

# MEXPRESS

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REACH US AT



Mechanical Engineering Association  
Department of Mechanical Engineering  
**KUMARAGURU COLLEGE OF TECHNOLOGY**



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## From the Editors...

*Celebrating Excellence: A Glimpse into Our Academic Journey*

Dear Readers,

Greetings to you all. It is with immense pleasure and pride that we present this edition's Editor's page, which shines a spotlight on the remarkable achievements and endeavors within our department.

Throughout the month, we have organized an array of educational programs that have not only enhanced the learning experiences of our students but have also provided a platform for intellectual exchange among our faculty and peers. Our esteemed faculty members have continued to be invaluable resources, sharing their expertise in various fields through workshops, seminars, and lectures, enriching the knowledge of students' community. The scholarly contributions of our faculty members have not gone unnoticed. Their research publications have furthered the boundaries of knowledge and earned recognition in the academic community. Our department's commitment to academic excellence is underscored by the rigorous review processes undertaken by our faculty members. Their efforts ensure that only the highest quality research makes it to publication.

We take immense pride in celebrating the accomplishments of our students and faculty. The awards they have received are a testament to their dedication and exceptional talent. Securing research grants has enabled our faculty to undertake groundbreaking studies that contribute to the advancement of their respective fields. Our faculty members have extended their expertise beyond the classroom, providing consultancy services to various industries and organizations, thus bridging the gap between academia and the practical world. Innovation knows no bounds at our department, and our students and faculty have not only come up with novel ideas but have also successfully secured patents for their innovations.

Participation in academic programs and conferences has broadened our horizons, allowing us to engage with a global network of scholars and researchers. Our students have also made their mark in the world of academia, with publications, presentations, and participation in various programs that showcase their potential and growth. A collection of snapshots that encapsulate the vibrancy and enthusiasm of campus life, reflecting the spirit of our academic community.

As we celebrate these achievements and milestones, we look forward to a future filled with even more academic excellence and innovative endeavors. Together, we continue to shape the future of education and contribute to the betterment of society. Thank you for your unwavering support and dedication to our institution. We hope you find this edition of our publication both informative and inspiring.

Best regards,

Editors....





