

backgroundhum



DEPARTMENT OF ELECTRICAL ENGINEERING
INDIAN INSTITUTE OF TECHNOLOGY, BOMBAY

AUGUST 2022



TABLE OF CONTENTS

03 LOOKING BACK: IITB IN THE '60S

05 TÊTE-À-TÊTE WITH PROF. SANDIP MONDAL

08 INTERNSHIP DIARIES

10 GRADUATE SCHOOL APPLICATIONS

12 DEPARTMENT RESEARCH ACTIVITIES

17 CONCEPT BYTE - VPNs

19 EE ACE CELL

21 EE ALUMNI TOUR

23 TOWARDS WELLNESS

27 INFORMAL SECTION

Looking back: IITB in the '60s

In conversation with Dr. Sharad Saraf

Dr. Sharad Saraf is an alumnus of IIT Bombay (BTech 1969, Electrical Engineering). Currently, he is the Chairman of the Board of Governors (BoG) of IIT Bombay as well as IIT Jammu. He is also the chairman cum managing director of Technocraft Industries, an established multinational industrial house which he co-founded along with his brother in 1972. Other than this, Dr. Saraf has headed several chambers of commerce.

He is a founding member of the Electrical Engineering Student's Association (EESA). Last November, we decided to talk to him about his experiences and find out how life was at IITB in his undergraduate days.

Q. As an alumnus, can you let us know what life was like at IITB in your days?

We were very carefree and relaxed. We did not have so many cultural and other events. The campus was lush green with a very pleasing ambience. There was a great bonding among the batch mates mainly because there were no other disruptions like mobile phone, laptops etc.

Q. What kind of extracurricular activities did students participate in those days?

Our extra-curricular activities consisted of inter hostel, inter IIT sports competitions, various types of inter hostel activities, hostel day etc. We also produced very high quality professional plays which were staged in Tejpal Auditorium, Mumbai. There was great stress on sports.

Q. How was the faculty - student interaction back then when the batch strength was lower?

Faculty - student interaction was very personal. The professors in the department knew almost all the students. The faculty members were ever ready to meet the students or resolve any issues.



ADIL KHAN



SAMYAK SHAH



Q. How did the idea of forming EESA (electrical engineering student's association) come about?

At our time when I was in my 4th year, I found that there was a very vibrant Chemical Engineering Students Association. So I wondered why we did not have a similar association for the Electrical Department. I discussed this with senior professors like Hariharan, Balakrishnan, Mukherjee among others and they were extremely kind and helpful.

Q. What plans did you have while forming EESA? In what manner did the department support it?

The main plan was factory and plant visits that would enhance student's knowledge of electrical engineering. For example, we visited Tarapur Atomic Power Station and a factory in Vadodara. There were also a few other visits. These visits were the source of bonding among members and we also had interesting lectures.

The faculty was extremely co-operative and never said no for any program or event.



Q. What factors affected career choices in those days and what went behind you choosing the path of entrepreneurship?

In those days the most favorite choice was to go to the US for higher studies. Almost 70% of my batch mates went to the US. Those who stayed back did so for various reasons like family issues, financial conditions, family businesses or simply the desire to do something in the country. I could say that I was kind of a born entrepreneur. Even during my stay in the hostel, I had set up small commercial activities which were great fun and also well liked by my hostel batch mates. I came from a traditional Marwari community and hence I had it in my DNA. After graduating, I worked in a factory manufacturing electric motors, and then in 1972 I established my own business.

Q. Looking back, how was the entrepreneurial scene in the '70s, especially at IITB as compared to what it is now?

In those days there was hardly any entrepreneurial spirit in our IIT students. There was no SINE or IT Sector. Hence almost all students preferred to go for professional jobs.

Q. How did you familiarise yourself with taxation, personal finance and other things that are important in daily life but aren't taught in the IITB classroom?

Many people have asked me this question. All non-technical services like taxation, personal finance etc. are available through chartered accountants and other professionals. I do not think there is a great need for any formal teaching of these subjects since there is not much creativity involved in them but general knowledge of taxation and personal finance comes on its own by experience.

Q. Could you please illustrate how the IIT Bombay network and peer group has helped you throughout your career?

Till mid 1980s there was no IITB networking except for among close batch mates or hostel mates. There was no email, mobile phone etc. and hence networking was restricted to landline phones. However, in the 1980s I started the IITB Alumni Association (Bombay Chapter). This became quite popular and finally spawned IITBAA and PAN IIT Alumni Association. We organized a monthly alumni meet in the Institute of Engineers, Mahalaxmi on the last Saturday of every month. We also did a lot of events including organizing an annual day on the last Sunday of every year.

Q. What would be your advice to students who are currently at IITB?

Basically all IITB students are quite creative, intelligent and dedicated. My advice is to remain focused, and have a CAN DO attitude. You will also find opportunity in every adversity provided you look for it intelligently.

Q. We came to know that you are soon coming up with a book on your life experiences. Would you like to share anything about that?

Yes, my book is under printing now. It is called "Engineering Karma" and contains certain important events and experiences from my life which carry some message. There are also chapters about my experience at IIT Bombay, the first 4 years of my career and also my subsequent business journey.

THIS INTERVIEW WAS FIRST PUBLISHED IN FUNDAMATICS (IITBAA MAGAZINE) IN MAY 2022. SCAN THE QR CODE TO VISIT THEIR WEBSITE.



Tête-à-Tête with Prof. Sandip Mondal



**ADIL
KHAN**



**JANEEL
PATEL**



**PRASANN
VISWANATHAN**



Professor Sandip Mondal joined the department as an Assistant Professor in September 2021. He completed his PhD from IISc Bangalore and subsequently worked as a post-doctoral researcher at Purdue University. His research interests include semiconductor device physics, microelectronics and neuromorphic engineering.

During his postgraduate days, he was also involved in many cultural activities. He has served as the chairman of Gymkhana at IISc and the chief coordinator of SPECTRUM (IISc's annual sports, literary and cultural fest).

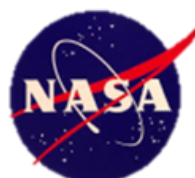
Q. Can you describe your life journey to date?

Well, I was born and raised in a village of Purba Medinipur district in West Bengal. My upbringing is in a very humble and simple family where my father worked as a police constable and my mother is a housewife. I completed my high school from the government school of my district which was 7 kms away from my village. I still remember spending hours walking to and from school every day.

After completing my schooling, I moved to Calcutta University to pursue my undergraduate education. Further, I joined the integrated MS - PhD program of IISc Bangalore. After receiving my PhD in 2017, I joined Western Digital (SanDisk) as a device engineer and where I worked on flash memory technology for 2 years. Later I moved to Purdue University where I worked with JTEC (Johnson Thermoelectric Energy Converter), APL-JHU (Johns Hopkins University Applied Physics Laboratory), and a NASA collaborative project as a postdoctoral researcher till 2021. I joined as an Assistant Professor in the Department of Electrical Engineering at IITB in 2021.



