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ENSIDER

Department of Energy Science and Engineering, IIT Bombay

The New Normal: 58th Convocation in VR Mode

By Garima Chaturvedi, PhD student

This year, IIT Bombay organized 58th convocation on 23rd August 2020 in virtual reality mode. The sincere efforts from staff and the students helped in successful execution of the program, following all the safety measures pertaining to pandemic. Prof. Duncan Haldane, co-recipient of the 2016 Nobel Prize in Physics, and a Professor of Physics at Princeton University was the Chief Guest during the ceremony. Mr. Stephen Schwarzman, Chairman, CEO and Co-Founder of Blackstone, world-renowned investor and philanthropist, was the Guest of Honour.

The Virtual Reality (VR) convocation was a new experience. A personalized avatar of each graduating student received the degree certificates from the personalized avatar of Prof. Subhasis Chaudhuri, Director of the institute.

Prof. Chaudhuri emphasized that the primary goal of the institute is to "Produce top quality graduates who would be future leaders in industry, research and academia. The skills they developed, the work culture they picked up and the peers they made during their studies at IIT Bombay will help them achieve success in their lives. The entire nation will be looking forward to their contributions in taking our country ahead".

He further said, "Providing virtual experience to all our graduates need not only highly innovative steps but also a tremendous effort by our professors and staff, they did it for the students. Hopefully, this will inspire our graduates as well as other engineers in the country to think big and think innovatively".

All the medal winners received their awards from the chief guest in digital avatars thereby preserving the sense of achievement and pride of passing out from India's premiere engineering institute. The entire event was telecast on DD India and DD Sahyadri channels as well as YouTube and Facebook .

(From left) Virtual avatars of Prof. Subhasis Chaudhuri and Nobel laureate Duncan Haldane, who confers a medal to a graduate.

This year institute also provided a unique option to socialize and interact with their friends and faculties for the last time. This was done via virtual presence, allowing students to roam around a virtual campus, visit their hostels and departments virtually, and meet their friends and faculty.

It took the efforts of 20 experts from the IDC, a school of design to create digital platform of mobile application and took more than 5000 person hours to build an app, said Prof. P Sunthar, co-convenor of Convocation Committee.

The graduating students this year include 381* PhDs, 18* Dual Degree (MTech/ M Phil + PhD) and 27* Dual Degrees (MSc + PhD). Out of these, 39 research scholars were selected for the award of 'Excellence in PhD Research' for the year 2018-20. In addition, 33 joint PhD degrees, in association with Monash University, were also conferred by the Vice-Chancellor and President of Monash University Prof. Margaret Gardner on the occasion. Besides, 684 BTech Degree, 342 Dual Degree (BTech + MTech), 225 two-year MSc, 110 MMgt, 621 MTech were awarded at the convocation. (*Including PhD degrees awarded during interim convocation.)

Three students bagged gold medals for their excellent academic performance. **Mr. Sahil Hiral Shah,** a BTech student from the Department of Computer Science and Engineering was conferred with the "President of India Medal". **Mr. Shashwat Shukla** from the Department of Electrical Engineering bagged the "Institute Gold Medal" for the session 2018-19 . **Mr. Prakash Singh Badal** from the Department of Civil Engineering received "Dr Shankar Dayal Sharma Gold Medal". Additionally, the silver medals were presented to the department toppers by the Chief Guest.

A glimpse to DESE Convocation 2020

The fifth departmental convocation as an extension of the 58th institute convocation was organized in virtual mode. This year about 3 BTech, 22* Dual Degree (B Tech + MTech), 2 MS, 2 MSc, 11* MSc-PhD, 30 MTech, 2 MTech-PhD, 9* PhDs were awarded (*Including degrees awarded during interim convocation).The students along with their parents connected virtually with the faculties to bid farewell to the institute. The event concluded with smiles, cheers, and hopes to build a better tomorrow.