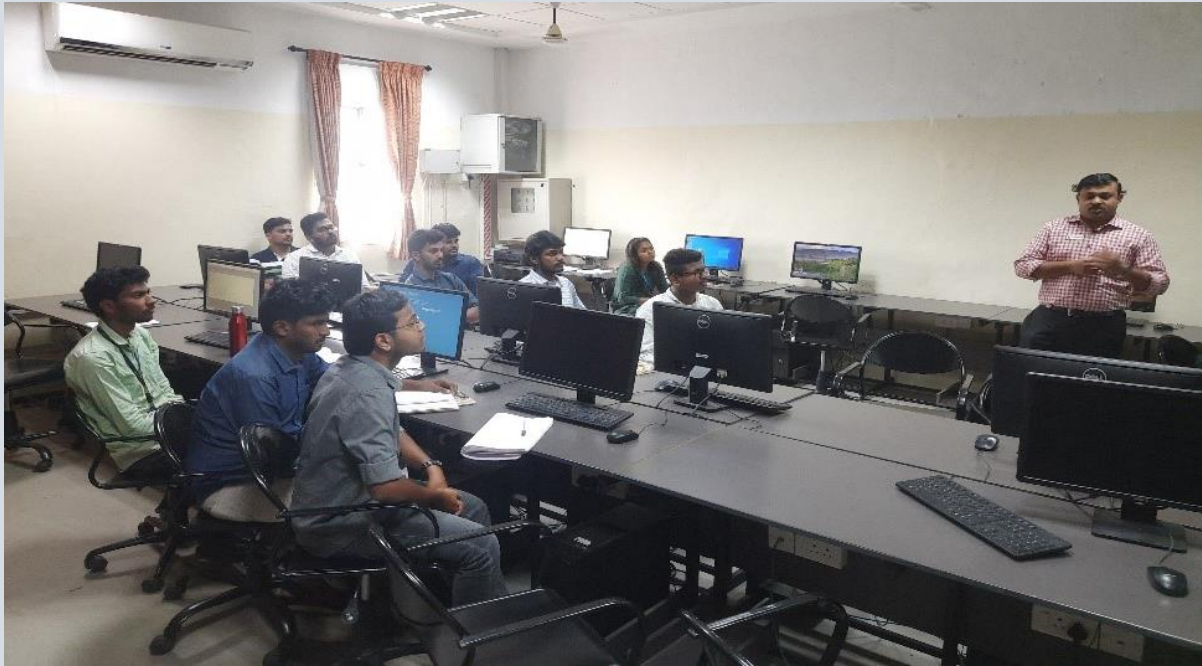
## PROGRAMMES ORGANIZED

An ANU Awareness Program “AKAM -ANU YATRA 2023” was organized by the department on 07-08-2023 and 08-08-2023. **Dr. B. Venkatraman**, Distinguished Scientist, Director, IGCAR. Dr.V. Subramanian, Head, RESD, IGCAR was the resource person. Following faculty members coordinated the program **Dr. C. Velmurugan**, HoD, **Dr. V. R. Muruganantham**, Associate Professor, **Dr. M. A. Vinayaga Moorthi**, Assistant Professor – II, **Dr. K. K. Arun**, Assistant Professor – III, **Mr. S. Prabhu**, Assistant Professor – II, **Mr. R. S. Mohankumar**, Assistant Professor – II, **Dr. N. Sangeetha**, Sr. Associate Professor, **Dr. A. P. Arun**, Assistant Professor – III, **Dr. K. Krishnamoorthi**, Assistant Professor – III, **Dr. S. Rajesh**, Assistant Professor – II, **Mr. P. Pradeep**, Assistant Professor – II, **Mr. K. Manikanda Prasath**, Assistant Professor – II and **Dr. B. N. Sreeharan**, Assistant Professor – II.



A seminar on “Operating Characteristics of Loop Heat Pipe for Aerospace Application” was organized by the department on 18-08-2023. **Dr. Godson Asirvatham**, Professor, Karunya University was the resource person. **Dr. S. Ramanathan**, Assistant Professor – III and **Mr. S. Sivakumar**, Assistant Professor – II were the coordinators for the seminar.





A Field/Exposure Visit to Incubation Unit to TNAU Agribusiness Incubation Society was organized on 24-08-2023. **Dr. S. Thirumurugaveerakumar**, Associate Professor and **Dr. V. Manivel Muralidaran**, Assistant Professor - III were the coordinators.







Internship Assessments cum Guest Lectures was organized by the department on 10-08-2023. **Mr. S. S. Kawin**, Proprietor, Am for you, Coimbatore and **Mr. Mohamed Shameer**, Surface Data Engineer, Cameron Manufacturing India Private Limited, were the resource persons. **Mr. P. D. Devan**, Assistant Professor - II and **Dr. P. S. Samuel Ratna Kumar**, Assistant Professor - I were the coordinators.

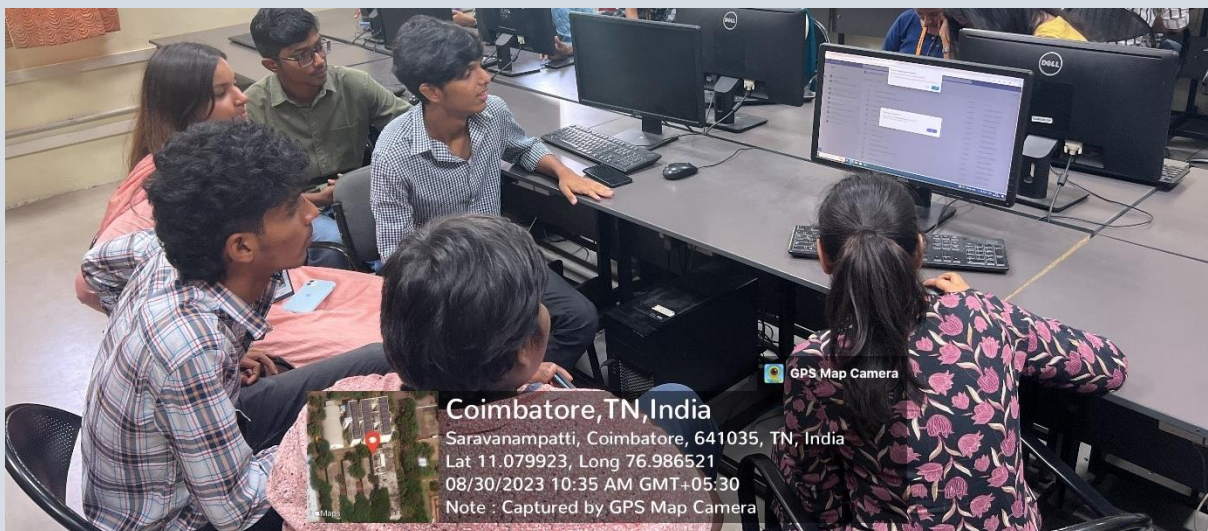




## Department Activities



A Visit to Karunya University for purpose of Establishment of Centre for Advanced Thermofluid Research was organized by the department on 23-08-2023. **Dr. S. Ramanathan**, Assistant Professor – III coordinated the visit.



