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INAE VISION 2020-2025

INAE VISION

To be the premier Engineering Academy of the World providing timely inputs to the national and international policy makers, and to extend appropriate assistance in developing engineered solutions for the challenging problems facing contemporary societies and the humanity as a whole.

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To be the premier Engineering Academy of the World providing timely inputs to the national and international policy makers, and to extend appropriate assistance in developing engineered solutions for the challenging problems facing contemporary societies and the humanity as a whole

INAE Mission

To serve professionals in building and institutionalizing engineering and technological excellence in education, research and industry in India and support advancement of engineering profession globally

Technology Roadmap

We are living in exciting times. We will have to contend with the profound transformation of our society and our industry, because of two revolutions in the making – namely, the digital revolution and the impending transition to fossil fuel free energy globally.

The digital revolution is rapidly transforming the very nature of industrial enterprise today. Many disruptive transformations are maturing rapidly because of the advent of cloud computing and internet of things (IoT) and due to major advances and breakthroughs being made on several fronts such as artificial intelligence (AI) including machine learning (ML) and big data analytics, robotics, autonomy, drones, 3D printing, advance sensors and 5G technologies.

Another revolution in the making is the exciting possibility of fossil fuel-free generation of electricity in the coming decade. The availability of electricity based on renewable sources such as sun, wind and biomass, will cause a major disruption as well as an opportunity for creating a cleaner world, since use of fossil fuels (coal, oil or natural gas) currently, creates deleterious environmental consequences which need urgent attention.

While both these revolutions will cause major disruptions in how we live and work, the transition to the new world in the making is contingent upon the availability of new sources of critical raw materials.

Both digital hardware and generation of electricity from renewables (including the technological challenges associated with energy storage) require a host of new metals and materials for which the new value chains (also the appropriate global supply chains) will have to be established. Innovative processes for extraction of minerals and metals as well as recycling, which are more energy efficient and environment-friendly will have to be developed to produce these critical elements.

To facilitate this global transition, we need to create human resources with high level of domain expertise in different facets of engineering as well as the much needed engineering skill sets needed to deal with the problems of scalability, uncertainty, reliability, complexity, system engineering, ability to deal with variability and yet manufacture products and create solutions of uniform and reproducible quality, capability to design, develop and optimize engineering systems for a given set of inputs and for a desirable set of assured outputs of consistent quality.

Our engineering education has to be appropriately re-engineered so as to equip our future leaders with not only the domain expertise but also the skillsets to innovate continuously and consistently in the face of constant change and dynamic transformations. The human ingenuity and the preparing the well-trained minds, will be critical ingredients in responding to the challenges ahead.

It in this context, INAE has come up with the following areas for our focused attention in the next five years. We believe that these efforts will assist us in facilitating the smooth transition to the new world in the making.

1. Accelerated Discovery, Development and Deployment of Novel Materials, particularly for strategic sectors like Defense, Atomic Energy and Space.

We have an urgent need of materials (metals, alloys as well as composites) development for the following sectors – auto sector (both electric vehicles as well as IC engines based vehicles), aerospace, ultra-supercritical power plants, nuclear power plants, renewable energy sector (novel PV materials, rare earth magnets, battery materials for both large scale energy storage as well as for electric vehicles and other electronic appliances, thermoelectric materials for converting low temperature heat into electricity), novel sensors for healthcare industry, materials for the defense applications and space applications, to name a few.

These materials will have to be engineered for India-specific applications. That means one must consider during the process of design & development itself, the kind of natural resources we have and the kind of supply chains we will be able to establish to source the starting raw materials, considering the complex geo-political scenario and vulnerabilities associated with dependence on raw materials from abroad.

The other important consideration is the speed of development. In order to remain globally competitive in this domain, we must leverage the state of the art digital platforms (equipped with advanced modeling, simulation, data analytics and knowledge engineering tools) for accelerating the development cycle from conception to deployment in actual applications as well as the entire life cycle (cradle to cradle or cradle to grave in some cases), that is, even for the structural health monitoring of the structures where these materials will be deployed.

Another important consideration is the environmental impact of these materials, that is, we must undertake a life cycle analysis, both with respect to the environmental footprint as well as the energy efficiency (actual consumption as compared to the thermodynamic energy needed to accomplish the particular task), for every developmental effort.

It is now well established that integrated computational materials engineering (ICME) approach can help accelerate the materials development cycle.

INAE will work towards coming up with a national strategy to establish and institutionalize the ICME based approach for all material development efforts. The digital platform, thus created, must be equipped with knowledge engineering capabilities so that it can not only act as a knowledge repository of all past efforts made thus far but also continues to update the knowledge going forward.

2. Strategies for Energy Transition to Fossil Fuels free Renewable Energy Sources

It is inevitable that India, like several other nations of the world, will move away from fossil fuels as a source of energy. While we have made some headway in developing renewable energy sources like solar and wind, the necessary infrastructure to support the energy transition does not exist at the present time.

INAE plans to create an interdisciplinary expert group to study the whole energy transition comprehensively and holistically, keeping in mind the challenges inherent in such a massive transformation.

INAE will focus on the following important sectors which will be disrupted in the immediate future and/or the areas of concern which we require a strategy for, urgently to facilitate the transition

- Large scale energy storage solutions - Solutions other than Lithium Ion Batteries which do not seem to be appropriate for a country like India for a variety of reasons including the fact that we do not have the basic raw materials - Liquid Metal Flow batteries (for example, Vanadium Flow Batteries) is another attractive option which must be explored.
- Electricity Grid Infrastructure - current grid will not be able to cater to intermittent and distributed electricity inputs; the concept of smart grids which is adequately robust to cater to both supply side challenges (renewable energy sources) as well as demand management (dynamic pricing to take care of its peak loads).
- Transportation (electric mobility, both for people as well as for goods).
- Mining, Mineral Processing and Extractive Metallurgy Industry (which currently depends totally on fossil fuels not only as a source of heat but also as a reductant to convert metal oxides to metals).
- Recycling of waste by-products including municipal waste, tailings and smelter slags including steel slag, red mud and spent pot lining, electronic waste and hospital waste.
- Supply chains for raw materials needed for the transition - sourcing strategies from other geographies, urban mining, deep sea mining and space mining.
- Finding alternative technology options for the manufacture of steel and cement to reduce the environmental foot-print - currently these two materials which will continue to remain the backbone of the Indian economy for the foreseeable future and the consumption is likely to increase by an order of magnitude in the coming decade.
- Waste-water treatment and recycling.
- Water purification technologies including desalination

3. Excellence in Engineering Education

Several groups including other academies globally, are working on the new curricula for engineering education so that our young emerging leaders are adequately equipped with necessary engineering skill sets to face the challenges in the coming decades.

Various deliberations within India as well as abroad have emphasised the need of providing hands-on design experience, problem solving skills and exposure to the systems engineering concepts, tools and technologies to the engineering students. The curricula also need to be updated with the advancements in digital technologies.

All engineers must be familiar with the sustainability paradigm and must be able to do life cycle analysis for every engineering product. They must be equipped with knowledge and the experience with various digital platforms and modelling tools such as computational materials engineering (all the way from atomistic scale to macroscopic scale), computational fluid dynamics, structural analysis tools, life cycle analysis modelling tools, engineering scale up, robust design methodologies to take care of uncertainty and complexity, machine learning and data analytics tools and algorithms, multi-objective and multi-variate optimization tools and technologies.

It is important that the professional ethics is part of the engineering course curricula. A multi-disciplinary systems perspective to all engineers will certainly broaden their horizons – much needed to face the emerging world scenario. Good communication skills and ability to work in teams, are also prerequisites for engineers to succeed in the real life.

All engineers must possess basic IT skillsets and it is a given since digital technologies are transforming every aspect of our lives.

A multidisciplinary INAE Expert Group will critically examine the current status of engineering education, identify gap areas and strive to fill those gaps with appropriate action plans

4. World Class Infrastructure

INAE will come up with an action plan in consultation with all stake- holders to upgrade our national infrastructure within next few years. This will include

- Requirements, technology options and the investments needed to create a few smart cities in the country - including mobility, healthcare facilities, e-governance, access to affordable housing, utilities (electricity and water), waste collection, processing and recycle, education, communication, maintenance of infrastructural facilities, disaster management infrastructure including extreme events (for example, excessive rain and floods) etc.
- Requirements, technology options and the investments needed to create a rural infrastructure so that they can enjoy access to certain basic amenities where they are located - digital connectivity for example can provide them with access to healthcare, online education, information dissemination, financial inclusion, logistics warehousing and agriculture and farm productivity with engineering focus etc.

5. Cyber-physical Systems

Globally innovations are taking place at the interface of digital technologies and domain expertise. For example, manufacturing is being transformed as a consequence of the following - robotics and automation, Internet of Things (IoT), cloud computing, 3D printing, AI, machine learning and data analytics (Digital Twins), structural health monitoring of built structures and engineered products, drones, autonomy, data analytics based predictive asset maintenance systems, blockchain technology to facilitate complete traceability of the products, digital platforms for integrated design, development, deployment and monitoring of materials and products and knowledge engineering platforms for capturing, retaining and context sensitive retrieval of knowledge to solve challenging problems.

Similarly leveraging the advanced digital technologies, the infrastructure available in a given locality or a city can be upgraded for easy accessibility – for example, healthcare facilities, e-governance, utilities (electricity and water)

It is now possible to make most of healthcare facilities available to the citizens at their place of residence (particularly important for senior citizens living alone) through the intervention of digital connectivity, sensors and IoT solutions. Provision of healthcare and affordable Medicare facilities through technological interventions is a key focus area.

INAE will select certain areas for focussed attention during the next five years and develop strategies to create infrastructure to facilitate digital transformation for achieving a set of desirable objectives for example, higher productivity, higher efficiency, better quality of life and better quality of products, reduced cost of services, higher safety of workers, etc.

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ACADEMY ACTIVITIES

New Leadership of INAE

Mr JD Patil, *FNAE* has taken over as President of INAE w.e.f. January 1, 2025 from Prof Indranil Manna, *FNAE* who was President of INAE from January 1, 2021 to Dec 31, 2024.

President of INAE



Mr. JD Patil

Member of Executive Committee of Management & Advisor (Precision Engineering & Semiconductor Technologies) to L&T CMD, Former Whole Time Director L&T; Member of the Board of IN-SPACE; Chairman Indian Space Association; and Founder Vice President & Past President Society of Indian Defence Manufacturers

Immediate Former President, INAE



Prof Indranil Manna

Vice Chancellor, Birla Institute of Technology (BIT), Mesra, Ranchi, Jharkhand [On lien from I.I.T. Kharagpur, W.B.] and Former Director, Indian Institute of Technology Kanpur, U.P.; Former Director, CSIR-Central Glass & Ceramic Research Institute (CGCRI), Kolkata.

For details regarding new composition of INAE Governing Council click on the link given below.

<https://www.inae.in/about-us/committees/governing-council/>

Academy News (Covering period from October 1, 2024 to January 31, 2025)

Joint activities with ANRF (erstwhile SERB), DST

I. ANRF (erstwhile SERB), DST-INAE Online and Digital Gaming Research Initiative

The ANRF (erstwhile SERB), DST-INAE Online and Digital Gaming Research Initiative was launched at the behest of DST as a unique program to leverage Digital Gaming Research and Industry in India and to achieve self-reliance in advanced Augmented Reality (AR)/ Virtual Reality (VR) technologies to create indigenous gaming platforms for several applications ranging from education to leisure with the backdrop of Indian Ethos, for desktop and hand-held devices. A Letter of Intent (LoI) for SERB - INAE Cooperation on SERB Digital Gaming Research Initiative was digitally signed during March 2022 between President, INAE and Secretary, SERB, for INAE to act as nodal agencies to partner and cooperate in the implementation of SERB-INAE Online and Digital Gaming Research Initiative. This initiative is in line with national priorities. The initiative launched to leverage Digital Gaming Research and promote such Industry in India is progressing well. The call for proposals were invited and the Program Management and Advisory Committee (PMAC) was constituted to evaluate, select, and review proposals received in response of the call for proposal. After rigorous selection process, a total of 12 proposals were approved by SERB during August 2023 in Category I: R&D in Learning, Educational, and Leisure Online Gaming Platforms and Category II: Immersive Game Prototypes, with a focus on Indian Culture & Values. Due to withdrawal of one of the projects, a total of 11 projects are currently being progressed. The funds had since been released and the projects were sanctioned. In order to regularly monitor the progress of these projects, it was decided by the PMAC to conduct a review meeting twice a year. In this context, two review meetings were held, one on March 12, 2024 and second on November 5, 2024, wherein project PIs presented their work progress before the PMAC. The next review meeting is planned to be held shortly.

II. INAE - ANRF (erstwhile SERB) Abdul Kalam Technology Innovation National Fellowship

The ANRF (erstwhile SERB), DST – INAE Abdul Kalam Technology Innovation National Fellowship launched in 2017 is a flagship initiative of INAE, funded by SERB (DST), to recognize, encourage and support translational research by individuals working in various capacities of engineering profession in public funded institutions in the country. Several of the translational research projects pursued by these Kalam Fellows have reached the stage of technology transfer and creation of start-ups including filing up of over 140 patents and technology transfers and around 430 publications. Patents and startups have been developed on various research proposals such as Laser-based technique to crystallize ferroelectric thin films at 300°C, Green/Sustainable IoT for Smart Environment, Next generation filtration devices for protection of environment and health, Tactile Diagrams for Visually Impaired, Automatic Assessment of Fluency in Spoken Language and a method thereof.

III. ANRF (erstwhile SERB), - INAE Collaborative Initiatives in Engineering:

(i) 18th National Frontiers of Engineering (NatFoE) & IMP 2024

The 18th Symposium on National Frontiers of Engineering (NatFoE), a flagship event organized by the Indian National Academy of Engineering (INAE) since 2006, aims to inspire young engineers (aged approximately 27-45) from industries, universities, and R&D labs to present cutting-edge research in various engineering fields. The 18th NatFoE-24 symposium was hosted by the Indian National Academy of Engineering (INAE) in collaboration with the National Institute of Technology Warangal, under the auspices of the ANRF (SERB) - INAE Conclave on *Atmanirbhar* Technologies for Engineering a Secured Future, held on November 15-16, 2024.

This annual event was attended by numerous young researchers from academic institutions, R&D laboratories, and industries. The symposium's inaugural function took place at the Ambedkar Learning Centre at NIT Warangal, with notable dignitaries including Prof. Indranil Manna President, INAE, Prof. Sivaji Chakravorti, Vice President, INAE, Prof. Bidyadhar Subudhi, Director, NIT Warangal, and Prof. Shirish H Sonawane, Dean of Research and Development, NIT Warangal gracing the occasion.

In line with the country's mission on Atmanirbhar Technologies under four themes were decided for the symposium as mentioned below:

- Additive Manufacturing and Automation
- Smart Grid: Power Electronic Converters, Control and Protection
- Green Hydrogen and Storage Technologies
- Quantum Computing, Artificial Intelligence, and Machine Learning

Based on the aforesaid themes, four sessions were conducted as follows:

Session 1: Additive Manufacturing and Automation

Coordinators: Prof. Adep Kumar, Prof. Ravi Kumar and Prof. Shivraman

Plenary Talk: Human-Centric Manufacturing and Industry 5.0

Prof. S K Pal highlighted the transformative potential of Artificial Intelligence (AI) and automation in manufacturing, with a focus on Industry 5.0's human-centric approach. Unlike Industry 4.0, which emphasizes digitization and automation, Industry 5.0 fosters collaboration between humans and intelligent machines, ensuring that human creativity, problem-solving, and emotional intelligence remain central to the process. AI and automation optimize manufacturing by improving efficiency, enhancing quality, reducing costs, and driving innovation. AI handles repetitive tasks, allowing humans to focus on more complex, creative work. However, the human element remains crucial for addressing challenges that require emotional intelligence and judgment. Prof. Pal also stressed the importance of sustainability in manufacturing, advocating for the integration of green technologies, alternative energy, and scalable automation. This approach can help small-scale industries reduce costs, enhance energy efficiency, and contribute to a greener future.

Cybersecurity risks related to AI and automation were another concern. As industries become more interconnected, robust cybersecurity measures are essential to protect data and operational safety. Looking to the future, Prof. Pal discussed the potential of 6G networks and the Internet of Things (IoT) in enabling real-time communication and self-optimizing factories. Tactile IoT systems will enhance precision and safety, making manufacturing smarter, more efficient, and safer.

Dr. Gururaj T (ARCI): Additive Manufacturing by Laser Powder Bed Fusion

Dr. Gururaj discussed key advancements in material development for Additive Manufacturing (AM) using Laser Powder Bed Fusion (L-PBF) technology. He emphasized the importance of alloy chemistry modification to optimize material properties for efficient 3D printing and the role of spherical powders in improving flowability and consistency, which enhances print quality and reduces defects.

He also highlighted the integration of conformal cooling channels in AM, which improve heat dissipation and extend the lifespan of manufacturing dies. Additionally, Dr. Gururaj stressed the benefits of topology optimization for designing lightweight structures, reducing material usage while maintaining structural integrity. Looking to the future, he outlined the development of new alloy powders, including non-weldable materials, and the potential of Artificial Intelligence (AI) and Machine Learning (ML) to optimize AM process parameters in real-time, enhancing precision and efficiency. He

also emphasized improving powder flowability by refining powder sphericity and eliminating satellite particles to ensure consistent and reliable printing.

In conclusion, Dr. Gururaj's insights pointed to a future where advancements in materials, AI-driven optimization, and refined powder characteristics will revolutionize Additive Manufacturing, benefiting industries like aerospace, automotive, and healthcare.

