Sl. No.	IIT Ropar List of Recent Publications with Abstract Coverage: March, 2021
1.	3D-Trajectory Design for Outage Minimization in UAV-Assisted 5G Communication System N Gupta, D Mishra, S Agarwal - IEEE 18th Annual Consumer Communications & Networking Conference, 2021 **Abstract:** In this paper, we study and optimize the trajectory for unmanned aerial vehicle (UAV) to provide fifth-generation (5G) cellular service to users in a given area. We consider a single UAV launched from the fixed initial to the final location, during which it serves the ground users that are distributed in a circular field. We introduced an optimization problem to minimize the average outage probability of the system by optimizing the three-dimensional (3D) trajectory of the UAV. As this problem is nonconvex, we proposed an efficient approach that involves two steps, firstly it frames a new problem to obtain a globally optimal location in 3D space for minimal average outage probability. This problem is shown to be conditionally convex and an efficient algorithm is proposed to obtain a globally optimal location within an acceptable tolerance. Thereafter, a sub-optimal solution is proposed for the original problem. Simulation results provide useful insights into the sub-optimal trajectory of UAV and show that our proposed approach on an average provides 24% outage improvement over the benchmark scheme. This improvement is further enhanced with the increase in the velocity of UAV.
2.	A Mathematical Torque Ripple Minimization Technique Based on Nonlinear Modulating Factor for Switched Reluctance Motor Drives AK Rana, AV Raviteja - IEEE Transactions on Industrial Electronics, 2021 **Abstract:** This paper presents a method to reduce the torque ripple in an 8/6 4-phase switched reluctance motor. The proposed scheme introduces a nonlinear modulating factor dependent on the rotor position and magnitude of the phase currents. This factor manipulates the currents in two adjacent phases during commutation and reduces the torque ripple effectively. Unlike conventionally available torque sharing functions (TSF), the proposed method instantaneously modulates every phase current obtained mathematically based on the other phase current in order to maintain the net torque constant. The proposed method requires minimal offline analysis and offers maximum possible torque with minimal ripple. The method is simple and easy to implement due to less computational burden. The proposed algorithm is implemented using Matlab/Simulink software and is also validated experimentally on a 0.6 hp 8/6 SRM using an FPGA-based hardware setup developed in the laboratory. Typical results are presented and compared with existing techniques. A torque ripple of 8%has been achieved.
3.	A New Generic Progressive Approach based on Spectral Difference for Single-sensor Multispectral Imaging System V Rathi, M Gupta, P Goyal - Proceedings of the 16th International Joint Conference on Computer Vision, Imaging and Computer Graphics Theory and Applications, 2021 **Abstract:** Single-sensor RGB cameras use a color filter array to capture the initial image and demosaicking technique to reproduce a full-color image. A similar concept can be extended from the color filter array (CFA) to a multispectral filter array (MSFA). It allows us to capture a multispectral image using a single-sensor at a low cost using MSFA demosaicking. The binary tree based MSFAs can be designed for any k-band multispectral images and are preferred,

	however the existing demosaicking methods are either not generic or are of limited efficacy. In this paper, we propose a new generic demosaicking method applicable on any k-band MSFAs, designed using preferred binary-tree based approach. The proposed method involves applying the bilinear interpolation and estimating the spectral correlation differences appropriately and progressively. Experimental results on two different multispectral image datasets consistently show that our method outperforms the existing state-of-art methods, both visually and quantitatively, as per the different metrics.
4.	A novel combined power and cooling cycle design and a modified conditional exergy destruction approach A Singh, R Das - Energy Conversion and Management, 2021 **Abstract:** This paper introduces a new combined power and cooling cycle (CPCC) formed by the integration of a modified Kalina and Goswami cycles sharing a common absorber that in turn demands for internal rectification in the former cycle. Unlike most of the conventional studies which are aimed at minimizing the overall exergy destruction of the cycle (ĖDx,OC), this work clarifies that such a practice does not ensure the optimized attainment of total turbine work output (ẆTR), cooling output (Ċcooling) and exergy efficiency (ηexergy) of the cycle. Therefore, this conditional nature of ĖDx,OC is addressed here through the optimization of an integrated objective function addressing each of the desired performance parameters using a dual-mode dragonfly algorithm. The optimization is performed for a range of strong solution concentration, boiler temperature and pressure, in which only the first two parameters are independently varying, while the third is dependent on the previous parameters to ensure partial vaporization. The temperature of the strong solution is kept below its bubble temperature while recovering heat from the hot liquid condensate so that there is no vaporization before entering the boiler. When the present optimization approach is performed for a given set of operational parameters, the values of ẆTR, Ċcooling and ηexergy are observed to improve by 1.84, 6.74, and 1.33 times, respectively with 1.35 times compromise in ĖDx,OC, with respect to the conventional practice. The temperature of the strong solution is kept below its Tbubble while recovering heat from the liquid condensate by performing pinch point calculations.
5.	A Strategic Review on Gallium Oxide Based Deep-Ultraviolet Photodetectors: Recent Progress and Future Prospects D Kaur, M Kumar - Advanced Optical Materials, 2021 **Abstract:** With the use of UV-C radiation sterilizers on the rise in the wake of the recent pandemic, it has become imperative to have health safety systems in place to curb the ill-effects on humans. This requires detection systems with suitable spectral response to the “invisible to the naked eye” radiation leaks with utmost sensitivity and swiftness. State of the art deep-UV photodetectors based on the wide bandgap material gallium oxide have achieved responsivities up to few hundred A W−1 while the minimum response time achieved is few hundred nanoseconds. However, due to the trade-off between these two key parameters, the ultimate performance of the photodetectors remains inadequate. The focus here is to give a thorough review of the gallium oxide based photodetectors, their recent progress and future prospects. This review highlights the fundamental physics and the key parameters such as dark current, responsivity, and response time with their dependence on the material properties. Exploration of the reasons behind current scenario in the field of gallium oxide is comprehensively and critically analyzed. The key challenges which limit device performance and inhibit the