Symposium: Energy Transition in Industry

By Prof. Srinivas Seethamraju

Power, transport and industry are the major contributing partners to fulfil global energy demands. Among these, power and transport have played a prominent role in mitigating the CO_2 emissions. However, the industry sector is still devoid of focus for a low carbon transition. Hence , a symposium on "Energy Transition in Industry" was organized by DESE, IIT Bombay and British Petroleum (BP) on 25th and 26th February 2020 with the sponsorship from BP.

The one-and-a-half day long event had 50 participants from both academia and industry. The first day of the symposium had invited talks . The second day was a half day long session which was open to industry participants and included wide spectrum of audience. The themes covered in various sessions include Energy efficiency and benchmarking, renewable energy use in the industry and next generation industrial process and carbon capture and storage (CCS) in industry.

The event hosted plenary talks by Prof. Eric Larson (Princeton University, USA) on net zero emission for the USA by 2050 and Prof. Rangan Banerjee (DESE, IIT Bombay) on decarbonisation of Indian Industry.

The symposium ended with a panel discussion and there was a strong consensus that a good potential exists for the technology development of next generation low carbon processes for the energy intensive industries.

Accomplishments: Students and Faculty

- **Institute Silver Medal:**
  (i) Mr. Mohit Padhee (MTech)

- **Baishnab and Kasturi Academic Excellence Award:**
  (i) Mr. Wasnik Chinmay Rahul (MTech)

- **Excellence in PhD research award:**
  (i) Dr. Ananta Kumar Sarkar
  (ii) Dr. Hazem Karbouj

- On September 1, **Prof. Suryanarayana Doolla**: Appointed as Editor of the IEEE Journal of Engineering and Selected Topics in Power Electronics

- On September 8, **Prof. Venkatasailanathan Ramadesigan** received departmental award for the excellence in teaching recognised for his significant contribution to the teaching activities

Interview with Devika Choudhury

By Garima Chaturvedi, PhD student

Dr. Devika Choudhury
(Senior Process Engineer, ASM America, USA)
In conversation with ***Garima Chaturvedi,*** talks about her journey from IIT Bombay to one of the best laboratory in USA and her aspirations.

Tell us about yourself.

I have completed my doctoral degree from DESE, IITB in 2017 and secured post doctoral position at Argonne National Lab (ANL), USA where I worked on Atomic Layer Deposition (ALD) technique for application like solar cell.

Moreover, I was also selected as an entrepreneur lead at Energy I-Corps Cohort 9 last year, organized by Department of Energy, USA in 2019. After two years at ANL, I joined ASM America earlier this year in January 2020.

What inspired you to take up research in the field of energy science and engineering?

I have a background in applied electronics and instrumentation. My work in masters was based on the thin film development for solar cells. This further propagated in my PhD where I worked on NCPRE project under the supervision of Prof. Shaibal K Sarkar. Besides, my grandfather who was a civil engineer had worked on several hydel power projects in his career. He had a huge influence on me to cultivate interest for research in energy sector .

What is the institute's contribution in carving you as a research scientist?

In IITB, I like that the students are made to think, we have more questions in the classroom. It was a constant challenge for me to push my limits throughout my PhD. Attending conferences has helped me to gain confidence and through one of the conference I got in touch with my post doctoral advisor Dr. Jeffery Elam and went to pursue research at ANL, USA.

ANL research group

During PhD we experience a phase of self doubt and lack of clarity, how to overcome ?

It's a long journey and things will not always be smooth or as we plan. Just remember not to lose your focus, you are here to do research and you need to finish it well. It's your dream so be determined about it and don't give up in any circumstances. Always remind yourself why you want to do it and that will act as fuel for your growth.

Did you partake any extra curricular during your stay in campus?

I am not much of an extra curricular activities person. But I did enrol in dance classes while in my first year and at the end of PhD took up teaching in NGO. I was lazy to jog, so I don't remember going for jogging for even a single day. But we used to go out for dinner and outing with my lab mates. Overall I loved my work in lab, so no complaints.

