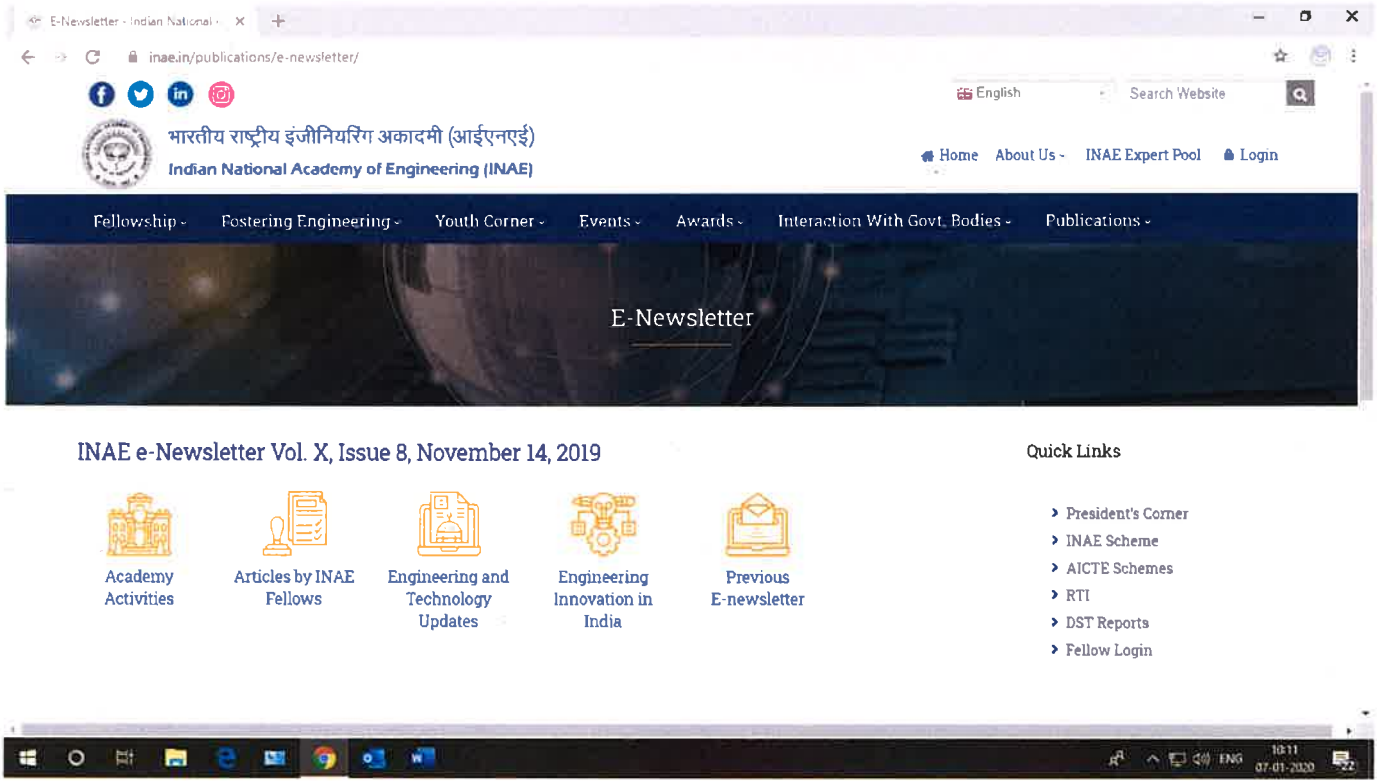

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From the Editor's Desk

ADVANCED ULTRA SUPER CRITICAL (AUSC) TECHNOLOGY IN INDIA

The improvement in life style of human beings and ever increasing desire for industrialisation of India are the important factors driving the demand for increased production of electricity. The demand for electric power in India has been projected to be around 6,40,000 MW by 2027. The current installed power generating capacity in India from various sources is about 3,61,500 MW. Out of the installed capacity, the contribution from coal based thermal power technologies is approximately around 56%.

In India, the fossil power is expected to remain as the primary source of electricity generation in the very near future in spite of the contributions from wind, solar and nuclear energy would be improving rapidly. It has been recognised worldwide that the emissions such as SO_x, NO_X and CO_2 from coal-fired thermal power plants are contributing very significantly to environmental pollution and global warming. The reduction in these gasses, particulate emissions, and increase in the energy efficiency are highly dependent on the operating conditions, which are dominantly dictated by steam temperature and pressure of coal-fired power plants. In on-going efforts to contain global warming, like many other countries engaged in pollution control in the world, India has also been contemplating to shift to Advanced Ultra Super Critical (AUSC) Power plants to augment its power production with tighter control over pollution levels. AUSC technology uses steam with very high temperatures in the range from 973K-1033K and pressure between 300-350 bars, resulting much higher efficiency (46-50%) than conventional coal-fired power plants. In AUSC plants, a unit burns much less coal, thereby generating less emissions per megawatt of power output. Less coal consumption ensures energy security through longevity of coal reserves. It can be expected that the AUSC thermal power plants would reduce to a certain extent, India's power woes, as the country looks to augment its power production with strict control over the gaseous emissions. In recent years, a Research and Development Project for "Development of Advanced Ultra Supercritical (Adv.USC) Technology for Thermal Power Plants" on a Mission Mode, has been approved by Government of India. The Principal Scientific Advisor's Office played a key role in knitting this AUSC mission. The important goal of this machine is to evolve a design for an 800 MWe capacity AUSC plant with steam parameters of 983K/993K and 310 bar so as to achieve a minimum efficiency of 46%. The first phase of this project is aimed at addressing R&D on all aspects related to improvement of power plant efficiency, reduce CO_2 emissions and reduce coal consumption per unit power generated. In the second phase, an 800 MWe Adv-USC demonstration power plant based on developed technology will be established. The project is jointly being executed by Bharat Heavy Electricals Limited (BHEL), Indira Gandhi Centre for Atomic Research (IGCAR, Kalpakkam) and National Thermal Power Corporation (NTPC), who have entered into a Memorandum of Undertaking. This is a time bound project which is expected to complete very soon. The objectives of the machine comprise of development of advanced high temperature materials, characterization of microstructure and mechanical properties, design of equipment and establishment of suitable manufacturing technologies for power cycle equipment, system engineering, component testing, evaluation and validation. The responsibilities of each of the project partners have been clearly identified. The progress made in the last few years with respect to indigenous development of materials, testing and evaluation, manufacturing of critical components and design has been discussed in detail at National Conference on AUSC Technology (AUSC-2019) held on 30th and 31st October 2019 in Hyderabad. It is very satisfying to know that 35 Indian academic institutions, well known research and production units are continuing to take part in realization of the targets associated with AUSC mission. This conference has also attracted several presentations from the countries within European Union, USA, Japan, UK, and Thailand.

The extremely high temperatures and pressure conditions envisaged in AUSC plants impose considerable demands on long-term creep strength and stability of the initial microstructure, oxidation/corrosion resistance, and deformation of the structural materials to be used. There are several important components in AUSC plants for which the appropriate choice of materials is required. The critical components of boilers for 983K/993K technology consists of membrane and furnace walls, the final superheater and reheater stages, boiler tubes and inlet and outlet headers for hot sections, thick-walled components for high pressure outlet headers and the piping to the turbine. For the design of high temperature components, the forecasted requirement of minimum creep strength is 100 MPa at 10^5 h of service. This requirement will not be fulfilled by the austenitic and ferritic-martensitic steels that are currently being used in a temperature region common for 873K power plants. Therefore, the realization of 983K/993K AUSC power plants would be based upon the usage of widely qualified Nickel-based superalloys such as Alloy 617(Modified) and Inconel 740H for high temperature components. Alloy 263 is also emerging as the most promising candidate material, since the manufacturing of large forged components has been demonstrated in the EU-funded project "Next Generation Power". Whenever, several materials are available, the designers' choice will be based upon the availability of the material, cost and the design code approval for the chosen material. These requirements have narrowed down the choice to the Superalloys 617M,740H, and 625M for different components for which the detailed investigations are in progress as a part of Indian AUSC mission. Indian industry, research labs and academic institutions have made rapid progress in spite of several challenges faced in materials development and fabrication technologies.