	realization of real-world practical detectors are also described. The lacunae currently plaguing the field is also discussed with possible remedial solutions.
6.	A TGA–DSC-based study on macroscopic behaviors of coal–oxygen reactions in context of underground coal fires J Li, Y Yang, J Li, Y Mao, V Saini, S Kokh - Journal of Thermal Analysis and Calorimetry, 2021 **Abstract:** Underground coal fires (UCFs) cause remarkable loss of energy resources and significant environmental pollution. Due to the limited capacity of oxygen transport, the inception and development of UCFs represent a very unique mode of coal–oxygen reactions. Therefore, a high-volatile flammable coal sample is thermally analyzed with the combined TGA–DSC approach under four oxygen concentrations (21%, 15%, 9% and 3%) and three heating rates (1 °C min−1, 2 °C min−1 and 5 °C min−1). It is found that the oxygen concentration does not significantly influence the early (low-temperature) stage of coal–oxygen reactions. With the decrease in oxygen concentration, the intensity of the exothermic reactions is reduced and the duration of reactions is extended. Based on the experimental results, the apparent activation energy is calculated. The variation of the apparent activation energy reflects the different reaction stages: volatiles burning and char oxidation, which is verified by the TGA–DSC results. Under the extreme condition of 3% oxygen concentration, a very distinct macroscopic thermochemical behavior is observed, and the limited oxygen supply controls the reaction rate throughout the entire process, which qualitatively explains the persistency of the burning phenomena in most UCFs.
7.	Analyzing the Environmental Burden of an Aquaponics System using LCA V Bhakar, K Kaur, H Singh - Procedia CIRP, 2021 **Abstract:** The Food and Agriculture Organization of the United Nations accepted that soil-less agricultural practices are among economic, scientific, and technological developments in the agriculture sector over the last 200 years. These emerging farming techniques (i.e., hydroponics, aquaponics, and aeroponics) are environment friendly. They can be a good production system in a controlled indoor environment or open-air with few possible alterations. Aquaponics is a combination of two agriculture technologies: recirculation aquaculture and hydroponics, within a close loop. It is less energy-intensive, environment friendly, and less water consumption with a minimum requirement of chemicals or fertilizers. However, other factors govern their agricultural operations, such as climatic conditions, water quality, etc. Above all, it's important if aquaponics is really resource-efficient and economically viable for small and marginal farmers. To understand the same, an environmental impact assessment of a small solar-powered aquaponics system is carried out using a simple life cycle assessment (LCA) methodology. The assessment provided visualization of potential benefits for farmers, which can be achieved with the help of the proposed system. The study also has highlighted if solar-powered systems are useful for agricultural production or grid-based power is more useful. The study's research outcomes will support the further development of aquaponics systems for small and marginal farmers. One important limitation of aquaponics systems is water choice when encountering Indian agriculture in terms of groundwater and surface water quality. This development will lead to the growth of new agriculture systems for urban food systems.

8.	Antenna Using a Magnetic-Slab Located in the Principal Magnetic-Field Region Beneath the Patch IJG Zuazola, A Sharma, M Filip, WG Whittow - Progress In Electromagnetics Research C, 2021 **Abstract:** This paper presents an analysis of microstrip patch antennas with different dielectric/magnetic substrate profiles in an attempt to obtain operating frequency reduction. Initially, different ridge shapes in the substrate were examined. An in-depth investigation of the ridge shape and its dimensions on the antenna performance has been carried out. Subsequently an antenna with a magneticslab loaded in the prime magnetic-field region beneath the patch is proposed. The new magnetic loaded antenna design is aimed to reduce the resonant frequency of a conventional patch and reduce the profile of an earlier design with a substrate ridge. Various magnetic materials have been embedded within the original dielectric substrate of the patch antenna. Measured results validated the hypothesis that this frequency can be reduced by placing magnetic materials at the centre of the patch. The achieved gain is expected to be further enhanced by using forthcoming magnetic materials with improved performance.
9.	Blockchain meets IoT: A Scalable Architecture for Security and Maintenance V Agarwal, S Pal - IEEE 17th International Conference on Mobile Ad Hoc and Sensor Systems, 2020 **Abstract:** Internet of Things, delineated as a network of connected heterogeneous devices is emerging as a widely adopted technology in almost all walks of life today. The massive increase in the number of IoT devices has introduced several issues related to security and management. Blockchains can be a promising technology to make IoT systems secure and distributed for the time to come. However, current blockchain systems are not capable of scaling in accordance to the huge IoT data without a loss in speed and time efficiency. Therefore, we use the concept of sidechains and offline data storage to alleviate the scalability issue of blockchains. In this work, we propose an architectural framework for the security and maintenance of IoT systems using blockchain technology. Smart contracts are used to enforce data authentication, authorization, and keep track of all the activities. Extensive simulation and analysis results demonstrate that the proposed blockchain architecture is highly scalable (in terms of average latency, throughput and cost) and can be applied efficiently in the IoT system.
10.	ChartSight: An Automated Scheme for Assisting Visually Impaired in Understanding Scientific Charts M Singh, P Goyal - Proceedings of the 16th International Joint Conference on Computer Vision, Imaging and Computer Graphics Theory and Applications, 2021 **Abstract:** The visual or Non-Textual components like charts, graphs, and plots are frequently used to represent the latent information in digital documents. These components bolster in better comprehension of the underlying complex information. However, these data visualization techniques are of not much use to visually impaired. Visually impaired people, especially in developing countries, rely on braille, tactile, or other conventional tools for reading purposes. Through these approaches, the understanding of Non-Textual components is a burdensome process with serious limitations. In this paper, we present ChartSight, an automated and interactive chart understanding system. ChartSight extracts and classifies the document images into different chart categories, and then uses heuristics-based content extraction methods optimized for line and bar charts. It finally represents the summarized content in audio format to

	the visually impaired users. We have presented a densely connected convolution network-based data-driven scheme for the chart classification problem, which shows comparatively better performance with the baseline models. Multiple datasets of chart images are used for the performance analysis. A comparative analysis of supporting features has also been performed with the other existing approaches.
11.	Deep Adversarial Network for Scene Independent Moving Object Segmentation PW Patil, AA Dudhane, S Murala, AB Gonde - IEEE Signal Processing Letters, 2021 **Abstract:** The current prevailing algorithms highly depend on additional pre-trained modules trained for other applications or complicated training procedures or neglect the inter-frame spatio-temporal structural dependencies. Also, the generalized effect of existing works with completely unseen data is difficult to identify. Specifically, the outdoor videos suffer from adverse atmospheric conditions like poor visibility, inclement weather, etc. In this letter, a novel end-to-end multi-scale temporal edge aggregation (MTPA) network is proposed with adversarial learning for scene dependent and independent object segmentation. The MTPA is proposed to extract the comprehensive spatio-temporal features from the current and reference frame. These MTPA features are used to guide the respective decoder through skip connections. To get authentic and consistent foreground object(s), the respective scale feedback of previous frame output is provided with respective MTPA features at each decoder input. The performance analysis of the proposed method is verified on CDnet-2014 and LASIESTA video datasets. The proposed method outperforms the existing state-of-the-art methods with scene dependent and independent analysis.
12.	Design and modeling of niobium oxide-tantalum oxide based self-selective memristor for large-scale crossbar memory AK Parit, MS Yadav, AK Gupta, A Mikhaylov, B Rawat - Chaos, Solitons & Fractals, 2021 **Abstract:** Memristor-based crossbar architecture has emerged as a promising candidate for 3-D memory, logic, and neuromorphic computing system as it offers remarkably high integration density, low power consumption, fast operation, and easy integration with CMOS technology. However, the fundamental obstacle for their development is the sneak current, which causes misreading and write-crosstalk. In this regard, we present the TiN/NbO2/TiN/TaOx/TiN based self-selective memristor by combining the threshold switching properties of niobium oxide (NbO2) and memory switching properties of tantalum oxide (TaOx) in a single device. The performance investigation is carried out using the finite element simulation method, based on self-consistent solutions of joule heating equation, drift-diffusion continuity equation, and current continuity for accurately capturing the temperature and field-dependent transport of vacancies. The results reveal that NbO2-TaOx based self-selective memristor can allow significantly lower OFF current (1.22 μA), higher read window (32.6), and higher non-linearity (141) than that of TiN/TaOx/TiN based memristor. We demonstrate that the self-selective memristor exhibits good speed with the operation time constant of 70 ns. Furthermore, the crossbar array using a self-selective memristor has shown excellent performance with an improved readout margin up to 27 word lines. Our material-to-circuit performance analysis promises a reliable and energy-efficient crossbar array using NbO2-TaOx cell that can be further utilized for implementing 3-D cross-bar array.

