



# Annual Report 2019-20



Indian National Academy  
of Engineering



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## Foreword

At this moment, my first thoughts are to express my best wishes for the good health and safety of the Fellows, Foreign Fellows and Young Associates, while the world is battling the ongoing Covid-19 Pandemic which has caused devastation to life and economic progress in most nations. It is my sincere prayer that the world gets a respite and comes out of the grip of the Pandemic and normalcy of life is restored at the earliest.

In this regard, the commitment of INAE to the efforts of Government of India in the fight against the COVID-19 Pandemic have been conveyed vide my letter addressed to Dr Pramod Kumar Mishra, Principal Secretary to the Prime Minister, wherein utmost admiration has been expressed for the exemplary manner in which measures have been taken by the Government of India under the inspired leadership of the Hon'ble Prime Minister, towards the containment and eradication of the COVID-19 pandemic. In the letter, I lauded the Government initiatives encompassing provision of medical services and facilities; promotion of indigenous medical testing facilities; development of cost-effective medical equipment; excellent governance; economic relief measures; repatriating Indian citizens from affected countries; appropriate education of citizens; timely lock-down of the country and ensuring essential supplies and facilities across the country. It was also highlighted that INAE commits itself to extend all and any support required by the Government for the furtherance of its initiatives and measures for the containment and eradication of the COVID-19 pandemic. Subsequently, the INAE Fellowship and INAE Young Associates were requested for relevant expertise in the concerned engineering fields to offer their expertise to mitigate any dimension of the COVID 19 Pandemic from engineering perspective. The inputs received were communicated vide my letter to Prof Ashutosh Sharma, Secretary, DST with the objective of making meaningful contributions to the various measures and initiatives of the Government by providing the pertinent technical inputs to synergize the efforts, with innovative engineering interventions and providing consultancy in concerned fields which has been appreciated.

It may please be recalled that INAE was founded on April 20, 1987 – the date on which the Academy was registered under the Societies Registration Act 1860 and subsequently the Inaugural Function of the Academy was held on April 11, 1988, wherein the erstwhile Prime Minister Mr. Rajiv Gandhi was the Chief Guest. Last year however, the Foundation Day celebrations were organized on April 11 by the INAE Local Chapters as well as INAE Headquarters by conduct of meaningful activities and meetings. From this year onwards, in consultation with former Presidents of INAE, it has been decided to commemorate the Foundation Day of the Academy by organizing the celebrations on April 20, each year, which is the correct date of the INAE Foundation Day.

You all have witnessed that since the raising of the Academy, INAE has undergone a change in terms of the increase in its visibility in the national engineering domain. In the recent past, INAE is recognized as an advisory body to the Government Departments/Agencies for providing inputs for engineering interventions to help solve problems on topics of current engineering interest and in framing of national policies on identified areas. Towards this achievement, the contributions of Dr BN Suresh, Immediate Past-President, INAE are exemplary and I have had the privilege of carrying the baton from him in these noble tasks. To facilitate the interface with the Government, INAE has in place joint Consultative Committees with Department of Science and Technology (DST) and Office of Principal Scientific Advisor (PSA) to the Government of India, which meet periodically to deliberate and identify topics of interest to the Government, to align future activities of the Academy accordingly.



INAE has embarked on a journey of progress over the decades with the institution of novel events and activities encompassing all aspects and fields of engineering and technology and also promoting of engineering education which is vital for the growth of the engineering profession. One of the most significant events in the last year is the seventh Engineers Conclave 2019 organized jointly with Bharat Electronics Limited (BEL) in September 2019 at BEL Academy of Excellence (Nalanda), Bangalore. The two themes of Engineers Conclave 2019 were “Defence Technology & Innovation” and “Transformation of Rural India Using Digital Technologies”. The Inaugural Session of the Engineers Conclave 2019 was graced by the Chief Guest, Hon’ble Raksha Mantri Shri Rajnath Singh who delivered a thought provoking address. Actionable recommendations based on the deliberations in terms of engineering interventions are being actively progressed with the concerned Government Departments/Agencies.

During a meeting of DST – INAE Consultative Committee held in November 2019 it was suggested that INAE should participate in the 107<sup>th</sup> Indian Science Congress Expo from January 3-7, 2020 being held at University of Agricultural Sciences, Bangalore, to increase the outreach of the Academy, within the scientific and engineering fraternity. Accordingly, INAE set up a stall showcasing the activities of the Academy, which was well received by the visitors. As also tasked by DST, a project entitled, “Pilot Project on Safe Laboratory Practices and Laboratory Waste Disposal” was undertaken with the objective of creating an implementable plan of action to enhance the awareness of health and safety issues in chemical laboratories as well as establish best practices for the disposal of chemical and hazardous wastes in the laboratories of universities, colleges and research institutions in India. A report on the proposed pilot project on Safe Laboratory Practices and Laboratory Waste Disposal, along with the project proposal, after duly incorporating all suggestions were prepared and submitted to Prof Ashutosh Sharma, Secretary, DST in February 2020.

It is a matter of pride for the Academy that our initiative to provide inputs for the development of indigenous Regional Transport Aircraft (RTA) has since been approved by the PMO and the proposal for constituting a Special Purpose Vehicle (SPV) as recommended by INAE, is being progressed with Ministry of Civil Aviation. In this regard, INAE Delegation met with Hon’ble Minister of Civil Aviation, Shri Hardeep Singh Puri on January 14, 2020 at New Delhi to present the recommendations on the “Development of Regional Transport Aircraft in the country”, which had emanated from the deliberations of various high-level meetings including the Engineers Conclave 2017, held at Bangalore. This is by far one of the most pathbreaking achievements of INAE that has been recognized at the national level.

The National Frontiers of Engineering Symposium- a flagship event launched primarily to provide a platform for outstanding young engineers from industry, academic institutions and R&D organizations to come together and deliberate upon emerging and cutting-edge research leading to cross-disciplinary translational research and innovation, has gained significance and has since become a popular event for the upcoming engineers. The Thirteenth National Frontiers of Engineering Symposium was organized jointly with IIT Bhubaneswar in May – June 2019 at IIT Bhubaneswar and the themes were Augmented Reality and Virtual Reality; Smart Grid; Advances in Materials and Manufacturing Technology and Next Generation Transportation Systems.

INAE had launched a quarterly journal “INAE Letters” published by M/s Springer in the year 2016. The objective of the journal was to provide a medium for rapid publication of new research results and invited short review articles across different domains of engineering science and technology. In the year 2020, the title of the Journal has been changed to “Transactions of Indian National Academy of Engineering – An International Journal of Engineering and Technology” and has become a full-fledged journal to include full Research Papers and Review Articles besides short communications. I request your inputs in popularizing the journal and soliciting submission of high quality research papers.

The Academy, realizing the importance of promoting young engineering students and Graduates and facilitating their engagement in the engineering activities at national level had instituted a Youth Forum in the year 2017, which was launched during the first Youth Conclave held at Birla Institute of Scientific Research, Jaipur in August 2017. The third INAE Youth Conclave was organized at IIT Delhi in August 2019. The engineering models and idea presentations by the engineering students were based on five topics of national importance namely Health is Wealth;

Digital Revolution; Environment Protection; Lab to Market and Waste to Wealth.

The Abdul Kalam Technology Innovation National Fellowship launched by INAE jointly with Science and Engineering Research Board (SERB), DST in the year 2017, with the objective of encouraging and supporting translational research in engineering in public funded institutions in the country, has since gained momentum with the receipt of high quality nominations from Academic and R&D institutions across the country. Seven eminent nominees were conferred with the subject Fellowship during the last year.

INAE has recently instituted the award in the year 2020 called “INAE Woman Engineer of the Year Award”. The purpose of the award is to recognize and honour our women engineers every year, who have made outstanding contributions to engineering/technology in India and who serve as role models to upcoming engineering professionals in the future. Three women engineers between the ages of 40 to 60 years, will be awarded each year- one each from the three categories viz. Academia, R&D and Industry. Nominations were invited for the award this year and the first awardees will be selected for conferment of the award.

The eight INAE Local Chapters at Bangalore, Kolkata, Delhi, Pune, Mumbai, Kharagpur, Kanpur and Hyderabad have been energized and a number of interesting technical events have been conducted by them which have had good attendance and representation from experts in allied fields. One such event is the Round Table Interaction of domain experts on “Role of Hydrogen in India’s Energy Strategy” organized by the INAE Pune Local Chapter in February 2020 at Pune. The invited experts shared insights on the current and future global situation about use of Hydrogen as an energy source; discussed the overall situation in India with respect to technologies, capabilities and affordability for generation, storage, transportation and usage of hydrogen and concluded on the approach to be followed by INAE in forwarding recommendations to the Government.

The INAE Forums have been actively engaged and have conducted meaningful technical activities, the most noteworthy being the Workshop on the Report “Urban Transportation: Challenges and Way Forward” organized by the INAE Forum on Civil Infrastructure at New Delhi in July 2019 and the Workshop on “Future Landscape of Structural Materials in India” organized by the INAE Forum on Indian Landscape of Advanced Structural Materials at Kolkata in December 2019. Both workshops were an astounding success.

Digitalization of the functioning of INAE is of high priority and an INAE Digital Platform has been instituted to facilitate the same. Twenty-two modules had been identified based on requirement document prepared by INAE Digital Committee constituted to oversee the activities under the aegis of the INAE Digital Platform. The modules are being developed for accepting online nominations and online applications for INAE Awards, INAE Schemes, AICTE Schemes and SERB scheme and their subsequent processing. Eight modules have been made live this year to receive online nominations and applications including submission of nominations online for INAE Fellowship.

As the only engineering Academy of the country, INAE represents India at the International Council of Academies of Engineering and Technological Sciences (CAETS); which is a premier non-governmental international organization comprising Member Academies from 30 countries across the world, with the objective of contributing to the advancement of science and technology and promoting sustainable economic growth of all nations. INAE organizes joint events from time to time with a few CAETS Member Academies on topics of mutual interest. The 3<sup>rd</sup> INAE-National Academy of Engineering of Korea, (NAEK) Workshop on “High Temperature Materials and System Engineering for Aerospace, Power Generation and Defence Industry” was held in July 2019 at Hyderabad. The workshop was a grand success towards meeting the objectives envisaged. Subsequent to the event, a letter of appreciation was received from President, NAEK.

A Welcome Meeting for Lt Col Shobhit Rai (Retd) who joined office as Deputy Executive Director, was held on January 6, 2020 at INAE Office who was felicitated by me with an Academy tie and a Memento.

After a brief overview of important activities/events conducted in the last year, I wish to inform that INAE had received a letter from DST in August 2019 to the effect that INAE has been advised to recast its Memorandum of Association (MoA), as per a model MoA recommended by DST in order to make the affairs of INAE regular and in conformity with the provisions of Government/CAG with respect to rules/regulations/ guidelines which are



applicable to Autonomous Bodies, which have been receiving grants from DST. This important issue was discussed during the Special General Meeting of Fellows held in December 2019 at Jaipur. I am pleased to inform that the draft documents have since been approved by the Governing Council and forwarded to DST for consideration.

As also suggested by DST, the INAE Vision 2020-25 Document has also been prepared which gives the Technological Roadmap of thrust areas for the next 5 years. Your support is sought in planning activities under this Technological Roadmap. All above activities have been realized with the active and noteworthy contributions of the INAE Fellows and the same are acknowledged not only by the Academy, but these efforts have been acclaimed at the highest national levels. I seek your continued co-operation and commitment in the future activities of INAE, some of which have been deferred due to the current situation in the face of the COVID -19 Pandemic.

I look forward to the valuable contributions of the Fellows, Foreign Fellows and Young Associates in the future endeavours of the Academy. Your rich suggestions and meaningful participation in the activities of INAE are always welcomed and are the key to the success of the initiatives undertaken.

I express my gratitude to the former Presidents of INAE for their esteemed advice and thank all the Office bearers for their dedicated commitment in the furthering the activities of the Academy and contributing towards enhancing of the image of INAE, in the national and international engineering domain.

At this point, I once again express my sincere prayers for the safety and good health of all and wish you outstanding success and continued contributions to the growth of engineering and technology in the nation. My best wishes to you and your families for excellent health and progress.

Dr Sanak Mishra  
President, INAE

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## *About the Academy*

The Indian National Academy of Engineering (INAE), founded in 1987, comprises India's most distinguished engineers, engineer-scientists and technologists covering the entire spectrum of engineering disciplines. INAE functions as an apex body and promotes the practice of engineering and technology and the related sciences for their application to solving problems of national importance. The Academy provides a forum for futuristic planning for country's development requiring engineering and technological inputs and brings together specialists from related fields as may be necessary for providing comprehensive solutions to the needs of the country.

INAE is the only engineering Academy in India. INAE is a Member of the International Council of Academies of Engineering and Technological Sciences (CAETS). The aims and objects of the Academy are given below.

- (a) To promote and advance the practice of engineering and technology and the related sciences and disciplines (hereinafter referred to as 'Engineering') in India and their application to problems of national importance.
- (b) To disseminate among its members information on all matters pertaining to 'Engineering' and to encourage, assist and extend knowledge and information connected therewith by publishing such proceedings, journals, memoirs and other publications as may be desirable and hold meetings, lectures, seminars, symposia etc.
- (c) To interact, after due and detailed consideration, with professional bodies, engineering and scientific academies etc. already established or as may be established in future in India and abroad.
- (d) To promote and safeguard academic and professional interest of persons involved in 'Engineering' (hereinafter referred to as 'Engineer' in India by laying down a code of ethics which shall be an obligation to be signed by all Fellows of the Academy on admission thereto).
- (e) To provide an association of eminent 'Engineers' and to present at all academic forums research and developmental activities on 'Engineering' on mutually interactive and cooperative basis, both in India and abroad.
- (f) To promote the National Policy on Education of the Government of India as announced from time to time, in all matters of technical education where the Academy is concerned.
- (g) To assist the Government of India, the Local Governments, All India Council of Technical Education and others in analysing, forecasting for the purpose of planning and formulating the policies in respect of education in 'Engineering' and ensuring the appropriate standard thereof.
- (h) To offer the Government of India, the Local Governments and others, facilities for conferring with and ascertaining the views of 'Engineers' as regards matters directly or indirectly pertaining to 'Engineering' and to confer with the said Governments and others in cooperation with other fraternal professional bodies in regard to all matters pertaining to 'Engineering'.
- (i) To encourage inventions, investigations and research and promote their applications for development of both organised and unorganised sectors of the national economy.



- (j) To encourage and promote the pursuit of excellence in the field of 'Engineering'.
- (k) To institute and establish Professorships, Fellowships, Studentships, Scholarships, Awards and other benefactions and to grant Certificates of Competency and Charter whether under any Act of Government of India or otherwise howsoever.
- (l) To do all such other acts and things as are incidental or conducive to the attainment of the above objects or any one of them.

## INAE Governing Council for the Year 2020



**President**

: Dr. Sanak Mishra, Member of the Governing Board of the Steel Research & Technology Mission of India. Formerly Managing Director, Rourkela Steel Plant and Director, Steel Authority of India Ltd.(SAIL); Vice-President, ArcelorMittal and CEO India Projects; Secretary General, Indian Steel Association; President, Indian Institute of Metals.



**Immediate Past President**

: Dr. BN Suresh, Chancellor, Indian Institute of Space Science & Technology (IIST) and Honorary Distinguished Professor, ISRO Headquarters, Bangalore and Formerly Director, Vikram Sarabhai Space Centre, Trivandrum; and Formerly Member, Space Commission and Founder Director, Indian Institute of Space Science & Technology (IIST), Trivandrum.



**Vice-President** (*Fellowship, Awards & Corporate Communication*)

: Prof. Indranil Manna, Professor, Department of Metallurgical and Materials Engineering, Indian Institute of Technology Kharagpur, Kharagpur and Former Director, IIT Kanpur.



**Vice-President** (*Finance & Establishment*)

: Dr. Purnendu Ghosh, Executive Director, Birla Institute of Scientific Research, Jaipur.



**Vice-President** (*Academic, Professional & International Affairs*)

: Dr. Pradip, Former Vice-President, TCS, Tata Research Development and Design Centre (TRDDC) (A Division of Tata Consultancy Services Ltd.), Pune.



**Chief Editor of Publications**

: Prof. K Bhanu Sankara Rao, Pratt & Whitney Chair Professor, School of Engineering Sciences and Technology, University of Hyderabad; Formerly Associate Director, Materials Development and Characterization Group and Head, Mechanical Metallurgy Division, IGCAR, Kalpakkam; Formerly Professor and Dean School of Engineering Sciences and Technology, University of Hyderabad, and Ministry of Steel Chair Professor, MGIT Hyderabad.

### Members



**Engineering Section-I**

: Ms Alpa Sheth, Managing Director, VMS Consultants Pvt Ltd, Mumbai.



**Engineering Section-II**

: Prof. Kamala Krithivasan, Formerly Professor and Head, Department of Computer Science and Engineering, IIT Madras, Chennai.

	Engineering Section-III	: Dr. V Bhujanga Rao, ISRO Chair Professor, National Institute of Advanced Studies (NIAS), Bangalore and Former Distinguished Scientist & Director General (Naval Systems & Materials), DRDO, (Min of Defence), New Delhi; Former Director, NSTL Visakhapatnam.
	Engineering Section-IV	: Mr. DP Misra, Director, Development Consultants Pvt. Ltd. & Adviser, Jindal Steel and Power Ltd., Mumbai.
	Engineering Section-V	: Prof. Sivaji Chakravorti, Director, National Institute of Technology, Calicut.
	Engineering Section-VI	: Prof. UB Desai, Former Director, Indian Institute of Technology Hyderabad, Kandi, Telangana.
	Engineering Section-VII	: Prof. S Gopalakrishnan, Department of Aerospace Engineering, Indian Institute of Science, Bangalore.
	Engineering Section-VIII	: Dr. U Kamachi Mudali, Chairman & Chief Executive, Heavy Water Board, Department of Atomic Energy, Mumbai.
	Engineering Section-IX	: Mr. MV Kotwal, Former Member of the Board & President-Heavy Engineering, Heavy Engineering Division, Larsen & Toubro Ltd., Mumbai.
	Engineering Section-X	: Dr. V Jayaraman, Prof. Satish Dhawan Professor and Sr. Advisor (Space Applications), ISRO Headquarters, Bangalore.
	Department of Science & Technology (DST), Ministry of Science & Technology	: Dr. BK Mishra, Director, Indian Institute of Technology Goa.
	Ministry of Human Resource Development (MHRD)	: Prof. BS Murty, Director, IIT Hyderabad & Institute Professor and Girija & R. Muralidharan Chair Professor IIT Madras, Indian Institute of Technology Hyderabad. Kandi, Telangana.

	Department of Space (DOS)	: Dr. V Narayanan, Director, Liquid Propulsion Systems Centre, Indian Space Research Organisation, Department of Space, Govt. of India, Thiruvananthapuram.
	All India Council for Technical Education (AICTE)	: Prof. Manoj K Tiwari, Director, National Institute of Industrial Engineering (NITIE), Mumbai.
	Indian National Science Academy (INSA)	: Prof. V Ramgopal Rao, Director, Indian Institute of Technology Delhi, New Delhi.
	Defence Research & Development Organisation (DRDO)	: Dr. SV Kamat, Director General, Naval Systems and Materials, DRDO, DG (NS&M) Office, Visakhapatnam.
	Department of Atomic Energy (DAE)	: Mr. RN Jayaraj, Formerly Chairman & Chief Executive, Nuclear Fuel Complex, Department of Atomic Energy, Hyderabad.
	Confederation of Indian Industry (CII)	: Mr. Soumitra Biswas, Adviser-Technology & Innovation, Confederation of Indian Industry (CII), Gurgaon.
	Federation of Indian Chambers of Commerce & Industry (FICCI)	: Mr. Shyam Bang, Chairman, FICCI Taskforce on Manufacturing Excellence, FICCI, New Delhi.
	The National Association of Software and Services Companies (NASSCOM)	: Mr Gaurav Hazra, VP and member of the NASSCOM leadership team



## *INAE Committees*

### *Sectional Committees*

The composition of the ten Sectional Committees are given below.

#### **Sectional Committee-I**

*(Civil Engineering)*

##### **Convener**

Prof. Sriman Kumar Bhattacharyya

##### **Members**

Dr. S Arunachalam

Prof. Subhasish Dey

Prof. R Gettu

Mr. VN Heggade

Dr. SK Kamra

Mr. MM Madan

Prof. Ligy Philip

Prof. DN Singh

Prof. Mukesh Sharma

Prof. Mahesh C Tandon

Dr. NK Tyagi

#### **Sectional Committee-III**

*(Mechanical Engineering)*

##### **Convener**

Prof. Pradip Dutta

##### **Members**

Prof. Amit Agrawal

Dr. Amrit Ambirajan

Prof. Bijoy Bhattacharya

Prof. Suman Chakraborty

Prof. PK Das

Prof. A Ghosal

Mr. K Jayarajan

Dr. Arun Narasimhan

Dr. CP Ramanarayanan

Dr. N Ravichandran

Mr. Anil Kumar Sinha

#### **Sectional Committee-II**

*(Computer Engineering and Information Technology)*

##### **Convener**

Prof. Subhasis Chaudhuri

##### **Members**

Prof. Santanu Chaudhury

Prof. Pallab Dasgupta

Dr. Manish Gupta

Mr. Vinay V Kulkarni

Prof. Amit Konar

Dr. Raghu Krishnapuram

Prof. Sushmita Mitra

Prof. Hema A Murthy

Prof. CSR Murthy

Prof. Sukumar Nandi

Dr. Rajeev Rastogi

#### **Sectional Committee-IV**

*(Chemical Engineering)*

##### **Convener**

Prof. AB Pandit

##### **Members**

Prof. Sunando Dasgupta

Mr. AN Deshpande

Dr. MO Garg

Prof. Animangsu Ghatak

Prof. Yogesh M. Joshi

Mr. VK Khilnane

Dr. MG Kulkarni

Dr. V Choudary Nettem

Prof. AW Patwardhan

Dr. KSMS Raghava Rao

Prof. AK Suresh



**Sectional Committee-V**  
(Electrical Engineering)

**Convener**

Dr. SN Singh

**Members**

Prof. Vivek Agarwal  
Prof. G Bhuvaneswari  
Prof. SV Kulkarni  
Prof. NP Padhy  
Prof. AK Pradhan  
Dr. BK Panigrahi  
Dr. Vijay Kanchanlal Shah  
Dr. Archana Sharma  
Mr. SK Soonee  
Mr. K Sreekumar  
Prof. HM Suryawanshi

**Sectional Committee – VII**  
(Aerospace Engineering)

**Convener**

Mr. T. Suvarna Raju

**Members**

Dr. G Ayyappan  
Prof. MS Bhat  
Dr. Debasis Chakraborty  
Prof. S Gopalakrishnan  
Prof. G Jagadeesh  
Mr. P Kunhikrishnan  
Prof. Joseph Mathew  
Dr. V Narayanan  
Dr. Jagannath Nayak  
Prof. RI Sujith  
Dr. Tessy Thomas

**Sectional Committee-IX**  
(Energy Engineering)

**Convener**

Mr. Pradeep Chaturvedi

**Members**

Prof. C Balaji  
Mr. Vivek Bhasin  
Prof. Santanu Bandyopadhyay  
Mr. GS Bindra  
Mr. SK Chande  
Dr. J Narayana Das  
Prof. Subroto Mukherjee  
Dr. Saswati B Roy  
Prof. PR Vasudeva Rao  
Mr. N Saibaba  
Prof. Chandra Venkataraman

**Sectional Committee-VI**  
(Electronics & Communication Engineering)

**Convener**

Prof. V Ramgopal Rao

**Members**

Prof. Navakanta Bhat  
Prof. Manav Bhatnagar  
Prof. Swades Kumar De  
Prof. GA Kottantharayil  
Dr. MM Mehendale  
Dr. R Muralidharan  
Dr. Venkata Narayana Padmanabhan  
Dr. N Ramamurthy  
Prof. SK Ray  
Mr. S Varadarajan  
Mr. N Venkatesh

**Sectional Committee – VIII**  
(Mining, Metallurgical and Materials Engineering)

**Convener**

Prof. Amol A Gokhale

**Members**

Prof. Jayanta Bhattacharya  
Prof. Bikramjit Basu  
Dr. SK Biswal  
Dr. SV Kamat  
Dr DK Likhi  
Prof. Dipak Mazumdar  
Prof. AJ Pal  
Prof. DC Panigrahi  
Dr. G Madhusudhan Reddy  
Dr. SC Sharma  
Dr. S Tarafder

**Sectional Committee-X**  
(Interdisciplinary and Special Engineering Fields and Leadership in Academia, R&D and Industry)

**Convener**

Prof. Rudra Pratap

**Members**

Prof. Sirshendu De  
Dr. Akhilesh Gupta  
Dr. S Venkata Mohan  
Prof. Sunil Nath  
Prof. T Pradeep  
Dr. J Raghava Rao  
Mr. M Narayana Rao  
Prof. Prasun K Roy  
Prof. Sampath Srinivasan  
Prof. Manoj Kumar Tiwari  
Dr. Rajiv Kumar Tayal





## *Other Committees and Forums*

### **DST-INAE Consultative Committee**

#### ***Chairman***

Dr. Sanak Mishra

#### ***Members from DST***

Prof. Ashutosh Sharma

Dr. HK Mittal

Dr. RK Tayal

Dr. Rajiv Sharma

#### ***Members from INAE***

Dr. BN Suresh

Prof. Indranil Manna

Dr. Purnendu Ghosh

Dr. Pradip

Prof. V Ramgopal Rao

Prof. Prem Krishna

### **Finance Committee**

#### ***Chairman***

Dr. Sanak Mishra

#### ***Members***

Dr. BN Suresh

Dr. Purnendu Ghosh

Prof. Indranil Manna

Dr. Pradip

Mr. Pradeep Chaturvedi

Dr. Ajay Mathur

Mr. MV Kotwal

JS&FA, DST

### **PSA-INAE Consultative Committee**

#### ***Chairman***

Prof. K VijayRaghavan

#### ***Members***

Dr. Sanak Mishra

Dr. BN Suresh

Dr. PS Goel

Prof. Indranil Manna

Dr. Pradip

Mr. Shirish Panda

Member-Secretary - Executive Director, INAE

### **Steering Committee – Research Schemes/Proposals**

#### ***Chairman***

Dr. Pradip

#### ***Members***

Prof. Indranil Manna

Dr. Purnendu Ghosh

Prof. K Bhanu Sankara Rao

Prof. Sriman K Bhattacharyya

Prof. Subhasis Chaudhuri

Prof. Pradip Dutta

Prof. AB Pandit

Dr. SN Singh

Prof. V Ramgopal Rao

Mr. T. Suvarna Raju

Prof. Amol A Gokhale

Mr. Pradeep Chaturvedi

Prof. Rudra Pratap

Prof. Sushmita Mitra

Dr. Saswati B. Roy

### **Selection Committee – Young Engineer and Innovative Student Projects Awards**

#### ***Chairman***

Prof. Indranil Manna

#### ***Members***

Dr. M Arunachalam  
Prof. M Balakrishnan  
Prof. Laxmidhar Behera  
Prof. K Bhanu Sankara Rao  
Prof. Bhargab B Bhattacharya  
Prof. Navakanta Bhat  
Prof. Bikramjit Basu  
Prof. Subrata Chakraborty  
Dr. Shashank Chaturvedi  
Prof. Sunando Dasgupta  
Prof. Ranjan Ganguli  
Dr. Purnendu Ghosh  
Prof. Nagesh R Iyer  
Dr. V Jayaraman  
Prof. Ujjwal Maulik  
Prof. Sukumar Mishra  
Prof. Sushmita Mitra  
Prof. Sanjay Mittal  
Prof. Jayanta Mukhopadhyay  
Dr. Arun Narasimhan  
Prof. S Narayanan  
Prof. Ganapati Panda  
Prof. AB Pandit  
Dr. Prasun K Roy  
Dr. Sunita Sarawagi  
Prof. Kehar Singh  
Dr. S Tarafder  
Prof. Manoj Kumar Tiwari  
Prof. Chandra Venkataraman

### **Publication Committee**

#### ***Chairman***

Prof. K Bhanu Sankara Rao

#### ***Members***

Dr. Purnendu Ghosh  
Dr. R Gopalan  
Prof. Nagesh R. Iyer  
Prof. Prem Krishna  
Prof. Joseph Mathew  
Prof. BS Murty  
Prof. Manoj Kumar Tiwari

### **Selection Committee - Life Time Contribution Award in Engineering, Professor Jai Krishna Memorial Award and Professor SN Mitra Memorial Award and Outstanding Teachers Award**

#### ***Chairman***

Dr. Sanak Mishra

#### ***Members***

Dr. Purnendu Ghosh  
Prof. Indranil Manna  
Dr. Pradip

### **INAE Young Entrepreneur Award Committee**

#### ***Chairman***

Prof. Indranil Manna

#### ***Members***

Dr. Debashish Bhattacharjee  
Mr. Pradeep Chaturvedi  
Dr. Indranil Chattoraj  
Dr. Manish Gupta  
Mr. VN Heggade  
Mr. MV Kotwal  
Dr. MM Mehendale  
Dr. Pradip  
Mr. B Prasada Rao  
Dr. Rajeev R Rastogi  
Dr. Archana Sharma  
Ms. Alpa Sheth  
Prof. Mahesh C Tandon  
Dr. G Venkatesh

### **Youth Committee**

#### ***Chairman***

Dr. Purnendu Ghosh

#### ***Members***

Prof. Amit Agrawal  
Dr. Manish Gupta  
Prof. Yogesh M Joshi  
Prof. Joseph Mathew  
Prof D Roy Chowdhury  
Prof. Manoj Kumar Tiwari



**AICTE-INAE Distinguished Visiting Professorship (DVP) Scheme Committee**

**Chairman**

Dr. Purnendu Ghosh

**Members**

Dr. M Arunachalam  
Prof. Santanu Chaudhury  
Prof. Nagesh R Iyer  
Prof. Indranil Manna  
Prof. S Narayanan  
Dr. BK Panigrahi  
Dr. Pradip  
Prof. Kripa Shanker  
Dr. Rajiv Kumar Tayal  
Prof. Manoj K Tiwari  
Prof. Dileep N. Malkhede – Rep., AICTE  
Rep – CII

**AICTE-INAE Travel Grant (TG) Scheme Committee**

**Chairman**

Dr. Purnendu Ghosh

**Convener**

Prof. BS Murty

**Members**

Prof. K Bhanu Sankara Rao  
Prof. Santanu Bandyopadhyay  
Prof. Suman Chakraborty  
Prof. Nandita Dasgupta  
Prof. Sirshendu De  
Prof. G Jagadeesh  
Prof. SV Kulkarni  
Prof. Sushmita Mitra  
Prof. NK Mukhopadhyay  
Prof. CVR Murty  
Prof. Hema A Murthy  
Prof. Ligy Philip  
Prof. Krishna Moorthy Sivalingam  
Prof. Dileep N. Malkhede – Rep., AICTE  
Rep – CII

**INAE Digital Platform Committee**

**Chairman**

Dr. Pradip

**Members**

Mr. K Ananth Krishnan  
Dr. Manish Gupta  
Mr. Vinay V. Kulkarni  
Prof. Hema A. Murthy  
Dr. Sriram K Rajamani  
Dr. K Ramamritham

**AICTE-INAE Teachers Research Fellowship (TRF) Scheme Committee**

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Prof. Indranil Manna  
Prof. BS Murty  
Prof. S Narayanan  
Dr. BK Panigrahi  
Prof. Kripa Shanker  
Dr. Rajiv Kumar Tayal  
Prof. Dileep N. Malkhede – Rep., AICTE  
Rep – CII  
Prof. SN Shome – Rep., CSIR  
Dr. BK Dutta – Rep., DAE  
Dr. DM Gaitonde – Rep., DAE  
Dr. Ashok Kumar – Rep., DRDO  
Prof. CRS Kumar – Rep., DRDO  
Smt. BK Niveditha – Rep., DOS  
Prof. CS Narayanmurty - Rep., DOS  
Convener - Executive Director

**INAE Travel Grant (TG) Scheme Committee**

**Chairman**

Dr. Pradip

**Members**

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Prof. Suman Chakraborty  
Prof. Sirshendu De  
Prof. G Jagadeesh  
Prof. NK Mukhopadhyay  
Prof. Sushmita Mitra  
Prof. CVR Murty  
Prof. Hema A Murthy  
Prof. Ligy Philip  
Prof. Krishna Moorthy Sivalingam

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Dr. Ajay Mathur

**Vice-Chairman**

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**Members**

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Mr. Pradeep Chaturvedi

Prof. Pradip Dutta

Mr. B Prasada Rao

Mr. N Saibaba

Mr. S K Soonee

Mr. AK Tripathy

Prof. Chandra Venkatraman

**Forum on Indian Landscape of Advanced Structural Materials****Chairman**

Dr. Debashish Bhattacharjee

**Advisors**

Dr. Sanak Mishra

Dr. Srikumar Banerjee

Dr. Dipankar Banerjee

**Joint Conveners**

Dr. GK Dey

Prof. Amol Gokhale

Dr. U Kamachi Mudali

**Members**

Dr. Biswajit Basu

Dr. Tim Leverton

Prof. Indranil Manna

Prof. BS Murty

Prof. BC Ray

Dr. Soumitra Tarafder

**Forum on Civil Infrastructure****Chairman**

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Dr. Satish Chandra

Mr. Sanjay Pant

Prof. N Raghavan

Mr. K Senou

Dr. Mangu Singh

Prof. PK Sikdar

Prof. Mahesh C Tandon

**Archives of Indian Engineering Heritage Metallurgy Group****Chairman**

Dr. U Kamachi Mudali

**Members**

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Dr. NK Mukhopadhyay

Dr. Soumitro Tarafder

Dr. S Venugopal

**Invitees**

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Prof. NB Ballal

Dr. Pravin P Deshpande

Dr. S Jaikishan

Dr. V Jeyaraj

Dr. P Parameswaran

Dr. Vasant Shinde

Dr. Sharada Srinivasan

Prof. Vibha Tripathi

**Forum on Engineering Interventions for Disaster Mitigation****Chairman**

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**Members**

Mr. VK Agarwal

Prof. PC Basu

Prof. SS Chakraborty

Prof. Prem Krishna

Ms. Alpa Sheth

Prof. DN Singh

Prof. SK Thakkar

**Forum on Technology Foresight and Management****Chairman**

Mr. VK Agarwal

**Members**

Mr. AK Anand

Dr. YP Anand

Mr. Pradeep Chaturvedi

Mr. Keshav Chandra

Mr. AK Gupta

Mr. SC Gupta

Mr. VN Mathur

Mr. AP Mishra

Dr. CR Prasad

Mr. KP Singh

Prof. Prem Vrat

## *Digitization of INAE activities*

The INAE Digital Centre was formally inaugurated by Prof Ashutosh Sharma, FNAE, Secretary, DST on Feb 15, 2019 which is located at the 9th Floor in the same building viz. SPAZE IT Park, Tower A, Gurgaon wherein the current INAE Office is housed at the 6th Floor. The INAE Digital Platform Committee constituted under the Chairmanship of Dr. Pradip, Vice-President, INAE with Mr. K Ananth Krishnan, Dr. Manish Gupta, Mr. Vinay V Kulkarni, Prof. Hema A Murthy, Dr. Sriram K Rajamani and Dr. K Ramamritham as members had played an important role in revamping and developing of newly designed interactive INAE website which is functional featuring Wider Slide Show of photos; Improved Site search; Quick Links; What's New - section including Recent / Forthcoming activities and INAE Activities Spotlight; Improved Sitemap (for better website navigation); Online application for INAE schemes; Downloadable INAE publications and Social media Integration. Under the guidance of the said INAE Digital Committee, online modules facilitating online submission of nomination for INAE Schemes, INAE Awards, AICTE-INAE Schemes and SERB Scheme have been created. Twenty-two modules were identified based on the existing schemes and awards dealt by the Academy.

**The digital modules which were shifted to the Live Server and activated subsequent to inviting of nominations are as below:**

1. Nomination for INAE Fellowship (includes both Indian and Foreign Fellowship)
2. Life Time Contribution Award in Engineering
3. Professor Jai Krishna Memorial award
4. Professor SN Mitra Memorial Award
5. Abdul Kalam Technology Innovation National Fellowship
6. INAE Chair Professorship (temporarily on hold)
7. INAE Distinguished Professor/Technologist (temporarily on hold)
8. INAE Travel Grant Scheme

**The modules which have already been activated on the live server and being used are as below:**

1. Secure Login
  - for individual INAE Fellow (including Fellows who have been inducted in 2019)
  - Young Associate Log in and Profile page
2. INAE Fellow personal Profile page with Dashboard
3. Access to Transactions of INAE
4. Mentoring of Engineering Teachers by INAE Fellows
5. Mentoring of Engineering Students by INAE Fellows
6. AICTE-INAE Travel Grant Scheme
7. Online Travel Request for INAE Fellows

**The modules which are in the process of revision are listed as below:**

1. INAE Outstanding Teachers Award
2. INAE Young Engineer Award
3. INAE Young Entrepreneur Award
4. Innovative Student Projects Award

5. AICTE-INAE Teachers Research Fellowship Scheme
6. AICTE-INAE Distinguished Visiting Professorship Scheme
7. Request for Webinar

Besides development of digital modules, the activities under the Digital Platform encompass online media publication and constructing videos based on video clips taken during INAE's flagship events. A Video recording of Engineers Conclave 2019 was carried out by New Concept Information Systems Pvt. Ltd (NCIS) and has since been uploaded on INAE website. A short film on the event is also available on YouTube. INAE Digital Platform initiative also intends to provide facility for conducting webinar by INAE Fellows, for which CISCO Webex software has been procured along with its license for implementing and using the facility. Though integration of the software with INAE Fellow dashboard is in process, the software has already been independently used for conducting several INAE meetings online.