The need for heavy forged components and parts with high chemical homogeneity for AUSC applications require the adaptation/development of advanced technologies during manufacturing of Alloy 617M. There are several critical parameters that are to be controlled during vacuum induction melting followed by vacuum arc melting/electro slag refining to achieve narrow range of chemistry specified and also to ensure low gas levels. In the large diameter ingots, 617M superalloy exhibits heavy segregation resulting in poor forgings. The segregation of slow diffusing alloying elements necessitates the usage of long homogenization cycles with respect to increase in diameter and dendrite arm spacing. Alloy 617M also exhibits poor workability and a very narrow range of hot processing window. Poor workability leads to increased machining allowances and yield loss whereas the poor machinability of the alloy calls for high machining time and high tooling cost. Overcoming several challenges crept during manufacturing, MIDHANI has successfully processed various critical components with near net shape forging such as large diameter tubes, Y-Piece forgings and billets for the production of extruded tubes. A significant milestone has been achieved by NFC Hyderabad in the indigenous development of extrusion technology of Alloy 617M by incorporating hot expansion to manufacture long length tubular finished product.

The ability to forge and weld are important issues for large rotor production. The rotors for AUSC design calls for development of dissimilar welding between nickel base superalloy and ferritic steel to minimize the use of expensive nickel-based superalloys. This technology development is necessary because of the difficulties in producing a large ingot for mono-block nickel-based superalloy rotors. The scientists at IGCAR Kalpakkam have successfully developed the narrow-gap TIG welding process for joining thick section forgings of 617M and 10% Cr steel. The weld joints passed in radiography, tensile and bend tests as per ASME Section IX requirements. Welding procedure specification including weld groove design and post weld heat treatment has been finalised for fabrication of welded turbine rotors for AUSC mission project.

The castings of a steam turbine are large structures with complex shapes that must provide the pressure containment for steam turbine. The major requirements for casing materials are the ability to cast them into the required size and shape through air casting process. BHEL has done excellent work in this area. For turbine casings Alloy 625M has been developed. It is to be remembered that

the high strength superalloys have to be evaluated for creep, fatigue, and creep-fatigue interaction design life cycle performance at elevated temperatures prior to their induction in the form of functional components. A facility for accelerated life cycle testing of AUSC turbine rotor is getting established at BHEL corporate R&D unit. Based on the control methodology developed for transient heating and cooling cycles, the rotors shall be tested for a number of pre-determined heating, steady state and cooling cycles. It is envisaged that accelerated creep and transient thermomechanical testing of AUSC steam turbine rotor in high temperature spin test rig simulates the actual damage seen in the life time of real rotor within a short and feasible time. A steam loop for corrosion studies in an existing plant has also been established. Thus, the presentations at AUSC-2019 national conference at Hyderabad provided an excellent in-depth coverage on indigenous efforts in design, materials development, assessment of microstructure and mechanical properties and manufacturing technologies for the advancement of AUSC technology in India. The participation of overseas delegates gave an opportunity to know the advances that have taken place in the recent past. The AUSC mission serves as an example of initiating the directed basic research work with emphasis on component realisation by bringing together the academic institutions, research laboratories, industries, design teams and operating power plant personnel onto one platform.

Prof. K. Bhanu Sankara Rao
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University of Hyderabad,
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ACADEMY ACTIVITIES

INAE Annual Convention 2019

The Annual Convention of the Academy will be held on **December 12-14, 2019 at Birla Institute of Scientific Research (BISR), Statue Circle, Jaipur, followed by a local excursion on December 15, 2019.** The highlights of the Annual Convention are as under.

(i) Lectures by winners of Life Time Contribution Award in Engineering; Prof. Jai Krishna & Prof. SN Mitra Memorial Awards; and Outstanding Teachers Award in the evening of December 12, 2019 followed by INAE Fellows Dinner.

(ii) Inaugural Session on Dec 13, 2019

(iii) Three Plenary Talks by eminent personalities on Dec 13-14, 2019.

(iv) Industry Session on Dec 14, 2019 in which the winners of the INAE Young Entrepreneur Award 2019 will make a presentation on the innovations for which they have been awarded.

(v) Technical Sessions on Dec 13, 2019 in which newly elected Fellows (whose Fellowship is effective from Nov 1, 2019) and INAE Young Engineer Awardees 2019 will be making presentations relating to their own significant engineering contributions.

(vi) The Grand Awards Function on December 13, 2019 wherein the Innovative Student Projects Awards, Young Entrepreneur Award, Young Engineer Awards, Prof. Jai Krishna and Prof. SN Mitra Memorial Awards; Outstanding Teacher Award and the Life Time Contribution Awards in Engineering will be presented by the President, INAE.

(vii) The Annual General Meeting including Induction Ceremony of Fellowship/newly selected Young Associates and Special General Meeting of Fellows of the Academy in the forenoon of December 14, 2019.

(viii) A local excursion on Dec 15, 2019 to visit prominent places in and around Jaipur.

(ix) Cultural Programme and Dinner on December 13, 2019.

INAE Local Chapter Activities

- **INAE Mumbai Local Chapter**

INAE Mumbai Local Chapter organized two events in the recent past as per details given below.

(i) 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 (IIChE) 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, 24th 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, IIChE and IEA at the end of the Inaugural Session.

(ii) 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 on16th 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, 16th 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 realise 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 28th 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
		Prof. K. Bhanu Sankara Rao, FNAE, Pratt & Whitney Chair Professor, University of Hyderabad
		Dr Dinesh Kumar Likhi, FNAE Chairman and Managing Director MIDHANI, Hyderabad
Members	-	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:

a) To conduct several Professional Conferences in different organizations located in and around Hyderabad.

b) 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.

c) To organize the second meeting of INAE Hyderabad Chapter at University of Hyderabad in the month of December, 2019.

d) To organize a lecture on Recent Developments in High Temperature Materials at IIT Hyderabad in the month of December, 2019.

e) To organize monthly lectures on various advanced disciplines of Engineering such as Machine Learning, Artificial Intelligence, Data Science etc.

Academia Industry Interaction

AICTE-INAE Distinguished Visiting Professorship Scheme

Industry-academia interactions over technological changes have become essential in recent times so that relevant knowledge that would be sustainable in the changing conditions can be imparted to the students in the engineering institutions. 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, academics 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.

Brief details pertaining to recent visits of industry experts under this scheme are given below.