13.	Design of Diffractive Optical Elements for Shaping the Laser Intensity Distribution V Dev, ANK Reddy, V Pal - ICOL-2019, Springer Proceedings in Physics, 2021 **Abstract:** We present simple designs of diffractive optical elements for generating high quality laser beams of different spatial shapes with uniform intensity distribution. The numerical results are presented for uniform intensity laser beams with annular, rectangular and square spatial shapes. We found that these beams exhibit small depth of focus (propagation distance over which the shape of a beam remains preserved). We also found that our designs have good tolerance against the possible errors caused by imperfections and noise.
14.	Drone assisted device to device cooperative communication for critical environments P Kumar, S Darshi, S Shailendra - IET Communications, 2021 **Abstract:** This paper proposes drone assisted device-to-device cooperative communication (DA-DDCC) for critical situations during post-disaster management. The proposed network utilizes the autonomous mode of D2D communication for setting up the link in the absence of a central node. This network incorporates cooperative communication using drone in D2D session for improving reliability of the overall system. A probability-based statistical channel model for such networks is proposed by taking the statistical independence of links into consideration. Unlike the existing air-to-ground (A2G) channel models that use either Rayleigh or Rician distribution for uplink (UL) and downlink (DL) channel modelling, our approach takes the probability of occurrence of line of sight (LoS) into account while predicting the appropriate channel distribution for UL and DL separately. For performance evaluation of the proposed network, average outage probability and average capacity are derived using the proposed channel model. Monte Carlo simulations are conducted to verify our analysis. Moreover, a multi-cluster DA-DDCC scenario is also being analyzed through simulations from an interference perspective to justify the usefulness of the proposed channel model. Results obtained through this investigation can be utilized in selecting various crucial system parameters judiciously for enhanced performance during post-disaster scenario.
15.	Effect of carbon nanotubes on the interlaminar and fracture properties of carbon fiber/epoxy composites HS Bedi, PK Agnihotri - Indian Journal of Engineering and Materials Sciences, 2020 **Abstract:** The average properties of carbon fiber reinforced plastics (CFRPs) depend on the extent of interaction between the fiber and matrix. Any means, therefore, to modify either of the two constituents of CFRPs is the key to design the composite. Carbon nanotubes (CNTs) are often used to tailor the interface/interphase in conventional CFRPs either by mixing the nanotubes in matrix or by growing them on the surface of fiber. However, the incorporation of nanotubes, by either means, may affect the mechanical performance of the matrix and that of the composite as a whole. Experiments are carried out to assess the effect of CNT dispersion on the rate sensitivity of matrix, and the effect of CNT grafting on the average mechanical properties of laminated composites. For better dispersion and interfacial interaction of nanotubes with matrix, molecular level designing of nanotubes is carried out by way of functionalization. It is found that the ultimate strength of epoxy composites increases with applied loading rate, and that neat epoxy is more rate sensitive than CNT based epoxy nanocomposites. Significant enhancements are also observed in the interlaminar and fracture properties of CFRPs after the incorporation of grafted nanotubes in the composite.

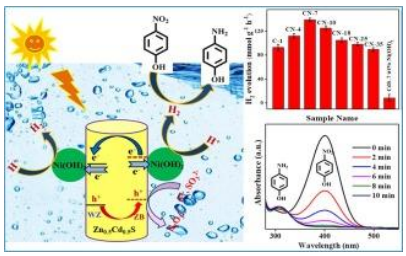
16. [Effects of stochasticity and social norms on complex dynamics of fisheries]
S Sarkar, A Narang, SK Sinha, PS Dutta - Physical Review E, 2021

Abstract: Recreational fishing is a highly socioecological process. Although recreational fisheries are self-regulating and resilient, changing anthropogenic pressure drives these fisheries to overharvest and collapse. Here, we evaluate the effect of demographic and environmental stochasticity for a social-ecological two-species fish model. In the presence of noise, we find that an increase in harvesting rate drives a critical transition from high-yield–low-price fisheries to low-yield–high-price fisheries. To calculate stochastic trajectories for demographic noise, we derive the master equation corresponding to the model and perform a Monte Carlo simulation. Moreover, the analysis of the probabilistic potential and mean first-passage time reveals the resilience of alternative steady states. We also describe the efficacy of a few generic indicators in forecasting sudden transitions. Furthermore, we show that incorporating social norms on the model allows a moderate fish density to maintain despite higher harvesting rates. Overall, our study highlights the occurrence of critical transitions in a stochastic social-ecological model and suggests ways to mitigate them.

17. [Efficient photocatalytic generation of hydrogen by twin $Zn_{0.5}Cd_{0.5}S$ nanorods decorated with noble metal-free co-catalyst and reduction of 4-nitrophenol in water]
B Debnath, S Dhingra, V Sharma, V Krishnan, CM Nagaraja - Applied Surface Science, 2021

Abstract: The development of heterostructure photocatalysts composed of homo- or hetero-junction is a favorable approach for efficient visible-light-assisted photocatalytic conversion of solar energy into clean fuel, H_2. Further, for large-scale production of hydrogen, the use of cost-effective earth-abundant photocatalysts is highly desirable. Consequently, herein we report the synthesis of heterostructure photocatalysts composed of twin $Zn_{0.5}Cd_{0.5}S$ nanorods (NRs) decorated with noble-metal-free co-catalyst, $Ni(OH)_2$ nanoparticles (NPs) for efficient visible-light-assisted H_2 generation from water. Remarkably, the optimized heterostructure, $Zn_{0.5}Cd_{0.5}S$/7wt%$Ni(OH)_2$ (CN-7) showed excellent catalytic activity with an H_2 generation rate of 139 mmol g^{-1} h^{-1} which was found to be about 1.5 and 9.4 times higher than those of pristine $Zn_{0.5}Cd_{0.5}S$ NRs (C-1) and CdS/7wt%$Ni(OH)_2$, respectively. Moreover, the photocatalyst is recyclable for several cycles and can work in both acidic and basic conditions. A probable mechanism of the H_2 generation by $Zn_{0.5}Cd_{0.5}S$/$Ni(OH)_2$ heterojunction has also been discussed. Interestingly, the photocatalytic activity was extended for efficient reduction of 4-nitrophenol from water using the *in situ* generated hydrogen as a reducing agent. Overall, this is a unique demonstration wherein water a green solvent is utilized as a source of reducing agent for visible-light-driven reduction of the environmental pollutants from water.

