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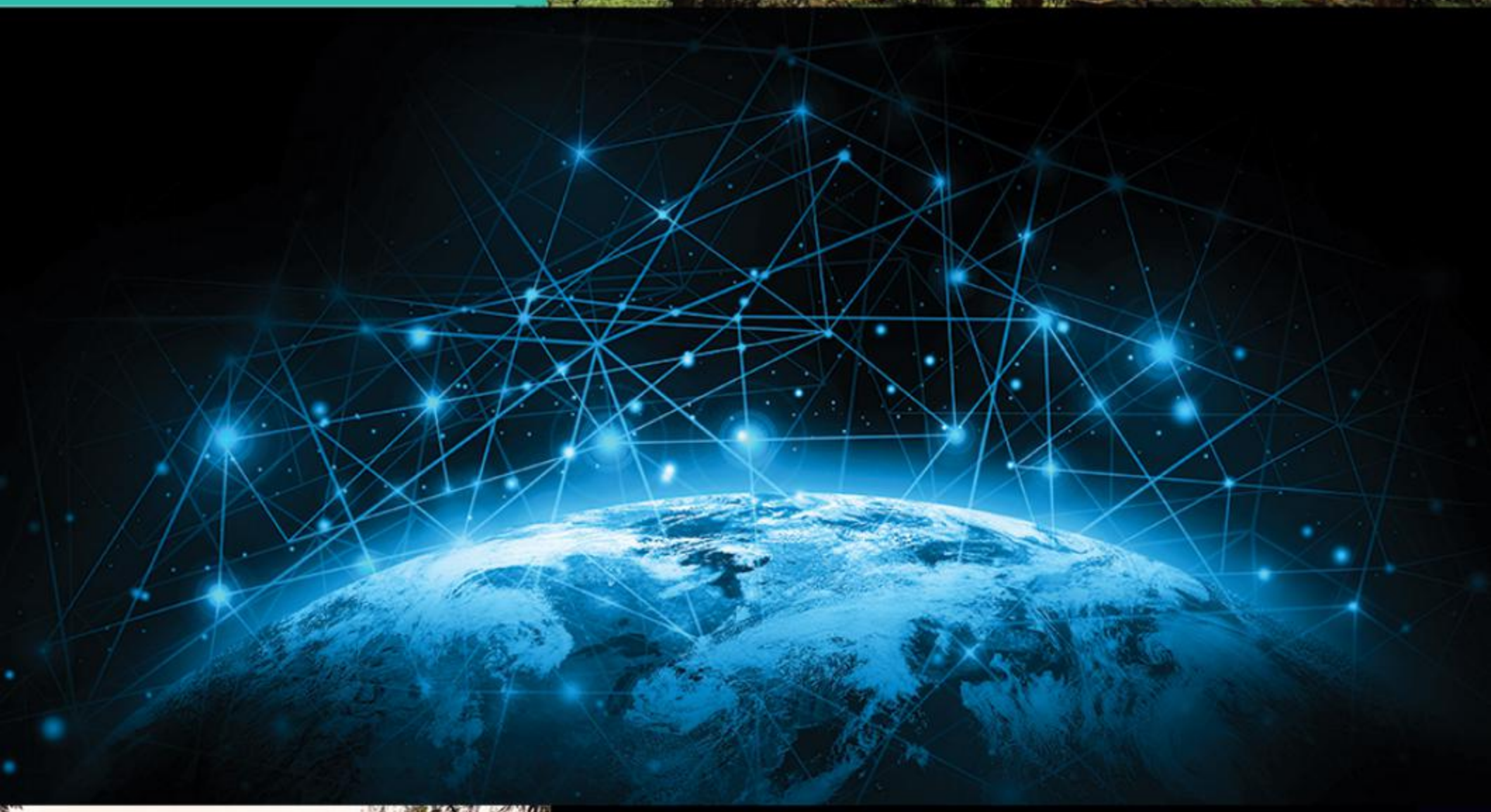

BACKGROUND
HUM

Department of Electrical Engineering

CONTENT

HOD's NOTE

Prof. Kishore Chatterjee

Head of Department
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The year 2020 was really an unprecedented one, to say the least. We had to terminate the even semester of the academic year 2019-20 prematurely. Activities related to research came to a sudden halt. There was an all-pervading despair all around. Slowly we realized that we had to negotiate this situation for quite some time. This realization helped us to reorient our mode of operation with the new normal. We commenced the odd semester of the academic year 2020-21 in online mode. It was not easy to shift gears in such a short span. However, the faculty members and the students worked hard patiently to develop the right kind of ethos to learn and create in this new domain of online interaction. Our PhD and Mtech scholars also started interacting with their thesis supervisors in online mode, and most of them could made significant progress in their projects. The toughest job was how to conduct the regular laboratory courses for both undergraduate and graduate courses. Our faculty members worked really hard to run the laboratory in video mode.

The Wadhwani Electronics Laboratory (WEL) of our department developed a unique scheme of transporting returnable laboratory kits to the students by post so that they can perform experiments from home by utilizing the USB ports of their laptops. But all said and done these efforts could not replicate the sense of belongingness, fellow feeling and the environment of experiential peer learning among the students. Some of them were uncomfortable while negotiating this hitherto unknown atmosphere. From time to time faculty advisors, senior faculty members have been organizing counselling sessions with the students so that they do not start feeling out of place in this trying situation.

Our students and faculty members have had fought the difficult phase leading from the front, and now we have got enough confidence to fight the remaining phase, which may be lasting for one or two more semesters, with conviction and grit. Keep your hopes high, stay well and stay safe wherever you are.

FINAL ADDRESS

VEDANT SATAV

Department General Secretary
EE,IIT Bombay || 2020-21

Dear BH readers,
After a wait of more than five years, I feel delighted to present the department newsletter Background Hum. The past year has seen a significant shift in the dynamics and priorities of the department- prioritising a better student experience through thorough documentation, adopting and adapting to the online format of education, increased importance to student mental and physical well-being, and setting up of better alumni relations.

In the latest edition, we attempt to provide our readers with the opportunity to know about the rich history of the department through some candid and interesting fire-side chats. We cover some developments in the field of Electrical Engineering and how the department labs are well-versed with them.

The Department of Electrical Engineering is the largest department in the institute in terms of student population. Needless to say, it has within itself a vast variety of students and faculties with their own exciting stories to tell. We have progressed with time and yet continue to strive for more. I hope the students make the most out of the opportunities made available here and develop skills that would help them in their professional as well as personal life. We are working towards making future studies more experiential and collaborative, a first of its kind initiative.
I would like to thank the Head of the Department, Prof. Chatterjee, and the office for their support of this newsletter publication. Deeply grateful to all the professors who spent their valuable time in helping us curate these articles. A lot of hands have been working tirelessly to bring you this edition. My congratulations to the editorial team as well as our ever-supportive EESA Council for all the help extended towards the final design.

Dear readers, do give it a good read and get back to us with your valuable feedback. I hope you enjoyed reading the articles!

HISTORY AND LEGACY OF EE DEPARTMENT

SINCE 1958

Imagine yourself walking the department's corridors 50 years from now. Maybe you are visiting for the first time since you left the place, or maybe you are an alumnus who has been in regular (and possibly generous) contact and are coming back for one of your routine visits. Or maybe you have been employed here for a while now, bearing witness to several of the changes that the place has gone through. In any case, you might wonder about what the department used to be "back in the day". You might marvel at all that has changed, still finding some of it unbelievable. You might try hard to jog your memory to recall just what stood in the place where an expansive server room now stands, engulfed in quiet, uninterrupted air-conditioning, with flashes of light emanating from the large devices inside. How nice it would be if we could capture every living memory of the department in a 'Pensieve' that one could revisit at any time. Well, that was the intention behind envisioning this article, although we have to admit that this is but only a humble attempt at capturing some of the changes that have come over the department over the last few decades. A secondary goal was to also understand the legacy of our department in terms of what it has been a symbol of, and what it has come to be over the course of its lifetime.