You are senior process engineer in ASM America, US. Please elaborate upon the key skills required to excel in the industry oriented job.

It's important to work on strengthening your fundamentals so that you can cope up with the pace which helps one to be on top of the game. Moreover, don't hesitate to ask questions, this will help you to grow. Overall, respect your fellow researchers and share your knowledge and experiences.

What is the most challenging part of your job?

I am working on the application of ALD on electronic devices. We have to develop and apply thin film materials on the components which are to be integrated into devices which is challenging. One has to do more aggressive research when working with the industry and the post-doc experience at ANL has helped me.

In academic one can delve deeper to understand the fundamental insight and it may take longer to solve a problem. Whereas in industry, the demand is based on the market and its quite dynamic and so one has to work aggressively on the deliverables

So the participation in Energy I-Corps and working with people from diverse culture has imparted confidence and sufficient skill in me to take up these challenges and keep up the pace.

Devika's team in Energy I-Corps, 2019

Tell us about your routine during the outbreak of COVID-19.

Currently I am in research based job which has been identified essential to the company's business, we engineers have to be on site. So work has been regular for me during this pandemic. But the company has CDC protocol in place which we are following when at work.

Women participation in science is quite limited, what are your comments on the scope for women in STEM.

I believe instead of gender issue its more about the choices made by an individual. There is scope, but sometimes women need to make more sacrifices to manage career and family together and I am lucky that my parents, husband, in-laws have been very supportive.

Ever realised it would have been easier if you were male?

No, I think it's ultimately your capability which defines the magnitude of success.

What's your biggest achievement and biggest failure, if any.

Gaining confidence in myself and my work, through all my past experiences is my biggest achievement till now.

Failures, I don't consider any failures because each failure has taught me an important lesson, so no regrets.

Where do you see yourself in next five years?

It's a tough question. Probably leading a team but I think I have to get enough training in order to deserve that level. It could also mean having my own company and leading a group of people.

What advice you would give to your younger self?

Don't be too harsh on yourself.

Every person has a role model so according to you who is your biggest inspiration?

I take inspiration from people around me, whosoever I find inspiring I try to learn and imbibe those qualities.

Have you ever thought of entrepreneurship?

I like to be involved in scientific pursuits and taking it to application. Entrepreneurship is not on my mind at this moment but may be in future. I will take things step by step and try to utilize every opportunity coming my way.

Thank you so much for your time. What would you advice to your fellow juniors?

Don't give up, whatever choice you have made, stick to it dedicatedly. Find your own ways to make it work and achieve success.

Development of Ultra-Safe Batteries for Manufacturing in the Indian Market

By Prasit Kumar Dutta, PhD

According to an article published in the Hindu, India has emerged as the world's largest smartphone market. There is also a growing demand for electric vehicles (two-wheelers, four-wheelers, e-rickshaws), all of which require lithium ion batteries for operation. According to a projection by the NITI Aayog, between 2017 and 2030, there would be a market of 300 billion US dollars (21 lakh crore INR) for electric vehicles. The report also suggests that India can cover 80 % of the market by domestic manufacturing rather than importing them. Undoubtedly, this is a great time for India to enter the battery manufacturing market.

In recent times, numerous incidents have come to light where conventional lithium ion batteries unexpectedly blow up or catch fire (Samsung Galaxy Note 7 saga), while devices are carried on flights, with airline companies prohibiting batteries in check-in luggage; some older models of electronics are also not accepted in carry-on luggage. With the Government of India's increased interest in the adoption of electric vehicles it is imperative to have safe batteries. The Tesla Model S explosion in Florida highlighted the dangers of commercial lithium ion batteries in electric vehicles. The tropical climate of India, and the comparatively higher temperatures increase the probability of batteries exploding, endangering the lives of users. Overcoming this hurdle is imperative to the commercialisation of battery manufacture in India. Prasit Kumar Dutta's research focuses on overcoming this hurdle by developing a cheaper alternative to commercial materials which is safe for operation at higher temperatures.