A Session on innovative project presentation in Engineering clinic “Empowering Innovation: A Two-Day Hackathon Workshop within the Realm of Engineering Clinics” was organized in the department from 28-08-2023 to 31-08-2023. **Dr. S. Thirumurugaveerakumar**, Associate Professor, **Mr. P. D. Devan**, Assistant Professor – II, **Dr. S. Rajesh**, Assistant Professor – II, **Mr. R. S. Mohankumar**, Assistant Professor – II.







A School Outreach programme on “Fostering innovation & Entrepreneurship: Empowering school students through Outreach” was organized on 28-08-2023. The programme was coordinated by **Dr. S. Thirumurugaveerakumar**, Associate Professor.

### FACULTY AS RESOURCE PERSONS

**Mr. V. R. Navaneeth**, Assistant Professor – II, acted as External Examiner for the Practical Examination at Hindusthan College of Engineering and Technology, Coimbatore on 07-08-2023. He also acted as External Examiner for the Practical Examination at Hindusthan Institute of Technology on 10-08-2023. He was also the External Examiner for the end semester paper valuation at SNS College of Engineering on 30-08-2023.



**Mr. S. Prabhu**, Assistant Professor – II, acted as External Examiner for the Practical Examination at Hindusthan College of Engineering and Technology on 10-08-2023.

**Dr. N. Sangeetha**, Senior Associate Professor, was one of the Interview panel members for the selection process of Project Engineer for KCT - Product Team along with Mr. N. Rahul at KCIRI on 09-08-2023.



**Dr. B. N. Sreeharan**, Assistant Professor - II was the Resource Person in the Professional Development Program “Advanced Excel” on 12-08-2023 organized by the Department of Information Technology, Manakula Vinayakar Institute of Technology, Puducherry. He also trained Engineers of Cameron Manufacturing India Private Limited, Coimbatore in effectively using Excel at Tidel Park, Coimbatore from 21-08-2023 to 25-08-2023.

**Dr. S. Ramanathan**, Assistant Professor – III, was the Guest Speaker in a One week FDP Program on Multiverse Approach to Upskill Professionals in Contemporary Environment in the topic of Advanced Heat Augmentation Techniques at SRM Madurai College for Engineering and Technology from 21-08-2023 to 26-08-2023.



**Dr. S. Rajesh**, Assistant Professor – II, acted as University Representative for the End Semester Theory Examination at Dr. NGP Institute of Technology on 31-08-2023.

## PAPER PUBLICATIONS



**Dr. N. Sangeetha**, Senior Associate Professor, published her paper entitled "Vibration Analysis of Washing Machine under Various Unbalanced Mass" in 2nd International Conference on Advancements in Electrical, Electronics, Communication, Computing and Automation (ICAECA), Coimbatore, India, 2023, pp. 1-5, doi: 10.1109/ICAECA56562.2023.10199585. IEEE Explorer.

**Mr. V. R. Navaeeth**, Assistant Professor – II, published his paper entitled "Microstructure and fracture analysis on MIG welding of Nimonic alloys" in the Elsevier Materials Today: Proceedings.



**Dr. M. A. Vinayaga Moorthi**, Assistant Professor – II, published his paper entitled "Design of Buffer Tank in Heat Pump System" in International Research Journal of Modernization in Engineering Technology and Science Volume:05/Issue:08/August-2023. He also published another paper entitled "Comprehensive analysis and comparison of the structural properties of aluminium alloy wheels" in International Journal of Advance Research, Ideas and Innovation in Technology Volume 9, Issue 2 - V9I2 -1440.

**Dr. S. Thirumurugaveerakumar**, Associate Professor, published his paper entitled "Comprehensive analysis and comparison of the structural properties of aluminium alloy wheels" in the International Journal of Advance Research, Ideas and Innovation in Technology Volume 9, Issue 2 - V9I2 -1440.



**Dr. M. Thirumalai Muthukumaran**, Assistant Professor – III published his paper entitled "Comprehensive analysis and comparison of the structural properties of aluminium alloy wheels" in the International Journal of Advance Research, Ideas and Innovation in Technology Volume 9, Issue 2 - V9I2 -1440.