SanDisk®



**PURDUE
UNIVERSITY®**

Q. Would you like to mention why you decided to choose a career in research and academia?

The main reason why I chose academia and research is the flexibility of research work (both in terms of choosing the research area as well the possibility of exploring new areas and problems) that is limited in industry. Moreover, I was always interested in teaching to and learning from young minds. Teaching is the top five admired professions considered all over the world through which a person is involved to offer a better shape of the society overall and the best means of sharing one's knowledge and experience. My belief is that the best way to learn is to teach and one continues to learn all through their life. My motto in teaching is as long as you live, learn how to live. I was fortunate enough at an early age to have been given the responsibility to teach during various opportunities that came up in my life. I have always cherished those moments and the process of guiding my students by enlightening them with my knowledge.

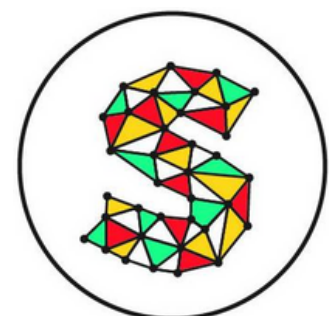
Q. You completed your post graduate studies from IISc Bangalore. What difference do you find in the research and teaching atmosphere at IIT Bombay as compared to that at IISc Bangalore?

IIT Bombay and IISc are the topmost educational institutions in India in terms of research and teaching. Both institutes are equally good. The core focus of IISc is to perform fundamental research and it is more inclined towards postgraduate teaching and research. Whereas IIT Bombay focuses on engineering research and teaching along with an emphasis on product development and entrepreneurship. Undergraduate program of IIT Bombay is among the best in the world.



Q. We saw that you were involved in many student and cultural activities at IISc. Would you like to elaborate on your experience organising and taking part in them?

I served as the Chairman of Gymkhana (head of the management committee) at IISc and Chief Coordinator of SPECTRUM 2015, a mega fest of IISc. Hence arranging funds and organising events was the major part of the process. Outreach and convincing business professionals to provide sponsorship was the major challenge of such activities. I learned resource management and event management during the whole process

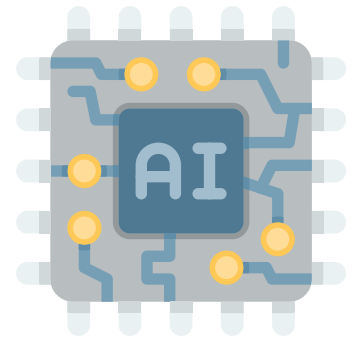
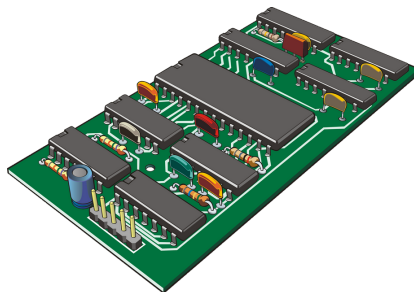
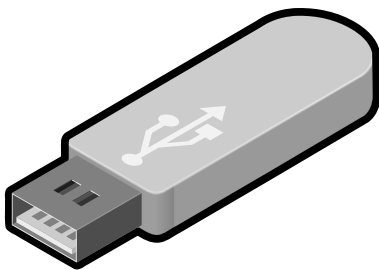


SPECTRUM

Q. Would you like to describe your research field and the areas that you plan to work on while at IIT Bombay?

The specialisation of my PhD is on fabrication methodology and measurement techniques of electronic devices, so there is a golden opportunity to continue my work in the area of my interest at IIT Bombay. Indeed, I will be able to use my physics knowledge directly to explain the underlying working mechanism of different kinds of devices. Since my aim is to contribute to society with science and technology, it would be a great opportunity for me to serve by working with the world-leading students and professors at IIT Bombay.

My main focus of interest and expertise is in the areas of semiconductor device physics, flash memory device technology (microelectronics), neuromorphic devices for artificial intelligence, and electronic systems design and circuits.



Q. How was your experience teaching your first course at IITB? What difference did you feel while teaching online versus offline?



In 2021, I taught EE620 with Prof. Souvik Mahapatra. It was a completely online course. I really enjoyed teaching with him. It was a great learning experience for me to use technology as a teaching medium. At present, I am teaching EE101 for students of the CS department and I am really enjoying the interaction with students during offline teaching.

Q. What would be your message to a student confused between a career in research and industry?

Every individual has their experience and choices. It will be better to explore both industry and academia and later decide on the future.

Internship Diaries

Hello people! This is Dhruv Shah from EE (BTech). This summer (2022) I took a research position at Simon Fraser University, Burnaby (Canada). In this article, I would be summarising my summer internship experience covering the various stages I went through.



WORK EXPERIENCE

My research project is titled - "A fast approach to Robust Optimal Control". Optimal control problems are generally hard to solve in practice and require a huge computational effort. The major idea of our work is to not look for truly optimal solutions but for suboptimal solutions that are faster to compute and are "good enough". Thus if one can devise a way of computing quick solutions, robustness against large disturbances can be guaranteed by just recomputing the solution! We are using the Cart-Pendulum system as a testbench for this approach as it is the simplest real system with sufficient nonlinearity to make it interesting. I have been working in the Physics department at SFU under Professor John Bechhoefer.

My research experience (12 weeks long!) was amazing. The major reason was because Professor John was always around for intense discussions.

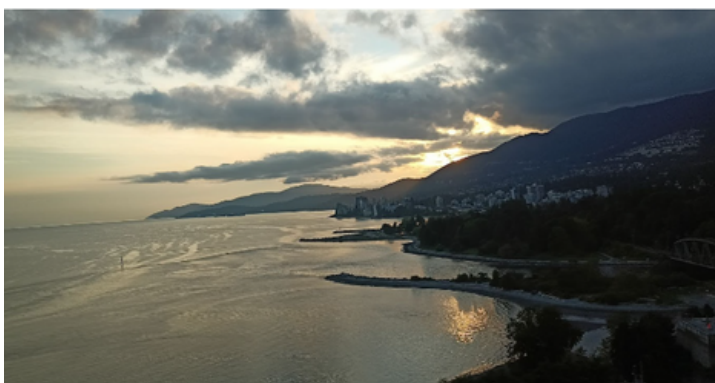


**SIMON FRASER
UNIVERSITY**

There were no "office hours" and one could come to the lab according to their preferred timing. We had a group meeting every week on Wednesday mornings where every member of the research group presented their progress (one person every week). These meetings were extremely interactive and educative. The meetings also served the purpose of obtaining feedback by the entire group and made the speaker look at his work from a different perspective hence providing further insight.

LIFE IN VANCOUVER

I was expected to work 40 hours a week and the weekends were completely off! This was quite new to me because back home I was used to working a lot more than this. This leaves out time for a lot of fun activities during the week and weekends.





The initial few weeks were not as exciting due to the lack of a social group. However, Vancouver being a beautiful city with cheap public transport facilities, I spent my first few weekends exploring the city alone. In the following weeks, I made friends with other MITACS interns (MITACS is the program through which I got this internship) from India and life became a lot more exciting! We tried out a lot of new stuff - hiking, ice skating, sea kayaking, biking, mountain climbing and a lot more. All of these activities

were extremely fun. The SFU (Simon Fraser University) Burnaby campus is quite beautiful and has a lot of hikes very close to the campus. We were also able to see deer right outside our window and also a black bear!!! There are a lot of picnic spots near the campus where we enjoyed the sunset on weekdays after work. One can travel farther from Vancouver, if interested. I have been to Whistler and Maple Ridge, both of which were worth the long travel. The University of British Columbia (UBC) is also close by and is a must-visit.

