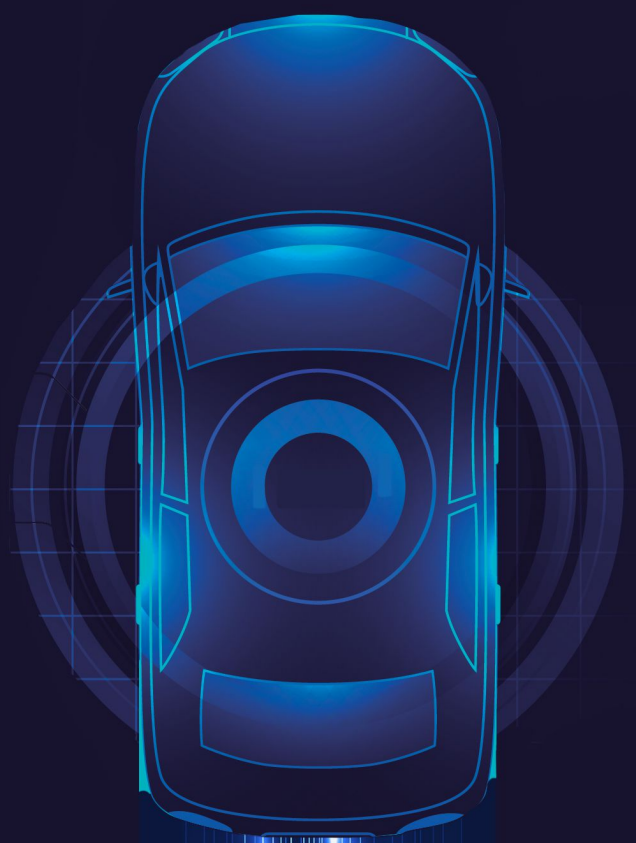
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
NATIONAL INSTITUTE OF TECHNOLOGY

TRONICALS

VOLUME 5 | ISSUE 2



COVER STORY
ELECTRIC VEHICLES

CONTENTS

Message from HOD & Faculty Advisor

Editorial

Vision and Mission of the Department

Placement and Intern Statistics

Journals and Conference Publications

SSD: The storage of tomorrow

RADAR: A history

Smart Vehicles

5G Network

Power Electronic Applications in EVs

EEEA Activities

NPEC

Office Bearers

MESSAGE FROM THE H.O.D.

DR. V. SANKARANARAYANAN

I am delighted to welcome the students to the Department of Electrical and Electronics Engineering. The department aims at providing the students with a holistic learning experience, which will help them for years to come.

We provide the best for the students to gain a wholesome and flawless understanding of the core aspects of the course. We encourage the pupils to take part in various multidisciplinary projects to enrich their knowledge beyond the curriculum. To improve their social skills we advise the students to take part in several extracurricular activities happening inside and outside the campus.

The Department is gifted with experienced faculty members from various specialisations within the field of Electrical and Electronics Engineering, ensuring a diverse pool of knowledge to act as a resource for the pupils. The teaching faculty undertake new innovative methods to engage the students well in the course. The non-teaching faculty are hardworking people dedicated to the smooth functioning of every facility made available.

I congratulate the team members of Currents 2020 for their honest effortsto rise the standards of the department and wish them the best of luck to continue doing the same.

MESSAGE FROM THE FACULTY ADVISOR

DR. MANORANJAN SAHOO

On behalf of EEE Association and TRONICALS of NITT, Iextend my warm greetings for the New Year 2020. Since assuming the office, the young, energetic and innovative team members are instrumental in conducting various events.In addition to conducting workshop on robotics,classes for GATE aspirants at various Engineering Colleges in different states and motivating school students for Electrical Engineering, the association has been involved in philanthropic activities at various orphanages and old age homes in Tamilnadu. One of the acclaimed technological symposium CURRENTS-20 is starting from 14th December 2020 which is based on the theme 'Electric Vehicle Technology'. As the event name suggests, you will enjoy the current in technology at the symposium. I congratulate the editorial team for their excellence in publishing this magazine to showcase the accomplishment and bring out a smile for the association.

EDITORIAL

It is our pleasure to be releasing the 2nd edition of this year's Tronicals. We have been a part of Tronicals for the past two years and this has been a bittersweet experience. Starting out by just ideating for side articles to deciding the layout for the entire magazine, we have come a long way. Being in the department for the past four years have taught us that it takes more than just knowledge to be a part of revolutionary technology. Creativity and innovation have pioneered some of the biggest revolutions in the past and this is something we will take home after our stint in the Department of Electrical and Electronics Engineering.

With the entire world shifting towards cleaner and more sustainable options, electric vehicles have formed a pivotal role in this revolution. It is almost a given that every country has some semblance of an electric future embedded in its policies. As a result, it was a fitting topic for the cover story. Aside from that, this edition is filled with other advancements and nuances in the field of electrical and electronics engineering, thus opening the readers' eyes to the possibilities that the future holds.

We hope you enjoy this edition of Tronicals that we've put together along with our wonderful team of juniors.

Cheers !

(Signing of batch 2016 to 2020)

Kiran Krishnan and Nandita Sreekumar
Editors - in - Chief, Tronicals

Vision and Mission of Department:

About the Department:

The Department of Electrical and Electronics Engineering, NIT, Tiruchirappalli was started in the year 1964. It offers one Under-Graduate programme (B.Tech.), two Post-Graduate programmes (M.Tech. in Power Systems and Power Electronics) and also research programmes (M.S. and PhD) 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 the teaching and research purposes. Thus, the department has dedicated and state of the art teaching/research laboratories. The department is recognized for excellence in research (First Department in NIT-T to be accorded QIP status for PhD programme), teaching and service to the profession.