## MANUSCRIPTS REVIEWED

**Dr. B. Senthilkumar**, Associate Professor, reviewed a manuscript titled "Influence of interlaminar shear strength and flexural properties of laminated composite materials for flexural loading for the Materials today: Proceedings Journal.



**Dr. V. Manivel Muralidaran**, Assistant Professor – III, reviewed a manuscript titled "Fatigue assessment of welded joints and crack growth considering residual stress" for the Engineering Research Express, IOP Science Publications.





**Dr. C. Velmurugan**, HoD, reviewed a manuscript titled “Multi criteria decision making based optimization of thermal modeling of Electric discharge machining for the Engineering Research Express, IOP Science Publications. He also reviewed another manuscript titled “Study on the process and microstructure of Fe34Mn13.5Al3Cr7.5Ni shape memory alloy prepared by spark plasma sintering based on elemental powder” for the Materials Today communications, Elsevier Publications.

**Dr. A. P. Arun**, Assistant Professor – III, reviewed a manuscript titled “Distinctive performance evolution of surface layer in TC4 alloy oxidized at high temperature: Softening and Hardening” for the Journal of Alloys and Compounds.



**Dr. P. S. Samuel Ratna Kumar**, Assistant Professor – I, reviewed a manuscript titled “Case Study on Composite Bush Bearing Manufactured from Particle Reinforced Epoxy Composites” for the Engineering Research Express (ERX). He also reviewed another manuscript titled “Advanced Manufacturability of Electrical Machine Architecture through 3D Printing Technology” for the Machines Journal.

**Mr. B. Jeeva**, Assistant Professor – II, reviewed a manuscript titled “3D printing of dual powder-based metallic alloys for functionally graded implants” for the National Academy Science Letters, Springer publication. He also reviewed another manuscript titled “Design and performance evaluation of a mini tractor mounted clod crusher for the Applied Science and Technology Journal.



### AWARDS RECEIVED



**Mr. K. Manikanda Prasath**, Assistant Professor – II, Certified Supply Chain Professional from the Association for Supply Chain Management, an International Private Association for Supply Chain Management on 31-07-2023.

### RESEARCH GRANT

A research grant titled “Development of AI enabled integrated fall detection, critical events and road condition prediction with a smart heads up helmet display system” for a sum of Rs. 10 Lakhs was received by **Dr. M. Ramesh Kumar**, Assistant Professor – II from IHub - Data, IIIT Hyderabad.



## CONSULTANCY



**Dr. B. Senthilkumar**, Associate Professor and **Dr. M. Ramesh Kumar**, Assistant Professor – II, provided consultancy to Sri Dwarak Engineering, Athipalayam Road, Periyanaickenpalayam on “The pilot study on analysis of weldment quality using voltage and current signature” worth Rs. 35000/-.



## PATENTS

**Mr. P. D. Devan**, Assistant Professor - II, published his patent “BOLT” bearing no. 369034-001 dated 04-08-2023.



**Dr. V. Muthukumaran**, Professor, **Mr. S. Balaji**, Assistant Professor - II and **Dr. K. M. Senthilkumar**, Associate Professor, published their patent “GUIDANCE ROBOT” bearing No. 382457 - 001 dated 07-08-2023.



**Dr. V. R. Muruganantham**, Associate Professor, and **Mr. P. D. Devan**, Assistant Professor – II, published their patent “Bathroom Jali with Detachable Cover” bearing No. 202241028007 dated 16-05-2023.





## PROGRAMMES PARTICIPATED



**Mr. R. S. Mohankumar**, Assistant Professor – II, participated in a “One day Workop on Exploring the AR/VR World with Unity” on 17-08-2023 organized by ARK Infosolutions PVT LTD.

**Mr. P. D. Devan**, Assistant Professor – II, participated in a Seminar on “Introduction to Ansys Motion” on 18-08-2023, organized by ARK Infosolutions PVT LTD. He also participated in an Industrial Visit on “Start up Thiruvizha” from 19-08-2023 to 20-08-2023, organized by CODISSIA Trade Fair Complex, CODISSIA Trade Fair Complex, Coimbatore. Further, he participated in an FDP on “Polymer Composites and Nanocomposites” (CU 60F)” from 07-08-2023 to 11-08-2023, organized by NITTR, NITTR, Kolkata.



**Mr. K. Manikanda Prasath**, Assistant Professor – II, participated in a “One day Workop on Exploring the AR/VR World with Unity” on 17-08-2023 organized by ARK Infosolutions PVT LTD.