Mr. Ankith Sahu, (Objectify Technologies Pvt Ltd): Qualification and Standards in Additive Manufacturing (AM), especially for aerospace and aviation applications

Mr. Ankit Sahu highlighted the critical role of process and material qualification in metal Additive Manufacturing (AM), especially for aerospace and aviation applications. He discussed strategies for design planning, ensuring regulatory compliance, and adhering to industry standards such as AWS D20, with a focus on dimensional tolerances, acceptance criteria, and Non-Destructive Testing (NDT) qualifications.

Mr. Sahu emphasized the importance of integrating online defect monitoring during the Laser Powder Bed Fusion (L-PBF) deposition process and process validation to enhance reliability and maintain high-quality manufacturing standards. He also outlined future efforts to advance regulatory compliance, improve defect detection methods, and refine manufacturing practices, all aimed at supporting the development of advanced components for aerospace and unmanned aerial vehicles.

Prof. Poonam Sundriyal (IIT KGP): 3D Printing for Energy Devices

Prof. Poonam Sundriyal explored the innovative application of 3D printing technology in the development of flexible, wearable supercapacitors integrated with energy-harvesting components. These supercapacitors are designed to efficiently store and deliver energy while being able to withstand mechanical stress, making them ideal for wearable electronics. The integration of energy-harvesting components enables these supercapacitors to generate power from external sources such as motion or environmental factors, providing a sustainable and self-sufficient energy solution. Prof. Sundriyal highlighted the promising performance of these devices in real-world conditions, where flexibility and durability are critical, especially in applications involving continuous wear or movement.

Looking to the future, Prof. Sundriyal emphasized the importance of advancing the technology behind cell-powered electronics. By incorporating higher-energy harvesting components and enhancing the durability of the supercapacitors, these devices can become more robust, capable of functioning reliably even under continuous deformation. This innovation will be crucial for the development of practical, sustainable, and energy-efficient solutions for a wide range of applications, from wearable health monitoring systems to flexible electronics in various industries. Prof. Sundriyal's research aims to not only push the boundaries of energy storage technology but also contribute to the creation of more environmentally friendly, self-powered devices that can meet the growing demand for efficient and sustainable electronic solutions.

Session 2: Smart Grid: Power Electronic Converters, Control and Protection

Coordinators: Prof. Ram Krishan and Prof. V. T. Somasekhar

The plenary session titled "Smart Electric Grids: Power Management, Control, and Protection Challenges" under theme 2 was presented by Prof. S. C. Srivastava from IIT Kanpur, a pioneer in power system advancements. Prof. Srivastava provided an enlightening overview of the history of smart grids and detailed the microgrid system, highlighting cutting-edge technologies for power management. Elucidating the operational challenges encountered while operating the microgrid initiated by IIT

Kanpur, he presented a real-time case study on renewable energy-integrated microgrid operations. Furthermore, during the interactive session, he explained the concept of net-zero emissions and the progress made in this cutting-edge research area. He opined that smart grids with extensive renewable energy integration pave the way to the herculean task of meeting the ever-growing electricity demand in the future.

As part of the smart grid theme, three invited lectures were delivered by young researchers from IIT Delhi, IIT Kharagpur, and IIT Bhubaneswar. Dr. Yashasvi Bansal, Assistant Professor in the Department of Electrical Engineering at IIT Delhi, gave an insightful presentation on the “Transformative Role of PMUs for Monitoring and Protection in Smart Grids.” She highlighted the crucial role of Phasor Measurement Units (PMUs) in real-time monitoring, protection, and control of smart grid systems, emphasizing their effectiveness in enhancing the reliability and stability of power grids.

The next lecture was presented by Dr. P. Deepak Reddy, Assistant Professor at IIT Kharagpur, who focused on the “Operation and Control of Microgrid Systems.” He shared his cutting-edge research on microgrid systems, discussing the various operational modes and control strategies that ensure efficient and reliable integration of renewable energy sources. In the final session, Dr. Chandrashekhar Perumalla from IIT Bhubaneswar provided valuable insights into wireless power transfer and the challenges involved in electric vehicle (EV) charging. He emphasized the importance of developing robust EV charging infrastructure to support India's ambitious net-zero emission targets, underscoring the critical role of innovative technologies in achieving a sustainable future.

Key Takeaways:

- **Integration of Renewables:** Transitioning to smart grids with renewable energy is inevitable for a sustainable future but requires innovative management strategies and new technologies.
- **Real-Time Monitoring:** PMUs and other real-time monitoring devices are essential to maintain grid stability and manage complex, dynamic systems.
- **Microgrid Flexibility:** Microgrids provide modular, adaptable solutions for modern grids, but require complex control strategies for seamless integration.
- **Investment in EV Infrastructure:** Scaling up EV charging infrastructure which includes wireless charging, is the key to evolving sustainable solutions in the arena of transportation.

These sessions collectively emphasized that the future of smart grids relies on technological innovation, renewable integration, infrastructure development, and effective administration to meet environmental and energy objectives.

Session 3: Green Hydrogen and Storage Technologies

Coordinators: Prof. P. V. Suresh and Prof. K. Manohar

The second day of NatFoE 2024, held on 17th November 2024, featured an engaging session on Green Hydrogen and Storage Technologies. The theme conveners extended a warm welcome to the speakers, guests, participants, and students, setting the stage for an important discussion at the intersection of innovation, sustainability, and national progress.

As the world faces the dual challenges of climate change and energy security, green hydrogen stands out as a promising solution. It is a clean, versatile energy carrier with the potential to revolutionize industries, transportation, and power generation. Simultaneously, advancements in energy storage technologies are essential for unlocking the full potential of renewable energy, ensuring stability, reliability, and scalability. Together, green hydrogen and storage technologies form the foundation of a sustainable energy future, both globally and in India.

The session began with a plenary lecture by Prof. S. Basu from IIT Delhi, a leading expert in electrochemical systems. His insightful talk, titled *Electrochemical Engines for Energy Storage and Conversion to Achieve Net Zero Carbon Emission*, provided a thorough overview of hydrogen's transformative potential as an energy carrier. Prof. Basu emphasized the critical advancements needed to make hydrogen and fuel cell technologies both sustainable and economically viable. He also highlighted the development of a membrane-less alkaline micro-electrolyser, a promising innovation that could significantly improve the efficiency and cost-effectiveness of hydrogen production.

This was followed by three **invited lectures** that further enriched the discussion:

- Dr. Vijay Radhakrishnan from Reliance India Limited, Mumbai, delivered an insightful overview of Sodium-ion batteries as a sustainable alternative to Lithium-ion batteries. He elaborated on the engineering challenges and commercialization pathways essential for advancing this technology.
- Dr. Sujit Pillai from MNRE presented updates on government policies supporting the green hydrogen mission. His talk on the *Indian National Green Hydrogen Mission* and advancements in electrolyzer technologies (PEM, AEM, SOEC, and alkaline electrolyzers) provided a roadmap for scaling up green hydrogen production in India.
- Dr. Sreedevi Varam from NIT Warangal shared cutting-edge research on on-demand hydrogen generation using novel aluminum composite materials. She explored aluminum's exceptional energy density and the role of metal activators and additives in addressing challenges in hydrogen storage and transportation, showcasing its transformative potential for clean energy systems.

These talks offered a comprehensive overview of the latest advancements, challenges, and opportunities in green hydrogen and storage technologies. Each lecture was followed by engaging audience interactions, with insightful questions and constructive suggestions that enriched the collaborative spirit of the session. The session concluded with heartfelt gratitude to INAE for providing this invaluable platform to exchange ideas, inspire innovation, and foster collaborations that will drive progress toward our net-zero aspirations.

Session 4: Quantum Computing and AI ML

Coordinators: Prof. P. Radhakrishna, Prof. Manish Kumar Bajpai and Prof. U. Venkanna

Five talks on state-of-the-art technologies were organized as a part of second day of NaTFoE 2024.

The main frontiers of each talk are listed below:

- **Quantum Technologies in the National Quantum Mission:** The National Quantum Mission (NQM) has created four technology verticals in quantum computing, communication, sensing and metrology, and materials and devices. These four verticals aim to translate quantum science into applicable technologies that benefit Indian industry and society. The main challenges discussed were Scaling Quantum Systems, efficient Quantum Algorithms, Quantum Materials and Hardware, Quantum Networking and Communication, Error Mitigation and Noise Management, and Standardization and Accessibility.
- **Importance of Remote Photoplethysmography in AI:** Remote photoplethysmography (rPPG) is a contactless technology that estimates physiological parameters such as heart rate, respiratory rate, and blood oxygen saturation using video-based analysis. Coupled with AI, rPPG has become a transformative tool across various domains, emphasizing its significance in modern healthcare, wellness, and beyond. The critical points discussed are AI integration with contactless health monitoring, development of AI algorithms for robust signal interpretation,

leveraging federated learning for privacy-preserving data analysis, and Integration of rPPG into interoperable AI-powered health systems.

- **Quantum Simulators and Accelerators: Harnessing PARAM for Quantum Computing Acceleration:** Quantum simulators and accelerators are crucial in advancing quantum computing, offering the capability to model quantum systems and execute quantum algorithms faster. PARAM, India's Indigenous supercomputing series, plays a vital role in fostering the development of quantum computing acceleration. By integrating quantum simulators and accelerators into its architecture, PARAM can lead India's efforts in quantum research, supporting applications in science, engineering, and beyond. This synergy positions PARAM as a cornerstone in the quantum computing revolution.
- **Symbiotic Relationship Between Artificial Intelligence and Computing Systems Design:** There is a symbiotic relationship between artificial intelligence, primarily machine learning and deep learning, and computing systems design, emphasizing how they have come to influence the progress of each other. Traditionally, we believe in providing more computing power to the ever-increasing complex ML/DL models. The symbiotic relationship between AI and computing systems design reshapes the technological landscape. This interplay drives innovation in AI applications and enhances computing platforms, paving the way for more intelligent, efficient, and sustainable systems. By harnessing this synergy, industries can address emerging challenges in energy, scalability, and real-world AI deployment.
- **AI Infrastructure: Optimizing LLM Inference for Efficiency and Scalability:** Large Language Models (LLMs) are revolutionizing AI applications with their unprecedented language understanding and generation capabilities. However, training and deploying these models at scale can be computationally expensive and resource-intensive. To unlock the full potential of LLMs, it is crucial to optimize their inference process. Optimizing LLM inference for efficiency and scalability is at the frontier of AI infrastructure development. Through innovations in model compression, hardware acceleration, memory optimization, and scalable frameworks, the field is moving toward sustainable, real-time, and accessible LLM deployment. These advancements enable broader adoption of LLMs and ensure their role in shaping transformative applications across industries.

Around 70 faculty and researchers from various engineering institutions participated in the two-day program. 28 posters were presented during the event and in addition a National Level Competition, Innovations in manufacturing practices was dovetailed with the 18th National Frontiers of Engineering (NatFoE-24) Symposium on the second day where students across India presented their innovative ideas.

Innovation in Manufacturing Practices 2024

The *Innovation in Manufacturing Practices (IMP) – 2024*, organized by INAE in collaboration with the National Institute of Technology Warangal under the aegis of the ANRF (SERB) - INAE Conclave on *Atmanirbhar Technologies- Engineering Secured Future*, took place on November 16, 2024. This event brought together a diverse group of participants, including undergraduate and postgraduate (Master's students) as well as start-ups, all presenting innovative ideas and projects related to advancements in the manufacturing sector.

A total of 24 teams participated, pitching their cutting-edge ideas and demonstrating how they could revolutionize manufacturing processes. The event highlighted a broad spectrum of topics, from new manufacturing techniques to sustainability innovations, all aimed at driving progress within the industry.

At the conclusion of the event, cash awards were presented by eminent guests in three distinct categories, recognizing the most outstanding projects. In addition, certificates were distributed to the best poster presentations across four themes, further encouraging participants to engage in deep research and innovative thinking. The event not only provided valuable exposure to the participants but also fostered collaborations, ideas exchange, and inspiration, contributing to the larger goal of fostering an *Atmanirbhar* (self-reliant) manufacturing ecosystem in India.

Highlights:

- Over 28 posters were presented at the symposium, each reviewed by Prof. Sivaji Chakravorti, Prof. Subudhi, and an evaluation committee for each theme. Best poster certificates were awarded to the top presentations.
- The event featured 18 plenary and keynote talks, with a focus on diversity in the topics covered.
- A total of 67 participants from across the country attended the two-day symposium, with 64 participants from IMP presenting their ideas.
- 24 innovative ideas were pitched in the IMP session, out of the 67 submitted.
- Prof. Manna and Prof. Sivaji Chakravorti engaged with the IMP participants, offering valuable insights and feedback while also reviewing the prototypes.
- An MoU was signed between NIT Warangal and Agastya Hydrogen, marking a significant step in advancing collaboration in hydrogen technologies.

Participants, especially students, expressed that the symposium provided an excellent learning opportunity. They were highly motivated and inspired by the posters and exhibits showcased during IMP, which fuelled their enthusiasm for innovation and research in the manufacturing sector.

Pictorial Delight of NatFoE-2024 and IMP-2024



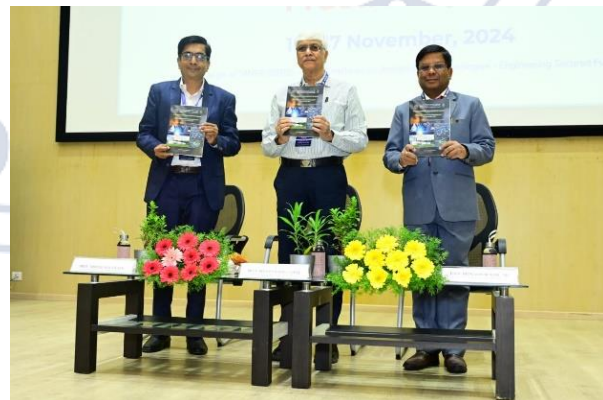
Inauguration of NatFoE at NIT Warangal on Nov 2024 by Prof Sivaji Chakravorti, Vice President INAE, Prof Bidyadhar



Group Photo of participants of NatFoE 2024



Presidential address by Prof Indranil Manna, the then President INAE as part of the Inaugural Function of NatFoE 2024



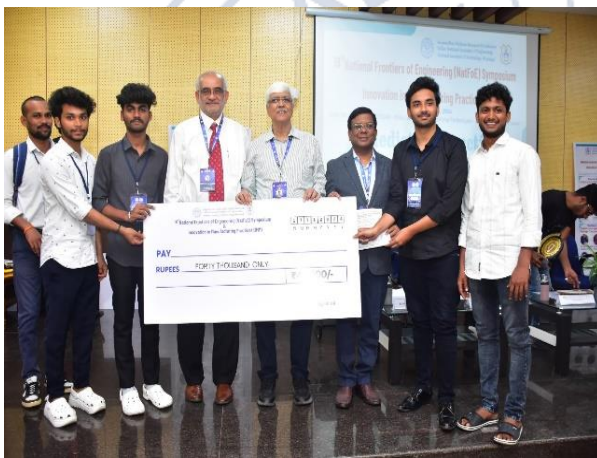
Release of NatFoE Souvenir during Inaugural Function



Memento presented to Prof Indranil Manna, the then President INAE by Prof Bidyadhar Subudhi, Director NIT Warangal



Memento presented to Prof Sivaji Chakravorti, Vice-President INAE by Prof Bidyadhar Subudhi, Director NIT Warangal



Prize Distribution to the winner of Innovation in Manufacturing Practices (IMP) 2024 by INAE leadership



Prize Distribution to the winner of Innovation in Manufacturing Practices (IMP) 2024 by INAE leadership

(ii) INAE Youth Conclave-2024 under the aegis of “ANRF (SERB)-INAE Innovation Hackathon”, December 12-13, 2024, IIT Bhilai

The Youth Conclave 2024 was organized at the Indian Institute of Technology Bhilai from December 12-13, 2024 under the aegis of “ANRF (SERB)-INAE Innovation Hackathon”. For this year’s Youth Conclave 2024 at IIT Bhilai, the theme was selected as AgriTech, HealthTech, FinTech, and Sustainable Technologies. The objective was to provide a platform to Bachelor/Master’s and Doctoral Level youth to express their technological creativity in these thematic areas. The conclave themes were chosen to promote engineering excellence, innovation, and youth leadership.

The Youth Conclave 2024 was inaugurated in the esteemed presence of Prof. N V Ramana Rao (Director, NIT Raipur), Prof. Sivaji Chakravorti (Vice President, INAE), Prof. Rajiv Prakash (Director, IIT Bhilai), and Dr. Nagesh D. Patil (Coordinator, Youth Conclave 2024, Associate Professor, IIT Bhilai). During the Inauguration ceremony (via online mode), Prof. Indranil Manna (the then President, INAE) delivered a magnificent presidential address. Further, Prof. Rajiv Prakash encouraged the participating students to come-up with new ideas that will be helpful for solving real-life problems in an amicable way. Prof. Sivaji Chakravorti shared his experience from industry and academia and discussed about frugal innovation. Prof. N V Ramana Rao expressed the significance of Innovation in Agritech, Healthtech, Fintech, and Sustainable technologies.

The conclave featured keynote lectures delivered by accomplished experts in their respective fields, who shared their insightful experiences and motivated the students for innovation and entrepreneurship. Some of the notable speakers included:

1. Prof N V Ramana Rao, Director, NIT Raipur (Title of talk: Innovation in Agritech, Healthtech, fintech and sustainable technologies)
2. Prof. Sivaji Chakravorti, Vice President, INAE (Title of talk: The backbone of sustainable human capital)
3. Prof. P. Chakrabarti, Former Director, IEST Shibpur & NIT-Allahabad, and Former Professor, IIT BHU, Varanasi (Title of talk: Impact of Disruptive Innovations on Industries)
4. Mr. Prashant Mathur, CEO, Innovation and Technology Foundation (IBITF), NM-ICPS – DST (Title of talk: Innovations and entrepreneurship)

Other than keynote lectures, the conclave featured a series of engaging events such as several Oral Presentations, Poster Presentations, and Innovation Hackathon Presentations by participating students.

