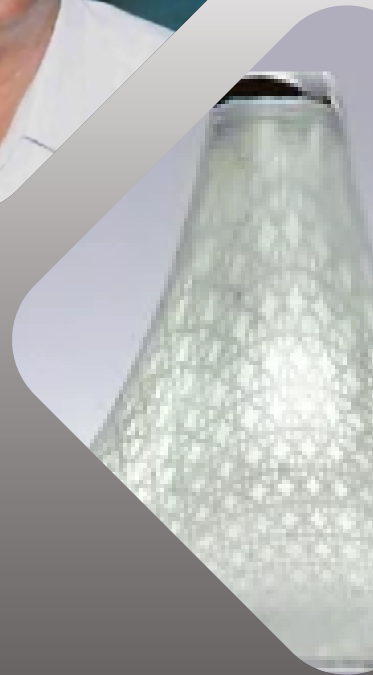
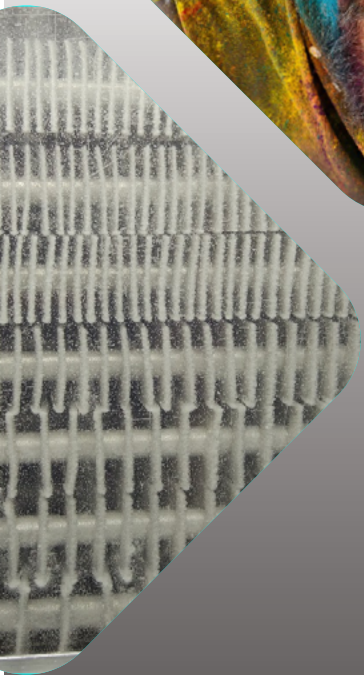




DEPARTMENT OF MECHANICAL ENGINEERING NEWSLETTER



June 2020 Edition



INSIDE THIS EDITION

MESSAGE FROM HOD

METAL FORMING
LABORATORY

LEARNING IN THE TIMES
OF A PANDEMIC

COOL AND EFFICIENT

BRINGING THE WORLD
TO THE DEPARTMENT

DOWN MEMORY LANE

FACULTY ACHIEVEMENT

DISTINGUISHED SERVICE
AWARDS-2020

DEPARTMENT IN
NUMBERS

यांत्रिकी अभियांत्रिकी विभाग

MECHANICAL ENGINEERING DEPARTMENT



We started the year with the visits of our alumni to the department during the 17th Alumni Meet and the golden jubilee reunion of the 1970 batch in the month of January. We also had the honour of hosting some of our distinguished alumni during that meet. The secretary of Ministry of Human Resource Development, Government of India, Shri. Amit Khare, visited us early in the year and we were able to showcase some of our research achievements. After a good start to the academic session, the COVID-19 pandemic hit us a little after the mid semester exams leading to an Institute lockdown and cancellation of many scheduled activities including Research Scholar's day, visits and talks by invited guests etc.

However, the pandemic failed to disrupt our academic activities, since we adapted to online mode of teaching to complete rest of the academic session with help of many of our past e-resources developed by the faculty like NPTEL lectures, SWAYAM courses and Virtual Laboratories, as well as improvised teaching through video conferencing systems. I must appreciate the efforts of all the faculty members of the department and the students as well, in the way they rose to the challenge and adapted themselves. Perhaps with the present situation, this may be the new normal for the future, and I am confident that we as a department are well prepared and equipped to handle any online teaching requirements in the future. Apart from courses, our faculty members also conducted online vivas including Ph.D. defenses, project evaluations and summer internships for the students, all in virtual mode. The COVID-19 also gave us another new avenue for research, and I am glad to report that on a war footing many of our faculty members are doing projects as a national demand, rising up to the occasion on equipment, testing, sanitization etc. During the lockdown faculty members from our department along with their staff and students have also developed prototype sanitization tunnels, road sweeping and sanitization machines to be used by the institute. And with our experience, I am sure we can face any such challenge in the future.

As usual we try to bring to you through this newsletter some stories from our department. We have added a new section called the "Department in numbers" to present some important statistics to show where we stand. We have aggressively started to recruit faculty members and hopefully in our next newsletter, I should be able to bring some details on the same.

Wishing each one of you a good health and safe stay.