**Dr. V. Manivel Muralidaran**, Assistant Professor – III, participated in a FDP on “Idea Generation in Methods” from 07-08-2023 to 09-08-2023, organized by ICT Academy at Dr. R. V. Arts and Science College, Dr. R. V. Arts and Science College, Coimbatore.



**Dr. S. Thirumurugaveerakumar**, Associate Professor, participated in an FDP on “Polymer Composites and Nanocomposites” (CU 60F)” from 07-08-2023 to 11-08-2023, organized by NITTR, NITTR, Kolkata.

**Dr. S. Ramanathan**, Assistant Professor – III, participated in an FDP on “Multiverse Approach to Upskill Professionals in Contemporary Environment” from 21-08-2023 to 26-08-2023, organized by SRM Madurai College for Engineering and Technology, SRM Madurai College for Engineering and Technology, Pottapalayam, Sivagangai DT.





**Dr. M. Thirumalai Muthukumaran**, Assistant Professor III participated in an Seminar on “Introduction to Ansys Motion” on 18-08-2023 to 18-08-2023, organized by ARK Infosolutions PVT LTD.

**Dr. B. N. Sreeharan**, Assistant Professor - II participated in an FDP on “Microsoft Power BI Data Analyst Associate” from 07-08-2023 to 11-08-2023, organized by ICT Academy - Manakula Vinayagar Institute of Technology, Manakula Vinayagar Institute of Technology, Puducherry and completed following courses conducted by Microsoft and obtained trophies and badges.



- Get started with Microsoft data analytics
- Discover data analysis
- Get started building with Power BI
- Get data with Power BI Desktop
- Explore data in Power BI
- Model Data in Power BI
- Use Visuals in Power BI
- Publish and Share in Power BI
- Distribute Power BI insights
- Create and use analytics reports with Power BI



**Dr. N. Sangeetha**, Senior Associate Professor, participated in a Seminar on “Introduction to Dynamic Meshing Using Ansys Fluent” on 07-08-2023, organized by ARK Infosolutions PVT LTD. She also participated in another Seminar on “Introduction to Ansys Motion” on 18-08-2023 organized by ARK Infosolutions PVT LTD. Further she participated in an FDP on “Polymer Composites and Nanocomposites” (CU 60F)” from 07-08-2023 to 11-08-2023, organized by NITTR, NITTR, Kolkata.

**Dr. K. K. Arun**, Assistant Professor – III, participated in a Seminar on “Introduction to Ansys Motion” from 18-08-2023 to 18-08-2023, organized by ARK Infosolutions PVT LTD and in an Industrial Visit on “Startup Thiruvizha” from 19-08-2023 to 20-08-2023, organized by CODISSIA Trade Fair Complex, CODISSIA Trade Fair Complex, Coimbatore. Further, he completed following courses.



- Explore roles and responsibilities in the world of data, Microsoft azure data fundamentals: Explore data in power BI, Explore core data concepts on 23-08-2023
- Regular Expressions in Python, Introduction to basic game development using scratch on 25-08-2023.



## SNAPSHOTS



Dr. Godson Asirvatham delivering the guest lecture



A Field/Exposure Visit to Incubation Unit to TNAU Agribusiness Incubation Society