HOW I GOT THIS INTERNSHIP (AND OTHER LOGISTICS)

The process of university applying is quite different from company internships. More detailed responses to this question can be found in a lot of fundae - sessions so I will be brief here. I applied to the MITACS GRI program and had also applied for the DAAD scholarship. Luckily I was accepted in both and chose to go ahead with MITACS. I had also individually mailed a lot of professors personally requesting for an internship and had 2 positive responses. MITACS fully funded my internship and the stipend is more than sufficient to live and have fun in Vancouver. The results were declared around December (MITACS) and around February (DAAD). One needs at least one letter of recommendation for applying to these programs. Previous research experience is advantageous.



LAST WORDS

Overall this summer has been one of the best parts of my life. I was able to achieve a good work-life balance here and learnt a lot of new skills (not just academic). The problem statement that I worked on was extremely exciting and I might continue my work over the next semester. Finally, I met an amazing bunch of people. It was their company that made my stay memorable. All in all, this is not what I had expected from the internship (expected a lot more work) but I am quite satisfied with my experience.

Graduate School Applications

Deciding the next step after IIT is a crucial decision and can have significant implications on one's professional trajectory. Grad Schools (higher education) are an option many students consider to explore their interests, pursue further research or sometimes get a change in geography. Each section of this article contains separate sections that address important questions students have.



**SAMYAK
SHAH**

Master's vs PhD

One must first choose whether to pursue a Master's or a PhD before starting the application process. While a PhD is the best option for people who want to conduct full-time research and is typically funded, Master's programs are less research oriented and also less likely to provide scholarships. Therefore, publications or undergraduate research provide master's applicants an advantage, while it is quite a standard requirement for PhD applicants. Because master's programs are shorter (often 1.5 to 2 years), they allow quicker career growth in the industry. Candidates for PhD programs must be willing to dedicate 4-6 years to research, and their choice of advisors is far more important than it is for candidates of Master's programs. There are quite a few interesting Master's programs if one wants to explore avenues other than Electrical Engineering, like Master's in Financial Engineering and Master's in Business Analytics, which are gaining popularity and becoming more industry-relevant.

Proficiency Tests



The GRE and TOEFL proficiency examinations are the initial stage in the admission process. IELTS can be used in place of the TOEFL, but before choosing which exam to study for and take, one should review the criteria of different colleges. We would recommend getting done with both in the summer or the beginning of the Fall semester. Both exams demand significant study, including learning new vocabulary and developing timed essay writing skills. The GRE is the more difficult of the two examinations, therefore we advise taking it first and the TOEFL shortly after. With the exception of TOEFL's speaking component, for which you would need to dedicate time separately, preparing for GRE would also cover the preparation required for the TOEFL.

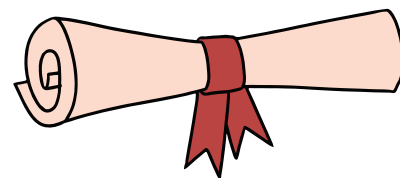
Barron's GRE book (especially its wordlists) along with Magoosh's Vocabulary Flashcard app is highly recommended for the preparation. The Reading Comprehension part, where the passages are too long for most students to read through, is a major barrier for many. For experienced readers, it presents less of a challenge, but there are many strategies accessible to try, test, and use for others. Understanding the significance of an essay's structure and creating a skeletal framework are crucial for the writing portions. Also beneficial for practice are test examples from Manhattan Prep or Princeton Review. The speaking component of TOEFL demands you to quickly plan your speech. To become used to the actual test situation, practice speaking in a noisy area, ideally with loud voices. You would be given the option to send your test results to three colleges for free at the conclusion of these assessments (you would thereafter be required to pay approximately \$25 for each exam). To save money, look up the relevant department codes before the test.

Picking the Schools and Professors

Remember to choose a mix of dream, good, and safe schools while making your selections. However, you should only select schools that you are willing to join. It is not useful to apply to a "low tier" university, just because it is safe, but when it comes down to it, you would not be willing to join there. Every university's program is unique as compared to the rest. So before applying, review the course plan and offered courses. We advise you to be open about your research preferences and to keep an open mind while you consider different professors in various departments. There are many professors who make it clear on their webpages that you shouldn't contact them before admissions; be on the lookout for such guidelines before you ruin your prospects in haste.

LoRs and SoPs

The most important parts of your application are SoPs (Statement of Purpose). As a mirror of your personality, a SoP must be wholly individual. It ought to be a representation of your background, outlook, and qualities. Don't bother singing praises about the university because they already know it; instead, personalise your SoP to the target university by talking about the professors and projects you are interested in and how you could contribute to the university. The purpose of LoRs (letter of recommendation), is to provide the university with information about the candidate from the perspective of a third party. The majority of colleges demand three LoRs, while some do allow for a few more. Choose professors with whom you have a good rapport. Guides for projects and internships are particularly helpful in this regard. Contact your recommenders well in advance of the deadline to give them time to respond and write the LoR.



To be Placed or not to be Placed

If one should register for placements and secure a backup is a frequently asked issue. Really, the choice is yours. What we can say is that both the placement procedure and the graduate application process take a lot of time and effort. It is challenging, but not impossible, to balance both in addition to the semester workload.

Submitting your Application

It is strongly advised that you submit your applications well in advance of the deadline. Do not consider it like a task that must be turned in on Moodle just before the due date. The LOR deadline typically falls after the date you submit the rest of your application, so keep a track of this, and if necessary, keep reminding your recommender to ensure that the LoR is uploaded on time. There are no extensions to the stated deadlines; it is your obligation to make sure everything is submitted on time.

Post Applying, Interviews and Results

Once you have submitted your application, relax! Professors typically contact shortlisted PhD applicants for interviews. The decision-making process is convoluted and masked in mystery; it is influenced by a wide range of elements outside of academia and research. So just prepare your application as best you can, and then hope for the best. Finally, being rejected in no way diminishes your value. Keep a positive attitude and don't lose hope; things will turn out well in the end.

All the best!

THIS ARTICLE IS BASED ON SARTHAK CONSUL'S BLOG ON EESA DESCRIBING HIS GRADUATE SCHOOL APPLICATION EXPERIENCE. SCAN THE QR CODE GIVEN BELOW TO VIEW THIS AND VARIOUS OTHER GRADUATE SCHOOL APPLICATION BLOGS ON THE EESA WEBSITE



Department Research Activities

Compact and efficient GaN-based power supply for E-mobility



ARNAB
SARKAR

Introduction

Power electronic converters play an essential role in the e-mobility industry. The ever-increasing demand for better efficiency, reliability, and compactness of the electric vehicle components requires innovation in power electronics. The wide bandgap (WBG) devices are a new disruptive technology that would drastically change the power electronics industry. Gallium Nitride (GaN) transistors, a WBG device, offer superior performance in various parameters than conventional Silicon (Si) based power devices. Properties such as very low input capacitance and low/negligible reverse recovery charge allow GaN devices to operate at higher switching frequency with lower power loss than Si devices. These features result in decreased cooling requirements and smaller passive components, contributing to lower system volume and costs as shown in Fig. 1.