Prof. Amiya R. Mohanty
Professor & Head of the Department

METAL FORMING LABORATORY



The Metal Forming Laboratory of the Department of Mechanical Engineering focuses on imparting the latest scientific knowledge and skills to a large number of UG, PG and PhD students through laboratory scale experimental research, theoretical modeling and virtual try-outs. Currently, Dr. Sushanta Kumar Panda is in charge of the Metal Forming Laboratory, and his specialization is in manufacturing processes, metal forming, mechanical metallurgy, formability and microstructure characterizations, metal plasticity and FE analysis. Under his leadership, the Metal Forming Research Group is engaged in fundamental and applied research on several different aspects of metal forming processes to improve the understanding of formability of light-weight materials with an objective of manufacturing precise and defect-free components.

Currently, 10 PhD students are working on different aspects of metal forming processes, and some of the ongoing research activities are forming limit diagram and development of formability process maps, tailor welded blanks, warm forming, hot forming, single point incremental forming, micro-forming and prediction of necking, fracture and earring defects. The major facilities in the laboratory are 100 ton double action hydraulic press, 20 ton single action hydraulic press, 50 kN hot forming machine, CNC controlled single point incremental forming machine, different laboratory scale tools and fixtures for limiting dome height, limiting drawing ratio, hole expansion ratio and springback tests, circular grid marking and strain measurement facility. The Metal Forming Laboratory has successfully finished sponsored and consultancy projects from different funding agencies like DST India, ISRO, BRNS, UKIERI, Tata Steel and is also actively engaged in research collaborations with WMG University of Warwick UK, Coventry University UK, King's College London UK, Seoul National University South Korea, University of Waterloo Canada, Autonomous University of Zacatecas Mexico and many premier institutes in India. In order to enhance laboratory practical skills, the short term courses have been conducted for students of other academic/sister institutions. Two specific research highlights from the Metal Forming Laboratory are presented here.

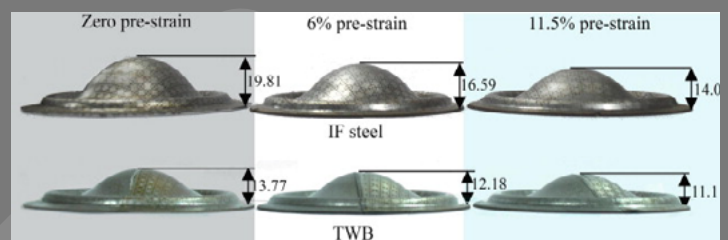
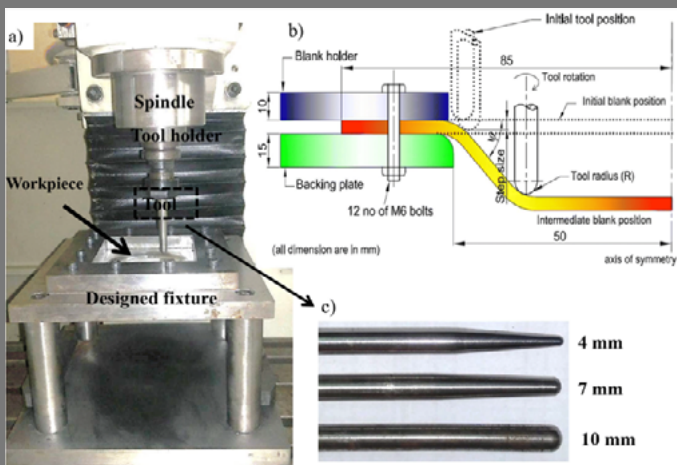


Fig. 1 CNC controlled single point incremental forming (SPIF) set-up and deformed specimens

The research group is continuously developing formability process maps of interstitial free steels, advanced high strength steels, stainless steels, aluminum alloys, Cu-alloys, IN718, sandwich panels and tailor welded blanks. The automotive industries are now pushing for implementation of near-net shape manufacturing technologies namely hot stamping of UHSSs, hydroforming of light weight tubes and high strain rate impulse forming of low formable aluminum alloys to address improvement in vehicle safety and reduction in fuel consumption. The Metal Forming Research Group is continuously thriving to enhance its state-of-art research facilities and looking for future opportunities to develop process maps for production of successful defect free components through the above forming technologies.