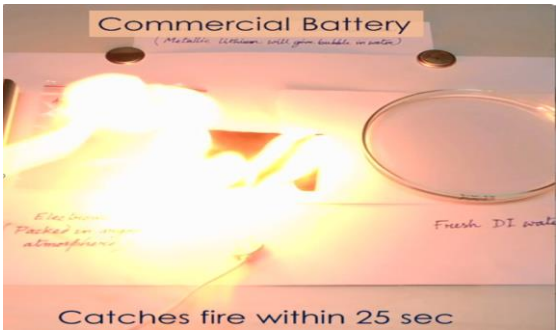
The explosion of batteries has been attributed to the formation of dendrites, which are grass-like lithium infiltrates which grow into the anode material (graphite) like a spike. Such dendrites tend to short circuit the battery internally, leading to explosions. They may form due to multiple issues: battery overcharging, issues in fabrication, absence of a protection circuit to reduce battery cost; among others. Formation of dendrites results in the battery swelling, heating up and ultimately, exploding. Due to the smaller size, the issue of dendrite formation is not as pronounced for smartphone batteries. However, for batteries developed for use in electric vehicles, the criteria for 'ultra-safety' would be to have a dendrite-free battery which does not heat up or swell even at highest ambient temperatures in any part of India. The current battery technology does not meet the criteria mentioned, and ultimately, it means that the standards for measuring battery performance would need to be redefined to suit the Indian context.

Prasit's work has resulted in the development of an anode material which can be produced at a fourth the cost of commercial materials with higher energy density, longer battery life and meeting the criteria for 'ultra-safety'. This material and the electrolyte, prevent the dendrite formation and allow operation at higher temperatures.

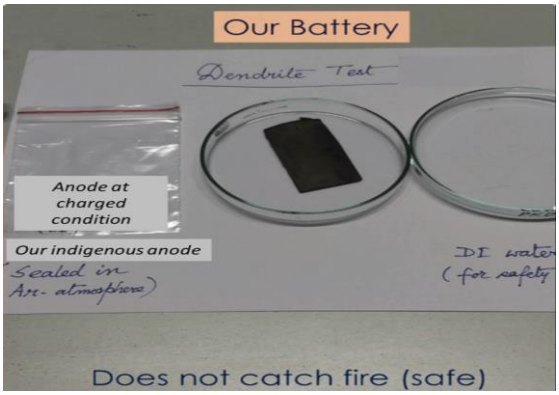
These batteries translates into a potential weight and volume reduction of about 15-20% and 10-15%, respectively. This material is synthesized at a much lower temperature (500 °C) as compared to graphite (3000 °C), which makes it less energy-intensive or greener as compared to graphite. With this new material, lithium ion and lithium polymer batteries can be made available at 10-15% cheaper price compared to a commercial one. Due to fast charging features these batteries are widely applicable to mobile phones, tablets, laptops, electric vehicles, grid storage, telecom towers, drones (defence applications) and many more.

In an interesting experiment, the superiority of synthesized material was compared with commercial batteries, by opening fully charging the batteries and collecting the electrode materials, which were then exposed to air at the same time. The charged commercial battery electrode would have lithium stored in the electrode, which combusted on exposure to air, within 25 seconds. However, the in-house material remain stable, no warming or dendrite formation was observed even after 6 minutes of air exposure. The material therefore stores lithium in a different, non-combustible form. This experiment also creates a new standard of tests for the 'ultra-safety' of a battery.

The ultra-safe battery program at IITB under the direction of Prof. Sagar Mitra has been demonstrated several times in technological exhibitions. awarded the first prize among 300+ participants in the Academia Industry Training (AIT) program, jointly organized by the Govt. of India and the Govt. of Switzerland. The ultra-safe technology involving material preparation is filed as an Indian patent.