Mr. VVR Sastry, FNAE Former Chairman Managing Director, BEL and Executive Director, Centre for Development of Telematics (CDOT)	BMS College of Engineering, Bangalore October 23, 2019	Delivered lectures on "National Board of Accreditation (NBA)" and "NBA Self-Assessment Report Review". As per the feedback from the engineering college, the interaction with the Visiting Professor has provided a complete insight into the NBA Accreditation process.
Dr. SL Mannan, FNAE Former Outstanding Scientist and Director Metallurgy and Materials Group, Indira Gandhi Centre for Atomic Research , Kalpakkam	Government College of Engineering, Salem October 21-23, 2019	Delivered lectures on "Strengthening Mechanisms - Strain Hardening and Grain Boundary Strengthening", "Strengthening Mechanisms - Solid Solution, Precipitation and Dispersion Hardening" and "How to write a Research Manuscript and Proposal". As per the feedback received from the engineering college the interactions with the Industry expert have been beneficial both for students and faculty members. He has also helped in guidance of on-going student projects and participated in discussions on review of Regulations and Syllabi of B.E. (Metallurgical Engineering) course.
Prof. Ganapati Panda, FNAE, Former Deputy Director & Prof. School of Electrical Sciences, IIT Bhubaneswar	BVRIT Hyderabad College of Engineering for Women September 28-30, 2019	Delivered lectures on "Introduction to Machine Learning, Classification of Engineering Problems, Clustering, Regression Modeling and Analysis, Hierarchical Clustering, Unsupervised Learning Techniques Reinforcement Learning, Convolutional Neural Networks and Artificial Neural Networks"; Bio-Inspired Techniques and Research Methodologies". As per the feedback received from the engineering college, the scheme is beneficial for all students and faculty members. Interactions with the visiting professor have also helped motivate students and faculty members in their research activities.
Mr. S. Krishna Kumar Former Senior Vice President (Retired), Lucas TVS Ltd, Chennai	RMK Engineering College, Kavaraipettai, Tamil Nadu September 25-27, 2019	Delivered lectures on "Entrepreneurship and Start -Ups under Make in India Programme for Automotive Related Industries"; " Review on Projects on Innovation in Smart Agricultural Farms and Earthquake-Proof Buildings" and "Product life Cycle Management - Industry Expectations and Career Opportunities". As per the feedback received from the engineering college, the scheme helps students to gain appropriate knowledge from their rich experience of the industry expert.

Prof. V Radhakrishnan, FNAE Former Professor, Department of Mechanical Engineering, IIT Madras & Emeritus Professor of Indian Institute of Space Science and Technology	College of Engineering Pune September 25-27,2019	Delivered lectures on "Surface Measurement and Precision Engineering"; "Micro - Meso Measurement" and "Art and Craft of Publishing Papers". As per the feedback from the faculty coordinator of the engineering college, the lectures by Prof. Radhakrishnan have helped strengthen the research activities of faculty members, PhD scholars and Post Graduate students.
Dr. SK Gupta, FNAE Former Project Coordinator (Saline Water), CSSRI, Karnal	Karnal Institute of Technology and Management, Karnal September 25-27,2019	Delivered lectures on "Dimensional Analysis Applications in Fluid Mechanics'; " Irrigation Water Management in Canal Commands of India" and " Hydrological Cycle: Assessing the Abstractions for Run - Off Calculations". As per the feedback received from the engineering college, the interactions with the visiting professor have been very beneficial for the students. He has also helped in arranging industry visit for students.
Dr. Suvankar Ganguly Principal Scientist, R&D Division, TATA Steel Ltd.	Jadavpur University, Kolkata September 27, 2019	Delivered lecture on "Heat Transfer Experiments". According to the feedback received from the engineering college, the scheme gives a very good opportunity for students and teachers to gain exposure to the latest industrial requirements.
Prof. Ranjit Kumar Ray, FNAE Formerly Head, Advance Centre for Materials Science, Department of Materials and Metallurgical Engineering, IIT Kanpur/ Visiting Scientist R&D Division, Tata Steel	CMR Institute of Technology, Bangalore September 11-13, 2019 SRM Institute of Science and Technology, Kattankulathur, Chennai September 16-18, 2019	Delivered lectures on "Crystallography"; "Crystal Imperfections and Atomic Diffusion" and "Mechanical Behaviour and Strengthening Mechanism". According to the feedback received from the engineering college, the scheme is highly beneficial both in terms of improvement in teaching quality and research activities. The scheme provides a great opportunity for the faculty members to learn pedagogy skills from a renowned professor like Prof. Ray. He also participated in discussion on Curriculum Formulation. Delivered lectures on "Crystallography" and "Crystallographic Texture". According to the feedback received from the engineering institute, the scheme helps boost research activities and formulation of new research problems.

Prof MR Madhav, FNAE Professor Emeritus and Visiting Professor, IIT Hyderabad and JNTUH	VNR Vignana Jyothi Institute of Engineering and Technology, Hyderabad August 21-23,2019	Delivered lectures on "Geotechnical Aspects of Foundation for Tall Buildings"; " Journal Paper Writing Skills" and "Granular Pile Anchors". According to the feedback received from the engineering college, the interactions with the visiting professor have provided useful inputs for revision of problem statements of projects undertaken by Post Graduate students.

International/National Conferences/Seminars being organized by IITs/other Institutions
To view a list of International/ National Conferences/Seminars being held in the month of November 2019, click here.

Honours and Awards

1.	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.

News of Fellows

1.	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. Prof Sankar Pal delivered the following prestigious Keynote/Named Lectures in India and abroad in the last one year. **Abroad:** • Series of Invited talk(s) at 5th International School on Big Data (BigDat 2019), University of Cambridge, U.K., January 7-11, 2019. • Keynote talk at the International Conference on Information, System and Convergence Applications (ICISCA), Bangkok, Thailand, January 23-25, 2019. • 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. • Invited talk in the Department of Electrical and Computer Engineering, University of Illinois, Urbana-Champaign (UIUC), IL, USA on May 7, 2019. • Invited talk at 3rd Qingdao International Academicians Conference, Qingdao, China, May 28 to 31, 2019. **India:** • 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.

	• 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. • CSIR Foundation Day Lecture at the Vigyan Auditorium, CSIR Madras Complex and CSIR-Structural Engineering Research Centre, Chennai, September 27, 2019
2.	Dr P.A. Lakshminarayanan, FNAE, Technical Advisor, Simpson Chennai and Former Head, Engine R&D, Ashok Leyland; Former Chief Technical Officer, Sampson & 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. **Design and Development of Heavy Duty Diesel Engines** · A Handbook Editors: Lakshminarayanan, P. A., Agarwal, Avinash Kumar (Eds.) Further details of the book are available at the link given below. https://www.springer.com/gp/book/9789811509698
3.	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.

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

International/National Conferences in November 2019

International Conference on Communication, Computing and Electronics Systems 2019 on 15th to 16th November 2019 at Coimbatore, Tamil Nadu
https://conferencealerts.com/show-event?id=213043

International Conference on Smart Systems and Inventive Technology (ICSSIT 2019) on 27th to 29th November 2019 at Tirunelveli, Tamil Nadu
https://conferencealerts.com/show-event?id=212855

43rd International JVE Conference "Dynamics, Noise, Vibration and Smart Materials" on 28th to 30th November 2019 at Greater Noida
https://conferencealerts.com/show-event?id=218028

International Conference on Recent Advancement in Air-conditioning and Refrigeration (RAAR-2019) on 28th to 30th November 2019 at Bhubaneswar, Odisha
https://conferencealerts.com/show-event?id=218024