The Youth Conclave 2024 received an overwhelming response from the engineering students of various universities and engineering colleges in and around Chhattisgarh state. The total participation of almost 220 engineering students was evident during Conclave 2024, where they presented and discussed their ideas on themes related to AgriTech, HealthTech, FinTech, and Sustainable Technologies. During the program, all the participants were given opportunity to present their vision through oral and poster presentations. These intuitive minds also got opportunity to participate in Innovation Hackathon for showcasing their skills and honing them further. For encouraging these students, IIT Bhilai conclave technical committee rigorously evaluated their ideas and suggested them with future scopes.

The Youth Conclave 2024 came to an end with the valedictory session. During valedictory session, Prof. P. Chakrabarti and Prof. Rajiv Prakash emphasized the need for innovation in engineering and technology for betterment of society and country at large. The participants were presented the participation certificates and also the winners for oral, poster, and hackathon presentation were felicitated. The end of valedictory session marked the successful beginning for igniting the spark for innovation and scope of new technologies among these Young Participants from different parts of India.

Some Photographs of the events:



The dignitaries are lighting the lamp during the inaugural ceremony on 12th Dec, 2024



Prof Indranil Manna, President, INAE delivering his Presidential Address during Inaugural function



Participating Students attending the keynote address



Some Photos of Participating Students presenting Oral and Poster Presentations



Group Photograph after the Keynote Lecture of Prof. Sivaji Chakravorti, Vice-President, INAE



Some Photographs during the Felicitation of Winners of Oral, Poster, and Hackathon Presentations



Group Photograph after the Valedictory Function in evening on 13th Dec, 2024

(i) **Poster Session organized under the aegis of “SERB (ANRF)-INAE Conclaves on Atmanirbhar Technologies - Engineering Secured Future” at IIT Delhi**

A Poster Session and competition was held under the aegis of “SERB (ANRF)-INAE Conclaves on Atmanirbhar Technologies - Engineering Secured Future” for Masters’ Students and PhD Scholars of IIT Delhi on Dec 19-20, 2024 on the sidelines of the INAE Annual Convention 2024. This was a golden opportunity for them to showcase their research contributions in ten broad engineering disciplines. The Posters were judged by a panel of expert jury members from INAE Fellowship and Faculty of IIT Delhi who also interacted with the students and asked pertinent questions. The prize distribution of the Poster Session and competition, was held on Dec 20, 2024. The students appreciated the Poster Competition and also appreciated the lectures on both days and gained insightful knowledge through the conduct of the Poster Session and participation in the convention.

Some Glimpses of Judging of the Poster Session at IIT Delhi



Prof SM Ishtiaque Judging the Posters



Judging by Prof Mahesh Tandon, FNAE & Mr VN Heggade, FNAE



Prof Sushmita Mitra, FNAE & Dr Lipika Dey, FNAE Judging Posters



Prof Suddasatwa Basu, FNAE evaluating Posters



Evaluation by Dr Archana Sharma, FNAE



Prof Maithili Sharan, FNAE in Judging Process

Pictorial Delight of Prize Distribution for Poster Session



Prof Sivaji Chakravorti, Vice-President, INAE (Extreme left) and Prof. Naresh Bhatnagar, FNAE, Dean (R & D), IIT Delhi (Extreme Right) presenting the Prizes to Winners of the Poster Session.



Prof Sivaji Chakravorti, Vice-President, INAE (Extreme left) and Prof. Naresh Bhatnagar, FNAE, Dean (R & D), IIT Delhi (Extreme Right) presenting Prizes to the Winners of the Poster Session.

INAE Events

INAE Annual Convention 2024

The Indian National Academy of Engineering (INAE) Annual Convention 2024 was held on December 19-21, 2024 hosted at Indian Institute of Technology Delhi, New Delhi. The Convention of the Academy was mega event attended by Fellows, Foreign Fellows, Young Associates, Scientists, Faculty and students of IIT Delhi and Invitees. This year's Annual Convention was made even more memorable as the Chief Guest of the Inaugural Session was Shri Rajnath Singh, Hon'ble Raksha Mantri, Ministry of Defence, Government of India. The Convention started with the traditional lighting of the lamp and invocation followed by the Welcome Addresses by Prof Indranil Manna, President, INAE and Prof. Rangan Banerjee, Director, IIT Delhi. A Visual Presentation on INAE was featured which gave a brief overview of Indian National Academy of Engineering (INAE) since inception and highlighted some of the major technical activities and contributions that have increased the visibility and outreach of the Academy in the National and International engineering domain. This was followed by release of Convention Souvenir featuring brief profiles of the newly elected Fellows, Foreign Fellows and Young Associates and it also contained details of the newly Instituted Memberships- Institutional, Corporate and Individual that has helped bring a larger section of the engineering community under the folds of the Academy.

The much awaited address by the Chief Guest Shri Rajnath Singh, Hon'ble Raksha Mantri was inspirational and though provoking and enthralled the august audience with his deep words of wisdom. During his speech he brought out that India is passing through a defining moment and will soon achieve a formidable technical edge in international arena. He exhorted scientists and engineers to specialise in high-end technologies for strengthening India's position in cutting-edge innovation. He also emphasized the calls to stay connected with the country's heritage while forging ahead and accentuated the need to establish better organic relationship among industry, R&D organisations and academia to achieve progress in disruptive technologies. The Chief Guest – Shri Rajnath Singh, Hon'ble Raksha Mantri, Ministry of Defence, Government of India and Guests of Honour –Dr Samir V Kamat, Secretary DDR&D and Chairman DRDO and Shri SN Subrahmanyam, Chairman & MD, Larsen & Toubro Ltd were felicitated by Prof Indranil Manna, President, INAE and Prof Rangan Banerjee, Director, IIT Delhi.



Dignitaries on the Dais during Visual presentation on INAE in Inaugural Session: Left to Right – Prof Indranil Manna, FNAE, the then President, INAE; Guest of Honour - Shri SN Subrahmanyam, FNAE, Chairman & MD, Larsen & Toubro Ltd; Chief Guest - Shri Rajnath Singh, Hon'ble Raksha Mantri, Ministry of Defence, Government of India; Guest of Honour -Dr Samir V Kamat, FNAE, Secretary DDR&D and Chairman DRDO and Prof Rangan Banerjee, FNAE, Director, IIT Delhi.



Release of INAE Annual Convention 2024 Souvenir by the Dignitaries on the Dais



Presentation of Memento to the Chief Guest- Shri Rajnath Singh, Hon'ble Raksha Mantri, Ministry of Defence, Government of India by Prof Indranil Manna, the then President, INAE



Presentation of Memento to the Guest of Honour - Shri SN Subrahmanyam, FNAE, Chairman & MD, Larsen & Toubro Ltd by Prof Indranil Manna, the then President, INAE



Presentation of Memento to the Guest of Honour - Dr Samir V Kamat, FNAE, Secretary DDR&D and Chairman DRDO by Prof Rangan Banerjee, FNAE, Director, IIT Delhi.



Chief Guest –Hon'ble Raksha Mantri Shri Rajnath Singh Delivering Inaugural Address

The highlights of the INAE Annual Convention 2024 on Day 1 were the Lectures by eminent leaders in the field of engineering & technology: Plenary Lectures by Shri SN Subrahmanyam, Chairman & MD, Larsen & Toubro Ltd and Dr. SV Kamat, Secretary DDR&D and Chairman DRDO, Ministry of Defence, New Delhi; Key-note Lectures by Dr Ajay Kumar, former Secretary Defence (Production) and Defence Secretary, Ministry of Defence, New Delhi and Dr. Ajay Mathur, DG, International Solar Alliance and Distinguished Lectures by Dr Manish Gupta, Director, Google Research India, Bangalore and Dr. SK Sarin, Director, ILBS and Former President, NAMS, a medical practitioner who highlighted the interface of engineering with medicine.



Plenary Lecture being delivered by Shri SN Subrahmanyam, FNAE, Chairman & MD, Larsen & Toubro Ltd and Dr BN Suresh, Former President, INAE Presenting a Token of Gratitude to him on behalf of INAE



Plenary Lecture being delivered by Dr. SV Kamat, Secretary DDR&D and Chairman DRDO, Ministry of Defence, New Delhi and Dr Sanak Mishra, Former President, INAE Presenting a Token of Gratitude to him on behalf of INAE



Key-note Lecture being delivered by Dr Ajay Kumar, former Secretary Defence (Production) and Defence Secretary, Ministry of Defence, New Delhi and Mr JD Patil, the then President Designate, INAE Presenting a Token of Gratitude to him on behalf of INAE



Key-note Lecture being delivered by Dr. Ajay Mathur, DG, International Solar Alliance and Prof Rangan Banerjee, FNAE, Director, IIT Delhi Presenting a Token of Gratitude to him on behalf of INAE



Distinguished Lecture being delivered by Dr. SK Sarin, Director, ILBS and Former President, NAMS and Prof Sivaji Chakravorti, Vice President, INAE Presenting a Token of Gratitude to him on behalf of INAE



Distinguished Lecture being delivered by Dr Manish Gupta, Director, Google Research India, Bangalore and Dr Rajeev Shorey, FNAE Presenting a Token of Gratitude to him on behalf of INAE

The INAE Governing Council Meeting was held on the evening of Dec 19, 2024 as per practice each year in the month of December 2024. An “Elevating Program” by SPIC MACAY was organized before the dinner on Day 1 featuring an entertaining Kathak recital by the famous artiste Vidushi Shovana Narayan.

ESTD - 1987



Kathak recital by SPIC MACAY by artiste Vidushi Shovana Narayan and the troupe.

The second day of the INAE Annual Convention i.e. Dec 20, 2024 commenced with the brief presentations on Technical Reports by the Conveners of the 10 INAE Sectional Committees based on the 10 broad based INAE Engineering Sections covering the entire spectrum of engineering disciplines. The genesis of this initiative is that the INAE Sectional Committees were requested to prepare 1-2 reports as a Technology Forecast/Review/Gap Analysis/Databases/analytics Document which is unique so as to make a marked difference in the respective domains and serve as a reference document for Government Departments/Agencies and other stakeholders as a roadmap for advancing the technology area in the country. The presentations highlighted the roadmap documents under preparation and were well appreciated.



Presentation by Prof KK Pant, FNAE for SC IV



Presentation by Prof L Umanand, FNAE for SC V



Presentation by Prof Suddasatwa Basu, FNAE for SC IX



Presentation by Prof Sandeep Verma, FNAE for SC X

The main technical features of Day 2 were the technical presentations by the newly elected Fellows and Young Associates on their engineering contributions that have brought them acclaim and have led to their election as Fellows and selection as Young Associates. The lectures were followed by Q&A and were illuminating and inspired the audience and also guided the student attendees who were enthused in their research work by the depth of knowledge and skills of the presenters.



Presentations by Newly Elected Fellows



Presentations by Young Associates

The evening session commenced with a Panel Discussion on “Road Map for Viksit Bharat” moderated by Prof Indranil Manna, President, INAE and the panellists were eminent experts from Academia/R&D organizations and Industry viz Dr. Tapan Sahoo, Executive Director (Engineering), Maruti Suzuki India Limited who covered the topic “Mobility” Dr. Mahesh Gupta, Chairman & MD, Kent RO Systems Ltd. Who touched upon “Water & Sanitation”; Prof. Manindra Agrawal, Director, IIT Kanpur who spoke on “Cyber Security” and “Renewable Energy” was covered by Dr. Ajay Mathur, DG, ISA, New Delhi. The Panellists responded to pertinent questions and expounded the challenges and opportunities on the path to a Viksit Bharat as envisaged by the Hon’ble Prime Minister by 2047. The deep insight and perception of the panellists added value to the rich technical content of the programme and were much appreciated by the eminent audience and students alike.



Panel Discussion on “Road Map for Viksit Bharat” (Left to Right) –Prof Manindra Agrawal, FNAE, Director, IIT Kanpur; Dr. Ajay Mathur, DG, ISA; Prof Indranil Manna, the then President, INAE; Dr. Mahesh Gupta, Chairman & MD, Kent RO Systems Ltd and Dr. Tapan Sahoo, Executive Director (Engineering), Maruti Suzuki India Limited.

This was followed by a motivational Fireside Chat in the areas of “Manufacturing” and “AI” with Mr. Bhavish Aggarwal, Founder & Chairman of Ola Consumer, Ola Electric, and India’s first AI unicorn Ola Krutrim as the Guest. The Session was moderated by Prof UB Desai, Vice-President, INAE who asked pertinent questions and the session was interesting, informative and the interactive part much appreciated by one and all. The essence of the Fireside Chat was that not only the technical issues were highlighted but the informal discussions and questions by the students of IIT Delhi enthused them and brought out the importance and success of entrepreneurship of the Guest, as an example to be emulated. The Networking Dinner was a befitting closure to Day 2 after a day filled with technical inputs and provided a platform for meaningful interactions.



Fireside Chat Moderated by Prof UB Desai, Vice-President, INAE (Left) with Mr. Bhavish Aggarwal, Founder & Chairman of Ola Consumer, Ola Electric, and India’s first AI unicorn Ola Krutrim (Right) as the Guest.

The third day of the INAE Annual Convention 2024 commenced with the Session on Follow-up discussion on “AI/ML: Future Directions, Threats, and Way Forward” moderated by Prof. UB Desai, Former IIT Hyderabad Director and Vice-President, INAE. The Panellists were eminent industry experts viz: Dr. Anand Deshpande, Founder, Chairman and Managing Director of Persistent Systems; Prof. Vineeth N Balasubramanian, IIT Hyderabad; Dr. Rajeev Rastogi, VP ML Amazon India; Dr. Harish Iyer, Melinda and Bill Gates Foundation and Dr. Shubhashis Gangopadhyay, Vice Chairperson, Center for Digital Future, and Founding Dean of ISPP, Economics, Law, Policy Praxis Lab. The relevant issues in the field of Artificial Intelligence and Machine Learning and the challenges and opportunities for advancement in this field that shall help progress of the nation and also ensure a better life for the citizens were deliberated during the discussion.



Session on AI/ML: Future Directions, Threats, and Way Forward” moderated by Prof. UB Desai, Vice-President, INAE (Left to Right) Prof. Vineeth N Balasubramanian, IIT Hyderabad; Dr. Rajeev Rastogi, VP ML Amazon India; Prof. UB Desai, Vice-President, INAE; Dr. Anand Deshpande, Founder, Chairman and Managing Director of Persistent Systems; Dr. Shubhashis Gangopadhyay, Vice Chairperson, Center for Digital Future, and Founding Dean of ISPP, Economics, Law, Policy Praxis Lab and Dr. Harish Iyer, Melinda and Bill Gates Foundation.

The Annual General Meeting and Special General Meeting of the Fellows brought an end to the technical events and deliberations and the Induction Ceremony of newly elected Fellows, Foreign Fellows and Young Associates was a memorable moment for the new inductees, as well as their peers and parent organizations to whom they have brought glory by advancing the growth of engineering and technology in their respective domains. After the Networking Lunch the delegates bade farewell and would look forward to the Conventions in future years, as a Calendar event that would be eagerly awaited with meaningful outcomes.



AGM in Progress: (Left to Right) Mr JD Patil, the then president, Designate, INAE; Prof Indranil Manna, the then President, INAE; Prof Sivaji Chakravorti, Vice-President, INAE and Prof UB Desai, Vice-President, INAE

A few Glimpses of Induction Ceremony of Fellows and Young Associates



Mr Sanjay Kirloskar Being Inducted as an INAE Fellow by Prof Indranil Manna, the then President, INAE in presence of Prof Sivaji Chakravorti, Vice-President, INAE



Dr C Bharathi Priya Being Inducted as a Young Associate by Prof Indranil Manna, the then President, INAE in presence of Prof Sivaji Chakravorti, Vice-President, INAE

(To view all photographs of the INAE Annual Convention 2024 click on the link <https://www.dropbox.com/scl/fo/b722xym7r2xxbq8spfi0b/ABNiMIJ2TSZK1AksIPGwykU?rlkey=ax6f2isivbh6sequeddda3t2i&st=kib7nosr&dl=0>)

The INAE Annual Convention 2024 was supported by Department of Science and Technology (DST), Government of India and Anusandhan National Research Foundation (ANRF) and partly sponsored by Maruti Suzuki Innovation and Ola.

Local Chapter Activities and Webinar Series held during October 2024 to January 2025

The following Webinars/activities/meetings/Technical Lectures were conducted during October 2024 to January 2025 by INAE and Local Chapters.

INAE Bhubaneswar Chapter

- (i) The 40th Distinguished Lecture of INAE Distinguished Lecture Series was jointly organised by INAE Bhubaneswar Chapter, SOA University, CSIR-IMMT Bhubaneswar, IIT Bhubaneswar, NISER Bhubaneswar and IEEE Bhubaneswar Sub-section and delivered by Prof. Sudeshna Sarkar, Professor, Department of Computer Science & Engineering, IIT Kharagpur on 1st October 2024 on “Uncovering Bias and Perspectives in News: NLP Approaches for Automated Content Analysis” in virtual mode.

Key Points: In today’s media landscape, where news reporting is often subjective, understanding diverse perspectives is essential. This talk delved into automated news content analysis using Natural Language Processing (NLP) techniques to extract events and arguments, and for examining biases and variations in news coverage. They focused on identifying selection, coverage, and statement biases through both machine learning (ML) and large language model (LLM)-based approaches. Key tasks included event extraction, stakeholder analysis, sentiment prediction, and bias detection, with a particular emphasis on few-shot and zero-shot settings to enhance model generalizability across various news domains. Notable contributions include a joint event extraction model, a natural language inference method for news aspect identification, and stakeholder classification using P-tuning. Additionally, they explored methods to mitigate sentiment bias in news articles using sentence rewriting techniques. This research introduces innovative methodologies, advancing computational journalism and providing valuable tools for analyzing modern media narratives.