Presently, there are two applications which maintain profiles of Fellows viz Expert Pool and the Profile Pages of Fellows which were created at different times by two different vendors. While Expert Pool is a static database and resides in public domain of INAE Website, the individual Profile Page of INAE Fellow is not in public domain of the website and can only be accessed by authenticated login. It has been observed that both the applications have similar fields but are supported by two separate databases. To do away with duplication of data, INAE Digital Platform Committee worked out a proposal wherein the data uploaded on Profile Page of the Fellows may be transferred to Expert Pool with the permission of individual Fellow. While completing the profile page, each Fellows will be given a choice as to whether his/her profile is to be made available in public domain (Expert Pool), so that other Fellows or people from industry, academia, R&D sector, private trusts, government agencies, startups and entrepreneurs may access the same.

### **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/pages/Indian-National-Academy-of-Engineering/714509531987607?ref=hl>
- (b) Twitter handle link <https://twitter.com/inaehq1>

All INAE Fellows are requested to visit and follow the above to increase the visibility of INAE in Social media.

## INAE Office Staff



LT COL SHOBHIT RAI (Retd)  
*Deputy Executive Director*



DR. GEETANJALI SAWHNEY  
*Senior Research Officer*



MS. PRATIGYA LAUR  
*Research Officer*



MR. VIRENDER KUMAR  
*Senior Manager (A&E)*



DR. DEBJANI BHATTACHARYA  
*Research Officer*



MS. SHELIKA ARORA  
*Research Officer*



MR. BHUWAN ADHLAKHA  
*Manager (F&A)*



MR. RAMACHANDRAN EP  
*Manager (A&E)*



MR. SHEETAL SHARMA  
*Assistant Systems Engineer*



MR. RAHUL GARG  
*Assistant Systems Engineer*



Ms. HEMA GUPTA  
*Senior Assistant Grade-I*



Mr. RS CHAUHAN  
*Senior Assistant Grade-III*



Mr. BALWANT SINGH  
*Assistant Grade-I*



Mr. GOURAV D KANDALGAONKAR  
*Assistant Grade-II*



Ms. RIDHI VASHISHT  
*Assistant Grade-II*



Mr. SATISH KUMAR VERMA  
*Multi-Tasking Staff*



## *New Initiatives during the Year*

During the last one year, INAE, in addition to many of its well-defined activities, has been giving a major thrust to identify the issues of National importance where engineering interventions can provide the appropriate solutions and also to get associated with some of the vital policy matters. INAE has been making efforts to identify such problems of National importance in consultation with many of the Government Departments and is looking at the policy matters which are referred to the Academy by the concerned agencies for generating the right inputs. With this objective in mind, INAE has undertaken a number of new initiatives in terms of commencing new programmes and conduct of unique events during this year, which have enhanced the outreach and visibility of the Academy both in India and abroad. INAE has also initiated novel programmes and instituted an award to honour distinguished women engineers. A brief summary of these novel initiatives is highlighted below.

### *Institution of the INAE Woman Engineer of the Year Award*

INAE has instituted a new award named “INAE Woman Engineer of the Year Award” from this year i.e. 2020 onwards, in order to recognize and promote meritorious contributions of women in engineering profession. Nominations have recently been invited for the INAE Woman Engineer of the Year Award 2020 during the month of March 2020. The purpose of the award is to recognize and honour deserving women engineers, every year, who have made outstanding contributions to any field of engineering and technology in India and may serve as role models to budding women engineering professionals in the future. The award aims to recognize meritorious and original contributions made by woman engineers in India from academia, research organizations or industry, whose individual efforts have made a significant difference in any branch of engineering and technology, by way of breakthrough innovation and disruptive change in different fields of engineering and have helped to advance the knowledge and competence to the benefit of the profession and people in India. The subject award is to be bestowed on an individual only and the nominations for the award should be nominated and seconded only by the Fellows of INAE. Woman engineers between the age of 40 to 60 years, who should be a citizen of India and working in India are eligible for nomination. In case the nominee is an INAE Fellow, she should not be a member of the INAE Governing Council during the year of the award. INAE will honour three women engineers between the age of 40 to 60 years, every year with this award – one from each of the three categories, (i) Academia, (ii) Industry and (iii) R&D. The award carries a cash award of Rs. 2 lakhs and a citation. The last date for the receipt of nominations for the subject award is May 15, 2020. The guidelines and nomination format for nomination can be downloaded from INAE website [www.inae.in](http://www.inae.in)

### *INAE Foundation Day Celebrations on 11th April 2019*

Indian National Academy of Engineering (INAE) was raised on 20th April 1987 having registered by the Registrar of Societies and was formally inaugurated on 11th April 1988 at New Delhi by the then Prime Minister, Mr. Rajiv Gandhi at a colourful Foundation Function in New Delhi. In order to commemorate this momentous occasion, INAE had decided to celebrate the FOUNDATION DAY of INAE on 11th April this year. Besides the INAE Office at Gurgaon, a number of Local Chapters had celebrated the Foundation Day and a brief report is given below.

#### *INAE Foundation Day Celebrations at INAE Office, Gurgaon*

The Foundation Day Celebrations at INAE Office, Gurgaon was organized on April 11, 2019 wherein Dr Sanak Mishra, President, INAE addressed the INAE staff headed by (Late) Brig Rajan Minocha, Executive Director, INAE in an informal meeting in which Shri Pradeep Chaturvedi, FNAE was also present. Dr Sanak Mishra welcomed all present and gave a brief overview of the history of INAE and the various locations in which the INAE office was housed. He also held interactions with the INAE staff about their experience in working at INAE office. Dr Sanak Mishra briefed all present on the recent activities and initiatives of the Academy that have increased its visibility in the engineering fora, as well as the policy domain. He also highlighted regarding the important forthcoming activities being planned in the near future. The meeting was an occasion for a lively interaction session of the INAE Staff wherein their suggestions and views regarding improved office functioning were sought by Dr Sanak Mishra,

President, INAE which was followed by high tea.



*Dr Sanak Mishra, President, INAE cutting the cake on Foundation Day Celebrations at INAE Office, Gurgaon*



*Group Photo of INAE Staff with Dr Sanak Mishra, President, INAE with Shri Pradeep Chaturvedi, FNAE to his right and (Late) Brig Rajan Minocha, Executive Director, INAE to his left*

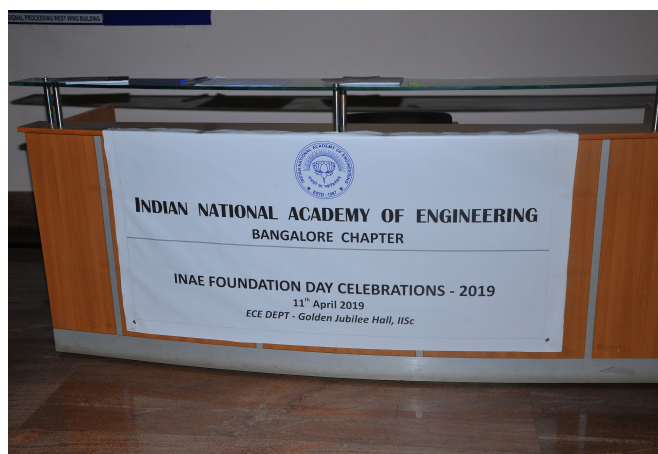
### ***INAE Foundation Day Celebrations at Bangalore***

INAE Foundation Day-2019 was celebrated by INAE - Bangalore Chapter (BC), at a function organized for the occasion on April 11, 2019 at Golden Jubilee Hall, ECE Dept, Indian Institute of Science, Bangalore. Dr VK Aatre, Chairman, INAE BC personally guided the EC of INAE BC in organising the function. The two-hour Programme



commenced with the Welcome Address by Dr AR Upadhya, Hon. Secretary, INAE BC wherein he briefly presented the milestones successfully achieved by INAE and its contributions since its founding in 1987. About 30 INAE Fellows/Young Associates participated in the function. The function was graced by the presence of Dr BN Suresh, Immediate Past President, INAE. Prof Anurag Kumar, Director, IISc though could not be present in person due to pressing engagements, conveyed his kind greetings for the success of the event. The following two talks were presented in the function:

1. “Employment Opportunities in Small Towns due to Digital Technologies”, by Dr Sridhar Mitta, Founder & Managing Director, Next Wealth Entrepreneurs Pvt Ltd, Bangalore
2. “Elements of a Proposal for a Study on Status of Engineering in the Country”, by Dr Rudra Pratap, Professor, CeNSE, IISc, Bangalore.



*Dr VK Aatre, Chairman, INAE BC in front seat*



*Audience at IISc, Bangalore*



*Left to Right: Dr AR Upadhya and Dr BN Suresh, Immediate Past-President, INAE*

Both the lectures were well received and generated good discussions. This was followed by brief addresses by Dr BN Suresh and Dr VK Aatre. The programme concluded with the Vote of Thanks by Prof G Jagadeesh, Jt. Secretary, INAE BC. Special thanks were given to Prof KJ Vinoy, Member EC, INAE-BC and his team for the excellent local arrangements for the function.

### ***INAE Foundation Day Celebrations at Kolkata***

INAE Foundation Day was celebrated by INAE Kolkata Chapter, on 11<sup>th</sup> April 2019, Thursday at the University of Calcutta, Salt Lake Campus (Board Room, Centre of Nanoscience and Nanotechnology, JD 2, Sector III, Salt Lake, Kolkata). All local INAE Fellows and Young Associates and their colleagues and students were invited to join the celebration.



*Prof Sankar Pal, FNAE cutting the cake with Prof Sushmita Mitra, FNAE and Prof Debatosh Guha, FNAE to his left*

### ***INAE Foundation Day Celebrations by INAE Kharagpur Chapter***

To commemorate the momentous occasion of the Foundation of the INAE on 11<sup>th</sup> April, 1987, a meeting of INAE Fellows at Kharagpur (primarily located at IIT Kharagpur) was organized in the Board Room of IIT Kharagpur on 11<sup>th</sup> April, 2019 at 5 pm. The meeting was convened by Prof Indranil Manna, Vice-President, INAE and was presided over by Prof PP Chakrabarti, FNAE, Director, IIT Kharagpur and was attended by 18 INAE Fellows and Young Associates. The meeting was essentially a brainstorming session and informal get-together to discuss several issues related to INAE and role of INAE in the national and state level wherein engineers and engineering could play a significant role. The Director emphasised the need to develop a better cohesion between school children and premier engineering institutions like IITs so that the former could clearly understand the career prospects, expectations and obligations of the engineering professionals and also, the engineering education system in IITs and other premier institutions so that the youth could fashion their educational as well as career objectives accordingly. He also stressed on the need to properly, if not aggressively, advertise the various achievements at both individual level and at the institute level at the IITs so that these achievements get their due attention and recognition from all corners. Some members also suggested that IITs should provide special incentives to carry out industrial projects at both UG and PG levels. The meeting ended by offering Vote of Thanks to the Director and to all the Fellows and Young Associates who attended the meeting.



*Group Photo during INAE Foundation Day Celebrations at IIT Kharagpur*





*Prof PP Chakrabarti, Director, IIT Kharagpur (in the centre) presiding over the celebrations*

## INAE Expert Groups

The guidelines for INAE Expert Groups to prepare Engineering/Technology Roadmaps with Actionable Recommendations on selected engineering themes/ domains, to assist the policymakers on strategies and implementation for desired impact, had been circulated to the Fellowship on July 31, 2019. Subsequently, the proposals under the initiative were invited vide email dated October 7, 2019, which contained the break-up of the budget of maximum Rs 20 Lakhs (for up to a two-year duration) covering contingency, consumables, communication charges, secretarial help, technical support, library/laboratory charges, travel within India and permissible honorarium. The objective of the proposals to be considered under the INAE Expert Pool initiative, as given in the guidelines is the development of a comprehensive engineering/technology roadmap with actionable recommendations on selected engineering themes or domains to help the country formulate a policy/strategy for implementation which will have the desired impact. It is expected that the specific topic chosen by the expert group is oriented towards or aligned with the Vision of INAE. INAE had been requested by DST, to submit its Vision for the next 5 years and the INAE Vision 2020-25 Document had been finalized and forwarded to DST, as per the requirement. These niche areas covered under the INAE Vision 2020-25 Document were given priority, while scrutinizing and recommending the five proposals received in the year.

The Steering Committee during its meeting on February 25, 2020 discussed five proposals and recommended the following for approval of the Governing Council. The objectives of the proposals are in consonance with the guidelines and the topics to be covered are also of importance in the national context.

- Proposal by Dr. Jayanta Bhattacharya, FNAE on “Infrastructure and Resource Requirements for Introduction of Automation and its Adoption in the Mineral Sector of India: A Stakeholder Engagement”.
- Proposal by Dr. Ashish Lele, FNAE on “Green Hydrogen in the Indian Economy – Technology Outlook for the Energy Transition”.
- Proposal by Prof. DN Singh, FNAE on “Industrial By-Products (IBPs) for Sustainable Infrastructure Development”.

The approval for these proposals by the Governing Council Members were subsequently taken by circulation in lieu of the Governing Council meeting scheduled on March 6, 2020 which was subsequently called off due to the travel advisory due to the COVID -19 Pandemic.

## *Academy Activities*

### *Seminars/Workshops/Conferences –National*

The Academy organizes Symposia/Seminars/Workshop/Conferences at national/international levels on topics of national importance. Based on the deliberations, INAE invariably brings out policy recommendations for suitable follow-up action by the concerned Ministry/Department/agency(ies).

#### **The Thirteenth National Frontiers of Engineering (13NatFoE) Symposium**

The Thirteenth National Frontiers of Engineering (13NatFoE) Symposium was organized by INAE jointly with IIT Bhubaneswar from May 31, 2019 to June 1, 2019 at IIT Bhubaneswar. The Inaugural Session of the two-day 13NatFoE Symposium was held on 31<sup>st</sup> May 2019 at IIT Bhubaneswar. Dr. Sanak Mishra, President, INAE was the Chief Guest and Prof. R.V. Raja Kumar, Director, IIT Bhubaneswar was the Guest of Honour. Prof. Indranil Manna, Vice -President, INAE and former Director, IIT Kanpur and Prof. K. Bhanu Sankara Rao, Chief Editor of INAE publications were also present at the Symposium. Prof Swarup Kumar Mahapatra, Dean- Continuing Education, Alumni Affairs and International Relations and Prof. S R Samantaray, Associate Professor, School of Electrical Sciences (SES) were the Coordinators of 13NatFoE Symposium.

The aim of the symposium was to bring together young and outstanding engineering professionals (aged~30-45 years) from the industry, universities, and research organizations to deliberate upon emerging and leading-edge research and development work in the domain of engineering and technology. Convening engineering professionals and technologists from various fields were provided a platform for brainstorming the contemporary and futuristic issues related to frontiers areas cross-disciplinary translational research and innovation. The overall purpose of the symposium was to interact and achieve synergy at distinctive scientific levels through presentations and discussions in the following four thematic areas: - Augmented Reality and Virtual Reality; Smart Grid; Advances in Materials and Manufacturing Technology and Next Generation Transportation Systems.

The speakers in their inaugural talks brought out very interesting points in their respective topics for meeting the pressing needs of the society. Prof. R.V. Rajakumar, Director, IIT Bhubaneswar during his Address emphasized the need for cross-disciplinary research and development to fulfil the needs of Industry. He touched upon the grand Science and Technology challenges facing the nation and the world at large and talked about the importance of the thematic areas of Augmented Reality (AR) and Virtual Reality (VR), Artificial Intelligence (AI), Smart Grid, Next-Gen Grid, Micro & Additive Manufacturing, IOT and 5G Communication for serving the needs of the modern society. He then gave a brief overview of the research activities taking place in IIT Bhubaneswar in these areas. He advised the young engineers to come up with energy efficient systems, which will help in reducing the carbon footprint and pave the way for environment restoration and energy saving. He also informed the audience about the initiative of IIT Bhubaneswar in accurately estimating the pressure and wind-speed in collaboration with IMD before the arrival of the extremely severe cyclone, “FANI”. He also thanked INAE for choosing IIT Bhubaneswar as the host of the 13thNatFoE Symposium. He complimented the Institute for hosting the event despite significant damage to the infrastructure caused by the cyclone, “FANI”.

Dr. Sanak Mishra, President, INAE then delivered an interesting speech with emphasis on Research & Development and the role of INAE in nation building; which was very well received by the audience. He also ascertained that themes of the Symposium were well chosen, as they are in line with NITI Aayog’s current projection of areas of national interest.



*Dignitaries at the Inaugural Session*



*Prof RV Raja Kumar, Director, IIT Bhubaneswar presenting a Memento to Dr Sanak Mishra, President, INAE*

About 60 professionals from various institutes and R&D labs, industries & start-ups attended the event and shared their contributions. A large number of research scholars and faculty members of IIT Bhubaneswar also attended the symposium and contributed in the organization of the symposium. The cross-functional interactions and networking between the participants from various domains of engineering in the Symposium allowed a larger perspective to the participants and exposed them to some of the immediate needs of the society and also gave them an overview of research work happening in various parts of India.



*Dr Sanak Mishra addressing the Audience*



*Prof Indranil Manna, Vice-President, INAE being presented a Bouquet in the Inaugural Session*

The programme of the Symposium included 21 presentations by domain experts in the thematic areas and Plenary Talks by eminent speakers such as Prof. Ashok Jhunjhunwala, FNAE, Institute Professor, IIT Madras; Dr. Manish Gupta, FNAE, Co-founder and CEO, VideoKen; Shri. R.N. Nayak, FNAE, Former Chairman and Managing Director, Power Grid Corporation of India; Prof. Jayanta Mukhopadhyay, FNAE, IIT Kharagpur; Prof. S.A. Soman, FNAE, IIT Bombay; Prof. Rudra Pratap, FNAE, Centre for Nano Science and Engineering, Indian Institute of Science, Bangalore and Prof. M. Parida, Dept. of Civil Engineering, IIT Roorkee. The Symposium provided an excellent opportunity for sharing of novel ideas and for catalysing the start of collaborative research partnerships between brilliant young engineers and researchers from different sectors of the engineering profession.

### **Engineers Conclave-2019 (EC-2019)**

The seventh Engineers Conclave 2019 (EC-2019) was organized jointly with Bharat Electronics Limited (BEL) on Sept 19-21, 2019 at BEL Academy of Excellence (Nalanda), Bangalore. The two themes of EC-2019 were “Defence



Technology & Innovation” coordinated by BEL and “Transformation of Rural India Using Digital Technologies” coordinated by INAE. Shri MV Gowtama, CMD, BEL was the Chair and Dr Sanak Mishra, President, INAE was the Co-Chair of EC-2019. The programme commenced in the forenoon of Sept 19, 2019 with an enlightening Plenary Talk on “Dimensions of Digital Revolution” by Dr Gulshan Rai, Former National Cyber Security Coordinator of India. The talk gave an overview of the national perspectives and components pertaining to fostering a Digital Transformation and also highlighted the forecast in Cyber Technology in the country, over the next decade. The Plenary Talk was followed by the parallel Technical Sessions on the two themes of the Conclave.

The Inaugural Session of the Engineers Conclave 2019 was held on Sept 19, 2019 (afternoon) which was graced by the Chief Guest, Hon’ble Raksha Mantri Shri Rajnath Singh. The session featured an invocation by staff of BEL and the lighting of the lamp by the dignitaries on the dais viz the Chief Guest, Hon’ble Raksha Mantri Shri Rajnath Singh; Shri MV Gowtama, CMD BEL; Dr Sanak Mishra, President, INAE; Dr G Satheesh Reddy, Secretary, Department of Defence R&D and Chairman, DRDO; Shri Mahesh V, Director (R&D) BEL and Chairman, Organizing Committee EC-2019 and Shri VVR. Sastry, FNAE, Former CMD BEL. The dignitaries on the dais addressed the gathering: Shri Mahesh V welcomed the delegates; Shri MV Gowtama highlighted the importance of the conclave; Dr Sanak Mishra presented a perspective of INAE and its activities and Dr G Satheesh Reddy briefed upon some latest developments in Defence R&D including the Light Combat Aircraft (LCA). He was delighted to apprise the august audience that the Hon’ble Raksha Mantri Shri Rajnath Singh on the forenoon of the same day, September 19, 2019 flew in the Tejas fighter aircraft from the HAL airport in Bangalore, becoming the first Defence Minister to fly in the indigenously-built Light Combat Aircraft (LCA).



*Dignitaries on the Dais in the Inaugural Session (Left to Right) Shri Mahesh V, Shri MV Gowtama, Hon’ble Shri Rajnath Singh, Dr G Satheesh Reddy, Dr Sanak Mishra and Shri VVR Sastry*

An interesting highlight of the Inaugural Session was the inauguration of the Product Development & Innovation Centre (PD&IC) of BEL by the Chief Guest, Hon’ble Raksha Mantri Shri Rajnath Singh through electronic mode. Shri MV Gowtama, CMD, BEL informed the gathering that the Centre will focus on IPR creation in strategic areas, reducing external dependence for critical subsystems, and standardisation of subsystems. The centre will also contribute to the ‘Make in India’ initiative of the government and is expected to provide a single window interface for DRDO and other R&D houses, and strengthen transfer of technology (ToT) processes and collaborative design efforts through involvement of start-ups and MSMEs.





*Inauguration of the Product Development & Innovation Centre, BEL  
by Hon'ble Shri Rajnath Singh*

Hon'ble Raksha Mantri Shri Rajnath Singh also unveiled a high-power transmitter for Akash-NG RF seeker, designed by the Microwave Tube Research & Development Center (MTRDC), and concurrently developed along with BEL, based on a production order from the Research Centre Imarat (RCI). During his address he reiterated the government's commitment to reach out to remote villages through the Digital India initiative. He opined that the development of critical and cutting-edge technologies in defence would help save foreign exchange, which can be used for other development activities. He thanked INAE and BEL for inviting him to the Conclave and expressed that he keenly awaited the outcome of the Engineers Conclave 2019 in terms of the recommendations emanating from the deliberations and wished the event success. The Inaugural Session concluded with the proposing of the Vote of Thanks by Shri V.V.R. Sastry, FNAE, Former CMD BEL.



*Unveiling of a high-power transmitter for Akash-NG RF seeker by Hon'ble Shri Rajnath Singh*



*Dr Sanak Mishra, President, INAE presenting a Memento to Dr G Satheesh Reddy, Secretary, Department of Defence R&D and Chairman, DRDO*

The parallel Technical Sessions on the two themes of the conclave were well attended by Fellows of INAE, invited dignitaries and delegates from Bharat Electronics Ltd. The Conclave was attended by about 120 INAE Fellows and Young Associates from across the country, who actively participated in the deliberations including as speakers and session chairs. Eminent experts and senior functionaries from Academia, R&D and Industry also participated in the conclave as delegates. The Technical Sessions on Theme - I on “Defence Technology and Innovation” comprised of Emerging Technologies & Trends for Defence, R&D in Defence, Policies, Growth Drivers and Skill Development, Strategic Partnerships/ Enabling International Cooperation and Success Stories & Way forward. Theme II on “Transformation of Rural India Using Digital Technologies” covered the sessions on the topics of Rural Digital Connectivity, e-Governance and Services, Enhancing Rural Livelihood Opportunities, Capacity Building Needs of Digital Rural India and Aspiring Rural India.

The Plenary talks held during the conclave both on technical and general topics captivated the audience. The second Plenary Talk by Art of Living Founder HH Sri Ravishankar was held through video conference and was coordinated by a devotee of his Ashram. The talk brought out the need for professionals with high pressure jobs such as engineers and technocrats to reduce tension in their lives in order to lead a healthy and meaningful life. The Third Plenary Talk on “Engineering Marvel” by Shri V. Gopinath, Chief Architect, EDRC, Project Director (SOU) L&T gave an enthralling pictorial representation of the various stages in the planning, designing and construction of the Statue of Unity (SOU) dedicated to the Iron Man of India, Sardar Vallabhbhai Patel. This towering piece of engineering is not only the tallest statue in the world but is a marvellous engineering feat by Indian engineers, artists and technologists as was brought out in the excellent presentation which was not only informative but a visual delight. The Fourth Plenary Talk on “Made in India – How to Make It Happen” was by Capt S. Prabhala (Retd), Former CMD BEL which covered strategies for achieving self-reliance in defence industry by development of indigenous technologies.

An entertaining cultural programme was also held in the evening of Sept 19, 2019 which featured a classical dance recital by a young artiste. An exhibition showcasing the products developed and manufactured indigenously by Bharat Electronics Limited was organized on the side-lines of Engineers Conclave. The delegates showed enthusiasm in their technical queries and appreciation of the products including Electronic Voting Machines, Radars, Electronic Warfare Systems, Akash Missile Systems, Opto-Electronic Equipment, Sonars and Akash Missile Systems.





*Exhibition Showcasing Products Developed by Bharat Electronics Ltd on the side-lines of EC-2019*

A Panel Discussion on the two Themes was held in the forenoon of September 21, 2019 wherein the panelists comprised of the respective Technical Session Chairs and the Moderators were the Coordinators of each concerned theme. The Panel Discussion focused on the points to be included in the recommendations to be compiled post conclave, based on the pertinent issues and suggestions emanating from the deliberations in the parallel technical sessions on both themes.

The Panel Discussion was followed by the Valedictory Session of EC-2019 which commenced with the Introductory Remarks and Welcome by Dr Sanak Mishra, President, INAE. Dr VK Saraswat, Member, Niti Aayog was the Chief Guest of the Valedictory Session. During the session, the summing up of the two themes was done by the respective Coordinators. The summing up of Theme I: Defence Technology & Innovation was done by Shri. Mahesh V, Dir (R&D) BEL, Coordinator, Theme-I, EC-2019 while that of Theme II: Transformation of Rural India Using Digital Technologies was presented by Dr. V. Jayaraman, Coordinator, Theme-II, EC-2019.



*Chief Guest of Valedictory Session, Dr VK Saraswat, Member, Niti Aayog delivering Address*



*Presentation of Memento to Chief Guest, Dr VK Saraswat by Dr Sanak Mishra, President, INAE*

Dr VK Saraswat, Member, Niti Aayog delivered a thought-provoking Valedictory Address wherein he emphasized that both themes of the conclave are apt and highly relevant in the present context. He expounded regarding a few initiatives and suggestions that would be desirable to enhance the innovativeness and productivity in the development of indigenous defence technologies in the country. He also emphasized the important parameters to be addressed in order to achieve the goal of transformation of Rural India using Digital Technologies and looked forward to the recommendations emanating as an outcome of the conclave. The Vote of Thanks on behalf of BEL was proposed by Smt. Padmini Balachandra, GM TP/CO, BEL. The Engineers Conclave 2019 was an astounding success and actionable recommendations emanating from the deliberations are under compilation for forwarding to the concerned stakeholders from the Government Departments/Agencies.



## *Seminars/Workshops/Conferences –International*

### **3rd INAE-NAEK Workshop on “High Temperature Materials and System Engineering for Aerospace, Power Generation and Defense Industry” held on 15-17th July 2019 at Hyderabad.**

The above workshop was attended by 65 delegates (12 Korean and 53 Indian). All the participants for the workshop were invited delegates. The Indian delegates were composed of the scientists and technologies who steered the programmes earlier in Aerospace, Power Generation and Defence Industry, the people who are currently leading and associated young researchers and technologists. The total number of invited papers are 24 and were organized in five sessions. A separate session was organized to give an opportunity for interactions among the participants and to work out collaborative research projects between the institutions. Prof. K. Bhanu Sankara Rao FNAE, Chief Editor INAE Publications and Pratt and Whitney Chair at University of Hyderabad, and Dr. D.K. Likhi FNAE, Chairman and Managing Director, MIDHANI, Hyderabad coordinated this event.



*Dignitaries on Dais in the Inaugural Session*



*Welcoming of Head of Korean Delegation*



*Lighting of the Lamp by Dignitaries*



*Group Photograph of Delegates*

High temperature materials constitute a very important element of the current as well as emerging programmes of the Defence Research and Development Organization (DRDO) in India. Gas turbine and defence materials development is capital and technology incentive and takes a long gestation period to establish. In order to attain the maturity in the creation of multifunctional high temperature materials and their processing technologies and to develop further on that basis require continuity in production that should be guaranteed through multiple and concurrent aero engine and other defence programmes. An eco-system that supports R&D, iterative trails to test the fruits of R&D on production scale, and adoption for production if found viable are essential to complete indigenization of aero engine and other materials involved in defence systems along with the processing technologies in the long run. Dr. SV Kamat, Director General, Naval Systems and Materials, gave an overview on the DRDO Perceptive of High Temperature Materials. He described the usage of various materials in gas turbine engines and various other defence systems and pointed out the current challenges looming around the development of high temperature materials and the manufacturing technologies to be adopted. He brought out clearly the various factors to be considered in the



development of high temperature materials depending on the systems and their operating conditions. He emphasized the role of advanced polycrystalline and single crystal superalloys, thermal barrier coatings on superalloys, the usage of Gamma TiAl in aero engine. He explained the potential usage of Titanium Matrix-SiC fibre, Ceramic Matrix (SiC-SiC fibre), and refractory metal- intermetallic (Nb-silicides) composites in aero engine and defence systems. He also pointed out the exploration of additive manufacturing processes for the fabrication of rotating components in aero engine and defence systems. He has foreseen a greater role for the Materials Genome Initiative and enumerated the challenges associated with its implementation.



*Presentation by Dr Dinesh Srivastava*



*Presentation by a Korean Delegate*

Dr. Inho Kim of Agency for Defense Development has presented a brief overview on Defense Science & Technology Strategy and Priorities in Korea. It is the only government funded R&D organization which has been performing its mission as a core agency for ROK security in Korea. The strategy and priorities for defense S&T based on future weapon systems and technology requirement was discussed. The DMTD (Defense Materials Technology Directorate) in ADD has many S&T programs related to the materials for defense applications such as ceramics, metals, and composites including high temperature materials. The progress on an international cooperation project in defense material research area between ROK and INDIA launched on high hardness armor material between ADD and DMRL has been presented.

The Indian Space Research Organization (ISRO) is currently engaged in the development of Reusable Launch Vehicles (RLVs), Air Breathing Propulsion (ABP) technology and missions like Two Stage To Orbit (TSTO) and Single Stage To Orbit (SSTO). The design and realization of these advanced space missions are governed largely by operational limits of available high temperature materials. The material sensitive architecture of these missions is expected to fulfil a combination of conflicting requirements to meet severe environmental conditions during ascent, orbital and atmospheric re-entry phases. ISRO has undertaken technology development programme for a variety of high temperature materials which addresses to the requirements of various heat flux regions of these space vehicles. It includes thermal protection systems, ceramic matrix-based composites, ultra-high temperature ceramics, thermal barrier and high emissivity coatings, high temperature adhesives and engineering technologies to enable induction of these materials for intended applications. The presentation by Dr. S.C. Sharma from Vikram Sarabhai Space Centre, Trivandrum on "High Temperature Materials for Indian Space Programme" enumerated the entire gamut of activities taking place in ISRO in the materials development beginning from lab scale developments and scaling-up of the process-technologies till their qualification for practical use.

A Case Study on Application of the Systems Engineering in the Korea Space Launch Vehicle II Project has been presented by Junyouk Jang, Il Sang Yoo, Young Soon Jang of Korea Aerospace Research Institute (KARI). In South Korea, the KSLV-II (Korea Space Launch Vehicle II) project is in progress to develop the space launch vehicle capable of launching 1.5-ton satellite into a SSO (Sun Synchronous Orbit) and to acquire related technology. It is a large-scale

and complex development project required a systematic approach. Space systems engineering is defined that the art and science of developing an operable system capable of meeting mission requirements within imposed constraints including (but not restricted to) mass, cost and schedule. A case study on application of the systems engineering in the KSLV-II project has been presented.

The aero propulsion R&D activities related to high temperature materials in Korea Aerospace Research Institute were presented by Dr. Inyoung Yang. He has presented briefly the component-level research that has been undertaken on gas turbine engines, high-speed air-breathing engines, and electric- or hybrid-powered propulsion systems. In case of the gas turbine engine, KARI is doing component-level design, analysis and test researches, as well as system-level controls design and engine performance test researches. Regarding the high-speed air-breathing engine, KARI has carried out research on the gas-fuelled and liquid-fuelled supersonic combustor and scramjet engine, as well as combined cycle engines such as air turbo ramjet and rocket-based combined cycle engine. Regarding the electric- or hybrid-powered systems, KARI succeeded to develop electric-powered systems, and currently evolving onto the hybrid propulsion system. He has described the supersonic test facilities available at KARI and about the thermal protection system for space plane.

Reduced activation ferritic-martensitic (RAFM) steels are potential candidate structural materials for first wall and test blanket modules (TBMs) of International Thermonuclear Experimental Reactor (ITER) which is under construction in France. India has developed INRAFM steel for the construction of its own TBM. The INRAFM steel was designed by altering the chemical composition of the conventional Mod.9Cr -1Mo ferritic-martensitic steel, with substitution of W and Ta for Mo and Nb respectively, in order to promote rapid decay of radioactivity after irradiation. Very low ductile-brittle transition temperature was achieved in this steel by adopting pure alloying elements, controlling residual and tramp elements to very low levels and by using vacuum induction melting and vacuum arc refining process. Fabrication of TBM by high heat input fusion welding processes such as shielded metal arc (SMA) and tungsten inert gas (TIG) welding processes develop a wider heat affected zone (HAZ) in ferritic-martensitic steels and generate an inhomogeneous microstructure in the HAZ, resulting in a marked variation in mechanical properties across the weld joint. Premature failures have been reported quite often in the ferritic-martensitic steel weld joints, due to the pronounced localization of creep deformation and cracking at the parent metal/HAZ interface; these are classified as Type IV cracking failures. In the light of these observations, electron beam welding (EBW) and friction stir welding (FSW) processes have been explored. The usage of FSW process in the fabrication of 12 mm thick INRAFM steel has been successfully demonstrated and optimized various parameters associated with FSW. The necessary post weld heat treatments for restoring the optimum microstructure for creep resistance and impact toughness have been described. The paper by M. Vijaya Lakshmi, K.V. Rajulapati, K. Bhanu Sankara Rao and G. M. Reddy gave important details of “New Joining Technology (FSW) for Creep Resistant Ferritic-Martensitic Steels for Conventional and Nuclear Energy Systems”.

Prof. Dipankar Banerjee of Indian Institute of Science, Bangalore presented an illuminating lecture on Intermetallics and Related Alloys. He described that a combination of lightweight and heat tolerance has driven the development of intermetallic and related alloys. Nevertheless, their inherent brittle behaviour has limited successful alloy development to only a few examples. Against this background he gave examples of the research work conducted in the past and being pursued currently which directed towards the development of intermetallics as well as alloys of Ni and Co that utilize the properties of intermetallics in precipitation hardening for applications at high temperatures. He touched upon the topics that include production of cast superalloys, and the role of micro segregation, incipient melting, origin of porosity,  $\gamma / \gamma'$  eutectic, blocky carbides and fine carbides. He has pointed out the need for modeling of fault energies, control of misfit, partitioning of various elements in  $\gamma / \gamma'$  in the design of Ni and Co-based superalloys.

Polycarbosilane (PCS), an organosilicon polymer has been of great interest as precursor for silicon carbide for different high-end applications such as structural material like SiC fibers, C/SiC and SiC/SiC composites in aerospace vehicles. “Indigenous Technologies for Synthesis of Polycarbosilane, PIP based C/SiC Composites and SiC



Fibers” has been dealt in detail by Suresh Kumar et.al from Defence Materials and Stores Research and Development Establishment (DMSRDE), Kanpur. This presentation summarized the research and development work conducted at DMSRDE to establish the synthesis and characterization of PCS, fabrication of C/SiC composite using the indigenous PCS precursor and SiC fibers. Indigenous PCS of select molecular weight was melt spun into PCS fibers and the fibers were cured under flowing air up to 200°C. The cured PCS fibers were pyrolyzed up to 1300°C under argon atmosphere. The SiC fibers were characterized using SEM, XRD, XPS, TEM, HRTEM and EPMA techniques for their microstructure, composition and crystalline phases. Details of the processes, results and micro-structure of the C/SiC composites and SiC fibers were presented. In addition, the feasibility of C/SiC composite components fabrication has also been highlighted.

Dr. LEE Yoonjoo of Korea Institute of Ceramic Engineering and Technology, Jinju, described “The sintering behavior of SiC-bulk derived from polycarbosilane with organic-inorganic conversion process”. Polycarbosilane is a typical ceramic precursor of polymer derived ceramic (PDC) technique. It was originally developed for producing SiC fiber, but as a SiC precursor it has been used in various applications such as high surface area ceramics, catalyst supporter, ceramic thin film, fabrication of CMC, etc. In order to obtain a high-quality ceramic by PDC technique, it is important to control the crystal size and densification as well as the purity of the SiC with understanding of the overall organic-inorganic conversion mechanism. In the case of polycarbosilane, the polymer converted to SiC through curing – pyrolysis – crystallization process, and the nucleation of SiC is accompanied by additional reactions such as graphitization and secondary thermal decomposition. The process conditions at each step influences on the element content, and it affects the crystal growth and densification of SiC. A critical review of the characteristic phenomena at each step of process, and the effect of Si, C, and O elements on sintering of SiC has been presented.

Dr. Manyoung LEE of Agency for Defence Development, Korea, presented a review on “High Temperature Ceramic Matrix Composites in Defence”. Ceramic matrix composites (CMCs) have been widely used for structural materials in various fields. Especially, fibre reinforced CMCs (e.g. C/C, C/SiC, and SiC/SiC) have been world-widely researched and more advanced because of their unique characteristics which are the high strength and heat-resistance properties and have been naturally to be focused to the fields which are the aerospace, atomic energy, other industries needed for heat protection as well as the defence. Out of these representative CMCs, the life time of C/SiC composite in high temperature circumstance up to about 2000°C is longer than that of C/C composite and the service temperature is higher than that of SiC/SiC composite. In view of this, the C/SiC composite has a host of possibility and applicability for military and has a potential to be more fabricated. Dr. Lee briefly introduced the C/SiC composite and its manufacturing processes, and Korean research work in the development of C/SiC composites.