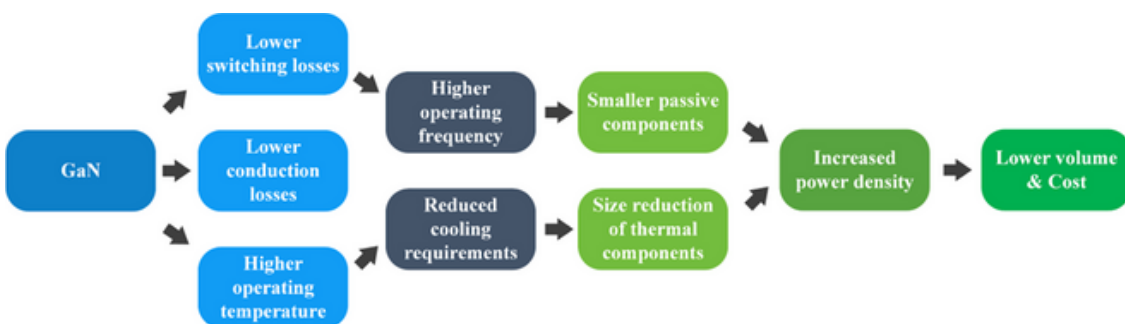


Fig. 1 Advantages of GaN technology in Power Electronics

The rapid advancement of wide bandgap power transistor technology has facilitated comprehensive R&D efforts in academia and industry to assess the impact of GaN devices for power electronic converters. Research is being carried out on converter topologies that can exploit the unique device characteristics of GaN transistors to get better performance in addition to the volume and loss reduction.

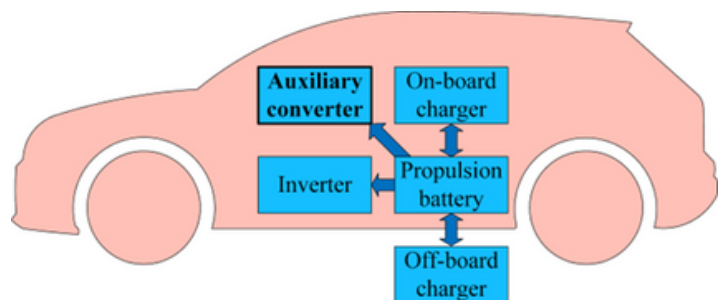


Fig. 2 Power electronic converters in an electric vehicle

One such research project by our team, led by Prof. Sandeep Anand from the department of electrical engineering, utilized the distinctive reverse conduction characteristics of GaN transistors to improve the performance of power electronic converters. This improvement reduces the cross-regulation while ensuring a small size and high efficiency of the auxiliary power supply for E-mobility applications.



The cross-regulation problem:

The four major power electronic converters in an electric vehicle are the off-board charger, on-board charger, inverter, and the auxiliary power supply, as shown in Fig. 2. Among these converters, the auxiliary power supply is used to provide power to the vehicle's various subsystems, such as communication, control, sensors, and protection circuits. Different levels of voltages are required to power these individual subsystems. Isolation between the output voltages and input supply is another key necessity. The multiple output flyback converters (MOFC) topology is widely used as the auxiliary power supply in low power applications because of its simplicity, fewer components and overall cost-effectiveness.

Cross-regulation between different outputs is an important requirement in conventional MOFCs. It is defined as the deviation of an output voltage due to a load disturbance on another output. Note that it is different from load regulation, which is the deviation of an output voltage due to the load disturbance in the same output. The voltage deviation due to cross-regulation can be upwards of 5% at the worst-case condition, which is unacceptable since a regulated DC voltage is desirable in most applications. Conventional methods of improving cross-regulation achieve better performance at either the cost of system efficiency, power density or both.



Use of GaN characteristics to achieve better regulation:

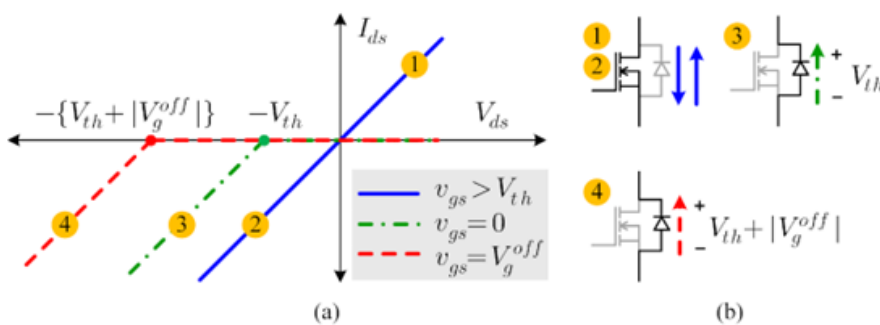


Fig. 3 (a) Gate dependent reverse conduction characteristic of an e-mode GaN HEMT. (b) Equivalent symbol representation.

To solve the cross-regulation problem of MOFCs, the team came up with an innovative technique where the gate dependent reverse conduction characteristics of enhancement-mode GaN transistors are utilized. In a nutshell, the GaN transistor can block a certain amount of voltage in the

reverse direction when it is turned OFF with a negative gate voltage, as observed from the I-V characteristics shown in Fig. 3. This property is utilized in the MOFC, where all active switches are GaN transistors. For example, in the case of a two-output flyback converter, while the primary switch is driven with a unipolar gate driver, bipolar gate drivers are used to turn ON the secondary and tertiary switches during two distinct intervals. Due to the use of negative turn OFF voltages, the secondary and tertiary windings conduct current in two distinct intervals. These two intervals, and consequently, the flow of current to each of the output capacitors is controlled using two PI controllers to independently regulate each output voltage.

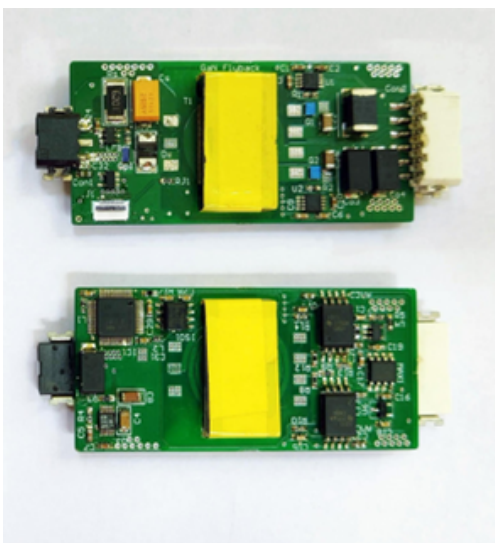


Fig. 4 Top and bottom view of the two-output flyback converter prototype



Experimental Prototype and Results

The team developed an experimental prototype of the two-output flyback converter to validate the proposed idea. The top and bottom view of the converter and its compact size is demonstrated in Fig. 4. The power density of the prototype is 51 W/in³. The team did multiple stages of the prototype development, namely the printed circuit board schematic and layout, component soldering, and experimental testing, in the laboratories available in the Department of Electrical Engineering. The magnetics was integrated into the main board using the planar transformer technology, where copper traces on the board are used as the transformer windings.