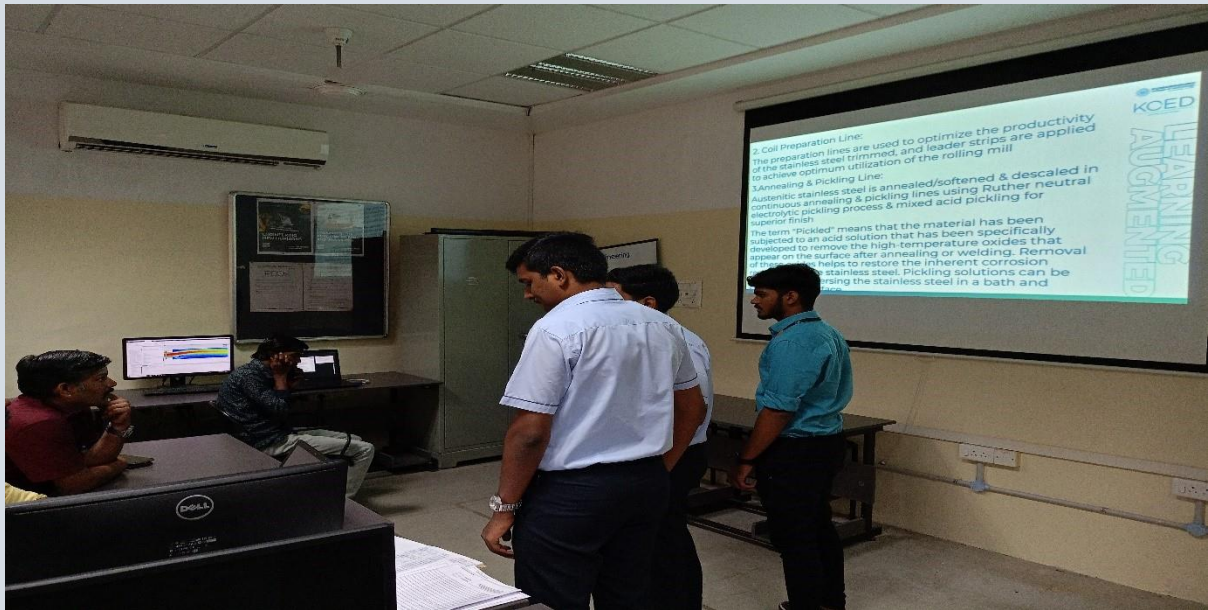


Our faculty at Incubation Unit Visit to TNAU Agribusiness Incubation Society

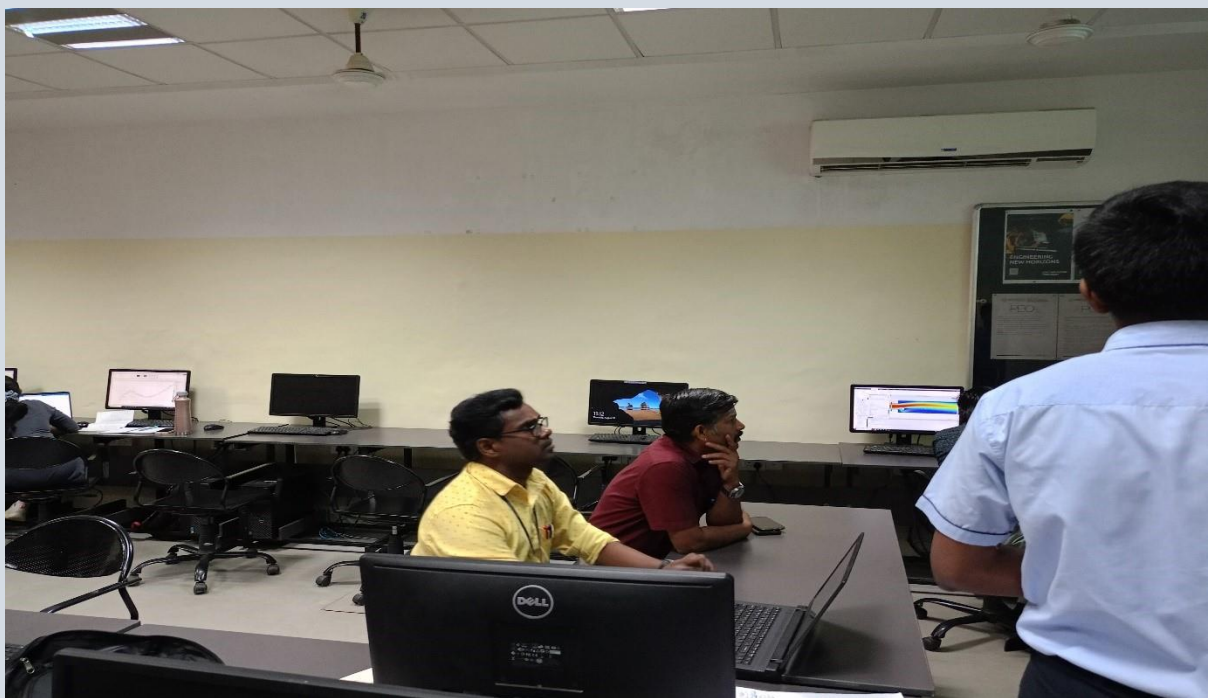


A Field/Exposure Visit to Incubation Unit to TNAU Agribusiness Incubation Society