MIDHANI, Hyderabad produces various grades of special steels, superalloys and Titanium alloys suitable for the high temperature applications especially in the areas of aerospace, power and defence. Some of the important superalloys developed in Midhani include SuperNi 742, Superni115, Superni 750 MW, Superni 617CC, Superni 718 (IN 718), Superco 605 (IN 605) etc. In addition to Superalloys having high temperature applications. MIDHANI has also developed various grades of titanium and steels such as Titan 26 (IMI 685), Titan 44 (Beta 21 S) and 17-4 PH, 347 MN, 9Cr1Mo, 10-1-1 respectively. All these materials were manufactured by surmounting the major challenges comprising of narrow range of chemical composition, reduction in presence of trace elements, casting the sound ingot, hot working without flow instability, optimization of thermo mechanical processing parameters, achieving the required microstructure and specified mechanical properties. Dr. S.K. Jha presented the “Advances in Processing of High Temperature Materials in MIDHANI”.

Dr. G. Padmanabham, D.Srinivasa Rao, R. Vijay and Ravi N. Bathe of International Advanced Research Centre for Powder Metallurgy and New Materials (ARCI), Hyderabad, presented an overview on “Advanced Materials and Manufacturing Process for High Temperature Applications” with special reference to the activities on-going at their Centre. Research results on Oxide Dispersion Strengthened steels of different types and their application in fast reactors and AUSC plants have been presented. The recent advances in the development of ODS- Iron Aluminides have been

highlighted. The efforts of ARCI on the development of thermal spray, electrolytic and vapor deposition coatings were described. The progress on Laser Arc Hybrid Welding and Laser Cladding and fabrication of components by Metal Additive Manufacturing were described. The repair and refurbication of aerospace components, extension of life of power plant systems, the development of Ceramics such as spinel and silicon carbide conducted at ARCI have been presented.

Prof Indranil Manna, Vice-President, INAE; Professor, IIT Kharagpur and former Director, IIT Kanpur gave an excellent overview on Laser Surface Engineering (LSE). In addition to covering the fundamental aspects associated with LSE, he explained in detail the LSE of Ti-Alloys with Si/Al, pulsed laser deposition of ceramic coatings, Graded microstructure development in IN-718 Superalloy and application of LSE for hardening, melting, alloying and cladding. He emphasized that LSE offers advantages of obtaining meta stable phases, stable microstructure and attaining of attractive combination of properties which were not possible by conventional equilibrium processing. He has touched upon ceramic to metal graded surface composite that may allow designing tailored properties.

Dr. Seyoung Kim (Korea Institute of Energy Research) presented an overview of the current status of Korea's ceramic composite research projects. A combustor for regenerative cooling type scramjet engine using fiber reinforced ceramic composite material was developed by Korea. A flow path was formed inside the CMC combustor and the performance was tested by exposing it to actual combustion environment. In addition, the efforts made for developing a sealant for air tightness maintenance of a fitting part for injecting fuel into the CMC regeneration cooling channel and a study conducted for micropore interception of the CMC material were presented. The pressure of the fuel injected for regeneration cooling was set to about 40 bar, and the design structural analysis of the CMC flow path and the actual pressure resistance test were performed together.

Functional requirements of speed, range, lethality, flexibility and survivability of defense systems depend heavily on numerous materials and material systems that are closely integrated to make up the structure of the vehicle and its propulsion system. In addition to functionality, choice of materials influence the life-cycle cost of vehicles and is therefore a key factor in deciding its affordability. Realization of very high speed aerospace vehicles, such as supersonic and hypersonic vehicles, is possible only if materials having sufficient strength and oxidation resistance at very high temperatures, coupled with resistance to thermal shocks are developed. Dr. V.V. Satya Prasad explained briefly the advances made at DMRL in the development of ultra-high temperature materials for futuristic high speed aero-space vehicles. He informed that the DMRL has developed technology to prepare Carbon fibre reinforced silicon carbide ( $C_f$ -SiC) composites using CVI-CVD process in the form of panels and a few selected shapes by optimizing process parameters such as fibre volume fraction and fibre interface coating. These composites have been characterized for various mechanical and thermal properties like tensile and flexural strength (both at room temperature and high temperature), fracture toughness, thermal conductivity etc. In addition, DMRL has also developed technology for synthesizing  $ZrB_2$  powder up to 5 kg scale and for preparing  $ZrB_2$ -SiC (UHTC) composites in the form of discs up to 150mm diameter. These composites exhibited consistency in room temperature flexural strength, oxidation resistance and strength retention after exposure to 1500C. The niobium based Cb 752 (Nb-10W-2.5 Zr) alloy is particularly suitable for very high temperature applications as it exhibits adequate strength even at 1400°C. Preparation of this alloy is a very challenging task in view of the differences in the densities and melting temperatures of Nb, W and Zr. The feasibility of preparing this alloy in the form of ingots up to 100 mm diameter and thermo-mechanical processing of the ingots to produce sheets of 5 mm thickness has been established at DMRL.

"Fabrication and testing of ultra-high temperature ceramic (UHTC) materials for TPS application" was narrated by Dr. Sea-Hoon Lee of Korea Institute of Materials Science, Changwon. In order to fabricate ablation resistant UHTC matrix composites, the investigations conducted on powder synthesis, dispersion, shaping, densification, coating process and ablation testing have been explained. The methods to synthesize nano-UHTC powders and liquid precursors having controlled size, shape, size distribution, chemical composition and purity were developed. Nano powder synthesis of  $ZrC$ ,  $ZrB_2$ ,  $HfB_2$  was conducted by innovative processes. Highly concentrated UHTC slurries up

to 57vol% were successfully fabricated. Ultra-fine (200 – 300 nm) and homogeneously distributed UHTC-SiC nano composites were successfully fabricated. The UHTC material showed excellent ablation resistance on ablation testing at 2000-2800°C using oxy-acetylene torch, arc-jet plasma wind tunnel and hybrid rocket. The maximum bending strength of the C<sub>f</sub>/HfC-SiC UHTC-CMC was 280MPa. The material did not lose its strength after the thermal shock test at 1500 . The thermal shock resistance of the UHTC was clearly improved by the fabrication of the CMC. Oxy-acetylene Torch Test, Arc-Jet Plasma Wind Tunnel Test and Rocket Motor Tests were successfully conducted.

Dr. A. K. Maiti of BHEL R&D Hyderabad dealt on “Thermal Barrier Coatings (TBC) for Gas Turbine Components”. Thermal barrier coatings (TBCs) perform an important function as heat resistant layer for component, such as gas turbine parts operating at elevated temperature. Typical examples are turbine blades, combustion liners, transition pieces and nozzles. TBCs have made possible the increase in operating temperature of gas turbines by protecting the underlying metallic body from damage by surrounding heat. TBC is normally a two-layer structure of bond coat and top coat. Bond coat is usually made of alloy (Ni/CoCrAlY) whereas the standard top coat is made of yttria stabilized zirconia (YSZ). YSZ is preferred because of its high melting point and thermal expansion coefficient. Incidentally YSZ top coats are not suitable as TBC beyond 1000<sup>o</sup> C. Advanced ceramic material like lanthanum/gadolinium zirconate are preferred and used as top coat for high temperature gas turbines. Bond coat and top coat material is deposited by plasma spray process (atmospheric/vacuum). Plasma spray process is normally used for depositing ceramic powder. EBPVD (Electron beam physical vapour deposition) is also used for depositing ceramic layer (YSZ). EBPVD process produces columnar grain whereas plasma spray gives lamellar grain structure. Columnar grains are better than lamellar grains due to high shock resistance but the process of EBPVD are not preferred commercially due to its high operating cost. Plasma spray is more popular due to its low cost and simplicity. The efforts of BHEL in developing TBC coatings and their characterization have been presented in detail.

Dr. D. Srivastava, presented the role of Nuclear fuel Complex, Hyderabad in “Manufacturing of Materials and Structural Components for various types of Reactors”. NFC has mandate to develop and manufacture structural components and fuel assemblies required for all the operating Nuclear Power Reactors as well as future advanced reactors in India. The Complex is engaged in the manufacture of various Zirconium alloy reactor core structurals like Pressure Tubes, Calandria Tubes, Garter Springs, Reactivity Mechanism Assemblies for the Pressurized Heavy Water Reactors (PHWRs) and Square Channels for the Boiling Water Reactors (BWRs). The type of structural elements varies with different types of reactors i.e., PHWR, BWR and the Breeders etc. The expertise gained in manufacturing Fast Breeder Test Reactor (FBTR) sub-assemblies was successfully translated to develop technologies required for manufacturing core sub-assemblies and components required for the forthcoming 500 MWe Prototype Fast Breeder Reactor (PFBR) at Kalpakkam. NFC had also manufactured a variety of seamless tubes for strategic applications to meet the requirements of DAE, Space and Defence. Various high temperature materials developed and their processing for application in experimental High Temperature Reactor have been mentioned.

“Current status of high temperature nuclear materials development for future nuclear reactor system applications” has been explained by Dr. Tae Kyu Kim of Korea Atomic Energy Research Institute, Daejeon. As a long-term national research project, high temperature nuclear materials are being developed at the Korea Atomic Energy Research Institute (KAERI) to improve the safety of nuclear reactor systems in the future. In case of the pressurized water reactor (PWR), the R&D activities are focused on the accident tolerant fuel (ATF) and 3D printing technology. Different grades of SA508 are used for pressure vessels, main stream line material and secondary piping. The R&D activities on the high-temperature nuclear materials for future nuclear reactor systems have been summarized as ferritic-martensitic (FM) steels such as Gr91/Gr92 steels for steam generators, T92 for cladding, HT9 for fuel sub-assembly and oxide dispersion strengthened (ODS) alloys for core applications in fast reactors. HT 9 duct was processed by VIM+ESR and fabricated by hot piercing. The VHTR which operates between 700-950°C will have ceramic coated pebbles, graphite core, and Alloy 800H and Inconel 617 for heat exchanger piping. SiC/SiC composites will be used for some internal structures.

The efficiency of conventional fossil-fired thermal power plants is a strong function of temperature and pressure. The need to reduce CO<sub>2</sub> emissions has provided an additional incentive to increase efficiency. More recently the interest has been evinced in the development of Advanced Ultra Super Critical (AUSC) Power Plants in India. Three major institutions (IGCAR, Kalpakkam, BHEL and NTPC) are involved in development of materials and AUSC Power Plant System Engineering. Several Indian Educational institutions and reputed research laboratories are also participating in the characterization of mechanical properties and development of welding technologies. Dr. K. Laha of AUSC Mission Directorate, Noida has made a detailed presentation on identifying, evaluating, and qualifying the materials needed for the fabrication of various components to be used in the construction of 800 MW AUSC power plant, the design of which is nearing completion. The Indian AUSC power plant is envisaged to operate with maximum steam temperature of 710 °C at 310 bar with plant efficiency more than 46 %. High temperature and pressure steam in AUSC plant needs better creep resistance material than ferritic-martensitic steels (T91 and T92) used in USC power plant. Austenitic stainless steel (Sanicro 25) and nickel base superalloy (Inconel 740) are considered for super heater and reheater tubes. Selection of the material among the different alternatives (Super 304H and Inconel 617) are based on the detailed creep strength and economic consideration. Inconel 617 and 740 both are qualified for headers and main pipes. Inconel 740 is preferred over Inconel 617 because of its higher creep rupture strength coupled with higher fatigue strength. Induction bending process for fabrication of the Inconel 740 pipes is being addressed. Key components of turbine are: Casing to contain and regulate steam flow; Bolts to integrate both halves of casings; and Rotor and Blade to extract the steam energy and convert into mechanical energy. In Indian AUSC, both the casing and rotor of HP and IP turbine will be welded ones. Complicated structure of the casing is produced by casting. In inner casing of AUSC, welded Inconel 625 / G911 steel will be used against G911 ferritic steel in USC. Establishment of welding technology for the dissimilar weld joint between alloy 625 and G911 is being persuaded. Bolts for integrity of both halves of casing will be Inconel 718 against alloy X9 in USC for higher stress relaxation resistance. The rotor is of welded Inconel alloy 617 / E911 ferritic steel in AUSC against E911 steel in USC. Large diameter ( $\approx$  1 meter) rotor will produced by forging process, bringing grain size inhomogeneity and hence mechanical properties. Welding process development of the dissimilar (625/E911) rotor is a key technology and is in the process of development. For LP turbine, an ultra-super clean NiCrMoV steel (control on P, Sn, Mn) will be used for both rotor and casing to minimize temper embrittlement at high temperatures. The materials selected for stationary and rotatory blades and valves have also been highlighted.

Dr. R. Sankarasubramanian and Dr. A. Venugopal Rao of DMRL Hyderabad dealt on “Role of Artificial Intelligence / Machine Learning and Integrated Computational Materials Engineering (ICME) in Materials Discovery”. Materials discovery is a rate controlling step in the design of new engineering structures. It is essential that materials design be incorporated as part of engineering design of structures and systems so that maximum benefit is realised. However, this seems to be extremely difficult task because the physical behaviour of engineering materials is extremely complex; features at several length scales and various phenomena occurring over several time scales control their properties and performance. Traditional materials development relies on trial-and-error based experimentation. This approach is laborious and time taking. Availability of affordable computing systems combined with advances in modelling and simulation in terms of reliable software and efficient algorithms, have started changing this scenario. Using the above ecosystem, ICME has recently emerged as a new discipline as a means to accelerate materials discovery. Further, the availability of extensive data accumulated over decades of research combined with the emergence of Artificial Intelligence (AI) has opened up extensive scope for accelerating discovery of newer materials. In this presentation, efforts of DMRL in making use of ICME-based approach for designing newer nickel-based superalloys have been elaborated. The prospect of incorporating AI-based approach in the design and processing of superalloys and in the aero engine turbine disc manufacturing by powder metallurgy were discussed.

“Application of digital and artificial intelligence technology to improve the energy efficiency and availability of existing thermal power plants” has been presented by Dr. Seog Hyeon Ryu, Advisor of Doosan Heavy Industries &





Construction, Korea. In-service, power generation facilities maintain normal functions through periodic overhaul and maintenance, but it is difficult to avoid decreasing the thermal efficiency and availability to some extent as the operation time increases. This presentation highlighted an early warning solution for power plant, boiler combustion optimization solution and boiler tube management system (BTMS) based on digital and artificial intelligence technology. It has been mentioned that, PreVision developed by Korea for early warning has two big features: detecting fault signs via prediction technology using sensor data and diagnosing the same for root cause analysis. These can help avoid unplanned plant outages by using prediction and diagnosis solutions. Optimizing the boiler furnace's combustion is effective at improving its thermal efficiency and reducing the fossil power plant's emissions. The artificial neural networks (ANN)-generated combustion model is applied to the particle swarm optimization (PSO) algorithm to explore the boiler's input values to optimize the combustion. The BTMS provides functions for predicting and managing the temperature distribution and lifetime of the tubes based on applying the boiler's design information, real-time operation information, and fuel information.

Prof. Hyochoong BANG of Korea Advanced Institute of Science and Technology, presented A Case Study on Space Education Initiatives by Cubesat. In this talk, recent university space activities in Korea are introduced in particular Cubesat program. The Cubesat is being considered as a new game changer in space education and innovative technology. KAIST) launched a 2kg size Cubesat into space with some success story in 2017. The program has significant impact on young generation by providing new opportunities. Korean government strongly supported university Cubesat initiatives. This talk generated attention with possibility of collaboration in Cubesat between India and Korea in the near future.

Prof. Vinay K Dadhwal, Indian Institute of Space Science and Technology, Trivandrum, gave a detailed presentation of Space Education Initiatives in India. Space education in India covers a very large canvas of science, technology and applications. The areas that address space education include astronomy and astrophysics, heliophysics, planetary science, astrobiology, to a number of engineering branches such as aerospace and avionics with inclusion of material science and technology, communication and optical engineering and earth science, geomatics and geodesy, positioning and navigation. Education opportunities in India for above disciplines were presented especially the leading institutions. Major centres focusing on PhD research and training in relevant areas of space are Physical Research Laboratory, Ahmadabad (estd. 1944), Indian Institute of Remote Sensing, Dehradun (estd. 1966 as Indian Photointerpretation Institute), Space Physics Laboratory (1968, under VSSC), National Atmospheric Research Laboratory, Gadanki (estd 1992 as National Mesosphere-Stratosphere-Troposphere Radar Facility NMRF). These organizations independently and through programs such as establishment of Space Technology Cells in IITs by ISRO, RESPOND program and a number of recent initiatives have been significant in spreading the space education through research and training. Most significant initiative of ISRO in the field of education has been establishment of Indian Institute of Space Science and Technology (IIST) in 2007. IIST is a deemed-to-be university under the Indian education system and offers undergraduate, post-graduate and doctoral degrees in relevant disciplines.

The research focus at IIST is both on (a) space relevant discipline-wise areas with particular emphasis on gap areas identified by ISRO and (b) conceptualize and realize space projects to provide system engineering experience to students, researchers and faculty. Recent such project on an ARIS (Advanced Retarding Potential Analyses for Ionospheric Studies) launched on PS4-OP on 1 april 2019 on PSLV C45 and would also fly shortly again PS4-OP on PSLC-C48. It has proven successful and its variants have been accepted to fly on upcoming ISRO missions to Mars (MON-2) and Venus. IIST has established a Small Spacecraft and Payload Centre (SSPACE) which currently is working on one in-house cubesat (AHAN) and two international collaborative small spacecraft projects, namely InspireSat-1 (with University of Colorado) and AAReST (with Caltech USA and University of Surrey, UK). IIST has designed various subsystems, including OBC, cold gas thrusters, EPS, flight software and all will be flown on ISRO vehicles in next 1-2 years. Ongoing international collaborations were presented.

A letter of appreciation has since been received from President, NAEK.

## *Other Activities/Affairs of INAE*

### **Frugal Innovation (National Innovation Council, DST)**

Besides the core activities of INAE, one of the objectives of the Academy is to pursue academic activities to addressing 'Engineering challenges' that the country is facing. The first focus is to undertake specific studies to address some urgent problems. Many of these have fructified in concrete action plans, in particular the reprocessing of automobile waste. The second major step was the organization of Engineers Conclave and this has led to very specific implementable recommendations. As a third focus, INAE Forums are providing very useful inputs to policy makers in key areas like Urban Transportation, Housing, Disaster Mitigation etc... In line with these initiatives took by INAE, one of the major initiatives was the institution of the Frugal Innovation Nurturing Programme (FINP) by INAE which is a follow up action of the two-day Workshop organized jointly with National Institute of Rural Development and Panchayat Raj (NIRDPR) on Frugal Innovation on July 7-8, 2017 at NIRDPR, Hyderabad.

Frugal Innovation Nurturing Programme (FINP) was instituted in August 2018 with an objective to nurture prospective frugal innovations which have reached prototype stage to scale up and commercialize them for greater exploitation. For this purpose, Innovation Promotion Committee (IPC) was constituted for implementation of the Programme under the Chairmanship of Dr. V Bhujanga Rao, FNAE. Frugal Innovation Nurturing Programme (FINP) has also joined hands with National Innovation Foundation (NIF) to identify some innovations that have reached prototype stage and have been successfully tried in the field, but were limited in out-reach in terms of infrastructure/means available with the inventor. Frugal Innovation Nurturing Programme (FINP) has since identified four such innovations during 2018-19 and one of them was scaled up from TRL-4 to TRL-9. After gaining experience in 2018-19, 13 such innovations have been identified for further exploitation and commercialization under this Programme.

## Welcome Meeting for Lt Col Shobhit Rai (Retd), Deputy Executive Director, INAE

A Welcome Meeting for Lt Col Shobhit Rai (Retd) who joined INAE Office as Deputy Executive Director was held on January 6, 2020 at INAE Office, Gurgaon. The meeting was presided over by Dr Sanak Mishra, President, INAE and was attended by the staff of INAE. Dr Sanak Mishra, President, INAE welcomed Lt Col Shobhit Rai (Retd) and felicitated him with the presentation of the Academy tie and a Memento and wished him a fruitful tenure at INAE.



*Dr. Sanak Mishra, President INAE welcoming Lt Col Shobhit Rai (Retd), Deputy Executive Director, INAE*



*Group Photograph with INAE Staff at Welcome Meeting*

## Participation of INAE in 107th Indian Science Congress

During the meeting of DST – INAE Consultative Committee held on November 28, 2019 in the Office of Secretary, Department of Science and Technology (DST), Prof. Ashutosh Sharma, FNAE, Secretary, DST had suggested that INAE should participate during the 107th Indian Science Congress Expo from January 3-7, 2020 being held at University of Agricultural Sciences, Bangalore, to increase the outreach of the Academy, within the scientific and engineering fraternity. Accordingly, Ms Pratigya Laur, Research Officer, INAE was deputed as a representative from INAE, to set up a stall pertaining to INAE, during the exhibition at the DST Pavilion at Pride of India Expo – Mega Science Exhibition in the 107th Indian Science Congress Expo held at Bangalore. Two posters containing information on 'About INAE' and the 'INAE-SERB, DST Abdul Kalam Technology Innovation National Fellowship' were showcased in the stall. This Expo was attended by persons from a very broad scientific and engineering community ranging from students to the highest professional levels. The visitors at the Congress appreciated the INAE stall and the information showcased about INAE was well received.



*INAE Stall at Indian Science Congress at Bangalore*

## Meeting of INAE Delegation with Hon'ble Minister of Civil Aviation

INAE Delegation comprising of Dr Sanak Mishra, President, INAE; Dr BN Suresh, Immediate Past -President, INAE; Dr Kota Harinarayana, Former DG, ADA; Dr PS Goel, Former President, INAE and Lt Col Shobhit Rai (Retd), Deputy Executive Director, INAE met with Hon'ble Minister of Civil Aviation, Shri Hardeep Singh Puri on January 14, 2020 at New Delhi to present the recommendations on the “Development of Regional Transport Aircraft in the country”, which had emanated from the deliberations of various high level meetings including the Engineers Conclave 2017, held at Bangalore. The issue is relevant in the context of India having the largest market in the world for the class of Regional Transport Aircraft, with 90-seater capacity.



*Left to Right: Dr Kota Harinarayana, Dr BN Suresh, Dr Sanak Mishra and Dr PS Goel at the Meeting in Office of Hon'ble Minister of Civil Aviation, New Delhi*



## *INAE Youth Activities*

### **INAE Youth Forum**

INAE had created a Youth Forum in the year 2017 with the objective of facilitating the engagement of Indian youth in engineering activities at national level. Through the institution of the Youth Forum, INAE extends Student Membership to winners of various competitions conducted for engineering students such as National Online Essay Competition, Innovative Student Project Awards and also other competitions under the aegis of the Youth Forum, thereby endorsing their talent and advocating their ability to contribute meaningfully to the development of the country. The Youth Forum provides a platform for the engineering students to voice their concerns on engineering aspects and also interact with INAE Fellows and Young Associates on issues of national interest that shall help shape their future careers in the engineering profession. The INAE Youth Forum was launched during the first INAE Youth Conclave held at Birla Institute of Scientific Research Jaipur on Aug 11-12, 2017.

### **The third INAE Youth Conclave 2019**

The third INAE Youth Conclave was organized at Indian Institute of Technology (IIT), Delhi on Aug 9-10, 2019. Prof. V Ramgopal Rao, Director IIT, Delhi had kindly hosted the event. Dr. Purnendu Ghosh, Vice President INAE and Chairman INAE Youth Committee along with Prof Shaikh Ziauddin Ahammad, IIT Delhi and Prof. BK Panigrahi, FNAE IIT Delhi organised the event. The Conclave was organized for engineering students in Graduate, Post Graduate and Doctoral level. The event included interactive sessions of students with INAE Fellows and other Subject Experts and presentations by students based on engineering models or engineering ideas. The engineering model and idea presentations were based on five topics of national importance namely (a) Health is Wealth (b) Digital Revolution (c) Environment Protection (d) Lab to Market and (e) Waste to Wealth. The Conclave was attended by more than 200 engineering students from all over the country, and about 30 INAE Fellows participated in the deliberations. The Conclave was inaugurated by the Chief Guest, Prof. Anil D Sahasrabudhe, Chairman AICTE and Guest of Honour was Prof K VijayRaghavan, Principal Scientific Adviser to the Government of India.



*Dr. Sanak Mishra, President INAE addressing the audience in the Inaugural Session of INAE Youth Conclave 2019*



*Chief Guest, Prof Anil D Sahasrabudhe, Chairman AICTE delivering Address during INAE Youth Conclave 2019*



*Guest of Honour, Prof. K VijayRaghavan, Principal Scientific Adviser to Govt. of India, delivering Address in INAE Youth Conclave 2019*

The Inaugural Session was followed by individual/team presentations by students on the five chosen theme areas. Each participating student/student team was judged by a panel of judges consisting of experts from academia and industry. The Top three from each group were awarded prize money of Rs. 25,000 for the winner, Rs. 15,000 for the first runner-up and Rs. 10,000 for the second runner-up. The presentation session was followed by technical sessions on “Engineering Education: Demand and Supply”, “Technical Innovation in India: Frugal and Conventional”, “Societal Reinvention through Technology” and “Young Entrepreneur: Prospect and Challenges”.





*Presentation of engineering ideas by student on Waste to Wealth during INAE Youth Conclave 2019*



*Panel Discussion Sessions by INAE Fellows (left to right): Prof. Amit Agrawal, IIT Bombay, Prof. Anurag Sharma, IIT Delhi and Prof Prem Krishna:*



*Prof. Manoj Tiwari, IIT Kharagpur, Prof. KL Chopra, Dr. Purnendu Ghosh and Prof BK Panigrahi*

The conclave concluded with the award ceremony for the awardees. The students who attended the conclave were held interactions with INAE Fellows from Academia, R&D and Industry during the sessions. Dr. Purnendu Ghosh, Vice President, INAE and Chairman INAE Youth Committee congratulated all the awardees. He informed that all the awardees would be inducted as INAE Student Members for a period of 5 years and encouraged their involvement in INAE activities.



*Presentation of Awards to Winners in Award Ceremony of INAE Youth Conclave 2019*



*Group Photograph of Participants and Delegates at INAE Youth Conclave 2019 at IIT Delhi*





## *INAE Study Group on Indian Engineering Heritage- Metallurgy*

INAE Engineering Heritage – Metallurgy Study Group was reconstituted during 2020 with Dr. U. Kamachi Mudali continuing as its Chairman with the following Fellows of INAE as members: Dr. E.S. Dwarakadasa, Bangalore, Dr. S. Venugopal, NIT Dimapur, Dr. N.K. Mukhopadhyay, IIT BHU, Dr. Soumitro Tarafder, NML, Jamshedpur, and also those who are involved in the metallurgical heritage filed as invitees for the Study Group meetings. The Study Group was given the following mandate by INAE:

- a. Organizing workshops, seminars & symposia on metallurgical heritage
- b. Commissioning research monographs on specific aspects of Indian heritage in metallurgy
- c. Promoting discourses, lectures and study projects on the Indian heritage in metallurgy for students at institutes and universities
- d. Enabling studentship and research in archaeometallurgy of the Indian sub-continent and enabling research fund for eminent projects
- e. Inspiring young leaders to work in the area of archaeometallurgy through promotion of mentoring by peers
- f. Inspiring new individuals and groups to work in the domains of priority
- g. Facilitating connectivity of Indian initiatives on archaeometallurgy with similar programmes of fraternal learned societies in India and abroad.

Keeping in view the mandate of the Group, a meeting of the Engineering Heritage – Metallurgy Study Group and a Workshop on “Advanced Characterisation of Ancient Metallic Objects” was discussed and proposed at Institute of Rajasthan Studies, Janardan Rai Nagar Rajasthan Vidyapeeth (Deemed -to -be) University, Udaipur. Dr. U. Kamachi Mudali, Chairman, IEH-Metallurgy, Prof. Lalit Pandey, Former Professor and Director, Institute of Rajasthan Studies, JRN Rajasthan Vidyapeeth, Udaipur and Dr. Pravin P. Deshpande, College of Engineering, Pune prepared a proposal to conduct the meeting and event during April 03-04, 2020. The objective of the workshop was to bring out the recent techniques available for characterization of ancient metallic objects along with review of existing techniques and the characterization carried out so far. IEH-Metallurgy Committee members and experts working on advanced characterisation techniques from all over India will be invited for the event. Further utilizing the huge data of characterization already available in the country for digitization will be discussed in a panel discussion at the end of Workshop. However, in view of Covid-19 pandemic the event was postponed till further announcement.

## *Abdul Kalam Technology Innovation National Fellowship*

Indian National Academy of Engineering (INAE) and Science and Engineering Research Board (SERB), Department of Science and Technology (DST) launched the INAE-SERB, DST Abdul Kalam Technology Innovation National Fellowship in the year 2017, to recognize, encourage and support translational research by Indian Nationals working in various capacities of engineering profession, in public funded institutions in the country.

The nominees for the subject Fellowship should have a minimum of 5 years' service left in the parent organization. The Fellowship amount is Rs 25,000/- per month in addition to salary being drawn and a Research Grant of Rs.15.00 lakh per annum will also be provided. An Overhead of Rs.1.00 lakh per annum will also be provided to the host institute. A Maximum of 10 Fellowships will be awarded per year. The duration of the Fellowship will be initially for three years, extendable by up to two more years depending on the performance and the Fellowship can be held for a maximum of 5 years.

The scheme has received a good response and has gained visibility in the engineering community across the country. A maximum of 10 Fellowships are awarded in a year and six Fellowships were conferred in the Financial Year 2017-18 and eight in the Financial Year 2018-19. The INAE Governing Council during its meeting on December 12, 2019 at Birla Institute of Scientific Research (BISR), Jaipur, approved the names of seven nominees selected during the Financial Year 2019-20, as per details given below.

- i) Prof Rohit Srivastava, IIT Bombay
- ii) Prof Pushpak Bhattacharyya, IIT Patna
- iii) Prof V Kamakoti, IIT Madras
- iv) Prof Sujatha Srinivasan, IIT Madras
- v) Prof Subhananda Chakrabarti, IIT Bombay
- vi) Prof Bikramjit Basu, Indian Institute of Science, Bangalore
- vii) Prof Debatosh Guha, University of Calcutta, Kolkata

This would now make a total of twenty-one nominees who have been selected for conferment of the subject Fellowship since its inception.



## *Reaching out to Policy Makers: Interaction with Govt. Agencies*

Indian National Academy of Engineering (INAE), during the recent past, in addition to its well-defined activities, has been giving a major thrust in carrying out activities on issues of National importance, where engineering interventions can provide the needed solutions. In order to facilitate identification of topics on thrust areas for conduct of activities, INAE has in place consultative/joint Committees with DST, Office of Principal Scientific Adviser (PSA) to Government of India, TIFAC, AICTE etc. The actionable recommendations emanated from the activities have been forwarded as inputs for policy formulation, to the concerned agencies, which have been well received and, in many cases, implemented. The progress made by INAE on some of these activities are summarized below.

### **DST-INAE Consultative Committee**

#### **Study on “Pilot Project on Safe Laboratory Practices and Laboratory Waste Disposal”**

During one of the DST-INAE Consultative Committee Meetings, Prof. Ashutosh Sharma, Secretary, DST entrusted the task to INAE for creating a plan of action to enhance the awareness of health and safety issues and safe disposal of chemicals and solvents in chemical and biological laboratories in Indian universities, research institutes and colleges. Accordingly, a project entitled, “Pilot Project on Safe Laboratory Practices and Laboratory Waste Disposal” was undertaken and report prepared.

The Study was carried out by Dr. S Sivaram, FNAE as the Principal Engineering Investigator (PI) and Dr. G.S. Grover, Chief Scientist (Retd), CSIR-National Chemical laboratory, Pune; as Team Member and Consultant and Mr. Shankar B. Kausley, TCS Pune as Team member. As a pilot project, three institutes were identified to create an implementable action plan as well as establish best practices for the disposal of chemical and hazardous wastes in the chemical and biological laboratories. The three institutes identified for undertaking of the study are:

1. Savitribai Phule Pune University (SPPU), Pune
2. Institute of Chemical Technology (ICT), Mumbai
3. Indian Institute of Science Education and Research (IISER), Kolkata

Other than the above mentioned three institutes, the inputs were also obtained from other institutes who are doing a remarkable work in this area viz IIT Delhi which has developed a zero-waste campus wherein the entire waste is being used to generate bio fuel to run the vehicles within the campus and carry out other activities. A report on the proposed pilot project on Safe Laboratory Practices and Laboratory Waste Disposal, along with the project proposal, after duly incorporating all suggestions has since been prepared and submitted to Prof Ashutosh Sharma, Secretary, DST on February 5, 2020 for consideration and allotting a time slot for making a presentation on the subject.

#### **Research Study on “Housing”**

DST had desired INAE to undertake a Research Study for providing optimal engineering solutions for Housing under Jan Awas Yojna announced by the Hon’ble Prime Minister of India. Accordingly, INAE Forum on Civil Infrastructure, chaired by Prof. Prem Krishna, Former Vice-President, INAE during its Forum meeting on November 6, 2019, had deliberated and submitted a proposal on ‘Housing’ to INAE with an objective to create a “White Paper” to provide a set of needed actions related to Policy Initiatives, Engineering R&D and Extension. Subsequently, during the meeting of the DST-INAE Consultative Committee held on Nov 28, 2019, Prof. Prem Krishna, Chairman, INAE Forum in Civil Infrastructure presented the proposal on ‘Housing’ to be undertaken by the Forum. He briefed the Committee that the proposed study will entail assessment of category-wise and region-wise shortage of housing units. It will involve a critical review of technologies for affordable housing, tried in recent years and currently

shortlisted for consideration. The project will also focus on Industrialised Mass Housing, which will encourage industry to come forward to support the mission. The time frame for completing the Study will be about 12 months and once completed a detailed Project Proposal on “Housing” will be submitted to DST.

### **PSA-INAE Consultative Committee Role of Hydrogen in India's Energy Strategy**

Prof. K VijayRaghavan, Principal Scientific Advisor (PSA) to Govt. of India on the side-lines of the R&D Conclave held on 17 December 2019 in Delhi expressed his willingness that INAE should prepare a concept paper on Hydrogen based approach for India's Energy Strategy. For this a Round Table Interaction of domain experts on “Role of Hydrogen in India's Energy Strategy” was organized by INAE Pune Local Chapter on February 15, 2020 at Pune, which was attended by domain experts from INAE Fellowship and other expert invitees from Academia, R&D organizations and Industry. The invited experts shared insights on the current and future global situation about use of Hydrogen as an energy source; discussed the overall situation in India with respect to technologies, capabilities and affordability for Generation, Storage, Transportation and Usage of Hydrogen and concluded on the approach to be followed by INAE in forwarding recommendations to the Government. Subsequent to the deliberations, the recommendations in the form of a White Paper containing all the pertinent issues related to Role of Hydrogen in India's Energy Strategy are being finalized and shall be submitted to Prof. K VijayRaghavan, Principal Scientific Advisor (PSA) to Govt. of India.





## *Research Schemes*

### **INAE Chair Professorship**

INAE Chair Professorship was instituted in order to encourage engineers/technologists with outstanding research contributions, promote long-term participation in academic research and enhance the research standards in academic institutions. INAE Fellows between the ages of 45 and 65 years, working in well-recognized teaching/research institutions in India are eligible for consideration.

The nominations were not invited during the year since it was decided to review the methodology for inviting and processing the nominations and other details of the INAE Chair Professorship scheme with a view to enhance its impact.

### **INAE Distinguished Professors/Technologists**

INAE Distinguished Professors/Technologists Scheme has been instituted in order to utilize the expertise of INAE Fellows after superannuation for research in engineering institutions/Universities/Research & Development establishments/industry in India. Superannuated Fellows below 70 years of age are eligible for consideration.

The nominations were not invited during the year since it was decided to review the methodology for inviting and processing the nominations and other details of the INAE Distinguished Professors/Technologists schemes with a view to enhance impact.

### **Mentoring of Engineering Teachers by INAE Fellows**

INAE undertakes mentoring of Engineering Teachers from recognized Engineering institutions, during the summer vacations, with a view to enhance the quality of Engineering education being imparted in the country.

A total of twenty one Engineering Teachers were selected under scheme on “Mentoring of Engineering Teachers by INAE Fellows” this year, as per details given below.

S No	Name of Mentor	Organization of the Mentor	Name of Engineering Teacher	Institution of Teacher
1	Prof. Suman Chakraborty	Indian Institute of Technology Kharagpur	Dr. Naresh Kumar Mani	Manipal Institute of Technology, Manipal
2			Dr. Debashis Pal	Indian Institute of Engineering Science and Technology, Shibpur
3	Prof. Bijnan Bandyopadhyay	Indian Institute of Technology Bombay	Dr. Prasiddh Trivedi	Ramrao Adik Institute of Technology, Navi Mumbai
4	Prof. K. Bhanu Sankara Rao	University of Hyderabad	Dr. Raffi Mohammed	National Institute of Technology, Andhra Pradesh
5	Prof. S.V. Kulkarni	Indian Institute of Technology Bombay	Mr. Vishal Shantaram Dake	Sardar Patel College of Engineering, Mumba
6	Prof. Radhakant Padhi	Indian Institute of Science, Bangalore	Dr. I. Thirunavukkarasu	Manipal Institute of Technology, Manipal
7	Dr. Soumitra Tarafder	CSIR- National Metallurgical Laboratory Jamshedpur	Dr. Md. Basiruddin Sk.	Jadavpur University, Kolkata

8	Dr. Surendra Kumar Biswal	CSIR - Institute of Minerals and Materials Technology, Orissa	Mr. Kashinath Barik	Indira Gandhi Institute of Technology, Sarang, Odisha
9	Dr Archana Sharma	Bhabha Atomic Research Centre, Mumbai	Dr Somesh Vinayak Tewari	SRM University, Andhra Pradesh
10	Dr. J. Krishnan	Retired L&T Chair, MS University, Baroda	Dr. Visvesh Badheka	Pandit Deendayal Petroleum University Gandhinagar Gujarat
11			Mr. Sachin Ganeshrao Solanke	Saraswati college of Engineering, Maharashtra
12	Dr. G. Madhusudhan Reddy	Defence Metallurgical Research Laboratory, Hyderabad	Dr. K. Guruvadyathri	University of Hyderabad
13	Prof. Ashok Kumar Pradhan	Indian Institute of Technology Kharagpur	Dr. Nabin Kumar Sahu	Dhirubhai Ambani Institute of Information and Communication Technology, Gandhinagar
14	Dr. Sukumar Mishra	Indian Institute of Technology Delhi	Mr. Saumendra Sarangi	MNNIT Allahabad
15			Ms. Stuti Shukla Datta	Amity School of Engineering and Technology, Lucknow
16	Prof. S.K. Koul	Indian Institute of Technology Delhi	Mr. Kushmanda Saurav	Indian Institute of Technology Jammu
17	Prof. J C Misra	Indian Institute of Technology Kharagpur	Dr. Satya Rajan Mishra	Institute of Technical Education & Research (ITER), Bhubaneswar
18			Dr. Priya Mathur	Poornima Institute of Engineering & Technology, Jaipur
19	Prof. Bidyadhar Subudhi	Indian Institute of Technology Goa	Dr. Bikramaditya Das	Veer Surendra Sai University of Technology, Sambalpur
20	Dr. Parag R Gagote	Institute of Chemical Technology Mumbai	Mr. Nandana Chakinala	Manipal University Jaipur
21	Prof. Anil Kottantharayil	Indian Institute of Technology Bombay	Dr. Lintu Rajan	National Institute of Technology, Calicut

### Mentoring of Engineering Students by INAE Fellows

INAE undertakes mentoring of meritorious 3<sup>rd</sup> /4<sup>th</sup> year B.E./B.Tech students from recognized Engineering institutions, during the summer vacations, with a view to provide them guidance so as to excel further in their field of study and improve the quality of engineering education.