The experimental load regulation results shown in Fig. 5 compare the cross-regulation performance of the proposed scheme with a conventional synchronous rectified MOFC with weighted feedbacks. The weighted feedback method is a popular cross-regulation reduction method used in industry, where the feedbacks from the outputs of the converter are given specific weights. However, as shown in Fig. 5 (a) and (b), the above method cannot eliminate the cross-regulation entirely. For example, when I_{o2} is changed from 10% to 90%, a 830 mV change in V_{o1} and a 184 mV change in V_{o2} are noticed. This indicates that the total error is distributed among both outputs. On the other hand, the results with the proposed scheme shown in Fig. 5 (c) and (d) indicate negligible cross-regulation. Over the whole load range, a 0.2% cross-regulation is obtained.

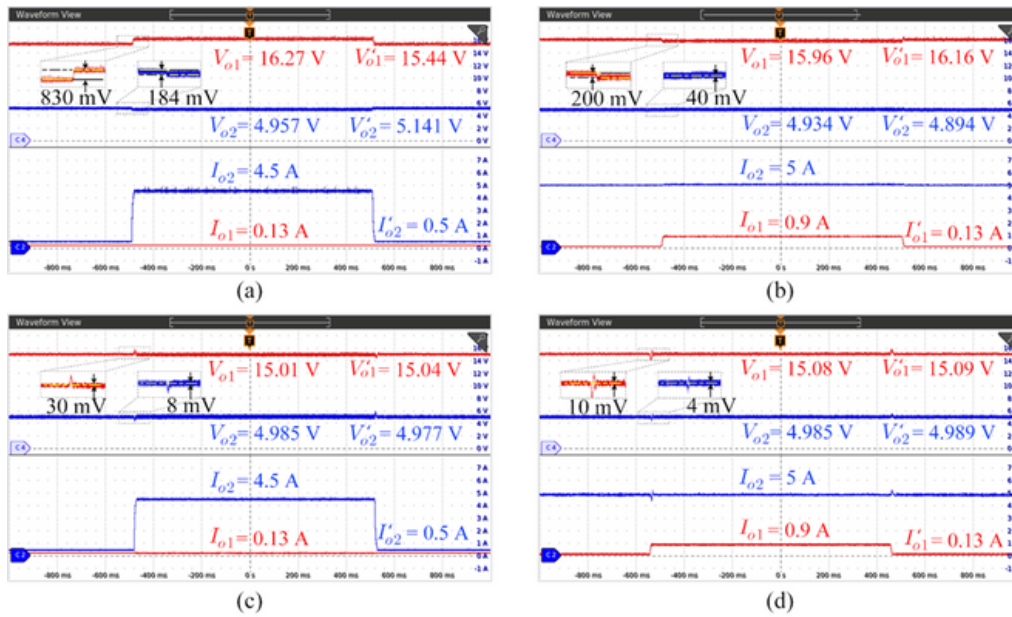


Fig. 5 Experimental load regulation waveforms

Based on the above result, the MOFC with the proposed scheme has potential in isolated output voltage applications where tight voltage regulation is required, such as the auxiliary power supply for E-mobility. Arnab Sarkar (PhD student in the Department of Electrical Engineering) also presented this work in the IEEE Industrial Electronics Society (IES) Student and Young Professional Competition 2021 and was awarded the third prize of 500 USD. The team is also working on various other aspects of WBG based power electronics for E-mobility applications.

Research Paper: A. Sarkar, B. T. Vankayalapati and S. Anand, "GaN-Based Multiple Output Flyback Converter With Independently Controlled Outputs," in IEEE Transactions on Industrial Electronics, vol. 69, no. 3, pp. 2565-2576, March 2022.

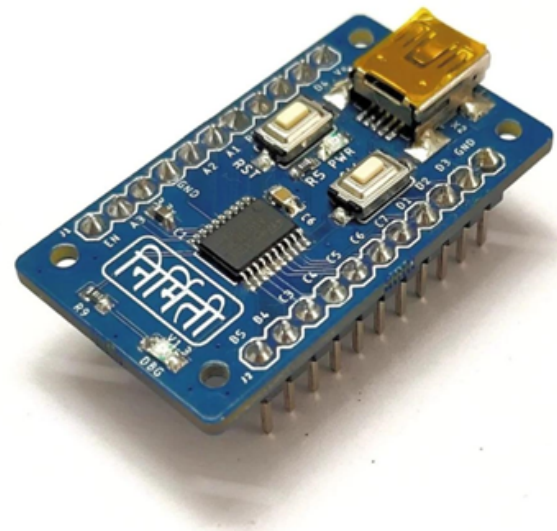
Making a difference through Nirmiti



RUTUJA
CHALKE

Innovations in the field of electrical engineering are now flourishing more than ever as students are keen to expand their knowledge beyond the course curriculum. The Nirmiti project by Mr. Vivekanand Dhakane, an M.Tech. student at IIT Bombay and Research Assistant (RA) at the Wadhvani Electronics Laboratory (WEL), is an inspiring initiative to make electronics easy to learn, user-friendly, affordable, and accessible for every student independent of their language, from school level to degree level and even for hobbyists. The initial prototype work of this project was funded by SINE at IIT Bombay under the Nidhi Prayas program offered by the Department of Science and Technology, Government of India. Technical implementation support was provided by the WEL staff - Mr. Maheshwar Mangat, Mr. Amit Shetye, and Mr. Mahesh Bhaganagare.

Vivekanand came up with the idea for Nirmiti at his hometown, Shevgaon, during the first wave of the COVID-19 pandemic in 2020. Since course lectures were conducted online during this period, he could utilize the extra time to work on his interests. He first created an affordable water level indicator (worth ₹1,200) for household purposes. Later, while he was in search of an affordable microcontroller to replace the high-cost Arduino he had used in his previous projects, Vivekanand came across the STM8S003F3P6 controller (worth ₹19); he started creating libraries for this microcontroller which led to the Nirmiti project. Later, his batchmate and fellow WEL RA, Mr. Rohit Kale, joined him in developing the libraries.



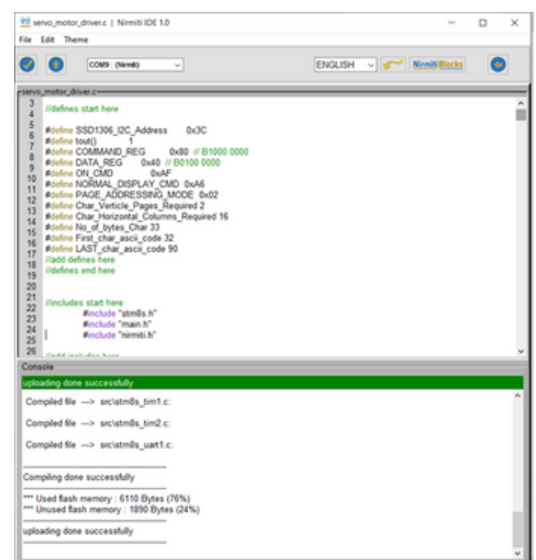
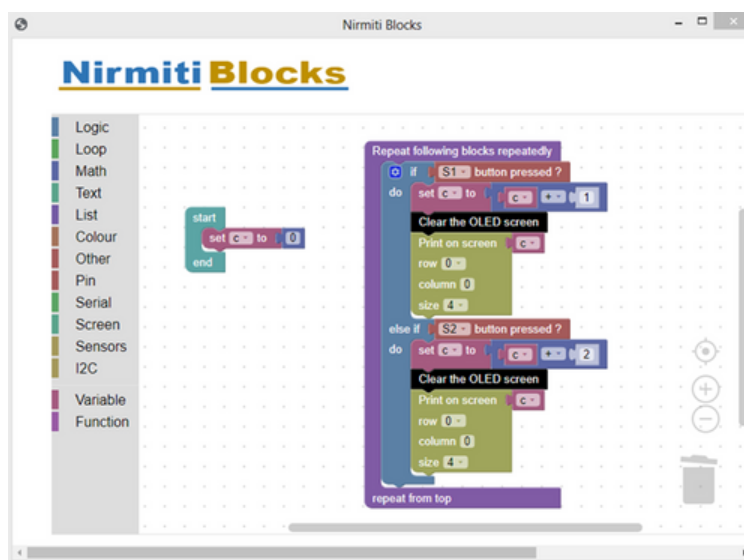
The Nirmiti Kit comprises of -