By Rohit MA

Quick Roundup

A glance at the department's history on its webpage tells us that it was formed in 1958, along with the establishment of the institute. The population has increased more than 10 fold since then, going from about 50 undergraduate and 40 postgraduate students to nearly 500 and 550 of them, respectively! Naturally, there have been changes in several other avenues such as the faculty population, research and teaching environment, infrastructure, and so on, some of which we take a closer look at below.

Has the Ice Thinned?

The changing population has been a harbinger of change in student-faculty relationships and interactions. "As a student, one tends to have more association with their hostel, and lesser with the department", says Prof. Juzer Vasi. This is true of most, if not all, undergraduates, and possibly many postgraduates too. "But gradually, over the course of the degree, the bonding between students & faculty tends to increase. In fact, I might even add that in comparison with today, this bonding was perhaps more back then, simply because of fewer students!", he adds, recounting his experience as a B.Tech student in the batch of 1969 and as a faculty member, 1981 onwards. "The faculty knew most students by name back when I was a student, but it's obviously quite difficult now, due to larger classes", opines Prof. Vivek Borkar, who graduated from the B.Tech. program in 1976.

The increasing focus on research in the department has also had an effect to this end. "My interactions as a senior professor have been more with PG students, most of which have been of a technical nature.

In my early years, on the other hand, interactions with UG students were more social. This was facilitated in part by the weekly movie nights which the faculty also attended enthusiastically, and bonded with students over", recollects Prof. Vasi.

Although movie nights are still quite popular in the institute today, the scale of attendance naturally limits the chances of close social interactions. So, to all the EE dept. students reading this, maybe it is time to think about having some regular social events within the department (a shout out to the EESA for already having been trying to facilitate this!) Along similar lines, Prof. Borkar hesitantly adds, "I always enjoy attending cultural and social events, but I have a crib to voice here - events on campus almost never start on time any more! As far as I can remember, most events adhered to announced schedules when I was a student." Now, this might just be one of those "Oh, kids these days!" kind of a crib, but we all know that he does have a point there.

The department has also been home to an endearing tradition of students returning to join as faculty. "Of course, there's nothing unique about that. This can and does happen in a lot of universities, and it has also been a tradition here. What I'd like to add is that when you join as faculty, you become a colleague to people who had once been your teachers..", says Prof. Vasi. While it would feel quite strange to think about working alongside your former teachers, Prof. Vasi has a nice thing to add about this, ".. they are very welcoming and make you feel part of the department. This helped me overcome the feeling of looking at myself as part of a strict establishment, and gain more insight into the research activities as well. As a UG student, access to department research was fairly limited back then."

To Teach or to Research? Both!

Our institute has gone through a transforma -tionfrom being a primarily teaching institute to one with emphasis on research as well as on teaching.This has also carried over to our department,which has seen increased faculty and funding for research and growing external collaborations."I have seen the department get newer faces with similar interests over the years, and it has given me the opportunity to communicate my research with more colleagues", says Prof. Borkar."Interacting with colleagues, talking about your work with them helps improve research. And a lot more of that is possible today. This has certainly improved over the years", concurs Prof. D. Manjunath.

For some faculty, especially for those with research areas closely allied with their teaching material, this has led to one influencing the other - results from research making it into the classroom, and discussions in class leading to further research exploration. The same way as we are currently living through a period with revolutionary advances happening in fields like machine learning and quantum computing, 30-40 years ago was a time of revolution in fields like digital signal processing and MOSFETs, which some of our faculty lived through as students or young professors. Some were even conducting their own research in these areas. "Research and teaching, therefore, became quite interconnected - research advancements helped provide live examples in class. And the occasional question by a student leaving a professor stumped led to the professor exploring the field in more depth", remarks Prof. Vasi, and jokingly adding, "And of course, there was no better way to wake the whole class up than finding the instructor unable to answer a student's question!".

The influence of research on teaching has also been more direct, in terms of introducing credited research-oriented components into the teaching curriculum, such as, having project-based components within a course, R&D projects equivalent to credited elective courses, introducing research paper reading assignments, etc. "Active participation of undergraduates in research projects has given a chance for more interactions in a scenario where the large class strength made it harder", says Prof. Borkar. "And this in turn has had an interesting effect on my research - I now end up diversifying my projects and choosing some of them to be in line with the background of UG students. This helps better facilitate their participation." Prof. Manjunath is of a similar opinion - "R&D projects and various new courses have indeed aided more interaction with undergraduate students", he says.

From Punch Cards to Paving path

Infrastructural development is perhaps one of the most inescapable changes that an educational facility undergoes during its existence, and our department has also, of course, had its fair share of that. It is, however, still remarkable to take a moment to appreciate how certain aspects of our lifestyle that we take for granted today, used to be quite different. Computing power, for instance, was one such. "Our batch was probably one of the last ones to use the EC-1030 - a punch-card based computer system. We had to first write all of our code on a sheet of paper, get the corres -ponding punch cards made by a person trained to do that, check them for errors and get them redone if any, and then finally submit the deck to be processed by the computer. Our courses on logic and programming were already interesting enough, and this activity certainly made them even more so!", recalls Pravil Gupta, fondly, who graduated in the B.Tech. class of 1988.

"As people get older, they generally tend to fall behind on recent happenings, but it's probably the opposite in my case. As a young researcher, I was a lot more outdated than I am today, thanks to the internet!!!"

-Prof. Borkar.

Imagine picking up a seemingly important research problem and pursuing it for years only to find, at the end of it, that, with easy and timely access to progress by others working in the same area, you could have saved a huge amount of time, money, and effort! Such was the predicament of resear -chers until only two to three decades ago. "We normally turned to published journals to pick up challenging problems to work on. But such material would typically reach us by surface mail about 3-6 months after publication. Before that, the article would have already spent 6-8 months in the reviewing and publishing processes. And prior to that,the research work itself would probably have taken about half to one year to complete. So, essentially, by time I was reading it and deciding to start down that line, I was already about a couple of years behind!", says Prof. Borkar. A lot of this has changed for the better now, thanks to e-print journals, pre-prints , and easier access through the internet.

"However", adds Prof. Vasi, in a prudent tone, "the internet has had its downsides. I remember when we went to a library in search of published material as students, we would soon end up getting lost in the sea of resources available there. You'd find things that you had no idea about. But now with the internet, looking things up is a lot more efficient. While that saves students a lot of time and helps them progress faster,they are probably missing out on spending hours just exploring other kinds of topics." While we agree to some extent with Prof. Vasi, he is probably blissfully unaware of the hours that we students still end up spending on the internet, as we descend one rabbit hole after another, browsing and reading about the fascinating research happening around the globe.

When it comes to choosing topics to conduct academic research on, we naturally tend to pick topics that are active, or are unexplored but of importance to the community.

Wrapping it up

When we set out to plan and write this article, we were a couple of students, looking at the department as outsiders, trying to study it under a microscope. We were looking to build this two-column table with headings that read 'Back then' and 'Now', fill it with an exhaustive set of interesting facts, and leave the reader staring in awe at the contrast. Although we may have only barely succeeded in achieving that goal, we did come to see, over the course of interviewing alumni and professors for this article, that the identity of an establishment such as an academic department is essentially shaped by the people associated with it. It also humbles us to think that we may also be involved, in some way, in our department's evolution - if not already, then perhaps sometime in the future. The exercise of tracing the steps that the department has taken ended up making us feel closer to it, and we hope that you share this feeling. We would like to extend our sincere acknowledgement to all the interviewees for having given us their time and making this possible.