1. The Statue of Unity - India

A tributary endeavour to the Iron Man of India, the Statue of Unity is an iconic 182-metre-tall statue situated on the isle of Sadhu-Bet. Located between the Mountain Ranges of Vindhyachal and Satpuda, this monument has many other attractive tourist spots in its proximity such as the Valley of Flowers, the Shoolpaneshwar Sanctuary and sacred temple, the Sardar Sarovar Dam and its water dykes, the scenic Zarvani Falls and majestic palaces of Rajpipla. The project management team & its engineers have built one of the tallest concrete gravity dams in the world and an irrigation system, which is one of the top irrigation networks of the world. India's largest engineering and construction company Larsen & Toubro was assigned the responsibility for designing, engineering, procurement, construction, operation and maintenance of the project. Noted sculptor Ram V. Sutar, a Padma Bhushan Awardee, who has created over 40 monumental sculptures over the past 40 years was designated as the sculptor for the Statue of Unity. The Statue of Unity stands as a naturalistic and inspirational portrayal of Sardar Patel, donning his characteristic garments and a pose that reflects dignity, confidence, iron will and kindness. Bronze cladding adds richness and visual appeal to the Statue. Sophisticated, state-of-the-art surveying technologies like, Light Detection and Ranging (LIDAR) and Telescopic Logging were used for the construction of the Statue. The construction of this National Monument utilised approximately 70,000 metric tonnes of cement, 18,500 metric tonnes of reinforcement bars and 6,000 metric tonnes of structural steel. The surface area of about 22,500 square metres has been clad with around 1,700 metric tonnes of bronze. L&T employed over 3000 workers and 250 engineers in the statue's construction. The core of the statue utilised 210,000 cubic metres (7,400,000 cu ft) of cement concrete, 6,500 tonnes of structural steel, and 18,500 tonnes of reinforced steel. The outer façade is made up of 1,700 tonnes of bronze plates and 1,850 tonnes of bronze cladding which in turn comprise 565 macro and 6,000 micro panels. The bronze panels were cast in Jiangxi Tongqing Metal Handicrafts Co. Ltd (the TQ Art foundry) in China as suitable facilities were unavailable in India. The bronze panels were transported over sea and then by road to the workshop near the construction site where they were assembled. The statue is divided into five zones of which only three are accessible to the public. From its base to the level of Patel's shins is the first zone which has three levels and includes an exhibition area, mezzanine and roof. Zone 1 contains a memorial garden and a museum. The second zone reaches up to Patel's thighs, while the third extends up to the viewing gallery at 153 metres. Zone 4 is the maintenance area while the final zone comprises the head and shoulders of the statue. The statue has been engineered to withstand wind speeds of up to 50 m per second (almost 180 km/hr). The challenge is not only of the wind blowing against the statue but the succession effect it creates at the back of the statue that had to considered in the structural design. To arrest any sway of such a tall structure, two Tuned Mass Dampers of 250 tonnes each have been used. In any given situation, all the four corners of the base raft remain rooted to the ground. The SoU can also survive earthquakes measuring up to 6.5 on the Richter Scale, at a depth of 10 km and within a radius of 12 km of the statue.

Source https://cecr.in/CurrentIssue/pages/40916

2. Achieving Quantum Supremacy: Researchers Demonstrate the Power Of 53 Entangled Qubits

Researchers in UC Santa Barbara/Google scientist John Martinis' group have made good on their claim to quantum supremacy. Using 53 entangled quantum bits ("qubits"), their Sycamore computer has taken on -- and solved -- a problem considered intractable for classical computers. "A computation that would take 10,000 years on a classical supercomputer took 200 seconds on our quantum computer," said Brooks Foxen, a graduate student researcher in the Martinis Group. "It is likely that the classical simulation time, currently estimated at 10,000 years, will be reduced by improved classical hardware and algorithms, but, since we are currently 1.5 trillion times faster, we feel comfortable laying claim to this achievement." The milestone comes after roughly two decades of quantum computing research conducted by Martinis and his group, from the development of a single superconducting qubit to systems including architectures of 72 and, with Sycamore, 54 qubits that take advantage of the both awe-inspiring and bizarre properties of quantum mechanics. The algorithm was chosen to emphasize the strengths of the quantum computer by leveraging the natural dynamics of the device. That is, the researchers wanted to test the computer's ability to hold and rapidly manipulate a vast amount of complex, unstructured data. "We basically wanted to produce an entangled state involving all of our qubits as quickly as we can," a researcher said, "and so we settled on a sequence of operations that produced a complicated superposition state that, when measured, returns bitstring with a probability determined by the specific sequence of operations used to prepare that particular superposition. The exercise, which was to verify that the circuit's output correspond to the sequence used to prepare the state, sampled the quantum circuit a million times in just a few minutes, exploring all possibilities -- before the system could lose its quantum coherence. "We performed a fixed set of operations that entangles 53 qubits into a complex superposition state," a lead researcher explained. "This superposition state encodes the probability distribution. For the quantum computer, preparing this superposition state is accomplished by applying a sequence of tens of control pulses to each qubit in a matter of microseconds. We can prepare and then sample from this distribution by measuring the qubits a million times in 200 seconds." "For classical computers, it is much more difficult to compute the outcome of these operations because it requires computing the probability of being in any one of the 2^53 possible states, where the 53 comes from the number of qubits -- the exponential scaling is why people are interested in quantum computing to begin with," he said. "This is done by matrix multiplication, which is expensive for classical computers as the matrices become large." According to the new paper, the researchers used a method called cross-entropy benchmarking to compare the quantum circuit's output (a "bitstring") to its "corresponding ideal probability computed via simulation on a classical computer" to ascertain that the quantum computer was working correctly. While the experiment was chosen as a proof-of-concept for the computer, the research has resulted in a very real and valuable tool: a certified random number generator. Useful in a variety of fields, random numbers can ensure that encrypted keys can't be guessed, or that a sample from a larger population is truly representative, leading to optimal solutions for complex problems and more robust machine learning applications. The speed with which the quantum circuit can produce its randomized bit string is so great that there is no time to analyze and "cheat" the system. "Quantum mechanical states do things that go beyond our day-to-day experience and so have the potential to provide capabilities and application that would otherwise be unattainable," commented a researcher. "The team has demonstrated the ability to reliably create and repeatedly sample complicated quantum states involving 53 entangled elements to carry out an exercise that would take millennia to do with a classical supercomputer. This is a major accomplishment: We are at the threshold of a new era of knowledge acquisition."

Source https://www.sciencedaily.com/releases/2019/10/191023133358.htm

3. Mimicking Body's Circulatory AC Could Keep Airplanes, Cars and Computers Cooler

The complex network of veins that keeps us cool during the heat of summer has inspired engineers to create novel thermal management systems. But replicating the circulatory system, in form or function, has been no easy task. Recently, a team of researchers from Drexel University and North Carolina State University have created a computational platform that could be the key to mimicking the body's evolutionary optimized cooling system. Microvasculature. In a study Ahmad Najafi, PhD, a professor in Drexel's College of Engineering, and his faculty collaborator, Jason Patrick, PhD, from North Carolina State University, report on how a computational technique they developed can quickly produce designs for 3D printing carbon-fibre composite materials with an internal vasculature optimized for active-cooling. "When you get hot, the body sends a signal to the circulatory system to pump more blood to the surface of the skin -- this is why we sometimes get red in the face" Najafi said. "This is a natural method for dissipating heat that works so well, scientists and engineers have been trying for years to replicate in mechanical cooling systems, like the ones that keep cars and computers from overheating." Najafi and Patrick's have developed an integrated platform to design and create bioinspired microvascular composites that can do just that. In minutes, their computer program, coined HyTopS, which is short for hybrid topology/shape optimization, can produce a schematic for a vascular network with the ideal shape, size and distribution of micro-vessels to actively cool a material via liquid circulation -- a trick that took Mother Nature more than a few evolutionary cycles to perfect. Microvascular fibre-composites are currently being developed to cool everything from electric vehicles to next generation aircraft, where increasingly higher performance is turning up the heat they generate. "These modern materials could revolutionize everything from hypersonic space vehicles to battery packaging in electric cars and even supercomputer cooling systems. As things move faster, and energy output and computing power continue to increase, an enormous amount of heat is generated that requires new approaches to cooling," Patrick said. "Inspired by circulatory systems in living organisms, internal micro-vasculature provides an effective means to thermal regulation in synthetic materials." This branch of bioinspired-based research has only been around for a decade or so, but the results it has generated are already quite promising, according to Najafi/Patrick who started their academic careers at the University of Illinois Urbana-Champaign developing microvascular materials for self-healing, active cooling and beyond. "Microvascular composites offer many advantages over existing liquid and air-cooling systems, primarily, they are much lighter with comparable strength, but they are also very durable -- which is important if you consider the widespread effect of corrosion on metallic components," Najafi sad. "And if you consider these among other factors, it's easy to see why they are being sought in aerospace, automotive and energy sectors." To put their optimization method to the test, the researchers designed and built a microvascular carbon-fibre composite using 3D printing and tested its cooling abilities against a reference design from prior studies. After heating the carbon-composites to a maximum temperature, liquid coolant (similar to the one in your car) was pumped through each vascular network to begin the cooling process. The HyTopS-optimized carbon-composite was not only cooler, but more uniform in terms of surface temperature distribution, and was able to cool down faster than the reference design. In addition to superior performance of the optimized material, the advantage the HyTopS method is that it automatically calculates the impact of changes to the diameter and arrangement of the channels, as well as how they are connected to one another. It takes into consideration the material makeup and overall geometry of the system being cooled and corresponding heat transfer characteristics. And it factors in parameters related to the manufacturing process, so the final design is a realistic microvascular material that can be made by 3D printing or other accessible fabrication approaches. "It's nearly impossible to reproduce the entire complexity of natural microvascular, but our program allows for a great deal of optimization input and considers manufacturing parameters to ensure the design can actually be constructed," Najafi said. The collaborative team intends to use the HyTopS method to explore other intriguing and interdisciplinary aspects of microvascular composites, including structural mechanics and electromagnetics.