- **Nirmiti Board:** A ready-to-use microcontroller board for STM8S003F3P6, which has a minimal circuit requirement to program the microcontroller
- **Nirmiti Base Shield:** An external peripheral module on which the Nirmiti board can be attached
- **Nirmiti Blocks:** A drag-and-drop graphical user interface for building a visual block code
- **Nirmiti IDE:** Software with a text editor for writing, compiling, and uploading the code wherein the code is auto-generated

One of the unique features of the Nirmiti board is that besides English, it can be programmed in Nirmiti software using regional languages (presently, using Marathi), which eliminates the need to know the C language used for programming. The onboard Li-PO battery charger on the Nirmiti board makes it a self-sufficient system.

The Nirmiti base shield has a Bluetooth port for wireless communication, along with a small OLED display and onboard sensors such as a distance sensor, motion sensor, and temperature sensor. The presence of these peripherals in Nirmiti enables its potential application in automation, data acquisition, and robotics. An interesting application of the Nirmiti project is the Nirmiti remote-controlled car, developed by Vivekanand, which can be controlled through the Nirmiti Android app via Bluetooth.

Like every other innovation, several challenges popped up during the development of the Nirmiti project. The primary challenge was the global chip shortage which has led to a rapid rise in component pricing since the beginning of this project. Fortunately, the chip supply is expected to increase significantly in a year. Delay in the delivery of requirements for the project to a rural place like Shevgaon was yet another challenge during the pandemic. Uncertainties and impact on timelines due to the unpredictable nature of the pandemic were challenges that were successfully overcome by the team.



In the future, Vivekanand aims to work on more such projects for demonstrating basic physics and mathematical experiments using Nirmiti, which can be useful educational resources for students. He is also planning on making the Nirmiti products available commercially in the next 1-2 years. Vivekanand believes that making Nirmiti software available in regional languages will help in removing language barriers for students willing to learn about electronics, especially in rural areas in India without access to the English medium of instruction. Besides Marathi, he is now working on adding Hindi as one of the languages in the software and eventually aims to include other regional languages as well. Another task under development is the creation of a user manual for Nirmiti software and hardware, which will help users seamlessly develop their applications. Vivekanand is focused on designing bug-proof software and mass manufacturable hardware. Once mass production is achieved, he plans to promote Nirmiti products on social media platforms by sharing project videos and to communicate the project by conducting workshops at school and college levels.

**TO KNOW FURTHER DETAILS ABOUT THE NIRMITI PROJECT VISIT
WWW.NIRMITI.TECH OR SCAN THIS QR CODE**



Concept Byte - VPNs



SIDDHARTH ANAND



PRIYANKA BAGADE



ADIL KHAN

Special Thanks to Prof. Varsha Apte for insightful discussions with us on working of VPNs



History of VPNs

The history of VPNs dates back to 1996, when it started with the development of PPTP – Peer to Peer Tunneling Protocol. Initially, VPNs were used almost exclusively in corporate environments. VPN was originally meant to be used by big companies and organizations for their business objectives and it wasn't intended for an average online user. Companies needed a secure private network to communicate and share data between different locations, and also to allow employees to access files while being outside the company's own network.

Using VPN, an employee could access a private business network through the internet, allowing the use of confidential data without the entire network being exposed to the outside world directly and reducing the risk of unauthorized users stealing data. However, the rash of high-profile security breaches occurring in the early 2000s was a key moment in the history of VPN technology. With this, everyday internet users became aware of the true risks of working online and began to look for more secure ways of doing so. Today, VPNs are used to secure internet connections, prevent malware and hacking and to ensure digital privacy. Easier to use and more affordable than ever, a VPN is an essential tool for staying safe and secure online.



Why does IITB need a Virtual Private Network?

There are a set of dedicated private IP addresses which are allotted to IITB by the internet service provider (ISP) and these are limited in number. All the devices inside IITB's network cannot be allotted a unique IP address within this limited range, and hence we need an internal private network with a different IP address range. IITB uses a 10-dot private address (Ranging from 10.0.0.0 to 10.255.255.255 — a 10.0.0.0 network with a 255.0.0.0 or /8 (an 8-bit) mask).



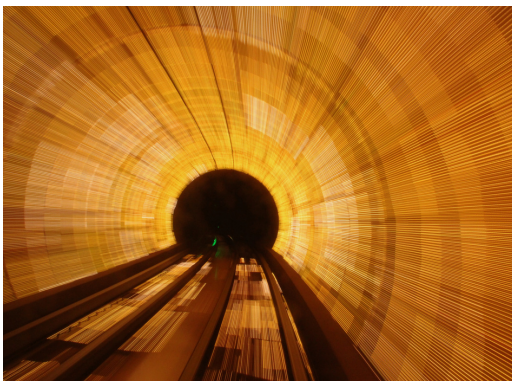
Implementing a 10-dot network gives around 1,67,77,216 addresses to use, and since IITB's network would never need these many addresses, so 10-dot is a good choice. These internal addresses are not visible to the outside world and can be accessed only within the campus network. Moreover, sensitive services are made available to certain specific IP addresses and not to any public IP. Now to access a particular host inside the campus network, say a department server or a lab machine over the internet, the use of a VPN is needed. This is because the host has a private IP address, which is not unique in the entire internet and hence is not visible outside. Hence one has to go to campus "virtually", which can be achieved by using a virtual private network.



How does a VPN work?

A VPN hides an IP address by letting the network redirect it through a specially configured remote server run by a VPN host. This means that if one surfs online using a VPN, the VPN server acts as the apparent source of your data. The Internet Service Provider (ISP) and other third parties cannot see the actual destination of the data sent and received online. Moreover, using encryption which takes place in real-time, the data itself can be made secure from being seen by intermediaries. Thus, a VPN makes it more difficult for third parties to track the activities of an online user.