Pravil Gupta
B.Tech class of 1988

Prof. Juzer Vasi
Professor Emeritus
B.Tech class of 1969

Prof. D. Manjunath
Professor

Prof. Vivek Borkar
Institute Chair Professor
B.Tech class of 1976

Prof. Rajesh Zele

The Cloaked Classroom

By Priyanka Bagade
and Vedant Satav

Professor Rajesh Zele is an alumnus of IITB (B.Tech 1989) who joined IIT Bombay as a professor after 22 years of industry experience. Prof. Zele has received his Ph.D. in ECE from Carnegie Mellon University, MSEE from Oregon State University, and is also a Senior Member of IEEE. Having been a student of IITB, like all of us, he has been through similar ups and downs in his institute life, starting from branch change from chemical engineering to the electrical engineering department (yes branch change did exist 25 years back :)) to building his own identity in the department. He is considered as one of the most approachable professors in the department and is always willing to talk to students and share his own experience.

The entire past year has been a roller-coaster ride for everyone in the world. It was also the first time that IIT Bombay shifted all the semester work to an online format. Although the institute released fairly detailed guidelines towards easing out the online semester process for all the parties involved, it is not a surprise that a lot many hiccups arose that were quite predictably unforeseen. All the various courses had different plans for the online semester. While some backfired, some like those of Prof. Zele was met with a lot of satisfaction from the students. We met up with Prof. Rajesh Zele and to know about his experience of the past semesters and also how the perspective of an online semester is for the other side of the laptop screen.

How would the lockdown experience be if it were in your days of being a student? And how has been the lockdown experience for you till now?

Life was a lot simpler when I was a student. We had only landline phones those days so I am pretty sure that we wouldn't have any WFH situation. We would have gotten long holidays. I would have made the most of it by reading a lot of books. Everyone is talking about WFH. Sometimes I feel more like P2WFH (Pretend to work from home). I would agree that education in this format is definitely compromised. There is a lot more to education than just attending lectures online. A substantial part of your education happens when you are in your hostel. How you learn and play as a team player is certainly missing. It's okay though. I hope this phase will get over soon and you will appreciate every moment when you are back on campus.

During the lockdown, we started working on COVID related project. Hence, I was able to get a few students back to campus as soon as the lockdown was lifted. So, I haven't seen any drastic change in my daily routine. We worked in our lab most of the time. I was also occupied with preparing the course material for the semester. Enjoyed doing videos/editing etc.

In the end, we cannot be bitter about the circumstances we are in. These are the cards that we have been dealt with. We should take it on our chin and move on gracefully. There is still a lot left for you in the future and you should look forward to it, hoping that this situation doesn't arise again.

How do you manage your time?

I like to make myself think that I have a lot of time. If you think that you don't have time, you simply don't know how to manage it properly. I learned this the hard way because I didn't get to spend much time with my family when I was young. Now I make it a priority to spend time with them as well as my students. My job is to excite the students about what they want to do. Once they are fired up, I get out of their way and let them explore. I need to devote my time to all these activities and managing my time well has helped me out.

What are your thoughts on the academic integrity of the students this semester? Do you think, given the immense quantity of quizzes and assignments, the students are justified for taking an easy way out to get some personal timeout?

Short cuts are okay only in the short run! Unfortunately, sometimes students don't realize this. The reputation of IIT Bombay relies on our students as well as us – the teachers. Any missteps by students (when caught) get amplified on social media hurting IIT Bombay in the long run. Human beings take steps to survive (academically). But life is not just about survival. It is about the journey and experience. And it is all those small steps that we take in our journey that are of utmost importance. What you do when nobody is looking defines you as a person. While you are doing an assignment at home, do you refer to the solutions or not is a question that you have to ask yourself. We as teachers put our trust in you. It hurts when we hear students breaking it. I must admit that it has been more of a rare exception in my experience. The class students I have engaged with, have been exceptional.

Society will never move forward if people commit bad things just because others are doing the same and getting away with it. In the bigger scheme of things, your CGPA (Conscience GPA) plays a larger role

How do you think cases of academic malpractices should be dealt with?

I have mixed feelings about punishments - do we punish for the mistakes or do we reward the correct? I remember this story about a daycare facility that used to close at 5 PM. Parents were supposed to pick up the kids before 5 PM so the employees could go home on time. On a few occasions, a parent would be late for pickup and the staff would be waiting at the door with kids to leave. Getting tired of these incidents, the owner decided to charge money for each minute the parent is late for pickup. Interestingly, the number of defaulters for late pickup increased substantially! I guess the punishment became an acceptable norm after quantification for the latecomers.

We see similar instances all around us. Cricket players committed ball-tampering until they got caught. Apologies, the small-time ban and now they are back in the game. Does punishment prevent anyone from cheating again? I don't think so. It's very complex — the risk of getting caught vs. short term rewards situation. I guess it's a double-edged sword.

The desire to cheat in the educational setting arises, because we are so infatuated with the CPI or marks. Imagine if we stop publishing CPI and if the companies started hiring students based on technical/non-technical interviews only, we can turn the whole situation on its head.

Have you thought of some changes you would like to incorporate in an offline semester based on your experience from an online semester?

I compare the online semester to a movie vs the offline semester to a live drama. Teaching a live class on campus gives the teacher instant feedback from the expressions on the face of students. Every chuckle, laugh, question, answer, expression is instant feedback for us. There is a rush of adrenaline for me. I still get butterflies in my stomach before starting a live class. Somehow the online class – even if it is in front of the live online audience – is quite unrewarding for the instructor. I have to work so hard to evoke any response from online students. Most prefer to stay cloaked and invisible. From the students' point of view, the online lecture is a boon since they can watch it anytime with no skin in the game. Unfortunately, most end up watching only the night before the exam, trying to cram in at the last minute. So, we started doing weekly quizzes using SAFE so that no-one is left behind. This seems to have worked reasonably well although there is quiz fatigue setting in amongst students. We have been very sensitive about the stress students are going through due to this COVID situation. I connect with the students one-on-one on the phone when possible to address their concerns. This is one change I would do in an offline semester – spend more time individually with students to motivate them!

Can you walk us through how you prepare for your online lectures?

I always like to sit on the other side and imagine what is going through your head. This time, I thought you all must be missing this wonderful place. I had to do something about it. Hence came up with the idea of using various department locations in the background for the lectures. Although towards the end of the semester, I had just run out of places to cover!

Randy Pausch, the late CMU professor, in his last lecture after being diagnosed with cancer, talks extensively about head-fakes. All the tricks, drama, jokes, analogies, and stories I do in my lectures is to cajole you into doing something else — to keep you interested in the course and learn a thing or two.

The lecture videos are of my own production. I avoid using any slides. I prefer to write/draw live in class. Just the production time for each lecture would be 6-8 hours, and I haven't even started about the time it takes to prepare the material! Working in the industry was way easier than this- all we had to do was make chips, sell them and then rewards follow. Right now, I am working harder since I have a short time left to make an impact. I work very closely with my TAs. They are my best critics before the lecture is presented. This semester I am teaching a new class – Mixed-Signal IC design. There is a whole lot of behind the scene planning that went on. We looked at the lectures taught by various instructors from different universities Stanford, Berkeley etc. Reviewed many textbooks. Finally, we created our own script giving it our own flavor. I enjoy the process of unlearning everything and then relearn again from the students' level of understanding. I spice things up by adding my personal industry experience stories illustrating what students would be expected to do if they work in this area. If you get someone interested at the beginning of the movie, you hope they will see the rest of it and then all the effort for the lecture videos is totally worth it!

WOMEN IN ENGINEERING

By Pratyush Ragini
& Akhila Khrishna K

Prof. Preeti Rao, working in audio signal processing and the senior-most woman professor in our department, talks about different stages of her life and how she discovered herself along the way.

It was true then and to some extent now that everyone tries to get into either Medical or Engineering. Students get funnelled into a college without too much active choosing or examining where their interests lie. And choices get made by themselves.

Due to her mother being a medical practitioner, everyone had assumed Prof. Rao would take up the medical stream. But being better at Maths and Physics drove her to choose Engineering. But once she entered the EE Dept. at IIT Bombay for a five year BTech program, the numerous electives helped her understand her inclination.