A total of thirty seven Engineering Students were selected under the scheme “Mentoring of Engineering Students by INAE Fellows” this year, as per details given below.

S No	Name of Mentor	Organization of the Mentor	Name of Engineering Student	Institution of Student
1	Prof. K. T. Jacob	Indian Institute of Science, Bangalore	Ms. Priyal Parihar	Maulana Azad National Institute of Technology, Bhopal
2	Dr. Parag. R. Gogate	Institute of Chemical Technology, Mumbai	Mr. Atindra Kumar Kushwaha	Madan Mohan Malviya University of Technology, Gorakhpur, Uttar Pradesh
3	Prof. K Bhanu Sankara Rao	University of Hyderabad	Ms. Anjuri Sai Mounika	National Institute of Technology, Andhra Pradesh
4			Ms. Tirumala Eswara Siri Vara Prasad	RGUKT - IIIT Nuzvid
5	Prof D.P. Kothari	VNIT, Nagpur	Mr. Anshuman Pathak	UPES, Dehradun
6	Prof. Shiban Koul	Indian Institute of Technology Delhi	Ms. Goutha Reddy Shalini	University College of Engineering, Osmania University, Hyderabad
7	Prof. Satyam Suwas	Indian Institute of Science, Bangalore	Ms. Namballa Baby Raga Malikasri	RGUKT - IIIT Nuzvid
8			Mr. Y Kaarrthikeyan	Mahatma Gandhi Institute of Technology, Hyderabad
9	Dr. R. Gopalan	ARCI, Chennai	Mr. ShemShetty Saicharan	Rajiv Gandhi University of Knowledge Technologies, Basar
10			Ms. KVS Aishwarya	Mahatma Gandhi Institute of Technology, Hyderabad
11	Dr. Neelesh B Mehta	Indian Institute of Science, Bangalore	Mr. Suman Roy Ghatak	Jadavpur University, Kolkata
12			Mr. Arunabh Srivastava	Indian Institute of Technology, Madras
13	Prof B S Murty	Indian Institute of Technology Hyderabad	Mr. Jajjara Sampath Kumar	RGUKT-IIIT NUZVID, Andhra Pradesh
14	Prof. Amol Gokhale	Indian Institute of Technology Bombay	Mr. S N Suprabhat	Mahatma Gandhi Institute of Technology, Hyderabad
15	Prof. SV Kulkarni	Indian Institute of Technology Bombay	Ms. Navyashree Shetty	VJTI, Mumbai
16			Mr. Pushkar NA	Indian Institute of Technology Kharagpur
17	Prof. Tammana Jayakumar	Defence Metallurgical Research Laboratory, Hyderabad	Mr. Murali Krishna Yenneti	National Institute of Technology, Karnataka
18			Mr. Naga Durga Sairam Vedireswarapu	SRKR Engineering College, Bhimavaram

19	Prof. Pradip Dutta	Indian Institute of Science, Bangalore	Mr. Raghvendra Dheeraj Peddinti	Indian Institute of Technology, Bhubaneswar
20	Prof. Suman Chakraborty	Indian Institute of Technology Kharagpur	Mr. Abhranil Guha Thakurta	Jadavpur University, Kolkata
21			Mr. Souvik Ghosh	Indian Institute of Engineering Science and Technology Shibpur
22	Prof. Vinay Gupta	Indian Institute of Technology Kanpur	Ms. Amrita Bhattacharjee	Jadavpur University, Kolkata
23	Dr. Vikas Kumar	Ex-Defence Metallurgical Research Laboratory, Hyderabad	Ms. Tailam Sasi Kala	RGUKT-IIIT NUZVID, Andhra Pradesh
24			Ms. E. Anjali Priya	Rajiv Gandhi University of Knowledge Technologies, Basar
25	Dr. G. Madhusudan Reddy	Defence Metallurgical Research Laboratory, Hyderabad	Mr. Gudavalli Revanth Sai Krishna	National Institute of Technology Andhra Pradesh
26			Ms. Amrutha PH S LR	Mahatma Gandhi Institute of Technology, Hyderabad
27	Prof. K. J. Vinoy	Indian Institute of Science, Bangalore	Ms. Akurati Meghana	University College of Engineering, Osmania University, Hyderabad
28	Dr. Sukumar Mishra	Indian Institute of Technology Delhi	Mr. Sudhansh Shekhar Singh	National Institute of Technology, Surathkal
29	Prof. Santosh Kumar Gupta	UPES, Dehradun	Ms. Gauri A Panday	Shiv Nadar University, Noida
30	Dr. Samir V Kamat	Defence Metallurgical Research Laboratory, Hyderabad	Ms. Cholleti Prathyusha	Rajiv Gandhi University of Knowledge Technologies, Basar
31			Mr. N Sai Sri	Mahatma Gandhi Institute of Technology, Hyderabad
32	Prof. Rahul Mitra	Indian Institute of Technology Kharagpur	Mr. Abhishek Jakhota	Mahatma Gandhi Institute of Technology, Hyderabad
33			Mr. Tanmay Garg	Indian Institute of Technology Bhubaneswar
34	Prof P K Dash	Siksha O Anusandhan University, Bhubaneswar	Mr. Abhishek Kumar Pandey	GIET University, Gunupur
35			Mr. Debasis Tripathy	Parala Maharaja Engineering College, Behrampur
36	Prof. R. Sarathi	Indian Institute of Technology Madras	Ms. Thirumagal V	SSN College of Engineering, Tamil Nadu
37	Prof. Saptarshi Basu	Indian Institute of Science, Bangalore	Mr. Aneek Chakraborty	Jadavpur University, Kolkata



## *INAE Forums*

One of the important objectives of the Academy is to assist the Government from time to time in formulating policies on critical technical issues. For this purpose, five forums have been constituted – INAE Forum on Energy, INAE Forum on Technology, Foresight and Management, INAE Forum on Engineering Interventions for Disaster Mitigation, INAE Forum on Indian Landscape of Advanced Structural Materials and INAE Forum on Civil Infrastructure. These forums enable giving inputs to policy makers, institutes of higher learning & research, industries, etc.

### **INAE Forum on “Indian Landscape of Advanced Structural Materials”**

#### ***Workshop on Future Landscape of Structural Materials in India (FLSMI)***

The Workshop on Future Landscape of Structural Materials in India (FLSMI) was organized under the aegis of the INAE Forum on Indian Landscape of Advanced Structural Materials at Kolkata on December 7, 2019. A brief background on the subject is as follows: While manufacturing is a key component for sustainable economic growth of a nation, the success of manufacturing of structural goods or components heavily depend on designing, developing and exploiting the appropriate material. Materials for structural applications that offer a diverse range of mechanical properties are mostly a combination of several materials and are produced by multi-step manufacturing process. Moreover, the urge for improvement never ceases as both stringency of service condition and need for technological advancement continuously rise.

The seed was sown to initiate this initiative in April 2016, at an INAE Meeting, when it was decided that an authentic compendium will be published on Structural Materials in India under the aegis of the INAE Forum on “Indian Landscape of Advanced Structural Materials”. It took another year and a half to work out the strategy and design a structure for the proposed book, with the chapter headlines and the relevant experts earmarked. The objective was to review the existing capability and readiness of the country to synthesise, develop and utilise advanced structural materials for the country’s need.

The main structural materials identified for the study are advanced high strength steels, new generation aluminium alloys, Ti and Mg-based structural alloys, FRP composites and advanced ceramics. The concerned beneficiary sectors would be Defence, Aerospace, Railways, Power Generation and Automotive, all with a target of high strength, higher properties, longer service life and reliability. The stakeholder coverage however would include industry in each materials sector, industrial R&D, Government research laboratories, R&D laboratories of OEMs and academic institutes.

The genesis of the Forum is that INAE initiated a Technology Forum on “Indian Landscape of Advanced Structural Materials” in 2016 with Dr Debashish Bhattacharjee, VP, Tata Steel as the Convener of the Forum. The first meeting was held in Ahmedabad in Dec 2016, followed by two more in Kanpur in Jun 2017 and Kolkata in Nov 2018. Based on the deliberations in different fora at various levels and occasions spanning over the last three years, it is now planned to create an authentic report on the current status and future needs and trends in designing and developing advanced structural materials for various important industrial and strategic sectors of India. The collated review articles may be published as a peer reviewed compendium by a reputed publishing house. In this connection, INAE organized a one-day National Workshop in Kolkata on 7th Dec 2019 (Saturday) on “Future Landscape of Structural Materials in India (FLSMI)” in Hotel Pride Plaza, New Town, Kolkata. The workshop was inaugurated by Dr Sanak Mishra, President, INAE. Day long deliberations comprised 12 oral presentations followed by extensive interaction for 20-30 min each (including 3 by skype) by experts who would eventually submit chapters devoted to specific themes and help INAE create a comprehensive technology forecast and policy roadmap document for the nation.

The areas under focus are structural materials and components for Railways, Aviation, Space technology, Automobiles, Defence, Thermal power and atomic energy power plants, Refractories, Structural glass, Bio-medical prosthesis /



implants, Carbon/graphene-based structures and design, Light metals (aluminium / titanium / magnesium based structural alloys), FRP composites and advanced ceramics.



*Dr Sanak Mishra, President, INAE delivering his address as the Chief Guest*



*Prof Indranil Manna, Vice- President, INAE delivering talk on high temperature materials*

The outcome of the study will be a report that will clearly highlight the following:

- (i) Current Indian scenario on development of advanced structural materials
- (ii) Gap with the rest of the world both in terms of volume and in terms of research and development
- (iii) Suggested actions that can be taken in terms of encouragement in research in certain areas through focused funding calls, or encouragement of start-ups and SMEs through intellectual and Government R&D support.

The workshop featured very interesting talks by eminent speakers and was a grand success.

## **INAE Forum on “Civil Infrastructure”**

### ***Workshop on the Report entitled, “Urban Transportation: Challenges and Way Forward”***

A Workshop on the Report entitled, “Urban Transportation: Challenges and Way Forward”, Prepared by the INAE Forum on Civil Infrastructure was held on 10 July 2019 at Metro Bhawan, New Delhi. The genesis of the event is highlighted as follows. The INAE Forum on Civil Infrastructure, set up in January, 2018, had planned to study three areas of great National concern – Traffic & Transportation, Housing, Water. A study was first taken up to assess the National status of Urban Transportation – the challenges being faced, and, the possible way forward to tackle these. A report on the study has been prepared by Prof. Mahesh Tandon, FNAE; Dr. Mangu Singh, FNAE; Prof. N. Raghavan, FNAE; Prof. P.K. Sikdar, FNAE; Prof. Prem Krishna, FNAE and, Dr. Satish Chandra, all of whom have experience of working in the subject area. The workshop was held to discuss the report with, as wide a representation as possible from amongst the stakeholders, in order to get their views/suggestions, before finalising the same. A copy of the Executive Summary was made available to the participants prior to the workshop.

Dr. Mangu Singh, FNAE, MD DMRC, kindly provided the support base for organising the workshop, and, it was held at the Metro Bhawan on July 10, 2019. Dr. V.K. Saraswat, FNAE, Member, Niti Aayog, kindly graced the inaugural session as the Chief Guest, and, Dr. Sanak Mishra, President INAE spared his valuable time to preside over it. Prof Prem Krishna, Chairman of the Forum, made a presentation on the Background and Salient Aspects of the Report. The session was well attended.



*L to R: Prof Prem Krishna, Dr VK Saraswat  
Dr Sanak Mishra and Dr Pradip*



*Dr VK Saraswat being felicitated by Dr Mangu Singh*

There were two Technical sessions, at which features of the report were presented and discussed. In the first session, chaired by Prof. S.S. Chakraborty, a presentation on Organisational and Policy Issues was made by Dr. Mangu Singh, and, Prof. Tandon, FNAE, presented his views on 'Infrastructure - Engineering Issues'. The post lunch technical session, was chaired by Mr. Rakesh Chopra, former Member Engineering of the Indian Railways. Presentations were made by Dr. Satish Chandra, Director, Central Road Research Institute (CRRI), on Multi-Modal Transport, and, by Dr. Sikdar, FNAE on ITS (Intelligent Transportation System). Both sessions had very meaningful discussions. Valuable comments were made by the President INAE at the closing session. The purpose of the Workshop was well served and the inputs received will help to finalise the Report and take it forward.



*Dr Sanak Mishra, President, INAE being  
felicitated by Dr Mangu Singh*



*Audience at the workshop*

## INAE Forum on Civil Infrastructure

### *Progress of Work*

The forum was formed to address the subject area of Infrastructure, to cover specifically the issues of Traffic & Transportation, Housing and Water. The main objective of the forum is to create reports from its study to recommend needed actions, related to, Policy Initiatives, Engineering Development/Research, Education, and suggesting the Way Forward. To begin with the area of Traffic & Transportation was addressed. A draft report entitled, “Urban Transportation: Challenges and Way Forward” based on the study, authored by Profs. Prem Krishna, Mahesh C. Tandon, P. K. Sikdar, Dr. Mangu Singh, Prof N. Raghavan, and, Prof Satish Chandra, Director CRRI, was presented for Brainstorming at a workshop held in July 2019. A brief on the deliberations of the workshop is given below:

As wide a representation as possible from amongst the stakeholders, was invited to the Workshop, in order to get their views/ suggestions, before finalising the same. A copy of the Executive Summary was made available to near about 40 participants prior to the workshop. Dr. Mangu Singh, FNAE, MD DMRC, kindly provided the support base for organising the workshop, and, it was held at the Metro Bhawan New Delhi. Dr. V. K. Saraswat, FNAE, member Niti Aayog, kindly graced the inaugural session as the Chief Guest, and Dr. Sanak Mishra, President INAE spared his valuable time to preside over it. Also present was Dr. Pradip, Vice President INAE. Dr. Prem Krishna, Chairman of the INAE Forum on Civil Infrastructure, made a presentation on the Background and Salient Aspects of the Report. The session was well attended. There were two technical sessions at which features of the report were presented and discussed. In the first session, chaired by Prof. S.S. Chakraborty, FNAE, a presentation on Organisational and Policy Issues was made by Dr. Mangu Singh, and, Prof. Tandon, FNAE, presented his views on ‘Infrastructure Engineering Issues’. The post lunch technical session, was chaired by Mr. Rakesh Chopra, former Member Engineering of the Indian Railways. Presentations were made by Dr. Satish Chandra, Director, Central Road Research Institute (CRRI), on Multi-Modal Transport, and, by Dr. Sikdar, FNAE on ITS (Intelligent Transportation System). Both sessions had very meaningful discussions. Valuable comments were made by the President INAE at the closing session. The purpose of the Workshop was well served and the inputs received helped to finalise the Report and take it forward.

Taking into account the ideas emerging from the workshop, the report was finalised and a hardbound printed version was released at the Annual Convention of the INAE at Jaipur in December, 2019. The recommendations for future action made in the report were grouped into four broad heads, namely, Organisational issues, Policy issues, Intelligent Transportation Systems, and, Engineering issues for Infrastructure.

The way forward as given in the report is as under.

1. An all-India cadre should be set up consisting of Traffic & Transportation personnel, including ITS experts in various fields (planning, IT, utilities, mechanical systems, etc.) for faster and more efficient delivery.
2. Considering the vital importance of metro rail development for easing out the urban traffic problems, it is imperative that this is provided with greater independence rather than being encumbered by the norms, practices and controls of the conventional railway systems.
3. National-level policies, to drive the multi – modal transport environment, will have to be framed for, promoting and implementing expeditiously in a planned manner, integrated Public transportation systems such as metros and BRT, with special provisions for NMT (bicycles and pedestrians etc.) for various urban centres.
4. A policy be framed to enable the setting up of a National database of all motorised vehicles covering smart number plates and all driving licenses adopting smart card driving licenses, etc., and, real time traffic accident data capture and management.
5. Automation to be introduced into Toll Collection, Traffic Control Systems including detection of traffic offences and issue of challans, besides the development of a City Traffic App for multi-modal transport system in a city, giving map-based information for transit from point A to point B across all available systems.





6. IRC codes should permit necessary deviations in geometrics and loading standards to be applied judiciously for urban situations, which call for it.
7. In order to facilitate appropriate planning of infrastructure for Urban Transportation, it is imperative that the space in cities, both above and below ground, is surveyed and accurately mapped in the digital mode, to be available to planners and the engineering organisations.
8. Implementation and functioning of Unified Metropolitan Transport Authority (UMTA) and Urban Transport Fund (UTF) and integration in urban transport development. Furthermore, it is imperative that the Government of India consider for legislation in the form of the Urban Transport Act to strengthen UMTA and its implementation in the states.
9. A nationwide drive to improve safety on the road has to be taken up in a comprehensive manner, involving all the stakeholders, through appropriate media campaigns, etc as the safety statistics are very alarming and getting worse day by day.

The report is under distribution by the INAE, and, effort is on such that the study can reach those concerned with the subject area within the Government as well as outside.

Further, as per the mandate of the Forum a study has been undertaken to address the subject of Housing. For this purpose, the membership of the Forum was reorganised such that it is more sharply focussed on the subject area of Housing. Members added are, Dr. S. K. Bhattacharyya, FNAE, Dr. S. K. Agarwal, Executive Director, BMTPC, Mr. K. Senou, Head Precast Initiatives, L&T, and, Mr. Sanjay Pant, Director Civil Engineering, Bureau of Indian Standards. The Forum has so far had four meetings, and, there is good understanding of issues and their dimensions. Depending upon how the situation due to the COVID – 19 shapes up, the report should be completed by June/July 2020.

### **INAE Forum on Engineering Interventions for Disaster Mitigation**

The Forum is in its seventh year of action, since its establishment by INAE on August 8, 2013 during which it has delivered a number of Actionable Recommendations from time to time, for nation-wide implementation. The follow-up of the recommendations has therefore been an integral part of every annual report. During the period under report, substantial progress has been achieved over three other major agenda items: (1) Apropos its reconstitution-Revamp and bolster Forum's ongoing programme in tune with the emerging areas of national concern (2) Pro-actively, take a major initiative in one of the top priority emerging areas aimed at actionable recommendations and (3) Continue to pro-actively engage with the government and private sector institutions to respond to emerging national concerns with science and technology and innovation based engineering interventions.

Of the many actionable recommendations<sup>1</sup> made by the Forum, the good news is that the Government of India, Ministry of Mines Committee on Establishment of Expenditure, has recently issued a Memo on Establishment of an autonomous "Centre for Landslide Research Studies and Management (CLRSM)" at Dehradun, in the state of Uttarakhand. It is a matter of great satisfaction because, but for the intensive INAE follow-up, direct interaction with NDMA, related completed Medium Term Research Study and Roundtable meetings conducted during the preceding years, the national level consensus would not have been possible. The Forum had recommended an empowered, autonomous Centre to "serve as a premier geo-hazard centre with state-of-the-art facilities, which would eventually grow into a national centre of excellence". The other good news is that, as suggested by INAE, "the CLRSM will be fully autonomous in its functioning, similar to that of a national laboratory of the Council of Scientific and Industrial Research with full operational freedom and an independent budget".

Ever since its establishment, the Forum had emphasized- both the importance and urgency of -scientific documentation of disasters aiming at a game plan to plough back the very same lessons in reshaping future

<sup>1</sup>(Ref: INAE Proceedings Volume 1 and Current Science, Volume 109, No5 of 10 September 2015).

engineering interventions. Keeping that end in view, the Forum had created a pace setting example by scientific study, documentation and publication of the Monograph on Malpa Landslide tragedies. It was done with fullest involvement of Member NDMA, Executive Director NIDM and other national level institutions and experts. The satisfaction came when the recommendation appeared as point 9 of the 10-point agenda presented by the Prime Minister of India at the inaugural of the 7<sup>th</sup> Asian Ministerial Conference, stating that “No opportunity to learn from disasters should be wasted.” Encouraged by this call, the Forum may consider delivering yet another monograph of scientific documentation based on its completed research study on Malingaon landslide disaster.

Establishment of Disaster Mitigation Fund (DMF) has been on the active national agenda since 2005. Because of its urgency and importance, the Forum participated intensively in the ensuing national debate. The resulting paper with advocacy on DMF was formally presented by the Chairman of the Forum at the meeting of the National Advisory Committee of the NDMA. The good news on this front is that, as per the latest news report, the XV Finance Commission (2020-2025) has already taken many significant decisions in this regard.

The recent reconstitution of the Forum has opened up a fresh set of opportunities for the Forum to think beyond the ideas projected in the earlier backgrounder. The discussion on new possibilities, held at the first two meetings of the newly constituted Forum, has so far helped in picking one newly emerging area of topmost Priority; namely; Valorization of Industrial Waste for Hazard Mitigation. Based on nation-wide consultations -the Forum’s proposal for hosting a Round Table Meeting is currently in the stage of implementation. Coordinated by Dr D.N. Singh, the details of the RTM were finalized and the event was scheduled for Friday the 20th March 2020. It had to be rescheduled because of the Covid-19 lock down.

The Forum is well on its way to pick two or more areas out of the shortlist prepared through discussions held so far. It also proposes to continue discussion on multi-hazard disaster resilience driven by the head winds of challenges in dealing with cascading and concatenation of disasters such as landslides, earthquakes and floods.

## **INAE Forum on Energy**

### ***Engineering Focus for Future Development in India***

#### **India-Future Growth**

In India today, the prime need is a higher and more sophisticated technology to meet the needs of the poorest sections of our society. In moving towards that goal, the Academy must keep in mind the basic aim of poverty alleviation as a fundamental objective and act as a forum of consolidating all indigenous engineering efforts. The major task of the Academy is to chalk out the future course of Indian engineering using interdisciplinary advantages and the vast and diverse experience that its Fellows have in India and abroad. The country expects from Fellows of the Academy to demonstrate that India can be innovative, that India can show imagination, and can orient science and technology to the three basic directions – of indigenous development of imported technologies, of indigenous generation of new technologies and of moving to the frontiers to put Indian science and technology at forefront in the world. The Academy’s duty will be to become an instrument for attaining technological and scientific self-reliance and try to bridge the gap between what is achievable and what India must achieve.

In keeping with this background, the Energy Forum has initiated an Academy-wide discussion on what the Academy considers to be the ‘future of engineering’, and what would be the ‘corresponding engineering education’ to meet the development challenges of the country. In doing so, we recall the national and government commitment to sustainable development, and consequently on the need for the Academy to focus on national and global actions to attain sustainable development.

It is necessary to first identify areas of development that are crucial for socio-economic growth of the country. While considering the future focus areas and subsequently the engineering education to match those requirements, it is also necessary to consider whether we have proposed engineering education in keeping with the technological changes. One example can be considered that whereas most of the control systems have now moved from pneumatic





and mechanical to electronic based systems, the engineering curriculum and text books are still carrying details of pneumatic control systems.

As a starting point, the Forum suggested the following focus areas of development in the country:

1. High speed freight movement
2. Connectivity through highways and other transportation systems
3. Development of cities – impact of smart cities
4. Integration of Automation and Artificial Intelligence (including control systems) in industry and in infrastructure.
5. Robotics in manufacturing and service sectors
6. Decarbonization in major sectors like cement, steel, and civil aviation.

The Energy Forum requested other Fora of the Academy for their inputs and consideration for joining the study. In this regard, the ‘Forum on Technology Foresight and Management’ took up the idea, and after detailed discussion has approved joining in this Study.

### Next Steps

The Energy Forum and the Technology Foresight and Management Forum are now approaching the Academy Steering Committee to initiate this as an Academy-wide study, under the Energy Forum, focusing on these sub-sectors and identifying the development requirements by the year 2030, and the requirement of matching engineering ecosystem, including educational systems and processes. In the area of engineering education, there is a need to identify and develop an approach to support knowledge creation and dissemination through engineering education at all levels; and at the same time, skills development at all levels. Knowledge and skill sets have to be developed for ensuring achievement of national goals.

The Academy may wish to initiate a national discussion on the impact of connectivity, globalization, digitization, and artificial intelligence on work, skills, incomes, and prosperity. Whereas on one hand wealth creation at the top will be the first priority for the business and industry, India will still have to consider as to how poor people can be pushed into what is normally termed as a middle class. The idea here is to eradicate poverty and pull as large a number of persons from the poverty areas into the next stage of middle income group.

It will also be extremely necessary to focus on industry so as to see if and how manufacturing companies could operate like tech companies, such as the creation of cross-functional platform teams in order to stay ahead of digital disruption. This would need action to create new work culture and bring around operational changes.

Start-ups, micro and small industry sector, in India as in the rest of the world, will also play an important role in global economic development. Can the engineering education and skills development programmes be so oriented that sufficient space in terms of knowledge and skill is created for upgrading them from start-up level to the major industries?

The Proposal for the Study to be conducted under the Energy Forum will now be submitted to the Steering Committee for their support.

### **INAE Forum on “Technology Foresight and Management for Addressing National Challenges”**

INAE Forum on Technology Foresight and Management for addressing National Challenges was constituted in 2012 under the Chairmanship of Mr. V.K. Agarwal, Formerly Chairman Railway Board & Ex-officio Principal Secretary to Govt. of India & Formerly Director Steel Authority of India and Indian Oil Corporation with Dr. Y.P. Anand, Formerly Chairman Railway Board & Ex-Officio Principal Secretary, Govt. of India; Prof. Prem Vrat, Vice-Chancellor and Professor of Eminence, ITM University, Gurgaon & Formerly Vice-Chancellor UP Technical University; Dr. C.R. Prasad, CMD, Everest Power Pvt. Ltd., New Delhi & Formerly CMD, GAIL; Mr. Anil Kumar Anand, Director

Technical, Microtroll Sterilisation Services, Mumbai & Formerly Director (Reactor Projects Group), BARC; Mr. Pradeep Chaturvedi, Vice President, World Environment Foundation & Formerly Regional Representative, Centre for Application of Solar Energy, UNIDO (joined later); Mr. Kishore Pal Singh, Formerly Managing Director RITES and Managing Director, Tata Projects Ltd.; Mr. Suresh Chandra Gupta, Formerly Member Electrical, Railway Board & Ex-officio Secretary to Govt of India; Mr. Vinoo Narain Mathur, Formerly Member Traffic Railway Board & Ex-Officio Secretary to Govt. of India; and Mr. Arun Kumar Gupta, Formerly Director Oil India Ltd. and Editor, RITES Journal as the Members of the Forum.

The mandate of the Forum is to evolve solutions keeping in view the issues of sustainable development, poverty reduction, and climate change in focus and suggest appropriate technologies accordingly. Further, suitable Engineering Management techniques will be employed to find cost effective and optimal solutions. Domain of National Challenges is very wide and also keeps on changing from time to time. This Forum would selectively address the following mentioned domains as a broad guide (a) Food Production and Utilisation and Conservation of Water (b) Energy Generation and Utilities (c) Manufacturing Technologies (d) Mass Transit Systems and (e) Building and Construction Technologies.

The First Report of the Forum was published in 2014 which covered the areas pertaining to Waste Management, Water – Meeting the Future Challenges, and Transport – Making it Greener. The Second Report of the Forum was published during 2016 which covered the aspects of Agriculture – Waste Reduction and its use; Energy – Major Thrust on Solar; and Mass Transit Systems. The Third Report of the Forum was published in 2018 which addressed pertinent issues and concerns regarding Rural Urban Continuum and development of High-Speed Rail in the country.

After the release of three reports, the Forum decided to bring out the Fourth Report covering three broad areas viz. (a) Issues of Environment / Climate Change / Sustainability (b) Rail-based Infrastructure Urgently Needs Four Major Interventions at the Level of Government of India (c) Improving the Operating Ratio of Indian Railways – A Way Forward. In order to cover the wide spectrum of the pertinent issues, Shri Keshav Chandra, Former Member Mechanical Railway Board & Ex-Officio Secretary to the Govt. of India and Shri A. P. Mishra, Former Member Engineering Railway Board and Ex-Officio Secretary to the Govt. of India were included as Members of the Forum especially with a view to cover the emerging challenges and to strengthen the Forum for handling the current issue of 'Boost to Rail in MSME Sector'. The Fourth Report of the Forum has been prepared and is under publishing which will be shortly available as INAE Publications on INAE website.

The Forum is currently examining the following:

1. "Logistics"
2. "Municipal Solid Waste Management"
3. "Energy Sector with special reference to Solar and Coal Power"
4. "Engineering Focus for Future Development in India"
5. "Boost to Rail in MSME Sector"



## ***INAE “Satish Dhawan Chair(s) of Engineering Eminence”***

INAE Satish Dhawan Chair of Engineering Eminence was instituted with the objective of enhancing the visibility of the Academy in the policy domain and establishing social connect. Eminent engineers who have contributed to some aspect of nation building are chosen for this esteemed position. The objective of the Chair is to utilize their competence to facilitate future growth of the nation in the engineering domain. The Satish Dhawan Chairs were conferred earlier on Dr. K Kasturirangan, FNAE, (Formerly Chairman, Space Commission and Secretary, Department of Space, Bangalore; Formerly Director, National Institute of Advanced Studies, Bangalore and Formerly Member (Science), Planning Commission, New Delhi) and Dr. Anil Kakodkar, FNAE, (Formerly Director, BARC, Mumbai; Formerly Chairman, Atomic Energy Commission and Secretary, Department of Atomic Energy, Mumbai).

In the year 2017, INAE Satish Dhawan Chair of Engineering Eminence was conferred on Dr Kota Harinarayana, FNAE, formerly Programme Director, Aeronautical Development Agency (ADA) Bangalore who was associated with NAL, Bangalore for necessary institutional support. The task undertaken under the aegis of the Chair was on preparing the policy document on “Aircraft for Regional Connectivity”. Based on his contributions and progress, Dr Kota Harinarayana was granted extension of the tenure of his association as Satish Dhawan Chair at NAL Bangalore; for a period of one more year upto end December 2018, in order to facilitate the completion of the task currently under progress and finalize the report.

In the year 2019, the INAE Satish Dhawan Chair of Engineering Eminence was conferred on Dr PS Goel, Honorary Distinguished Professor, ISRO Hqrs. and Raja Ramanna Chair Visiting Professor and Formerly Secretary, Ministry of Earth Sciences and Chairman, Earth Commission; and Director, ISRO Satellite Centre, Bangalore; Formerly Chairman, Recruitment and Assessment Centre, DRDO, Ministry of Defence, Govt. of India Delhi and Formerly Prof. M.G.K Menon DRDO Chair. Dr PS Goel was conferred the Satish Dhawan Chair in recognition of his outstanding contributions to the Indian Space Programme as well as leadership role in the growth of the engineering profession in the country. He was associated with National institute of Advanced studies (NIAS), Bangalore for institutional support to carry out work under the aegis of the subject chair. Dr PS Goel has undertaken multi focused activities under the aegis of the subject chair which include:

- Editing a book “Climate Change and the White World”, to be published by Springer. Editors: Dr. P.S. Goel, Dr. Rasiok Ravindra and Dr. Sulagna Chattopadhyay.
- Writing of a book “Making of a Satellite Centre” which will bring the history of development of Satellite Technology and Evolution of Satellite Centre (Earlier ISRO Satellite Centre (ISAC) and now UR Rao Satellite Centre (URSC)).
- Keeping Track of Advanced Technologies for the common man, for which he has been closely coordinating with labs of CSIR, DST, MoES and NIF. Keeping Track of Advances in Advance Technologies particularly in Aerospace and alerting respective labs of CSIR (NAL for example) and ISRO.

Dr PS Goel has since been granted one year extension of tenure w.e.f January 1, 2020 as INAE Satish Dhawan Chair in order to complete the task undertaken under the aegis of the subject chair.

## ***Engineering Excellence Awards***

### **Life Time Contribution Award in Engineering 2019**

This award is given to an eminent Indian citizen who has made most distinguished contributions in the field of Engineering / Engineering Research / Technology, which have brought prestige to the nation and regarded as landmarks of technological development of the country.

During the year 2019, the Life Time Contribution Award in Engineering was conferred on:



Prof. EC Subbarao, Formerly Professor, IIT Kanpur; Director and then Chief Consulting Advisor, Tata Research Development & Design Center, Pune

Prof. EC Subbarao was conferred the award in recognition of his pioneering contributions to ferroelectrics and zirconia ceramics and leadership in nurturing two world class institutions – IIT Kanpur (higher education) and TRDDC (industrial research).



Mr. AS Kiran Kumar, Formerly Director, Space Application Centre (SAC), Ahmedabad (Gujarat); Former Chairman, Space Commission, Chairman, ISRO and Secretary, Dept of Space, Govt. of India. Mr. AS Kiran Kumar was conferred the award in recognition of his pioneering contributions to the development and application of space science and technology for national development, space science research and planetary exploration.

### **Prof. Jai Krishna and Prof. SN Mitra Memorial Award 2019**

These awards are given to an eminent engineer, engineer-scientist or a technologist for one or more of the following:

- (a) Academic and scholarly achievements in any discipline of technology
- (b) Outstanding research in engineering and technology and application thereof.
- (c) Outstanding contributions in the management of education and research in engineering
- (d) Outstanding achievements and contributions in the Indian industry, engineering services or engineering projects

Prof Jai Krishna Memorial Award is given from among the disciplines of Engineering Section I (Civil Engineering), Engineering Section III (Mechanical Engineering), Engineering Section IV (Chemical Engineering), Engineering Section VII (Aerospace Engineering) and Engineering Section VIII (Mining, Metallurgical and Materials Engineering).

Prof S N Mitra Memorial Award is given from among the disciplines of Engineering Section II (Computer Engineering and Information Technology), Engineering Section V (Electrical Engineering), Engineering Section VI (Electronics & Communication Engineering), Engineering Section IX (Energy Engineering) and Engineering Section X (Interdisciplinary and Special Engineering Fields and Leadership in Academia, R&D and Industry)

During the year 2019, Prof Jai Krishna and Professor SN Mitral Memorial Awards were conferred on:

#### ***Prof Jai Krishna Memorial Awardee***



Prof. KT Jacob, Emeritus Professor, Department of Materials Engineering, Indian Institute of Science, Bangalore was conferred the Prof Jai Krishna Memorial Award 2019 in recognition of his outstanding contributions to pathbreaking research and promotion of education and in the fields of Metallurgy and Materials Science in the country.





### ***Professor SN Mitra Memorial Awardee***



Prof. RK Shevgaonkar, Vice Chancellor and Professor of Eminence in School of Engineering and Applied Sciences, Bennett University, Greater Noida was conferred the Prof SN Mitra Memorial Award 2019 in recognition of his outstanding contributions for providing dynamic leadership to Engineering Education in the country and outstanding research contributions in the areas of Radio Astronomy, Fibre Optic Communication and Antennas.

### **INAE Outstanding Teachers Award 2019**

The Academy has instituted the “Outstanding Engineering Teachers Award” in the year 2013 to honour INAE Fellows who have excelled in the field of teaching in Indian colleges, universities, and institutions, and have provided guidance and inspired students to take up careers in Engineering and Technology. Two such awards are given per year with one award in each group as under.

Group-1 - covering Engineering Section I (Civil Engineering), Engineering Section III (Mechanical Engineering), Engineering Section IV (Chemical Engineering), Engineering Section VII (Aerospace Engineering) and Engineering Section VIII (Mining, Metallurgical and Materials Engineering).

Group-2 - covering Engineering Section II (Computer Engineering and Information Technology), Engineering Section V (Electrical Engineering), Engineering Section VI (Electronics & Communication Engineering), Engineering Section IX (Energy Engineering) and Engineering Section X (Interdisciplinary and Special Engineering Fields and Leadership in Academia, R&D and Industry).

During the year 2019, INAE Outstanding Teachers Award was conferred on :



Prof. BS Murty, Director, IIT Hyderabad & Institute Professor and Girija & R. Muralidharan Chair Professor IIT Madras, JC Bose National Fellow was conferred the Outstanding Teachers Award in recognition of his outstanding teaching; motivating research scholars to carry out high quality of research and his research interests in high entropy alloys, nanocrystalline materials, bulk metallic glasses and in-situ composites.

### **INAE Young Engineer Awards 2019**

The Academy instituted INAE Young Engineer Awards in 1996, to recognize excellence in design and technology transfer, innovative development and engineering research. The scheme has attracted nominations of bright young talent in the country and has become a prestigious national award since then. So far, 243 young engineers have been conferred this award and their early recognition has encouraged the best upcoming talent to make innovative engineering and technological contributions for our national development. The nominations for INAE Young Engineer Award for the year 2019 were sought from INAE Fellowship, Engineering institutions, R&D Labs. Out of 137 nominations, 50 were shortlisted by the Sectional Committees. The shortlisted candidates gave presentation of their work before the Selection Committee on August 26, 2019 at New Delhi.