Source https://www.sciencedaily.com/releases/2019/10/191031112516.htm

4. 'Artificial Leaf' Successfully Produces Clean Gas

A widely-used gas that is currently produced from fossil fuels can instead be made by an 'artificial leaf' that uses only sunlight, carbon dioxide and water, and which could eventually be used to develop a sustainable liquid fuel alternative to petrol. The carbon-neutral device sets a new benchmark in the field of solar fuels, after researchers at the University of Cambridge demonstrated that it can directly produce the gas -- called syngas -- in a sustainable and simple way. Rather than running on fossil fuels, the artificial leaf is powered by sunlight, although it still works efficiently on cloudy and overcast days. And unlike the current industrial processes for producing syngas, the leaf does not release any additional carbon dioxide into the atmosphere. Syngas is currently made from a mixture of hydrogen and carbon monoxide, and is used to produce a range of commodities, such as fuels, pharmaceuticals, plastics and fertilisers. The device Professor Erwin Reisner from Cambridge's Department of Chemistry and his colleagues produced is inspired by photosynthesis -- the natural process by which plants use the energy from sunlight to turn carbon dioxide into food. On the artificial leaf, two light absorbers, similar to the molecules in plants that harvest sunlight, are combined with a catalyst made from the naturally abundant element cobalt. When the device is immersed in water, one light absorber uses the catalyst to produce oxygen. The other carries out the chemical reaction that reduces carbon dioxide and water into carbon monoxide and hydrogen, forming the syngas mixture. As an added bonus, the researchers discovered that their light absorbers work even under the low levels of sunlight on a rainy or overcast day. The team's fundamental research to produce syngas as the basis for liquid fuel in a carbon neutral way is ground-breaking," said a lead researcher. Other 'artificial leaf' devices have also been developed, but these usually only produce hydrogen. The Cambridge researchers say the reason they have been able to make theirs produce syngas sustainably is thanks the combination of materials and catalysts they used. These include state-of-the-art perovskite light absorbers, which provide a high photovoltage and electrical current to power the chemical reaction by which carbon dioxide is reduced to carbon monoxide, in comparison to light absorbers made from silicon or dye-sensitised materials. The researchers also used cobalt as their molecular catalyst, instead of platinum or silver. Cobalt is not only lower-cost, but it is better at producing carbon monoxide than other catalysts. The team is now looking at ways to use their technology to produce a sustainable liquid fuel alternative to petrol. Syngas is already used as a building block in the production of liquid fuels. "What we'd like to do next, instead of first making syngas and then converting it into liquid fuel, is to make the liquid fuel in one step from carbon dioxide and water," said Reisner. Although great advances are being made in generating electricity from renewable energy sources such as wind power and photovoltaics, Reisner says the development of synthetic petrol is vital, as electricity can currently only satisfy about 25% of our total global energy demand. "There is a major demand for liquid fuels to power heavy transport, shipping and aviation sustainably," he said. "We are aiming at sustainably creating products such as ethanol, which can readily be used as a fuel," said a researcher of the team. "It's challenging to produce it in one step from sunlight using the carbon dioxide reduction reaction. But we are confident that we are going in the right direction, and that we have the right catalysts, so we believe we will be able to produce a device that can demonstrate this process in the near future."

Source https://www.sciencedaily.com/releases/2019/10/191021111826.htm

5. Paving the Way for Sensor Interfaces that are 30 Times Smaller

The Green IC research group in the Department of Electrical and Computer Engineering at the National University of Singapore's (NUS) Faculty of Engineering invented a novel class of Digital-to-Analog (DAC) and Analog-to-Digital Converters (ADC) that can be entirely designed with a fully-automated digital design methodology, thanks to its fully-digital architecture. Compared to traditional analog architectures and methodologies, the design turnaround time for these novel sensor interfaces is reduced from months to hours. The drastic reduction in the design effort is highly beneficial in cost-sensitive silicon systems, such as sensors for the Internet of Things (IoT). The novel data converter architecture also has very low complexity, reducing the silicon area and hence the manufacturing cost by at least 30 times, compared to conventional designs. Such novel data converters also exhibit the unprecedented capability of gracefully degrading the signal fidelity when its supply voltage or clock frequency experience wide fluctuations. Such fluctuations are common in energy-harvested IoT sensors, being that the power harvested from the surrounding environment (e.g., solar cell) is highly erratic. In turn, this allows uninterrupted sensor signal monitoring even under unfavourable harvested power conditions, and without voltage regulation. Instead, traditional data converters suffer from catastrophic resolution degradation when the supply voltage is below its minimum rated value Vmin (or the frequency exceeds its maximum rated value) hence needing power-hungry circuits for voltage and frequency regulation. "Our research transforms the traditionally analog and mostly-manual design of data converters into fully-automated digital design, reducing the silicon area by an order of magnitude and the design time by two orders of magnitude, allowing semiconductor companies to be cost-competitive while reaching markets faster," said the team leader Associate Professor Massimo Alioto, who is from the Department of Electrical and Computer Engineering at the NUS Faculty of Engineering. He added, "Being digital, our sensor interfaces are effortlessly ported across manufacturing technologies and applications, and can be immersed in digital circuits to avoid the traditional effort required by their integration on the same silicon chip." The NUS team demonstrated the concept through several silicon chips implementing both DACs and ADCs with extremely low area. As an example, a 12-bit DAC manufactured in 40nm standard CMOS technology has been demonstrated with an area equal to the diameter of a strand of human hair. Its inherent amenability for technology scaling makes it shrink by approximately another 32 times when implemented in the currently finest technology (7 nm). At the same time, the NUS invention has been shown to enable data converters with high resolutions (up to 16 bits), while achieving design simplicity and compactness. Team member Dr Orazio Aiello, "Our team has introduced a new design paradigm that pushes us closer to the ultimate vision of inexpensive, technology-scalable and ultra-compact IoT devices." The NUS innovation further simplifies integrated system design, leveraging the unprecedented ability to withstand very substantial voltage and frequency fluctuations, thus relaxing the accuracy requirements in voltage and frequency generation. Indeed, conventional data converters operating at a supply voltage below its minimum rated value (or excessive clock frequency) experiences catastrophic failure, and hence fails to perform its intended function. On the contrary, the innovative data converters invented by the NUS team exhibit graceful degradation of the resolution and signal fidelity when supply voltage or clock frequency exceeds its allowed range. As an example, a DAC designed for 1 V was demonstrated to correctly operate at half this voltage, while degrading its resolution by only 1 bit when the supply voltage is reduced by a substantial 0.3V. Assoc Prof Alioto said, "The capability of having graceful resolution degradation under voltage and frequency overscaling suppresses the need for complex circuit solutions that accurately regulate the supply voltage and the clock frequency being utilised by data converters. In other words, our data converters are simpler to design, and also simplify the system that they are employed in." The team is currently working on a novel paradigm that turns traditionally analog and design-intensive silicon sub-systems into digital standard cell-based designs that are supported by fully-automated design flows, pushing the boundary of classical digitally-assisted design. This research study involves several fundamental sub-systems such as amplifiers, oscillators, voltage and current references, and many others. The research team aims to transform the way integrated systems are designed, enabling ultra-rapid, ultra-compact and technology-portable design of entire systems.