"I went from a girls' school to a boys' school", is what she says about her student life at IIT

Everyone has heard about students enjoying the IIT non-academic life and making a lot of friends. But for the girls, it was a bit different. Being one of the six girls in a batch of 300, the feeling of loneliness and isolation used to creep in every so often. Senior guidance was also hard to come by. There was no internet in those days, and nobody owned a phone, so once the girls entered their hostel, they used to get cut off from everything. On a lighter note, she adds that bunking a class was difficult too as girls were the first to get noticed if missing from the classroom.

When asked about extra-curricular, she tells us how she was a voracious reader interested in writing. Getting involved with the department magazine, she got the opportunity to interact with some of her classmates. There used to be hikes organised by Gymkhana under the name of Himankan. During two such summers at Dehradun and Manali, she got to know a few seniors and juniors across departments. But on the department's picnics, she talked to the faculty members' families instead.

Talking about how she entered the field of Digital Signal Processing, she tells how to an extent, it was a method of elimination she used to decide. She also gives credit to the pedagogy and the curriculum. It was only the CS Dept. which offered a DSP course at that time, but it was oriented more towards computation. It was only during her MS when she had a proper DSP course. By then, textbooks on the topic had also started becoming available.

After completing her MS and PhD at the University of Florida, she returned to India, unlike many of her peers who stayed back in the USA. In those days, getting a job in India for PhD holders was almost impossible. Being treated 'overqualified' for industry jobs, she could only enter academia. So, she and her husband, who was also a batchmate of hers during BTech, together, applied to IITs. That is how they reached the beautiful campus of IIT Kanpur. There was only one woman professor in the department, and from her, she learnt a lot about life in academics. But in the classroom, she used to doubt herself and her capabilities, whether she would be able to deal with the overly competitive students' questions. It felt like she'd gotten into the same place she had been trying to escape years ago. But no, she told herself, she was a Professor now and held a perspective that could help the students understand the subject. And soon enough she started enjoying the role she'd stepped into. But living five years away from their families, it was time to come back to IIT Bombay.

Passionate about building things with a tangible connection to society, Prof. Rao was more into applied work. For her Postdoc, she worked in the Speech and Hearing Dept. at the University of Illinois at Urbana-Champaign, her first step into the field of speech and audio signal processing. Moreover, her music processing journey started with some musician students who wanted to work on its technological aspect. Through exposure in workshops and conferences, her research group entered collaborations including a large funded project from the European Research Council with a prominent partner in Spain. They received funding to work on Hindustani classical music, wherein they had to find descriptors and signatures that define a genre. These can constitute information on the Raga or the rhythm structure, all through audio signal processing of the physical performance recording. Such interdisciplinary projects involved a rich interaction with many musicians and musicologists.

The team had also developed a demo tool where the user could hum a Bollywood song, and the software would retrieve the actual song from the database. It was a big hit and was showcased in the Science Express, a science exhibition on a train that travelled across India, and TechFest and Mood Indigo. One of the use cases of this prototype was to give singers feedback about their note accuracy, which led to the development of a score-based karaoke system and automatic auditioning tool. And that was the birth of Sensibol Audio Technologies. Funded by SINE IIT Bombay, they approached several Music Labels like Saregama and Sony Entertainment. More prototypes followed when they understood the many technological gaps in the entertainment industry that could be bridged using audio tools. Automatic lyric alignment to songs, and choosing representative clips, or hooks, for radio stations were a few amongst them. The team soon expanded and got into realising all these ideas as products. It was a challenging but illuminating experience, learning how to understand what a potential customer needs and customise one's own work to find a solution. Close to completing ten years, the company has a total of around 15 people employed. Prof. Rao describes it as a great learning experience for both her and her student co-founders as they went about talking to investors explaining to them about their work and how it can benefit the industry.

The greatest thing, she says, about academia is this very flexible nature. There's a lot of freedom to decide the kind of research one wants to pursue. One can choose to do more foundational research and publish excellent papers or deliver on projects and build things to create industrial value. Some people choose to write textbooks on their subject matter and develop labs. It's all about finding something where one feels they can contribute best. When it comes to applied work, one can always take up industrial projects, or be an advisor or consultant in their work field. Besides work, she enjoys interacting with her research students. If she can mentor them to make them see the same excitement that she does, or advise them into looking at things from a new perspective, she considers her job as a teacher worth it. A common question women in her position are asked is if they faced any gender discrimination at any point in time. And the common thing amongst all their answers is that it's a minor part of the challenges women face. In reality, it is their self-confidence that holds them back the most. If you're good at something, then there will always be people who would recognise your worth irrespective of your gender. But women, in general are not self-promoting. Around 15 years ago, Prof. Rao read about imposter syndrome. It affects women a lot more than it affects men because they tend to be more self-doubting. Wikipedia explains imposter syndrome as "a psychological pattern in which an individual doubts their skills, talents or accomplishments and has a persistent internalised fear of being exposed as a 'fraud'.

She realised how she had faced these doubts at different points in her life, be it cracking JEE, answering questions others were unable to, or when she started teaching for the first time. This self-doubt is the biggest enemy to women because it becomes that much harder to grab the right opportunities and get ahead. But like every coin has two sides, this one does too. The good that comes out of this is the sense of duty that develops, which is vital in any aspect of life.

She advises students to really plan their future and not just wander into things. "There are a lot of options, and you shouldn't think that this is the best opportunity and take it just like that. Think about what's good for you and what you really want to do and make the best decisions possible. It matters because these decisions eventually shape your career. Compromising too much is a loss to everyone; you'll be unhappy and the society, too, will be at a loss because you could have contributed positively somewhere else. Don't be overly critical of yourself and don't underplay your strengths. Talk to people. Your faculty are good judges; they have experience with many people and can tell your strengths and weaknesses. And it's important to take those outside inputs besides examining yourself, to figure out and get clarity about what you want to do. It can be academics, industry or a field completely different from engineering. It should be something that you look forward to getting back to and you feel bad if you are away from it for too long."

IOT IN AGRICULTURE

Multi-hop wireless sensor network for in-situ agricultural applications

Special thanks to Karan P. Rane. Research paper by Jobish John, Vinay S Palaparathy, Gaurav S Kasbekar and Maryam Shojaei Baghini. Edited by Pratyush Ragini

Aridity is an ecological situation in which water income is less than potential water expenditure (runoff, evapotranspiration, etc.). 48% of India's landmass is either arid or semi-arid. With life on the farm becoming more and more uncertain, it is important to measure and analyze whatever we can. This would allow for a system to control the water input more optimally. Metrics like soil moisture content and nitrogen content need to be kept track of more accurately. Through their research, Jobish John et al, are looking at qualitatively and quantitatively better ways to monitor farm conditions. The primary focus is also on optimising the cost factor, which is a significant hurdle to India's financially challenged farm sector. They have designed and implemented a wireless sensor network (WSN) for agricultural monitoring application using multi-hop tree-based architecture. The sensor network has two functions: sensing soil moisture and transmitting the sensed information wirelessly to a central node.

Neutron scattering probe technique, time-domain reflectometry (TDR), frequency domain reflectometry (FDR), and microelectromechanical systems (MEMS) are some technologies that are usually used for in-situ soil moisture measurement. However, these techniques are expensive, so the researchers developed in-house capacitive-based soil moisture sensors. For these sensors, the soil acts as the dielectric medium. When the water content in this soil varies, there is a change in the dielectric constant of the medium and consequently a change in the capacitance. This is then calibrated and used to measure the change in soil moisture. This technique also holds the advantage of quick response time and lower power consumption.