You Tube Video Recording Link : <https://youtu.be/U2L9wdbXTNk>

People Participated: 62

- (ii) The 41st Distinguished Lecture of INAE Distinguished Lecture Series was jointly organised by INAE Bhubaneswar Chapter, SOA University, CSIR-IMMT Bhubaneswar, IIT Bhubaneswar, NISER Bhubaneswar and IEEE Bhubaneswar Sub-section and delivered by Dr. Shankar S Mantha, Chancellor, RB University, Nagpur on 3rd October, 2024 on “AI in Education” in virtual mode.

Key Points: The application of Artificial Intelligence (AI) in education holds the potential to revolutionize the learning experience for both educators and students. AI technologies, such as sentiment analysis algorithms, can be trained to interpret complex emotions and concepts, including those found in Sanskrit Shlokas. By identifying not only the positive or negative sentiments but also the specific emotions conveyed in the text, AI offers deeper insights into educational content and emotional intelligence, paving the way for more personalized and effective learning experiences.

You Tube Video Recording Link : <https://youtu.be/zs7Mibf94vM>

People Participated: 49

- (iii) The 42nd Distinguished Lecture of INAE Distinguished Lecture Series was jointly organised by INAE Bhubaneswar Chapter, SOA University, CSIR-IMMT Bhubaneswar, IIT Bhubaneswar, NISER Bhubaneswar and IEEE Bhubaneswar Sub-section and delivered by Prof. Debdeep Mukhopadhyay, Institute Chair Professor, Dept. of Computer Science and Engineering, Indian Institute of Technology Kharagpur on 30th October, 2024 on “Hardware Security in the Modern World: From Things to Cloud” in virtual mode.

Key Points: Cryptography plays a vital role in securing electronic transactions. However, in spite of their mathematical robustness when these algorithms are translated to concrete implementations there can be opportunities for attacks due to weaknesses in underlying implementations. Hardware Security addresses this gap between theory and practice, and attempts to model these menacing side-channel leakages. The talk emphasized some key findings in this amazing journey of translating crypto-theory to practically secure-systems, starting with an optimal differential-fault-analysis of the Advanced-Encryption-Standard, which is the de-facto standard block-cipher world-wide. Subsequently, a quick peek was taken into the contributions in fault-tolerance in cryptography, where the researchers unearth how countermeasures can be compromised using novel fault-analysis, along with how such countermeasures can be assessed for leakage using scalable test-methodologies. The talk then shifted its focus to the domain of micro-architectural leakages which presents some of the earliest reports world-wide of exposing how computer architecture developed with only performance in perspective can compromise ciphers. The talk subsequently briefed their fundamental contributions in promoting usage of novel hardware-security primitives, called Physically-Unclonable-Functions for authentication in resource constrained environments, like Internet-of-Things (IoT). The talk concluded with their recent break-through in making encrypted-search a reality, addressing privacy concerns in the pervasive cloud.

You Tube Video Recording Link : <https://youtu.be/DnF9QUmb5aY>

People Participated: 178

- (iv) The 43rd Distinguished Lecture of INAE Distinguished Lecture Series was jointly organised by INAE Bhubaneswar Chapter, SOA University, CSIR-IMMT Bhubaneswar, IIT Bhubaneswar, NISER Bhubaneswar and IEEE Bhubaneswar Sub-section and delivered by Dr. Shibashish Giri, Endogenous stem cell specialist in Medical Research and Therapy in Medical faculty of University of Leipzig and Technical University of Munich, Germany and Chief Scientific Officer (AB Company, UK, USA) adjunct professor in MIPT, Moscow, Russia and other European Universities on 13th November, 2024 on “Nobel Discoveries for Health and wellness” in virtual mode.

Key Points: The Nobel Prize-winning technology of 2023 in medicine have witnessed a revolutionary development in the field of mRNA technology in medicine, have now become universally accepted for best solution for both early diagnostic as well as for therapeutic applications for all kind of diseases. The researchers have also discovered wide range of mRNA and established mRNA profiles to detect diabetic, prediabetic, osteoporosis, heart blockage, liver cancer, fatty liver and breast cancer in 5 to 7 years in advance. Conventional diagnostics are complex, expensive and time consuming, but the mRNA diagnostic could be a simple, blood based super sensitive diagnostic tool to detect the diseases in very early stage. Crucially, mRNA technology is simple enough that it should be possible to make these next generations of treatments and diagnostic wide range diseases around the world including Odisha, at low cost, even in places with few resources. The mRNA-based inventions presented could be a next generation state-of-the-art technique in early diagnostic tools production and have huge therapeutic potentials.

You Tube Video Recording Link : <https://youtu.be/AyvTe6U2tQU>

People Participated: 125

- (v) The 44th Distinguished Lecture of INAE Distinguished Lecture Series was jointly organised by INAE Bhubaneswar Chapter, SOA University, CSIR-IMMT Bhubaneswar, IIT Bhubaneswar, NISER Bhubaneswar and IEEE Bhubaneswar Sub-section and delivered by Prof. Ashok Kumar Gupta, Professor (HAG) in the Environmental Engineering Division in the Department of Civil Engineering at the Indian Institute of Technology Kharagpur on 14th November 2024 on “Transforming India’s water and wastewater management: Treatment technologies, Sustainable Practices, and Resource Recovery” in virtual mode.

Key Points: With the advent of human civilization, water and wastewater management have been integral aspects of human life, as evident from the developments of the Indus Valley civilization. While certain challenges remain unchanged, such as the need for clean water, advancements in technology, and population growth have introduced new complexities that must be addressed scientifically and sustainably. In this regard, the presentation addressed the state of water and wastewater management in India. It emphasized the amount of wastewater generated, existing treatment technologies, and policy aspects. It also highlighted natural and sustainable methods for treating wastewater, along with effective fecal sludge management techniques and resource recovery practices. Additionally, the discussion covered current water demand, the installed capacity of water treatment plants, and innovative space-saving technologies. Furthermore, various government initiatives for water supply in both rural and urban areas were presented. By focusing on these aspects, the presentation aimed to provide insights into the challenges and solutions for managing water resources effectively across the country.

You Tube Video Recording Link : https://youtu.be/oiMu_FZ7t8Q

People Participated: 65

- (vi) The 45th Distinguished Lecture of INAE Distinguished Lecture Series was jointly organised by INAE Bhubaneswar Chapter, SOA University, CSIR-IMMT Bhubaneswar, IIT Bhubaneswar, NISER Bhubaneswar and IEEE Bhubaneswar Sub-section and delivered by Prof. Makarand Madhao Ghangrekar, Director of National Institute of Technology, Puducherry and Professor in Department of Civil Engineering, IIT Kharagpur on 16 November, 2024 on “Biological and bio-electrochemical wastewater treatment technologies and their efficacies for imparting sustainability to wastewater treatment”.
- (vii) The 46th Distinguished Lecture of INAE Distinguished Lecture Series was jointly organised by INAE Bhubaneswar Chapter, SOA University, CSIR-IMMT Bhubaneswar, IIT Bhubaneswar, NISER Bhubaneswar and IEEE Bhubaneswar Sub-section and delivered by Prof. Pradip Dutta, Professor, Centre for Energy Research, Department of Mechanical Engineering, Indian Institute of Science, Bangalore on 25th November, 2024 on “Transition to Clean Energy – New R&D Opportunities for Engineers” in virtual mode.
- (viii) The 47th Distinguished Lecture of INAE Distinguished Lecture Series was jointly organised by INAE Bhubaneswar Chapter, SOA University, CSIR-IMMT Bhubaneswar, IIT Bhubaneswar, NISER Bhubaneswar and IEEE Bhubaneswar Sub-section and delivered by Prof. Hirendra N. Ghosh, National Institute of Science Education and Research (NISER), Bhubaneswar, Odisha on 26th November 2024 on “Ultrafast Charge Carrier Dynamics of 2D-Transition Metal Chalcogenides Based Heterosystems” in virtual mode.
- (ix) The 48th Distinguished Lecture of INAE Distinguished Lecture Series was jointly organised by INAE Bhubaneswar Chapter, SOA University, CSIR-IMMT Bhubaneswar, IIT Bhubaneswar, NISER Bhubaneswar and IEEE Bhubaneswar Sub-section and delivered by Shri Skuanta Nanda, Architect and Mentor, AI and HPC Research Center, IIT Bhubaneswar on 28th November, 2024 on “Cybersecurity Attacks and Risk Mitigation Strategies for Critical Infrastructures’ in virtual mode.
- (x) The 49th Distinguished Lecture of INAE Distinguished Lecture Series was jointly organised by INAE Bhubaneswar Chapter, SOA University, CSIR-IMMT Bhubaneswar, IIT Bhubaneswar, NISER Bhubaneswar and IEEE Bhubaneswar Sub-section and delivered by Prof. Sunil Murlidhar Shastri, Consultant, Educator and Speaker in Ocean and Environmental Governance on 6th December, 2024 on “One Ocean, Three Approaches, Five Issues, Seven Solutions” in virtual mode.
- (xi) The 50th Distinguished Lecture of INAE Distinguished Lecture Series was jointly organised by INAE Bhubaneswar Chapter, SOA University, CSIR-IMMT Bhubaneswar, IIT Bhubaneswar, NISER Bhubaneswar and IEEE Bhubaneswar Sub-section and delivered by Prof. Jyotsna Dutta Majumdar, *FNAE*, Institute Chair Professor, Dept. of Metallurgical & Materials Engineering, Indian Institute of Technology Kharagpur on 10th December, 2024 on “Increased Lifetime of Metallic Bio-Implants by Surface Engineering” in virtual mode.
- (xii) The 51st Distinguished Lecture of INAE Distinguished Lecture Series was jointly organised by INAE Bhubaneswar Chapter, SOA University, CSIR-IMMT Bhubaneswar, IIT Bhubaneswar, NISER Bhubaneswar and IEEE Bhubaneswar Sub-section and delivered by Prof. Durga Misra, Department of Electrical and Computer Engineering, New Jersey Institute of Technology, Newark on 30th December, 2024 on “Low Power Devices for In-Memory Computing Hardware” in hybrid mode.

- (xiii) The 52nd lecture of the INAE Distinguished Lecture Series was organized by INAE Bhubaneswar Chapter, jointly with SOA University, CSIR-IMMT Bhubaneswar, IIT Bhubaneswar, NISER Bhubaneswar and IEEE Bhubaneswar Sub-section and delivered by Prof. Swagata Dasgupta, Department of Chemistry, IIT Kharagpur on 30th January, 2025 on “The Twists and Turns of Protein Chemistry”.

INAE Delhi Chapter

A Seminar by Professor Dr T.G. Sitharam, *FNAE*, Chairman, All India Council for Technical Education (AICTE) on “Indigenous Knowledge in India on Civil Engineering” was jointly organized by INAE Delhi Chapter, the Indian Knowledge Systems (IKS) Program sponsored by the Ram & Mithlesh Gupta Foundation at Indian Institute of Technology (IIT) Delhi and Department of Civil Engineering at IIT Delhi in hybrid mode on 1st January 2025.

INAE Kolkata Chapter

Annual Meeting of INAE Kolkata Chapter was held at Center for Soft Computing Research, Kolkata on 29th January 2025 to discuss the following Agenda: Reporting the activities of INAE Kolkata Chapter for the year 2024; Proposal for INAE activities for the current year; Election of the office bearers and any other matters.

INAE Mumbai Chapter

INAE Mumbai Chapter in association with Centre of Excellence in Oil, Gas and Energy-IIT Bombay jointly organized a Webinar delivered by Professor (Dr.) Ganpati D Yadav, National Science Chair Govt. of India; Emeritus Professor of Eminence; Former Vice Chancellor, Institute of Chemical Technology, Mumbai on “Aiming for the Net Negative Goal to Achieve Sustainability: Role of Green Hydrogen in Energy Security, Decarbonization, Biomass Valorization & Waste Plastic Recycling” on 16th October 2024 at IIT Bombay, Mumbai in hybrid mode.

INAE Forums

I. Meetings of INAE Forum on Civil Infrastructure

The Forum had undertaken a study on “Sustainability of the Built Environment”, so as to prepare a report with recommendations on policies and actions required for sustainability in respect of civil infrastructure. The issues being addressed include sustainability at all stages, like functional design, detailed engineering, selection of materials, construction methodology, construction management; Recyclability and use of waste materials in the building and construction sector. Meetings were held of the Forum on October 1, 15, 18, 2024 and Dec 2, 30, 2024 and January 31, 2025. The timeline for completing the Chapter drafts was decided to be the end of April 2025. The details and modalities for the proposed workshop on the subject were discussed and it was decided that the workshop be held on 11 March, 2025 preferably in the in-person mode. The domain experts were identified to participate in the workshop and a letter of request from the INAE was sent to them accompanied by a one-page summary of the study in hand along with the abridged list of contents as background material for the deliberations.

Joint Initiatives with DST

I. The Women in Space and Allied Sciences Leadership Programme (WiSLP), New Delhi

The Women in Space and Allied Sciences Leadership Programme (WiSLP) was held from 21–24 of January 2025 at the Aryabhata Hall, Department of Science and Technology (DST), New Delhi, India. The programme was organised by the DST and the UK-India Education and Research Initiative (UKIERI), India, delivered by the British Council, India and the Coventry University, UK, and hosted by the DST and the Indian National Academy of Engineering (INAE). The initiative focuses on supporting institutions and women scientists in fostering and strengthening women's leadership. The 4-day fully residential workshop featured various activities that gauged and honed the communication, decision-making, and technical skills of the candidates, especially skills relevant to the areas of leadership, administration, and financial management.

The programme enabled the candidates to nurture a leadership identity, inculcate confidence, and facilitate effective communication. In addition, they learned the role of ethics and tangible knowledge of intellectual property rights (IPR) and Indian policies in the building of a leader, who is capable of delivering optimum governance and effecting strategic management of academic institutions.

❖ Identifying Candidates

The WiSLP aims to empower women scientists in the field of space and allied science areas in India towards leadership and governance roles. These potential leaders will be provided mentoring and training workshops under the programme in order to hone their skill sets required for such attaining leadership positions.

Applications were invited from women scientists with promising research credentials from various scientific and technical Indian institutions and universities. Candidates were shortlisted based on the following eligibility criteria:

- Regular employed women Scientists (early and mid-career) working in S&T institution, in the age range of 35–50 years.
- Area of research interest related with space or any of the allied areas of S&T

The candidates were shortlisted by a selection committee, on the basis of factors including recognized leadership potential, demonstrated initiative, and excellent performance in academics & research. Justification for candidature provided by the applicants was also considered for identifying potential candidates for the training. Travel support of up to Rs. 14,000, in addition to airport pickup and drop facility, and accommodation for four days was provided to the shortlisted candidates.

❖ Day-wise Highlights of the Programme

The inaugural session of the Women in Space and Allied Sciences Leadership Programme (WiSLP) set the stage for an empowering four-day workshop aimed at fostering leadership among women scientists in space and allied sciences. The session commenced with welcome remarks by Dr. Vandana Singh, Head of the WISE-KIRAN Division, DST, New Delhi. Following this, Mr. Michael Houlgate, Deputy Director, British Council India, delivered the opening remarks, emphasizing the significance of international collaboration in leadership development. Eminent dignitaries, including Mr. Pradeep Chaturvedi, Vice-President (Academic, Professional, & International Affairs), INAE, New Delhi, and Ms. A. Dhanalakshmi, Joint Secretary, DST, Govt. of India, New Delhi, highlighted the national and international initiatives that support women in STEM leadership roles.



Dr. Vandana Singh, Head, WISE-KIRAN Division, DST, New Delhi (extreme left) with key invitees Mr. Pradeep Chaturvedi, Vice-President (Academic, Professional, & International Affairs), INAE, New Delhi (left), Ms. A. Dhanalakshmi, Joint Secretary, DST, Govt. of India, New Delhi (centre), and Mr. Michael Houlgate, Deputy Director of the British Council India (right) during the inaugural session

Ms. A. Dhanalakshmi, in her address, highlighted the importance of gender parity in the country. She also mentioned that such workshops will provide pathways to women scientists for rising the ladder and attaining leadership position in science and research careers. Mr. Pradeep Chaturvedi, during his address, provided an insightful overview of the INAE and its various programmes. He highlighted the Academy's key initiatives aimed at fostering innovation, research, and excellence in engineering. Furthermore, Mr. Chaturvedi elaborated on both international and national activities undertaken by INAE, emphasizing their significance in supporting aspiring engineers and professionals. These initiatives provide valuable opportunities for participants to engage in collaborative research, knowledge-sharing, and professional development. The session concluded with a vote of thanks proposed by Lt Col Shobhit Rai (Retd), Deputy Executive Director, INAE, New Delhi, marking the official commencement of the programme.

Following the vote of thanks, the first training session of the day began with the trainers Prof. Elena Gaura, Associate Pro Vice-Chancellor (Research) (Academic Engagement) and Prof. James Brusey, Professor of Computer Science, Research Centre for Computational Science and Mathematical Modelling, from the Coventry University, UK, introducing the WiSLP to the candidates. They elaborated upon the programme's intent and goals, especially the development of mentoring and networking skills. The candidates acknowledged the importance of mutual understanding in the program's success. They recapitulated as well as updated their knowledge of online collaborative tools and established the digital setup and resources required for subsequent sessions.

A 40-minute talk by Shri Rohit Kumar (Director, Finance, DST) on financial management followed, wherein the candidates learnt key aspects of financial policies, planning, and budgeting as well as grant and risk management. They were acquainted with general financial rules (GFR) for procurement, the GeM portal, and types of tenders. He explained the concepts of grant-in-aid and financial propriety as well as the ideal elements for efficient management of public money.