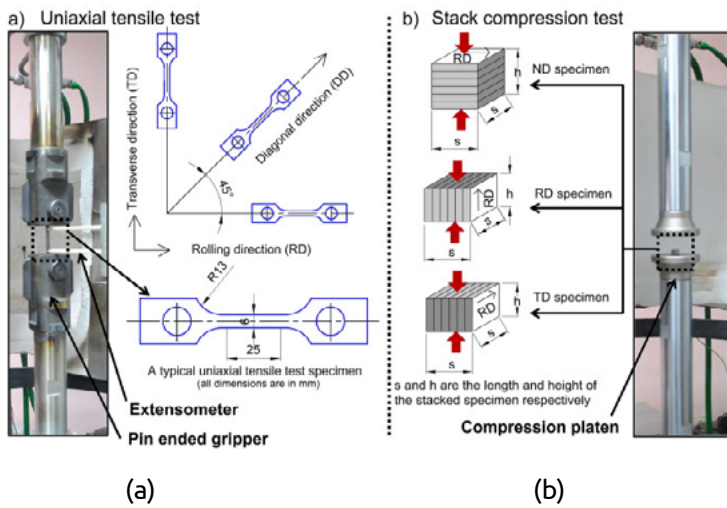


Fig. 2 Experimental setup for (a) uniaxial tensile tests and (b) stack compression tests with the schematic diagram of different samples used.

stretch forming and single point incremental forming process case studies. Experimental set-up and few deformed samples are shown in Fig. 1. In another study, the formability of CP Ti sheet material has been experimentally investigated in terms of limiting drawing ratio, thickness distribution and earring defect. Tensile and stack compression tests are conducted along different directions with respect to rolling direction to characterize the anisotropic properties as shown in Fig. 2, and these data have been used to develop CPB06 constitutive model. This developed constitutive model has been implemented in conjunction with Swift hardening law in the FE model to predict the earring defect successfully, and the non-uniform material flow into the die cavity has been identified and studied in depth (Fig. 3). Moreover, a two-stage initial blank modification technique has been proposed to reduce earring defect and scarp.

Auto-bodies are mostly manufactured through multi-stage stamping operations, and in each stage the strain path changes due to the change in material flow pattern over the punch and die surface. Also, the manufactured thin structures experience different plane stress state under operational and accidental conditions. Hence, the anisotropic yield surface and the localized necking and fracture strains of different equi-biaxial, plane strain and uniaxial pre-stained sheet materials have been extensively characterized in the Metal Forming Laboratory. All the failure strains have been theoretically predicted using Marciniak–Kuczynski (MK) and Bao–Wierzbicki (BW) model and further transposed into polar effective plastic strain locus using different advanced anisotropy yield theories. The robustness and predictive accuracy of the use of polar effective plastic strain based limits for failure prediction have been successfully demonstrated through deep drawing,

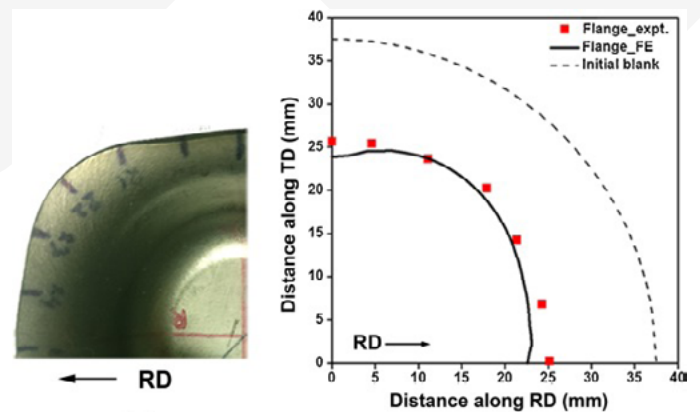


Fig. 3 Top view of partially deep drawn cup of CP Ti sheet materials showing non-uniform flow of material and comparison of experimental and FE predicted flange profile.

LEARNING IN THE TIMES OF A PANDEMIC...



Sometime in the middle of March 2020, the Department received a notice about the immediate suspension of all academic activities. This meant that the Department had to make contingency plans for completing the planned educational activities. In a giant Department like ours, with over thousand students and about hundred courses running parallel; this was a massive ask. However, the indomitable spirit of the Department meant that we took the challenge head-on.