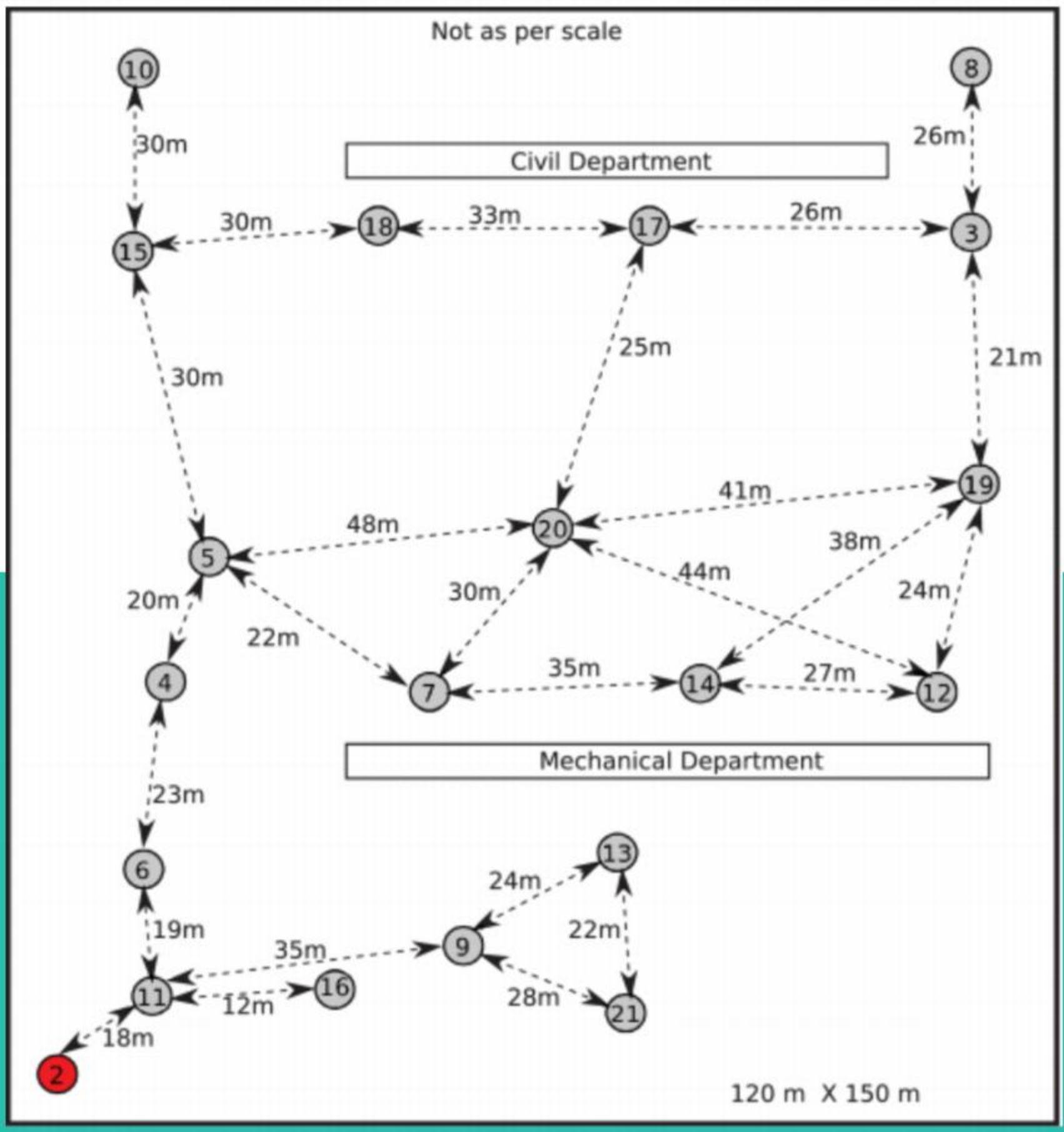
ZigBee and LoRa are generally preferred wireless technologies for agricultural applications because of their low power consumption and wide communication range. But these are expensive and not easy to use. Hence the researchers have used TelosB modules for wireless communication at the nodes in the multi-hop wireless network architecture.

The nodes of the sensor network are deployed in a random fashion on an agricultural farm. Each node senses information and sends it to a central node called the sink node which is connected to a base station where decisions are made based on the analysis of the collected data. A cycle of data transmission starts with the formation of a data collection tree followed by the synchronised periodic sleep-wake up scheduling of the nodes.

A data collection tree is a map which the central node generates after receiving connectivity information of all the nodes. The gathering of information starts with the neighbour discovery phase. Each node finds all its neighbouring nodes and assigns a weight to each of them. The weight between two nodes is computed using the node's battery levels and the quality of the wireless link connecting the nodes.

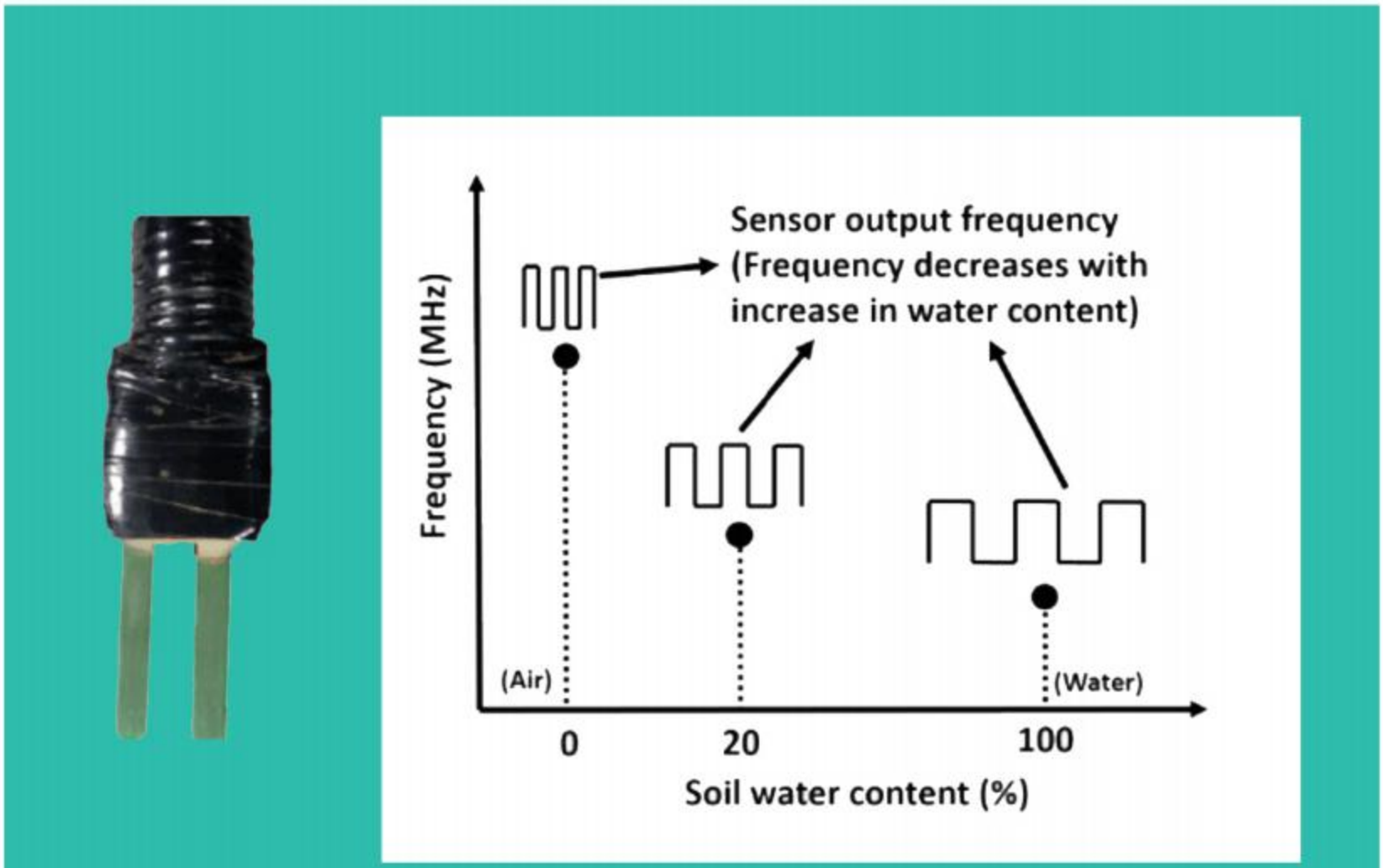
The data collection tree can be constructed using algorithms such as minimum spanning tree and the shortest path tree. The researchers have used the latter for its efficiency. Once the data collection tree is built, the sink node informs each node about its parent, and all the nodes are synchronised to the sink node along the edges of the tree using a modified version of the flooding time synchronisation protocol (FTSP). Time synchronisation helps the nodes follow a coordinated periodic sleep wake-up schedule to save energy and increase the node's lifetime.