Shri Rohit Kumar, Director, Finance, DST, New Delhi, during his talk on Financial Management: Key Aspects, Tools, and Resources

This was followed by a 90-minute discussion on the role of women in leadership, highlighting their contributions to space science through the Space Superstars initiative. After lunch, the session explored leadership traits (and how to acquire them), the difference between leadership and management, and the signature of a good leader, employing group and individual activities. Another networking break allowed for building peer connections. The day concluded with a reflection on intersectionality and identity: participants examined their leadership potential by evaluating their current capabilities and their aspirations. In addition, they commenced preparing their Day-4 presentations.

The candidates reviewed highlights from Day 1 that they deemed the best, in addition to previewing the Day-2 schedule. The interactive activities primarily focused on self-reflection, leadership strategies, and skill-building within leadership frameworks. The candidates discussed common qualities they admired in their WiS role models and also identified their authentic leadership style.



Dr. Mamta Pathania, Associate Professor, Indian Institute of Public Administration (IIPA), Delhi, during her talk on Ethics, Accountability, and Governance

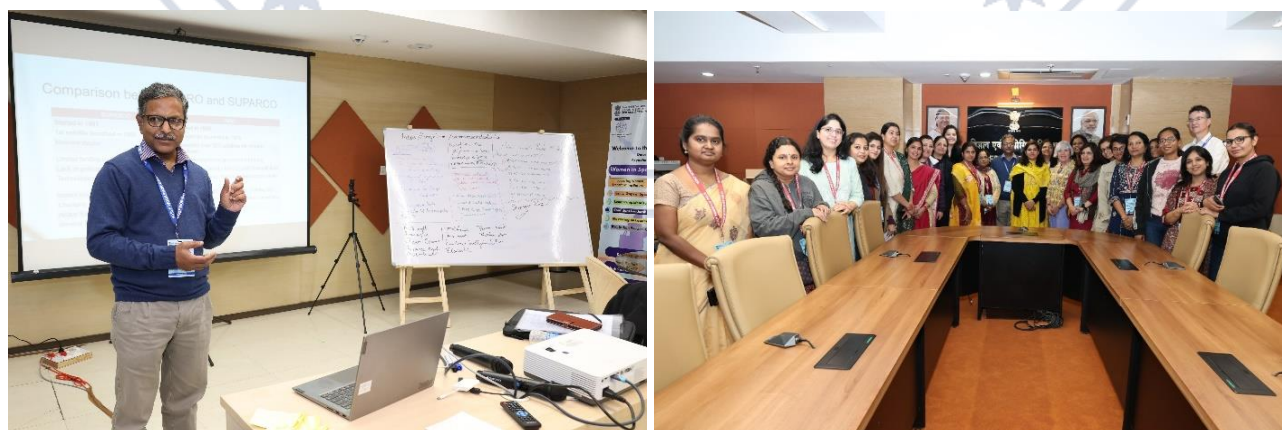
A 40-minute talk around mid-morning by Dr. Mamta Pathania, Associate Professor, Indian Institute of Public Administration (IIPA), Delhi, touched upon ethical dilemmas and integrity threats. She began her talk by prodding the candidates to recall their earliest lessons on ethics from their childhood. Having set the stage for how we interpret ethics and morality and what its implications are in our professional lives, she went on to discuss the dilemmas we face in the workplace that put to test our decision-making. She discussed accountability in the workplace and in governance and public trust, employing a quick activity and a video clip to supplement her talk.

This was followed by a 90-minute training session on effective communication skills, including writing concisely across formats and using tools, such as a large language model (LLM)-based application. Following lunch, a 75-minute session on women's soft power and its implications in leadership underscored the unique strengths of women leaders, outlining strategies for collaborating with male colleagues and fostering allies in the process. A networking break was followed by a 60-minute session on people and team management, focussing on technical, empathetic, inclusive, and balanced leadership. Participants also planned research themes and identified focus areas for Day-3 and Day-4 sessions.

The sessions for the day focussed on learning and demonstrating confident communication techniques and bridging gaps in their leadership skills. The candidates reflected upon their learnings from the previous day; a group activity followed that helped them appreciate the significance of diversity and inclusion in the workplace. A subsequent session delved into the candidates' attitudes toward their careers, their families, and societal values, with a special focus on mental health and overall well-being.



Trainers from the Coventry University, UK, Prof. Elena Gaura, Associate Pro Vice-Chancellor (Research) (Academic Engagement) and Prof. James Brusey, Professor of Computer Science, Research Centre for Computational Science and Mathematical Modelling, during their respective training sessions on Day 3



Dr. Sachin Chowdhry, Associate Professor, Indian Institute of Public Administration (IIPA), Delhi a) during his talk on Indian policies and governance and b) with the programme candidates

A 40-minute talk by Dr. Sachin Chowdhry, Associate Professor, Indian Institute of Public Administration (IIPA), Delhi, provided insights into governance and policy frameworks. The speaker invoked several recent government schemes and policies to emphasise his points. He discussed the various elements of policy formulation: stakeholder consultation, evidence-based policymaking, scale and logistics, etc. A query from one of the candidates that resonated with her peers was, “How can we participate in and contribute towards national policymaking?”, to which Dr Chowdhry offered tangible suggestions and solutions, encouraging the candidates to apply what they learnt in their professional and social lives.

In a 75-minute session after lunch, the candidates explored the everyday work lives of notable role models in the field of Space, through which they learnt the role of empathy in traversing diverse social and economic landscapes.

This was followed by a 60-minute session on the complementary relationship between leadership and management. The candidates learnt project management essentials, including budgeting and science administration, through guided exercises. The candidates further prepared their Day-4 presentations. The day concluded with a special session by Dr. Sanjay Mishra, Senior advisor/Scientist-H, Department of Biotechnology (DBT), Govt. of India. He delivered an insightful talk on "Adaptive Leadership: Leading Through Uncertainty" wherein he emphasized the importance of adaptability in leadership, especially in the face of uncertainty and rapid change. He highlighted key strategies for effective decision-making, resilience, and innovation in challenging environments. His talk provided valuable perspectives to the participants, equipping them with practical approaches to enhance their leadership skills in dynamic and unpredictable scenarios.



Dr Sanjay Mishra, Senior advisor/Scientist-H, Department of Biotechnology (DBT), New Delhi, with the programme candidates

The sessions for the day focussed on practical leadership skills, including negotiation, presentation, and influencing. The candidates recapitulated insights from the previous day. They drew future-oriented action plans as leaders and practised navigating challenges through role-playing exercises. They learnt how to manage difficult conversations, exchange feedback, and address criticism with humility, confidence, and a willingness to improve.



Prof. (Dr.) Avinash Kumar, Former Associate Director/Scientist G, ER&IPR, DRDO HQ, Delhi, during his talk on IPR and intellectual-assets management

A 40-minute talk by Prof. (Dr.) Avinash Kumar, Former Associate Director/Scientist G, ER&IPR, DRDO HQ, Delhi, introduced the candidates to intellectual property rights (IPR) in the context of Indian higher education. The candidates learnt how to manage their intellectual assets effectively. He drew from his experiences at various organizations, describing the nuances of policy formulation and industry collaboration in the context of research and development.

The candidates delivered Three-Minute-Thesis (3MT) presentations, showcasing their ideas. Certificates for completion of the programme were distributed in addition to the People's Choice Award for the three best 3MT presentations. An evaluation survey questionnaire was sent to the candidates by the trainers, soliciting feedback from the former.

Prof. Abhay Karandikar, Secretary, DST, interacted with the participants of the Women in Space and Allied Sciences Leadership Program (WiSLP) on January 24, 2024, during the concluding session. During his address, Prof. Karandikar emphasized the crucial role of women in science, technology, and leadership, encouraging participants to take on greater responsibilities and drive innovation in their respective fields. He highlighted various DST initiatives supporting women in STEM and underscored the importance of collaboration, mentorship, and continuous learning in shaping future leaders.

The session was highly engaging, with participants actively seeking guidance on career growth, policy-making, and research opportunities. Prof. Karandikar addressed their queries, offering valuable insights and motivation. His inspiring words left a lasting impact, reinforcing the importance of resilience, leadership, and excellence in the evolving landscape of space and allied sciences.



Candidates and the organizing team of WiSLP-Delhi with Prof. Abhay Karandikar, Secretary, DST, New Delhi following the closing session

❖ **Key Takeaways for Candidates**

A key highlight of the programme was the informal format of discussions between the trainers and the candidates that allowed an unhindered exchange of ideas and views. Through their responses to the feedback questions, the candidates reported the following about the programme:

- The training workshop helped them learn techniques to overcome workplace obstacles as women in STEM as well as complete tasks in a short period.
- The talks were extremely relevant, especially in the context of the Indian academic and administrative scenario; they added that they are now better prepared to resolve everyday problems facing them at their institutes and universities. One of the candidates from north-eastern India noted that she feels encouraged to organize a similar leadership workshop at her university with the assistance of the DST in order to disseminate the knowledge to more researchers and educators from the north-east.
- The candidates plan to apply their learnings to “advocate for inclusivity and collaboration, mentor women and sponsor projects devised and managed by women, build diverse teams, challenge bias, strengthen networking, etc.” They intend to “implement adaptive strategies to address challenges in education and team management effectively”. As stated by one, “By shifting from a purely technical mindset to one that emphasizes leadership and influence, I can create positive change both within my team and in the wider scientific community.”
- Noting the importance of mental well-being, one of the candidates emphasised the significance of work-life integration by setting boundaries and prioritizing self-care.
- One of the candidates found the sessions to be a “perfect combination of engaging storytelling, providing both enrichment and insight...the complex topics were made accessible and inspiring” for such a diverse set of learners; “their capacity to cultivate an interactive and inclusive learning environment fostered an environment in which ideas thrived and all individuals were motivated to participate.”



Candidates during a role-playing session

- The candidates outlined diverse plans to disseminate their learnings. Several aimed to conduct workshops and seminars at their universities, targeting scientists, and engineering professionals. Sharing workshop insights through mentorship networks, informal discussions, and focused sessions was a common theme. Some planned to integrate the acquired knowledge into existing training programs and guest lectures. Several participants emphasized creating mentorship programs, both formal and informal, to support junior faculty and students, especially women in STEM. Dissemination through publications, conference presentations, and advocacy for women in STEM were also mentioned. One participant specifically expressed interest in leading initiatives for women in Space Bioengineering, highlighting leadership development as a key takeaway.

❖ **Key Takeaways for Organiser and Host Institutions**

The INAE prepared a feedback questionnaire, which were emailed to the candidates on the 23rd of January 2025. The feedback received, with responses from 15 out of 26 candidates, was highly encouraging.

- 12 out of 15 respondents rated their overall experience as “excellent”. The rest rated it as “good”.
- 8 out of 15 respondents found the workshop content “highly relevant”, with the remaining 6 finding the content “moderately relevant”
- 14 respondents found the workshop to be well-structured in terms of sessions, activities, breaks, etc., and 1 found it to be partially well-structured.
- The knowledge and communication skills of the facilitators and speakers were rated as “excellent” by 14 and “good” by 1 out of 15 respondents.
- Average rating (out of 5) by the respondents for
 - quality of topics covered: 4.5
 - relevance of leadership skills discussed: 4.7
 - clarity of presentations: 4.4
 - effectiveness of group discussions: 4.7
 - engagement and interactivity: 4.8

The candidates offered diverse feedback for improving future workshops. A key suggestion was incorporating more interactive elements such as simulations as well as more tailored case studies relevant to participants' specific career challenges. Several candidates requested more technical content, including lectures on recent research and technologies. They also suggested expanding the diversity of speakers and facilitators to include individuals from varied backgrounds, industries, and experiences. Curriculum enhancements were also proposed. The candidates suggested allocating more time for discussions with speakers and for addressing participant questions and advocated for post-workshop mentorship programs to provide continued support and guidance. Some suggested incorporating allyship training for male colleagues and implementing long-term mentorship networks to foster continuous growth.

Candidates reported satisfaction with the venue, facilities, and arrangements; all respondents agreed that the workshop was conducted in a supportive and inclusive environment. Some candidates requested earlier notification for registration to facilitate travel arrangements, as well as increased travel support. A few candidates suggested a more detailed and organized program schedule to better manage time and engagement. The candidates reiterated that they look forward to participating in more such workshops in the future, recommending that this programme be conducted across the country to benefit women researchers, educators, and administrators, not just in the field of space and allied sciences but also in other STEM fields.

II. India-Taiwan Programme of Cooperation in Science & Technology

International Cooperation Division (ICD), DST entrusted INAE to implement India-Taiwan joint program from 2023 onwards. This cooperation is being coordinated by National Science and Technology Council (NSTC) from Taiwan's side. It is a joint program of cooperation between India and Taiwan and a joint call for proposal is launched every year. In this regard, a MoU was signed between INAE and ICD, DST on May 15, 2023 in presence of the Secretary, DST, and the President, INAE wherein it was discussed to launch a call for proposal (CFP) for the projects every year. A total of 11 projects for call for proposal 2022, and 15 projects for call for proposal 2023 were approved for a period of three years.

The call for proposal 2024 was launched during June 2024 to July 2024. The priority areas for R&D projects are Artificial Intelligence, IoT (Internet of Things), Big Data, Cyber Security; Biotechnology, Healthcare including Functional Genomics, Drug Development and Biomedical Devices; Agriculture and Food Sciences; Green Energy Technology/ Renewable Energy (solar energy and bioenergy)/ Clean Energy; Semiconductor & Communication; Aerospace Technology and Manufacturing Technologies. A total of 165 eligible bilateral proposals were received which were evaluated by the members of the Project Evaluation Committee constituted for the purpose and a total of 15 bilateral proposals are approved mutually by India and Taiwan for a period of three years to be commenced from January 2025.

III. Vaishvik Bharatiya Vaigyanik (VAIBHAV) Fellowship

This initiative is pursuant to Government of India VAIBHAV Summit organized in October 2020 to connect Indian STEMM diaspora with Indian Institutions. In this connection, the Government has taken a step further to shape and implement the VAIBHAV programme and announced VAIBHAV Fellowship Call-2023 in June 2023 as a first step and the results were announced on 23 Jan 2024. DST has assigned INAE to administer and implement VAIBHAV Fellowship. The Sanction order for the fellowship was received on September 17, 2024 from DST and the release of grant has been disbursed to all eligible VAIBHAV and Distinguished VAIBHAV fellows selected under the first call. So far 22 VAIBHAV fellows and 02 Distinguished VAIBHAV fellows have been selected under first call. The visit by VAIBHAV fellows has since been progressed and post visit reports submitted to DST.

IV. DST-Women International Grant Support (WINGS) program

DST has entrusted INAE to undertake the implementation of WINGS program, which aimed to provide opportunities to Indian Women Scientists, Engineers & Technologists to undertake international-level research experience in advanced research labs of relevant institutions of the world, to enhance their scientific research capacities. The program includes three modules (i) Module I: WINGS Internship (up to 12 months), (ii) Module II: WINGS Fellowship (up to 12 months), and (iii) Module III: Wings Science visit (up to one month). Recently, a workshop for Women Scientists working in Space and Allied Sciences (WiSLP) in collaboration with the British Council under the UKEIRI programme was organised at Delhi and between 22-25 January, 2025 at the Aryabhata Hall, Department of Science and Technology (DST), New Delhi, India. The programme was organised by the DST and the UK-India Education and Research Initiative (UKIERI), India, delivered by the British Council, India and the Coventry University, UK, and hosted by the DST and the Indian National Academy of Engineering (INAE). The initiative focused on supporting institutions and women scientists in fostering and strengthening women's leadership. The Workshop incorporated various activities that gauged and honed the communication, decision-making, and technical skills of the candidates, especially skills relevant to the areas of leadership, administration, and financial management.

International Affairs

CAETS Engineering Education Working Group

International Council of Academies of Engineering and Technological Sciences CAETS is an independent non-political, non-governmental, international organization of engineering and technological sciences academies, one-member Academy per country. INAE being the only engineering academy of the country represents India at CAETS. One of the activities of CAETS, chaired by the President, INAE, is the CAETS Engineering Education Working Group (EEWG). The meetings of this working group are held quarterly. The objective of EEWG is to contribute to continuous improvement and modernization of engineering education and practice internationally and bring out a report on the subject. A recent meeting of CAETS EEWG was held on November 22, 2024 wherein the following two topics were discussed giving country wise perception – (i) Intellectual Property Rights (IPR), and (ii) Accreditation of engineering degree courses.

Election of Fellows and Foreign Fellows

Nominations for Fellowship and Foreign Fellowship have been invited in January 2025 with last date of March 31, 2025. As a part of the on-going initiative of INAE to digitize as much of its operation as possible, kindly note that from the year 2020 onwards, nominations for election to the Fellowship of INAE are to be submitted online through a Digital Platform (using personal log-in credentials of the Fellows registered with INAE). However, as this is the fifth year of transition in exceptional circumstances, nominations can also be submitted as soft copy forwarded through email, if not feasible for submission through Digital Platform. Details regarding eligibility criteria, nomination process, nomination forms and other important issues have been uploaded on INAE website and are available at the link <https://www.inae.in/forms/>

INAE Young Associate

Nominations have been invited for INAE Young Associate 2025 with last date of March 31, 2025. The sponsor must be either a Fellow of INAE or Head of the organization/ institution/HoD/Dean where the nominee is working. The recognition of "INAE Young Associate" is being given by INAE as per guidelines, to recognize outstanding achievements/contributions made by Young Engineers with strong potential for future professional growth impact in any branch of engineering. The objective of the recognition is to identify, recognize and encourage young and promising talents in India who have made and are likely to continue to make outstanding contributions impacting engineering research and design, technology development and transfer. The criteria entails evidence of excellence in engineering research, product/process, design, technology development and transfer. Specific contribution submitted

for consideration of the recognition which should have been carried out in India. Any citizen of India not older than 35 years holding the first tertiary degree in engineering/technology as on 1st of January each year is eligible for consideration. However, lady nominees are eligible for age relaxation of five years for consideration. Upto 30 INAE Young Associates shall be selected each year. A Certificate as INAE Young Associate shall be given to the selected nominees, however there is no cash prize. All INAE Young Associates on selection and shall continue to be so till attaining 45 years of age. Further details and application proforma can be downloaded from INAE website at the link <https://www.inae.in/young-criteria/>

INAE Publications

Transactions of Indian National Academy of Engineering – An International Journal of Engineering and Technology”

INAE is currently publishing a Journal named “Transactions of Indian National Academy of Engineering – International Journal of Engineering and Technology” published by M/s Springer which was earlier named INAE Letters. **Transactions of INAE Volume 9, Issue 4, December 2024** was published through Springer Publishers during the period October 2024 to January 2025.