Course lectures were delivered through a variety of methods like zoom meetings, skype, google meet, WebEx, posting videos on YouTube or relying on NPTEL lectures delivered by the faculty previously. For some PG level courses with small class size, reading material was sent by email followed by an in-depth discussion via online meetings.

Exams and assessments are critical towards maintaining the academic standards which we have come to expect and are duty-bound to protect. Even though the end-semester exams were cancelled, there was still some assessment which had to be undertaken. Conducting a fair exam with students outside of the campus proved to be a significant challenge. We wanted to prevent cheating but also keep in mind that some students would not have access to decent internet connectivity. Objective type exams through online mediums such as google form was the most popular form of assessment. However, doubts lingered over the fairness of the system, one of the first faculty who undertook his test in this format confided that the extremely high number of students with full marks was suspicious and seemed unusual. Learning from his experiences, we refined the process including but not limited to randomly ordered questions with parametric numerical values; highly time-constrained exams etc.

While we continue to evolve and improve the system, there have been few hiccups. A couple of faculty member described how for the supplementary exam they decided to have an online exam involving objective questions. For enforcement of no cheating, all the students were mandated to appear online in Zoom meeting to have some “virtual invigilation”. Everything seemed to be going well, and the two faculty started to discuss some matter through “private message” feature in Zoom. Suddenly, it dawned upon them that if the two of them could communicate through private messaging in Zoom, so could the rest of the students. In the name of “virtual invigilation” they had unwittingly provided a platform for the students to interact and discuss the answers!

One crucial component of learning at the Department is hands-on projects within the scope of different theses. The plans for the bachelor and master thesis had to be changed due to lack of access to the labs. The pending experiments in the lab had to be replaced by modelling and theoretical activities with weekly online meetings. The students rose to the challenge and completed their projects and reports satisfactorily. For the assessment of the bachelor thesis projects, the students were instructed to record their presentations in the form of slide-shows with commentary, which was followed by online interaction with a panel. The process was well received by the students and faculty alike. We have prior experience in holding online PhD seminars/defences and thus were able to schedule the registration, extension and final seminars of the PhD students in a timely manner.

The last couple of months have been a steep learning curve for the faculty as we faced unique challenges. The pandemic has undoubtedly accelerated our embrace of technological tools as we continue on our never-ending pursuit of delivering high-quality learning experience for our students.



Aaditya Saikiran Pegallapati is a PhD. student in his fifth year working on frost formation over domestic refrigerator evaporators. Refrigerators are ubiquitous with millions of units sold in India every year, and improving their energy efficiency could result in substantial likely energy savings. Many frost-free domestic refrigerators use electrical heaters to remove the frost formed over them at regular intervals, which consumes additional energy. Aaditya's research focuses on understanding the factors influencing the frost formation, developing mathematical models, and recommending design modifications to improve efficiency.

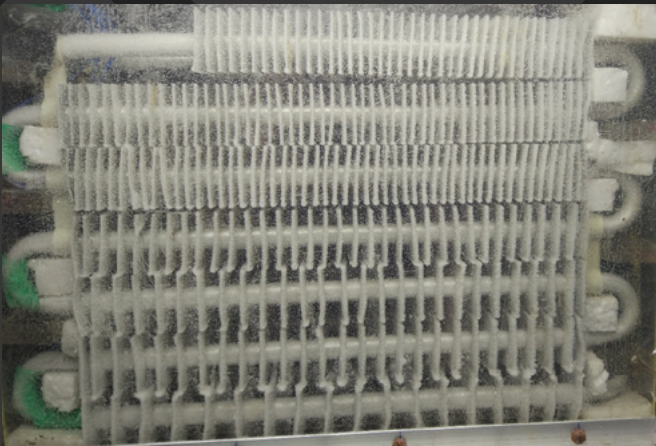


Fig. 1 Frost formation on evaporator of refrigerator

Aaditya joined the Department in 2016. He finished his Dual Degree with a BTech in Mechanical Engineering with MTech specialization in Thermal Science and Engineering from the department. After completing his graduate studies, he worked in an engineering design firm for three years, where he was involved in designing the material handling systems and associated utility systems of thermal power plants. Aaditya's research interests focus on refrigeration, and a dedicated Refrigeration and Air conditioning lab in the Department has been pivotal in significantly improving his theoretical and practical knowledge of the subject. Aaditya credits his experience gained and progress so far to the continuous support and inspiration from his supervisor Prof. Ramgopal Maddali.