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 (PEOs):

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

1. for graduate study in engineering
2. to work in research and development organizations
3. for employment in electrical power industries
4. to acquire job in electronic circuit design and fabrication industries
5. to work in IT and ITES industries

Programme Outcomes (POs):

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

1. will have an ability to apply knowledge of mathematics and science in EEE systems.
2. will have an ability to provide solutions for EEE problems by designing and conducting experiments, interpreting and analysing data, and reporting the results.
3. 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.
4. will have knowledge and exposure on different power electronic circuits and drives for industrial applications.
5. will have in-depth knowledge in transmission and distribution systems, power system analysis and protection systems to pursue a career in the power sector.
6. will have a good knowledge in microprocessors/microcontrollers, data structures, computer programming and simulation software.
7. will be able to develop mathematical modelling, analysis and design of control systems and associated instrumentation for EEE.
8. will be able to systematically carry out projects related to EEE.
9. will have an ability to participate as members in various professional bodies as well as multidisciplinary design teams.
10. will demonstrate the ability to choose and apply appropriate resource management techniques so as to optimally utilize the available resources.
11. will be proficient in English language in both verbal and written forms which will enable them to compete globally.
12. will have confidence to apply engineering solutions with professional, ethical and social responsibilities.
13. will be able to excel in their professional endeavours through self-education.
14. 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 (PEOs):

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:

1. Research programmes in Power Systems Engineering
2. Employment in power research and development organisations
3. To work in electric power industries and energy sectors
4. Faculty positions in reputed institutions

Programme Outcomes (POs):

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

M.TECH IN POWER ELECTRONICS

Programme Educational Objectives (PEOs):

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:

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

Programme Outcomes (POs):

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

Journals

1. C. Maria Jenisha, N. Ammasai Gounden, D. R. Binu Ben Jose, "Power Electronic Controller with Time-Sharing Switching strategy for grid-connected PV Systems" Turkish Journal of Electrical Engineering and Computer Sciences, Vol. 27, pp. 243 - 257, Jan.2019. (ISSN: 1300-0632)

2. K Sundareswaran, S Simon, P NAYAK, "MPPT in PV systems using ant colony optimization with dwindling population" IET Renewable Power Generation, 2020.

3. SP Simon, KA Kumar, K Sundareswaran, PSR Nayak, NP Padhy, "Impact & economic assessment on solar PV mirroring system–A feasibility report" Energy Conversion & Management 203, 112222, 2020.

4. SK Murugan, SP Simon, K Sundareswaran, SRN Panugothu, NP Padhy, "Hardware-in-the Loop Testing of Power Transformer Differential Relay Using RTDS and DSP" Electric Power Components and Systems 47 (11-12), 1090-1100, 2020.

5. B Bijukumar, AGK Raam, SI Ganesan, C Nagamani, "Adaptability of grid-connected PV inverters with thermoelectric generator as a power source: a performance comparison" IET Power, Electronics, 2019.

6. A Karthikeyan, C Nagamani, "FPGA based direct torque control with speed loop Pseudo derivative controller for PMSM drive" Cluster Computing 22 (6), 13511-13519, 2019.

7. NS Suresh, M Kumar, SA Daniel, "Multi-agent strategy for low voltage DC supply for a smart home" Smart and Sustainable Built Environment, 2019.

8. S Nindra, LR Paila, K Natarajan, SM Parvathy, "Experimental Investigation on a New Hybrid System Employing Wind-Driven DFIG and Solar PV Panels" Journal of The Institution of Engineers (India): Series B 100 (6), 561-574, 2019.

9. DU Maheswari, S Sudha, M Meenalochani, "Fuzzy based adaptive clustering to improve the lifetime of wireless sensor network" China Communications 16 (12), 56-71, 2019.

10. M Manickam, N Hemavathi, S Sudha, "Performance Analysis of Iterative Linear Regression-Based Clustering in Wireless Sensor Networks" IET Science, Measurement & Technology, 2019.

11. P Padmagirisan, V Sankaranarayanan, "Powertrain control of a solar photovoltaic-battery powered hybrid electric vehicle" Frontiers in Energy 13 (2), 296-306, 2019.

12. Diptak Pal, B. Mallikarjuna, P.Gopakumar, M. Jaya Bharata Reddy, B.K.Panigrahi and D.K.Mohanta, "Probabilistic study of Under-Voltage Load Shedding Scheme to mitigate the impact of Protection System Hidden Failures", IEEE Systems Journal, Accepted for Publication. (SCIE) ISSN: 1932-8184.

13. Anmol Dwivedi, B. Mallikarjuna, Diptak Pal, M. Jaya Bharata Reddy and D.K.Mohanta, "A Real-Time Synchrophasor Based Zone-3 Supervision of Distance Relays Under Load Encroachment Condition", IEEE Systems Journal, Accepted for Publication. (SCIE) ISSN: 1932-8184.

14. Dheepanchakkravarthy, A., Jawahar, M.R., Venkatraman, K., Selvan, M.P. and Moorthi, S., "Performance Evaluation of FPGA based Predictive Current Controller for Four-leg DSTATCOM in Electric Distribution Systems" IET Generation, Transmission and Distribution, Accepted for Publication, 2019.

15. Sekhar Nindra, Lakshmana Rao Paila, Kumaresan, N. and Selvan, M.P. "Experimental Investigation on a New Hybrid System Employing Wind-Driven DFIG and Solar PV Panels", Journal of The Institution of Engineers (India): Series B, Springer, 2019, Available Online, Scopus Indexed ISSN: 2250-2106.

16. M Mohanty, S Selvakumar, C Koodalsamy, S P Simon, "Global maximum operating point tracking for PV system using fast convergence firefly algorithm" Turkish Journal of Electrical Engineering and Computer Science 27 (6), 4640-4658, November 2019.

17. S. Aditya and S. Moorthi, "A wide tunable fast settling 4-bit Digitally Controlled Oscillator for reconfigurable multi-band RF applications", Microelectronics Journal, Elsevier (Accepted).

18. Suman M. and Venkatakirthiga M., "Disturbance Injection based Decentralised Identification of Accidental Islanding", IEEE Transactions on Industrial Electronics, Accepted for publication, DOI: 10.1109/TIE.2019.2917361, Print ISSN: 0278-0046, Online ISSN: 1557-9948.

19. Ravichandran MH, Venkatakirthiga Murali, Sadasivan Achari VT and CC Joseph, " A Comprehensive Study on Transverse Flux Motor for Direct Drive Low-Speed Spacecraft Applications", IEEE Transactions on Industrial Electronics, Accepted for publication,DOI 10.1109/TIE.2020.2965487.

20. J Ganesh Moorthy, Sumit Manual, S Moorthi and P. Raja, "Performance analysis of solar PV based DC optimizer distributed system with simplified MPPT method", Springer Journal on SN Applied Sciences, | https://doi.org/10.1007/s42452-020- 2010-2, available on-line, January 2020.

21. D. Kishan, P. Srinivasa Rao Nayak, B. Naresh Kumar Reddy " Implementation of Identical Spiral Square Inductive Coils for Wireless EV Battery Charging Application" Iranian Journal of Electrical And Electronic Engineering (Accepted for Publication).