Effect on commercial battery



Effect on indigenous battery

Name of the student:
Dr. Prasit Kumar Datta
(Thesis defended, August 2020)
Founder CTO, Virya Batteries Pvt. Ltd.

Name of the supervisor:
Prof. Sagar Mitra

Title of the project:
Development of anode material for sodium ion battery

For further information on the related research, please contact: Dr. Prasit Kumar Datta (prasit.dutta@gmail.com)

This research story is compiled by Aditya Chalishazar and Garima Chaturvedi with inputs from research scholar.

Tailoring Metal Oxides for Enhanced Energy Storage

By Alhad Parashtekar, PhD student, IITB-Monash

Properties of the materials are influenced by underlying arrangement of atoms and the composition of constituent elements. It is surprising that tip of pencil and diamond contain carbon yet exist in forms due to difference in atomic arrangement. On the other hand, addition of 1 atom of Phosphorous / Aluminium per 1 million atoms of Silicon changes the conductivity of Silicon. This lead to the electronic revolution of our generation .

The relation between structure, composition and properties is widely explored which helps in tuning the material for various applications. Similar effects are studied by Alhad for a class of material known as metal oxide. The question of interest is what will happen to internal arrangement of the atoms on adding small amount of other elements to these materials. The investigation of this question requires both theoretical approach (to understand why the things are happening) and experimental approach (to understand how things are happening).

The methods for research have been laid out from the works of eminent scientists like Dr Kirchheim, Dr Shuch. They have worked on the metals proposed a successful mathematical model. Similar phenomenon is also observed in ceramics. The change in the concentration of constituent elements affects salient properties (creep resistance, electrical conductivity, energy storage capacity) of ceramics and also alters the grain boundary concentration. The research in this particular area has not advanced as much as it has in metals. Therefore, this particular class of materials is chosen for its importance and the opportunity for research.

The study is based on Nickel Oxide. Apart from a broad spectrum of its applications, the Nickel Oxide shares common feature such as non-stoichiometry with most of the metal oxides. Hence, it is easier to predict the properties of the material. Using various experimental techniques, the material is characterized to analyse the internal arrangement. The key question to investigate is the effect on defects for a given composition. To study the behaviour, material is synthesized by varying some parameters like temperature and concentration of the other chemicals. Then grain boundary concentration and other properties are measured. The results are studied to look for a particular relation between the chemical composition, grain boundary concentration and other properties. Once the relation is found out, it is then linked to underline atomic arrangement through experiments and mathematical models. The understanding of effects of synthesis conditions on atomic arrangements can be used to tailor-made the materials to the requirements of the targeted energy storage device.

Name of the student:
Mr. Alhad Parashtekar

Name of the supervisor:
Prof. Sankara Sarma V Tatiparti

Title of the project:
Nanostructure stabilization in energy materials

For further information about this work, contact:
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This research story is compiled by Aditya Chalishazar and Garima Chaturvedi with inputs from research scholar.

The Chemistry of Slopes

By *Anirban Nanda, PhD student*

Nothing can come close to a sad story when it is a matter of people's hearts. No matter how frequently we glorify happiness, we know too well how much we respect (and fear) the tragic. And unutilized youth is the greatest tragedy of all. This is me, lying on the ground in front of Hostel 14; frozen for 87 days, 5 hours and 16 minutes. And counting. I used to travel the campus, getting wet in the sweet, cool drizzle, taking in all the petrichor I can. The monsoon has arrived again, and I can feel in my bones that this is going to be the end of me.