Aaditya has developed an experimental test facility to study the frost formation on the evaporator. He has also developed dynamic models of frosting and vapor compression refrigeration systems using Modelica language. His work shows that by suitably distributing the fins on the evaporator, the defrost cycle times can be improved, leading to less energy consumption.

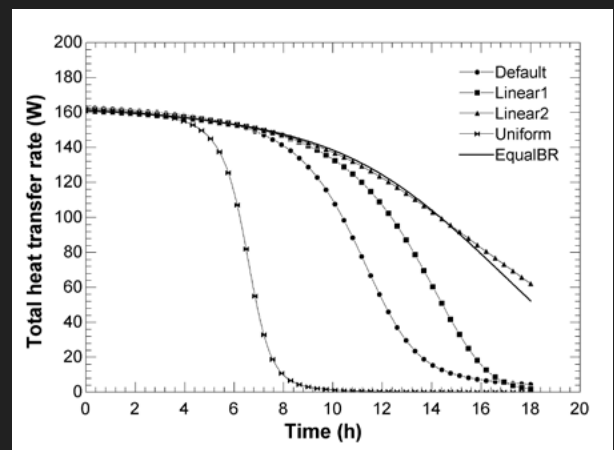


Fig. 2 Reduction in heat transfer rate for different fin arrangements

BRINGING THE WORLD TO THE DEPARTMENT – International scholars and their experiences



As IIT Kharagpur aims to establish itself from a Higher Education institution of national importance to one of global eminence, internationalization forms one of our major imperatives. Over the last 4 years the Institute has invested significant resources in setting up its internationalization program through its Office of International Relations (OIR) that aims to attract students and faculty members from across the world. Here too, the Mechanical Engineering Department has led the way hosting as many as 8 students and scholars from different countries in the last one year alone.

Dr. Olivier Bochet was born in France and spent most of his life in city of Rennes including his PhD from Rennes Geosciences laboratory. During his doctoral work involving reactive transport in porous media, he met Dr. Aditya Bandopadhyay who was doing a post-doctoral stint in the same group. The two struck a close friendship and on completion of his Ph.D., Aditya offered him to come to IIT Kharagpur as a spot doctoral fellow. *"I was excited to work with Aditya and to discover India, whose culture had always attracted me. So I decided to come here."*



Olivier Bochet enjoying Holi on campus

Adeoti Oladapo as working was a Condition Monitoring Engineer with Dangote cement PLC in Nigeria. While surfing the internet in search of training materials on condition monitoring, he stumbled on Prof. A. R. Mohanty's lectures on machinery fault diagnostics and signal processing. The rich content of the lectures motivated him to apply for study leave and pursue an M.Tech. at IIT Kharagpur in Prof. Mohanty's research group.



Oladapo Adeoti

While Olivier and Oladapo are here as full time scholars, the department hosted several visiting students in the recent past. Taleya Ouellet and Kiran Edwardson came to IIT Kharagpur from University of Waterloo, Canada in Jan 2019 for 4-months under the IITKGP and WIN-MITACS program. While Taleya worked under the mentorship of Prof. Vikranth Racherla on a project related to affordable water filtration, Kiran was attached to the Microfluidics lab led by Prof. Suman Chakraborty.

Around the same time, the department also hosted Tom Andre Bredesen, Erling Vingelsgard and Benjamin Espedalen from the Norwegian University of Science and Technology (NTNU). The three students worked on their Masters projects

under the joint supervision of our professors in the field of refrigeration and air conditioning. Tom and Erling worked with Profs. M. Ramgopal and Sourav Mitra respectively, while Benjamin was supervised jointly by Profs. P. K. Das and Anandaroop Bhattacharya.

"I think that fellow students are very sharp, making it a very different learning experience. Professors are passionate and are very helpful, their research is backed by very sound knowledge and good planning. I rate the academics here to be of very high quality" opined Benjamin. Tom agreed and added *"I am surprised by the amount of talent in the community around me"*.