22. Prashant Upadhyay, Rajneesh Kumar, Shelas Sathyan. A Coupled-Inductor Based High Gain Converter Utilizing Magnetizing Inductance to Achieve soft-switching with Low Voltage Stress on Devices. Journal: IET Power Electronics. 2019/11.

23. Josephine R L, Catherine Helen and Soundarrajan. Encompassing Monte Carlo Estimator with fair division method in determination of best-suited methods in photovoltaic systems under partial shading conditions. Journal of Electrical Engineering 2019.

24. Josephine R L, Catherine Helen and Soundarrajan. Enhanced power generation using Index squaring and Calcudoko methods for partial shading photovoltaic system. Journal of Applied Mathematics 2019.

25. Josephine R L, Sathiyanathan Jeganathan. Design and Analysis of Universal Power Converter for Hybrid Solar and Thermoelectric Generators. Journal of Power Electronics 2019.

26. Aaryan Shah, Harsh Mahajan and M. Venkata Kirthiga, "Android Application Based Parameter Analysis of Induction Motor", Ninth National Power Electronics Conference, during 13th - 15th December 2019, at the National Institute of Technology Tiruchirappalli.

27. Srividhya S., Keerthana and M. Venkata Kirthiga, "Analysis on Fault Current Contribution by Different Types of DGs and Relay Coordination in Non-Autonomous Micro-Grids", Ninth National Power Electronics Conference, during 13th - 15th December 2019, at the National Institute of Technology Tiruchirappalli.

28. K. Thirumala, A. Kanjolia, T. Jain, and A. C. Umarikar, "Empirical Wavelet Transform and Dual Feed Forward Neural Network for Classification of Power Quality isturbances," Int. J. Power and Energy Conversion, vol. 11, no.1, pp. 1-21, January

Conference Preceding

1. Ganesh Moorthy. J, Mahima M and Raja. P, "Parallel operation of a grid-connected Microinverters with pulsated power decoupling capability", 35th National Convention of Electrical Engineers & National Conference on Storing Energy for a Sustainable Future-Future Energy in an Isolated World, Chennai, India, 2019.

2. K. Marimuthu, S.Vynatheya, N.Vasudev and P.Raja, "Quality Analysis of Ceramic Insulators Under Electro-Thermal Stresses" IEEE International Conference on High Voltage Engineering & Technology (ICHVET-2019), Hyderabad, 2019.

3. Srinivasa Rao Nayak Panugothu, Peddanna Gundugallu, T Manikandan, Damalla Ekalavya and Sishaj P Simon " Analysis of Mutual Inductance Between Rectangular Structured WirelessCoupled Coils with Different Misalignments Using Finite Element Modeling" National Power Electronics Conference(IEEE), December 2019 NITT.

4. Srinivasa Rao Nayak Panugothu, Peddanna Gundugallu, K Kamalapathi, B Krishna Naick "Analysis of mutual inductance between multi-single coupled coils at square structure using FEM" International Conference on Electrical, Control And Instrumentation Engineering (ICECIE 2019), Kuala Lumpur, Malaysia.

5. Kumbha Veera Hanuman, Shelas Sathyan, Manoranjan Sahoo. High Power Factor 3-Level Boost Converter For Interfacing Micro Hydal Generation System To D.C Micro Grid. 2019 Innovations in Power and Advanced Computing Technologies (i-PACT). 2020/1/16.

6. Jisma M, Venkata Sai Aditya Gedda, Vivek Mohan Probabilistic Evaluation of System Adequacy with Variations in Load Demand, Renewable Energy and Generator Topology. Conference: TENCON 2019. 2019/10.

7. Harshal Jamode, K. Thirumala, T. Jain, and A. C. Umarikar, "Virtual Power QualityDisturbance Classifier using Knowledge-based Neural Network," National PowerElectronics Conference (NPEC 2019), NIT Tiruchirappalli, India, December 13 -15,2019.

8. S Kanagalakshmi, S Mageshwari, Ajeet Kumar, "Design of Control Strategy of DC/AC Converter for Grid-Connected PV System" November 2019.

Books

1. K Sundareswaran, "A learner's guide to fuzzy logic systems" CRC Press, 2019.

2.K Sundareswaran, "Elementary Concepts of Power Electronic Drives" CRC Press, 2019.

PLACEMENTS STATISTICS AND INTERNSHIPS

INTERNSHIPS

Bajaj Auto	Aiyush Tiwari
Qualcomm	Adarsh Nunna ,Poorvaja
Texas Instruments	Satyam Pawar,Neeraj Kumar, Madhumita C,Varun Reddy,
Microsoft	Arathi
Western Digital	Akil
P&G	Benjamin
SSIR	Ayush Agarwal, Chennuru Gaurav
SRIB	Karaen
AbInBev	Harishankar
JP Morgan	Dwitikrushna Behera
HPE	Adithya Kumar SINGH
Standard Charterted	Raj Kumar Bhagat
Mathworks	Mohit Agarwal
Boeing	Prakar Singh
Viasat	Deekha Pandey
HLS Asia	Yogesh Kumar
Reliance	Arun Pransanna, Karthey Purnima Unnikrishnan