Donations to INAE Corpus Fund

INAE had faced an unexpected development because of the decision of the Government conveyed through the Department of Science and Technology that the funding of INAE would cease from April 1, 2025 onwards. Therefore, a lot of measures had to be taken to counter the situation and the Governing Council took the decision that INAE should raise its own corpus so as to become not only functionally but financially autonomous. A target to achieve about Rs 100 Crores was set so that the annual interest of Rs 5-6 Crores could meet the operational cost of the Academy. Since then, good progress has been made and substantial commitment and contributions have been received, which shall ensure the continuance of the Academy and that INAE would not only survive but thrive.

INAE had worked out a strategy to generate a Corpus Fund of Rs 100 crores to ensure its sustainability with financial and functional autonomy seeking contributions from (i) Corporate Donations/Membership; (ii) Institutional Membership (Academic and R&D institutions); (iii) Individual Donations/Membership; (iv) Corporate Social Responsibility (CSR); (v) Government/ Projects; and (vi) Publications. Positive response has been received regarding Corporate Donations and Members and Institutional Members and it is also aimed to reach a figure of ten thousand Individual Members over the years. Many of our esteemed Fellows have already contributed to this cause, voluntarily and with alacrity. INAE gratefully acknowledges their contributions to bolster our collective efforts and resolution. However, though a beginning has been made, the number need to be enhanced with active support from the Fellowship and engineering community at large and increase in outreach and visibility of INAE. The details for forwarding of donations and tax benefits to donors are given below:

Bank Details for receipt of donation to INAE:

Name of beneficiary: **INAE Corpus Fund**

Account Number: **41790835603**

Bank Address: **Jawaharlal Nehru University, New Mehrauli Road, New Delhi**

Type of Account: **Savings**

IFSC: **SBIN0001624**

Tax benefits for donors

The contribution to the **INAE Corpus Fund** qualifies to be considered under the category of donation and is eligible for 50% tax deduction under section 80G under the old tax regime. The donors will get a receipt and the 80G certificate within a fortnight.

INAE is extremely grateful to all Fellows who have generously contributed to the INAE Corpus Fund and welcomes further contributions/donations from Fellows, Young Associates, Awardees; Industry Leaders and Industry Houses etc with a view to achieving self-sufficiency in functioning in the near future. A donor wall containing names of Fellows who have generously donated is posted on INAE website at the link <https://www.inae.in/donor-wall/>

Categories of Memberships Introduced in INAE

INAE Membership was introduced to embrace a wider reach and participation of engineering community, which shall be accorded to working professionals in engineering in the industry, R&D or academic institutions, engineering services, entrepreneurship firms, and government/private agencies. After a duly approved process, Individual Membership will be awarded to aspiring mid-career to senior engineering professionals, to give them a fillip for their future professional journeys who still have milestones to achieve in their career path, before they attain the gold standards to be elected as Fellows of INAE. Individual Membership entails a yearly fee and is as per timelines. The Fellowship retains the premier Gold Standard and the Membership category is independent and by no means affects the prestige of the Fellowship category. An appeal has been made to all Fellows to support these initiatives and help facilitate a greater number of Memberships in all three categories – Institutional, Corporate and Individual Memberships. INAE Fellows have been requested to help facilitate forwarding of nominations for Memberships in all three categories – Institutional, Corporate and Individual Memberships.

Infosys Foundation and INAE Collaborate to Transform Engineering Education in India

Infosys Foundation, the philanthropic and CSR arm of Infosys, has signed a four-year MoU with the Indian National Academy of Engineering (INAE) to enhance and transform engineering education in India on Dec 16, 2024. The Press Release regarding this news was announced during the INAE Annual Convention 2024 on Dec 21, 2024 at New Delhi. For further details, please click on the link given below:

<https://www.infosys.com/newsroom/press-releases/2024/collaborate-transform-engineering-education-india.html>

Important Meetings held during October 2024 to January 2025

October 2024

- i. Meeting of INAE Forum on Civil Infrastructure held on October 1, 2024 over WebEx.
- ii. Meeting of Sectional Committee –VII (Aerospace Engineering) regarding preparation of Technology Roadmap Reports held on October 8, 2024 over WebEx.
- iii. Meeting for evaluation of Individual Membership Applications Cycle-2 held on October 8, 2024 over WebEx
- iv. Meeting of INAE Forum on Civil Infrastructure held on October 15, 2024 over WebEx.
- v. CAETS Communications Committee quarterly meeting held on October 17, 2024 over WebEx.
- vi. Meeting of INAE Forum on Civil Infrastructure held on October 18, 2024 over WebEx.

November 2024

- i. Review Meeting of Digital Gaming Research Initiative held on November 5, 2024 over WebEx.
- ii. Meeting of Conveners of Sectional Committees with President, INAE held on November 5, 2024 over WebEx.
- iii. Meeting of Sectional Committee VIII (Mining, Metallurgical and Materials Engineering) to discuss INAE Reports on “Technology Review / Forecasting / Gap Analysis held on November 7, 2024 over WebEx.

- iv. 50th Apex Committee Meeting held on November 9, 2024 over WebEx.
- v. Online Meetings of PEC domain experts held on November 13-14, 2024 and November 19-21, 2024 over WebEx
- vi. CAETS Engineering Education Working Group Meeting held on November 22, 2024 over WebEx.
- vii. Meeting of Sectional Committee Conveners with President, INAE to review progress on Technology Roadmap Articles on November 25, 2024 over WebEx.

December 2024

- i. Meeting of INAE Forum on Civil Infrastructure held on December 2, 2024 over WebEx.
- ii. 42nd Finance Committee Meeting of INAE held on December 6, 2024 in hybrid mode.
- iii. 153rd Governing Council meeting held on December 19, 2024 at IIT Delhi in hybrid mode.
- iv. 36th AGM of Fellows (Part-B) and SGM of Fellows (2024) held on December 21, 2024 at IIT Delhi in hybrid mode.
- v. Meeting of INAE Forum on Civil Infrastructure held on December 30, 2024 over WebEx.

January 2025

- i. 52nd Apex Committee Meeting of INAE held on January 14, 2025 at INAE Office, New Delhi in hybrid mode.
- ii. Meeting of INAE Forum on Civil Infrastructure held on January 17, 31, 2025 over WebEx.
- iii. Meeting of Scouting Committee to identify nominees from Industry for election as Fellows held on January 31, 2025 over WebEx.

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INTERNATIONAL/NATIONAL CONFERENCES/SEMINARS BEING ORGANIZED BY IITS/OTHER INSTITUTIONS

International Conference on Applications of AI & Machine Learning (ICAML-2025) online and in-person on 22nd to 23rd February 2025 at Chandigarh
<https://icaml.in/>

7th IEEE International Conference on Emerging Smart Computing and Informatics (ESCI-2025) online and in-person on 5th to 7th March 2025 at Pune, Maharashtra
Website: <https://esciioit.org/>

DBT-Sponsored International Conference on Sustainable AI Innovations in Biotechnology and Healthcare (SAIIBH 2025) online and in-person on 20th to 21st March 2025 at Coimbatore, Tamil Nadu
<https://skct.edu.in/saiibh2025/>

1st International Conference on Microstructure, VLSI, Robotics, Communication, Electrical & Emerging Technologies online and in-person on 21st to 22nd March 2025 at Vijayawada, Andhra Pradesh
<https://icmvrct2025.in/>

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HONOURS AND AWARDS

Padma Awards

1. Dr. Pawan Kumar Goenka, *FNAE*, Chairman, IN-SPACE, Department of Space, Government of India has been conferred with the prestigious “Padma Shri” Award in the field of “Trade and Industry” by President of India on Republic Day January 26, 2025.
2. Prof Ashutosh Sharma, *FNAE*, Institute Chair Professor, Department of Chemical Engineering, IIT Kanpur has been conferred with the prestigious “Padma Shri” Award in the field of “Science and Engineering” by President of India on Republic Day January 26, 2025

Honours and Awards (covering the period October 2024 to January 2025)

1	Prof. M.R. Madhav, <i>FNAE</i> , Professor Emeritus, JNT University; Visiting Professor, IIT, Hyderabad was selected as a recipient of the first ISSMGE Asian Lifetime Service Awards which is a testament to his remarkable contributions and achievements in the field. The award will be given during the 1st Geotech Asia 2025 to be held in Goa.
2	Dr Vallam Sundar, <i>FNAE</i> , Advisory Consultant and formerly Professor Emeritus, Department of Ocean Engineering, Indian Institute of Technology Madras, Chennai was presented the Hamaguchi Award in recognition of his outstanding achievement and contribution to tsunami /Coastal Disaster Resilience technology on the occasion of World Tsunami Awareness Day (November 5) presented by the Minister of Land, Infrastructure, Transport & Tourism, Japan, on October 30, 2024.
3	Prof Mahesh Tandon, <i>FNAE</i> , Chairman of Tandon Consultants Pvt Ltd has been conferred with the Lifetime Achievement Award of Consulting Engineers Association of India on January 10, 2025 in recognition of his innovative, aesthetic and environmentally sensitive designs in projects acclaimed both in India and internationally.
4	Mr S Somanath, <i>FNAE</i> , former Chairman, ISRO received the International Astronautical Federation’s (IAF) prestigious World Space Award for Chandrayaan-3’s remarkable achievement during a ceremony, in Milan, Italy in October 2024 to celebrate India’s contributions to space explorations

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NEWS OF FELLOWS

News of Fellows (covering the period October 2024 to January 2025)

1.	Dr. V Narayanan, <i>FNAE</i> , Director and Outstanding Scientist, Liquid Propulsion Systems Centre, ISRO, Thiruvananthapuram assumed the office of the Secretary, Department of Space (Government of India) and Chairman, Space Commission beginning 14th January 2025. With nearly four decades of experience in the Indian space sector, he has held several pivotal positions within the organization, specializing in rocket and spacecraft propulsion. Among his notable achievements, Dr. Narayanan served as the Project Director for the C25 Cryogenic Project of the GSLV Mk III vehicle. Under his leadership, the team successfully developed the C25 Stage, a crucial component of the GSLV Mk III.
2.	Prof GD Yadav, <i>FNAE</i> , National Science Chair, Govt. of India and Emeritus Professor of Eminence, ICT and JC Bose National Fellow, Institute of Chemical Technology, Mumbai, Former Vice Chancellor & R.T. Mody Distinguished Professor, Institute of Chemical Technology; Former Tata Chemicals Darbari Seth Distinguished Professor of Leadership and Innovation; Conjoint Professor, University of New Castle, Australia; Adjunct Professor, RMIT University, Australia and Adjunct Professor, University of Saskatchewan, Canada has been approved for the conferment of the award of CSIR Bhatnagar Fellowship for the year 2024 by the Council of Scientific and Industrial Research (CSIR) in recognition of his outstanding work in science and technology.
3.	Prof. Dr. S.N. Mukhopadhyay, <i>FNAE</i> , Former Professor, DBEB, IIT Delhi; Former Professor & Head, BERC, IIT Delhi with wife Mrs Sakuntala have jointly written their biopic book Anande Jeebansrote in Bangla medium printed by SR Print studio associated with KMS, C.R. Park, New Delhi where he is a life member. They also jointly contributed the article "Our Goa Visits" in Souvenir Durga Puja 2024 which has been printed by KMS, C.R.Park, New Delhi in January 2025.
4.	Dr. Raksh Vir Jasra, <i>FNAE</i> , Senior Vice-President (R&D), R&D Centre, Vadodara Manufacturing Division, Reliance Industries Limited, Vadodara, Gujarat has been listed at number 34 in top 50 inventors of India published by Insights GREYB. For details click on links below. https://insights.greyb.com/top-50-indian-inventors-leading-the-patent-filing-in-india/ https://insights.greyb.com/raksh-vir-jasra-patents/
5.	Dr. S. Venkata Mohan, <i>FNAE</i> , Chief Scientist at the CSIR-Indian Institute of Chemical Technology (CSIR-IICT), Hyderabad took over as Director of the CSIR-National Environmental Engineering Research Institute (CSIR-NEERI) on January 30, 2025.
6.	Prof Subhasis Chaudhuri, <i>FNAE</i> , Former Director, Indian Institute of Technology Bombay, Mumbai- has been appointed as Chairman of the Board of Directors of BSE Limited.
7.	Dr. Jaiteerth R Joshi, <i>FNAE</i> , Outstanding Scientist & Former Programme Director, Programme LRSAM, Defence R&D Laboratory, Hyderabad has assumed charge as Director-General of BrahMos, DRDO and CEO & Managing Director, BrahMos Aerospace from Dec 1, 2024.

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INAE ON FACEBOOK AND TWITTER

INAE has created a Facebook and Twitter Account to post the news of recent INAE activities in the Social Media. The same can be viewed at the link below.

(a) Facebook -link <https://www.facebook.com/inaehq1>

(b) Twitter handle link <https://twitter.com/inaehq1>

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INAE Staff

INAE has a lean team of staff functioning at INAE Headquarters located in Technology Bhavan, DST Complex, New Delhi and a recent group photograph is given below.



OBITUARIES

Shri Ratan Tata



(28 December 1937 – 9 October 2024)

Shri Ratan Tata, FNAE born on 28 December 1937 passed away on 9 October 2024. He was elected to INAE Fellowship in the year 1992 and affiliated to Engineering Section X (Interdisciplinary and Special Engineering Fields and Leadership in Academia, R&D and Industry).

Shri Ratan Tata, Chairman Emeritus, Tata Industries Ltd, Mumbai; former Chairman, Tata Sons was a doyen of Indian Industry who took the reins of the Tata Group in 1991 and over his two-decade-long leadership, he oversaw the diversification and expansion of the group into sectors such as IT, steel, automobiles, and hospitality. Mr Tata had served as the chairman of major Tata companies, including Tata Motors, Tata Steel, Tata Consultancy Services, Tata Power, Tata Global Beverages, Tata Chemicals, Indian Hotels and Tata Teleservices and took them to greater heights of excellence. The introduction of the Tata Nano in 2008, aimed at providing affordable cars for the masses, stands out as one of his important accomplishments. Under his guidance, the Tata Group also made key global acquisitions, including Tetley, Jaguar Land Rover, and Corus. Tata also championed startups and entrepreneurship, investing in young innovators and fostering a spirit of innovation in India through ventures like Tata Capital and Tata Start-up Hub.

Shri Tata was conferred the INAE Life Time Contribution Award in Engineering in the year 2008 for his outstanding contributions to the growth of the Indian Industry and for being a visionary business leader, par excellence. He was also inducted as a Member of the National Academy of Engineering, USA in recognition of his outstanding contributions to industrial development in India and across the world. He was honored with the Padma Bhushan in 2000 and the Padma Vibhushan in 2004 by the Hon'ble President of India for his contributions to Indian industry.

Shri Tata was recognized not only for his outstanding contributions to Indian Industry, corporate sector and engineering community but for his grace, eminence and philanthropy. He leaves behind a profound legacy of business leadership, global expansion, and a deep commitment to societal betterment, having donated generously to charitable causes. He was a supporter of education, medicine and rural development and recognized for his deep commitment as a philanthropist. In his demise, the country and the engineering fraternity have lost one of the greatest icons and inspiration for excellence.

May God bless his soul to rest in peace

Dr R Chidambaram



(November 11, 1936 - January 4, 2025)

Dr R Chidambaram, FNAE born on November 11, 1936 passed away on January 4, 2025. He was elected to INAE Fellowship in the year 1998 and affiliated to Engineering Section IX (Energy Engineering).

Dr R Chidambaram, FNAE, Chairman (Honorary), School for Advanced Studies in Nuclear Science & Technology, Bhabha Atomic Research Centre (BARC), Mumbai and Formerly Director, BARC; Formerly Chairman, Atomic Energy Commission and Secretary, Department of Atomic Energy and Formerly Principal Scientific Adviser to the Govt. of India & DAE Homi Bhabha Professor, Bhabha Atomic Research Centre, Mumbai was an eminent physicist who is known for his integral role in India's nuclear weapons program. He was a part of the team conducting the first Indian nuclear test (Smiling Buddha) at Pokhran Test Range in 1974. He also led and represented the team of the Department of Atomic Energy (DAE) while observing and leading efforts to conduct the second nuclear tests in May 1998.

Some of Dr Chidambaram's initiatives as Principal Scientific Adviser to the Govt. of India including the setting up of the Core Advisory Group for R&D in the Automotive Sector (CAR) to increase academia-industry interaction, the creation of RuTAGs (Rural Technology Action Groups) for effective need based technology delivery in rural areas and the establishment of SETS (Society for Electronic Transactions and Security) are making significant impact. He jointly with the National Informatics Center helped conceptualise and supervise the setting up of the high-speed 'National Knowledge Network' to connect about 1,500 educational and research institutions in India. He also had emphasized the need for 'Coherent Synergy' (a phrase he had coined) in India's Science & Technology (S&T) efforts to take India on a sustained fast-growth path. He had also focused on the importance of 'Directed Basic Research' as an addition to self-directed basic research. As Chair of the Scientific Advisory Committee to the Cabinet, he championed advancements in energy security, materials science, supercomputing, and nanotechnology. Dr Chidambaram was conferred with several distinguished awards and honours including the Padma Shri in 1975 and the Padma Vibushan in 1999 by President of India. He was conferred the INAE Life Time Contribution Award in Engineering during the year 2009.