The following fifteen candidates were selected and conferred INAE Young Engineer Award 2019.

- 1 Dr. Sandip Chakraborty, Indian Institute of Technology Kharagpur  
(*Computer Systems and Ubiquitous Computing*)
- 2 Dr. Ravishankar Krishnaswamy, Microsoft Research India, Bangalore  
(*Design and analysis of algorithms for fundamental optimization problems*)
- 3 Dr. Venugopal Arumuru, Indian Institute of Technology Bhubaneswar  
(*Fluid and Thermal Science*)

- 4 Dr. Shyamprasad Karagadde, Indian Institute of Technology Bombay  
(Solidification, Computational methods)
- 5 Dr. Bhushan Jayant Toley, Indian Institute of Science, Bangalore  
(Microfluidics and Point-of-Care Diagnostics)
- 6 Dr. Rakesh Gupta, Tata Research Development & Design Centre, Pune  
(Chemical Engineering, Multiscale Modelling and Nanotechnology)
- 7 Dr. R Sudharshan Kaarthik, Indian Institute of Space Science and Technology, Thiruvananthapuram  
(Electrical Power Systems for satellite, Electronic Systems, Renewable Energy)
- 8 Dr. Shyam Kamal, Indian Institute of Technology (Banaras Hindu University), Varanasi  
(Control Systems)
- 9 Dr. Ketan Rajawat, Indian Institute of Technology Kanpur  
(Signal Processing in Networks)
- 10 Dr. VR Supradeepa, Indian Institute of Science, Bangalore  
(Photonics and Lasers, Optical Communications and RF Photonics)
- 11 Mr. S Narendar, Defence Research and Development Laboratory, Hyderabad  
(Thermo-Structural Testing and Wave Propagation in Nanostructures)
- 12 Mr. Sourabh Karmarkar, Liquid Propulsion Systems Centre, Thiruvanthapuram  
(Design, development & analysis of liquid propulsion Stage Systems)
- 13 Dr. Uttam Kumar Ghorai, Ramakrishna Mission Vidyamandira, Howrah  
(Materials Science & Engineering, Nanoscience & Nanotechnology)
- 14 Dr. Poulami Chakraborty, Bhabha Atomic Research Centre, Mumbai  
(Liquid Metal Corrosion, Materials for Fusion & Advanced Nuclear Reactors)
- 15 Dr. Javed Nabibaksha Sheikh, Indian Institute of Technology Delhi  
(Fibres & Textile Processing Technology)

### INAE Young Entrepreneur Award 2019

The INAE Young Entrepreneur Award was instituted in the year 2017 to encourage and recognize innovation and entrepreneurship among Young Engineers. The engineering innovations/inventions/ concepts that have been actually realized and implemented in industry either in new processes or products are given weightage.

The recipients of the award for the year 2019 are:

- 1 Mr. Suteerth Tripathi and Ms Shivani Gupta  
Inochi Care Private Limited, New Delhi.  
(Mechatronics Biotechnology and Biotechnology)
- 2 Mr. Prakhar Jain and Mr. Usama Ahmed Abbasi  
MicroX Labs, Bangalore  
(Chemical Engineering and Biomedical Engineering)



## Innovative Student Projects Awards, 2019

The Academy has instituted Innovative Students Projects Award since 1998 to identify innovative and creative projects undertaken by the students at three levels B.E./ B. Tech, M.E/ M.Tech and PhD in engineering colleges. This Award recognizes innovative and creative projects and theses of students and research scholars in engineering institutions, since an early recognition of merit and talent can often mark the beginning of a brilliant career.

A total 136 nominations received (37 at Doctoral level; 37 at Master's level and 62 at Bachelor level) were examined by the Selection Committee. Out of these, 47 nominations (18 at Doctoral level; 10 at Master's level and 19 at Bachelor level) were shortlisted for presentations of their work before the Selection Committee. Ten candidates at Doctoral level, five at Master's level and ten at Bachelor level were selected by the Selection Committee for conferment of Innovative Student Projects Awards 2019 as given below.

### Doctoral Level

- 1 Dr. Abir De, Indian Institute of Technology Kharagpur  
(*Modelling and Learning Influence in Social Networks*)
- 2 Dr. Gaurav Goswami, Indraprastha Institute of Information Technology, Delhi  
(*Unravelling Representations for Face Recognition: from Handcrafted to Deep Learning*)
- 3 Dr. Subham Swaroop Sahoo, Indian Institute of Technology Delhi  
(*Coordinated Control of DC Microgrids*)
- 4 Dr. Shambhu Sau, Indian Institute of Technology Bombay  
(*Modular Converter Topologies with Reduced Transformer Rating and Capacitor Size for High-Power Regenerative Drives*)
- 5 Dr. Surender Singh, Indian Institute of Technology Roorkee  
(*Utilization of RAP for Sustainable Concrete Pavements*)
- 6 Dr. P Mastanaiah, Indian Institute of Technology Hyderabad  
(*Electron Beam Welding and Friction Stir Welding of Dissimilar Aluminium Alloys (AA2219 and AA5083)*)
- 7 Dr. Raosaheb Ananda Farakte, Institute of Chemical Technology, Mumbai  
(*Transport Phenomena in Multiphase Processes*)
- 8 Dr. Lokamanya Chikmath, Jain University, Bangalore  
(*Non-linear Prognostic Analysis of Fastener Joints for Structural Health Monitoring Applications*)
- 9 Dr. Atasi Dan, Indian Institute of Science, Bangalore  
(*Spectrally Selective Tandem Absorbers for Photothermal Conversion in High Temperature Solar Thermal Systems*)
- 10 Dr. Nithin Chandran, Indian Institute of Technology Kharagpur  
(*Sequence and Structural Analysis of RNAs and their Interactions with Proteins*)

### Master's Level

- 1 Mr. Shivam Harshadkumar Ribadiya, Chandubhai S Patel Institute of Technology, CHARUSAT University, Gujarat  
(*Time Synchronization Protocol using NavIC*)

- 2 Mr. Rishab Anand, Indian Institute of Technology Bombay  
*(Simplified Control Strategy for Inhomogeneous Series-Connected Battery Strings)*
- 3 Mr. Vikram Kishore Bharti, Indian Institute of Technology Hyderabad  
*(Carbon-Sulfur Composites as High-Performance Cathode Materials for Lithium-Sulfur Batteries)*
- 4 Ms. Neethu M, Indian Institute of Space Science and Technology, Thiruvananthapuram  
*(Actuator Interface Board Design for Momentum-biased Cubesat ADCS)*
- 5 Ms. Ruchika Zalpouri, College of Agricultural Engineering and Technology, Punjab Agricultural University, Ludhiana  
*(Development and Evaluation of Refraction Based System for Dehydration of Potato)*

## Bachelor Level

- 1 Mr. Rohit Gandikota, Indian Institute of Space Science and Technology, Thiruvananthapuram  
*(Harnessing Deep Generative Models for Multimedia Data Hiding)*
- 2 Ms. Sharmila Reddy Nangi, Indian Institute of Technology Kharagpur  
*(A Deep Generative Model for Code-Switched Text)*
- 3 Ms. Archana CM, Indian Institute of Space Science and Technology, Thiruvananthapuram  
*(Dodecagonal Voltage Space Vector Based Direct Torque Control Scheme for Open-End Winding Induction Motor with a Single DC Source)*
- 4 Ms. Sneha Gem Mathew, Indian Institute of Space Science and Technology, Thiruvananthapuram  
*(Low Complexity Cyclostationary Feature Detection using Sub-Nyquist Samples)*
- 5 Mr. Bala Suraj Pedasingu, Indian Institute of Technology Tirupati  
*(ALTO: Adversarial Learning for Tracking Objects)*
- 6 Mr. Suraj R, Indian Institute of Space Science and Technology, Thiruvananthapuram  
*(PS4Net: An Opportunistic Software Defined Networking Framework Over PSLV Stage 4)*
- 7 Mr. V Charan, Mr. G Raja Vallabh and Ms. Y. Aishwarya Reddy  
Mahatma Gandhi Institute of Technology, Hyderabad  
*(Path Correcting Multi-Purpose Agricultural Robot)*
- 8 Mr. K Lakshman Vedavyas and Ms. L Pooja  
Mahatma Gandhi Institute of Technology, Hyderabad  
*(Effect of Milling Time and Optimization of Poling Conditions on Piezoelectric Properties of BCZT Ceramics)*
- 9 Mr. Gracio Joyal Lobo, Ms. Amrutha K, Mr. Dumpeti Vineeth and Mr. Medisetti Swami Charan  
International Institute for Aerospace Engineering and Management, Jain University, Bangalore.  
*(Tubercles Effect on a Wing Performance for NACA 634-421 Aerofoil)*
- 10 Mr. J Chandra Bose, Mr. G Mohankumar, Mr. A Muthushivashankar and Mr. CB Raambalagi  
National Engineering College, Kovilpatti  
*(Experimental Study on Bio-Concrete by Partial Replacement of Fine Aggregate Using Medical Vial Waste)*





## *Joint Schemes with AICTE*

### **AICTE-INAE Distinguished Visiting Professorship Scheme**

Industry-academia interactions have become essential as with the world over technological changes in recent times these can impart relevant knowledge to the students in the engineering institutions, that is sustainable in the changing conditions. While industries could gain by using the Academia's knowledge base to improve the industry's cost, quality and global competitive dimensions; thereby reducing dependence on foreign know-how and expenditure on internal R&D, academicians benefit by seeing their knowledge and expertise being fruitfully utilized practically and also by strengthening of curricula of educational programs being offered at engineering colleges/institutions. INAE together with All India Council for Technical Education (AICTE) launched "AICTE-INAE Distinguished Visiting Professorship Scheme" in 1999. Under this scheme, Industry experts are encouraged to give a few lectures in engineering institutions. This scheme has become popular among industry experts as well as engineering colleges.

Due to irregular disbursement of fund from AICTE the scheme was temporarily put on hold. To review the performance of the existing Distinguished Visiting Professors (DVPs) under the scheme and to deliberate on the fund required to continue with the scheme, the annual meeting of AICTE-INAE Distinguished Visiting Professorship Scheme Committee was scheduled on March 16, 2020.

As there was a sudden & rapid outbreak of Coronavirus (COVID-19), the meeting was postponed and approval on important points of the agenda was taken by circulation through email. Based on the regularity of lectures given by the Distinguished Visiting Professors in their respective associated AICTE approved engineering college(s), forty DVPs were given extension of tenure. Selection of new DVPs was withheld due to delay in release of AICTE fund. Subsequent to AICTE releasing the remaining projected funds for financial year 2019-20, a meeting of AICTE-INAE DVP Scheme Committee will be held to select new DVPs.

### **AICTE-INAE Teachers Research Fellowship**

Indian National Academy of Engineering (INAE) launched AICTE-INAE Teachers Research Fellowship Scheme jointly with AICTE during 2013, for Engineering Teachers to pursue Doctoral Research in Central Laboratories under Council of Scientific and Industrial Research (CSIR)/ Defence Research and Development Organization (DRDO)/ Department of Space (DOS)/ Department of Atomic Energy (DAE). The Ph.D degree is awarded by AcSIR for CSIR, IIST for DoS, DIAT for DRDO and corresponding institution of concerned DAE lab.

To implement the scheme effectively, the AICTE-INAE Teachers Research Fellowship (TRF) Scheme Committee has been constituted with members from INAE Fellowship and reps from AICTE, INAE, CII, CSIR, DRDO, DOS and DAE.

The scheme this year, was promoted by AICTE through advertisement in print media and by sending mails to Principals of engineering colleges. Only two applications from eligible engineering teachers were received under the scheme during the current year. As the number of applications was only two, no meeting for shortlisting the candidates was held during February, 2020.

Lab Name	Number of candidates selected for academic year 2019-20
CSIR	1
DIAT	1
DOS	1
DAE	none

The labs have been contacted to get the vacancies available with them for Academic year 2020-21.

## **AICTE-INAE Travel Grant Scheme for Engineering Students**

Indian National Academy of Engineering (INAE) launched AICTE-INAE Travel Grant Scheme for Engineering Students jointly with AICTE during 2013 to provide financial support to pre-final and final year Bachelors and Masters Level engineering students for presenting a research paper in an international scientific event (conference/seminar/symposium/workshop/exhibition etc.) in order to encourage engineering students to engage in research.

The scheme facilitates a student to travel abroad and take part in presenting his/her research work in International Platform by providing of 100% Registration Fee, 100% Visa fee, 50% of the actual Airfare for discounted /concessional air ticket, and local travel from the Engineering College/ Institution to the nearest airport and back. Maximum financial support per student towards registration, concessional travel expenditure and visa fees, is limited to Rs. 1 lakh.

AICTE-INAE Travel Grant (TG) Scheme Committee comprising of INAE Fellows from different Engineering Sections has been constituted to review the operation of the scheme regularly and select deserving candidates as per defined criteria.

The Scheme was promoted by AICTE through print media and by sending mails to Principals of AICTE approved Engineering colleges. There was an increase in number of valid applications received this year. Due to irregular release of fund, the scheme was temporarily on hold from October 2019 till December 2019. The scheme was resumed in January, 2020. Out of 108 applications received under the scheme during 2019-20, 65 students were selected.

The MoU of AICTE-INAE Travel Grant Scheme was renewed on November 22, 2019 for next three years with effect from June 21, 2019.



## *INAE Travel Grant Scheme for Engineering Students*

Indian National Academy of Engineering (INAE) launched the INAE Travel Grant Scheme for Engineering Students during 2014 with the objective to facilitate engineering students to present papers abroad with the purpose of enhancing the quality of engineering education in the country. The objective of the scheme is to provide partial travel assistance and registration fees to third/fourth year B.E./B.Tech; first/second year M.E./M.Tech; or fourth/fifth year Integrated M.Tech Level engineering students from Institutions/Colleges other than AICTE approved Engineering Colleges such as IITs, IISc, NITs, IIITs and other engineering colleges/institutes/universities in order to encourage engineering students to engage in research.

The applicant should have an invitation for presenting a research paper which has been accepted in a conference /seminar /symposium /workshop abroad. Reimbursement of 100% Registration Fee, Visa Fee, 50% of the actual Airfare for discounted/concessional air tickets and actual fare not exceeding AC II Class train fare will be admissible for travel from the Technical Institution to the nearest airport and back. Maximum financial support per student towards registration, concessional travel expenditure and visa fees, is limited to Rs. 1 lakh.

A new Selection Committee comprising of INAE Fellows from different engineering sections has been constituted to review the operation of the scheme regularly, select deserving candidates, and revisit eligibility criteria for selection so that more students can avail of the scheme.

The Committee considered new courses in engineering which are being introduced by IITs, NITs and other autonomous Universities. The Committee decided that the applications from students of any degree with 4 years or 5 years of engineering studies will be accepted besides regular BTech/ MTech and Integrated MTech as per eligibility criteria.

During the year, 15 applications were received under the scheme and 8 students were selected.

## *Events organized by Local Chapters*

### INAE Kolkata Local Chapter

#### National Engineers Day Celebrations

INAE Kolkata Chapter celebrated National Engineers Day on September 18, 2019 at the Gurukul Campus of the Institute of Engineering and Management, Salt Lake Electronics Complex, Kolkata. On this occasion, Prof. Indranil Manna, Vice-President, INAE and Professor, Department of Metallurgical and Materials Engineering, Indian Institute of Technology Kharagpur delivered the “Engineers Day Lecture” on “Towards Academic Excellence and Technology Development”. In his thought-provoking talk, Prof. Manna addressed the ancient gurukul system of pursuing knowledge and several transformations with time and change of our society. He described the national initiative of Government of India called IMPacting Research INnovation and Technology (IMPRINT) and its goal of translational research through collaboration between academia and industry. At the end, he highlighted the various programs and initiatives taken by INAE. This motivational talk was well received by the audience and raised enthusiastic discussions among the participants.

Prof. Sankar K. Pal, FNAE, Distinguished Scientist and former Director, Indian Statistical Institute, Kolkata, addressed the audience and encouraged the young group of engineers to elevate their career with INAE. He also highlighted the vast opportunities and immense scope that INAE provides to every engineer. Prof. Bimalendu Bhusan Bhattacharya, FNAE, S.N. Bose National Centre for Basic Sciences, Kolkata also participated in the celebrations. Prof. A.K. Nayak, Principal, IEM formally welcomed the gathering and Prof. Debatosh Guha, FNAE, Secretary, INAE Kolkata Chapter conducted the proceedings of the meeting. The event was attended by more than 50 participants including INAE Fellows, researchers, graduate students, and young faculty members from various departments of several universities, institutes, and industries located in and around Kolkata.



*Prof. Indranil Manna delivering the lecture*



*Prof. S K Pal addressing the audience*



*Audience present at the program*



*Prof. Debatosh Guha conducting the proceedings*



## ***INAE Kolkata Local Chapter Organizes Science Day Lecture 2020***

Indian National Academy of Engineering (INAE) Kolkata Chapter celebrated National Science Day on 1<sup>st</sup> March 2020 at the National Institute of Technology Sikkim, Ravangla, Sikkim. Prof. Mahesh Chandra Govil, Director, NIT Sikkim delivered the Science Day Lecture at 4:30 PM in the Institute auditorium. He addressed the challenges and advances in the wide application of Internet of Things. That lecture was enthusiastically attended by of about 80 young scientists, students, and INAE Fellows. The talk triggered several questions among the students. Prof. Bhargab B. Bhattacharya, President, INAE Kolkata Chapter, presided over the function. Padma Shri Prof. Sankar K. Pal, INSA Distinguished Professor, DST-SERB National Science Chair, and former Director of Indian Statistical Institute graced the occasion and concluded the event by offering a memento to the speaker.



*Prof. Mahesh Chandra Govil, Director, NIT Sikkim  
delivering INAE Science Day  
Lecture at NIT Sikkim, Ravangla*



*Prof. MC Govil (right) receiving the memento from  
Prof. Sankar K. Pal (middle) in presence of Prof.  
Bhargab B. Bhattacharyya (left).*

## ***INAE Workshop on “Recent Advances in Engineering Science and Technology” Organized by INAE Kolkata Local Chapter in association with NIT Sikkim***

A one-week workshop on “Recent Advances in Engineering Science and Technology” was held at the National Institute of Technology (NIT) Sikkim, Ravangla, Sikkim during 1-5 March 2020. This event was jointly organized by INAE Kolkata Chapter and NIT Sikkim. The inaugural session in the morning of the first day of the workshop indicated a huge interest among the participants gathered from different engineering institutes such as North Eastern Regional Institute of Science and Technology, Sikkim Institute of Science and Technology, Sikkim Manipal Institute of Technology, along with the host institute- NIT Sikkim. About 90 participants attended the event. Prof. Mahesh Chandra Govil, Director, NIT Sikkim extended maximum support for the workshop, within the limited facilities available in the purely hilly terrain of Sikkim and made this event possible. He presided over the inaugural function and heartily welcomed all the participants. Prof. Sankar K. Pal, INSA Distinguished Professor, DST-SERB National Science Chair, and former Director of Indian Statistical Institute delivered the inaugural address. Prof. Bhargab B. Bhattacharya represented INAE Kolkata Chapter as its present President and addressed the audience. Prof. Debatosh Guha, Secretary INAE Kolkata Chapter discussed the background of this workshop and read out the welcome message of the INAE President, Dr. Sanak Mishra. Dr. Surajit Kundu proposed the formal vote of thanks on behalf of the host institute.

Several state-of-the-art topics have been covered by several eminent speakers and educators which include: Prof. Sankar K. Pal, (Granular Mining and Data Analytics), Prof. Bhargab B. Bhattacharya (Automating Biochemical Protocols with Microfluidic lab-on-chip), Prof. Mahesh Chandra Govil (Internet of Things), Prof. Debatosh Guha (New Generation Wireless Techniques), Prof. Virendra Singh (Computer Architecture in 21<sup>st</sup> Century), Prof. Pragati Kumar (Analog Signal Processing Circuits), Prof. Mrinal Kanti Mandal (Microwave Circuits and Systems), Prof. S. K. Parui (SIW Technology), Dr. Ramesh Babu Battula (Next Generation Communications), Dr. Anindya Bose

(GNSS) and Dr. Surajit Kundu (Printed Antennas). Along with the technical talks and tutorials, some specific hands-on-training were also arranged for the participants.

Participation certificates were given to all attendees in the valedictory session. The local organizers had gratefully acknowledged their collaboration with INAE Kolkata Chapter and also the technical cum financial support from the INAE, for organizing the workshop in a North-Eastern state of the country. The workshop was a great success and the participants re-iterated in their feedback that more such workshops be held in the future.



Inauguration of the Workshop



Participants at the Inaugural Session



Prof. Sankar K. Pal delivering his talk



Delegates felicitated by the organizers



Prof. Bhargab B. Bhattacharya  
Delivering his talk



Group Photograph of Participants with the Delegates



## INAE Pune Local Chapter and Pune Engineering Forum

With the objective of bringing together the Core engineering with Computer Science, INAE Pune Chapter organized an event on November 7, 2019 at College of Engineering, (COEP), Bhau Institute Auditorium. Theme of this event was: “Engineering Complex Adaptive systems with Digital Twins”. The program comprised invited talks by eminent experts from industry. At the outset, Mr MV Kotwal, Chairman INAE Pune Chapter and Pune Engineering Forum, delivered the Welcome Address. Dr Pradip, Vice President INAE, gave a brief introduction to INAE to the august audience, while Mr Vinay Kulkarni, Secretary INAE Pune Chapter, introduced the theme along with the invited speakers. The invited talks were followed by interaction with the workshop participants which are highlighted as follows. Mr Vijay Talele, CEO Bhau Institute, provided a brief overview of Bhau Institute. Mr Ram Kulkarni, Secretary Pune Engineering Forum, proposed the Vote of Thanks. The interactions between the delegated continued post event over tea. The details of the invited talks are given below.

### **Talk #1: Experience sharing from automotive industry on Model based Systems Engineering by Shri Puran Parekh, iASys**



Abstract: Automotive Industry involves very complex multi-domain engineering and a high level of innovation. Right from fundamental material science to advanced AI technology - everything has to work in harmony. Automotive industry has come a long way from pure mechanical engineering to sophisticated complex mechatronics. This necessitates the need for model-based systems-engineering (Digital Twin) approach to speed up the development process. The task gets more complex due to its multi-disciplinary nature. Need for a structured data management

approach from different domains is key for creating Digital Twins of the physical world. A few examples in the vehicle powertrain area were used to explain the complexity and possible solutions.

### **Talk #2: Supporting dynamic adaptation of enterprise in the face of partial information and uncertainty by Dr Souvik Barat, TCS Research and Innovation**



Abstract: Modern enterprises are large complex “system of systems” operating in a dynamic and uncertain environment to achieve their goals. To stay ahead of the competition and achieve moving business targets, these enterprises require continuous analysis, adaptation, transformation, and also design to operate in a new way. The state-of-the-practice to decide appropriate changes and design are primarily intuition based, which is significantly lacking the rigour and often results into ineffective solutions. Pure historical data-centric AI-driven approaches also fail to demonstrate

expected precision as the existing data of most of the enterprise is often inadequate and frequently it becomes irrelevant in this dynamic world. The talk covered a model-based simulation-aided, evidence-backed approach to make enterprises adaptive. The approach hinges on the concept of Digital Twin – a set of relevant models that are amenable to analysis and simulation. The efficacy of this approach was clearly brought out using some real-life case studies.

### **Talk #3: Skin Digital Twin: A Computational Approach Towards Mimicking Nature by Dr Beena Rai, TCS Research and Innovation**



Abstract: Human skin is one of the complex and versatile organs, responsible for various functions like preventing the body from excessive loss of water and attack of foreign pathogens. Besides these physiological functions, the importance of the skin aesthetics has been the focus of humankind since ages. Skin is one of the largest organs of human body (~1.5 – 2 sqm of surface area) anatomically being composed of three layers. The top-most layer, called epidermis, is responsible for skin's health apart from providing it glow, youthfulness and texture. Epidermis is further

divided into 5 sub-layers of which stratum corneum (SC) – the most external one, is responsible for skin's barrier function. Dermis, located beneath epidermis is primarily made up of collagen and elastin and provides structural support and elasticity. The deepest layer named as hypodermis is composed of adipose tissues and provides the heat

resistance. Both pharma and cosmetics industry have been leveraging skin for various businesses like transdermal delivery of drugs or skin care products. However, traditional route of design and development of these products has been laborious and time-consuming experimentations involving in-vitro and in-vivo methods. Needless to add, the process not only remains expensive but also presents a threat to the environment where millions of animals are sacrificed every year. Irony of the situation is that, in spite of these costly and unethical efforts, the success rate for viable products remains very low (10-30% only). Therefore, it is hardly a surprise that both these industries are looking for digital interventions which could substitute or eliminate animal testing. At TCS, we have developed a first principle based computational model of human skin which mimics physiological properties of skin. A multiscale modelling framework linking atomistic-molecular-mesoscale-macroscale is employed to study molecular transport across the skin. The model thus developed has provided a base to develop an IT enabled platform (TCS Digital Skin Twin Platform) for the simulation-based design and development of pharma/cosmetics products. The concept of a skin digital twin was described and its utility in product design & testing was vividly illustrated using examples from the pharma and cosmetics industries.

#### **Talk #4: A platform for integrated engineering of materials, products and manufacturing processes by Shri Sreedhar Reddy, TCS Research and Innovation**



Abstract: Industry 4.0 and smart manufacturing are about taking advantage of

digital technologies to achieve higher efficiencies in the manufacturing industry. At the heart of manufacturing lies product engineering and doing this right requires taking an integrated view on the design of materials, products and manufacturing processes. At the moment this is largely done in a “silo-ed” manner with a high degree of dependence on human expertise, leading to suboptimal outcomes. Integrated computational material engineering (ICME) is an emerging approach for integrated engineering of products, materials and manufacturing processes. It advocates a knowledge guided, data supported, simulation driven approach for “in-silico” exploration of the design space, thereby significantly reducing the dependence on human expertise and trial-and-error based experimentation cycles. However, this requires a technology platform that enables seamless integration of product design with process and materials design so that all three can be investigated, analyzed and optimized simultaneously to be able to obtain the right material for the right product to be manufactured in the right way. The platform should provide for seamless integration of multiple kinds of simulation models, tools, data sources and decision support systems. It should be capable of extracting and integrating knowledge from various sources and reasoning with it so as to be able to provide context-appropriate guidance to the designers during the design process. In this talk a platform called TCS-PREMAP being developed at TCS was described.

#### ***Indian National Academy of Engineering (INAE) Pune Local Chapter organised a Round Table interaction on “Role of Hydrogen in India’s Energy Strategy” on 15<sup>th</sup> February 2020 at Tata Consultancy Services (TCS), Pune***

A Round Table Interaction of domain experts on “Role of Hydrogen in India’s Energy Strategy” was organized by INAE Pune Local Chapter on February 15, 2020 at Pune. The meeting was attended by Dr Sanak Mishra, President, INAE; Dr PS Goel, Former President, INAE; Dr BN Suresh, Immediate Past - President, INAE and domain experts from INAE Fellowship and other expert invitees from Academia, R&D organizations and Industry. The meeting was organized with active support from Mr MV Kotwal, Chairman Pune Local Chapter and Dr Pradip, Vice-President, INAE. The invited experts shared insights on the current and future global situation about use of Hydrogen as an energy source; discussed the overall situation in India with respect to technologies, capabilities and affordability for Generation, Storage, Transportation and Usage of Hydrogen and concluded on the approach to be followed by INAE in forwarding recommendations to the Government.

A brief Background note on the pertinent issues related to Role of Hydrogen in India’s Energy Strategy which were addressed in the presentations and deliberations during the subject Round table interaction are summarized below:



## Energy Strategy – Crucial in India's growth

India's growth & sustainability are rooted in selecting the right strategic path, integrating renewable energy – Solar, Geo-thermal, Tidal, Biomass & Wind, with existing sources involving Hydro, Coal, Oil, Gas & Nuclear. Towards this, India will have to carve out its own strategy while considering the rapid developments taking place globally. This strategy will have to be necessarily transformative, to satisfy aspirations of millions of young Indians and for the country to play its rightful role in a sustainable global community.

**The Direction:** India's energy security by and large will have to depend on its own resources both renewable as well as non-renewable. This implies that energy sources like solar, wind, biomass will have to be seamlessly integrated with conventional, well-established sources. Simultaneously, the imperatives of reduction in GHGs and the carbon footprint must be factored in. Linkages need to be established also keeping in mind the necessary energy storage requirements. The current electricity transmission & distribution infrastructure will not be able to support the above needs. It is obvious that a clean and well-planned distributed energy system will always remain a vital component of India's energy strategy.

**Demand side implications:** Keeping in mind the demand side scenario for industrial, residential, commercial, rural & transport sectors, multiple options have been considered by several agencies and working groups. Apart from technological feasibility, the most important questions of financial viability and affordability have also been covered to some extent. As an example, the proposed switch from fossil-fueled vehicles to EVs, while bringing in significant benefits, poses challenges in terms of availability of suitable charging networks and strategically important access to basic raw materials if Lithium-based batteries are the primary mode for energy storage.

The moot question to be answered whether Hydrogen can play an important role in this energy strategy for India covers the above issues. In the interaction meeting the speakers shared insights on the current and future global situation about use of Hydrogen as an energy source and discussed the overall situation in India with respect to technologies, capabilities and affordability for Generation, Storage, Transportation & Usage of Hydrogen.

A draft report summarizing the deliberations has been prepared which is under finalization with suggestions from all participants. It is envisaged that subsequently, the recommendations will be summarized in the form of a White Paper containing all the pertinent issues related to Role of Hydrogen in India's Energy Strategy for submission to Prof. K VijayRaghavan, Principal Scientific Advisor (PSA) to the Govt. of India, as suggested.



*Ongoing Deliberations during the meeting*



*Group Photograph of Delegates in the Round Table Interaction*

## **INAE Bangalore Local Chapter**

### ***India-USA Lecture Series on Aging Aircraft Organized by Indian Institute of Science, Bangalore; INAE Bangalore Local Chapter and CSIR-NAL, Bangalore.***

The India-USA Lecture Series on Aging Aircraft organized by Indian Institute of Science, Bangalore; INAE Bangalore Local Chapter and CSIR-National Aerospace Laboratories (CSIR-NAL), Bangalore was held on November 27-29, 2019 at a Department of Aerospace Engineering, Indian Institute of Science, Bangalore. The events' Main Sponsors were India-USA Science and Technology Forum (ISSTF) and Office of Naval Research (ONR), USA. The event also received gracious partial support from Institute of Mechanical Engineers (IMechE), UK and Defence Research and Development Organization (DRDO). Prof. S. Gopalakrishnan from Department of Aerospace Engineering was the Coordinator from Indian Side and Prof. Lalita Udpa from The Michigan State University as its Coordinator from US Side. Dr S. G Sampath and Dr AR Upadhyaya were the course Directors from the US and Indian side respectively.

The event featured six speakers from USA, nine from India and two from Canada and one from Italy. The list of speakers who delivered lectures in this Lecture Series are as follows. Speakers From USA: Dr Bill Nickerson, Office of Naval Research, USA; Dr S G Sampath, Former Scientist, FAA, USA and US Army; Prof. Lalita Udpa, Michigan State University, USA; Prof. Sankaran Mahadevan, Vanderbilt University, USA; Prof. Colin Drury, University of Buffalo, USA and Dr. Jayanth Kudva, NextGen Aeronautics, California, USA. The speakers from Canada and Europe were: Prof. Afzal Sulaiman, University of Victoria, Canada; Dr Prakash Patnaik, National Research Council, Canada and Mr Mariani Ugo, Leonardo Helicopters, Italy. Air Marshal Vibhas Panday, Indian Air Force and Dr R Sundar, Biss Research, Bangalore; Prof. Krishnan Balasubramaniam, IIT, Madras; Dr P D Mangalgiri, Visiting Professor, IIT Kanpur; Dr K Vijayaraju, Aeronautical Development Agency, Bangalore; Mr Yogesh Kumar, Former Executive Director, HAL, Bangalore; Mr HRS Prasad, Center of Excellence in Aerospace, VTU, Bangalore; Dr Ramakanth Singh, DGCA, New Delhi and Mr Siddhartha Ghosh, Spice Jet, Gurgaon were the speakers from India.

The Lecture series inauguration took place on November 27<sup>th</sup> 2019 at 9.0 am. The Inaugural Function included speeches by Dr Tessy Thomas, Distinguished Scientist and Director General of Aeronautics, DRDO, Mr G. Rajashekar,



Additional Director General, Department of Civil Aviation, Government of India, Dr. S. G Sampath, Course Director of Lecture Series from USA, Prof. Lalita Udpa, Course Coordinator from USA, and Dr A R Upadhy, Course Director of Lecture Series from India. Prof. S. Gopalakrishnan, Course Coordinator from India proposed the Vote of Thanks.



*IULSAA Inauguration: L--R; Dr Tessy Thomas, Mr Rajashekar, Prof. Lalita Udpa, Dr Sampath and Prof. S. Gopalakrishnan*



*Dr Tessy Thomas, FNAE addressing the gathering in the Inaugural function*

The Inaugural Function was followed by two plenary talks, the first talk by Air Marshal Vibhas Pande, Director General (Aircrafts), Air Headquarters, New Delhi and the second by Dr Bill Nickerson, Office of Naval research--Global, USA. The talk by Air Marshal concentrated on Aging Issues in Air Fleet management, while the plenary talk by Dr Nickerson concentrated on the environmental issues such as corrosion on the aircraft aging.



*Air Marshal Vibhas Pande, VSM, Director General (Aircraft), IAF delivering Plenary Talk*



*Dr Bill Nickerson from Office of Naval research, USA delivering Plenary talk*

The talks by various speakers spread over eight sessions. Each talk was of 45 minutes duration with 15 minutes allocated for discussion. The Lecture Session began by Dr S G Sampath giving an overview of the aging aircraft issues based on his own experience on FAA, USA. In all, there were 18 lectures, covering a wide spectrum of areas that included Fatigue behaviour, Corrosion behaviour, Aging Aircraft Engines, Aging Helicopters, Aging Wiring, Aging Avionics, New Material system insertion and Human factor issues and policy guidelines. The Lecture series also featured a lecture from regulator Directorate of Civil Aviation and also a lecture from a private airline Spice jet official. These two lectures in particular, addressed the aging issues faced by aircraft certification agencies and the commercial airlines, respectively.



*Prof. Krishnan Balasubramaniam from IIT Madras delivering Lecture*



*Dr S G Sampath from FAA, USA delivering Lecture*



*Dr. Mariani Ugo from Leonardo Helicopters, Italy delivering Lecture*



*Dr Jayant Kudva from NextGen Aeronautics, USA delivering Lecture*

At the end of the first day, a Cultural Program was held during which a Carnatic music concert was rendered by Prof. Sankaran Mahadevan, who also happened to be an expert in Uncertainty Quantification and was also a speaker in the Lecture Series.



*Cultural Evening: Carnatic Music Concert given by Prof. Sankaran Mahadevan from Vanderbilt University USA*



The response to this Lecture Series was tremendous. In all over 160 delegates from both Government and Private agencies registered for this lecture series out of which there were 25 student registrations. Students who attended the Lecture series were primarily from IISc, IIT Madras, IIT Kharagpur, NIT Calicut, and JNU, Hyderabad. There was substantial participation from Indian Airforce, who were also one of the stakeholders of this Lecture Series.



*Air Marshal Vibhas Pande and his IAF team interacting with Dr AR Upadhyaya, the Course Director IULSAA*



*Delegates attending Lecture Series Inauguration Program*

Delegates from both Government and private aerospace agencies attended this Lecture Series and the list gives the organizations that participated in this event are given below.

**Government Organizations:** (a) Aeronautical Development Agency (b) Center for Airborne Systems (c) CEMILAC (d) Hindustan Aeronautics Limited (e) National Aerospace Laboratories (f) Department of Civil Aviation (g) R & D E (Engrs) and (g) Indian Air Force –Maintenance Command and Air Headquarters.

**Private Aerospace and other Agencies:** (a) Boeing Aircraft Company (b) Textron (c) Airbus Industries (d) Axis Cades (e) Several NDT companies in Bangalore (f) GE Aviation (h) Rolls Royce.

**Private Airline Companies:** (a) Spice Jet (b) Air India and (c) Blue Dart Aviation

Several leading Aerospace Scientists and Engineers participated in this Lecture series, which included Dr Kota Harinarayana, Dr A R Upadhyaya, Mr Ashok Baweja, Prof. Dattaguru, Cmde C D Balaji to name a few.



*Dr Kota Harinarayana, Former Program Director, ADA Chairing a Session*



*Mr Ashok Baweja, Former CMD, HAL and Chairman, IMechE India chairing a Session*

On the evening of November 28, the Banquet dinner was arranged at Bangalore Golf Club which was attended by over 150 delegates. The Lecture Series ended on November 29, 2019 with a feedback session. The event was greatly appreciated by the delegates and there was a general agreement that India should have a separate Center for Aviation

Safety Research and a draft proposal prepared by Dr Ramchand Former Director of CABS and Dr S.G Sampath was circulated to all the delegates. It was decided that a committee will be setup to finalize the details of this center and then talk to the Government for the funding details. At the end of the event, Prof. Gopalakrishnan summarized the critical aspects of different lectures delivered in this event and thanked all the volunteers who made the organization of this Lecture Series possible.

### ***Meeting with the Hon'ble Deputy Chief Minister & Minister for IT, BT and S&T, Higher Education and Skill Development***

As informed by Dr AR Upadhya, Hon. Secretary, INAE Bangalore Chapter, the initiative by Dr VK Aatre, Chairman, INAE Bangalore Chapter to engage with the State Govt of Karnataka led to a meeting of a small group of INAE Fellows led by Dr Aatre with the Hon'ble Deputy Chief Minister & Minister for IT, BT and S&T, Higher Education and Skill Development, Shri CN Ashwathnarayana on 14<sup>th</sup> February 2020. The DCM was briefed about INAE, the rich and diverse Technology & Engineering expertise and experience available with the FNAES, and how it could be utilised gainfully for finding solutions for some of the problems faced by the state. Subsequently a write up on INAE including a list of technical studies that the Academy has carried out so far, the recommendations of which have been sent to the GoI, was sent to the DCM for favour of information.