The researchers implemented a WSN consisting of 20 sensor nodes in the IIT Bombay campus. The sensor nodes were placed randomly in a region covering approximately 120 m × 150 m. The region lies between the Department of Civil Engineering and the Department of Mechanical Engineering and holds red soil. The sink node was connected to a laptop, which was used as a base station for logging the sensor data. Each sensor node was equipped with an in-house developed capacitive soil moisture sensor, an atmospheric temperature sensor, and a relative humidity sensor.



Tree used for data collection

A Lithium-ion battery was used- to power the system, and store the energy produced by the solar panel accompanying the system. The soil moisture sensor was deployed at a depth of 10 cm from the surface. MCP9700A and HIH5030 were used to measure the atmospheric temperature and relative humidity, respectively. Each node was equipped with a TelosB mote which uses an IEEE 802.15.4 compliant radio chip CC2420 for wireless communication.



In-house developed capacitive sensor and its response

The interval between two consecutive data collection time slots in the experiment was 1 hour, and the data collection tree was rebuilt once every 10 hours. In actual field applications, the same data collection tree can be used to collect the sensor readings for a longer period so that the energy overhead because of the tree construction phase can be minimised. The researchers used TDR (TRIME PICO 64) to validate the measurements obtained from the capacitive sensors. This work can also be translated to other developing nations with a similarly resource-challenged agriculture sector.

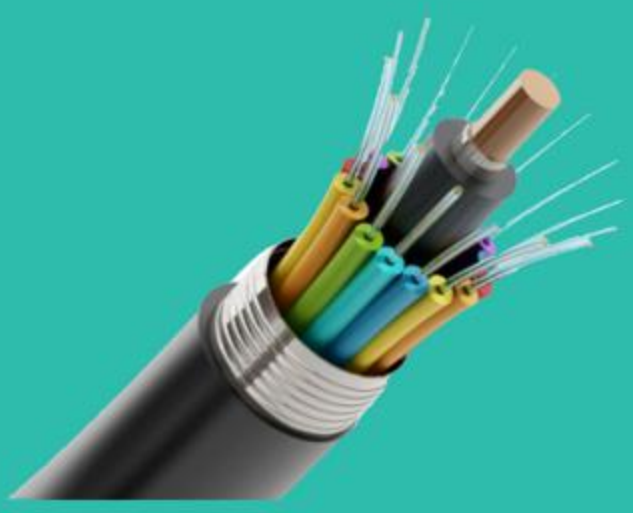
With crop loss across the country becoming a challenging issue, it is imperative to make use of technology like IoT to make the best use of the land and resources we have. Measuring soil moisture content could provide vital irrigation data to the farmer to improve yield. To take this idea a step further, Proximal Soilsens, incubated by Society For Innovation & Entrepreneurship (SINE), IIT Bombay, is conducting pilot tests in agricultural fields across the country and is looking to scale up implementation.

LABS OVERVIEW

By Param Rathour and Pratyush Ragini

Fibre Optics Communication Lab

The need for higher bandwidth and low-cost techniques for communication is pushing research in the electro-optic domain. The use of optical fibers is increasing for their high-performance data networking. Using light pulses for information transmission, they work on the principle of total internal reflection thereby considerably reducing attenuation.



The Fiber Optics Communication (FOC) Laboratory in the EE Dept. is involved in research on optical communication, networking and sensor applications. Optical fiber is primarily of two types - singlemode (for long-distance communication) and multimode (for short-distance communication).

There's a third type called few-mode which isn't yet used in our lab. The research scholars in the lab are currently experimenting on multimode fiber. ArbStudio Arbitrary Waveform Generator is used to import the data that needs to be transmitted and a photodetector is present at the receiving end. These received signals are further processed by exporting files through the oscilloscope.

For this experimental setup to work seamlessly, vibration-free tables are a necessity. The equipment for the lab is purchased as per the needs of the students. The projects are now focusing on hardware experiments and not just simulation work. Students interested in the area and with a background in Digital Communication, Optical Fibre Communication, Digital Signal Processing can explore projects in this lab.

Location:
Second Floor, Main Building,
Department of Electrical Engineering.

Associated Faculty Members:
Prof.Kumar Appaiah
Prof. Joseph John

LABS OVERVIEW

Nanoelectronics Computation Laboratory

Nanoelectronics is the use of nanotechnology in electronic components using tiny devices and materials. At this nanoscale, the need arises for investigating inter-atomic interactions and quantum mechanical properties. Computational approaches aid the understanding of the behaviour and further develop these devices.

The Nanoelectronics Computation Laboratory's prime focus is to research various devices, technologies, and problems, including multi-gate MOSFETs, tunnel-FETs, power semiconductor devices, and statistical process variations, compact model development, development of algorithms for compact model parameter extraction, different materials for curvature devices. Lab is situated at room no. 205 in the second floor of the Annexe Building of the Department of Electrical Engineering, with capacity of 30-35 students and air-conditioned space seating space. Server room is accessible remotely.

Experiments nowadays focus more on the reliability of devices under pressure. PVT (Process Voltage Temperature) characterisation identifies process corners. Process corners are extreme values of the parameters for which the circuit functions correct, like max temperature that the device can sustain. Fast and slow corners exhibit carrier mobilities that are higher and lower than normal, respectively. Technology Computer Aided Design (TCAD) Tools, namely Sentaurus and Silvaco are used for Device characterisation. Integrated Circuit Characterization and Analysis Program (ICCAP) is also available on demand. Institute-wide licenses requiring hardware can use servers available here too. After simulation, specifications are sent to Fabrication Lab for manufacturing the device.

To explore projects in this lab, students need to cover courses in Solid State Devices (EE733) and Microelectronics Simulation Lab (EE735).

Associated Faculty Members:
Prof. Swaroop Ganguly
Prof. Udayan Ganguly
Prof. Dipankar Saha
Prof. Pradeep R. Nair
Prof. Valipe Ramgopal Rao
Prof. Souvik Mahapatra
Prof. Saurabh Lodha

Prof. Desai takes us 40 years back

"I chose academia over the industry because here in IITs there is no interference and one can teach and carry out research freely"

-Prof Madhav P. Desai

Professor Madhav P Desai is an alumnus of IITB [Batch 1984]. Prof. Desai has received his PhD and M.S in Electrical Engineering from the University of Illinois (Urbana-Champaign) in 1991 and 1986 respectively. During the period 1992-1996, he worked in the Semiconductor Engineering Group at the Digital Equipment Corporation in Hudson, MA, where he was a Principal Engineer. After this brief period in the industry, Prof. Desai joined IIT Bombay as a professor. Through this article, Prof. Desai takes us 40 years back into the glorious past of IIT Bombay and tells us about the hostel and academic culture that existed when he was a student. He also explains to us about his research works and his motivation to come back to IIT Bombay.

By Pratyush Ragini and E Abhishek

Life was very different in the institute back when I was a student at IIT Bombay. We were a batch of just 60 students in the 5-year BTech program. The longer period gave us a lot of opportunities to explore the department. BTech projects were taken quite seriously, and due to the small class size, every student got attention from the teachers. The professors were more focused on teaching as the quantity of research was relatively lesser in those days. The coursework was very fundamentals-oriented, and exams became a secondary thing, unlike what we were used to in our junior colleges. But it was during those school days itself when I found my interest inclination towards circuits and semiconductors. Not having much knowledge about other engineering disciplines, I ended up latching on to this interest and chose to pursue Electrical Engineering.