Mr. S. S. Kawin during Internship Assessments



Mr. P. D. Devan and S. S. Kawin during Internship Assessments





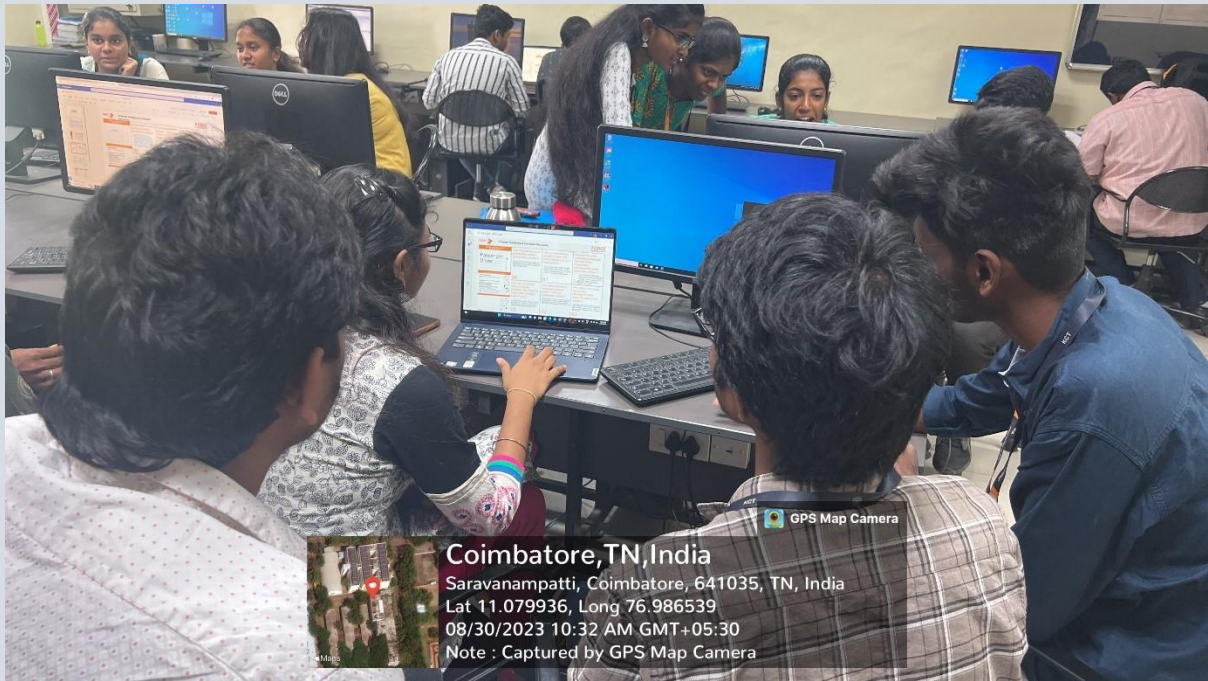
Dr. Samuel Ratna Kumar and Mr. Mohamed Shameer during Internship Assessments



A Visit to Karunya University



## Department Activities



Two-day Engineering Clinics Hackathon



Two-day Engineering Clinics Hackathon

## PAPER PUBLICATIONS

**Mr. Vaseekaran S L**, and **Mr. Vetriselvan V**, published their paper entitled "Design of Buffer Tank in Heat Pump System" in the International Research Journal of Modernization in Engineering Technology and Science Volume: 05/Issue: 08/August-2023

**Mr. Joel David** published his paper entitled "Comprehensive analysis and comparison of the structural properties of aluminium alloy wheels" in the International Journal of Advance Research, Ideas and Innovation in Technology Volume 9, Issue 2 - V9I2 -1440.

## PAPER PRESENTATIONS

**Vidhun C R** presented his papers entitled "CFD Analysis of Surfboard Fin: Navigating Waves of Innovation" and Investigation of Different Windshield Coating for Improved Visibility and Safety" in the Swinburne Sarawak Postgraduate Conference 2023 held during 03-08-2023 to 04-08-2023 organized by Swinburne University of Technology, Sarawak campus.

## PROGRAMMES ORGANIZED

Following students actively involved themselves in organizing AKAM -ANU YATRA 2023 - ANU Awareness Program during 07-08-2023 and 08-08-2023 in association with IGCAR, Kalpakkam.

**Mr. Abdul Khadar Hussain S**  
**Mr. Vaseekaran S L**  
**Mr. Joel David**  
**Mr. Lalitkishore N**  
**Mr. Kathiravan S V**  
**Mr. Kumarasamy R**  
**Mr. Sabarivasan S**  
**Mr. Vaanmugilan M**  
**Mr. Joel Prince P**  
**Mr. Nikil R**  
**Mr. Nithesh S V**

**Mr. Mohammed Asik**  
**Mr. Prasath**  
**Mr. Anand R**  
**Mr. Naveen G G**  
**Mr. Divakar C S**  
**Mr. Pravan B G**  
**Mr. Sivaprasad B**  
**Mr. Jayasivaraman R E**  
**Mr. Sanjay R**  
**Mr. Gokulakrishnan M**

**Mr. T. Suresh**, Research Scholar participated in a Seminar on "3D Metal Printing Technology" on 24-08-202 at PSN College of Engineering and Technology, Tirunelveli. He also participated in another Seminar titled "Navigating the pathways of publishing in High-quality journals by using Scopus and ScienceDirect on 01-09-2023 organized in KCT, Coimbatore

## STUDENT COMPETITIONS

**Mr. Vidhun C R** participated in Autonomous Drone Development Competition (ADDC) 2023 at KCG College of Technology KCG College of Technology, Chennai during 25<sup>th</sup> and 26<sup>th</sup> August, 2023 and won first prize.