Following this, the DCM's Office had asked INAE BC to nominate a Fellow each as a member of the following State Govt Bodies under the Dept of S&T:

- i. Karnataka Knowledge Commission, chaired by Dr K Kasturirangan.
- ii. Karnataka State Council for Science and Technology (KSCST), President: Hon'ble Chief Minister, Government of Karnataka; Vice Presidents: Minister for Finance, Director, IISc and Minister for S&T
- iii. Executive Committee of KSCST, Chairman: Director, IISc, Co-Chairman: Chief Secretary, Government of Karnataka

Based on a discussion in the Executive Committee of the Bangalore Chapter, the following INAE Fellows have been nominated by the BC to the above bodies:

- Dr KG Narayanan, Former Director, DRDO- ADE, Bangalore and former Advisor to DG, DRDO, Member, Karnataka Knowledge Commission
- Dr G Jagadeesh, Professor, Dept. of Aerospace Engineering, IISc, Member, KSCST
- Dr V Bhujanga Rao, Former DS & Former DG(NS&M), DRDO and presently, ISRO Chair Professor at NIAS, Bangalore, Member, Executive Committee, KSCST

### **INAE Mumbai Local Chapter**

#### ***Talk by Prof JM Vasi, FNAE on the topic "Assessing the Performance of Solar Photovoltaics in India: Need for a Multi-disciplinary Approach" at IIT Bombay, Mumbai on May 3, 2019***

INAE Mumbai Local Chapter organized a talk by Prof JM Vasi, FNAE on the topic "Assessing the Performance of Solar Photovoltaics in India: Need for a Multi-disciplinary Approach" at IIT Bombay, Mumbai on May 3, 2019. The key highlights of the program was a welcome address by Prof DN Singh, Hon. Secy, INAE Mumbai Chapter, followed by introduction to the Chapter and the speaker by Prof Grover, Hon. Co-Chair, INAE Mumbai Chapter. Following this, a talk by Prof Vasi on "Assessing the Performance of Solar Photovoltaics in India: Need for a Multi-disciplinary Approach" followed by discussions was the major highlight. A brief meeting of Executive Committee members on programs followed the talk.



*Prof AK Suresh, Co-Chair, INAE Mumbai Local Chapter presenting a Bouquet to Prof JM Vasi*



*Group Photo of Participants at INAE Mumbai Local Chapter Event at IIT Bombay*

The event was attended by about 50 INAE Fellows and other experts and was a great success.

***One-Day National Workshop entitled: “Urban and Rural Challenges in Management of Solid Waste in India: A Circular Economy Approach to Building Smart Habitats”.***

INAE Mumbai Local Chapter, IIT Bombay, Indian Institute of Chemical Engineers (IICChE) and Indian Environmental Association (IEA), Mumbai, jointly organized a One-Day National Workshop entitled: “Urban and Rural Challenges in Management of Solid Waste in India: A Circular Economy Approach to Building Smart Habitats”. This Workshop was held in IIT Bombay, Mumbai on Tuesday, 24<sup>th</sup> September, 2019 during 9:00 AM and 6:00 PM.

The One-Day Workshop was attended by the delegates from Municipal Corporation of Greater Mumbai, plastic manufacturers and users, housing societies, ALMs, real estate developers, corporate organisations engaged in providing processes and products, waste management companies and academic institutions. About 155 delegates participated in the Workshop. A brief background about the significance of the topic of the workshop is given below.

India has had satisfactory track record of contributing in the international initiatives, namely; Millennium Development Goals (MDGs) during 2001 and 2015 as well as Sustainable Development Goals (SDGs) since 2016



– wherein each nation has its own targets to be fulfilled and each reports the respective progress to the steering committee at the United Nations Organization (UNO). In the same period, the Government of India has had several targeted programmes to upgrade sanitation and other municipal services across the nation through several initiatives including Jawaharlal Nehru National Urban Renewal Mission (JNNURM) and Smart Cities programme managed by the Ministry of Urban Development. The Swachh Bharat Abhiyan steered by the Prime Minister has recently inspired all the citizens to participate actively in the nation-wide campaign to clean-up our habitats and work places.



*Photographs of the Audience*



*Dr Anil Kakodkar, FNAE delivering Address*



*Dr Pradip, Vice-President, INAE presenting Memento*



*Interaction of Senior Delegates at the Workshop*



*Group Photograph of Participants*





The Experts during their presentations appealed to the participants in the Workshop to formally adopt the “8-R concept” (Regulate, Rethink, Repair, Reduce, Reuse, Recover, Recycle and Re-manufacture) to conserve energy, minimize wastes, and promote waste recycling. This would be possible in reality only when the development planning agencies make targeted efforts to create the markets and engage the local community to make this strategy financially viable and socially sustainable.

Dr. Pradip, Vice President, INAE delivered the Welcome Address and Prof. A. K. Suresh, FNAE, Deputy Director, IIT Bombay during his briefing elaborated the focus and content of the Workshop. The Workshop was graced by Dr. Anil Kakodkar, FNAE as the Chief Guest and he delivered the Keynote Address. Mr. D. P. Misra, FNAE proposed the Vote of Thanks on behalf of INAE, IIT Bombay, IChE and IEA at the end of the Inaugural Session.

### **Speaker Meeting Featuring talk by Dr. Lawrence L. Kazmerski, FNAE on “Photovoltaics History, Technology, Innovation, and Progress: The Future is Now...”**

A Speaker Meeting of INAE Mumbai Local Chapter was held on 16th October 2019 at IIT Bombay, Mumbai featuring a talk by Dr. Lawrence L. Kazmerski, FNAE. The technical details of the special talk are given below.

#### ***Talk on “Photovoltaics History, Technology, Innovation, and Progress: The Future is Now . . .” Delivered by Dr. Lawrence L. Kazmerski, FNAE***

Member Research Staff (Emeritus), National Renewable Energy Laboratory, Golden, CO Research Professor, University of Colorado Boulder, Boulder, CO, Visiting Professor, IIT Bombay, India At Room No 23, VMCC, IIT Bombay, 16<sup>th</sup> October 2019

Dr. Lawrence L. (‘Kaz’) Kazmerski is one of the global experts and pioneers in solar photovoltaics (PV). With his ongoing association at NREL, University of Colorado Boulder and IIT Bombay, he continues to remain active in R&D activities. His talk at IIT Bombay, which had an audience of about 40 persons including Fellows of INAE, focused on the current state-of-the-art as well as the historical background of solar PV.

Dr. Kazmerski mentioned that the idea of using the sun as a source of energy was proposed by several engineers in the first couple of decades of this century, including giants such as Edison, Tesla and Steinmetz. However, the first practical solar cell (with an efficiency of 5%) was developed only in the mid 1950’s by Bell Telephone Laboratories to be used in their rural ‘repeater’ stations. The Vanguard-1 satellite launched in 1958 was the first to use solar cells as the power source. Subsequently, all satellites have relied on solar power. Modern satellites use very complex multijunction solar cells with high efficiencies approaching 40%.

Today, solar PV is being driven mainly by terrestrial deployment. This started in the 1970’s, but took off rapidly in the 2000’s due to falling prices. Solar power is now becoming cheaper (computed on LCOE basis) than any other energy source, driven mainly by China’s manufacturing prowess. The total world-wide deployed solar power is approaching 500 GW, and is likely to cross 1 TW in the next few years. India is one of the three largest deployers of solar power today. Besides being cheap and easy to set up, solar power also has a much smaller carbon footprint, said Dr. Kazmerski.

Most of the solar panels in production today are based on silicon. Though this is the oldest technology, continuous developments have made the Si cells more efficient, and today the record efficiency is 26%, which is quite close to the theoretical. However, Dr. Kazmerski explained that there are several exciting alternatives to silicon, one of which is perovskites, which emerged only a few years ago, but whose efficiencies have rapidly increased from a few percent to 25% today. Perovskite-on-silicon tandem cells have recently shown record efficiencies, and a roadmap exists to take this to greater than 30% for terrestrial applications. The long-term stability and reliability remain to be explored, though, before these can replace silicon. Another alternative to silicon is organic solar cells, which have the advantage of being made on flexible substrates. Dr. Kazmerski passed around a flexible organic solar cell.

Dr. Kazmerski ended his talk by describing how far we have come since the early days when he started his career and expressed his conviction that many new developments will carry solar PV even further in the future. Dr. Kazmerski also designs colourful ties and scarves with a solar motif in his spare time, and he distributed several of these to members of the audience.

## INAE Hyderabad Local Chapter

It is well known that Hyderabad has a prominent place in the Engineering map of India especially because it houses a large number of globally renowned R&D centres, Academic Institutions and a large cluster of Industries and Information Technology companies that are directly connected with the Engineering and Technology. Defence labs, BHEL, NFC, MIDHANI, IITH, UOH, TCS, CYIENT are among a few to name, along with many small-scale industries and several other academic institutions encompassing and demonstrating voluminous and diversified engineering activities by many engineering professionals associated with these organizations.

Yet another significant highlight of Hyderabad has been the number of resident INAE Fellows crossing a significant number viz., more than 50 indicates the valuable contribution of the engineers, engineer-scientists and technologists from Hyderabad who have contributed to the overall development of the Nation.

One of the major objectives of INAE has been *“To encourage and promote the pursuit of excellence in the field of Engineering”*. In order to realize such an objective and to provide a knowledge-based platform for all the stakeholders, INAE has been instituting Local Chapters for easy dissemination and recognition of local talent on a national scale. In this connection, Dr Dasharath Ram, FNAE, DS and Director, DRDL, Hyderabad was requested by INAE in the recent past, to initiate the process of starting a INAE Local Chapter at Hyderabad which was accordingly instituted.

Based on the suggestions by Dr Dasharath Ram, the following members had met at University of Hyderabad on 28<sup>th</sup> October 2019 to discuss the formation of INAE Hyderabad Local Chapter:

1. Prof. K. Bhanu Sankara Rao, FNAE,  
Pratt & Whitney Chair Professor, University of Hyderabad
2. Dr G. Madhusudhan Reddy, FNAE,  
Outstanding Scientist and Associate Director, DMRL, Hyderabad.
3. Dr Jaiteerth R. Joshi, Scientist ‘G’, DRDL, Hyderabad
4. Dr L. Rama Krishna, Scientist ‘F’, ARCI, Hyderabad
5. Dr.-Ing. V.V.S.S. Srikanth, Associate Professor, SEST, University of Hyderabad
6. Dr. Koteswararao V. Rajulapati, Associate Professor, SEST, University of Hyderabad
7. Dr Sushmee Badhulika, Associate Professor, Department of Electrical Engineering, IIT Hyderabad

After due deliberations, it was decided to formulate the Managing Committee comprising of Fellows of INAE and active members of various other professional bodies. Accordingly, the composition of the Managing Committee of INAE Hyderabad Local Chapter is as under:

Chairman	-	Dr Dasharath Ram, FNAE DS and Director, DRDL, Hyderabad
Secretary	-	Dr G. Madhusudhan Reddy, FNAE OS and Associate Director, DMRL, Hyderabad
Joint Secretary	-	Dr-Ing. V.V.S.S. Srikanth Associate Professor, SEST, University of Hyderabad
Treasurer	-	Dr Jaiteerth R. Joshi, Scientist ‘G’, DRDL, Hyderabad
Advisors	-	Mr B.V.R. Mohan Reddy, FNAE Founder and Executive Chairman, CYIENT Ltd. Hyderabad



Members	-	Prof. K. Bhanu Sankara Rao, FNAE, Pratt & Whitney Chair Professor, University of Hyderabad
		Dr Dinesh Kumar Likhi, FNAE Chairman and Managing Director MIDHANI, Hyderabad
		Dr Venkata Mohan Srinivasulu Reddy, FNAE Tata Innovation Fellow and Principal Scientist CSIR-IICT, Hyderabad
		Dr L. Rama Krishna, Scientist 'F', ARCI, Hyderabad
		Dr P. Venkata Ramana, Professor, MGIT, Hyderabad
		Dr Koteswararao V. Rajulapati, Associate Professor, SEST, University of Hyderabad
		Dr Sushmee Badhulika, Associate Professor, IIT Hyderabad
		Dr Seshagiri Rao Ambati Associate Professor, NIT Warangal
		Dr M. Phani Surya Kiran Scientist 'E', DMRL, Hyderabad
		Dr Swati Ghosh Acharyya Assistant Professor, SEST, University of Hyderabad

The members present also discussed in detail about the activities to be taken up by the INAE Hyderabad Local Chapter and the following activities were decided to be undertaken by the Chapter:

- To conduct several Professional Conferences in different organizations located in and around Hyderabad.
- To organize the first meeting of INAE Hyderabad Chapter at DRDL, Hyderabad sometime in the month of November, 2019 by inviting the Fellows and INAE Young Associates located at Hyderabad. Dr Dasharath Ram, FNAE, Chairman, INAE Hyderabad Local Chapter would deliver a talk on the Manufacturing Aspects of Advanced Materials during the meeting.
- To organize the second meeting of INAE Hyderabad Chapter at University of Hyderabad in the month of December, 2019.
- To organize a lecture on Recent Developments in High Temperature Materials at IIT Hyderabad in the month of December, 2019.
- To organize monthly lectures on various advanced disciplines of Engineering such as Machine Learning, Artificial Intelligence, Data Science etc.

INAE Hyderabad Chapter and the Department of Metallurgical and Materials Engineering, Mahatma Gandhi Institute of Technology, Hyderabad has organized a one-day National Conference on “Advances in Metallurgical Engineering” on March 4<sup>th</sup>, 2020 at MGIT Hyderabad for educating the undergraduate and post graduate students. Dr. G.D. Janaki Ram, Professor, Department of MSME, IIT Hyderabad has graced the occasion as a chief Guest. In his keynote address, Prof. G.D. Janaki Ram dealt the emerging aspects in Additive Manufacturing and its growing application in the fabrication of various components. More than 200 delegates participated in the conference.

Prof. K. Bhanu Sankara Rao FNAE provided the necessary guidance in the selection of speakers and the successful organization of the conference.

## INAE Kharagpur Local Chapter

### *One-day Workshop on Steel Technology at IIT Kharagpur*

The Department of Metallurgical and Materials Engineering, Indian Institute of Technology Kharagpur, the Kharagpur Chapter of Indian Institute of Metals and the Kharagpur Chapter of Indian National Academy of Engineering had jointly organizing one-day ‘Workshop on Steel Technology’ on 24<sup>th</sup> October 2019. The workshop was organized at Prof. S.N. Bose Auditorium in IIT Kharagpur. Prof. Sriman Kumar Bhattacharjee, Officiating Director of IIT Kharagpur inaugurated the workshop. Prof. Rahul Mitra, Head of the Department of Metallurgical and Materials Engineering delivered the welcome address and shared the activities of the department. Prof. Suman Chakraborty, Dean of SRIC, IIT Kharagpur and INAE Chair Professor, Prof. Surjya Kanta Pal, Chairman of Steel Technology Center and DHI Center of Excellence in Advanced Manufacturing also addressed the gathering informing about the various initiatives and activities taken by IIT Kharagpur to support the manufacturing sector. The workshop covered various important areas of steel metallurgy through the following theme-based sessions, conducted by eminent academicians of IIT Kharagpur as session chairpersons:

- Progress in iron and steel making, (Chaired by Prof. P.K. Sen),
- Advanced physical metallurgy and processing of steel, (Chaired by Prof. S.B. Singh),
- Innovative coating, joining and modelling studies on steel, (Chaired by Prof. K. Das and Prof. G.G. Roy).

Besides the faculty members and research students of IIT Kharagpur, several faculty members and scientists from IIST Shibpur, Jadavpur University, NIT Durgapur and Rourkela, National Metallurgical Laboratory and Tata Steel in Jamshedpur, and RDCIS-SAIL Ranchi participated in the workshop and presented their research activities related to steel. The presence of eminent experts like Dr. Soumitra Tarafder from NML Jamshedpur, Prof. Pravash Chandra Chakraborti from Jadavpur University and Prof. Santanu Ray, former scientist of RDCIS-SAIL and present JSPL and JSL Chair-professor and Editor of Metal News, during the workshop, is worth mentioning.

The following two distinguished international doyens attended the workshop and delivered Institute Lectures: 1) Dr Debashish Bhattacharjee, Vice President, Technology and New Materials, Tata Steel and Former Group Director of Global Research, Development and Technology, Tata Steel and 2) Prof Dr H J Fecht, Chair Professor and Director “Institute of Micro and Nanomaterials” at Ulm University, Eureka Cluster Office Director Metallurgy Europe, Member of European Academy of Sciences and Arts. The Workshop was coordinated by Prof. Debalay Chakrabarti with the help, support and advice from Prof. Rahul Mitra, Head of the Department of Metallurgical and Materials Engineering, IIT Kharagpur, Prof. Tapas Laha and Prof. G.G. Roy from the Indian Institute of Metals Kharagpur Chapter, Prof. Sumantra Mandal and Prof. Indranil Manna, Vice-President, INAE from INAE Kharagpur Local Chapter.



*Prof SK Bhattacharyya, FNAE, Officiating Director, and Prof Indranil Manna, Vice-President, INAE Lighting the Lamp*





*Lighting of Lamp by Prof Suman Chakraborty*



*Prof Rahul Mitra Delivering the Welcome Address*



*Prof SK Bhattacharyya Addressing the Audience*



*Prof Indranil Manna, Vice-President, INAE Felicitating Prof Dr H J Fecht*



*Audience in the event*



*Prof Suman Chakraborty delivering talk*



*Prof Indranil Manna addressing the audience*



*Dr Debashish Bhattacharjee giving presentation*





*Prof Indranil Manna and Prof Dr H J Fecht*



*Dr Debashish Bhattacharjee delivering lecture*

## INAE Kanpur Local Chapter

### *Learning Through Virtual Laboratories at IIT Kanpur*

A full day Virtual Laboratory workshop was organised by Indian Institute of Technology (IIT) Kanpur and INAE Kanpur Local Chapter on September 14, 2019. Prof. K. Muralidhar, President, INAE Kanpur Local Chapter, and Prof. Kantesh Balani, Coordinator, Virtual Lab IIT Kanpur, lighted the lamp and inaugurated the workshop. Prof. Muralidhar, in his introductory remarks, highlighted the grand challenges that engineers need to focus on as per global needs. He also emphasised the need of tools, from hammer to virtual laboratories that enhance the value of engineers in today's world. The Virtual Laboratory workshop witnessed the enthusiastic participation of 184 delegates from 13 colleges and 5 schools (from Indore, Sultanpur, Kannauj, Banda, Moradabad, Motihari, and Kanpur). Such large participation highlights that the domain of virtual laboratories is gaining popularity and momentum in the recent times. The technical program started with an introduction to 'Virtual Laboratories' by Prof. Kantesh Balani, who highlighted the need of building confidence via gaining knowledge through virtual lab platform. This Virtual Laboratory initiative is being supported by Ministry of Human Resource and Development (MHRD) under the National Mission on Education through Information and Communication Technology (NMEICT). The lead coordinator of this Virtual Lab initiative is IIT Delhi with 23 participating institutes across the country.



*Prof K Muralidhar Lighting the lamp*



*Audience in the event*

Prof. D. Goswami highlighted 'Ultrafast Laser Spectroscopy', and later Ms. Sonal Dixit, Mr. Boda Pool Singh, Mr. Narendra Dhar, and Mr. Arun Kumar Sharma together introduced 'Transducers and Instrumentation' virtual laboratory developed by Prof. Nishchal Verma. Then, Prof. Kantesh Balani demonstrated virtual laboratory on,

'Material Response to Microstructural-, Mechanical-, Thermal- and Biological-Stimuli', followed by showcasing of 'Production Shop Simulation Laboratory', by Prof. Deepu Philip. The lunch break allowed participants to engage in discussions with the eminent speakers. Following lunch, Prof. Pankaj Jain enticed students with 'Virtual Astrophysics Laboratory' talking about fascinations of watching stars from earth. Prof. K.V. Srivastava showcased 'RF and Microwave Characterization Laboratory', which is jointly developed with Prof. M.J. Akhtar. Prof. S. Banerjee elicited conceptual notes on 'Waves and Phenomena' and highlighted that oscillations are inherently present in our daily lives. The last talk by Prof. S. Kamle on 'Aerospace Virtual Laboratory' served as icing on the cake and emphasized on learning new concepts by conducting experiments.

The participants from various schools and colleges highly appreciated this opportunity of engaging with IIT Kanpur faculty through this Virtual Laboratories platform. The energy and enthusiasm in the workshop was never ending, and encouragement by participating faculty and students was without boundaries. The ignited curiosity of students and invigorating participation from faculty was highly satisfying. Involvement of participants percolated to requests of hosting such workshops specifically at their schools and colleges. The program was successfully concluded with distribution of certificates by Prof. S. Kamle, and presentation of vote-of-thanks by Dr. Aparna Dixit. The workshop was hosted by Prof. Kantesh Balani, and the organisational aspects were assisted by Mr. Dhananjay Umrao, Ms. Sheetal Singh, Mr. Shivam Shukla, Mr. Raj Babu, Mr. Dinesh Diwakar, and volunteers from Pranveer Singh Institute of Technology, and IIT Kanpur.

### ***Women in Sciences and Engineering (WiSE) 2019 Conference Organized by IIT Kanpur in association with INAE Kanpur Local Chapter***

As a part of Diamond Jubilee Celebrations at IIT Kanpur, Women in Sciences and Engineering (WiSE) Conference 2019 was organised with support from Indian National Academy of Engineering (INAE) Kanpur Chapter. WiSE 2019 was inaugurated by Dr. Abhay Karandikar, Director, IIT Kanpur, Chief Guest Dr. Asha Agarwal (retired from GSVM), guest of honour Dr. Mamta Vyas (Chief Medical Officer, IIT Kanpur), Dr. S.C. Srivastava (on behalf of Dr. K. Muralidhar, President, INAE Kanpur Chapter), and conference organisers (Dr. Bushra Ateeq and Dr. Kantesh Balani). All expressed a desire to enhance the participation of women in sciences and engineering and sensitizing the policy makers towards creating sustainable opportunities for women to be able to pursue these as career options.



*Inauguration Ceremony and Address by Prof. Abhay Karandikar during Women in Sciences and Engineering 2019 Conference at IIT Kanpur on October 19, 2019*



The WiSE 2019 conference is a very different and unique concept which witnessed eminent women speakers discuss their research. This conference addressed multi-thematic areas and served as a platform for thought stimulating interactions. The open discussion time for the group of speakers addressing an erudite audience not directly from their domain encouraged cross-discipline and engaging dialogue to force open new areas of collaborative research.

WiSE 2019 conference witnessed two plenary talks, and 20 technical talks including the impact of these technologies on society and need of linguistic diversity. In addition, concept of virtual laboratories and an activity-based leadership talk also fascinated the participants. Over 64 participants and occasional footfall raised the participants to over 80. Further, two panel discussions, i.e. “Opportunities & Challenges for Women in Sciences and Engineering” and “Innovation and Entrepreneurship” were also highly informative and useful for both women and men in sciences and engineering domains.

Video message by Dr. Rohini Godbole (IISc Bangalore), Dr. Madhu Loomba (Madhuraj Hospitals, Kanpur), Dr. Debrupa Lahiri (IIT Roorkee), and Dr. S.T. Aruna (NAL Bangalore), also emphasised that women need to embrace womanhood beyond her home and be able to pursue their career ...free of any gender-discrimination. A total of 24 talks (two plenary talks, and other thematic talks) along with two panel discussions are planned for the conference during Oct. 19-20, 2019 at IIT Kanpur. Dr. Asha Agarwal delivered plenary talk highlighting need of early cancer detection, which was followed by 10 invited talks on themes of materials, electronics, and energy/environment.



*Participants listening to video message by eminent supporters of WiSE 2019.*



*Collage of talks from various speakers during Women in Sciences and Engineering Conference at IIT Kanpur on October 19, 2019*



Later, the panel discussion on “Opportunities & Challenges for Women in Sciences and Engineering” was received with very active engagement of audience in sensitizing the gender equality that is demanded in work setting. The session was moderated by Dr. Neetu Singh from IIT Delhi, and panel member included Dr. Emila Panda from IIT Gandhinagar, Dr. Prita Pant from IIT Bombay, Ms. Arpita Gupta (counsellor at IIT Kanpur), Dr. Pratibha Sharma from IIT Kanpur & Ms. Apoorva (student at IIT Kanpur). The gender biases need to be eradicated from the society and a natural flow must ensue towards sharing equal responsibility. The panel members expressed the need of sharing these recommendations to higher bodies for sensitizing these issues for consideration when making policy-decisions.



*Panellists of “Opportunities & Challenges for Women in Sciences and Engineering” during Women in Sciences and Engineering Conference at IIT Kanpur on October 19, 2019.*

The second day started with plenary talk by Dr. Anuradha Godavarty, Florida International University, FL, USA. She highlighted the aspects and importance of transition from a researcher to an innovator and to an entrepreneur. This talk set the mood for the panel discussion later in the day.



*Plenary talk by Dr. Anuradha Godavarty via Skype on October 20, 2019*

The next talk was on leadership and women-empowerment that involved the participants in engaging activity and highlighted team building. The enthusiasm persisted on the second day of WiSE 2019 conference with thematic talks hovering on biomedical materials and agricultural sciences. The day ended with an involving panel discussion on “Innovation and Entrepreneurship”, which was moderated by Dr. Mini Chandran (IIT Kanpur) and the panellists included Dr. Arpita Amarnani (GIM, Goa), Dr. Neetu Singh (IIT Delhi), Dr. Koumudi Patil (IIT Kanpur), Dr. Renu (Principal Scientist, ICAR-NBAIM, Maunath Bhanjan, U.P.



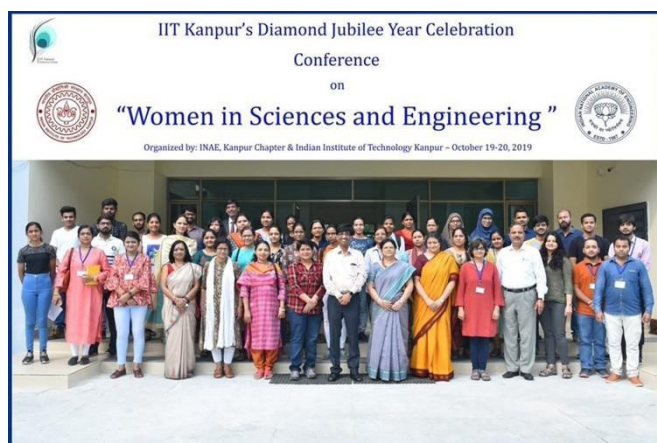
*Collage of various speakers giving talk during Women in Sciences and Engineering Conference at IIT Kanpur on October 20, 2019.*



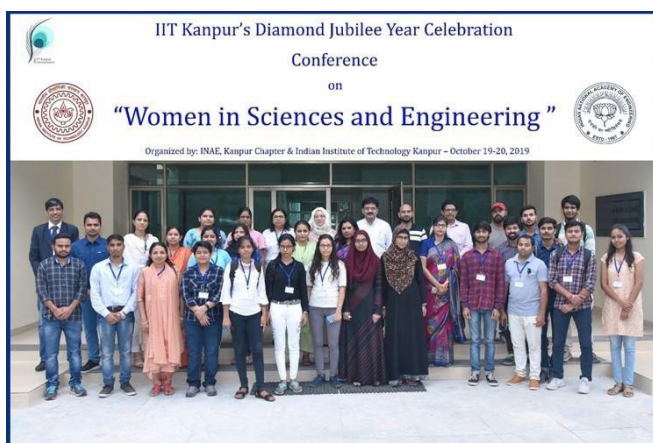


Panelists of “Innovation and Entrepreneurship” interacting with audience during Women in Sciences and Engineering Conference at IIT Kanpur on Oct. 20, 2019.

In summary, WiSE 2019 conference was very well received by the community and all the participants recommended that such an event should become a regular event. All the participants extended their full-hearted support for organisation of next WiSE at much bigger scale in near future.



Day 1: October 19, 2019



Day 2: October 20, 2019

## INAE Delhi Local Chapter

***Indian National Academy of Engineering (INAE) Delhi Local Chapter in association with Bharti School of Telecom and Technology Management (IIT Delhi) and IEEE Delhi Local Chapter organized a Lecture by Prof. Arumugam Nallanathan from Queen Mary University, London, UK***

The Indian National Academy of Engineering (INAE) Delhi Local Chapter in association with Bharti School of Telecom and Technology Management (IIT Delhi) and IEEE Delhi Local Chapter organized a lecture on Communication Technologies and Requirements for Industry 4.0 on Feb 3, 2020 at 4.30 P.M. at Bharti School of Telecom and Technology Management, IIT Delhi.

**Abstract of the Lecture:** The Fourth Industrial Revolution (Industry 4.0) is coming, and this revolution will fundamentally enhance the way the factories manufacture products. The modern manufacturing industry will upgrade to a new era of productivity with the confidence to reinvent their business. To realize this ambitious goal, the industry needs a solution that could support to access real-time information, eliminate downtime, production automation, empower employees with the freedom to work anywhere, anytime, etc. Therefore, the conventional wired lines connecting central controller to robots or actuators will be replaced by wireless communication networks due to its low cost of maintenance and high deployment flexibility, which becomes an evitable trend. However, mission-critical industrial applications require ultra-high reliability and low latency communication (URLLC) that is not supported by our current wireless communication systems and is one of the primary cornerstones of the fifth generation (5G). Thus, there is an urgent need for rethinking the design of communication system. This lecture highlighted the communication requirements and technologies for the revolution towards Industrial 4.0, and the recent advances in information theory for the transmission of short packets, which provide the theoretical principles that govern the practical design of system parameters, followed by proposed framework and methodologies to solve the key issues in the context of URLLC that indispensably needed by Industry 4.0. The talk concluded with directions for future research.

**Speaker Profile:** Dr Arumugam Nallanathan is Professor of Wireless Communications and Head of the Communication Systems Research (CSR) group in the School of Electronic Engineering and Computer Science at Queen Mary University of London since September 2017. His research interests include Artificial Intelligence for Wireless Systems, 5G and beyond Wireless Networks, Internet of Things (IoT) and Molecular Communications. He published nearly 500 technical papers (including more than 200 top IEEE journal papers) in scientific journals and international conferences.

***INAE Delhi Local Chapter organized a lecture by Prof. Sukumar Mishra the topic “Reliable and Secure DC Microgrids” on February 4, 2020 at Bharti School of Telecommunications Technology & Management, IIT Delhi.***

INAE Delhi Local Chapter organized a lecture by Prof. Sukumar Mishra, an INAE Chair Professor, in the Department of Electrical Engineering at IIT Delhi on the topic “Reliable and Secure DC Microgrids” on February 4, 2020 at Bharti School of Telecommunications Technology & Management at IIT Delhi Campus, New Delhi. In his talk he first defined what is microgrid, and contrasted with conventional regional and national grids as well as with respect to nanogrid (individual household level) and picogrid (human body level power control, on the order of milliwatts). He then explained the power grid connectivity requirements, and subsequently the aspect of generator based grid connectivity versus current-day solar/wind power based grid connectivity. The issue of lack of any inertia in solar DC grid in grid network stability was addressed. Besides, though there are newer DC-based electrical products coming to the market that can fit with the new DC energy type, the conventional AC-based electrical product manufacturers have concerns on their product lines. Yet, there are efforts on DC microgrid-operated electrical appliances.

Prof. Mishra then discussed some of his efforts on DC-microgrid operated home appliance experiments, including DC-power operated home and EV charging park. To account for the electrical connection/disconnection related surge and instability issue, he introduced the discussion on AI-based intelligent control of microgrid control, where





his concept of “de-rating” of photovoltaic source was presented. The concept of local battery usage instead of “de-rating” was discussed from cost-efficiency tradeoff perspective. Finally, the tradeoff between microgrid performance optimality and easy/fast controllability in the face of communication link uncertainties through decentralized (instead of fully-centralized) controllability was discussed. The talk was attended by about 20 research students and industry practitioners as well as a few IIT Delhi faculty members. Following the talk, a brief informal discussion was held on the industry-academia collaboration and technology-oriented research.

***Indian National Academy of Engineering (INAE) Delhi Local Chapter organized an interaction event with Telecommunications Standards Development Society, India on February 14, 2020 at Indian Institute of Technology Delhi***

An interaction event was organized by Indian National Academy of Engineering (INAE) Delhi Local Chapter with Telecommunications Standards Development Society, India at Indian Institute of Technology (IIT) Delhi on February 14, 2020. The event was organised with the objective of developing a better understanding on Telecommunications Standards Development Society, India activities on technology standardization to find a synergy towards the Indian academic researchers’ technology-oriented research. Telecommunications Standards Development Society, India (TSDSI) officials gave presentations on how the society could assist the academic researchers in the standardization efforts, and explained the other details of TSDSI membership benefits and travel support.

## ***Commitment of INAE to the Efforts of Government of India towards Containment and Eradication of COVID-19 Pandemic***

Dr Sanak Mishra, President INAE has written a letter to Dr Pramod Kumar Mishra, Principal Secretary to the Prime Minister conveying utmost admiration in the exemplary manner in which measures have been taken by the Government of India under the inspired leadership of the Hon'ble Prime Minister, towards the containment and eradication of the COVID-19 pandemic. He lauded the Government initiatives encompassing provision of medical services and facilities; promotion of indigenous medical testing facilities; development of cost-effective medical equipment; excellent governance; economic relief measures; repatriating Indian citizens from affected countries; appropriate education of citizens; timely lock-down of the country and ensuring essential supplies and facilities across the country. Dr Sanak Mishra highlighted that INAE commits itself to extend all and any support required by the Government for the furtherance of its initiatives and measures for the containment and eradication of the COVID-19 pandemic and he looked forward to the Academy contributing to the ongoing and novel measures and innovative strategies of the Government of India.

In this regard, Dr Sanak Mishra, President INAE had initiated a letter to the INAE Fellowship and INAE Young Associates requesting for relevant expertise in the engineering fields from Fellows who can come forward to offer their expertise to mitigate any dimension of the COVID 19 Pandemic from engineering perspective. Once inputs were received, these were to be communicated to Department of Science and Technology with the objective of making meaningful contributions to the various measures and initiatives of the Government by providing the pertinent technical inputs to synergize the efforts, with innovative engineering interventions and providing consultancy in concerned fields. Subsequently, the names of INAE Fellows and Young Associates willing to contribute to the pertinent activities and measures initiated by DST in the containment and eradication of the COVID was forwarded by Dr Sanak Mishra, President INAE to Prof Ashutosh Sharma, Secretary, DST.



## *International Affairs*

### *CAETS 2019 Convocation and Annual Meetings in Stockholm, Sweden*

#### **CAETS and International Conference on Engineering a Better World – Next 100 Years.**

Global challenges were on the agenda when engineers and scientists from all over the world met at the CAETS Conference (Council of Academies of Engineering and Technological Sciences), organized by the Swedish Academy of Engineering Sciences (IVA). The meetings of CAETS Executive Board and the Conference were held during 24 – 28 June 2019 at Stockholm, Sweden. Dr. Sanak Mishra, President INAE and Member of the Executive Board of CAETS, Dr. Pradip, Vice President INAE and Mr. Pradeep Chaturvedi, Fellow INAE attended as official delegates.

Together with Ruth A. David, Secretary General of International Council of Engineering Science and Technological Sciences, CAETS, Prof. Tuula Teeri, Chair of CAETS and President of IVA, opened the annual CAETS conference at the City Conference Centre in Stockholm.

The fact that IVA hosted the event this year was no coincidence, as IVA– the world's first engineering sciences academy – turns 100 years old in 2019.

Welcoming the participants in the Conference, Prof. Tuula Teeri remarked: “My elder colleagues may disagree with me, but I think we have never before faced such great challenges in the world. However, we have probably said so for 100, 1,000 or 2,000 years, and we have always managed to solve the problems”.

Mr. Ibrahim Baylan, Minister for Business, Industry and Innovation, Swedish Government, in his thought-provoking inaugural address emphasized the need to keep peoples' needs in mind. “All technology shifts have killed jobs, but they have also always created new jobs. We, therefore, need a society that helps people to go from old to new jobs, through vocational training, investments in research and development, education, and so forth.” Interestingly, he illustrated the need to conceive of a world free of fossil fuels, with the example of steel and electric vehicles. He emphasized the need to develop fossil-fuel free steel.

The conference brought together 400 participants from all over the world, including delegates from 26 CAETS academies of engineering and 3 from Nigeria, New Zealand and Serbia that were elected as new members of CAETS.

#### **Topics of Different Presentations**

A number of international thinkers and experts in areas of great significance for the immediate future were invited to address the Conference.

For three days, the role of science, technology and engineering in meeting global societal challenges was in focus. To shed light on some of the most acute challenges facing the society and explore possible solutions, the Swedish Academy put together a cross-disciplinary program. That was really a unique way of conducting the conference. The conference turned out to be a meeting place for everyone working within or interested in science, technology, engineering and societal issues.

‘Engineering a Better World: The Next 100 Years’ was a Conference within the framework of the CAETS international network of academies of engineering sciences.

The Conference consisted of a series of sessions, each devoted to a specific topic of immediate concern. The first session reflecting ‘Progress’ included the opening presentation on ‘The first 100 Years’ which provided an overview of developments since the inception of the Swedish Academy. This session also included presentations on ‘Internet – Engineering for Society’; and ‘LIGO – Engineering for Science’.

The second session was entitled, ‘Challenges’ and it included presentations on ‘Energy System of the Future – Evolution or Revolution’; ‘Unequal Cities’; ‘Antibiotic Resistance – a Multiple Systems Failure’; and ‘Water as Leverage – from Risk to Reward’.



The third session was on 'Creative Chaos' which included presentations on 'Engineering the Climate'; 'Sustainable Transition Pathways for Plastics' and a Panel Discussion on: 'Future Health – Are New Business Models Required'?