May God bless his soul to Rest in Peace

Prof R Subbayyan

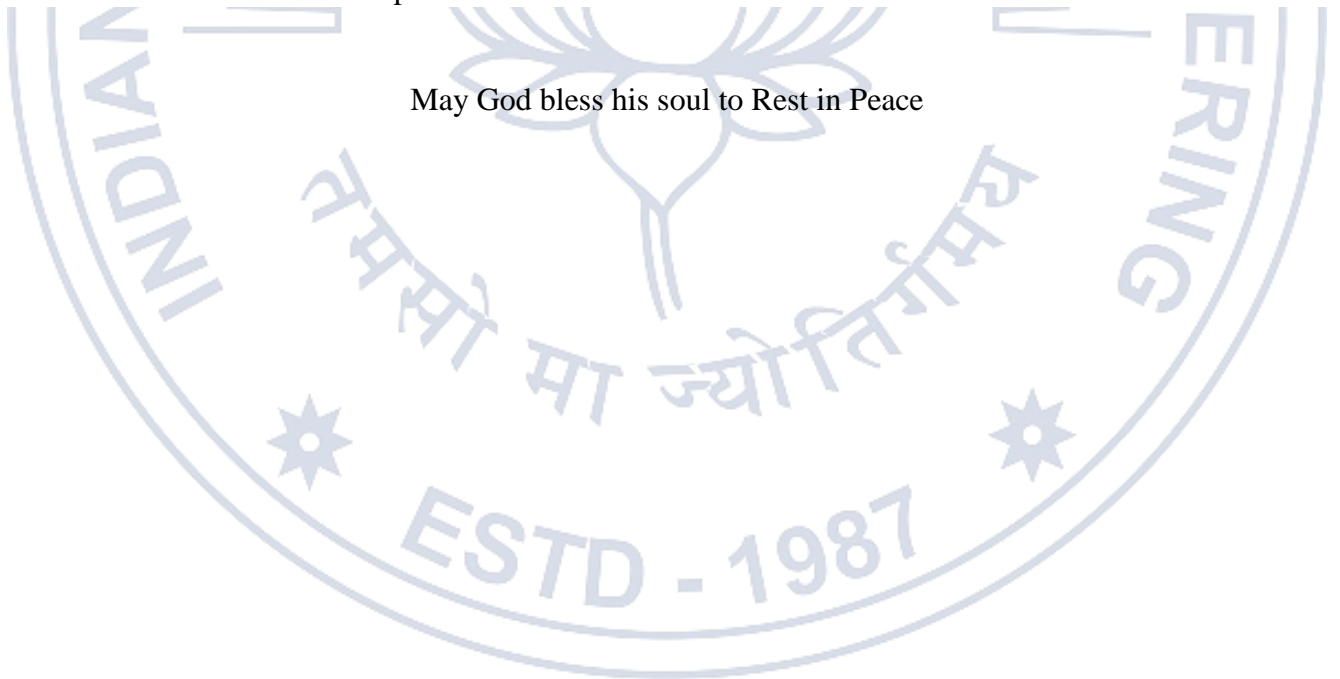


((June 08, 1925- May 2, 2023))

Prof R Subbayyan, FNAE, Former Vice-Chancellor, Bharathiar University, Coimbatore, born on June 08, 1925 passed away on May 2, 2023. He was affiliated to Engineering Section – V (Electrical Engineering) and elected to INAE Fellowship in the year 2013.

Prof R Subbayyan had made significant research contributions in the areas of Electric Machines & Power Systems and Systems Engineering. He was the first Vice- Chancellor of Bharathiar University and served from 1982 to 1988. An Emeritus Professor of University Grants Commission from 1988 to 1990, he was an executive committee member of AICTE from 1994 to 1997. He contributed significantly to the development of PSG College of Technology, Coimbatore and served as Member of several educational committees, and also was on the board of numerous institutions. He was an advisor and consultant for joint projects with industry. He published more than 50 research papers in national and international technical journals, seminars and conferences proceedings. He was the education consultant for Asian Development Bank and Chairman of Assessment Committee and Consultant for Defence Research and Development Laboratories.

May God bless his soul to Rest in Peace



Prof. Subhash Mahajan

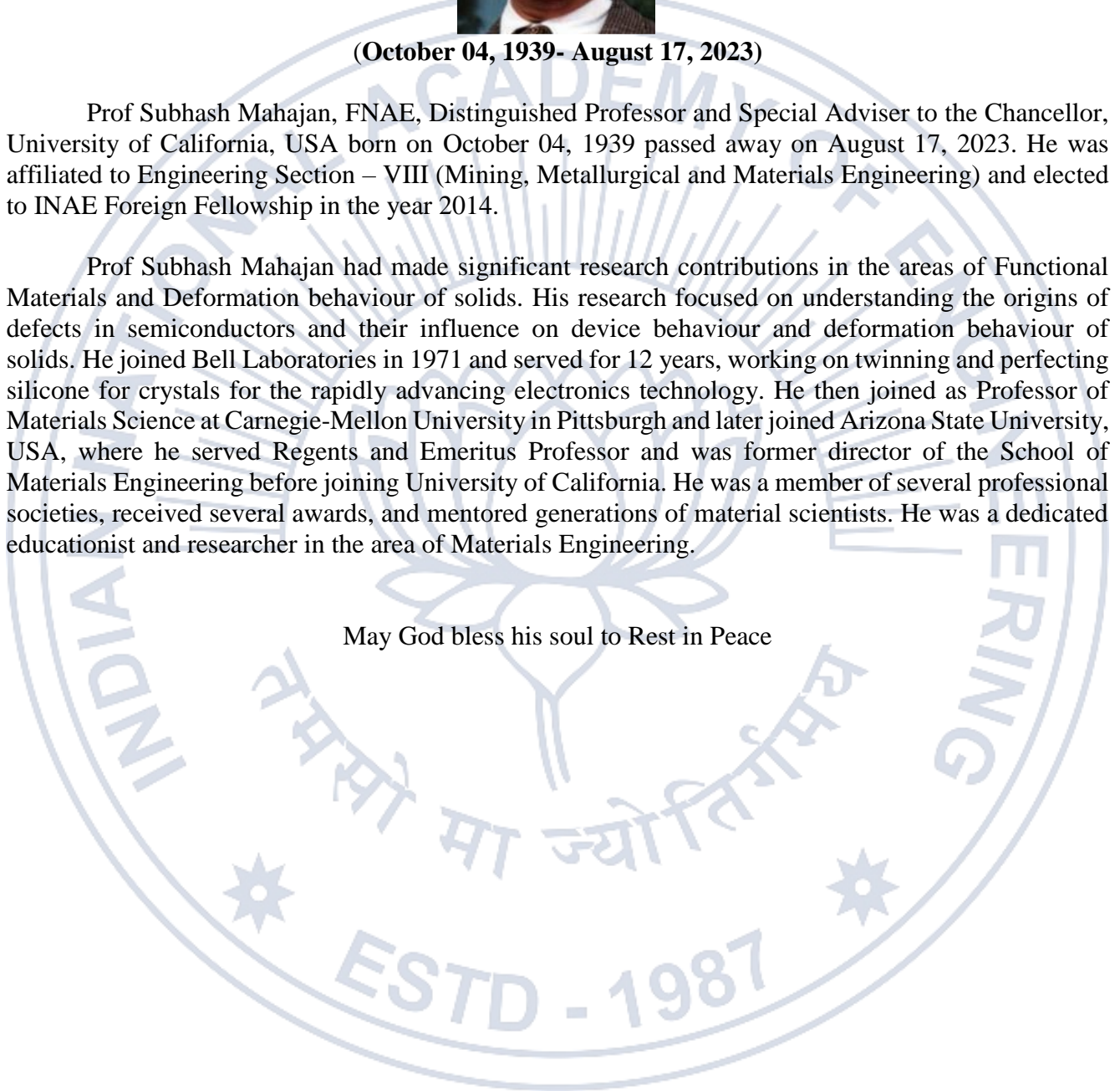


(October 04, 1939- August 17, 2023)

Prof Subhash Mahajan, FNAE, Distinguished Professor and Special Adviser to the Chancellor, University of California, USA born on October 04, 1939 passed away on August 17, 2023. He was affiliated to Engineering Section – VIII (Mining, Metallurgical and Materials Engineering) and elected to INAE Foreign Fellowship in the year 2014.

Prof Subhash Mahajan had made significant research contributions in the areas of Functional Materials and Deformation behaviour of solids. His research focused on understanding the origins of defects in semiconductors and their influence on device behaviour and deformation behaviour of solids. He joined Bell Laboratories in 1971 and served for 12 years, working on twinning and perfecting silicone for crystals for the rapidly advancing electronics technology. He then joined as Professor of Materials Science at Carnegie-Mellon University in Pittsburgh and later joined Arizona State University, USA, where he served Regents and Emeritus Professor and was former director of the School of Materials Engineering before joining University of California. He was a member of several professional societies, received several awards, and mentored generations of material scientists. He was a dedicated educationist and researcher in the area of Materials Engineering.

May God bless his soul to Rest in Peace



Prof. AP Kudchadker



(February 16, 1934 - August 13, 2024)

Prof. AP Kudchadker, FNAE, Professor Emeritus, Indian Institute of Technology Bombay, Mumbai born on February 16, 1934 passed away on August 13, 2024. He was affiliated to Engineering Section – IV (Chemical Engineering) and elected to INAE Fellowship in the year 1994.

Prof. AP Kudchadker had made significant research contributions in the area of Process Engineering. He was a faculty of Chemical Engineering at IIT Kanpur, prior to joining IIT Bombay and after retirement was founding Director of Dhirubhai Ambani Institute of Information and Communication Technology and Pandit Deendayal Upadhyay Petroleum University in Gujarat. He made outstanding contributions to the growth of engineering education, research and academic administration. He was a mentor to several generations of students and served as Deputy Director at IIT Bombay from 1986-1994. He worked in the area of Thermodynamics, and developed a laboratory in thermodynamics research at IIT Bombay. He was among the first to recognize the importance of sustainable chemical processing, and initiated programs with a broad vision for shifting the focus to bio-based raw materials from fossil-based ones.

May God bless his soul to Rest in Peace

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ENGINEERING AND TECHNOLOGY UPDATES

Civil Engineering

1. Scientists develop 3D concrete printing method that captures carbon dioxide

Scientists at Nanyang Technological University, Singapore (NTU Singapore) have developed a 3D concrete printing method that captures carbon, demonstrating a new pathway to reduce the environmental impact of the construction industry. The innovative method aims to significantly reduce the carbon footprint of cement -- a material responsible for 1.6 billion metric tonnes of carbon dioxide (CO₂) or about eight per cent of global CO₂ emissions -- through lower material usage, reduced construction time, and labour requirements. The newly developed 3D concrete printing process involves injecting steam and CO₂, captured as the by-products of industrial processes, into the mixing concrete, which then directly incorporates and stores the CO₂ in the concrete structure. Results have showed that the CO₂ and steam injection method improved the mechanical properties of the concrete, offering increased strength compared to conventional 3D printed concrete. Principal investigator of the study said, "The building and construction sector causes a significant portion of global greenhouse gas emissions. Our newly developed 3D concrete printing system offers a carbon reducing alternative by not only improving the mechanical properties of concrete but also contributing to reducing the sector's environmental impact. It demonstrates the possibility of using CO₂ produced by power plants or other industries for 3D concrete printing. Since traditional cement emits a lot of carbon, our method offers a way to plough back CO₂ through 3D concrete printing."The research team believes their innovation represents a promising contribution towards achieving global sustainable development goals and reducing the industry's reliance on conventional energy-intensive processes like reinforced concrete construction. To develop their 3D concrete printing system, the research team connected the 3D printer to CO₂ pumps and a jet that sprays steam. When activated, the system pumps CO₂ and steam into the concrete mix as the structure is printed. CO₂ reacts with the components in the concrete, turning into a solid form that stays locked inside the material (sequestered and stored). At the same time, steam improves the absorption of CO₂ into the 3D printed structure, enhancing its properties. In lab tests, researchers found the printed concrete structure showed a 50 per cent improvement in printability -- meaning it can be shaped and printed more efficiently. The structure also displayed better strength and durability. The printed concrete was up to 36.8 per cent stronger in compression (how much weight it can bear) and up to 45.3 per cent stronger in bending (how much it can flex before breaking) compared to regular 3D printed concrete. Notably, the method is also greener, absorbing and trapping 38 per cent more carbon dioxide compared to traditional 3D printing methods.

Source <https://www.sciencedaily.com/releases/2024/12/241216130026.htm>

ESTD - 1987

2. AI predicts cancer prognoses, responses to treatment

The melding of visual information (microscopic and X-ray images, CT and MRI scans, for example) with text (exam notes, communications between physicians of varying specialties) is a key component of cancer care. But while artificial intelligence helps doctors review images and home in on disease-associated anomalies like abnormally shaped cells, it's been difficult to develop computerized models that can incorporate multiple types of data. Now researchers at Stanford Medicine have developed an AI model able to incorporate visual and language-based information. After training on 50 million medical images of standard pathology slides and more than 1 billion pathology-related texts, the model outperformed standard methods in its ability to predict the prognoses of thousands of people with diverse types of cancer, to identify which people with lung or gastroesophageal cancers are likely to benefit from immunotherapy, and to pinpoint people with melanoma who are most likely to experience a recurrence of their cancer. The researchers named the model MUSK, for multimodal transformer with unified mask modeling. MUSK represents a marked deviation from the way artificial intelligence is currently used in clinical care settings, and the researchers believe it stands to transform how artificial intelligence can guide patient care. Although artificial intelligence tools have been increasingly used in the clinic, they have been primarily for diagnostics (does this microscope image or scan show signs of cancer?) rather than for prognosis (what is this person's likely clinical outcome, and which therapy is most effective for an individual?). Part of the challenge is the need to train the models on large amounts of labeled data (this is a microscope slide of a slice of lung tissue with a cancerous tumour, for example) and paired data (here are the clinical notes about the patient from whom the tumour was obtained). But carefully curated and annotated datasets are hard to come by. In artificial intelligence terms, MUSK is what's called a foundation model. Foundation models pretrained on vast amounts of data can be customized with additional training to perform specific tasks. Because the researchers designed MUSK to use unpaired multimodal data that doesn't meet the traditional requirements for training artificial intelligence, the pool of data that the computer can use to "learn" during its initial training is expanded by several orders of magnitude. With this head start, any subsequent training is accomplished with much smaller, more specialized sets of data. In effect, MUSK is an off-the-shelf tool that doctors can fine-tune to help answer specific clinical questions. The researchers collected microscopic slides of tissue sections, the associated pathology reports and follow-up data (including how the patients fared) from the national database The Cancer Genome Atlas for people with 16 major types of cancer, including breast, lung, colorectal, pancreas, kidney, bladder, head and neck. They used the information to train MUSK to predict disease-specific survival, or the percentage of people who have not died from a specific disease during a defined time period. For all cancer types, MUSK accurately predicted the disease-specific survival of a patient 75% of the time. In contrast, standard predictions based on a person's cancer stage and other clinical risk factors were correct 64% of the time. In another example, the researchers trained MUSK to use thousands of bits of information to predict which patients with cancers of the lung or of the gastric and oesophageal tracts are most likely to benefit from immunotherapy. For non-small cell lung cancer, MUSK correctly identified patients who benefited from immunotherapy treatment about 77% of the time. In contrast, the standard method of predicting immunotherapy response based on PD-L1 expression was correct only about 61% of the time. Similar results were obtained when the researchers trained MUSK to identify which people with melanoma were most likely to relapse within five years after their initial treatment. In this case the model was correct about 83% of the time, which is about 12% more accurate than the predictions generated by other foundation models.

Source <https://www.sciencedaily.com/releases/2025/01/250108173150.htm>

Mechanical Engineering

3. Realistic emission tests for motorbikes, mopeds and quads

As part of an international project consortium, TU Graz has developed new measurement techniques and methods to measure emissions from Category-L vehicles in realistic operation and to determine corresponding limit values. As part of the "LENS" project (L-vehicles Emissions and Noise Mitigation Solutions) funded by the European Commission, Graz University of Technology (TU Graz), as part of an international consortium, has now developed corresponding test procedures and the necessary test equipment. "The measurement methods developed for passenger cars in recent years are not applicable to the much more dynamic Category-L vehicles," says Stephan Schmidt from the Institute of Thermodynamics and Sustainable Propulsion Systems at TU Graz. "So, we had to develop our own measuring methods, which also included the development and further development of suitable measuring devices that are small and light enough to be used on motorbikes and mopeds. The measurement methodology and technology developed and the emissions data collected are unique worldwide." A total of 15 partners are involved in the project consortium, including nine research institutions, four manufacturers of two-wheelers and producers of measurement technology. As part of "LENS," the project consortium measured a total of 150 vehicles on the road and in the laboratory, 40 of them at TU Graz alone. The Institute of Thermodynamics and Sustainable Propulsion Systems and the Institute of Electrical Measurement and Sensor Systems were responsible for developing and creating the measurement methodology and some of the measurement technology for all project participants. In addition to the creation of route profiles suitable for tests with all Category-L vehicle types, the miniaturisation of the measurement technology was a particular challenge. While equipment weighing more than 60 kilograms does not play much of a role in a car, it makes a huge difference on a motorbike and especially on mopeds -- both in terms of pollutant emissions and riding characteristics. For motorbikes, the necessary reduction in size and weight was achieved by involving an external partner. For the weaker vehicles, a consortium partner contributed small measuring devices which, although not as accurate, provide good reference values. Creating the route profiles was challenging because a scooter with just a few horsepower is completely different to ride compared with a motorbike with over 100 horsepower. In the end, the researchers found a good mix that included both sporty and hilly sections and took different vehicle classes and driving styles into account. However, the wide range of drive systems, drive outputs, installation space ratios and vehicle masses required a measurement methodology adapted to the subclasses. Precise measurement of the exhaust gas mass flow is crucial for calculating emissions. With small-volume single-cylinder engines, however, mass flow measurement using conventional methods is difficult. However, the model-based method for mass flow calculation developed at TU Graz and used in the LENS project provided a solution. As the vehicles in the lower performance classes can be fully extended on the test bench, the researchers were able to create a model based on the test bench data, from which the mass flows during the journey can be calculated. This enabled the team to obtain usable emission data from the reference values of the small measuring devices. "The many engine concepts and performance classes in the L-vehicle sector are a challenge when it comes to finding standardised test methods that realistically measure noise and exhaust emissions," says Stephan Schmidt. "In the LENS project, however, we have succeeded in doing this and, together with our consortium, we have created the technical basis for manufacturers, legislators and law enforcement agencies to be able to assess vehicles on the basis of realistic values in future. This will contribute to a significant reduction in pollutant emissions from the Category-L vehicle fleet."