I loved half of the courses I took at IITB, mostly in the machines and semiconductor field. At that time, we did not even have breadboards for labs. Prof. Vasi, who taught one of the semiconductor courses, took the lead and got us breadboards to work with. Apart from core courses I also enjoyed some of the maths courses like the linear algebra one. Hostels were one of the most active places on the campus. We built some strong bonds with hostel mates during sports events. I was more into literary competitions and quizzes. The lake was a popular spot back then too, especially for wildlife enthusiasts. The wildlife and boat clubs were very active. There even were trips to the Himalayas every year. And in Mumbai, one had to travel all the way to South Bombay to dine out or watch a movie. I remember I had my first pizza in Bandra which was the only place in the whole of Mumbai that made them. Times have changed so much. Now you get your pizzas at your doorstep.

While passing out, we had very limited options. Half of the students went for higher studies and the other half went for either an MBA or a job. After my B Tech in IIT Bombay, I had three choices: IISc, ISRO and Illinois. I chose to pursue my Masters in the University of Illinois, wherein I continued with my PhD as well. It felt like an adventure and my parents and peer group were quite supportive of it too. Post my PhD, I took up an industrial job in the USA. The work was great, but the memories of home called me back to India.

I chose academia over the industry because here in IITs there is no interference and one can teach and carry out research freely. Many of my batchmates, like Prof. Preeti Rao, Prof. Mahesh Patil and Prof. Mukul Chandorkar, too are back here as professors. Unlike foreign universities where work is more of an incremental nature, here we have to build things from scratch. And most companies prefer to import rather than develop technologies in India. We overcame this challenge by working on a completely Made in India microprocessor, AJIT. It had to work in a competitive manner and be reusable. To me, this was a perfect combination of research and development. The research was more about the way to build a microprocessor from scratch rather than the microprocessor itself.

When I look at the current times I find that the undergrads are under a lot of pressure. There are various opportunities to choose from. Students just don't get to relax now. Summers are spent in internships which was not a thing back in our day. We had only practical training in our fourth-year summer and the rest of them were completely free. But today, students are always doing something or the other, and this has become a necessity too given the number of options they're presented with. In the end, exploration is what drives choices.

MINDFULNESS

By Pratyush Ragini

At some point or the other, we've all felt stressed, be it due to past regrets or future worries. "People around me are doing so much better; how can I do better?", "Will I get a good internship?" , "Could I have utilised my time better in the past?" These are questions that nag us time and again. But how to avoid this train of thought?

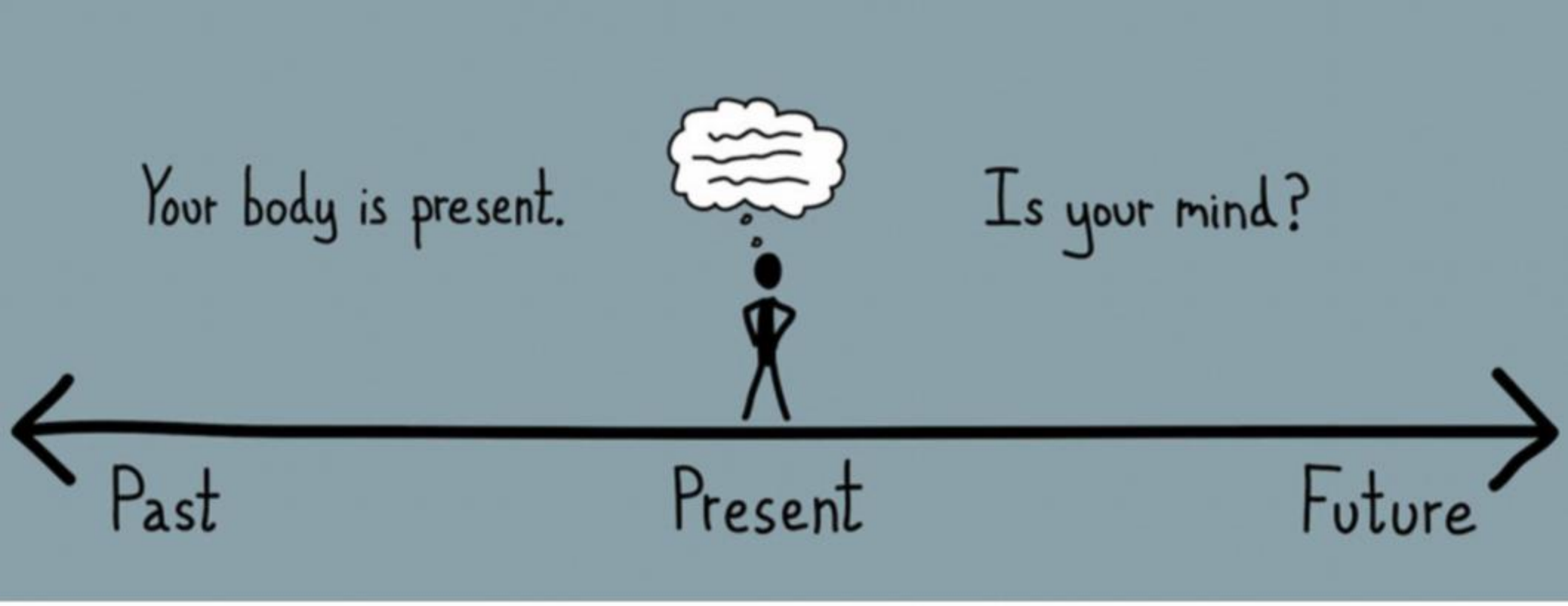
Dr Rajendra Barve, mindfulness teacher, takes us through a logical approach to do just that. Rechristened as Sugat Acharya, he has been a consultant psychiatrist in private practice for over 40 years. Founder of Parivartan— The Turning Point, he has been associated with IIT Bombay for quite a long time.

These are typical questions of a disillusioned mind, he says, where we feel lost and helpless about achieving the goal. In contrast, an innovative mind is one where we redefine ourselves by setting new goals and playing by our strengths. And bridging this gap between a disillusioned mind and an innovative mind needs some hard work.This is where mindfulness comes in. It is a skill that can be internalised by practising it again and again.

Mindfulness has its roots in the Indian philosophy of sammasati - wholesome knowledge, wholesomeness in the sense of being aware of our knowledge, capab -ilities, and potential to see the world the way it exists. But to understand awareness, we first need to take a closer look at the human brain which has three major parts. The very primitive part of our brain is the reptilian brain which gives us physical awareness and a sense of consciousness. Then comes the emotional brain that attaches a feeling to the physical sensations, and last comes the rational brain responsible for creativity and imagination.

The mind is very much like a pendulum. It moves from past to future, back and forth, but the equilibrium point remains now— the present.

The questions mentioned in the beginning are all due to something called 'emotional hijack'. The emotional brain overpowers the rational brain, and we end up feeling anxious about imagined situations brought from the future or the past. But we experience all this worry now, the present moment. And this is when we lose our concentration on the real goal. We need to make our rational brain powerful enough to stay in the present moment and remain focused. Because now is when we can solve a problem at hand, now is when we need to do stuff.



Procrastination is one of our constant companions shadowing us. And it is so because we have low frustration tolerance. Solving the problem now makes us anxious, and we take the escape route. But being present makes us tolerant and accepting of this frustration and boredom and remain focused on what we need to do now. It takes our brain only a fraction of a second to wander off. And the skill of mindfulness will help us reach meta-awareness, the awareness of being aware and use it to bring our awareness back when it's lost.

Mindfulness revolves around the breath; yes, the very breath we take in and out every moment. Breathing is the one thing that can't be done for either the future or the past. The breath is only for the present. When we become aware of our breath, we come back to the present. We become aware of whatever is passing through our mind. And we don't block it, no, we simply let it pass. Let the thoughts flow in and out, and the moment we find our mind latching onto one of them, just bring it back to the breath. Always bring it back.

In this manner, we train our brain to be more aware and focused on the present that matters. The emotions get regulated, and the mind feels much calmer because there is no clutter any more. We learn to respond instead of reacting.