The fourth session was on 'Digital Dawn', which included a presentation on 'Productivity and Performance in a Digital Age'. It covered the impact of technologies like AI and Machine Learning.

The fifth session on 'Effective Education' had presentations on: 'The Changing Face of Global Engineering Education and Logic', and 'Landscape of the 'Knowledge System – Implications for the Educational System'.

The session on 'Inclusive Infrastructure' included presentations on: 'The All-Embracing Transportation System'; 'Design and Engineering for Sustainability Transitions', and 'Society 5.0 – a Human-Centric Strategy'.

The Conference concluded with the panel discussions on 'Policy Advice for the Future' and 'Industry – Academy Collaboration for the Future'.

## **The Major Takeaways from the Conference**

The major takeaways from the Conference are summarized below:

- (i) When considering the global challenges that we are facing today, it feels that they are graver than ever before. Then again, historical records from 100, 500 or 2000 years ago suggest that people have always felt that their current problems are the worst ever. And yet, humankind has always been able to put things right and the world has become progressively a better place, than before.
- (ii) New, powerful technological solutions are the key to solving many of our current challenges but at the same time, the technology is perceived as a threat by many people in the turbulent labour markets. Many fears for the loss of their jobs and for losing control over their lives by technological advances like automation, robotics and artificial intelligence, have to be innovatively addressed.

Engineers like us will have to make efforts in convincing people that new technology will help us lead a better life. Otherwise they will be very vulnerable to demagogues declaring new technology is “wrong and dangerous”.

- (iii) One clear message from the speakers at the conference was that we will need to put people at the centre of all our efforts, engaging them in discussions and involve them in the decision-making process, concerning the effects and implementation of different emerging technologies.

The focus of our national development should not just be technology-driven but human-centred and based on the core values of openness, open to criticism, sustainability and inclusion.

Inequalities between regions, countries and citizens is a huge obstacle for reaching our climate goals. The fundamental issue will be to find a balance between the environmental and the social agendas.

- (iv) The world is becoming more complex, globalized and very difficult to grasp in its entirety. Our current economic models predicting future trends tend to fail to account for e.g. intangible assets important in the digital world. There are also long implementation and restructuring lags with the introduction of new technology before people experience long-lasting positive impacts, in their lives.

Inclusive innovation, collaboration and prosperity shared by all will be needed to overcome the obstacles of increasing fear about technology.

- (v) Due to the complexity and the scale of our challenges, what is needed in the world is perhaps first and foremost cooperation and sharing between scientists, engineers and the policy-makers – between scientists and engineers from different fields, and between scientists, engineers, the political decision-makers and the general public.

To solve our problems, we must learn to manage complex collaborations.

- (vi) We need to reach a common understanding of the problems we face and the ways in which they can be solved. The longer we argue, the more likely it will be that we reach unforeseen tipping points, which can't be reversed. The high speed of our development gives us genuine hope but only as long as our institutions are capable of changing, in response to the call of the times.

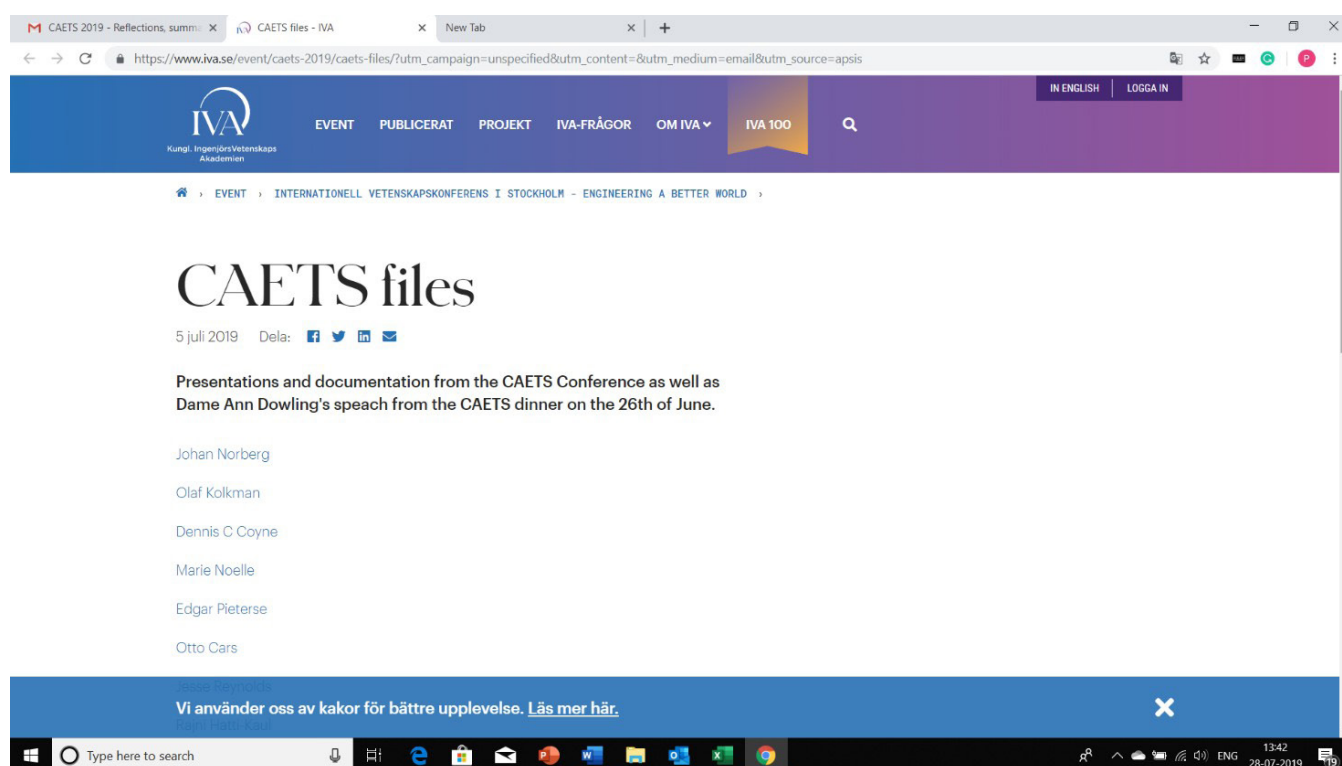


Tomorrow's leaders need to have a multidisciplinary, integrated approach, clarity of vision and a big focus on equality. Mentoring the future leaders who are inclusive and trained in necessary engineering skill sets that is, dealing with complexity, uncertainty and decision-making even in the face of a lack of complete scientific understanding of real-life problems, should be on our immediate agenda.

- (vii) The engineering academies must play a pro-active role and find ways and means to create appropriate linkages (and partnership, if possible) with the policymakers to be able to facilitate technology transitions – for example, today to renewable energy, electrification, digital transformation and a fossil-fuel free, people-centric public transportation. Another role the engineering academies must play is to inspire our next generation of emerging leaders to take up engineering as a profession and solve challenging problems facing us. Need for appropriate changes in our engineering education system including internships, increasing exposure to industry and enhancing academia-industry collaboration were also discussed as one of the key responsibilities of engineering academies.

**IVA has made the copies of all the power-point presentations on the above-mentioned topics, available on their website. The readers are requested to download them directly from the link provided below:**

[https://www.iva.se/event/caets-2019/caets-files/?utm\\_campaign=unspecified&utm\\_content=&utm\\_medium=email&utm\\_source=apsis](https://www.iva.se/event/caets-2019/caets-files/?utm_campaign=unspecified&utm_content=&utm_medium=email&utm_source=apsis)



### Sideline Meetings with Member Academies

Indian (INAE) delegation held bilateral meetings with engineering academies of UK, France, Australia, Korea and Sweden. Possibilities of cooperation and collaboration with various academies were discussed. A review of past activities was undertaken and the possibilities of future strengthening of cooperation were discussed. The President, INAE emphasized in all meetings that programs that can proactively provide inputs to the government need to be emphasized. The President also emphasized that mechanism for mutual exchange programs need to be developed on a reciprocal basis, to which all academies agreed.



*Dr. Sanak Mishra, Dr. Pradip and Mr. Pradeep Chaturvedi with the Korean Delegation at CAETS Conference, June 2019, Stockholm, Sweden*

Discussion with RAEng UK focused on cooperation in the areas of smart city, artificial intelligence, climate change and sustainable development.

Discussion with NATE, France focused on the need to identify a few thrust areas where funding possibilities could be geared up. Some of the areas identified included energy, smart grids, artificial intelligence (especially applied to agriculture and health) and urban sewage treatment.

Discussion with Korean Academy included a review of the forthcoming INAE – NAEK Workshop on “High Temperature Material and System Engineering for Aerospace, Power Generation and Defence Industry” being organized at Hyderabad during July 15-17, 2019. The areas for cooperation for future cooperation discussed were artificial intelligence, robotics, IOT and automotive manufacturing including electric vehicles.

Discussion with ATSE, Australia, emphasized on identifying areas of mutual interest. Delegation of ATSE explained that the framework of Indo-Australian Inter-Governmental Fund has indicated health technologies, biotechnologies and medical device technologies as some of the preferred programs.

Discussion with the President of the Swedish Academy indicated a strong desire and an opportunity to collaborate with IVA, especially in the areas of knowledge, entrepreneurship, business development and motivation for young engineers. Swedish Academy also showed keen interest in having an agreement with INAE.

## **CAETS Meetings**

The CAETS Executive Board met on 24 June 2019 and was attended by Dr. Sanak Mishra, President, INAE. Subsequently CAETS Council meeting was organized on June 27, 2019 and was attended by Dr. Sanak Mishra, President, INAE and Dr. Pradip, Vice President, INAE. Highlights of the meeting was that three more engineering academies, namely from New Zealand, Serbia and Nigeria were inducted into CAETS. The next CAETS meeting, that is, CAETS 2020, will be held in Seoul, South Korea during June 22-25, 2020, hosted by NAEK. The theme of CAETS 2020 is “Engineering A Better World – Smart Society”. The Engineering Academy of Argentina will host the CAETS 2021 during Dec 21-25, 2021 and the theme of the conference will be “The Future of Energy” with special emphasis on training of human resources to lead the transition to a Renewable Energy Future. The venue of CAETS 2022 has also been decided and it will be Paris, hosted by the French Academy of Engineering in March 2022. The meeting also included formal presentations by the CAETS working committees on various themes – namely on Energy, Engineering Education, Communicating with Public (particularly the next generation), and on Diversity and Inclusion.

## The Fellowship

The selection process for election to the Fellowship was reviewed a few years back and modified wherein two stage selection process had been introduced. The comments from the Fellowship on the nominations received are also obtained prior to the first meeting of the Sectional Committees. In the first stage, the nominations are initially shortlisted to seek peer review reports from the recommended Fellows/domain experts. In the second stage, the peer review reports received are considered by the Sectional Committees to recommend nominations for election to the Fellowship for approval of the Governing Council. The following were elected as Fellows of the Academy w.e.f. Nov 1, 2019.

### Newly elected Fellows

#### Engineering Section-I (Civil Engineering)



- 1 Dr. V Sundar, Professor Emeritus, Department of Ocean Engineering, Indian Institute of Technology Madras, Chennai.



- 2 Mr. Alok Bhowmick, Managing Director, B&S Engineering Consultants Pvt. Ltd., Noida.

#### Engineering Section-II (Computer Engineering & Information Technology)



- 1 Prof. Vijay Natarajan, Professor, Department of Computer Science & Automation, Indian Institute of Science, Bangalore



- 2 Dr. Manik Varma, Senior Principal Researcher, Microsoft Research India, New Delhi.



- 3 Prof. Supratik Chakraborty, Bajaj Group Chair Professor, Department of Computer Science & Engineering, Indian Institute of Technology Bombay, Mumbai.

#### Engineering Section-III (Mechanical Engineering)



- 1 Dr. NC Murmu, Senior Principal Scientist/Scientist-F and Head, Surface Engineering and Tribology, CSIR-Central Mechanical Engineering Research Institute, Durgapur.



- 2 Prof. SG Deshmukh, Professor, Mechanical Engineering Department, Indian Institute of Technology Delhi, New Delhi.



- 3 Prof. Sameer Khandekar, Sir M Visvesvaraya Chair Professor, Room SL-109, Department of Mechanical Engineering, Indian Institute of Technology Kanpur, Kanpur.



#### ***Engineering Section-IV (Chemical Engineering)***



- 1 Prof. Sachin C Patwardhan, Professor, Department of Chemical Engineering, Indian Institute of Technology Bombay, Powai, Mumbai-400 076



- 2 Dr. Parag R Gogate, Professor, Chemical Engineering Department, Institute of Chemical Technology (ICT), Mumbai.



- 3 Dr. Guruswamy Kumaraswamy, Professor, Department of Chemical Engineering, Indian Institute of Technology Bombay, Mumbai.

#### ***Engineering Section-V (Electrical Engineering)***



- 1 Prof. Bidyadhar Subudhi, Professor, School of Electrical Sciences, Indian Institute of Technology Goa.



- 2 Prof. SA Khaparde, former Professor, Department of Electrical Engineering, Indian Institute of Technology Bombay, Mumbai.

#### ***Engineering Section-VI (Electronics & Communication Engineering)***



- 1 Prof. Nandita Dasgupta, Professor, Department of Electrical Engineering, Indian Institute of Technology Madras, Chennai.



- 2 Prof. AG Ramakrishnan, Professor, MILE Laboratory, Department of Electrical Engineering, Indian Institute of Science, Bangalore.

- 3 Prof. D Manjunath, Professor, Department of Electrical Engineering, Indian Institute of Technology Bombay, Mumbai.

#### ***Engineering Section-VII (Aerospace Engineering)***



- 1 Dr. D Roy Mahapatra, Associate Professor and DRDO Chair, Department of Aerospace Engineering, Indian Institute of Science, Bangalore.



- 2 Prof. Radhakant Padhi, Professor, Department of Aerospace Engineering, Indian Institute of Science, Bangalore.



- 3 Dr. L Venkatakrishnan, Chief Scientist & Head, Experimental Aerodynamics Division, National Aerospace Laboratories, Bangalore.

### ***Engineering Section-VIII (Mining, Metallurgical and Materials Engineering)***



- 1 Prof. Satyam Suwas, Professor, Department of Materials Engineering, Indian Institute of Science, Bangalore.



- 2 Prof. N Ravishankar, Professor, Materials Research Centre, Indian Institute of Science, Bangalore.



- 3 Dr. Vikas Kumar, former Distinguished Scientist and Director, Defence Metallurgical Research Laboratory, Hyderabad.

### ***Engineering Section-IX (Energy Engineering)***



- 1 Prof. K Srinivasa Reddy, Professor, HT&TP Laboratory, Department of Mechanical Engineering, Indian Institute of Technology Madras, Chennai.



- 2 Mr. MS Unnikrishnan, Managing Director & CEO, Thermax Limited, Pune.



- 3 Dr. Bibek Bandyopadhyay, Senior Advisor, Transaction Advisory Services, Ernst & Young LLP, New Delhi; Senior Advisor, International Institute of Energy Conservation, New Delhi.

### ***Engineering Section-X (Interdisciplinary and Special Engineering Fields and Leadership in Academia, R&D and Industry)***



- 1 Dr. Sanjay Bajpai, Scientist G and Head (Technology Mission Division: Energy Water and all others), Department of Science & Technology, Technology Bhawan, New Mehrauli Road, New Delhi



- 2 Mr. Ranajit Kumar, Outstanding Scientist & Head, Nuclear Controls and Planning Wing (NCPW), Department of Atomic Energy, Mumbai.



- 3 Prof. Pramod Kumar Jain, Director, Indian Institute of Technology (BHU), Varanasi.

## *Newly elected Foreign Fellows*



- 1 Prof. M. Packirisamy, Professor & Concordia Research Chair, Director Micro Nano Bio Integration Centre, Department of Mechanical, Industrial and Aerospace Engineering, Gina Cody School of Engineering and Computer Science, Concordia University, Canada.



- 2 Prof. Liang-Shih Fan, Distinguished University Professor, C. John Easton Professor in Engineering and Professor of Chemical and Biomolecular Engineering, The Ohio State University, USA.



- 3 Prof. Timothy Charles Lieuwen, Regents Professor and David S. Lewis, Jr. Chair, Department of Aerospace Engineering & Department of Mechanical Engineering and Executive Director, Strategic Energy Institute, Georgia Institute of Technology, USA.

## *Fellows elected under Rule 37(g)*

During the AGM of Fellows in the year 2015, it was brought out that many eminent experts from the Industry who have excelled in their respective spheres are not Fellows of the Academy since they are not nominated for election to the Fellowship through the normal process. Therefore, the percentage of elected Fellowship on the rolls of the Academy from the category of “Industry” was only 19%. With a view to enhance the visibility of INAE in Industry domain and also to increase industry representation in the Fellowship, it was decided during the year 2015 to increase the intake of eminent experts from thirty to forty at any point of time to be elected as Fellows under Rule 37(g) effective from the year 2016 onwards. Since then, upto five exceptional eminent persons from the Industry category are being elected as Fellows under the Rule 37(g) in a year.

This year, three eminent engineering luminaries elected from Industry category under Rule 37(g) were.



- 1 Mr. MV Gowtama, Chairman & Managing Director, Bharat Electronics Ltd., Bangalore.



- 2 Mr. SS Mohanty, Vice-Chairman cum Managing Director, Nelloch Ispat Nigam Ltd., Bhubaneswar.



- 3 Dr. Ramachandra Naidu Galla, Founder & Chairman, Amara Raja Group, Karakambadi, Chittoor Dist. (A.P.).



## *Honours and Awards*

### **Republic Day Award**

The following INAE Fellows have been conferred with the prestigious award of Padma Bhushan Award and Padma Shri Award on the occasion of the Republic Day on January 26, 2020.

### **Padma Bhushan Award**

- Mr Venu Srinivasan, Chairman, TVS Motors Company Ltd., Chennai

### **Padma Shri Award**

- Prof. Sujoy K. Guha, Professor, School of Medical Science and Technology, Indian Institute of Technology Kharagpur
- Prof. Sudhir K Jain, Director, Indian Institute of Technology Gandhinagar
- Prof. T Pradeep, Professor, Department of Chemistry, Indian Institute of Technology Madras

### **Other Awards**

The details of awards received by INAE Fellows during the year are given below.

1	<p>Prof. Roddam Narasimha, FNAE, Chairman, Engineering Mechanics Unit, Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore was one of the two scientists from India who received the 2019 Nature Awards for Mentoring in Science. Both the scientists earned praise from former trainees for prioritizing the success of their laboratory members over competition or a publish-or-perish mentality, and for the joy they find in science. Nature's mentoring award programme, which in 2019 marked its 15<sup>th</sup> year, annual confers two prizes: one for a mid-career mentor, and other for a lifetime of achievement in mentoring. The 2019 awards sought nominations from India, a country that produced 24,300 PhD graduates in 2014, the fourth-highest number in the world after the United States, the United Kingdom and Germany. The nominations were judged by a panel that included Indians scientists working in the nation and abroad and each award had a prize of Rs 7 lakhs. Prof Roddam Narsimha, a fluid dynamicist received the Lifetime Achievement award.</p>
2	<p>Dr G Satheesh Reddy, FNAE, Secretary to Government of India, Dept of Defence R&amp;D, Chairman, Defence Research and Development Organisation (DRDO), Scientific Adviser to Raksha Mantri and Director General, Aeronautical Development Agency (ADA), has been conferred with the prestigious AIAA Missile Systems Award 2019 by American Institute of Aeronautics and Astronautics (AIAA), one of the world's largest and reputed aerospace technical societies. The award recognizes excellence in developing and implementing missile systems technology and for inspired leadership of missile systems programmes. Dr G. Satheesh Reddy was selected for his over three decades of significant national contributions toward indigenous design, development, and deployment of diversified strategic and tactical missile systems, guided weapons, advanced avionics, and navigation technologies in India. He is the first Indian to be conferred with this Award.</p> <p>The news clippings regarding the same may be viewed at the links given below</p> <p><a href="https://www.thehindu.com/todays-paper/tp-national/drdo-chairman-wins-missile-systems-award/article26422423.ece">https://www.thehindu.com/todays-paper/tp-national/drdo-chairman-wins-missile-systems-award/article26422423.ece</a></p> <p><a href="https://timesofindia.indiatimes.com/city/hyderabad/international-award-for-satheesh-reddy/articleshow/68237684.cms">https://timesofindia.indiatimes.com/city/hyderabad/international-award-for-satheesh-reddy/articleshow/68237684.cms</a></p>



3	Prof Bikramjit Basu, FNAE, Honorary Professor, University of Manchester, UK; Guest Professor, Wuhan University of Technology, China and Professor, Materials Research Centre, Indian Institute of Science, Bangalore has been selected to be elevated to the grade of Fellow of The American Ceramic Society, founded in 1899. Recognition of this achievement will be given at the ACerS Honours and Awards Banquet at the 121st Annual Meeting of the American Ceramic Society on, September 30, 2019 in Portland Oregon, USA.
4	Dr. Prahlada Ramarao, FNAE, Pro Chancellor S-VYASA, Director, Centre for Energy Research and Adjunct Faculty, Dept of Management IISc and NIAS, Bengaluru has been nominated by the President of India, in his capacity as the Visitor of Indian Institute of Science (IISc), Bangalore as his nominee on the Court of the Institute as per Clause 8.1 (a) of the Scheme, Regulations and Bye-Laws of IISc Bangalore.
5	Prof Bhargab B. Bhattacharya, FNAE Professor of Computer Science & Engineering (Retd.) Indian Statistical Institute, Kolkata & Distinguished Visiting Professor Department of Computer Science & Engineering IIT Kharagpur and his research group at ISI Kolkata has recently received a recognition from the Institution of Engineers-India (IEI) and IEEE. Prof Bhargab B. Bhattacharya was conferred with the IEI-IEEE Joint Award for Engineering Excellence - 2018 for contributions to VLSI and microfluidic biochips and their bio-medical applications. Some of the relevant work was supported by INAE Chair Professorship (2016-2018). Further details may be viewed at the link <a href="https://www.ieee.org/about/awards/joint-awards-est.html#india">https://www.ieee.org/about/awards/joint-awards-est.html#india</a>
6	Prof R.P. Mohanty, FNAE Chief Consultant, SOA (Deemed to be University), Bhubaneswar, Formerly Vice-President, The Associated Cement Companies Ltd., Mumbai, Formerly Chair Professor, Dean and Advisor, ITM Group of Institutions, Navi Mumbai; Vice-Chancellor, Siksha 'O' Anusandhan University, Bhubaneswar; Former Senior Advisor, ICAFI Group, IFHE University, Hyderabad has been nominated by the National Council of Indian Institution of Industrial Engineering (IIIE), (NHQ Mumbai) as the National President for a period of 2 years (2019-2021).
7	Prof Ganti Prasada Rao, FNAE Member UNESCO-EOLSS Joint Committee, Abu Dhabi, UAE has been honoured as Distinguished Alumnus of Indian Institute of Technology Kharagpur; Notable Alumni of Jawaharlal Nehru Technological University (JNTU), Kakainada and also a Notable Alumni of Maharajah's College, Vizianagaram, all three institutions of higher learning that he attended after his schooling.
8	Dr Ravindra Gettu, FNAE, Dean, Industrial Consultancy & Sponsored Research and Prof. V.S. Raju Chair Professor, Department of Civil Engineering, Indian Institute of Technology Madras, Chennai has been elected as a Foreign Member of the Russian Academy of Engineering.
9	Prof BV Rao, FNAE Adjunct Faculty, NIAS, Bangalore; National President, IIPE and formerly Professor IIT Madras and former Pro-Chancellor & Advisor VIT University, Vellore has been conferred with Lifetime achievement Award at the Indian Technology Congress (ITC)-2019, held on September 4-5, 2019 at Bangalore. This Award was presented at the Inaugural Ceremony of the Congress on 4th Sep with a Citation.
10	Prof. Manoj Kumar Tiwari, FNAE, Department of Industrial and Systems Engineering, IIT Kharagpur has been elected as fellow of NASI Prayagraj. His NASI Fellowship will be effective from 23rd December 2019.
11	Dr. J.C. Misra, Ph.D., D.Sc., FNASc., FNAE, FIMA (UK), FITHP, FRSM (London), FIET (UK); Adjunct Professor, Indian Institute of Engineering Science and Technology, Shibpur, Howrah; Formerly, Pro Vice-Chancellor, SOA University, Bhubaneswar; Former Professor and Head, Department of Mathematics, IIT Kharagpur; Ex-President, Mathematical Sciences Section, Indian Science Congress and Recipient of INAE Outstanding Teachers Award and Ram Mohan Puraskar has been elected a Fellow of the Institution of Engineering and Technology (IET), London - a highly prestigious world-famous multidisciplinary professional engineering institution.  Dr. J.C. Misra, has also been elected as a of Fellow the Royal Society of Biology (London) on 1 April 2020 in recognition of his research contributions in Physiological Fluid Dynamics. He has been elected a Fellow of the Royal Society of Public Health in recognition of research contributions in Bioengineering/Physiological Fluid Dynamics that have promising impact on Public Health.



## News of Fellows

1.	Dr Sanak Mishra, President, INAE and Formerly Managing Director, Rourkela Steel Plant and Director, Steel Authority of India Ltd.(SAIL); Vice-President, ArcelorMittal and CEO India Projects; Secretary General, Indian Steel Association was the Guest of Honour and Chief Speaker at the Engineers Day Celebrations organized by Rourkela Steel Plant, in association with Institution of Engineers on September 15, 2019 at Civic Centre, Rourkela Steel Township. Dr Sanak Mishra was also the distinguished speaker and delivered the Dr Dara P Antia Memorial Lecture: A Discourse on the Art of Leadership Practice organized by the Indian Institute of Metals Pune Chapter and Dr Dara P Antia Memorial Lecture Committee on September 17, 2019 at College of Engineering, Pune. Dr. Dara Antia, was a recipient of the INAE “Lifetime Contribution in Engineering” Award. He was the Founding Member of the Indian Institute of Metals and a Distinguished Alumnus of Banaras Hindu University. He also had the unique distinction of being the very first Indian to receive his Sc.D. in Metallurgical Engineering from MIT USA (1943).
2.	Dr Purnendu Ghosh, Vice-President, INAE and Executive Director, Birla Institute of Scientific Research, Jaipur has authored a book titled “ <b>FLOATING IMAGES</b> ” published by Pothis Publishers. Some of his other books are: The rising sun, Neural suitcase, Ethics of the chair, Looking into the mirror, Magic of the morning sun, Biotechnology in India and Engineering of life and life technologies. A brief description of the book titled “ <b>FLOATING IMAGES</b> ” is as follows. During his journey, the author met various people. Some people/events made a mark on him. In this collection of poems, the author has interpreted his experiences about the intricacies of human nature. This book is about knowing the self, more than anything else.
3.	Dr RK Bhandari, FNAE, Formerly Director, Central Building Research Institute, Roorkee & Programme Director, UN-HABITAT, Nairobi and Formerly Chairman, Centre for Disaster Mitigation and Management, VIT, Vellore delivered the 4th Arvind Verma Memorial Lecture on August 21, 2019 at New Delhi. The topic of the lecture was “ The Urgency for Resurgence of the Culture of Geotechnical Engineering Practice in India”.
4.	Prof BS Murty, FNAE Professor, Department of Metallurgical & Materials Engineering, IIT Madras has taken over as Director of IIT Hyderabad from August 26, 2019.
5.	Mr RN Jayaraj, FNAE, Formerly Chairman & Chief Executive, Nuclear Fuel Complex, Department of Atomic Energy, Hyderabad has been chosen by Ministry of Electronics and Information Technology, Government of India for the Honorary Position of Chairman of “Research and Technology Committee” for development of Technologies for e-waste Management in the country. The Centre of Excellence for this task is being created at Hyderabad in the Campus of Centre for Materials for Electronics Technology (C-MET), Cherlapalli.
6.	Prof DN Singh, FNAE, Institute Chair Professor, Geotechnical Engineering Division, Department of Civil Engineering, Indian Institute of Technology Bombay, Mumbai was Principal Investigator of a study led by IIT Bombay which was featured in an article titled “Mineral Contents of Buldhana’s Lonar Lake Similar to Moon Rocks: IIT-Bombay Study” published in Hindustan Times, Mumbai on March 25, 2019. Prof DN Singh has requested for suggestions and comments on the article which may be viewed at the link given below <a href="https://www.hindustantimes.com/mumbai-news/mineral-contents-of-buldhana-s-lonar-lake-similar-to-moon-rocks-iit-bombay-study/story-sl9v4p3gBvp2oIorYDY77H.html">https://www.hindustantimes.com/mumbai-news/mineral-contents-of-buldhana-s-lonar-lake-similar-to-moon-rocks-iit-bombay-study/story-sl9v4p3gBvp2oIorYDY77H.html</a>

7.	Dr Debabrata Das, FNAE, Visiting Professor, Former Head and Renewable Energy Chair Professor, Department of Biotechnology and Former Professor-in-Charge P K Sinha Center for Bioenergy, Indian Institute of Technology, Kharagpur has jointly authored a book with Dr Jhansi L. Varanasi titled “Fundamentals of Biofuel Production Processes” published by CRC Press, USA in 2019. Focusing on fundamentals of biofuel production from renewable energy sources and biohydrogen production, this book offers a complete understanding of the bioconversion processes. Dr. Das also authored a book entitled “Biochemical Engineering: An Introductory Text Book” published by Jenny Stanford Publishing Pte. Ltd., Singapore. The book provides students the knowledge that will enable them to contribute in various professional fields, including bioprocess development, modelling and simulation and environmental engineering.
8.	Prof R.N. Iyengar, FNAE, Distinguished Professor, Centre for Ancient History & Culture, Jain University, Bangalore has recently authored a book on “ <b>Nārada Śilpaśāstra</b> ” published by Jain University Press.
9.	Dr. Debabrata Das, FNAE, Visiting Professor, Former Head and Renewable Energy Chair Professor, Department of Biotechnology and Former Professor-in-Charge, P K Sinha Center for Bioenergy, Indian Institute of Technology, Kharagpur and his research group have recently signed a Technology License Agreement on their Biohydrogen Production process with M/s. Dhampur Sugar Mills Ltd.
10.	<p>Prof. Sankar K. Pal, FNAE, Distinguished Scientist and Former Director, Indian Statistical Institute, Kolkata has assumed the office of Distinguished Professor Chair of Indian National Science Academy (INSA) at the Indian Statistical Institute, Kolkata on Oct 1, 2018. This Chair position is one of the highest scientific honours that INSA confers.</p> <p>Prof Sankar Pal delivered the following prestigious Keynote/Named Lectures in India and abroad in the last one year.</p> <p><b>Abroad:</b></p> <ul style="list-style-type: none"> <li>• Series of Invited talk(s) at 5th International School on Big Data (BigDat 2019), University of Cambridge, U.K., January 7-11, 2019.</li> <li>• Keynote talk at the International Conference on Information, System and Convergence Applications (ICISCA), Bangkok, Thailand, January 23-25, 2019.</li> <li>• Keynote speech at the Int. Conf. on Smart Grid Technology and Data Processing: Smart Urban and its Breakthrough in Technology and Management, Suzhou, China, Feb 28 - March 1, 2019.</li> <li>• Invited talk in the Department of Electrical and Computer Engineering, University of Illinois, Urbana-Champaign (UIUC), IL, USA on May 7, 2019.</li> <li>• Invited talk at 3rd Qingdao International Academicians Conference, Qingdao, China, May 28 to 31, 2019.</li> </ul> <p><b>India:</b></p> <ul style="list-style-type: none"> <li>• Prof. Meghnad Saha Memorial Lecture of the National Academy of Sciences, India, Jharkhand Chapter, to commemorate the 125th Birth anniversary of its founder, CSIR-NML Auditorium, Jamshedpur, October 5, 2018.</li> <li>• Prof. M. N. Saha Memorial Lecture of the National Academy of Sciences, India, Varanasi Chapter, to commemorate the 125th Birth anniversary of its founder, Banaras Hindu University, Banaras (BHU), March 29, 2019.</li> <li>• CSIR Foundation Day Lecture at the Vigyan Auditorium, CSIR Madras Complex and CSIR-Structural Engineering Research Centre, Chennai, September 27, 2019</li> </ul>

11.	<p>Dr P.A. Lakshminarayanan, FNAE, Technical Advisor, Simpson Chennai and Former Head, Engine R&amp;D, Ashok Leyland; Former Chief Technical Officer, Sampson &amp; Co. Ltd has edited his third book to be released in November 2019 at the ISEES Conference at NEERI, CSIR, Nagpur. The details of the book are given below.</p> <p>Design and Development of Heavy Duty Diesel Engines · A Handbook</p> <p>Editors: Lakshminarayanan, P. A., Agarwal, Avinash Kumar (Eds.)</p> <p>Further details of the book are available at the link given below.</p> <p><a href="https://www.springer.com/gp/book/9789811509698">https://www.springer.com/gp/book/9789811509698</a></p>
12.	<p>Prof. Manoj Kumar Tiwari, FNAE, Department of Industrial and Systems Engineering, IIT Kharagpur has been appointed as Director of NITIE (National Institute of Industrial Engineering Mumbai) by MHRD Govt of India for the period of five years. He took over the charge w.e.f. 5th November 2019.</p>
13.	<p>Mr Ajay N Deshpande, FNAE and Ex CMD/D(T) of EIL was invited to speak in Leadership Panel titled “Excellence Strategies &amp; Leadership Insights” at the India Operational Excellence Conference (IOPEX) organised by The Energy &amp; Climate Initiatives Society at New Delhi on November 18, 2019. Mr Deshpande in his talk covered the operational excellence benchmarks to be improved upon in both the project implementation as well as post-operational stages of Oil &amp; Gas projects. While process intensification, modularisation, smart 3D modelling, construction mechanisation and overall digitalisation of activities are the bench marks to be met in project implementation stage, capacity utilisation energy numbers, operational availability, volumetric expansion in production with GHG footprint are the bench marks in plant operations. The talk was met with an enthusiastic response in Q&amp;A session by the audience.</p>
14.	<p>Prof Bikramjit Basu, FNAE, Professor, Materials Research Centre, Indian Institute of Science, Bangalore has been informed by the International Union of Societies for Biomaterials Science and Engineering (IUSBSE) that his nomination to receive the accolade of Fellow Biomaterials Science and Engineering (FBSE) has been approved. The presentation of the Fellowship which will occur in 2020 at the 12<sup>th</sup> World Biomaterials Congress to be held in Glasgow, United Kingdom.</p> <p>Prof Bikramjit Basu has also been elected as Fellow of the Indian Academy of Sciences, Bangalore during 2019 (effective 2020).</p>
15.	<p>Prof SN Mukhopadhyay, FNAE Ex-Adjunct Professor, Birla Institute of Technology &amp; Science, Pilani has authored a book on “Fundamentals of Waste and Environmental Engineering” published by TERI Press, New Delhi.</p>
16.	<p>Mr Ajay N Deshpande, FNAE, ex CMD/Director (Technical) of EIL, was invited to Manipal University-Jaipur to deliver a talk on the National Science Day by the School of Chemical &amp; Civil Engineering. In his talk titled “Technology / Engineering / Manufacturing Challenges in Hydrocarbon Sector”, Mr Deshpande covered the opportunities available for graduating students within the state of Rajasthan due to investments in upstream oil and gas exploration/ production activity, as also in downstream refining and petrochemicals segment. Choice of a career whether in a Technology driven EPC or an Operation company, offers ample challenges for technology innovation, design indigenisation, localised manufacturing and providing value add-services, which he emphasised citing examples in each area. The talk was followed with an engaged discussion on utilizing of these opportunities.</p>



17.	Mr AN Desphande, FNAE, ex CMD/Director (Technical) of EIL, was invited to chair a session and also speak as member of a panel discussion at a workshop titled - “Changing Energy Paradigm” organised by the Lovraj Kumar Memorial Trust (LKMT) at the India International Centre, New Delhi. While the session he chaired was about the importance of Biofuels and technologies available for their commercialisation to target the Government of India sponsored JIVAN scheme, during the panel discussion he spoke on the imperatives and options for Petroleum Refining industry to integrate Petrochemicals production for enhancing the value generation per barrel crude processed and also to combat the challenge posed to transport fuels by EVs and the expanding gas market. The sessions were vibrant with audience’s active participation in Q&A session.
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### *News of INAE Young Associates*

1	Dr Koteswararao V. Rajulapati, Associate Professor, School of Engineering Sciences and Technology, University of Hyderabad, Hyderabad was elected in March 2019 as “Fellow of Telangana Academy of Sciences (FTAS)” in recognition of his contributions to Science & Technology. He is currently in the grade of Professor at University of Hyderabad.
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## ***Fellows Deceased in Last one Year***

During the year 2019-20, it was learnt about the sad demise of the following INAE Fellows. Deepest condolences have been expressed to the families of the deceased Fellows on behalf of INAE and prayers were offered for their souls to rest in peace. Brief Obituaries as a mark of respect for the departed INAE Fellows are given below.

### **Obituaries**

#### **Dr Tuhin Kumar Roy**

Dr Tuhin Kumar Roy, FNAE born on August 1, 1923 passed away on August 4, 2019.

Dr Tuhin Kumar Roy, FNAE Chairman, CMD Design Pvt. Co. Ltd., New Delhi and Formerly Professor and Head, Chemical Engineering Department, Jadavpur University, Kolkata had made outstanding research contributions in the field of Chemical Engineering, covering the areas of Hydrometallurgy and Fluidization. His proactive efforts in the transfer of indigenously developed technologies to commercial scale, for utilization in Chemical Manufacturing Plants in India, are well recognized. As an inventor, he developed novel technologies and processes for recovery of nickel and cobalt from ore leach solutions for commercialization. He held several patents in India and USA in the fields of hydrometallurgy and chemical processes and published many research papers on reactions in fluidized bed, selective precipitation of metal powders and metallic sulphides and oxidative leaching of minerals. He had guided project work on coal processing plants including low temperature carbonization, formed coke and coal beneficiation. He had served as President of the Indian Institute of Chemical Engineers and the National Association of Consulting Engineers. In 2007, he was conferred with the Indian Institute of Chemical Engineers Diamond Award. Dr TK Roy had also contributed significantly to the activities and programmes of INAE and served as Honorary Treasurer from 1993 to 1995.