PLACEMENTS

Number of students registered : 59

Number of students placed : 52

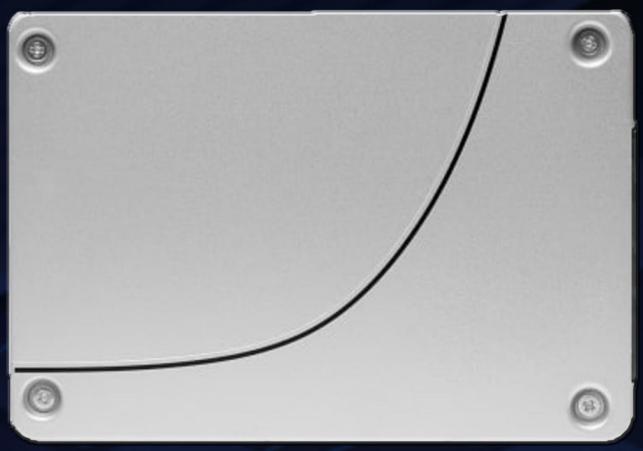
Tronic : 14

Trical : 16

Software : 18

Management : 4

SSD
The storage of tomorrow



For the past two decades, Hard Disk Drives(HDD) were the go-to solution for non-volatile data storage in laptops and desktops. HDD uses magnetization to store and retrieve digital information using one or more rapidly rotating disks known as platters, coated with magnetic material. Data is read or written by moving a magnetic head back and forth over the spinning platter. Though these drives offer a larger storage base capacity at a reasonable boot-up time and read/write speed. In recent years, the name SSD (or Solid State Drive) is gaining popularity due to its unique speed and performance characteristics. If you bought an ultraportable laptop anytime in the last few years, you very likely got an SSD as the primary boot drive. Larger laptops are increasingly moving to SSD boot drives, too, while budget machines still tend to prefer HDDs. Meanwhile, some hard drive manufacturers, like Samsung and Seagate, speculated that if you add a few gigabytes of flash chips to a spinning hard drive, you could create a so-called "hybrid" drive. This combines the large storage capacity of a hard drive with the performance of an SSD, at a price only slightly higher than that of a typical hard drive. So, it is up to the user to decide between getting either an SSD or an HDD or hybrid drive as the storage component depending on their computing needs.

What makes SSDs faster than HDDs?

Unlike classic mechanical HDD, A solid-state drive uses flash-based or RAM-based memory, which doesn't require any spinning parts. A RAM-based solid-state drive caches data on DRAM or SRAM chips, which means that it will lose its contents when the power is turned off. To preserve the contents, a RAM-based solid-state drive copies volatile memory to non-volatile memory upon instruction or when the drive is powered down. On the other hand, a flash-based SSD uses NAND or NOR flash memory, which saves data as blocks and when power is disconnected, a metal-oxide-semiconductor will provide an extra charge to the memory cell, thereby caching the data. Floating gate transistors (FGT), which are structured similarly to NAND or NOR logic gates are used as metal-oxide-semiconductors in flash-based SSDs. Each block (or a grid of NAND flash cells) can store between 256KB and 4MB. SSDs have an embedded processor (memory controller) that contains the exact

address of the blocks so that when your PC requests a file it is (almost) instantly Apart from SSDs, another well-known storage device that uses NAND flash memory is a flash drive. So, is SSD just a larger version of the pen drive? Well, it is not. SSDs are faster and more reliable than a regular flash drive due to the underlying technology used to construct the NAND flash memory and function of the flash memory controller present onboard. An SSD controller is a microprocessor that executes firmware-level code, error-correcting code (ECC) and performs functions like wear leveling, bad block mapping encryption etc. Another difference lies in the way how these devices connect to computers. A flash stick normally uses a Standard-A USB plug that provides the physical interface to the host computer, while SSD often use interfaces like SATA.

Few common interfaces to connect SSDs to the system include SATA, PCIe, M.2, U.2, mSATA, SATA Express, and recently SSDs now come soldered to the motherboard.

Serial Advanced Technology Attachment (SATA) is a computer bus interface that was designed specifically to connect mass storage devices like HDD, with speeds up to 6 GBit/s or about 600 MB per second. So, a 2.5-inch SATA-based SSD is a great way to boost the speed of an older computer with a spinning hard drive and increase the computer's ability to read/write data, possibly by tenfold.

PCIe (Peripheral Component Interconnect Express) is another type of interface used to connect graphics cards, network cards, offering high bandwidth and low latency. Generally, an SSD connected via a PCIe 3.0 x16 interface provides a faster interface speed of 16Gb/s compared to the SATA 3.0 standard offering a speed of 6.0Gb/s.

NVMe (non-volatile memory express) is a high performance, NUMA (Non-Uniform Memory Access) optimized, storage protocol built to speed up the transfer of data between enterprise and client systems and SSD over a computer's high-speed PCIe bus. This type of SSDs can scatter/ gather commands and process them out of turn to offer far higher IOPS (Input/Output Operations Per Second) and lower data latencies.

Though SSDs offer high speed and durability (shock-resistant, not affected by magnets), an expensive price and limited number of write/erase cycles makes it difficult to replace conventional HDDs in the market. However, with recent advancements and increasing demand, the price of SSDs is on a continuous fall, which is drawing users' attention all over the world.

- A Monish Prabhu

5G NETWORK
THE NEXT BREAKTHROUGH IN TECHNOLOGY

Every generation of wireless network delivers better speed and more functionality to our smartphones. 1G brought us the very first cell phones, 2G let us send text messages for the very first time through our mobile phones, 3G brought us online and 4G delivered the speeds that we enjoy today. But as more users come online, 4G networks have just about reached the limit of what they are capable of. Now we are headed towards 5G, the next generation of wireless networks. It will be able to handle a thousand times more traffic than today's networks and will be up to 10 times faster than 4G LTE. 5G also promises to be the foundation for augmented and virtual reality, autonomous driving, the Internet of Things and more. How does 5G do it, you ask? Well, here's how.

5G uses new radio technology, the part of any wireless device that makes connections. 5G uses radio frequencies in a band known as SUB 6, from 600 megahertz to 6 gigahertz. Part of this is also used by current 4G LTE. However, 5G will also use a higher band of radio frequencies from 24 gigahertz to as high as 86 gigahertz. These frequencies are much higher and as a result, can transfer data at faster rates. But there is a catch. These waves cannot travel far, or through buildings or other obstacles and they tend to be absorbed by plants and rain. To get around this problem we'll need Small Cell Networks. Today's wireless networks rely on large high-powered cell towers to broadcast their signals over long distances. Small cell networks would solve that problem, using thousands of low-power mini base stations. These base stations would be much closer together than traditional towers, forming a relay team of sorts, to transmit signals around obstacles. This would be especially useful in today's concrete jungles, that we call cities. As a user gets obstructed by an obstacle, his smartphone would automatically switch to a new base station that gives better coverage for his device, allowing him to keep his connection.