Muhammed Lawan Jibril came from Nigeria as a short term research visitor to complete his Ph.D. research on fuzzy rule driven datamining framework. He worked in the Soft Computing Lab of the department under the mentorship of Prof. D. K. Pratihari. He fondly recollects his academic experience as well as his stay in the campus and calls it his best experience ever -

"IIT Kharagpur is a center of research excellence, peace, breakthrough innovation, creativity and hospitality. As someone who never been to in India, talk less of Kolkata or Kharagpur, I was treated like newborn baby throughout my stay at Institute." The students were unanimous in their appreciation for the hospitality extended to them by their supervisors and faculty members of the department as well as the student community.



Erling Vingelsgård

Apart from academics, the natural beauty of the campus along with the rich and vibrant campus life, seemed to leave an everlasting impression on the minds of these students. *"I love the beauty of the campus. So vivid, so huge. I really am proud to choose IIT Kharagpur, for exchange"* Taleya could not seem to stop praising. Kiran too joined in *"Oh! What an experience this exchange is. Kharagpur is just amazing. The beautiful green campus, the never seen before landscapes, the perfect weather, the chirping birds, just wow. I am overjoyed with the extra academic life"*. *"Just bought some tennis equipment and started playing. I am more into sports and IIT KGP has provided me with all the prerequisites."* added Erling, the sports enthusiast. Olivier rekindled his old passion for football and

soon became a key member of the IIT Kharagpur soccer team that won the Inter-IIT gold in 2019. Spring Fest, Kshitij, Holi, Durga Puja, Diwali and Illumination Contest ... the festive celebrations provided a rich and unique cultural experience.

Prof. A.R. Mohanty the Head of the Department said *"This is really like world without borders, where there is a free flow and exchange of ideas amongst us and our international scholars, where apart from academics we have cultural exchanges too. I recall few researchers also visited us in the department and stayed with us for short periods from Australia, Ecuador, France, Sweden and the United States in the recent past just by browsing about us in the web. Today the internet has brought us all so close, and now again in the Covid era, world without borders has a new meaning altogether. As we go to press with this newsletter, I understand that there are several applications from international students to join our research programme."* *"Having students and faculty members on our campus from different corners of the world leads to cross pollination of ideas among cross-cultural teams leading to mutual academic enrichment. I am really proud of the way the ME Dept. has embraced this mission"* added Anandaroop Bhattacharya, Associate Dean of International Relations and a faculty member of the department.



Taleya Ouellet



Muhammad Lawan Jibril



IN CONVERSATION WITH PROF. A.B. CHATTOPADHYAY

"Hello! Aami Prof. Chattopadhyay bolchi (this is Prof. Chattopadhyay)" - the familiar voice greeted me over the phone - the same crystal clear voice from more than 25 years back that used to keep the class of 60 odd students mesmerized. In a moment, my mind was flooded with memories as I recollected the lectures and interactions of our batch with one of the towering figures of the department during our student days.



Prof. A.B. Chattopadhyay or ABC as students used to call him, joined the Mechanical Engineering Department at IIT Kharagpur in 1980 after serving as a member of faculty in Jadavpur University (JU) for 14 years. Over the next 28 years till his retirement in 2008, he established himself as one of the foremost academics in the field of manufacturing sciences in the country and one of the best teachers, the department has seen to this date. During the course of his illustrious career he taught many courses and electives at the UG and PG levels in the manufacturing domain, that included the core course on "Machine Tools and Metal Cutting" for 2nd year undergraduates which he taught for more than 20 years, and the elective on "Quantitative Production Methods" that went on to become very popular.

"Teaching was my passion, you know. I taught students from several streams - Mechanical, Manufacturing, Metallurgical Engineering, Materials Science and many other departments," his voice clearly giving away the affection that he still feels for his students. I recall and remind him of his impeccable drawing skills that used to leave us spellbound, especially the way he could draw complex machines on the chalkboard. He immediately responds, "It's a skill I picked up from teachers - Prof. Gopal C. Sen and Prof. Amitabh Bhattacharya in JU."