I miss him, his smile and the soft whistle he used to make when I came speeding down the slope from Main Building till New SAC. Even for a few seconds, it made him fly. Not only him, I too, unpedalled, rolled down in joy, my bell clinking, overtaking the e-shuttle with pride. Initially, before me, he could do nothing but walk in the humid sun, not bothering to fight for an auto during the rush hours of the morning and after-lunch classes. He'd plug in his earphones tight and punch up the volume a notch and walk solemnly; his forehead creased with irritation, eyes down on his feet, and fists shut close in his pockets. I can clearly remember the day he bought me (He shouted, 'The blue one! The blue one!', to the bicycle shop-owner). The relief on his face was something to behold. He'd not open the plastic coverings on me for weeks. His appreciation for me showed in the way he took care of me: weekly cleaning and oiling, remembering to park me under the shade every time, making sure there was enough air in the tyres. He loved riding me. Be it daunting crowds or challenging uphill, he'd maneuver the gears deftly and buzz past, often taking people by surprise.

Just a few weeks before he had left, something beautiful happened. The mid-semester exam was over, and as it were, with a happy glow, he was riding back to his room. He almost crashed into another bicycle near Brews N Bites. My tight brakes came in handy as he stopped inches away from the person who was trying to fix the chain of the bike. He was embarrassed beyond measure and started apologizing to the girl who looked scared and angry at the same time. He came down from his bike and said, 'I am so very sorry. The truck was blocking me, and I didn't see you.' With such repeated explanations and apologies, the girl calmed down a bit. He asked her if she needed any help even though just by looking at her bike, it was apparent what was the problem. With little hesitation, she asked him if he could help her take the bike to the repair shop near Hostel 4. He didn't answer and sat down to fix the chain. His experiences with me made it easy for him to get the chain on the rear gear, and the bike was ready in no time. The girl was visibly impressed. She asked him if he'd like to have a cup of coffee if he was not too busy. Of course, he wasn't.

They started hanging out after that day. I too liked to stand and look at the girl's black bike. It was strange. I had it in me to develop romantic feelings for some other bike. But gradually, without me noticing it, I started looking forward to their meetings which meant I got to see her bike again. I loved the boathouse of all places. The quiet, the lush greenery inspired me to talk to her bike. We discussed normal bike-things. Everything was going so well. But as fate would have it, all the students were asked to vacate the hostels

because of you-know-too-well. He had to pack everything quickly and take the first flight the next day. The hours went into a daze.

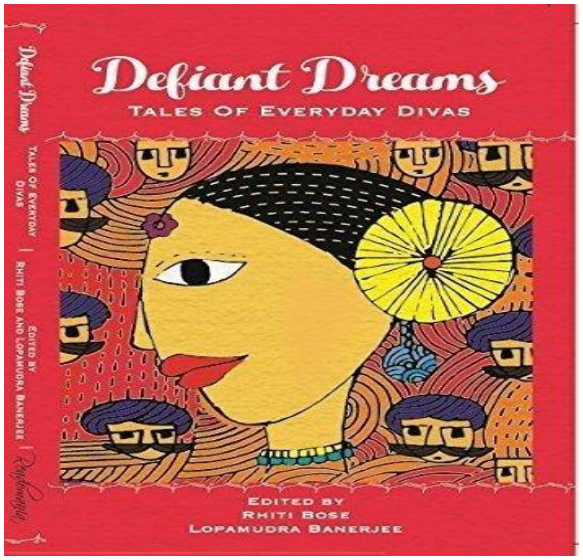
It somehow slipped from his mind that I had not been parked in the shade. From that day, I have been standing here by the mess area and counting hours. With the humid weather here and now rain coming on, I have started catching rusts on parts of my body. I feel weak in my bones.