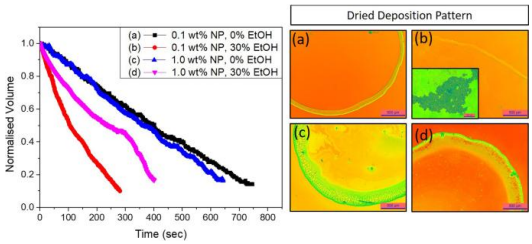
Graphical Abstract:



18.	Finite-time performance of a single-ion quantum Otto engine S Chand, S Dasgupta, A Biswas - Physical Review E, 2021 **Abstract**: We study how a quantum heat engine based on a single trapped ion performs in finite time. The always-on thermal environment acts like the hot bath, while the motional degree of freedom of the ion plays the role of the effective cold bath. The hot isochoric stroke is implemented via the interaction of the ion with its hot environment, while a projective measurement of the internal state of the ion is performed as an equivalent to the cold isochoric stroke. The expansion and compression strokes are implemented via suitable change in applied magnetic field. We study in detail how the finite duration of each stroke affects the engine performance. We show that partial thermalization can in fact enhance the efficiency of the engine, due to the residual coherence, whereas faster expansion and compression strokes increase the inner friction and therefore reduce the efficiency.
19.	Forced Convective Flow of Bingham Plastic Fluids in a Branching Channel with the Effect of T-channel Branching Angle A Maurya, N Tiwari, RP Chhabra - Journal of Fluids Engineering, 2021 **Abstract**: This work aims to explore the T-channel momentum and heat transfer characteristics with the combined effect of Bingham plastic fluids ($0.01 \le Bn \le 20$) behavior and geometrical variation in terms of branching angle ($30 \text{ deg} \le \alpha \le 90 \text{ deg}$). The problem has been solved over a wide range of Reynolds number ($50 \le Re \le 300$) and Prandtl number ($10 \le Pr \le 50$). For the momentum flow, qualitative and quantitative features are analyzed in terms of streamlines, structure of yielded/unyielded regions, shear rate contours, plug width and length variation, and local pressure coefficient. These features have been represented in terms of isotherm patterns, temperature profile, Nusselt number, and its asymptotic value for heat transfer characteristics. The recirculating flows have been presented here in the vicinity of T-junction, which promote mixing and heat transfer. Broadly, the size of this zone bears a positive dependence on Re and α. However, fluid yield stress tends to suppress it. The critical Reynolds and Bingham numbers were found to be strong functions of the pertinent parameters like α. The inclination angle exerts only a weak effect on the yielded/unyielded regions and on the recirculation length of main branch. Results show a strong relationship of the plug width and length with key parameters and branches. The Nusselt number exhibits a positive relationship with α, Bn, and Re but for lower Pr in the T-junction vicinity for both branches. Such length indicates the required optimum channel length for thermal mixing.
20.	Frictional Granular Matter: Protocol Dependence of Mechanical Properties A Lemaître, C Mondal, I Procaccia, S Roy, Y Wang, J Zhang - Physical Review Letters, 2021 **Abstract**: Theoretical treatments of frictional granular matter often assume that it is legitimate to invoke classical elastic theory to describe its coarse-grained mechanical properties. Here, we show, based on experiments and numerical simulations, that this is generically not the case since stress autocorrelation functions decay more slowly than what is expected from elasticity theory. It was theoretically shown that standard elastic decay demands pressure and torque density fluctuations to be normal, with possibly one of them being hyperuniform. However, generic compressed frictional assemblies exhibit abnormal pressure fluctuations, failing to conform with the central limit theorem. The physics of this failure is linked to correlations built in the material during compression from a dilute configuration prior to jamming. By changing the protocol of

	compression, one can observe different pressure fluctuations, and stress autocorrelations decay at large scales.
21.	Graphical Approach for V2V Connectivity Enhancement in Clustering-based VANET R Singh, D Saluja, S Kumar - IEEE Wireless Communications Letters, 2021 **Abstract**: In the clustering based Vehicular Ad-hoc Network (VANET), the Vehicular to Vehicular (V2V) connectivity relies on the milli-meter wave which possesses several connectivity issues (e.g., poor diffraction and high attenuation). Moreover, the broadcasting nature of connected vehicles raises the issue of V2V interference. In this work, we have shown that a large portion of V2V interference comes from the intra-cluster vehicles only. Then, we propose a dual-slot transmission scheme for intra-cluster interference suppression. Finally, we propose a graph-based algorithm to assure that the dominant interfering nodes may transmit in the different time slots. Further, through simulation results, it is shown that the proposed approach significantly enhances the V2V connectivity of clustering based VANET.
22.	Identification of Defective Nodes in Cyber-Physical Systems V Agarwal, S Pal, N Sharma, V Sethi - IEEE 17th International Conference on Mobile Ad Hoc and Sensor Systems, 2020 **Abstract**: Cyber-physical systems (CPSs) comprise physical systems or objects incorporated with computing functionalities and data storage systems. Different sensor nodes in a CPS communicate with each other and devices like actuators and microcontrollers regulate the physical systems through smart algorithms. Efficient communication and networking algorithms play a critical role in supporting smooth interaction between the cyber and physical worlds. Internet of Things (IoT) belongs to the physical part of CPS. In the physical part, the sensor nodes are connected with each other and each node sends data to the root node through their respective parent node in a multi-hop manner. The physical devices in a CPS may stop sensing the environment due to logical and physical failures. To solve this, we propose a real time defective nodes detection scheme (R2D) in a cyber-physical system. The root node of the CPS gathers sensed data, detects the defective nodes and performs data analysis in the cyber part of the CPS. The results show that our proposed R2D protocol achieves a 10.2% higher packet delivery ratio and a 12.5% increase in throughput as compared to the flooding approach. Moreover, an improvement by almost 50% in throughput is observed when compared to RPL with an increase in packet loss rate of 20%.
23.	Identifying and Analyzing the Factors Affecting Disassembly of Products in Remanufacturing Organizations PK Singh, P Sarkar - Procedia CIRP, 2021 **Abstract:** Disassembly is a key operation that differentiates remanufacturing from traditional manufacturing. However, various factors that affects the process of disassembly are not clearly understood by the researchers. This study focuses on identifying and analyzing the factors that affect the disassembly process in remanufacturing organizations. A literature survey is conducted to identify the factors that can influence the disassembly of products. A total of 17 factors are obtained which are further classified into three main factors viz. Organizational Capabilities (OC), Process Choices (PC) and Product Attributes (PA). An approach based on Analytical Hierarchy Process (AHP) is utilized to analyze the factors for developing a list of priority of these factors. A team of 8 experts from industry and academia is involved in this research for