Massive MIMO (multiple input multiple output) is another development in 5G networks. Today's 4G base stations have about a dozen ports for antennas that handle all cellular traffic, but massive MIMO base stations can support about a hundred ports. This could increase the capacity of today's networks by a factor of 22 or more. Of course, massive MIMO comes with its own complications. Today's cellular antennas broadcast information in every direction at once and all those crossing signals, at times, cause serious interference. And the solution to this is Beamforming - a technology akin to traffic signals for cellular signals. Instead of broadcasting in every direction, it would allow a base station to send a focused stream of data to a specific user. This precision prevents interference and is way

Say, you are in a cluster of buildings and you are trying to make a phone call. Your signal is ricocheting off surrounding buildings and crisscrossing with other signals from users in the area. A massive MIMO base station receives all these signals and keeps track of the timing and the direction of their arrival. It then uses signal processing algorithms to triangulate exactly where each signal is coming from and plots the best transmission route back through the air to each phone. Sometimes it'll even bounce individual packets of data in different directions off different obstacles to keep signals from interfering with each other, the result is a coherent data stream sent only to you. If you ever used a walkie-talkie, you know that in order to communicate you must take turns talking and listening. That's kind of a drag. Today's cellular base stations have that exact same holdup. A basic antenna can only do one job at a time, either transmit or receive. This is because of a principle called reciprocity, which is the tendency for radio to propagate both forward and backward along the same frequency.

This brings us to the use of Full Duplex. Researchers have used silicon transistors to create high-speed switches that halt the backward roll of these waves. It is similar to a signalling system that can momentarily reroute two trains so that they can get past each other without any interference. 5G has renewed concerns about the safety of cellular radio waves. Hence, some cities have acted to block 5G deployment.

Health questions have come up around 5G's use of microwave frequencies. 5G may sound like a lot of microwave ovens mounted on poles running with their doors open. In fact, microwaves are nothing new, already emitted by our smartphones, old cordless phones, our wireless headphones and just about anything with Wi-Fi, along with microwave ovens. But even 5G's highest frequencies are considered by scientists to be non-ionizing radiation, which is harmless (keeping the propaganda in view).

As it stands, 5G might take years to roll out, due to the complexity of deployment and debugging. However, the stellar data speeds and other promising features make it worth the wait!

SMART VEHICLES

Imagine a futuristic scenario wherein cars communicate with one another and create an environment to ensure safe commutation and greater convenience. Car-to-car information sharing can send various alerts to the drivers ahead and behind. This is not as distant as it seems. The evolution of smart vehicles brings us one step closer to the dawn of autonomous vehicles.

A smart automotive transportation system includes the facilitation of stop signs and traffic lights communicating with the vehicles in a smart intersection. This ensures safe sequencing in merging vehicles, an effective accident prevention system at crossroads and also makes traffic crimes reporting a lot easier. The system can also pave the way to better and more intelligent traffic flow, suggesting automatic switching of signals for emergency vehicles such as ambulances and fire-trucks.

This also suggests better fuel economy as it provides efficacious solutions such as battery charging technologies, direct-injection engine management and brushless DC motor drives. It also marks the onset of a green technology that intertwines sustainability and convenience.

Connected cars or smart cars come with enormous potential for innovation. A few of them are as follows:

- They will be capable of processing voice-response commands. They will also let you connect with apps on your phone via the car's voice-recognition interface. You might be able to pre-order your dinner, shop online, pay for petrol and do a whole lot more, by connecting to your phone using your car's voice interface.
- They will be able to pair up with wearables that assess the medical conditions of the driver and transmit the information to a healthcare specialist in case of emergency. It might also be equipped with features to call emergency contacts in case any abnormalities are detected and drive you to the nearest hospital.
- They will revolutionize the realm of entertainment. Be it the types of movies you repeatedly watch or that one song that captivates your soul, your car picks it up for you. It can also suggest songs or movies depending on your mood which can be assessed by your health parameters.
- They will be programmed with parking algorithms and might help in finding spaces to park.
- Greater communication with the surroundings enhances the overall driving skills, thereby paving the way for a safe and secure neighbourhood.

It also enables the incorporation of Geofencing. Geofencing is a feature in a software programme that uses the global positioning system (GPS) or radio frequency identification (RFID) to define geographical boundaries. It allows an administrator to set-up triggers so when a device enters (or exits) the boundaries defined by the administrator; an alert is issued. Many geofencing applications incorporate Google Earth, allowing administrators to define boundaries on a specific geographical area. Other applications define boundaries by longitude and latitude or through user-created and web-based maps.

One of its key features that embarks it as a safer transportation method is the electronic braking system. Electronic activation of the EBS braking components reduces response and build-up times in brake cylinders. This, in turn, reduces braking distance by several meters, which can be decisive in some situations. The integrated ABS function ensures driving stability and steerability throughout the braking procedure. This helps to avert traumatic instances and possible accidents.

It also simplifies car-pooling with automation, as a replacement to the traditional ask-and-approve system. Sensors in cars, tied to GPS positioning, could let a backend network know where a car is parked at any given moment, and plan car-pooling based on that information.

In less than a decade, petrol pumps are going to be obsolete and fuel prices will rise to an all-time high owing to the problems of global warming and resource exhaustion. The citizens will be forced to invest in electric vehicles and similar technologies. They have lesser maintenance cost and have a near-zero marginal cost of fuel, resulting in the collapse of the petroleum industry. The innovation of electric cars, all the more, facilitates these features and provide scope for many more of them to come.

The best part of technology is that it reiterates the accuracy of the popular phrasing - necessity is the mother of invention. With growing needs and eternal greed, budding technologies such as connected cars have high prospects of serving humanity in the best way possible. We are, indeed, at the cusp of the Internet of cars.

RADAR AS SEEN DURING WWII

It's 1935, and the German War Machine had finally gone into full gear. They outnumbered the factories owned by Britain and her colonies, had more resources and a modern army unlike France, and wanted to test their new toys in the art of battle. Their opportunity came on the 17th of July 1936, when Spain started to fight a civil war. The Nationalists under General Franco were supported by the Germans in their fight against the Communists who were backed by the Soviet Union. The Soviets were confident that they will be able to defeat the Germans with their superior tanks. They go on the battlefield, get their tanks and spotters ready. Minutes pass, and then hours, but no signs of enemy German tanks. Suddenly they start hearing high pitched shrieks. An ungodly shriek that drives fear into the hearts of the brave soviets

"Stuka Bombers" .