Source <https://www.sciencedaily.com/releases/2025/01/250109130035.htm>

Chemical Engineering

4. New method turns e-waste to gold

A Cornell University-led research team has developed a method for extracting gold from electronics waste, then using the recovered precious metal as a catalyst for converting carbon dioxide (CO₂), a greenhouse gas, to organic materials. The method could provide a sustainable use for some of the approximately 50 million tons of e-waste discarded each year, only 20% of which is recycled, according to Amin Zadehnazari, a postdoctoral researcher in the lab of Alireza Abbaspourrad, professor of food chemistry and ingredient technology. Zadehnazari synthesized a pair of vinyl-linked covalent organic frameworks (VCOFs) to remove gold ions and nanoparticles from circuit boards in discarded electronic devices. One of his VCOFs was shown to selectively capture 99.9% of the gold and very little of other metals, including nickel and copper, from the devices. "We can then use the gold-loaded COFs to convert CO₂ into useful chemicals," Zadehnazari said. "By transforming CO₂ into value-added materials, we not only reduce waste disposal demands, we also provide both environmental and practical benefits. It's kind of a win-win for the environment." Electronics waste is a literal gold mine: It's estimated that a ton of e-waste contains at least 10 times more gold than a ton of the ore from which gold is extracted. Traditional methods for recovering gold from e-waste involve harsh chemicals, including cyanide, which pose environmental risks. Zadehnazari's method is achieved without hazardous chemicals, using chemical adsorption -- the adhesion of particles to a surface.

Source <https://www.sciencedaily.com/releases/2025/01/250102162300.htm>



Electrical Engineering

5. Engineers grow 'high-rise' 3D chips

The electronics industry is approaching a limit to the number of transistors that can be packed onto the surface of a computer chip. So, chip manufacturers are looking to build up rather than out. Instead of squeezing ever-smaller transistors onto a single surface, the industry is aiming to stack multiple surfaces of transistors and semiconducting elements. Such multi-layered chips could handle exponentially more data and carry out many more complex functions than today's electronics. A significant hurdle, however, is the platform on which chips are built. Today, bulky silicon wafers serve as the main scaffold on which high-quality, single-crystalline semiconducting elements are grown. Any stackable chip would have to include thick silicon "flooring" as part of each layer, slowing down any communication between functional semiconducting layers. Now, MIT engineers have found a way around this hurdle, with a multi-layered chip design that doesn't require any silicon wafer substrates and works at temperatures low enough to preserve the underlying layer's circuitry. In a study the team reports using the new method to fabricate a multi-layered chip with alternating layers of high-quality semiconducting material grown directly on top of each other. The method enables engineers to build high-performance transistors and memory and logic elements on any random crystalline surface -- not just on the bulky crystal scaffold of silicon wafers. Without these thick silicon substrates, multiple semiconducting layers can be in more direct contact, leading to better and faster communication and computation between layers, the researchers say. The researchers envision that the method could be used to build AI hardware, in the form of stacked chips for laptops or wearable devices, that would be as fast and powerful as today's supercomputers and could store huge amounts of data on par with physical data centres.

Source <https://www.sciencedaily.com/releases/2024/12/241218131321.htm>



6. A smart ring with a tiny camera lets users point and click to control home devices

While smart devices in homes have grown to include speakers, security systems, lights and thermostats, the ways to control them have remained relatively stable. Users can interact with a phone, or talk to the tech, but these are frequently less convenient than the simple switches they replace: "Turn on the lamp.... Not that one.... Turn up the speaker volume.... Not that loud!" University of Washington researchers have developed IRIS, a smart ring that allows users to control smart devices by aiming the ring's small camera at the device and clicking a built-in button. The prototype Bluetooth ring sends an image of the selected device to the user's phone, which controls the device. The user can adjust the device with the button and -- for devices with gradient controls, such as a speaker's volume -- by rotating their hand. IRIS, or Interactive Ring for Interfacing with Smart home devices, operates off a charge for 16-24 hours. IRIS is not currently available to the public. The team decided to put the system in a ring because they believed users would realistically wear that throughout the day. The challenge, then, was integrating a camera into a wireless smart ring with its size and power constraints. The system also had to toggle devices in under a second; otherwise, users tend to think it is not working. To achieve this, researchers had the ring compress the images before sending them to a phone. Rather than streaming images all the time, the ring gets activated when the user clicks the button, then turns off after 3 seconds of inactivity. In a study with 23 participants, twice as many users preferred IRIS over a voice command system alone. On average, IRIS controlled home devices more than two seconds faster than voice commands.

Source <https://www.sciencedaily.com/releases/2025/01/250109130038.htm>



Aerospace Engineering

7. NISAR Satellite by NASA and ISRO to Monitor Earth Like Never Before

A collaboration between NASA and the Indian Space Research Organisation (ISRO) has resulted in the NISAR (NASA-ISRO Synthetic Aperture Radar) satellite, which is set to launch in a few months. This mission, designed to track and monitor Earth's dynamic surface, will use synthetic aperture radar technology to measure changes in land and ice formations. Capable of delivering precise data down to centimetre-level accuracy, NISAR will contribute significantly to understanding natural disasters, ice-sheet movements, and global vegetation shifts. According to an official press release by NASA, NISAR is equipped with two radar systems: the L-band with a wavelength of 25 centimetres and the S-band with a 10-centimetre wavelength. This dual-band configuration enables detailed observations of various features, from small surface elements to larger structures. These advanced radars will collect data frequently, covering nearly all land and ice surfaces to provide a comprehensive view of Earth's transformations. As per reports, synthetic aperture radar technology, first utilised by NASA in the 1970s, has been refined for this mission. The data from NISAR will support ecosystem research, cryosphere studies, and disaster response initiatives. Stored and processed in the cloud, the data will be freely accessible to researchers, governments, and disaster management agencies. The partnership between NASA and ISRO, brought together teams to create this dual-band radar satellite. Hardware was developed across continents, with final assembly in India. ISRO's Space Applications Centre developed the S-band radar, while NASA's Jet Propulsion Laboratory provided the L-band radar and other key components. The satellite will launch from ISRO's Satish Dhawan Space Centre and will be operated by ISRO's Telemetry Tracking and Command Network. NISAR's deployment highlights international collaboration in addressing global challenges, promising transformative insights into Earth's changing landscapes.

Source: <https://www.gadgets360.com/science/news/us-india-nisar-satellite-revolutionary-earth-observing-technology-launches-soon-7425892>



8. Novel graphene ribbons poised to advance quantum technologies

Researchers from the National University of Singapore (NUS) have recently achieved a significant breakthrough in the development of next-generation carbon-based quantum materials, opening new horizons for advancements in quantum electronics. The innovation involves a novel type of graphene nanoribbon (GNR), named Janus GNR (JGNR). The material has a unique zigzag edge, with a special ferromagnetic edge state located on one of the edges. This unique design enables the realisation of one-dimensional ferromagnetic spin chain, which could have important applications in quantum electronics and quantum computing. Graphene nanoribbons, which are narrow strips of nanoscale honeycomb carbon structures, exhibit remarkable magnetic properties due to the behaviour of unpaired electrons in the atoms' π -orbitals. Through atomically precise engineering of their edge structures into a zigzag arrangement, a one-dimensional spin-polarised channel can be constructed. This feature offers immense potential for applications in spintronic devices or serving as next-generation multi-qubit systems which are the fundamental building blocks of quantum computing. Janus, the ancient Roman god of beginnings and endings, is often depicted as having two faces pointing in opposite directions representing the past and the future. The term "Janus" has been applied in materials science to describe materials that have different properties on opposite sides. JGNR has a novel structure with only one edge of the ribbon having a zigzag form, making it the world's first one-dimensional ferromagnetic carbon chain. This design is achieved by employing a Z-shaped precursor design which introduces a periodic array of hexagon carbon rings on one of the zigzag edges, breaking the structural and spin symmetry of the ribbon. The significant achievement is a result of close collaboration among synthetic chemists, materials scientists, and theoretical physicists. To produce the JGNR, the researchers initially designed and synthesised a series of special 'Z-shape' molecular precursors via conventional in-solution chemistry. These precursors were then used for subsequent on-surface synthesis, which is a new type of solid-phase chemical reaction performed in an ultra-clean environment. This approach allowed the researchers to precisely control the shape and structure of the graphene nanoribbons at the atomic level. The 'Z-shape' design allows for the asymmetric fabrication by independently modifying one of the two branches, thereby creating a desired 'defective' edge, while maintaining the other zigzag edge unchanged. Moreover, adjusting the length of the modified branch enables the modulation of the width of the JGNRs. Characterisation via state-of-art scanning probe microscopy/spectroscopy and first-principles density functional theory confirms the successful fabrication of JGNRs with ferromagnetic ground state exclusively localised along the single zigzag edge.

Source <https://www.sciencedaily.com/releases/2025/01/250109125912.htm>

Energy Engineering

9. Solar-powered charging: Self-charging supercapacitors developed

Researchers have developed a high-performance self-charging energy storage device capable of efficiently storing solar energy. The research team has dramatically improved the performance of existing supercapacitor devices by utilizing transition metal-based electrode materials and proposed a new energy storage technology that combines supercapacitors with solar cells. The research team designed the electrodes using a nickel-based carbonate and hydroxide composite material and maximized the conductivity and stability of the electrodes by adding transition metal ions such as Mn, Co, Cu, Fe, and Zn. This technology has greatly improved the performance of energy storage devices, demonstrating significant advancements in energy density, power density, and charge and discharge stability. Particularly, the energy density achieved in this study is 35.5 Wh kg^{-1} , which is significantly higher than the energy storage per unit weight in previous studies ($5\text{-}20 \text{ Wh kg}^{-1}$). The power density is 2555.6 W kg^{-1} , significantly exceeding the values from previous studies ($\sim 1000 \text{ W kg}^{-1}$), demonstrating the ability to release higher power rapidly, enabling immediate energy supply even for high-power devices. Additionally, the performance showed minimal degradation during repeated charge and discharge cycles, confirming the long-term usability of the device. Furthermore, the research team developed an energy storage device that combines silicon solar cells with supercapacitors, creating a system capable of storing solar energy and utilizing it in real time. This system achieved an energy storage efficiency of 63% and an overall efficiency of 5.17%, effectively validating the potential for commercializing the self-charging energy storage device. Jeongmin Kim, Senior Researcher at the Nanotechnology Division of DGIST, states, "This study is a significant achievement, as it marks the development of Korea's first self-charging energy storage device combining supercapacitors with solar cells. By utilizing transition metal-based composite materials, we have overcome the limitations of energy storage devices and presented a sustainable energy solution." Damini Lee, a researcher at the RLRC of Kyungpook National University, stated, "We will continue to conduct follow-up research to further improve the efficiency of the self-charging device and enhance its potential for commercialization."

Source <https://www.sciencedaily.com/releases/2024/12/241230131926.htm>



10. Minuscule robots for targeted drug delivery

In the future, delivering therapeutic drugs exactly where they are needed within the body could be the task of miniature robots. Not little metal humanoid or even bio-mimicking robots; think instead of tiny bubble-like spheres. Such robots would have a long and challenging list of requirements. For example, they would need to survive in bodily fluids, such as stomach acids, and be controllable, so they could be directed precisely to targeted sites. They also must release their medical cargo only when they reach their target, and then be absorbable by the body without causing harm. Now, microrobots that tick all those boxes have been developed by a Caltech-led team. Using the bots, the team successfully delivered therapeutics that decreased the size of bladder tumors in mice. The robots also have to be biocompatible and bioresorbable, meaning that they leave nothing toxic behind in the body. The Caltech-developed microrobots are spherical microstructures made of a hydrogel called poly (ethylene glycol) diacrylate. Hydrogels are materials that start out in liquid or resin form and become solid when the network of polymers found within them becomes cross-linked, or hardens. This structure and composition enable hydrogels to retain large amounts of fluid, making many of them biocompatible. The additive manufacturing fabrication method also enables the outer sphere to carry the therapeutic cargo to a target site within the body. Expertise in two-photon polymerization (TPP) lithography, a technique that uses extremely fast pulses of infrared laser light to selectively cross-link photosensitive polymers according to a particular pattern in a very precise manner was deployed. The technique allows a structure to be built up layer by layer, in a way reminiscent of 3D printers, but in this case, with much greater precision and form complexity. The research group managed to "write," or print out, microstructures that are roughly 30 microns in diameter -- about the diameter of a human hair. In their final form, the microrobots incorporate magnetic nanoparticles and the therapeutic drug within the outer structure of the spheres. The magnetic nanoparticles allow the scientists to direct the robots to a desired location using an external magnetic field. When the robots reach their target, they remain in that spot, and the drug passively diffuses out. Researchers further designed the exterior of the microstructure to be hydrophilic -- that is, attracted to water -- which ensures that the individual robots do not clump together as they travel through the body. However, the inner surface of the microrobot cannot be hydrophilic because it needs to trap an air bubble, and bubbles are easy to collapse or dissolve. To construct hybrid microrobots that are both hydrophilic on their exterior and hydrophobic, or repellent to water, in their interior, the researchers devised a two-step chemical modification. First, they attached long-chain carbon molecules to the hydrogel, making the entire structure hydrophobic. Then the researchers used a technique called oxygen plasma etching to remove some of those long-chain carbon structures from the interior, leaving the outside hydrophobic and the interior hydrophilic. This was one of the key innovations of this project. This asymmetric surface modification, where the inside is hydrophobic and the outside is hydrophilic, really allows us to use many robots and still trap bubbles for a prolonged period of time in biofluids, such as urine or serum. Indeed, the team showed that the bubbles can last for as long as several days with this treatment versus the few minutes that would otherwise be possible. The presence of trapped bubbles is also crucial for moving the robots and for keeping track of them with real-time imaging. For example, to enable propulsion, the team designed the microrobot sphere to have two cylinder-like openings -- one at the top and another to one side. When the robots are exposed to an ultrasound field, the bubbles vibrate, causing the surrounding fluid to stream away from the robots through the opening, propelling the robots through the fluid. The team found that the use of two openings gave the robots the ability to move not only in various viscous biofluids, but also at greater speeds than can be achieved with a single opening. Trapped within each microstructure is an egg-like bubble that serves as an excellent ultrasound imaging contrast agent, enabling real-time monitoring of the bots *in vivo*. The final stage of development involved testing the microrobots as a drug-delivery tool in mice with bladder tumors. The researchers found that four deliveries of therapeutics provided by the microrobots over the course of 21 days was more effective at shrinking tumors than a therapeutic not delivered by robots.

Source <https://www.sciencedaily.com/releases/2024/12/241211143603.htm>

ENGINEERING INNOVATION IN INDIA

India launches space docking experiment with PSLV rocket, advancing major ambitions

ISRO successfully launched spacecraft recently designed to test docking technologies crucial to the country's major space ambitions. A Polar Satellite Launch Vehicle (PSLV) lifted off on Dec. 30, 2024 from the Satish Dhawan Space Centre in Sriharikota, with the rocket climbing into the night sky. The PSLV-C60 rocket carried the primary payload in the form of the Space Docking Experiment (SpaDeX) as well as 24 different experiments aboard the POEM-4 secondary payload module. Of the latter, 14 are Indian Space Research Organisation (ISRO) and institutional payloads and 10 further payloads from non-government entities. These include a walking robotic arm, a debris capture robotic manipulator, a compact plant research module and a range of sensors. SpaDeX is a mission by ISRO aimed at demonstrating on-orbit docking technology using two small spacecraft. This capability is crucial for India's future space endeavours including lunar sample return missions and the development of the Bharatiya Antariksh Station (BAS). SpaDeX includes two 220-kilogram spacecraft: SDX01, the chaser spacecraft, and SDX02, the target. The pair were placed into their intended 475-kilometer circular orbits with a 55-degree inclination. The mission includes an indigenous, low-impact docking system with an approach velocity of about 10 millimeters per second, as well as a Laser Range Finder (LRF), Corner Cube Retro Reflectors, and other advanced sensors to facilitate precise docking manoeuvres. A GNSS-based Relative Orbit Determination and Propagation (RODP) processor will be used for accurate relative positioning. "After successful docking and rigidization, electrical power transfer between the two satellites will be demonstrated before undocking and separation of the two satellites to start the operation of their respective payloads for the expected mission life of up to two years," ISRO stated in a mission briefing. The mission is part of India's efforts to become the fourth country to develop independent human spaceflight capabilities with its Gaganyaan program, with a first crewed flight. The docking technology will also be needed for India's Chandrayaan-4 lunar south pole sampling mission, expected to launch around 2027 or 2028. Docking will be required to get samples collected from the surface from an ascent vehicle and into a service module capable of returning to Earth.

Source <https://spacenews.com/india-launches-space-docking-experiment-with-pslv-rocket-advancing-major-ambitions/>

Note: *Fellows are requested to forward their achievements/achievements of their organization to be featured under the heading "Engineering Innovation in India".*

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