	collecting their opinions. Results of this study show that product attributes play a key role in the disassembly of products for remanufacturing. 'Value of recovered products', 'number of components', 'sequence of disassembly', 'volume of cores supply' and 'implementation of ecodesign principles' are identified as the top five factors affecting the process of disassembly. The findings of this research can be useful for effective disassembly of products in remanufacturing based organizations. The decision makers of remanufacturing organizations can use the priority list of factors developed in this study for managing the disassembly activities in the organization.
24.	Influence of natural crosslinker and fibre weightage on waste kibisu fibre reinforced wheatgluten biocomposite P Bhowmik, R Kant, R Nair, H Singh - Journal of Polymer Research, 2021 **Abstract:** In this era of green and sustainable manufacturing, natural fibre-reinforced polymer composites (NFPC) have been widely accepted as the potential alternatives for polymer matrix composites (PMC) or any other non-biodegradable composites. Despite the increasing need to replace plastic bottles, bags, disposable plastic plates and trays, seedling pots used in our day to day life, not many studies have been made in this direction. The current work aims at developing a hundred percent biodegradable composite by reinforcing waste Kibisu silk fibre into wheat gluten as a possible replacement of plastic disposables. The developed composites are made up of different mass fractions of Kibisu silk fibre reinforced into plasticised wheat gluten. The prepared composites have been characterised to obtain the best combination. The developed composites were found to have adequate tensile property, mass degradation at a considerably high temperature and most importantly, the outstanding rate of biodegradation under normal atmospheric conditions. The soil quality test before and after degradation also showed no significant changes in the quality of the soil. FTIR studies revealed improved interaction between wheat gluten, glycerol and Kibisu fibres upon addition of natural lemon extract as crosslinker. Overall results indicate that the developed biocomposites have the potential to substitute harmful plastic disposables like plastic seedling pots and plates, disposable hospital tray, dustbin, etc.
25.	Interconnected drying phenomena in nanoparticle laden water-ethanol binary droplets D Lohani, S Sarkar - The European Physical Journal E, 2021 **Abstract:** Understanding the evaporation of a multi-component droplet has found immense importance in various technological applications. This study investigates the evaporation behaviour of a colloidal binary droplet system comprising of the ethanol-water mixture and polystyrene nanoparticles. The wetting and evaporation dynamics were studied with an emphasis on the collective influence of ethanol and nanoparticle concentrations. The temporal behaviour of the contact angles, shapes and volumes of the droplets was monitored in order to analyse the evaporative behaviour. With increase of ethanol concentrations, the binary droplet volumes were found to decrease nonlinearly with time. Ethanol being more volatile evaporated in the initial stage. Towards the end of the evaporation process, the evaporation characteristics mimics the behaviour of pure water. Our study shows that the initial contact angle decreases monotonically with increased concentration of ethanol in the mixture. The contact angle is maximum for a particular nanoparticle concentration. Droplets with higher ethanol concentration show higher wettability which in its turn is maximum for low nanoparticle concentrations. This trend shows the interconnected effect of ethanol and nanoparticle concentrations on evaporation. Rim width of the final deposition pattern increases with nanoparticle concentration although it is almost

	independent of ethanol concentration. Finally, it is noticed that fast evaporation of a relatively more volatile component in a binary mixture droplet leads to nanoparticle segregation for low nanoparticle concentrations. Thus for binary mixtures, the evaporation of the more volatile component, ethanol for our case, offers characteristic differences in the resulting evaporation dynamics from that of pure water which finds applicability for multi-component evaporation processes. **Graphical Abstract:** 
26.	Investigation on Transformer Oil Parameters Using Support Vector Machine B Singh, AH Kumar, CC Reddy - IEEE 15th International Conference on Industrial and Information Systems, 2020 **Abstract:** Machine Learning has been used to predict the transformer oil parameters by using data obtained from Megger tests and transformer oil test. The relationship among the measured insulation resistance (among distribution transformer's low tension winding, high tension winding and ground) with breakdown strength, acidity, water content, and interfacial tension of transformer oil is modeled for the prediction. Support Vector Machine is the algorithm used for the prediction of the parameters. A cascaded network approach has been used where stage-wise division has been done to obtain different parameters depending on their correlation with each other. The cascaded network takes insulation resistances as input to predict breakdown and interfacial tension which are further used along with colour as input to predict water content which is further used to predict the acidity. Even though there was a lack of sufficient dataset for training the network the results seemed to be promising. Testing data was used to verify the network and the results were good as evident from the confusion matrices obtained. Therefore it is concluded that SVM is a good technique to predict transformer oil parameters with accuracy.
27.	Machine learning-based Acoustic Repellent System for Protecting Crops against Wild Animal Attacks D Ranparia, G Singh, A Rattan, H Singh, N Auluck - IEEE 15th International Conference on Industrial and Information Systems, 2020 **Abstract:** In this paper, we present some insights on the issue of crop destruction by wild animals. This is a serious concern for the affected farmers throughout the world and leads to significant social and financial distress among them. In order to understand the background of this problem, a survey of Katli village, Rupnagar, (India) was conducted. The main aim of the current work is to develop a device to protect crops from damage by wild animals by diverting them from the farms, without harming them physically. In this context, an Acoustic Repellent System has been designed which uses a convolutional neural network (CNN) based machine learning model and an IR camera to identify target animals, such as wild boar, nilgai, and deer. A Raspberry Pi (Rpi) module has been integrated with a camera and a frequency generator to

	recognise different animals and produce corresponding frequencies that keep them away from the farms of interest. Moreover, the architectural aspects of the proposed solution have also been detailed. Lastly, the potential impact of the proposed solution has been discussed.
28.	mm-Wave micro-wave integrated Sub-RAN for CRAN performance enhancement SK Singh, R Singh, B Kumbhani - IET Communications, 2021 **Abstract:** Coordinated Multi-Point (CoMP) transmission in Cloud Radio Access Network (CRAN) requires a large amount of data transmission and processing within a coherence time window. Hence, CoMP transmission puts a lot of burden on the central processor and back-haul unit. Also, establishing CoMP for high-mobility users is challenging due to small coherence window and large beamforming overhead over mm-Wave transmission. This paper proposes a two-layer CRAN architecture with intelligent mm-Wave and micro-Wave allocation. A dual connectivity framework has been introduced to increase the coverage of high-mobility users. Further, it is shown that the proposed scenario reduces the load on the central processor and central back-haul. To avoid unnecessary handoffs, a mobility management algorithm is also proposed, which can provide seamless connectivity to the users irrespective of their velocity. Further, through simulation results, it is shown that the proposed network outperforms the existing CRAN framework.
29.	Modeling cortical bone adaptation using strain gradients AK Tiwari, A Goyal, J Prasad - Proceedings of the Institution of Mechanical Engineers, Part H: Journal of Engineering in Medicine, 2021 **Abstract:** Cyclic and low-magnitude loading promotes osteogenesis (i.e. new bone formation). Normal strain, strain energy density and fatigue damage accumulation are typically considered as osteogenic stimuli in computer models to predict site-specific new bone formation. These models however had limited success in explaining osteogenesis near the sites of minimal normal strain, for example, neutral axis of bending. Other stimuli such as fluid motion or strain gradient also stimulate bone formation. In silico studies modeled the new bone formation as a function of fluid motion, however, computation of fluid motion involves complex mathematical calculations. Strain gradients drive fluid flow and thus can also be established as the stimulus. Osteogenic potential of strain gradients is however not well established. The present study establishes strain gradients as osteogenic stimuli. Bending-induced strain gradients are computed at cortical bone cross-sections reported in animal loading in vivo studies. Correlation analysis between strain gradients and site of osteogenesis is analyzed. In silico model is also developed to test the osteogenic potential of strain gradients. The model closely predicts in vivo new bone distribution as a function of strain gradients. The outcome establishes strain gradient as computationally easy and robust stimuli to predict site-specific osteogenesis. The present study may be useful in the development of biomechanical approaches to mitigate bone loss.
30.	Numerical simulation of a one-dimensional flexible filament mimicking anguilliform mode of swimming using discrete vortex method S Chakravarty, D Samanta - Physical Review Fluids, 2021 **Abstract:** The article discusses the numerical simulation of swimming dynamics of a one-dimensional flexible filament in inviscid conditions using the discrete vortex method (DVM). The DVM is used to reduce the computational cost of mesh generation in these types of unsteady problems. To mimic the anguilliform mode of swimming, we have applied the relevant