To understand how VPN works, we can use an analogy - A private meet is organized exclusively for IITB students. Students are recognized only if they wear a specific IITB T-shirt. The meet is confidential and every student has to report “under-cover”. Hence, each student wears a gown on top of their specific T-shirts. The gown would make travel from the initial point to the final destination not suspicious/ special. Tunneling is a process by which each data packet is encapsulated inside another data packet (a gown), thus making it difficult for third parties to read in transit. When VPN tunneling is initiated, it connects with the VPN server of campus. This is the act by which one gets the T-shirt. Tunneling and connection with the VPN server ensure that only authorized things are let on the campus.



When using a VPN gateway, an IP packet is encapsulated inside another IP packet and the inner packet is the real IP packet (containing actual data). The outer IP packet uses a public IP address in its header (as source or destination) and the internal IP address is referred to by the internal packet. This real IP packet is retrieved by decapsulation of the outer IP packet at the destination. Routers inside the campus network (which is being accessed from outside) can only understand this retrieved IP packet.

While being connected to IITB’s VPN server, access to certain things is not permitted even when outside campus. Why is this implemented?

Being connected to the VPN server implies that one is virtually inside IITB’s network, and hence all the firewalls and access rules of campus apply. There are quite a few rules imposed by CC (Computer Centre) when on the campus network and therefore, there are certain things one cannot access even on being connected to IITB’s VPN server.

Earlier, there was an upper limit of 300 concurrent connections to the VPN server that has been raised to 1500 now. Why is such a limit necessary?

The limits have been set because of the processing and connection capacity of the machinery employed. Tunneling and decapsulation of IP packets consume bandwidth. With an increase in the number of packets tunneled, there is an increase in the bandwidth consumed. Hence, there is a maximum limit to the connections that can be made to the VPN server at a single time.

EE ACE

The Department's Alumni and Corporate Engagement cell

EE ACE is an initiative launched by the Electrical Engineering Department in 2019. The motivation behind establishing ACE was to set up a proper hierarchical communication system among the institute offices and inter-departmental cells for connecting alumni with the department. Its aim is to showcase the latest research and invite industrial collaborative opportunities. EE ACE cell is guided by an advisory committee of distinguished alumni and experienced faculty. Its active members are its staff members, faculty committee members and students who report to the Head of the Department.



SHRUSHTI TAPAR

Tasks and responsibilities of the EE ACE team

With a focus on department-level engagement, the EE Alumni and Corporate Engagement (EE ACE) office complements and supports the Institute ACR office in their mission of developing long term relationships with Alumni and Industry in four of the five sub-categories shown below.



Outreach: The most crucial step of starting communication is to create a common platform. The Outreach section works on a foundational level for communicating events, activities, initiatives and ongoing state-of-the-art research through mass emails, Institute ACR and Alumni Association newsletters in joint venture with the departmental magazine Background Hum and social media sites like Facebook, Instagram managed by EESA.

Engagement: The bond gets stronger with relevant communication and engagement at the department level with an interested set of alumni. With the vision of building a strong EE community, yearly activities like talks, interaction with faculty, student-guided lab tours have been well-received by alumni. The department is actively learning through the experiences of alumni, who have made significant contributions in their fields.



(Left) '96 Silver Jubilee batch group picture during department visit.
(Right) Lab tour for the silver jubilee alums

Industry partnership: Industry partnerships work for bridging the gap between academic research and industrial research and thereby enhancing the skills and job opportunities for students.



Secured the formal partnership with Society of Indian Automotive Manufacturers (SIAM) for E-Mobility



Media coverage on the partnership announcement

A preliminary proposal for an industry-facing Centre of Excellence in the area of E-Mobility was initiated from EE ACE, championed by Prof. Sandeep Anand and Prof. B.G. Fernandes, which was later taken up by IITB DRF. EE ACE continues to support it in terms of outreach to industry bodies.

Departmental projects: “Tell me and I forgot, teach me and I may remember, involve me and I learn” by Benjamin Franklin. The learning and teaching experience was pushed towards enhancement in the department through revamping of existing infrastructure. Advanced learning methods are the need of the hour for sustaining more flexible learning with ever-growing technology. EE ACE took responsibility for sustaining these needs to accelerate the learning experience of students. One such example is the Collaborative Classroom and Experiential Lab. Maker Bhavan Foundation (MBF) is an alumni-established charity organization working in the higher education sector. EE ACE staff worked to pitch a proposal on collaborative learning to MBF, leading to the renovation of two classrooms for a collaborative learning mode.

Fund raising: “Alone we can do little, together we can do so much” - Hellen Keller. Assisting DRF, ACR and other institute offices with background information is the main focus of the fundraising aspects of EE ACE office.



(Left) Inauguration of the Collaborative classroom and Experiential Lab by Dr. Hemant Kanakia on 14th February 2022

(Right) Prof. V.M. Gadre teaching in the collaborative classroom.

Future Vision

With the mission “To get a diverse set of people talking to each other”, we are brainstorming themes and domain-specific events. The TBD flagship EE ACE event would invite professionals and academics belonging to a specific technical domain as well as future aspirants with the prospect of working in the domain to interact with each other, creating collaborative opportunities. We will keep expanding our outreach to alumni for cultivating a strong EE community - in the department, campus and beyond!

EE Alumni Tour

On 25th June 2022, the Department of Electrical Engineering held its first-ever lab tour for local alumni organized by the EE Alumni and Corporate Engagement (ACE) team. The enthusiasm from the alumni community and students was unprecedented. Alumni visited us from places as far as Rajasthan, Pune and as nearby as Andheri. We had 75 attendees ranging between 70 years to 3 years old! We had our undergrads visit off-limit labs and we also had great food! We hope you enjoy the picture journey of a successful and eventful day!



Registration



Welcome by Faculty



Orientation and welcome



WEL Lab



Nanofabrication Facility



NCPRE



Control and Computing Lab



aiCAS Lab



WEL Lab



Exhibit



Lunch Interaction



Exhibit



End of Day Interaction



ACE team with volunteers and staff

Towards Wellness

The Pressures of Being Human while Breathing Engineering

The hum about health and wellness is growing across the world, especially after our stellar entry into the 20s of the 2000s. What makes for good health? What components add up to constitute that elusive state of being that several billion people have been grappling with lately?



**NEHA
CHAUDHURI**

The previous article in the series sat you down to four most common human individual actions. The simple act of starting and ending the day consistently and with awareness will develop psycho-emotional protections one takes for granted until they're ripped away. In this one, we explore not individual responsibility but the importance of community and relationships.

Do you think you have a lot to offer to the world around us? Or are you the one who will have this in the heart of their hearts – “grades and job, that’s all that matters.” Are we so occupied with seeking out what we need from the system that we miss out on the opportunities to cultivate our character? But how is character-building related to electrical engineering?

Coming Together

We held something unique in the first week of August 2022: A Reunion-Convocation for the graduated batches of 2020 and 2021. An event like this is the perfect example of blurring of lines – student-professional, or alumnus-student. Things that happen when pressures beyond our control impose upon us. The event was a stepping-stone for the entire department, providing much-needed closure to what has been a tough couple of years. Everyone grappled with unprecedented challenges around the world. Things are still not back to ‘normal’ for many, but each day improves on the last one.