He vividly recounts his interactions with students as a teacher and supervisor. "Anando, let me tell you. While it is often said that teachers make students, I would say that STUDENTS MAKE TEACHERS. I consider myself fortunate that I got to teach the best and the brightest students of the country. They brought out the best in me. I am indebted to my students."

How does he feel about his students carrying on his legacy in the Institute? Prof. ABC becomes passionate once again. He fondly remembers his former students Prof. Soumitra Paul, Prof. Asimava Roy Chowdhury, Prof. P.P. Bandopadhyay and many others who are all faculty members of the department today. "Even Ajoy (Prof. A.K. Chattopadhyay, who retired in 2017) was my student. He was more like my friend but he was my first Ph.D. student in Jadavpur". He reminds me that Profs Anirvan Dasgupta, Kingshook Bhattacharya, Goutam Chakraborty, Jeevanjyoti Chakraborty and many others (including me) are all his former students. Over the course of his career, he had supervised around 120 B.Tech. students and 150 M.Tech. students on their projects. "Students used to like working with me since they got a chance to work on hands-on projects," he adds.

As we approach the end of our conversation I asked him about his feelings as he looks back on his career here. His voice exudes pride as he says "IIT Kharagpur was my dream. The institute made me what I am. As I look back, I have only good things to say about the institute. I do not have any grievances or complains whatsoever."

So which was more satisfying - the stint at JU or IIT Kharagpur? I try to provoke him. "Both. JU established me as an academic but I was still a Bengali. IIT made me an Indian," he signs off in vintage ABC style.

In conversation with Prof. Anandaroop Bhattacharya

MEMORIES REVISITED WITH MR. BIMAL KARMAKAR

Mr. Bimal Karmakar joined the Mechanical Engineering Department in 1991 when Professor B. C. Majumdar was the Head. He was initially part of the cleaning and maintenance staff but, through his own initiative, transitioned to a position of greater responsibility in the Department office. His duties included getting photocopies done; ensuring that files get transferred from the Department to various Institute sections; overseeing the younger staff responsible for cleaning and maintenance; and helping out the store manager (Mr Jana) in various dispatches.



Any faculty, past and present, will attest to the crucial need of a responsible person who is in charge of the above duties, and Mr. Karmakar was thoroughly relied upon. In fact, many a time, it happened that he had to leave his lunch mid-way to deliver a particularly urgent file! On other occasions, when asked to come to the Department early, he would offer to come even earlier! In addition to his duties, Mr. Karmakar was an integral part of any departmental function, including the yearly Vishwakarma Puja celebrations which he would oversee from planning stage to final formalities.

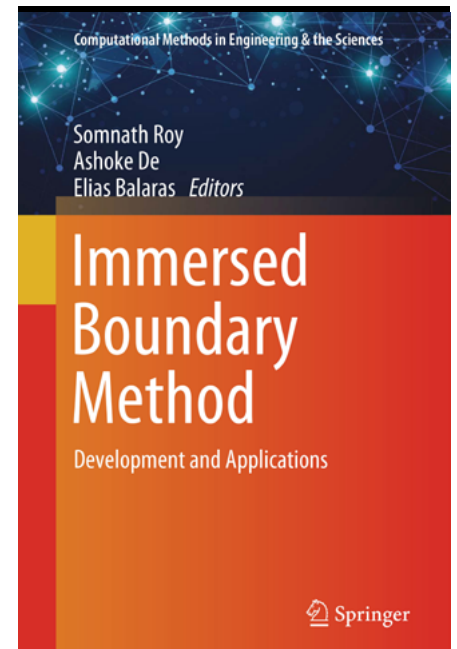
Mr. Karmakar fondly remembers his interactions with all the faculty members and the heads under whom he worked in the department – especially, Professors Amalendu Mukherjee, A. B. Chattopadhyay, A. K. Chattopadhyay, P. K. Nag, P. K. Das, S. K. Som and many others – all of whom treated him very kindly. He particularly remembers an incident where there was some issue in releasing his yearly increment wherein the then Head, Professor M. A. Faruqi personally intervened to help him out.

After 25 years of dedicated service, Mr. Karmakar retired in 2016, and now lives with his family in the Inda area of Kharagpur town. On being asked whether he misses the Department, he immediately replied that if asked, he is ready to rush to the department anytime for any help that he can extend! The ME Department also fondly remembers their dear Bimal-da and misses him dearly.