These bombers were extremely precise, able to drop bombs on ground targets with ungodly accuracy. The worst part of these 'Devils of the Sky' was that it was almost impossible to see them coming except seeing them. The German War machine had started to produce this Aircraft en .masse and they had one target in their mind - London

The British had to come up with something to fight against these advancements in air warfare, or they'd have the face the grim reality that they cannot challenge the Luftwaffe, or the German Air Force. Their answer came to them as a result of a failed "Death-ray making competition", where contestants were asked to make a death ray which can kill the pilot in an aircraft. One of the contestants, Dr Robert Watson Watt observed something weird. In his pursuit of building a death ray, a project in which he had no hopes, he observed that his radio devices observed interference when RAF aircrafts moved close to his tower. With the permission of his .Government, he developed this concept and began to test it

He set his RADAR up on two BBC radio stations and asked an RAF bomber to fly between. His mind was blown. As the display pings accurately tracked the flight, he uttered these famous words “Britain is an island again” . The British begin to erect hundreds of these towers all along the coast of Britain. To Hitler’s caution, these RADAR stations were being observed, but all they could hear was static. What the Germans didn’t know back then was that they were just searching at the wrong bandwidth, and this might’ve been a grave mistake. There was an issue of manning these RADAR stations though. As most men were fighting in the war against tyranny and fascism, there was a void created of required jobs. This was the rise of women in the war effort as these RADAR stations were operated almost exclusively for women. This was a sign of solidarity in their ultimate fight against the Nazis. It’s 1940, and the Germans have rolled over France and are ready to beat Britain into submission. They grew more and more cautious about these RADAR stations, but in the end, largely ignored them. This was another blunder in the long run. As waves of .German planes crashed onto the English shore, they were met with surprisingly stiff resistance

They thought to themselves, “These Brits must be outnumbering us, there’s no other way.” The truth was that The British had fewer planes than the Germans did, but they were in the right place at the right time. By the end of the infamous Battle of Britain, the air superiority was in the hands of the King and his countrymen (And colonies, but why give them freedom when they can fight for the freedom of others). The United States was quite early to this age of RADAR, as they knew about the importance of RADAR after their humiliating defeat at Pearl Harbor in the hands of the Japanese. They integrated the Ivy League institutes directly into military research and development to a point that the Japanese were defeated at their own game. At the beginning of the war with the USA, the Japanese were 6 months behind the US with their technology, but by the end of the war, they were behind by almost 6 years! RADAR was this invisible wall that kept people safe in the bunkers at Britain and made sure that the convoys bringing food to the home .islands stayed afloat

Without this technology, the world as we know it would not be remotely similar and might’ve . .taken a turn for the worse

ELECTRIC VEHICLES

Overview

With global warming and climate change becoming a significantly large concern for various people across the globe, humanity must focus on cutting down their negative impact on this planet in order to survive. The Environmental Defense Fund (EDF) has estimated hat on-road motor vehicles cause one-third of the air pollution in the atmosphere and transportation contributes to around 27 percent of the greenhouse emissions around the world. These shocking statistics diverted theattention to electric vehicles and made companies want to consider it as a vital replacement for its present fossil fuel-driven counterpart.

Electric Vehicles began around the same time as the beginning of the automotive industry, in the mid-nineteenth century, to be more accurate. In fact, in the early stages of the automotive industry, electric vehicles were preferred over the now conventional petroleum and diesel vehicles as they were a more cost-effective option because the fossil fuel extraction techniques were not quite advanced at that time.

Overview (contd)

The first known electric locomotive on record is known to be in the year 1837. Robert Davidson, a Scottish chemist, designed his locomotive called Galvani with the help of galvanic cells. This model did not achieve extensive usage, mostly because it was not rechargeable. With the drop in the prices of petroleum, the growth in fossil fuel-powered automotive boomed, leaving electric vehicles behind during the revolutionary industrialisation period.

Later, with the development of rechargeable batteries, electric vehicles started getting more recognition. In the early 20th century, many electric vehicle taxi cabs were operable in several parts of Europe. They were sometimes preferred over gasoline cars, especially in cities, because of them not having loud noise or odd smell often associated with the conventional locomotives.

Power Electronics - history and application

With more focus drawn towards clean technology, electric vehicles have now reached a peak for research in academia and industry. Since electric vehicles run on motors, motor drive control has been one of the most researched topics. This led to the involvement of power electronic circuits in this field.

Power Electronics has found its way into almost every field that involves electrical and electronics engineering. The study of involving solid-state electronics for control and conversion of electrical power is a necessary application in concepts like motor drive, power systems, high voltage engineering, and whatnot.

This omnipresent field of study started with the development of mercury arc rectifiers in 1902. This development was the first-ever circuit to convert alternating current (AC) to direct current (DC). As time progressed, with the advent of better solid-state electronic devices,this field helped in groundbreaking research and inventions in practically every area of circuital engineering. In some cases, power electronic converters were also used in non-circuital branches and opened the gates to more interdisciplinary studies.

Power Electronics - history and application(contd.)

The different variety of devices that can be used to design and implement these power electronic converters and controller circuits like BJTs, field-emission transistors (FETs), SCRs, thyristors, MOSFETs and IGBTs have allowed the research in this field to be extremely diverse.

The devices are being used as switches, amplifiers, and in several other analog circuits to achieve a plethora of useful circuits that perform various necessary functions. With the development in the synthesis of these devices, we have a wide range of operation, from a few volts or microamperes to a few kilovolts or kiloamperes.

Power electronics being such a critical study finds an exciting and significant role in electric vehicles.It acts as a device for controlling power between the battery and the charger, converting power between the battery and motor in more than one step. It is also used to convert power from the battery to other auxiliary loads in the car like air conditioners and radios.

Why are power electronic devices necessary in EVs?

Power electronic circuits are a necessary part in electric vehicles primarily to make the locomotive run, or in layman terms, to enable smooth running and control of the motor that drives the vehicle. The AC motor, mostly induction motors, requires the usage of an inverter which will convert the High Voltage, Direct Current (HVDC) supply from the battery to the rated AC voltage and current of the motor. In case of Brushless DC motors and Brushed DC motors that are used in electric vehicles, the inverter is replaced with a simple DC-DC converter to match the HVDC battery output to the rated input for the motor.

An induction motor (squirrel cage)is a constant speed motor where the rotor speed which is mechanically coupled to the axle, is dependent on the supply voltage and frequency, which is constant from a given source, in this case, a battery. However, when there is a requirement to have variable speed control and even zero-speed control in a vehicle, the power electronic circuits included are used to control the supply frequency and voltage to the motor, enabling smooth speed control. This application of power electronic circuits in AC motors is called variable-frequency control of induction motors. This application is not just limited to AC machines, but also for the other Brushless DC (BLDC) motors and Brushed DC motors.

Why are power electronic devices necessary in EVs?(contd.)