	kinematics in the flexible filament motion. Various parameters like wavelength, tail oscillation amplitude, amplitude growth factor, and frequency were varied to quantify the coefficient of thrust and swimming efficiency. For the ranges of parameters covered in our simulations, we identified the boundary between the drag regime and the thrust regime. Further, the role of tail oscillation amplitude with Strouhal number on the transition from the drag to thrust regime is examined. We showed that the wake vortices assume a Bénard–von Kármán (BvK) configuration in the drag producing regime and rearranges to reverse Bénard–von Kármán (rBvK) configuration in the thrust producing regime. The resultant wake vortex distribution, contour map, and associated velocity field are presented to clarify the differences between BvK in the drag regime, axisymmetric vortex distribution in the vicinity of the transition regime of drag and thrust regimes, and rBvK in the thrust regime. Thus, we have identified the optimum parameter regimes to obtain high thrust or achieve swimming efficiency of two-dimensional (2D) flexible filaments. Finally, we believe our numerical simulations can be extended to elucidate the wake vortice's dynamics of flexible filaments in 2D flows or pitching motion of rigid airfoils in quasi-2D flows.
31.	On the Measurement of Surface Voltage of Insulators and Bushings AJ Thomas, C Iyyappan; CC Reddy - IEEE Transactions on Power Delivery, 2021 **Abstract:** The surface voltage of an insulator assumes importance for understanding tracking and flashover characteristics. Until now, determination of surface voltage of insulating surfaces is left to simulation software and such simulations are left unverified experimentally, leading to uncertainty of the results, which may sometimes be erratic with improper choice of boundary or initial conditions or inaccurate material properties, nonlinearities etc. The paper presents a novel method, using which the surface voltage of any insulating surface such as insulator strings or transformer bushings can be measured. Unlike a conducting surface, the measurement of insulating surface voltage using voltage dividers would be erratic as the measuring arrangement itself will vary the voltage division due to the local unknown impedance between the insulated surface and hv conductor. Recently a method for measurement of surface voltage of an insulated conductor using cylindrical strips was reported. In this paper, based on analytical derivations, a more generalized method of measurement, applicable to any point on an insulating surface of arbitrary geometry is proposed using circular-disc strips. The proposed experimental method is applied to insulator strings and transformer bushings and validated by simulation of the entire systems. The simulation and experimental results are in excellent agreement.
32.	Online Energy-efficient Scheduling Algorithm for Renewable Energy-powered Roadside units in VANETs V Sethi, S Pal, A Vyas - IEEE 17th International Conference on Mobile Ad Hoc and Sensor Systems, 2020 **Abstract:** Road-side unit (RSU) plays an important role in providing connectivity among the vehicles on the road. In rural areas, RSUs are powered using renewable energy, such as solar or wind energy. Hence, the energy consumption across such RSUs should be efficient i.e., energy consumption at RSUs should be minimized and no RSU gets over-utilized while others are under-utilized. The amount of energy consumption depends upon the scheduling of different kinds of data requests at RSU. In this paper, we propose a scheduling architecture for minimizing energy consumption at RSU and attaining uniform energy consumption across neighboring RSUs. This, in turn, increases the request fulfillment percentage at RSUs. The proposed

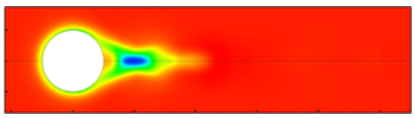
	architecture categorizes the incoming request as a Traditional (less computation) or a Smart request (high computation). Two approaches- Hard-deadline Less Computation requirement Approach (HLCA) and Soft-deadline High Computation requirement Approach (SHCA) are proposed for addressing Traditional and Smart data requests, respectively. In HLCA approach, the receiving RSU uses the scheduling metric to select the servicing RSU for request fulfillment. We prove by analysis, how scheduling metric helps in minimizing and achieving uniform energy consumption across the RSUs. In SHCA approach, Fog computing is used for handling high computation requests. Energy consumption at RSUs is further optimized by using Auction game-based relay vehicle selection mechanism. Simulation results demonstrate that our proposed approaches achieve uniform energy consumption across multiple RSUs and 10% more efficient than scheduling algorithms for single RSU model such as Nearest Fastest Set Scheduler (NFS).
33.	Optimized 3D Polarized H-field Forming for Orientation-Insensitive Wireless Power Transfer Systems VK Srivastava, A Sharma - IEEE Transactions on Antennas and Propagation, 2021 **Abstract:** This paper addresses the angular misalignment problem in Wireless Power Transfer (WPT) systems by a magnetic field (H-field) forming approach using coil antennas. To power up a planar receiver coil in any orientation, three dimensional (3D) rotating H-field is required. Using the transmitter coil antennas with amplitude-modulated current excitations, 3D polarization of H-field is achieved. The power transfer efficiency depends on the polarization of the H-field and varies with receiver inclination. This is applicable for a spherically polarized H-field which is otherwise expected to provide uniform induced voltage in the receiver in any orientation. To completely mitigate the misalignment problem, mathematical analysis of H-field forming is presented followed by optimization of the 3D polarization. This evolves in understanding the effect of various 3D H-field polarizations on the induced voltage and results in an optimum ellipsoidal polarization achieving performance that is invariant to the receiver orientation. The results are compared for various 3D polarizations and the best performance is shown by the proposed solution. The analytically obtained results are validated through simulations and experimental studies. The results thus obtained proved the potential of the proposed optimized 3D H-field polarization in WPT systems where a free-orientation of the receiver is necessary.
34.	Optimum Placement of Relay Nodes in WBANs for Improving the QoS of Indoor RPM System A Vyas, S Pal - IEEE Sensors Journal, 2021 **Abstract:** Pandemic situation such as COVID-19 boosted the demand for remote patient monitoring (RPM) system. The medical sensors attached to the human body in RPM system experience varying channel quality due to body movements. This paper analyzes the signal received from RPM sensors when a patient rotates by different angles while sitting on a chair as well as heed the use of a relay node placed on his/her body. Literature suggests many relay-based communication protocols to deliver physio-signals efficiently in an RPM application. However, limited studies have focused on the position of a relay node on the human body. In this paper, we empirically analyze the off-body communication path of sensor nodes by collecting data from different body orientations in a residential room. We estimate the path loss parameters for underweight, normal and overweight body mass index (BMI) categories. The estimated parameters are then used to simulate the physical layer of a home-based indoor RPM application. We inspect different relay node positions on the human body and allude an optimal position of