FACULTY ACHIEVEMENT



Dr. Somnath Roy, Associate Professor of Mechanical Engineering published an edited book titled “Immersed Boundary Method-Development and Applications”. Co-edited with Prof. Elias Balaras of George Washington University and Dr. Ashoke Dey of IIT Kanpur, the book is a valuable compilation of important topics in the field of immersed boundary (IB) methods in the area of computational mechanics.



Dr. Anandaroop Bhattacharya, Associate Professor of Mechanical Engineering and Associate Dean, International Relations received the Fulbright-Nehru International Education Administrators Seminar (FN-IEAS) Fellowship for 2020-21, administered by the United States-India Educational Foundation (USIEF). Dr. Bhattacharya was also awarded the Shastri Mobility Programme (SMP) Award administered by Shastri Indo-Canadian Institute (SICI) for a visiting scholar program to McMaster University, Canada.

DISTINGUISHED SERVICE AWARDS – 2020



The Mechanical Engineering Department is proud to feature four of its eminent alumni who were conferred with the prestigious Distinguished Service Awards by IIT Kharagpur in Jan 2020 in recognition of their outstanding services to the Institute.



SHYAMAL GHOSH [1960/BTech/ME/RP]

Mr Shyamal Ghosh pursued a career in mechanical engineering for 30 years in the field of Material Handling Machine Design. Thereafter, he joined American Express and owned a very successful financial planning business for 22 years. Mr. Ghosh set up endowment for 4 student scholarships and the Shyamal and Sunanda Ghosh Chair Professorship in Mechanical Engineering.

KIRTTAN BIHARI BEHERA [1965/BTech/ME/NH]

Mr Kirttan B. Behera is an eminent management consultant and entrepreneur who retired in 2001 as the Chairman and CEO of Regent Jack Mfg Real Estate Co. He set up an endowment for the Kirttan B Behera best all-rounder (BAR) student award at IIT Kharagpur. Mr. Behera also played an instrumental role in setting up the Los Angeles IIT Alumni Chapter.



VIJAY KIYAWAT [1967/BTech/ME/NH]

Mr Vijay Kiyawat, who retired in 2008 after holding the position of managing director of Duraline Corporation India, is now a renowned water-colourist. He helped set up the Vijay Kiyawat Endowment Fund that provides financial support for the medical treatment of both teaching and non-teaching staff. He also contributed funds to help students of Nehru Hall and the Mechanical Engineering Department get a reading room and digital repository respectively.

BINOD KUMAR DAS [1980/BTech/ME/PH]

Mr Binod K Das is a respected figure in metal and mining sector in India and former VP, Iron Making at Tata Steel. He is closely attached to his alma mater and has been instrumental in restarting the alumni chapter in Jamshedpur. He played key role in the process safety initiative with IIT Kharagpur, enhancing partnership with industry.



DEPARTMENT IN NUMBERS



QS Rank 2020 in Mechanical, Mfg. and Aeronautical Engineering

51 - 100



Programs

B. Tech. Programs – 2 (Mechanical, Manufacturing)

Dual Degree Programs – 4

M. Tech. Specializations – 3

No. of faculty: 45

No. of Staff: 36

Post-doctoral fellows: 03

Undergraduate students: 856 (incl. 22 female)

Postgraduate students: 158 (incl. 3 female)

Ph. D. Scholars: 197 (incl. 13 female)

Personnel and student strength

Teacher – Student Ratio – 1:27



Funding

MHRD non-recurring grant: ₹ 200 Lakhs**

MHRD recurring grant: ₹ 60 Lakhs**

Sponsored research funds^: ₹ 4407 Lakhs

Consultancy projects^: ₹ 108 Lakhs

Outreach activity revenue^: ₹ 34 Lakhs

Journal Papers* (2019): 241

Patents filed: 16

Citations per faculty*: 136.8

h-index*: 71



Research Output



Faculty distinctions

Faculty with 100+ journal papers*: 6

Fellows of National Academies: 5

Chair professors: 4

Department Footprint Area: ~120000 Sq. ft.

Specialized Research Labs: 6

Instructional Labs: 20



Infrastructure

*** Annual average, *Web of Science 2019 data, ^2019 data*



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