"I will preserve my uniqueness. So what if my friends are doing good in some other thing? I will do what I like. And I will do it now to become better."
"Let me work hard now to get that internship in the future. When the time comes, it will pay off."
"What's done is done.Let me not procrastinate from now on."
Bringing ourselves back to now is what will get us through our problems. And once we practise this, again and again, it becomes an automatic process, a habit. It becomes our personality. Twenty minutes for eight weeks.

Sit down. Breathe. Relax!!!

Youtube Recommendations

Smarter Every Day

This channel's motivation is to inspire curiosity in as many people as possible.

Reducible

This channel is about animating computer science concepts in a fun, interactive, and intuitive manner.

Mark Rober

YouTube videos on popular science, do-it-yourself gadgets and creative ideas.

Primer

Communicates deep ideas of academic subjects like evolution, economics.

By Param Rathour

Poems

REFLECTION

A STATE OF MIND

A state of mind
Arriving without an appointment
Leaving without a goodbye
Submerging us in its sea
With a few shells leaving behind
Explaining the whole universe

FORGOTTEN SOULS

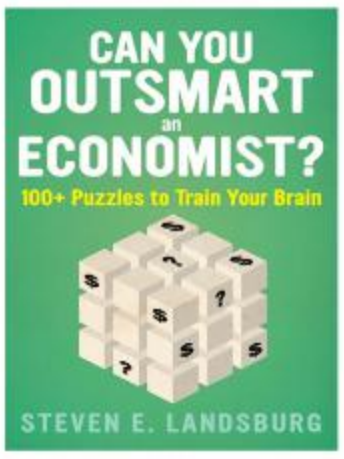
When death recalls her life
Bliss, melancholy as a wave
Painting a portrait of her fleece
Reminding the indelible
expressions of life
Just to unfurl the fact that
"SHE MATTERS".

Am I an introvert?
Hey I am not a touch me not
Which closes its heart when someone
triggers it
Not a lover of the eternal loneliness
Who digs deep into the inner thoughts
Not a deep researcher of the world's
infiniteness.
The centre of the galaxy around which the
crowd revolves
The feather of every children
But I am not this either
Who am I then?
Am I a pendulum which oscillates between
2 phases of life?
Two types of characters?
Or a pivotal centre of the whole creative
universe or the so-called "Ambivert"?
I don't know again
As life narrates nothing
But some jumbled words of creativity.

-written by
Akhila Krishna K

Book Recommendations

By Param Rathour

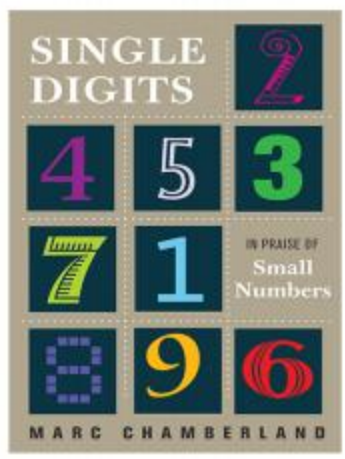


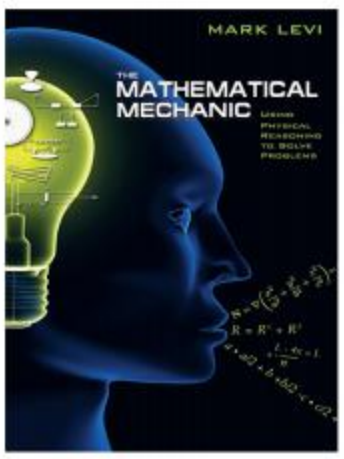
Can You Outsmart an Economist? - Steven Landsburg

A unique economics primer with over a hundred brain teasers that illuminate key concepts and traps in economics. Puzzles covering logic, probability, strategy, irrationality and many more complex topics for effective decision making and problem-solving.

Single Digits - Marc Chamberland

This book is about single digits, enlightening everyone about the magical ways how 1 to 9 are connected to a multitude of mathematics. Each number has fascinating properties related to many different areas of mathematics, including number theory, geometry, chaos, numerical analysis, mathematical



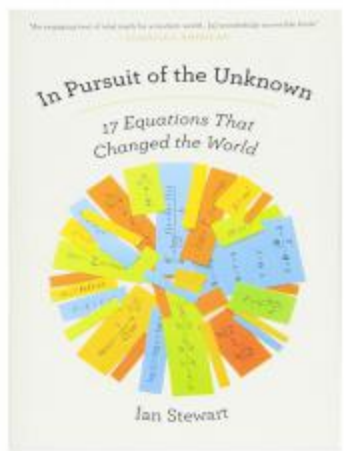


The Mathematical Mechanic - Mark Levi

Usually, mathematics lays the foundation for solving physics. This book uses a reverse approach; for students interested in physics but finds mathematics dry or dull. It uses physical systems to solve mathematical problems from Pythagoras theorem to Complex Variables :).

In Pursuit Of The Unknown 17 Equations That Changed The World - Ian Stewart

The author examines seventeen ground-breaking equations that have altered the course of human history and their many applications.



A LETTER FROM EESA

The Electrical Engineering Student Association (EESA) represents all the current students within the Electrical Engineering department. The goal of this student body is to organize social and professional activities which strengthen and enrich the community, and also to help publicize various research activities within the department. It organizes social events, hosts community talks by guest speakers and students, and facilitates communication between the department functionaries and the students. Over this past year, EESA has conducted numerous events to maintain as much social wellbeing as possible given the circumstances of an online system of conduction.

EESA launched the Know Your Professor (KYP) series where the professors of the EE department discussed their life journey, research interests, teaching experiences along with other engaging and interesting stories. Prof. Pradeep Nair and Prof. Anupama Kowli were amongst the first to share their life stories. The association also set up a board of 10 editors and designers to work on revamping the department newsletter, Background Hum.

Online interactive sessions with seniors were organized for the thirdies to help confront their perplexity regarding choosing specialization. Another session was held for the freshers where the HoD introduced them to the various opportunities in the EE department. EESA also contacted the alumni batches to conduct mock interviews and group discussions to help prepare the final year students with the placements. A placement mentorship program was initiated with the aid of SARC. Core talks 2020-21 too were organized as part of creating more awareness of industrial research. One of our esteemed alumni, Dr. Yatish Turakhia, an incoming assistant professor at the University of California, San Diego, was invited to take an introductory session on the field of accelerating biology and medicine with hardware specialization.

For the first time, EESA conducted an intra Department Online Chess Tournament on lichess with more than 50 students participating in the tournament. A freshers' game night was also conducted post mid-semester examinations to steam off all the stress through online games. A mental health awareness event was organized to discuss the common problems being faced by the students in the ongoing environment. 'Campus Showreel' was launched by EESA in collaboration with Silverscreen. It accepted short videos of the institute shot by the campus residents with the motive of keeping the recently graduated rooted and connected and also providing hope to the freshmen who haven't yet visited the campus.

To further introduce the freshers batch of 2020 to the rest of the batches, EESA conducted an online interaction on how on-campus life would be different and the seniors' views on certain aspects of life at IITB. The freshers' video on EESA's Youtube channel clearly showcases the confidence with which these students are breaking the stereotypes of our institute.

Through all these events this student body association kept one and only one motive in mind which was to enhance the experience of the students through whatever means of interaction possible. Leaving all in content and rest.

EESA Council 2020-21
Signing off.

THANK YOU

EDITORIAL BOARD

Last year was full of changes and adaptation. One of the good changes we came up with is bringing you a brand new issue of Background Hum.

The editorial team has put together a variety of articles taking you through the department. We would like to thank all the faculty members and students who shared their stories and helped us pen this edition.

We value your feedback to keep bringing you better and more interesting content.

Email us at bh@ee.iitb.ac.in to share your thoughts.

EDITORIAL TEAM

Pratyush Ragini Singh
Vedant Satav
Rohit M A
Priyanka Bagade
E Abhishek
Akhila Krishna K
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