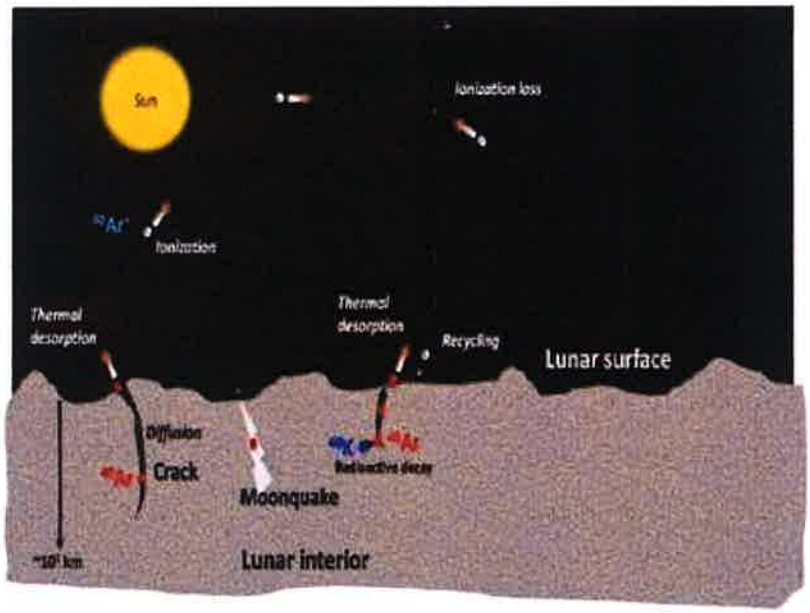
Source https://www.sciencedaily.com/releases/2019/10/191022112135.htm

6. 'Transformative Electronics Systems' to Broaden Wearable Applications

Imagine a handheld electronic gadget that can soften and deform when attached to our skin. This will be the future of electronics we all dreamed of. A research team at KAIST says their new platform called 'Transformative Electronics Systems' will open a new class of electronics, allowing reconfigurable electronic interfaces to be optimized for a variety of applications. A team working under Prof Jae-Woong Jeong from the School of Electrical Engineering at KAIST has invented a multifunctional electronic platform that can mechanically transform its shape, flexibility, and stretchability. This platform allows users to seamlessly and precisely tune its stiffness and shape. "This new class of electronics will not only offer robust, convenient interfaces for use in both tabletop or handheld setups, but also allow seamless integration with the skin when applied onto our bodies," said Prof Jeong. The transformative electronics consist of a special gallium metal structure, hermetically encapsulated and sealed within a soft silicone material, combined with electronics that are designed to be flexible and stretchable. The mechanical transformation of the electronic systems is specifically triggered by temperature change events controlled by the user. "Gallium is an interesting key material. It is biocompatible, has high rigidity in solid form, and melts at a temperature comparable to the skin's temperature," said lead author Sang-Hyuk Byun, a researcher at KAIST. Once the transformative electronic platform comes in contact with a human body, the gallium metal encapsulated inside the silicone changes to a liquid state and softens the whole electronic structure, making it stretchable, flexible, and wearable. The gallium metal then solidifies again once the structure is peeled off the skin, making the electronic circuits stiff and stable. When flexible electronic circuits were integrated onto these transformative platforms, it empowered them with the ability to become either flexible and stretchable or rigid. "This technology could not have been achieved without interdisciplinary efforts," said co-lead author Joo Yong Sim, who is a researcher with ETRI. "We worked together with electrical, mechanical, and biomedical engineers, as well as material scientists and neuroscientists to make this breakthrough." This universal electronics platform allowed researchers to demonstrate applications that were highly adaptable and customizable, such as a multi-purpose personal electronics with variable stiffness and stretchability, a pressure sensor with tuneable bandwidth and sensitivity, and a neural probe that softens upon implantation into brain tissue. Applicable for both traditional and emerging electronics technologies, this breakthrough can potentially reshape the consumer electronics industry, especially in the biomedical and robotic domains. The researchers believe that with further development, this novel electronics technology can significantly impact the way we use electronics in our daily life.

Source https://www.sciencedaily.com/releases/2019/11/191101143957.htm

7. Chandrayaan-2 Finds Easily Detectable 'Argon-40' Isotope



The Indian Space Research Organisation (ISRO) on Oct 31, 2019 said that the Chandra's Atmospheric Composition Explorer-2 (CHACE-2) payload on Chandrayaan-2 has detected Argon-40 (40Ar) from the lunar exosphere. Among the radiogenic gases on the lunar surface, 40Ar is one of the isotopes of Argon, a noble gas. "Argon, is an important constituent of the lunar exosphere. It originates from the radioactive disintegration of Potassium-40 (40K), which has a half-life of 1.2 X 109 years," ISRO said in a statement. The statement further read that 40K nuclide, which is present deep below the lunar surface, disintegrates to 40Ar, which, in turn, makes way up to the lunar exosphere through seepages and faults. The detection of 40Ar is significant for ISRO, but this won't be the first time that the isotope has been studied, given that it has a high escape rate. R Richard Hodges from the University of Colorado Boulder, in a research paper published earlier, says: "In polar areas of the moon the maximum temperatures reached in some permanently shaded areas are well below the temperature required to retain water ice for billions of years, and cold enough to hold other volatiles for shorter periods. Aside from water, the most significant lunar volatiles are the radiogenic gases, of which argon-40 is the most easily detected, both in situ and as retrapped ions in rocks returned from the surface on the moon." Argon-40 escapes from Moon at a surprisingly high rate that is between 3% and 6% of its total production. "Its brief lifetime in the lunar exosphere is marked by numerous adsorption/desorption events. Collisions with the lunar surface in cold, permanently shaded areas lead to long term storage, forming reservoirs of trapped gas that may be disturbed occasionally to produce sudden increases in atmospheric argon," the paper adds. It is postulated that this may explain at least part of the time variations in Apollo 17 mass spectrometer measurements of argon that were previously attributed to internal processes associated with the release of radiogenic gases from the moon.