## Student Activities

**Mr. Shakeel Akthar**, got recognized by The Institution of Engineers (India), Navi Mumbai on 29-08-2023 as best student researcher.

**Mr. Kalaiselvan P** of Final Year of our Department has cleared Proficiency Test N4 level in Japanese Language.

### PATENTS

Our Alumni, **Mr. Karan Ram S** has been granted with a patent titled "Slip Joint Repair Coupling" bearing no. 202041008136 dated 13-12-2022.

Three Students of Our Department **Mr. Kalaiselvan P**, **Mr. Jeevabharathi K** and **Mr. Vijay M** have been published their patent "BOLT" bearing no. 369034-001 dated 04-08-2023.

### PROGRAMMES PARTICIPATED

On 30-08-2023 our students participated in a Workshop on IPG and IP management for Start Up Entrepreneurs conducted by Dr. K. Paramasivam, Professor, EEE Department, Head Govt. Schemes & Projects and IPR Cell of KCT.

On Behalf of our College 10 Students has Volunteered Hero Asian Champions Trophy Chennai at Mayor Radhakrishnan Hockey Stadium in Chennai. Our students Volunteered from 3<sup>rd</sup> August 2023 to 12<sup>th</sup> August 2023 and received Certificate for Volunteering.





**KUMARAGURU**  
college of technology

COIMBATORE – 641 049

## Department of Mechanical Engineering

### INSTITUTE VISION:

The vision of the college is to become a technical university of International Standards through continuous improvement.

### INSTITUTE MISSION:

Kumaraguru College of Technology (KCT) is committed to providing quality Education and Training in Engineering and Technology to prepare students for life and work equipping them to contribute to the technological, economic, and social development of India. The College pursues excellence in providing training to develop a sense of professional responsibility, social and cultural awareness and set students on the path to leadership.

### DEPARTMENT VISION:

To emerge as a centre, that imparts quality higher education through the programme in the field of Mechanical Engineering and to meet the changing needs of the society.

### DEPARTMENT MISSION:

The department involves in sustained curricular and co-curricular activities with competent faculty through teaching and research that generates technically capable Mechanical Engineering professionals to serve the society with delight and gratification.

## B. E. MECHANICAL ENGINEERING

### PROGRAM EDUCATIONAL OUTCOMES (PEO's):

- PEO 1 :** Graduates will take up career in manufacturing and design related disciplines.
- PEO 2 :** Graduates will be involved in the execution of Mechanical Engineering projects.
- PEO 3 :** Graduates will take up educational programme in mastering Mechanical sciences and management studies.

### PROGRAM OUTCOMES (PO's):

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and teamwork:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.



## PROGRAM SPECIFIC OUTCOMES (PSO's):

1. Apply the fundamentals of science and mathematics to solve complex problems in the field of design and thermal sciences.
2. Apply the concepts of production planning and industrial engineering techniques in the field of manufacturing engineering.

## M. E. INDUSTRIAL ENGINEERING

## PROGRAM EDUCATIONAL OBJECTIVES (PEO's):

- PEO 1 :** Graduates will be mid to higher level management / engineering professionals with responsibilities in engineering management, data analysis and business operations.
- PEO 2 :** Graduates will be engineering professionals, and technology leaders who would manage such functions as plant engineering, production, supply chain and quality management.
- PEO3 :** Graduates would function as educators or researchers in academic institutions.

## PROGRAM OUTCOMES (PO's):

- P01 :** An ability to independently carry out research /investigation and development work to solve practical problems.
- P02 :** An ability to write and present a substantial technical report/document.
- P03 :** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.
- P04 :** Apply knowledge and competencies in manufacturing, analytics, supply chain, quality and engineering management.
- P05 :** Apply principles of industrial engineering to solve problems in industry.
- P06 :** An ability to work as part of interdisciplinary teams, communicate effectively, model and design engineering systems optimally.