The Department’s Head today, Prof. Kishore Chatterjee addressed the gathering with a kernel of a lesson one can only gain from experience – that enjoying the work you do, enjoying the intellectual stimulation or the camaraderie of colleagues, at the end of the day is important. That money is good, but it is not the only thing in life. Department Head during Covid, Prof. BG Fernandes, followed with a bullet list of wisdom distilled from decades of interactions and experiences. Here it is, word for word:

- Health is important. Wealth is also important. Also, build on relationships.
- Don’t speak/ write emails when angry.
- Don’t make decisions when you’re sad.
- Don’t promise things when you’re happy.

In essence, know what is important and don’t let the ebb and flow of emotion sway you.



Prof. B. G. Fernandes



Prof. Kishore Chatterjee

Wise Words

Wisdom is termed wisdom because the blurring of lines – like with our reunion-cum-convocation – is on the surface while rock-solid lessons never go away. There is an element of the eternal to them. That is why they are passed on – from student to teacher, from friend to friend, from colleague to colleague and in our personal relationships.

Wisdom is termed wisdom because it has withstood pressures of time, space, multiple historical eras and several degrees of human violence and annihilation. A man is called wise when he too has done the same and lived to tell you about it.

“There is no such thing as a good or a bad boss.”

His wiry frame stood at the podium with conviction, “Baba, you learn from everyone. Learn from the person about how you should not treat people.”

“And to the one who hurts you say thank you, you have given me the opportunity to release myself and find someone else.”

Because the relationships you have and the company you keep can make you “a drop of water shining on a lotus leaf or an indistinguishable mass of a big lake.” How does he get to this conviction, your teacher? How does he hand them over to you in 5 minutes: a whole lifetime’s learning about living?



Pressures: They Exist



In physics we study about pressure – at its very basic, it is applied perpendicular to an object’s surface area. (We can discuss the finer points of it being scalar or a force (as used informally) later.) We hear about our planet under increasing pressures of ...can you guess? We talk about the pressure for excellence and the increasing pressure of performance on our students and faculty. When we talk about these, we hunch, look down, bemoan some aspect of our lives or watch the next thing on Netflix before we head off to play Counterstrike.

At other times we study pressure in Fluid Dynamics, utilize capacitive sensors to assess pressure, employ strain gauges to tweak systems to optimal adjustment. We use high-pressured tanks for storing oxygen, argon, nitrogen gases using them to make semiconductor devices. We use pressure as buffer, storage and protection. We use it for holding, moulding and shaping. We have devices to check for multitude of pressures, so we can be prepared for... what exactly? Doom, disaster, destruction? So that we can achieve...optimal perfection?

Why are we surrounded by pressure and why do we need to work with it? Why can certain pressures break you down and not the other person? Why are some pressures universally considered good while others, well, bad? And what pressures lead to the distilled wisdom? Apart from the thorough knowledge of their subject, what makes a teacher more than just a teacher? By extension, what makes a student more than just a young person here for a good set of grades, for the promise of a job at the end of the grind?

Pressures: They Make

We are all forms of carbon, yet only the long dead things under our feet having spent eons being crushed and turned into carbon mush are eligible for forming diamonds. Having died, buried, crushed and mushed together is not enough though. It is only with surrounding diamond-formation conditions, which are precise and intense, that diamonds come into being.



“Diamonds begin to form at about 725,000 pounds per square inch of pressure and temperatures between 2,000 and 2,200 degrees Fahrenheit. At this high pressure and temperature, carbon atoms combine to form crystals. Each carbon atom combines with four other carbon atoms to create the famous strength of diamond, the hardest material in the world.” You can make diamonds in the lab. You can recreate those conditions, take bits of Moissanite, Zircon or Topaz, and make diamonds. You can buy and sell them at cheaper prices too. They even look more diamond-y than real ones. But they are called simulation diamonds for a reason. They’re not made in the natural world, do not have the durability or hardness of the real deal and to a connoisseur who knows the difference, sparkles without those properties don’t matter.

Four Carbon Atoms

Getting into the chemistry of it all is perhaps something best handed over to the Chemistry Department. I’d like to get into the community or the humanity of it. And the role of relationships in strengthening or depleting you. Why the strength of four - friend, family, foe, guru? We are much carbon after all. A lot of teachers can know their subjects like the back of their hands. Many individuals can spend their lives studying and teaching them. Yet only a handful of people can bring the whole drama of living into your awareness and shake you awake when conveying how to be a certain kind of human being too. Such people take the wounds of their experiences, absorb and direct increasing pressures on the world and their own lives, and transform them into lessons for all. Not all people who do this can talk to you about how they did it. Not all of them end up alive for very long. Not all of them stick around where you are. The probability of finding a person like that is like trekking in Lohagarh and finding a diamond on the way.

Yet here we were, all of us, listening in the air-conditioned Convocation Hall, on the cusp of being student-professional or alumnus-student to a teacher who said, “Be kind. Help each other out.” without expecting anything back in return. Each one of us has a lot to offer to the world around us, yet we are so occupied with seeking out what we need from the system that we miss the opportunities to develop the tensile strength of giving.



How can we do that? We can do that through absorbing the liminal energy of people around us as we show up. We can do that by offering them the best of ourselves every moment. Our department has worked very hard over many decades to have such teachers. And students work very hard, have worked for many decades to come to EE, to stay here, to work here. Many dreams were born and many died. You walk on eons of dead wishes, aspirations, broken dreams and fulfilled lives of others until those have turned to mush. Right now, you are in a high-pressure womb – the one of your Alma Mater, as Prof. Amit Sethi put it to wrap up the evening before Vedant Satav took the stage. Welcome the pressures. Find your buffers. Make strong bonds with your friends and teachers. Please default-count yourself lucky, seek out your mentor-teachers – and utilize the positive power of the forces around to turn you into little diamonds.

Ms. Neha Chaudhuri is a part of the EE ACE team. She can be reached at eeacr.iitb@gmail.com.

Informal Section



JANEEL
PATEL



SAMYAK
SHAH



Sinkar Sharvaree Rajendra



Prof. Siddharth Tallur

The Hymn of Love

*I seemed to try to be happy
Deep I knew not I was
When no longer was I able to
Resist, I told him; I am sad,
Cause is small; effect is lit
Lit like fire
Craving to harm
Is a mere understatement.*

*I think this is the only way, I say
He shows me, no, never is there one way
Never is!*

- Vemparala Lakshmi Pravallika



Vemparala Lakshmi Pravallika

Chief Editor

Adil Khan

Design

Bhavesh Khichi
Ojasvi Kathuria

Editorial Team

Amol Shah
Janeel Patel
Mihika Dhok
Mihir Kavishwar
Prasann Viswanathan
Pudi Seshasainadh
Samyak Shah
Sheel Shah
Siddharth Anand

Special Thanks

Neha Chaudhuri
Shrushti Tapar
Arnab Sarkar
Rutuja Chalke
WEL Lab

Image Credits: Freepik

We hope that everything is well with you and your loved ones. We are excited to present to you the August 2022 issue of Background Hum, our department's student newsletter. We would like to express our gratitude to the faculty, students, and EE ACE team whose important contributions made this edition possible.

Your opinions and comments regarding the newsletter are welcome. Feel free to reach out to us at bh@ee.iitb.ac.in. Wish to contribute? Have an article idea? We're all ears!

Visit the Background Hum website at www.ee.iitb.ac.in/~bh by scanning this QR code to find our present and past newsletter editions and article posts