Source https://timesofindia.indiatimes.com/india/chandrayaan-2-finds-easily-detectable-argon-40-isotope/articleshow/71840510.cms

8. Sponge-Like 2D Material with Interesting Electrical Conductivity and Magnetic Properties

Chemists at the Centre for Multidimensional Carbon Materials (CMCM), within the Institute for Basic Science (IBS, South Korea), have reported the synthesis of a novel type of 2D metal organic framework (MOF) with interesting electrical conductivity and magnetic properties. This new material may potentially contribute to optoelectronics, photovoltaics, (photo)electrocatalysis, and energy storage. Also known as sponge-like materials, MOFs are made of metal ions connected to organic ligands and are characterized by nano-sized holes. IBS researchers designed and synthesized Ni(II) tetraaza[14]annulene-linked MOF (NiTAA-MOF), where the metal component is nickel and the nickel tetraaza[14]annulene molecules are used as MOF building blocks for the first time. The researchers discovered that doping this MOF with iodine changes its conductivity and magnetism. Pristine NiTAA-MOF conducts poorly. It is actually an insulator with an electrical conductivity smaller than 10-10 Siemens per centimetre. However, when it is chemically oxidized by iodine, the same measurement rises to 0.01 Siemens per centimetre (the larger this number, the better the conductor). This result shows the vital role of ligand oxidation in the electrical conductivity of some 2D MOFs, expanding the understanding of the origin of electrical conductivity in this type of MOFs. In addition, the team checked how this material becomes magnetized in an applied magnetic field. Magnetization measurements performed by the researchers of the School of Materials Science showed that iodine-doped NiTAA-MOF is paramagnetic, that is it is weakly attracted by an external magnetic field, and becomes antiferromagnetic at very low temperatures. This means that it could become useful as a polarizing agent in dynamic nuclear polarization-nuclear magnetic resonance (DNP-NMR) that is used in experiments for material characterization. The 2D MOF structure was also modelled through detailed calculations and analyzed by a variety of methods, such as X-ray diffraction, infrared, X-ray photoelectron, diffuse reflectance UV-vis, electron paramagnetic resonance, and Raman spectroscopies. "Our work can contribute to the fundamental understanding of structure-property relationships in 2D electrically conductive MOFs, and may pave the way to develop new electrically conductive MOFs," says Professor Ruoff, one of the corresponding authors of this study and UNIST professor. "Besides, the as-synthesized and iodine-doped NiTAA-MOF might be applicable in catalase mimics, catalysis, and energy storage."

Source https://www.sciencedaily.com/releases/2019/10/191031100505.htm

9. Engineers Develop A New Way to Remove Carbon Dioxide from Air

A new way of removing carbon dioxide from a stream of air could provide a significant tool in the battle against climate change. The new system can work on the gas at virtually any concentration level, even down to the roughly 400 parts per million currently found in the atmosphere. Most methods of removing carbon dioxide from a stream of gas require higher concentrations, such as those found in the flue emissions from fossil fuel-based power plants. A few variations have been developed that can work with the low concentrations found in air, but the new method is significantly less energy-intensive and expensive, the researchers say. The technique, based on passing air through a stack of charged electrochemical plates has been developed by MIT Postdoc Sahag Voskian. The device is essentially a large, specialized battery that absorbs carbon dioxide from the air (or other gas stream) passing over its electrodes as it is being charged up, and then releases the gas as it is being discharged. In operation, the device would simply alternate between charging and discharging, with fresh air or feed gas being blown through the system during the charging cycle, and then the pure, concentrated carbon dioxide being blown out during the discharging. As the battery charges, an electrochemical reaction takes place at the surface of each of a stack of electrodes. These are coated with a compound called polyanthraquinone, which is composited with carbon nanotubes. The electrodes have a natural affinity for carbon dioxide and readily react with its molecules in the airstream or feed gas, even when it is present at very low concentrations. The reverse reaction takes place when the battery is discharged -- during which the device can provide part of the power needed for the whole system -- and in the process ejects a stream of pure carbon dioxide. The whole system operates at room temperature and normal air pressure. "The greatest advantage of this technology over most other carbon capture or carbon absorbing technologies is the binary nature of the adsorbent's affinity to carbon dioxide," explains Voskian. In other words, the electrode material, by its nature, "has either a high affinity or no affinity whatsoever," depending on the battery's state of charging or discharging. Other reactions used for carbon capture require intermediate chemical processing steps or the input of significant energy such as heat, or pressure differences. "This binary affinity allows capture of carbon dioxide from any concentration, including 400 parts per million, and allows its release into any carrier stream, including 100 percent CO_2," Voskian says. That is, as any gas flows through the stack of these flat electrochemical cells, during the release step the captured carbon dioxide will be carried along with it. For example, if the desired end-product is pure carbon dioxide to be used in the carbonation of beverages, then a stream of the pure gas can be blown through the plates. The captured gas is then released from the plates and joins the stream. The process this system uses for capturing and releasing carbon dioxide "is revolutionary" he says. "All of this is at ambient conditions -- there's no need for thermal, pressure, or chemical input. It's just these very thin sheets, with both surfaces active, that can be stacked in a box and connected to a source of electricity." In a working plant -- for example, in a power plant where exhaust gas is being produced continuously -- two sets of such stacks of the electrochemical cells could be set up side by side to operate in parallel, with flue gas being directed first at one set for carbon capture, then diverted to the second set while the first set goes into its discharge cycle. By alternating back and forth, the system could always be both capturing and discharging the gas. In the lab, the team has proven the system can withstand at least 7,000 charging-discharging cycles, with a 30 percent loss in efficiency over that time. The researchers estimate that they can readily improve that to 20,000 to 50,000 cycles. The electrodes themselves can be manufactured by standard chemical processing methods. While today this is done in a laboratory setting, it can be adapted so that ultimately they could be made in large quantities through a roll-to-roll manufacturing process similar to a newspaper printing press, Voskian says. Compared to other existing carbon capture technologies, this system is quite energy efficient, using about one gigajoule of energy per ton of carbon dioxide captured, consistently. Other existing methods have energy consumption which vary between 1 to 10 gigajoules per ton, depending on the inlet carbon dioxide concentration, Voskian says. The researchers have set up a company called Verdox to commercialize the process, and hope to develop a pilot-scale plant within the next few years, he says. And the system is very easy to scale up, he says: "If you want more capacity, you just need to make more electrodes."

Source https://www.sciencedaily.com/releases/2019/10/191025170815.htm

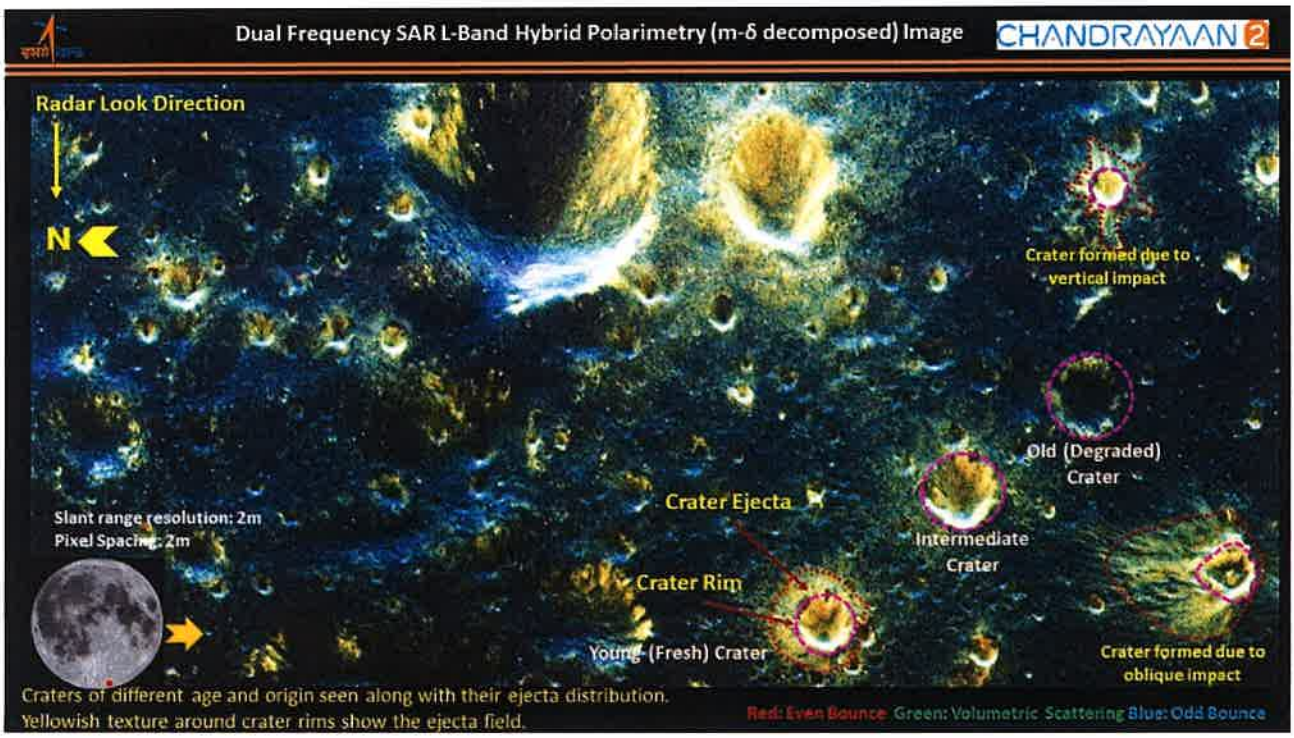
10. Intuitive Virtual Reality: Bimodal 'Electronic Skin' Developed