	the relay node that cover the transmission range of all sensors and provides an improved channel quality. We improve the Quality of Service (QoS) during non-line-of-sight (NLOS) situation and design an adaptive cross-layer communication protocol for WBANs.
35.	QoS Driven Task Offloading and Resource Allocation at Edge Servers in RAN Slicing S Saibharath, S Mishra, C Hota - IEEE 18th Annual Consumer Communications & Networking Conference, 2021 **Abstract:** Task offloading results in the remote execution of tasks, thereby reducing the load on the lower capacity devices and mobile instruments. The offloaded tasks to edge servers in RANs get executed in container-based virtualization technologies. In this paper, we examine traffic offtoading and scheduling, where we investigate QoS-based traffic assignment to edge servers in network slices. We propose an ensemble method for classifying through Multiple Attribute Decision Making (MADM), Single Attribute Categorization (SAC), and fuzzy rules. Then, we apply enhanced weighted Borda scoring to categorize the task into its priority class, which are placed in their respective Kafka topics. Finally, we present a probabilistic, priority-driven Kafka-topic consumer which schedules the offloaded tasks in the edge containers. The slice-based setup constitutes of Flowvisor, Mininet, Beacon and Pox controllers, Kafka, and Docker engine. The proposed ensemble categorization exhibits 26% and 12.5% better accuracy than simple additive and multiplicative exponential weighting MADM methods. Experimental results show that the proposed scheduling methodology on average reduces long piling of medium and low priority tasks by a factor of 7% and 12% respectively.
36.	Quantum Free-Start Collision Attacks on Double Block Length Hashing with Round-Reduced AES-256 AK Chauhan, A Kumar, SK Sanadhya - IACR Transactions on Symmetric Cryptology, 2021 **Abstract:** Recently, Hosoyamada and Sasaki (EUROCRYPT 2020), and Xiaoyang Dong et al. (ASIACRYPT 2020) proposed quantum collision attacks against AES-like hashing modes AES-MMO and AES-MP. Their collision attacks are based on the quantum version of the rebound attack technique exploiting the differential trails whose probabilities are too low to be useful in the classical setting but large enough in the quantum setting. In this work, we present dedicated quantum free-start collision attacks on Hirose's double block length compression function instantiated with AES-256, namely HCF-AES-256. The best publicly known classical attack against HCF-AES-256 covers up to 9 out of 14 rounds. We present a new 10-round differential trail for HCF-AES-256 with probability 2^{-160}, and use it to find collisions with a quantum version of the rebound attack. Our attack succeeds with a time complexity of $2^{85.11}$ and requires 2^{16} qRAM in the quantum-attack setting, where an attacker can make only classical queries to the oracle and perform offline computations. We also present a quantum free-start collision attack on HCF-AES-256 with a time complexity of $2^{86.07}$ which outperforms Chailloux, Naya-Plasencia, and Schrottenloher's generic quantum collision attack (ASIACRYPT 2017) in a model when large qRAM is not available.
37.	Role of superhydrophobic coatings in biomedical applications R Kumar, AK Sahani - Materials Today: Proceedings, 2021 **Abstract:** Superhydrophobic coatings repel water and, in some cases, other liquids as well. The non-adhesiveness is actuated by topographically elements at the nano-/micro scale and low surface energy. There are various applications which use superhydrophobic coatings such as

	biomedical, marine, auto- motive and energy sectors etc. Only a few superhydrophobic coatings are suitable for the biomedical applications because of the synthesis compounds' toxic behaviour. Here, in this review, we start with a discussion of superhydrophobicity and the various aspects that are required for the development of biocompatible superhydrophobic coatings for the application of medical diagnosis, medical equipment, use in covid-19 and hospital hygiene management.
38.	Sarcasm Detection in Newspaper Headlines P Shrikhande, V Setty, A Sahani - IEEE 15th International Conference on Industrial and Information Systems, 2020 **Abstract:** Sarcasm is an important part of communication, and detecting sarcasm is difficult for humans, let alone computers. Newspapers often seem to employ sarcasm in their headlines to grab the readers' attention. However, more often than not, the readers find it difficult to detect the irony in the headlines, thus getting a wrong idea about that particular news and further passing on their understanding to their friends, colleagues, etc. Thus, a system which can automatically and reliably detect sarcasm is more important now than ever. We build sarcasm detectors using neural networks and attempt to understand how a computer learns the patterns of sarcasm. The input to our project consists of sequences that are labeled sarcastic or non-sarcastic. These sequences come from two different datasets containing news headlines and social media commentary. Our classifiers are evaluated on their accuracies. Our model performs highly and is capable of reliably classifying sarcastic or non-sarcastic phrases.
39.	Statistical Post-processing Approaches for Active Infrared Thermography: A Comparative Study K Kaur, R Mulaveesala - IEEE 11th Annual Computing and Communication Workshop and Conference, 2021 **Abstract:** Active infrared thermography is one of the favourable non-destructive testing and evaluation methods popularly being used for remote inspection of various materials/products/components/structures. It captures the temperature distribution over the test material for predefined thermal stimulus onto the surface, which is further processed to detect the sub-surface anomalies/defects hidden inside the test object. Various attempts have been made by several research groups to reveal the hidden finer subsurface features with improved sensitivity and resolution. Present work highlights a principal component analysis and its extension, robust principal component analysis to inspect for sub-surface flat-bottomed hole defects inside a mild steel sample. Further, the proposed data analysis approaches and their capabilities have been compared on the temporal thermal experimental sequence for a frequency modulated incident thermal stimulus. It is clear from the obtained results that principal component analysis outperforms the robust principal component analysis in providing the information regarding the hidden defect details lying deep inside the material with enhanced signal to noise ratio leading to increased temperature contrast over the detected sub-surface defects.
40.	Stochastic models with mixtures of tempered stable subordinators N Gupta, A Kumar, N Leonenko - Mathematical Communications, 2021 **Abstract:** In this article, we introduce mixtures of tempered stable subordinators. These mixtures define a class of subordinators which generalize tempered stable subordinators (TSS). The main properties like the probability density function (pdf), L´evy density, moments, governing Fokker-Planck-Kolmogorov (FPK) type equations and the asymptotic form of potential density are

	derived. Further, the governing FPK type equation and the asymptotic form of the renewal function for the corresponding inverse subordinator are discussed. We generalize these results to n-th order mixtures of TSS. The governing fractional difference and differential equations of the time-changed Poisson process and Brownian motion are also discussed.
41.	Stress correlations in frictional granular media A Lemaître, C Mondal, I Procaccia, S Roy - Physical Review B, 2021 **Abstract:** This paper investigates whether in frictional granular packings, like in Hamiltonian amorphous elastic solids, the stress autocorrelation matrix presents long range anisotropic contributions just as elastic Green's functions. We find that in a standard model of frictional granular packing this is not the case. We prove quite generally that mechanical balance and material isotropy constrain the stress autocorrelation matrix to be fully determined by two spatially isotropic functions: the pressure and torque autocorrelations. The pressure and torque fluctuations being, respectively, normal and hyperuniform force the stress autocorrelation to decay as the elastic Green's function. Since we find the torque fluctuations to be hyperuniform, the culprit is the pressure whose fluctuations decay slower than normally as a function of the system's size. Investigating the reason for these abnormal pressure fluctuations we discover that anomalous correlations build up already during the compression of the dilute system before jamming. Once jammed these correlations remain frozen. Whether this is true for frictional matter in general or it is the consequence of the model properties is a question that must await experimental scrutiny and possible alternative models.
42.	Synthesis and transfer of large area graphene without support layer V Ghai, H Singh, PK Agnihotri - Indian Journal of Engineering and Materials Sciences, 2020 **Abstract:** Graphene is a 2-dimensional flat sheet of carbon species confined into a honeycomb structure exhibits unique optical, electrical, thermal and mechanical properties. Graphene due to its fascinating properties finds application in the area offlexible electronics, nano-devices, health care, defence, photovoltaics and many others. In this work, graphene is grown on acopper foil using thermal chemical vapor deposition (CVD) at 1000 °C. Methane is used as a carbon source and hydrogen issupplied for the reduction of copper catalyst.Raman spectroscopy along with surface morphology and surface topologyconfirms the formation of graphene layer. Further, the fabricated graphene is directly transferred toglass substrate withoutany support layer. SEM and Raman confirms the defect-free transfer of graphene. Moreover, transferred graphene sheetshows high transparency along with hydrophobic nature with a contact angle of 93°.
43.	Synthesis of amino alcohols, cyclic urea, urethanes, and cyclic carbonates and tandem one-pot conversion of an epoxide to urethanes using a Zn–Zr bimetallic oxide catalyst GS More, R Srivastava - Sustainable Energy & Fuels, 2021 **Abstract:** The insertion of CO produces useful chemicals such as urethanes, cyclic carbonates, and cyclic urea using CO2 or urea as a sacrificial source. Synthesis of these chemicals using CO2 as a reactant requires stringent conditions such as high pressure and temperature and complicated catalyst design. Similar products can be prepared using urea as a sacrificial CO source employing simple catalysts having optimum acidity and basicity. This study demonstrates urethane synthesis directly from an epoxide using a Zn–Zr bimetallic oxide catalyst in a one-pot tandem reaction. First, amino alcohols are synthesized using the Zn–Zr catalyst, and then the amino alcohols are reacted with urea to produce urethanes using the same catalyst. Moreover,