In the case of Hybrid Electric Vehicles, power electronic circuits are used in two formats: series and parallel hybrids. Both of these formats have the primary goal of having a harmonious relationship between the electric motor and the Internal Combustion Engine (ICE). These electric vehicles are not just limited to cars, but also other locomotiveslike trains, buses and other moving vehicles. Electric trains use Pulse Width Modulation (PWM) rectifiers to obtain power and for vector control. The devices used for the speed control are broadly classified as Electronic Speed Control (ECS).These devices are used for dynamic braking, regenerative braking and variable- frequency control. Many large ESC circuits are used in commercial electric vehicles which generally draws power in the range of kilowatts, producing torque in the range of a few hundred- newton metres. These circuits are also used to store energy when the vehicle brake or coasts, which changes the mode of operation from being a motor to a generator and thereby reducing the speed of the machine.

These ESC circuits are observed in the Nissan Leaf electric vehicles, and Tesla Roadster. In some particular models of electric vehicles, like those released by Tesla, the ESC circuits are so capable that the conventional brakes are only required when the vehicle's speed is very low because the ESCcircuit is capable of bringing the speed of the machine down by an exponential degree. In other models, like the Nissan Leaf, there is only a minimal "drag" effect, which reduces the speed of the machine to a small extent, after which the conventionalbrakes will take over.

Why are power electronic devices necessary in EVs?(contd.)

ESC circuits used in mass-produced electric cars usually have reversing capability, allowing the motor to run in both directions.The car may only have one gear ratio,and the motor runs in the opposite direction to make the car move in reverse motion. Some electric cars with DC motors also have this feature, using an electrical switch to reverse the direction of the motor. However, others run the motor in the same direction all the time and use a traditional manual or automatic transmission to reverse direction. Usually, this is easier,since the vehicle used for the conversion already has the transmission, and the electric motor is installed in place of the original engine.

An ESC can be a stand-alone unit which plugs into the receiver's throttle control channel or incorporated into the receiver itself, as is the case in most toy-grade R/C vehicles. Some R/C manufacturers that install proprietary hobby-grade electronics in their entry-level vehicles, vessels or aircraft use onboard electronics that combine the two on a single circuit board.

ESC circuits designed for sports use in radio-controlled cars generally have reversing capability; newer sport controls can have the reversing ability overridden so that it can not be used in a race. Controls explicitly designed for racing and even some sport controls have the added advantage of dynamic braking capability. The ESC forces the motor to act as a generator by placing an electrical load across the armature. This, in turn, makes the armature harder to turn, thus slowing or stopping the model.Some controllers add the benefit of regenerative braking.

Why are power electronic devices necessary in EVs?(contd.)

The application of ESC circuits are not limited to cars, but any locomotive.Electronic Speed Controllers (ESC) are an essential component of modern quadcopters (and all multirotor) that offer high power, high frequency, high-resolution 3-phase AC power to the motors in an extremely compact miniature package. These crafts depend entirely on the variable speed of the motors driving the propellers. This wide variation and excellent RPM control in motor/prop speed give all of the control necessary for a quadcopter (and all multirotor) to fly.

Soft starting techniques are widely favoured to increase the longevity of the machine, and thus by extension, the vehicle itself. It is a procedure-wherein the load and torque in the powertrain, which in this case is the HVDC battery is temporarily reduced. It ensures that surge current through the machine during the starting does not harm the machine, while also not compromising on the smooth functioning. This reduces the mechanical stress on the rotating parts of the machine, and the electrodynamic stress on the power cables and distribution networks. These techniques are implemented in both mechanical(in the form of clutches and lubricants) orelectronic. Power electronic circuits are typically implemented to design soft starting devices for these machines.

Future of EVs

Renewable energy sources and clean energy is on the rise owing to rising pollution rates and global warming. With that in mind, and considering the rate of development of electric vehicles commercially, it is almost a given that electric vehicles will play a significant role in future transportation. The reason electric vehicles did not boom in the beginning was primarily because of the primitive nature of the power source, the battery. However, nowadays, the situation has changed drastically.

First, advances in lithium-ion batteries, in large part driven by the consumer electronics industry, allow full-sized, highway- capable electric vehicles to be propelled as far on a single charge as conventional cars go on a single tank of gasoline. Lithium batteries have been made safe, can be recharged in minutes instead of hours, and now last longer than the typical vehicle.The production cost of these lighter, higher-capacity lithium batteries is gradually decreasing as the technology matures and production volumes increase.

In May 2017, India was the first to announce plans to sell only electric vehicles by 2030. Prime Minister Narendra Modi's government kickstarted the ambitious plan by loating a tender to purchase 10,000 electric vehicles, hailed as " the world's single-largest EV procurement initiative". Along with fulfilling the urgent need to keep air pollution in check, the Indian government aims at reducing the petroleum import bill and running cost of vehicles.

Conclusion

India, as a country has been making several efforts to make breakthroughs in this field. India unveiled the 'National Electric Mobility Mission Plan (NEMMP) 2020' in 2013 to address the issues of national energy security, vehicular pollution and growth of domestic manufacturing capabilities. Reiterating its commitment to the Paris Agreement, the Government of India has plans to make a significant shift to electric vehicles by 2030.

The charging infrastructure for electric vehicles in India has not been fully developed yet. There have been initiatives to set up community charging stations, as in the case of Plugin India facilitated charging stations. News reports have indicated plans to provide solar-powered charging points at the existing fuel stations of the country.

In conclusion, from recent trends, one can confidently say that electric vehicles will play a massive role in humanity's future. Renewable energy sources that power these vehicles make them more approachable and practical to everyone.

EEEA INAUGURATION

The department of Electrical and Electronics Engineering, NIT Trichy held the inauguration of the EEE Association (EEEA) 2019-20 on 30th of August 2019 at EEE Auditorium. The association's objective was to bring together the various cogs in the wheel, to ensure a frictionless relationship between the students of this department, and its faculty.

The chief guest of the event was Dr Balamurugan Sridharan, Senior Engineer at GE Aviation and a NITT alumnus. The event started off with an invocation, followed by a welcome address by HOD in-charge Dr N Kumaresan. It was succeeded by an overview of Currents '19 and the unveiling of the association by the association's faculty advisor, Dr Manoranjan Sahoo. Further, EEEA Chairperson Mr Harinaathgobi C walked through the agenda of the association for the academic year 2019-20. The event then proceeded with a speech by IDAS officer Mr Purushottaman.