May God Bless his soul to Rest in Peace

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#### **Col BK Rai (Retd)**

Col BK Rai, FNAE born on November 21, 1926 passed away on August 19, 2019.

Col BK Rai, FNAE, Formerly Chairman, UPTRON Group, HCL Ltd had made outstanding contributions in the growth of the Electronics Industry. His role in building up UPTRON from scratch into a highly diversified and profitable venture is well recognized. The major areas of activity of UPTRON are: Computer and microprocessor-based systems; Computer communications; Radio and line communication systems; Office Automation; Mining control and communications; Process control and instrumentation; ground water electronic data logging; online computerised seat reservation systems for Air India and Indian Airlines; electrolytic capacitors; energy optimization systems and Black & White and colour picture tubes and low-cost Television and radios. Previously, he had held important positions in Air Headquarters and later joined the private sector. He also contributed towards identification of technologies for development of high technology products, of national importance, in industrially backward areas. He has trained senior personnel in technology and industrial management and helped nurture entrepreneurship in the Electronics field in remote areas.

May God Bless his soul to Rest in Peace

#### **Prof AS Arya**

Prof AS Arya, FNAE born on June 16, 1931 passed away on September 1, 2019.

Prof AS Arya, FNAE, Member, State Disaster Management Authority, Govt. of India and Formerly Seismic Capacity Building Advisor, Ministry of Home Affairs, Govt. of India-UNDP DRM Programme and Professor Emeritus, IIT Roorkee has made significant contributions in the field of Earthquake Engineering including formulation of the Codes of Practice and guidelines for earthquake resistant design and construction of buildings. He played a key role in developing indigenous expertise relating to earthquake disaster prevention and mitigation for structures ranging

from multi-storeyed buildings, dams, nuclear power plants and petrochemical plants etc. He was instrumental in developing several courses in structural and earthquake engineering based on state-of-art in the subjects covering frontier areas of research. His innovative approach in developing laboratories for research were acclaimed and contributed significantly to conduct of experimental studies related to dynamic behaviour of masonry buildings and structures. All his life, he worked with zeal on implementation of seismic safety measures and was responsible for preparation of Vulnerability Atlas of India and Techno-legal Regime for Natural Disaster Reduction by Chairing of an Expert Group and helped create national awareness of disaster risk and safety practices and policies. Prof AS Arya was conferred with the Padma Shri Award by President of India and received the INAE Lifetime Contribution Award in Engineering in 2002.

May God Bless his soul to Rest in Peace

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### **Prof Tarun K Ghose**

Prof Tarun K Ghose, FNAE born on September 1, 1924 passed away on September 24, 2019.

Prof Tarun K Ghose, Founding Chair, Biochemical Engineering and Biotechnology, IIT Delhi was a pioneer in introducing biochemical engineering education and research in the country. He had made outstanding research contributions in the areas of Biotechnology and Biochemical Engineering including elucidation of the mode of formation of cellulase enzyme complex. He was recognized worldwide for his research work in the nineteen sixties on elucidation of the mode of formation and action of cellulase enzyme complex and its action on rapid saccharification of cellulose. This led to the development of what is known as “membrane reactor” for simultaneous reaction and separation of products of cellulose saccharification. His significant research contributions also covered areas of modelling, analysis and development of several optimal systems including strategy on dynamic control on rapid release of enzyme; analysis of immobilized cell bioreactor- a pioneering concept; rapid conversion of cellulose to ethanol and its separation by a non-distillative route and development of a biphasic biomethanation process. Prof TK Ghose initiated the Department of food technology and biochemical engineering at Jadavpur University, H.B. Technological Institute, Kanpur, and Biochemical Engineering Research Centre at IIT Delhi. He was conferred with the INAE Life Time Contribution Award in Engineering in the year 2017.

May God Bless his soul to Rest in Peace

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### **Dr. VR Kanetkar**

Dr VR Kanetkar, FNAE born on March 7, 1954 passed away on September 30, 2019.

Dr VR Kanetkar, Consultant- Technical Services, Autometers Alliance Ltd, Noida and formerly Assistant Vice-President, Corporate R&D, ABB Limited, Vadodara and Vice-President, Autometers Alliance Ltd had made significant research contributions in the areas of Power Electronics. He has several power electronic products and systems to his credit as a designer and most of these are from concept to commissioning including thyristorized DC drives, series parallel slip power recovery system, thyristorized reactive power compensators, semiconductor fuseless design for thyristor converters, medium voltage thyristor converters, Elevator drive and insulated-gate bipolar transistor (IGBT) converter based Dynamic reactive power compensators. At ABB, Dr Kanetkar's responsibilities included development of electronic and power electronics products and systems necessary for Indian environment and customers. He provided support to the business areas on drives, traction, networks, automation, communication and relays in terms of analysis, simulation, guidelines for specific requirements, site problem solving, technical evaluations and studies and negotiations for orders. He contributed in major power electronics R&D work and implemented international standards for the functioning units of ABB. Dr VR Kanetkar translated his vast experience to Indian industries, Universities and Professional organizations.

May God Bless his soul to Rest in Peace

## Technical Contributions by INAE Fellows

### 1. Summary of book authored by Prof R.N. Iyengar, FNAE on “Nārada Śilpaśāstra”

Prof R.N. Iyengar, FNAE, Distinguished Professor, Centre for Ancient History & Culture, Jain University, Bangalore has recently authored a book on “Nārada Śilpaśāstra” published by Jain University Press. A brief summary of the book is given below.

#### Nārada Śilpaśāstra

[Sanskrit Text on Architectural Civil Engineering]

R.N. Iyengar, (helped by K.S.Kannan & S.Y.Wakankar)

Jain University Press, 2018, Rs.300/- (ISBN 978-93-85327-58-2)

India has a rich and ancient tradition of building cities, monuments, towers, dams, bridges, reservoirs, step-wells and other civic infrastructure besides beautiful temples and palaces. Some of the present-day highways are aligned on ancient tracts that were first laid several centuries ago. There are several ancient Sanskrit texts known as either Vāstuśāstra or Śilpaśāstra that describe some aspects of residential buildings, temples and other structures. The present text, attributed to the authorship of Nārada, the legendary sage and polymath, is a Vāstuśāstra text, although traditionally the manuscripts are titled Nārada Śilpaśāstra. This text, in terse technical Sanskrit prose describes site selection, planning of villages and cities, construction of roads, dams, lakes, foundation, basement, building typology, importance rating, super structure of private and public buildings including marriage halls, art galleries, theatres and temples. Internal evidences point out that in its present form, this text originated at a time when weekdays were not in vogue, but acquired additional material at a later period and fixed in South India around 6th century CE. Prof. R.N. Iyengar, himself a renowned Civil Engineer, helped by two Sanskrit scholars, has for the first time brought out this unique Sanskrit text on the theory and practice of Architectural Civil Engineering in ancient India with Introduction, translation, notes and figures.

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Excerpts from the Foreword of Prof. Michel Danino (Member, ICHR)

“.....The efforts... bound to elicit much scholarly interest in India and abroad. This critical edition, based on three manuscripts, comes with a careful editorial apparatus, which includes

... Prof. Iyengar’s meticulous discussion of the date and provenance of the text, which he attributes to the sixth century CE at the latest and to south India respectively, is in my view conclusive; it also shows the breadth of his scholarship in the technical literature in Sanskrit...it is certain that from the angle of sustainability at least, if not also aesthetics, our “modern” concepts or urbanism and architecture would benefit from an open-minded scrutiny of texts... such as the one Prof. Iyengar and his collaborators have now put in our hands....”

[ju.publications@jainuniversity.ac.in](mailto:ju.publications@jainuniversity.ac.in)

### 2. Summary of Technology License Agreement on Biohydrogen Production Process signed by Dr. Debabrata Das, FNAE & his research group at IIT Kharagpur with M/s. Dhampur Sugar Mills Ltd.

#### Technology License Agreement on Biohydrogen Production Process

Indian Institute of Technology (IIT) Kharagpur has pioneered the promising Research and Development of biohydrogen production process by applying fermentation technology and actively involved in this research work for a period of last more than twenty years. The commendable contributions towards development of a commercially competitive and environmentally benign bioprocess began with the isolation and characterization of high-yielding hydrogen producing bacterial strain *Enterobacter cloacae* IIT-BT 08, which is known to be the highest producer of hydrogen by fermentation. They successfully demonstrated 10 m<sup>3</sup> Pilot Plant studies for the commercial exploitation



of the process using cane molasses, rice mill wastes, distillery effluent, sewage sludge, etc. sponsored by MNRE, Government of India. The aim was to synchronize the bioremediation of wastewater with clean energy generation. IIT Kharagpur and M/s. Dhampur Sugar Mills. Ltd., Dhampur, UP signed a Technology License Agreement on 3<sup>rd</sup> May, 2019 on the development of Biohydrogen Production Process in the commercial scale. They have published 6 books and more than 150 publication in the peer reviewed journals on the different bioenergy generation processes. International Association of Hydrogen Energy conferred Akira Mitsui award to Prof. Debabrata Das, FNAE, Group leader for his contribution in hydrogen research at WHEC 2008 at Brisbane.



*10 m<sup>3</sup> Biohydrogen Pilot Plant at IIT Kharagpur*



*Mr. Vijay Goel, President, M/s. Ms. Dhampur Sugar Mills Ltd., India, Prof. Debabrata Das, Inventor and Prof. Pallab Dasgupta, Dean, SRIC, IIT Kharagpur at the Technology Licence Agreement Ceremony on “Biohydrogen production from the distillery effluent” at IIT Kharagpur.*

## INAE Annual Convention

The INAE Annual Convention 2019, hosted by Birla Institute of Scientific Research (BISR), Jaipur, from December 12 -14, 2019 and coordinated by Dr Purnendu Ghosh, Vice – President, INAE and Executive Director, BISR, Jaipur was held at BISR, Jaipur. All INAE Fellows and Young Associates had been invited to participate in the Annual Convention 2019. The Convention commenced with the INAE Governing Council Meeting on December 12, 2019 followed by the Award Lectures by the winners of Life Time Contribution Award in Engineering 2019 viz Prof EC Subbarao and Mr AS Kiran Kumar; Prof Jai Krishna Memorial Awardee - Prof KT Jacob; Prof SN Mitra Memorial Awardee- Prof RK Shevgaonkar and the INAE Outstanding Teacher Awardee- Prof BS Murty. After the Award Lectures, the INAE Fellows Dinner was held which provided an excellent opportunity for networking of Fellows.

The Inaugural Session of the INAE Annual Convention 2019 was held on December 13, 2019, which commenced with the lighting of the lamp by the dignitaries on the dais, followed by wonderful rendition of a melodious invocation by the BISR team. The Welcome Address was delivered by Dr Purnendu Ghosh, Vice – President, INAE and Executive Director, Birla Institute of Scientific Research, Jaipur. Dr Sanak Mishra, President, Indian National Academy of Engineering (INAE) in his Presidential Address, gave an overview of the Academy and the major activities of the last one year. The highlight of the event was the inspiring talk delivered by the Chief Guest – Mr SK Roongta, Chairman, BALCO to the august audience. The book “Mind of an Engineer Volume II” edited by Dr Purnendu Ghosh released during the Inaugural Session is the second volume of a series of books featuring articles by INAE Fellows about the reminiscences, inspirations, challenges and opportunities in their professional journeys. The next feature of the Inaugural Session was the release of the Report on “Urban Transportation: Challenges and Way Forward” edited by Prof Prem Krishna, former Vice-President, INAE and Chairman, INAE Forum on Civil Infrastructure. The report comprises of an analysis of the challenges faced in the modernization of Urban Transportation and suggests solutions to overcome the same. This was followed by the Special Induction Ceremony of INAE Fellows from Industry wherein two stalwarts of industry viz. Mr SS Mohanty, Vice- Chairman cum Managing Director, Neelachal Ispat Nigam Limited and Dr Ramachandra Naidu Galla, Founder & Chairman, Amara Raja Group were inducted as Fellows of INAE. The Inaugural Session concluded with the proposing of the vote of thanks by Prof Indranil Manna, Vice-President, INAE.



*Release of book “Mind of an Engineer Volume II”*





*Release of Report on “Urban Transportation: Challenges and Way Forward”*

Three Plenary Talks were delivered during the Annual Convention by eminent personalities as per details below.

- First Plenary Talk on “Hydraulic Design of Water Resources Structures- Role of Model Studies” by Dr. (Ms.) Varsha V. Bhosekar, Director, Central Water and Power Research Station, Pune on December 13, 2019
- Second Plenary Talk on “Disruptive Innovations in Iron & Steel Industry” by Mr. Manoranjan Ram, Associate Vice-President, SMS Group, Paul Wurth India Pvt Ltd., Gurgaon on December 13, 2019.
- Third Plenary Talk on ‘Ecologically Yours: Tagore’s Empathy with Environment’ by Ms Pramita Mallick, renowned vocalist and exponent of “Rabindra Sangeet” (the music of Tagore) on December 14, 2019

Technical Sessions were held on December 13, 2019 in which newly elected Fellows (whose Fellowship is effective from November 1, 2019) and INAE Young Engineer Awardees 2019 made presentations relating to their own significant engineering contributions.

The Grand Award Function was held on the evening of December 13, 2019, wherein Prof EC Subbarao and Mr AS Kiran Kumar were conferred the Life Time Contribution Award in Engineering 2019. Prof KT Jacob and Prof RK Shevgaonkar were conferred the Prof Jai Krishna Memorial Award and Prof SN Mitra Memorial Award 2019 respectively and Prof BS Murty was conferred the INAE Outstanding Teacher Award 2019. The awardees for INAE Young Entrepreneur Award 2019 were Mr. Suteerth Tripathi and Ms. Shivani Gupta, Inochi Care Private Limited, New Delhi and Mr. Prakhar Jain and Mr. Usama Ahmed Abbasi, MicroX Labs Pvt Ltd. Fifteen Young Engineer Awards 2019 were conferred to brilliant engineers below 35 year of age. The Innovative Student Project Awardees 2019 comprised of ten awards at Doctoral level; five at Master’s Level and ten at Bachelors Level who were presented for innovation in their project/thesis work. The Innovative Student Project Awardees 2019 and the team leaders of the INAE Youth Conclave 2019 competition award winning teams were also inducted as INAE Student Members during the Grand Award function. After the vote of thanks proposed by Dr Pradip, Vice- President, INAE a Cultural Programme was organized prior to the Dinner. The artists enthralled the audience with their entertaining performance.





*Prof EC Subbarao being conferred with the Life Time Contribution Award in Engineering 2019*



*Mr AS Kiran Kumar being conferred with the Life Time Contribution Award in Engineering 2019*





*Prof KT Jacob being conferred the Prof Jai Krishna Memorial Award 2019*



*Prof RK Shevgaonkar being conferred the Prof SN Mitra Memorial Award 2019*





*Prof BS Murty being conferred the INAE Outstanding Teachers Award 2019*



*Dr Poulami Chakraborty being conferred the INAE Young Engineer Award 2019*





*Mr Suteerth Tripathi & Ms Shivani Gupta being conferred the INAE Young Entrepreneur Award 2019*



*Dr Gaurav Goswami being conferred the Innovative Student Project Award 2019*



The session on lectures by the INAE Young Entrepreneur Awardees 2019 was held in the morning of December 14, 2019 wherein Mr Sutheerth Tripathi delivered a lecture on “High performance multi-functional wound healing technology” and Mr Usama Ahmed Abbasi delivered a lecture on “Portable, efficient and affordable blood cell counter”.

The Annual General Meeting of Fellows was held on December 14, 2019 wherein during the Induction Ceremony, the newly elected Fellows and Young Associates were formally admitted into the Academy by the President, INAE. The was followed by the Special General Meeting of Fellows and the event concluded with lunch. A scenic tour of historical places, in and around Jaipur, was organized for the interested Fellows and Young Associates on December 15, 2019.



*Group Photo with Newly Elected Fellows*



*Group Photo with INAE Young Associates*



## *Publications of the Academy*

### **Mind of an Engineer Volume II**

The book – The Mind of an Engineer Volume 1, an initiative of the INAE published in the year 2016 is a reflection of the experiences of some of the Fellows of the INAE in the field of science, technology and engineering. The book is about the reminiscences, eureka moments, inspirations, challenges and opportunities in the journey the professionals took toward self-realization and the goals they achieved. “The Mind of an Engineer: Volume 2” has been brought out by Indian National Academy of Engineering (INAE) recently, which is the second book of the series of a unique initiative undertaken by the Academy, to publish somewhat autobiographical articles by INAE Fellows on the subtle nuances in their personal and professional experiences that have helped shape their minds as eminent engineering professionals. Dr Purnendu Ghosh, Vice-President, INAE is the editor of “The Mind of an Engineer: Volume 2” which was released during the INAE Annual Convention held at Jaipur in December 2019.

### **INAE Journal - Transactions of Indian National Academy of Engineering- An International Journal of Engineering and Technology**

The title of the INAE Letters Journal has been changed to “Transactions of Indian National Academy of Engineering- An International Journal of Engineering and Technology” to make it a full- fledged journal to include full Research Papers and Review Articles, besides short communications w.e.f January 2020. Prof. K. Bhanu Sankara Rao FNAE, is the Editor-in-Chief and being published in co-operation with Springer Nature. The Editorial Board of Transactions of Indian National Academy of Engineering” has also since been re-constituted to include one Fellow from each of the Engineering Sections as an Editor, and few Young Associates as Associate Editors. Necessary changes have been made on the website of M/s Springer, which also contains the revised guidelines for submission of papers by authors. A link has also been provided on INAE website in the publication section, to access the website of M/s Springer for submission of papers by authors online. Provision for free online access of research papers published in the Transactions of Indian National Academy of Engineering has also been made through the login facility of INAE Fellows.



# Statement of Accounts 2019-20



*Indian National Academy of Engineering*







**JAIN PRAMOD JAIN & CO.**  
CHARTERED ACCOUNTANTS

Phone: 41401901  
Email: jainpjco@gmail.com  
F-591, Sarita Vihar,  
New Delhi - 110076

**THE MEMBERS**  
**INDIAN NATIONAL ACADEMY OF ENGINEERING**  
**NEW DELHI-110016**

## **AUDITORS' REPORT**

We report that we have audited the Balance Sheet of **INDIAN NATIONAL ACADEMY OF ENGINEERING** as at March 31<sup>st</sup> 2020 and also the Income and Expenditure Account for the year ended on that day annexed thereto. These Financial statements are the responsibility of the Academy's Management. Our responsibility is to express an opinion on these financial statements based on our Audit.

We conducted our Audit in accordance with auditing standards generally accepted in India. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether the financial statements are free of material misstatement. An Audit includes examining, on a test basis, evidence supporting the amounts and disclosures in the financial statements. An Audit also includes assessing the accounting principles used and significant estimates made by the management, as well as evaluating the overall financial statement presentation. We believe that our Audit provides a reasonable basis for our opinion.

We report that;

- i. We have obtained all that information and explanations which to the best of our knowledge and belief were necessary for the purpose of our audit.
- ii. In our opinion, proper books of account as required by the law have been kept by the Academy so far as appears from our examination of those books.
- iii. The Balance Sheet and the Income and Expenditure Account dealt with by this report are in agreement with the books of account.
- iv. In our opinion, the Balance Sheet and Income and expenditures Account dealt with by this report comply with the accounting standards.
- v. In our opinion and to the best of our information and according to the explanations given to us the said accounts, read with accounting policies and Notes to Accounts thereon, give a true and fair view in conformity with accounting principles generally accepted in India:
  - a. In the case of Balance sheet, of the state of affairs of the Academy as at March 31, 2020 and
  - b. In the case of Income and Expenditure Account, of the surplus of Income over Expenditure of the Academy for the year ended on March 31<sup>st</sup> 2020.

Place: New Delhi  
Date: 14.07.2020

For **Jain Pramod Jain & Co.**  
Chartered Accountants  
(Firm Registration No. 016746 N)



*P.K. Jain*

(P.K.JAIN)  
Partner

Membership No. 010479  
UDIN: 20010479AAAABN1739

## BALANCE SHEET AS AT 31ST MARCH, 2020

(AMOUNT IN RS.)

	SCHEDULE	CURRENT YEAR 2019-20	PREVIOUS YEAR 2018-19
<b>CORPUS/CAPITAL FUND AND LIABILITIES</b>			
CORPUS/ GENERAL FUND	1	10,99,14,706	11,75,46,299
RESERVE AND SURPLUS	2	-	-
EARMARKED/ ENDOWMENT FUNDS	3	24,76,778	24,04,639
SECURED LOANS AND BORROWINGS	4	-	-
UNSECURED LOANS AND BORROWINGS	5	-	-
DEFERRED CREDIT LIABILITIES	6	-	-
CURRENT LIABILITIES AND PROVISIONS	7	4,05,53,372	3,13,30,440
<b>TOTAL</b>		<b>15,29,44,856</b>	<b>15,12,81,378</b>
<b>ASSETS</b>			
FIXED ASSETS	8	2,51,59,703	2,80,43,474
INVESTMENTS - FROM EARMARKED/ENDOWMENT FUNDS	9	-	-
INVESTMENTS - OTHERS	10	8,45,00,000	9,45,00,000
CURRENT ASSETS, LOANS, ADVANCES ETC.	11	4,32,85,153	2,87,37,904
MISCELLANEOUS EXPENDITURE( TO THE EXTENT NOT WRITTEN OFF OR ADJUSTED)		-	-
<b>TOTAL</b>		<b>15,29,44,856</b>	<b>15,12,81,378</b>
SIGNIFICANT ACCOUNTING POLICIES	24		
CONTINGENT LAIBILITIES AND NOTICES ON ACCOUNTS	25		

AS PER OUR REPORT OF EVEN DATE  
FOR JAIN PRAMOD JAIN & CO.  
CHARTERED ACCOUNTANTS

(FIRM REG. NO. - 016746N)



P.K. JAIN  
PARTNER  
(MEMBERSHIP NO. 010479)

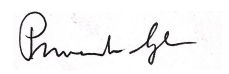
PLACE: NEW DELHI  
DATED: 14.07.2020





MANAGER (F & A)

ON BEHALF OF THE COUNCIL:

PRESIDENT : 

VICE-PRESIDENT   
(FINANCE & ESTABLISHMENT)

Lt. Col Shobhit Rai (RETD)   
DEPUTY EXECUTIVE DIRECTOR.....



# INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31ST MARCH 2020

(AMOUNT IN RS.)

INCOME	SCHEDULE	CURRENT YEAR 2019-20	PREVIOUS YEAR 2018-19
INCOME FROM SALES/SERVICES	12	-	-
GRANTS / SUBSIDIES	13	8,21,24,580	8,13,93,269
FEES/ SUBSCRIPTIONS	14	65,000	-
INCOME FROM INVESTMENTS	15	30,78,625	36,11,926
INCOME FROM ROYALTY, PUBLICATION ETC.	16	7,416	-
INTEREST EARNED	17	40,76,500	48,40,178
OTHER INCOME	18	2,221	7,54,573
WITHDRAWAL FROM CORPUS FUND (REFERENCE SCHEDULE-1)		1,16,03,895	-
INCREASE/(DECREASE) IN STOCK OF FINISHED GOODS AND WORK-IN-PROGRESS	19	-	-
<b>TOTAL (A)</b>		<b>10,09,58,237</b>	<b>9,05,99,946</b>
<b>EXPENDITURE</b>			
ESTABLISHMENT EXPENSES	20	2,59,59,924	1,30,27,836
OTHER ADMINISTRATIVE EXPENSES ETC.	21	48,22,369	42,83,799
EXPENDITURE ON ENGINEERING PROGRAMES AND ACTIVITIES	21-A		
I) SEMINARS / CONFERENCES / SYMPOSIUMS / WORKSHOPS		52,13,268	70,22,158
II) INAE CHAIR , DISTINGUISHED PROFESSORS & MENTORING SCHEMES		27,11,719	52,17,924
III) RESEARCH STUDIES/ PROJECTS		17,53,852	14,02,050
IV) INAE AWARDS		49,08,299	41,22,326
V) ACADEMIA-INDUSTRY INTERACTION AICTE-INAE SCHEMES		85,71,700	61,35,253
VI) INAE FORUMS		3,91,658	3,73,320
VII) ACADEMY MEETINGS		35,13,365	39,96,745
VIII) ANNUAL CONVENTION		36,72,322	25,21,541
IX) INTERNATIONAL AFFAIRS		15,36,304	43,04,972
X) INAE PUBLICATIONS		15,51,779	16,81,255
XI) FINANCIAL ASSISTANCE FOR ENGINEERING ACTIVITIES		5,00,000	-
XII) SERB-INAE ABDUL KALAM TECHNOLOGY INNOVATION NATIONAL FELLOWSHIP		2,74,01,615	2,57,39,686
XIII) INAE DIGITAL RESEARCH CENTRE REPOSITORY		84,134	3,52,644
EXPENDITURE ON GRANTS, SUBSIDIES ETC.	22	-	-
INTEREST	23	2,26,913	-
DEPRECIATION (NET TOTAL AT THE YEAR END - CORRESPONDING TO SCHEDULE 8)		28,83,771	32,21,269
<b>TOTAL (B)</b>		<b>9,57,02,992</b>	<b>8,34,02,778</b>
BALANCE BEING EXCESS OF INCOME OVER EXPENDITURE (A-B)		52,55,245	71,97,168
TRANSFER TO DKRC DEVELOPMENT FUND		72,139	3,59,687
TRANSFER TO CORPUS FUND		30,06,486	32,52,239
TRANSFER TO FIXED ASSETS (GRANT UTILISED FOR CAPITAL ASSETS)		12,10,804	18,99,183
BALANCE BEING SURPLUS / (DEFICIT) CARRIED TO GENERAL FUND		9,65,816	16,86,059
SIGNIFICANT ACCOUNTING POLICIES	24		
CONTINGENT LIABILITIES AND NOTES ON ACCOUNTS	25		

AS PER OUR REPORT OF EVEN DATE

ON BEHALF OF THE COUNCIL:

FOR JAIN PRAMOD JAIN & CO.  
CHARTERED ACCOUNTANTS  
(FIRM REG. NO. - 016746N)

*P.K. Jain*

P.K. JAIN  
PARTNER  
(MEMBERSHIP NO. 010479)  
PLACE: NEW DELHI  
DATED: 14.07.2020



MANAGER (F & A) *[Signature]*

PRESIDENT : *[Signature]*

VICE-PRESIDENT *[Signature]*  
(FINANCE & ESTABLISHMENT)

Lt. Col Shobhit Rai (RETD)  
DEPUTY EXECUTIVE DIRECTOR : *[Signature]*



## INDIAN NATIONAL ACADEMY OF ENGINEERING

### SCHEDULE- 24

#### ACCOUNTING POLICIES

##### 1. Basis of Accounting

These accounts are prepared on the basis of historical cost convention and on the accrual method of accounting.

##### 2. Grant-in-aid

Grant received from the Department of Science & Technology and others are accounted to the extent utilized and unspent grant has been shown under current liabilities. Grants relating to fixed assets have been shown under Income and Expenditure Account and its utilization has been transferred to fixed assets under section 11(I) of The Income Tax Act, 1961.

##### 3. Fixed Assets

Fixed Assets are stated at cost of acquisition including inward freight, duties and taxes and direct expenses related to acquisition.

##### 4. Depredation on Furniture and Office Equipments

Fixed Assets are depreciated on written down value method of depreciation as per following rate prescribed in Income Tax Rules

Building	-	10%	Office Furniture	-	10%
Office Equipments	-	15%	Computers	-	40%

However no depreciation has been provided on assets purchased from 01.04.2017 and applied u/s 11 (1) of The Income Tax Act 1961. and in fixed assets schedule it has been shown as utilization under section 11 (1) of Income Tax Act 1961.

##### 5. Interest on Investments

There are two types of Investments, one against Corpus and General Fund and the other against Earmarked Funds interest on which have been included in Income and Expenditure account and transferred to respective fund.

##### 6. Gratuity & Leave Encashment

Provision for Gratuity is made as per the payment of Gratuity Act, 1972 and provision for accumulated leave and encashment has been made on the basis of no. of days of leave accumulated for employee. Actuarial valuation is not made to ascertain such liability.



## SCHEDULE -25

### CONTINGENT LIABILITIES AND NOTES ON ACCOUNTS

1. Contingent Liabilities claims against the entity not acknowledged as debts Rs. NIL (Previous year Rs. NIL)
2. Balance Sheet and Income and Expenditure account from the current year has been prepared as per uniform format of accounts for Central Autonomous Bodies prescribed by the committee of expert constituted with the approval of Hon'ble Finance Minister.
3. Interest Income of Rs. 2,33,788/- surrendered to DST for the year 2018-19 has been debited to Unspent DST Grant by transfer of funds to Consolidated fund of India through Bharat Kosh.
4. Figures in Balance Sheet and Income and Expenditure Account have been given as applicable to INAE as per uniform format except Expenditure on Engineering programme and activities have been included in Income and Expenditure Account.
5. During the year ended March 31, 2020 a sum of Rs.18,27,000/- has been received from DST as Grant-in- aid towards capital asset creation. Out of the said grant a sum of Rs. 12,10,804/- has been utilized towards procurement of Fixed Assets and there is a balance amount of Rs.6,16,196/- at the end of financial year 2019-20 which is carried forward to financial year 2020-21 along with interest Rs.28,264/- .
6. The balance of security deposits and advances are subject to confirmation/reconciliation.
7. INAE corpus fund was created in the financial year 2015-16 as approved in governing council meeting held on December 09, 2015 by transfer of Rs. 3,62,00,000/- from the balance available in the general fund as on April 01, 2015 and surplus Rs. 45,00,000/- of financial 2015-16. Interest on corpus fund investment has also been credited to such fund.
8. During the Governing Council meeting held on June 13, 2019, it was informed that the implementation of the Recommendations of the 7th Central Pay Commission for INAE employees applicable from January 01, 2016 is pending due to the fact that the relevant letter from DST has not yet been received till date. The matter is being pursued earnestly by INAE with DST.

Under the circumstances , the Governing Council considered and approved the following as a temporary interim measure:

- I. The arrears that will arise as dues to INAE employees (contingent upon implementation of the Recommendations of the 7th Central Pay Commission) from Jan 1, 2016 to 31<sup>st</sup> May 2019 may be paid to the employees now by drawing from the INAE Corpus Fund.
- II. As and when letter for implementation of the Recommendations of 7th Central Pay Commission is issued by DST, the amount drawn from the INAE Corpus Fund will be recouped.
- III. The additional monthly recurring expenditure on account of revision of salaries of INAE employees may be drawn from
  - a. the interest accruing on the Corpus Fund and,
  - b. administrative expenditure granted to INAE for administering the Abdul Kalam Technology Innovation National Fellowship and AICTE Schemes






Accordingly, an amount of Rs. 1,16,03,895/- has been withdrawn towards payment of Interim Relief as arrears (contingent upon implementation of the Recommendations of the 7<sup>th</sup> Central Pay Commission) from Jan 1, 2016 to May 31, 2019 amounting Rs.90,97,616/- and interim relief as additional monthly recurring expenditure amounting Rs. 25,06,279/- (against the total additional monthly recurring expenditure of Rs. 42,00,170/- after charging off Rs. 10,00,000/- as manpower grant from SERB under Abdul Kalam TIN Fellowship and Rs.6,93,891/- as Secretarial Assistance grant from AICTE.)

INAE has applied to Department of Science and Technology (DST) for sanction of Grant of Rs. 1,16,03,895/- for implementation of 7th CPC and pending release of this grant, the sum of Rs. 1,16,03,895/- has been drawn from INAE Corpus Fund and the same will be recouped on receipt of the above grant from DST.

9. Investment (others)- Term Deposit aggregating to Rs.8,45,00,000/- with SBI taken out of corpus fund and others have been included in investment others.
10. Utilization certificates are being received from Research Scholars on term year end basis in place of financial year end basis, in respect of the expenditure of Rs. 2,74,01,615/- on SERB INAE Abdul Kalam Technology Innovation National Fellowship.
11. Figures are rounded off to Rupees.

For Jain Pramod Jain & Co.  
Chartered Accountants  
(FRN 016746 N)

On behalf of the Council:

*P.K. Jain*

(P.K.Jain)  
Partner  
Membership No. 010479



President.....*Manan Thakur*

Vice-President.....*Pramod Jain*  
(Finance & Establishment)

Lt. Col Shobhit Rai (RETD)  
Deputy Executive Director.....*Shobhit Rai*

Place: New Delhi  
Date.: 14 Jul 2020

Manager (F&A).....*Shobhit Rai*



## RECEIPT AND PAYMENT ACCOUNT FOR THE YEAR ENDED 31ST MARCH 2020

RECEIPT		(AMOUNT IN RS.) 2019-20	PAYMENTS		(AMOUNT IN RS.) 2019-20
<b>I.</b>	<b>OPENING BALANCES</b>		<b>I.</b>	<b>EXPENSES</b>	
	A) CASH IN HAND	3,056		A) ESTABLISHMENT EXPENSES SH 20 AS ADJUSTED	2,38,37,151
	B) BANK BALANCES			B) ADMINISTRATION EXPENSES SH 21 AS ADJUSTED	47,93,581
	I) IN CURRENT ACCOUNTS	5,58,085			
	II) IN DEPOSIT ACCOUNTS	9,45,00,000			
	III) SAVINGS ACCOUNTS	2,12,63,376			
<b>II.</b>	<b>GRANTS RECEIVED</b>		<b>II.</b>	<b>PAYMENTS MADE AGAINST FUNDS FOR VARIOUS PROJECTS</b>	
	A) FROM GOVERNMENT OF INDIA			ENGINEERING PROGRAMMES & ACTIVITIES SH. 21A AS ADJUSTED	6,38,14,494
	REVENUE	4,61,84,000			
	CAPITAL	18,27,000			
	B) FROM STATE GOVERNMENT	-	<b>III.</b>	<b>INVESTMENTS AND DEPOSITS MADE</b>	
	C) FROM OTHER SOURCES (DETAILS)			A) OUT OF EARMARKED/ENDOWMENT FUNDS	-
	GRANT FROM OTHER GOVT. AGENCIES	4,18,10,361		B) OUT OF OWN FUNDS (INVESTMENTS-OTHER)	-
<b>III.</b>	<b>INCOME ON INVESTMENTS FROM</b>		<b>IV.</b>	<b>EXPENDITURE ON FIXED ASSETS &amp; CAPITAL WORK-IN-PROGRESS</b>	
	A) EARMARKED/ ENDOW FUNDS	-		A) PURCHASE OF FIXED ASSETS	12,10,804
	B) OWN FUNDS (OTH INVESTMENT)	-		B) EXPENDITURE ON CAPITAL WORK-IN-PROGRESS	-
<b>IV.</b>	<b>INTEREST RECEIVED</b>		<b>V.</b>	<b>REFUND OF SURPLUS MONEY/LOANS</b>	
	A) ON BANK DEPOSITS	12,68,702		A) TO THE GOVERNMENT OF INDIA	-
	B) LOANS, ADVANCES ETC.	-		B) TO THE STATE GOVERNMENT	-
<b>V.</b>	<b>OTHER INCOME</b>			C) TO OTHER PROVIDERS OR FUNDS	-
	VOLUNTARY CONTRIBUTION/ SPONSORSHIP ETC.	2,92,000	<b>VI.</b>	<b>FINANCE CHARGES (INTEREST)</b>	
	FOREIGN CONTRIBUTION	70,200		INTEREST FOR FY 2018-19 REMITED TO DST THROUGH BHARAT KOSH	2,33,788
	REGISTRATION FEES	65,000			
	ROYALTY ON PUBLICATIONS	7,416	<b>VII.</b>	<b>OTHER PAYMENTS (SPECIFY)</b>	
<b>VI.</b>	<b>AMOUNT BORROWED</b>	-		TDS ON INCOMES	6,33,169
<b>VII.</b>	<b>ANY OTHER RECEIPTS</b>		<b>VIII.</b>	<b>CLOSING BALANCES</b>	
	REFUND OF UNSPENT BALANCE BY NCL PUNE	4,44,867		A) CASH IN HAND	18,793
	REFUND OF UNSPENT BALANCE IIT GUWAHATI NATFOE 2018	3,49,494		B) BANK BALANCES	
	REFUND OF INCOME TAX-TDS	9,36,451		I) IN CURRENT ACCOUNTS	-
	REFUND OF UNSPENT BALANCE LET EC 2018	13,720		II) IN DEPOSIT ACCOUNTS	8,45,00,000
	TDS ON ACCRUED INTEREST	6,16,679		III) SAVINGS ACCOUNTS	3,11,80,823
	MISC. RECEIPTS	12,196			
	<b>TOTAL</b>	<b>21,02,22,603</b>		<b>TOTAL</b>	<b>21,02,22,603</b>



  
**(BHUVAN ADHLAKHA)**  
 MANAGER (F&A)

## Notes.....



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Indian National Academy of Engineering  
Unit No. 604-609, 6th Floor,  
Tower A, SPAZE I-Tech Park, Sector 49,  
Sohna Road, Gurgaon – 122018 (India)  
Phone : (91) - 0124 – 4239480/83/84  
Fax : (91) - 0124 - 4239481  
Email : [inaehq@inae.in](mailto:inaehq@inae.in)

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New Delhi - 110 016 (India)  
Email : [inaehq@inae.in](mailto:inaehq@inae.in)

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Unit No. 928, 9th Floor,  
Tower A, SPAZE I-Tech Park, Sector 49,  
Sohna Road, Gurgaon – 122018 (India)  
Phone : (91) - 0124 – 4239474/75  
Email : [inaehq@inae.in](mailto:inaehq@inae.in)

Registered under the Societies Registration Act 1860  
(XXI of 1860) No : S-17673 of 20 April 1987

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*Published by :*  
Indian National Academy of Engineering.

*Designed and Printed at :*  
Semaphore Technologies Pvt. Ltd.  
Kolkata, Ph. +91 9836873211



Indian National Academy of Engineering