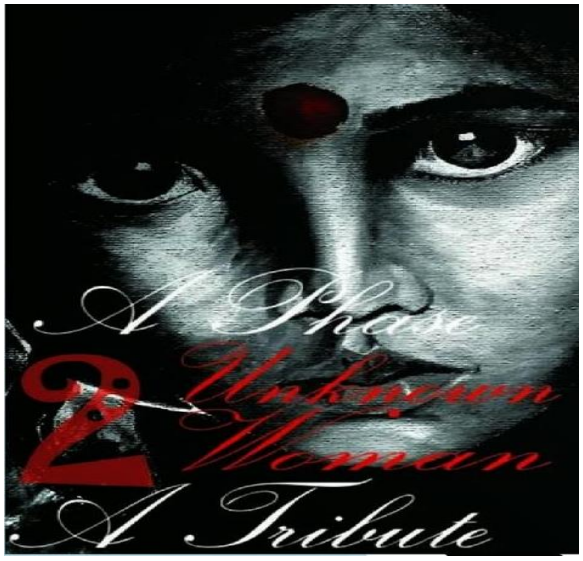
I fear my youth is not being utilized to its full potential. I am the protagonist of a banal tragedy. But there is still one thing to cling on to. Hope. I hope I'll get to see him again. I hope that it'll be soon. I hope I'll again be able to roam around the campus freely. I hope to see them meet after a long time with happiness and disbelief in their eyes. I hope I'll stand by her bike. I hope life will be normal again. I hope...

THE END.

For more information on Anirban's anthology work,
Contact : anirban.igp@gmail.com

You can also follow his blogpost "Alphabet Speaks" at https://anirbanigp.wordpress.com/





A Learner's Perspective

By Prof. Manaswita Bose

We are going through an unprecedented phase of life. Proverb like "there's many a slip 'twixt the cup and the lip" was, perhaps never realized so well, ever before! The life that we had been used to, was changed. We learnt new skills, enjoyed something that we overlooked before, realized the importance of certain aspects that we brushed aside earlier. Mornings started on different notes each day. On one such morning, compiled some scattered thoughts on "learning"!

A Learner's Perspective

Tough times in life leave us with two options:
(i) be the prisoner of the situation
(ii) be the driver of one's own life.
The choice is ours.
It is extremely difficult to concentrate on "studies" when the mind is preoccupied with agony, uncertainty, and anxiety; however, "learning" never ceases.
"Learning" is a continuous, enjoyable process, free from exams, marks, and grades!
"Learning" is seeking the answer to a question, doesn't matter if millions of people have answered it before me! The pleasure that I get in exploring the unknown, is the joy of learning.
"Learning" is solving a problem, perhaps an easy one for hundreds out there! The feeling that I have, of overcoming a difficulty, is the joy of learning, that's my own happiness!
"Learning" is making mistakes, laughing at those mistakes, not repeating the same but making new mistakes!
"Learning" is taking a deep breath and searching within!
"Learning" is being active, pursuing my own dreams, trying to be a better me today than what I was yesterday!
So Happy Learning! Let the external perturbations help me learn to become a calm person!

A learner, forever!

Bliss is the love you receive

By Shreya Sharma ,MSc-PhD student

Bliss is the love you receive,
Each time you get deceived by yourself.

Love from those who believe in you,
Becomes the key for hard work you do.

Belief which makes you smile in pain,
You learn to stand despite falling again, and again.

Smile makes you look beautiful,
It tells that you are most precious for you.

Beautiful is the world you live in,
Each day is the chance to nourish and grow.

World becomes bliss for those,
who have faith in dreams they chose.
Bliss is the love you receive.

Venture

By Stuti, MSc-PhD student

Here it goes,
The journey to the unpredictable time
And to those claiming
creation as predestined

Questioning your weapons
Meant for filthy fight
How come you win battles,
Not yet defined?

Here we are living lives so confined
As if the ones who commit crimes

Yet a hope, a ray of light
Freeing those till now blind

When will we narrate this hindsight
To the little unknowns still
comprehending life

Painting the Sun with Photography

By Prof. Chetan Singh Solanki

This photo of the sun was captured by keeping the sun out of focus as a result gives an illusion of a painting.