Through the crafty use of magnetic fields, scientists from the Helmholtz-Zentrum Dresden-Rossendorf (HZDR) and the Johannes Kepler University in Linz have developed the first electronic sensor that can simultaneously process both touchless and tactile stimuli. Prior attempts have so far failed to combine these functions on a single device due to overlapping signals of the various stimuli. As the sensor is readily applied to the human skin, it could provide a seamless interactive platform for virtual and augmented reality scenarios. The largest human organ -- the skin -- is likely the most functionally versatile part of the body. It is not only able to differentiate between the most varied stimuli within seconds, but it can also classify the intensity of signals over a broad range. A research team have managed to produce an electronic counterpart with similar characteristics. According to the scientists, their new sensor could massively simplify the interplay between humans and machines, as a researcher explains: "Applications in virtual reality are becoming increasingly more complex. We therefore need devices which can process and discriminate multiple interaction modes." The current systems, however, work either by only registering physical touch or by tracking objects in a touchless manner. Both interaction pathways have now been combined for the first time on the sensor, which has been termed a "magnetic microelectromechanical system" (m-MEMS) by the scientists. "Our sensor processes the electrical signals of the touchless and the tactile interactions in different regions," says a lead researcher, adding, "and in this way, it can differentiate the stimuli's origin in real time and suppress disturbing influences from other sources." The foundation for this work is the unusual design the scientists worked out. On a thin polymer film, they first fabricated a magnetic sensor, which relies on what is known as the Giant Magneto Resistance (GMR). This film in turn was sealed by a silicon-based polymer layer (polydimethylsiloxane) containing a round cavity designed to be precisely aligned with the sensor. Inside this void, the researchers integrated a flexible permanent magnet with pyramid-like tips protruding from its surface. "The result is rather more reminiscent of cling film with optical embellishments," comments a scientist. "But this is precisely one of our sensor's strengths." This is how it remains so exceptionally flexible: it fits all environments perfectly. Even under curved conditions, it works without losing its functionality. The sensor can thus very easily be placed, for example, on the fingertip. It is precisely in this manner that the scientists tested their development. The team elaborates: "On the leaf of a daisy we attached a permanent magnet, whose magnetic field points in the opposite direction of the magnet attached to our platform." As the finger now approaches this external magnetic field, the electrical resistance of the GMR sensor changes: it drops. This occurs until the point when the finger actually touches the leaf. At this moment, it rises abruptly because the built-in permanent magnet is pressed closer to the GMR sensor and thus superimposes the external magnetic field. "This is how our m-MEMS platform can register a clear shift from touchless to tactile interaction in seconds," they say. This allows the sensor to selectively control both physical and virtual objects, as one of the experiments conducted by the team demonstrates: on a glass plate with which they furnished a permanent magnet, the physicists projected virtual buttons that manipulate real conditions, such as the room temperature or brightness. Using a finger on which the "electronic skin" had been applied, the scientists could first select the desired virtual function touchless through interaction with the permanent magnet. As soon as the finger touched the plate, the m-MEMS platform switched automatically to the tactile interaction mode. Light or heavy pressure could then be used, for example, to lower or increase the room temperature accordingly. This "electronic skin" -- in addition to virtual reality spaces -- could also be used, for example, in sterile environments. Surgeons could use the sensors to handle medical equipment without touching it during a procedure, which would reduce the danger of contamination.

Source https://www.sciencedaily.com/releases/2019/10/191029104802.htm

Engineering Innovation in India

Chandrayaan-2: ISRO Releases Pictures of Impact Craters on Moon



Indian space agency has released fresh set of pictures of impact craters on moon surface taken by its Chandrayaan-2 Orbiter as per news of October 24, 2019. The Indian Space Research Organisation (ISRO) while releasing a picture on its Twitter handle, said the images were taken by the Dual Frequency-Synthetic Aperture Radar (DF-SAR) on its Chandrayaan-2 Orbiter. According to ISRO, the Moon has been continuously bombarded by meteorites, asteroids and comets since its formation. This has resulted in the formation of innumerable impact craters that form the most distinct geographic features on its surface. Impact craters are approximately circular depressions on the surface of the moon, ranging from small, simple, bowl-shaped depressions to large, complex, multi-ringed impact basins. "In contrast to volcanic craters, which result from explosion or internal collapse, impact craters typically have raised rims and floors that are lower in elevation than the surrounding terrain," ISRO said. The study of the nature, size, distribution and composition of impact craters and associated ejecta features reveal valuable information about the origin and evolution of craters. According to ISRO, weathering processes result in many of the crater physical features and ejecta material get covered by layers of regolith making some of them undetectable using optical cameras. The Indian space agency said, the SAR is a powerful remote sensing instrument for studying planetary surfaces and subsurface due to the ability of the radar signal to penetrate the surface. It is also sensitive to the roughness, structure and composition of the surface material and the buried terrain. Previous lunar-orbiting SAR systems such as the S-band hybrid-polarimetric SAR on ISRO's Chandrayaan-1 and the S & X-band hybrid-polarimetric SAR on NASA's LRO, provided valuable data on the scattering characterisation of ejecta materials of lunar impact craters, ISRO said. However, L & S band SAR on Chandraayan-2 is designed to produce greater details about the morphology and ejecta materials of impact craters due to its ability of imaging with higher resolution (2 - 75m slant range) and full-polarimetric modes in standalone as well as joint modes in S and L-band with wide range of incidence angle coverage (9.5 degrees - 35 degrees). In addition, the greater depth of penetration of L-band (3-5 meters) enables probing the buried terrain at greater depths. The L&S band SAR payload helps in unambiguously identifying and quantitatively estimating the lunar polar water-ice in permanently shadowed regions, ISRO said. "Chandrayaan-2 Orbiter's DF- SAR has been operated in full-polarimetry mode- a gold

standard in SAR polarimetry, and is the first-ever by any planetary SAR instrument," ISRO said. This image presents many interesting facts about the secondary craters of different ages and origins in the lunar south polar region, the space agency said. "The yellowish tone around crater rims in the image shows ejecta fields. The distribution of ejecta fields, whether uniformly distributed in all directions or oriented towards a particular side of a crater, indicates the nature of the impact," ISRO explained. According to ISRO, the image shows craters of vertical impact and oblique impact on the top-right and bottom-right, respectively. Similarly, the roughness of the ejecta materials associated with the impact craters indicates the degree of weathering a crater has undergone. Three similar sized craters along a row on the bottom-right of the image show examples of young crater, moderately weathered crater and an old degraded crater. Many of the ejecta fields seen in the image are not visible in high-resolution optical image over the same region, indicating the ejecta fields are buried beneath regolith layers.

Source https://gadgets.ndtv.com/science/news/chandrayaan-2-isro-releases-pictures-of-impact-craters-on-moon-2121994