	cyclic urea and glycerol carbonate/other cyclic carbonates are prepared by the reaction of diamine or glycerol/diols with urea. Optimum amounts of Zn and Zr having optimum acidity and basicity are required to achieve the best catalytic activity in the individual steps and one-pot tandem conversion of an epoxide to urethanes. The catalyst is efficiently recyclable with retention of activity without losing the catalytically active phase and species. A simple, solvent-free, economical, and eco-friendly catalyst affording three important chemicals, using urea as a sacrificial reactant, would attract significant scientific and industrial interest.
44.	Thermoelectric properties of half Heusler topological semi-metal LiAuTe A Yadav, S Kumar, M Muruganathan, R Kumar - EPL (Europhysics Letters), 2021 **Abstract:** In this article, we report theoretical investigations of topological and thermoelectric properties of the non-centrosymmetric compound LiAuTe which forms into a dynamically stable FCC structure of space group $F\bar{4}3m$. While HSE calculations reveal the compound as a topological semi-metal with a band inversion at the Γ-point, a high value of m_e^*/m_h^* as per its band structure calculations indicates its arising thermoelectric properties. From further investigations of thermoelectricity, the Seeback coefficient and power factor are $-136\ \mu\mathrm{V/K}$ and $2.1 \times 10^{11}\ \mathrm{W \cdot m^{-1} \cdot K^{-2} \cdot s^{-1}}$, respectively, which are comparable to those of well-known thermoelectric materials like HgTe, SnTe, etc. The theoretical investigations show that LiAuTe carries huge potentials for applications in spintronics as well as thermoelectricity, therefore needs to be synthesized and investigated experimentally.
45.	Tuning Structure, Electronic, and Catalytic Properties of Non-Metal Atom Doped Janus Transition Metal Dichalcogenides for Hydrogen Evolution SP Kaur, TJD Kumar - Applied Surface Science, 2021 **Abstract:** The doping of hetero-non-metal atoms into the conventional Transition Metal Dichalcogenide (TMD) monolayer sheets is reported to tune their structural, electronic, magnetic, and catalytic properties. Herein, the physicochemical properties of Janus MoSSe monolayer with the doping of atoms viz.B, C, N, and P are systematically studied using density functional theory. The high binding energies for the doping of non-metal atoms into TMD sheets show energetic stability of the doped Janus sheets. The doping reduces the band gaps as compared to pristine sheet because of the introduction of the bands near the Fermi region. The doping of non-metal atoms also tunes the magnetic properties of Janus nanosheets and broaden up their applications in spintronics. The catalytic activity of the Janus TMDs for Hydrogen Evolution Reaction (HER) is explored which possess inherent strain due to asymmetry. The density functional theoretical studies of the pristine and non-metal atom doped Janus TMDs as HER catalysts are reported in terms of Gibbs free energy which depends on the electronegativity of dopants. The Gibbs free energy of adsorption is tuned to 0 eV with heteroatom doping. Overall results indicate that the boron doped Janus sheet possesses reduced band gap and tunable work function which contributes to the superior catalytic performance for HER even in the absence of external strains and large basal plane vacancies.
46.	Two-step synthesis of polyurethane/multi-walled carbon nanotubes polymer composite to achieve high percentage particle reinforcement for mechanical applications D Kumar, SA Bansal, N Kumar, P Jindal - Journal of Composite Materials, 2021 **Abstract:** The present work has been aimed to synthesize Polyurethane (PU)/Multi-Walled Carbon Nanotubes (MWCNTs) composite using a two-step method to enhance mechanical

	properties. In the first step, films (0.2 mm thickness) have been synthesized using a solution mixing method to disperse MWCNTs in the PU matrix. In the second step, thin films of uniformly dispersed MWCNTs in the PU matrix have been compression molded to synthesize PU/MWCNTs composite required for real mechanical applications. The two-step method has the advantages of solution mixing as well as compression molding method. The results of quasi-static nanoindentation tests indicated that in comparison to pure PU, elastic modulus and hardness have been enhanced by 124% and 53% respectively for 10 wt% PU/MWCNTs composite. Fracture resistance of PU/MWCNTs composites, with 7 wt% of MWCNTs, has been enhanced by 52% as compared to pure PU. To understand bulk behavior, nanoindentation results have been cross-verified with compression testing. Results of compressive testing shown that the modulus of composite material has been significantly improved under the influence of the increasing composition of MWCNTs. A noticeable improvement of 52% has been observed in compressive modulus of 10 wt% composite in equivalence to pure PU. The overall improvement in mechanical behavior has been attributed to the uniform dispersion of MWCNTs in the PU matrix by the two-step synthesis method.
47.	Unsteady motion past a sphere translating steadily in wormlike micellar solutions: a numerical analysis C Sasmal - Journal of Fluid Mechanics, 2021 **Abstract:** This study numerically investigates the flow characteristics past a solid and smooth sphere translating steadily along the axis of a cylindrical tube filled with wormlike micellar solutions in the creeping flow regime. The two-species Vasquez–Cook–McKinley and single-species Giesekus constitutive models are used to characterize the rheological behaviour of the micellar solutions. Once the Weissenberg number exceeds a critical value, an unsteady motion downstream of the sphere is observed in the case of the two-species model. We provide evidence that this unsteady motion downstream of the sphere is caused by the sudden rupture of long and stretched micelles in this region, resulting from an increase in the extensional flow strength. The corresponding single-species Giesekus model for the wormlike micellar solution, with no breakage and reformation, predicts a steady flow field under otherwise identical conditions. Therefore, it further provides evidence presented herein for the onset of this unsteady motion. Furthermore, we find that the onset of this unsteady motion downstream of the sphere is delayed as the ratio of sphere to tube diameter decreases. A similar kind of unsteady motion has also been observed in several earlier experiments for the problem of a sphere sedimenting in a tube filled with wormlike micellar solutions. We find a remarkable qualitative similarity in the flow characteristics between the present numerical results for a steadily translating sphere and prior experimental results for a falling sphere. 

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