Perception

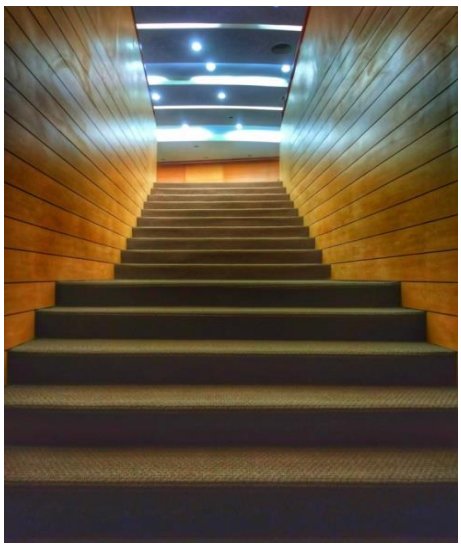
By Chinmay Wasnik, MTech

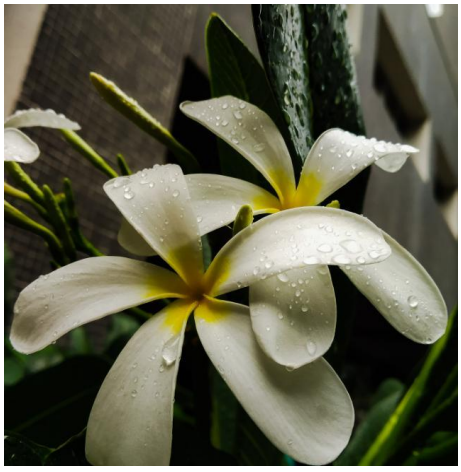
Tallest and grandest

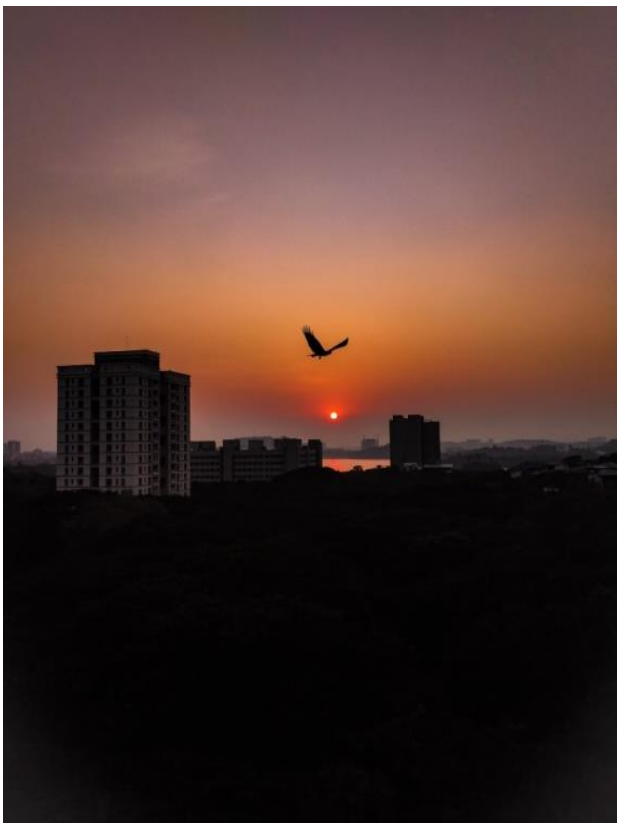
By Harshal, PhD student

Campus Grandeur

By Hemant Suthar, DESE Staff







Editor's Corner

Dear Readers,

We are glad to release the second issue of the department newsletter, ENsider. This aims to give you a glimpse of the activities at DESE. We appreciate our alumna Dr. Devika Choudhury who took out some time from her busy schedule for the interview. We acknowledge the efforts of our staff and the students for showcasing their creative skills in lockdown period which have been published in this issue featuring as "Lockdown Diaries". We welcome your feedback on this issue and the ideas for the next.

Stay safe and enjoy reading!
Garima Chaturvedi

The ENsider Team

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