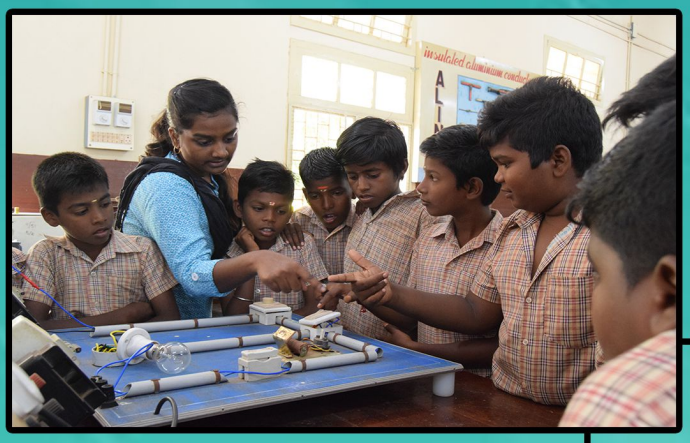
The event's highlight was the lecture by the Chief Guest Dr Balamurugan, who spoke about his life post his undergraduate degree and shared his experiences of an electrical career in the aviation industry. The event concluded with a vote of thanks by the treasurer Mr DC Vivek.

SPARK PHASE 1 REPORT

The social responsibility team of our EEE association went on a humanitarian mission to "All the Children" Orphanage in Chennai as a part of Spark. It was a change of pace from regular college responsibilities, as we were admiring how responsible the children had gotten at such a young age. The members of the social responsibility team worked diligently to bring light to the orphanage by installing low energy LED lights to brighten up the lives of the kids and ensure that they have a positive outlook on life. We also donated Rs 10,000 to the Ashram as a token of goodwill.

SPARK PHASE 2 REPORT

The second phase of our social responsibility initiative, Spark, was conducted on the 6th of February for the students of REC Middle School and Saint Joseph's School in Trichy. It started off with an interactive presentation by Dr P Raja on basic electricity and magnetism, and its applications in everyday life. This was followed by a hands-on demonstration, which consisted of a variety of experiments designed to show the practical application of what they learnt in the presentation. The demonstration included experiments involving series/parallel connections, staircase switches, earthing, and many more. The event saw a large number of students learning science in a practical, comfortable and fun manner, which led to it being a grand success.



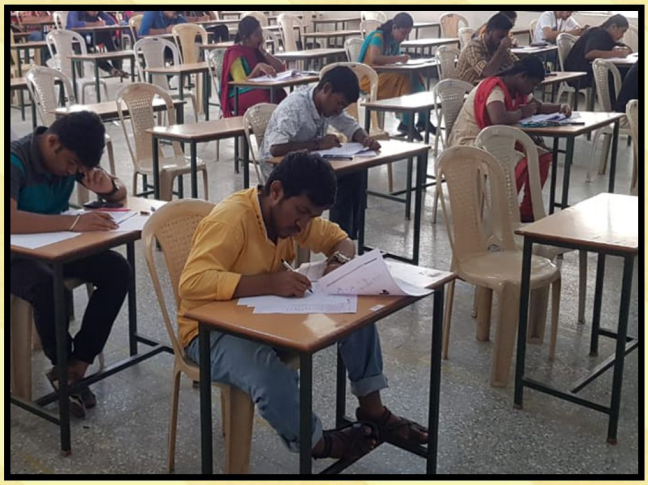
MALARCHI ASHRAM

The social responsibility team of our EEE association went on a humanitarian mission to "All the Children" Orphanage in Chennai as a part of Spark. It was a change of pace from regular college responsibilities, as we were admiring how responsible the children had gotten at such a young age. The members of the social responsibility team worked diligently to bring light to the orphanage by installing low energy LED lights to brighten up the lives of the kids and ensure that they have a positive outlook on life. We also donated Rs 10,000 to the Ashram as a token of goodwill.

VOLTS REPORT

Volts '20 was a mock GATE exam organised by Currents, in association with Ace Engineering Institute for college students in towns across South India, namely, Sivakasi, Trichy, Calicut and Karaikal. It was designed for students from the streams EEE, ECE, CSE, Civil Engineering and EIE to simulate GATE's high-pressure environment for those who are unable to access similar institutions near them. There were a large number of attendees in every examination centre and was described to be very similar to the actual GATE experience, thus justifying calling the event a success

Mock GATE Exam happening in Sivakasi.



Mock GATE Exam happening in Coimbatore.

NPEC 2019

The 9th National Power Electronics Conference (NPEC 2019), a biennial conference of Power Electronics forum in India focused on the dissemination of the potential research findings in Industries and Academia. It featured extensive exposition on Power Electronics through Plenary talks, Panel discussions, Tutorials and Paper Presentations. NPEC was first organized at IIT Bombay in 2003 and subsequently in IIT Kharagpur (2005), IISc Bangalore (2007), IIT Roorkee (2010), IIEST Shipur (2011), IIT Kanpur (2013), IIT Bombay (2015) and College of Engineering, Pune (2017) to enhance the interaction of the peers in the field of Power Electronics.

This conference was a launchpad for many researchers to exhibit the influence of Power Electronics on various applications viz. industry, domestic, commercial, mobility and electric utility systems. Its impact on effective energy conversion has been envisaged in this forum. Technical sessions by industrial experts deliberately brought out the recent challenges faced in the industry which will provide an opportunity for inspirational minds to solve them. This has led to a sturdy power electronic community comprising of academicians, research scholars and industry professionals. The development of new circuits and tools for the power electronic systems has also been an outcome of this conference.

The 9th edition of this prestigious conference was held at National Institute of Technology, Tiruchirappalli, an institute of national importance which is situated in the banks of river Cauvery and is the top amongst NITs and also holds 10th rank in the NIRF rankings. It was another proud moment for NIT Tiruchirappalli to organize this conference which was a formal get-together for the power electronics community.

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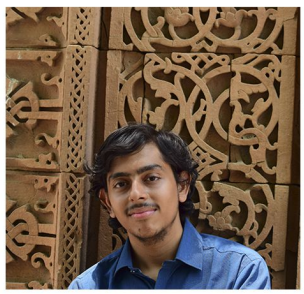

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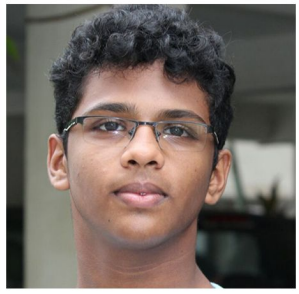

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