# BOOK OF ABSTRACT

## 4TH INTERNATIONAL CONFERENCE

## on

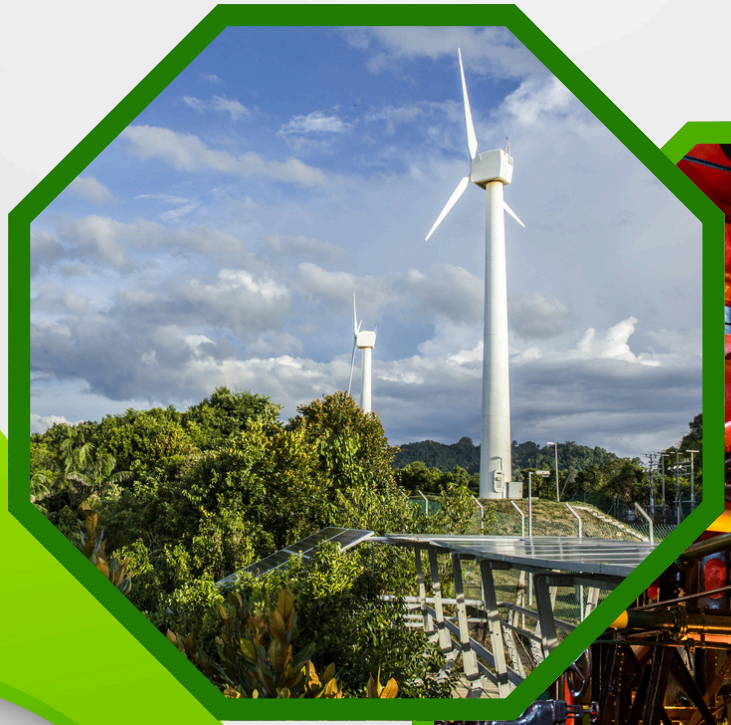
## INDUSTRIAL ENGINEERING AND MECHANICAL POWER

## IEMPOWER 2025

[18TH JULY - 20TH JULY, 2025]

**ORGANIZED BY**

**DEPARTMENT OF MECHANICAL ENGINEERING**
**INSTITUTE OF ENGINEERING & MANAGEMENT, KOLKATA**
**SCHOOL OF UNIVERSITY OF ENGINEERING AND MANAGEMENT**



# 4TH INTERNATIONAL CONFERENCE
# ON
# INDUSTRIAL ENGINEERING AND MECHANICAL POWER

# IEMPOWER 2025

## 18th July - 20th July, 2025 | Kolkata, West Bengal, India

organized by

INSTITUTE OF ENGINEERING & MANAGEMENT
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UNIVERSITY OF ENGINEERING & MANAGEMENT
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INSTITUTE OF ENGINEERING & MANAGEMENT, KOLKATA
SCHOOL OF UNIVERSITY OF ENGINEERING AND MANAGEMENT

## Co-Hosted by

SMART Society, USA
American Society of Heating, Refrigeration, and Air Conditioning Engineers
(ASHRAE) East India Chapter

## Partners

Climate Change Research (CoE_CCR)
IEM Institute of Fundamental Research (CoE_IIFR)
Additive Manufacturing (CoE_AM)
Atal Community Innovation Center (CoE_ACIC)

# PREFACE

We are delighted to welcome you to the fourth edition of our conference, Industrial Engineering & Mechanical Power (IEMPOWER), which this year is thoughtfully structured around three transformative themes central to the future of global industry and technology: Smart Manufacturing & Industrial Engineering, Sustainable Energy Transition, and Advanced Mechanical Systems Design. Our primary goal is to foster a dynamic environment that facilitates knowledge sharing, inspires collaboration, sparks innovation, and bridges the gap between academia and industry. The remarkable global attention IEMPOWER 2025 has received highlights its growing academic relevance within the engineering community. We extend our sincere gratitude to the authors for their insightful contributions, the reviewers for their meticulous evaluations, and all contributors for their invaluable support in making this event a vibrant platform for innovation. This year, the conference received 337 submissions, from which 92 outstanding papers were selected for presentation and publication in association with Springer. The comprehensive program includes 6 distinguished keynote lectures, 12 technical sessions, and engaging industry sessions featuring 4 insightful talks and an interactive panel discussion. The keynote lectures will be delivered by Prof. Dr. Dilip Kumar Pratihar on Drone Technology, Prof. J. K. Dutt on Active Vibration Control, Prof. Sudipta De on Hybrid Renewable Systems, Prof. Fausto Pedro García Márquez on Cloud Intelligence, Prof. Len Gelman on Vibro-Acoustic Signal Processing, and Prof. Mustafizur Rahman on Innovation for Sustainable Development. We look forward to stimulating discussions, thought-provoking presentations, and the emergence of groundbreaking ideas as we collectively strive toward developing intelligent, sustainable, and inclusive engineering solutions.

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# MESSAGE

## Chief Patron

*Prof. Banani Chakrabarti*

*President, Institute of Engineering & Management, Kolkata, India*

Good Afternoon

Respected dignitaries on the dias, all the faculty members of IEM-UEM group & my dear students, I welcome you all to the 9th International Conference on Industrial Engineering & Mechanical Power,

IEMPOWER 2025This gathering brings together the brilliant minds from academia, industry & research in engineering through collaboration & cutting-edge thinking.The theme of this Conference – Smart manufacturing, sustainable energy and advanced mechanical systems are deeply aligned with the evolving needs of modern industry & society.This Conference is not just a platform to exchange ideas – It's a spark to ignite new ones. Let us have this opportunity to learn, network and shape the future together.Once the famous Henry Ford said “Coming together is a beginning, staying together is progress & working together is success.”I extend my best wishes to all participants and organizers, of IEMPOWER 2025

# MESSAGE

**Patron**

*Prof. (Dr.) Satyajit Chakrabarti*

*Director of Institute of Engineering & Management, Kolkata.*

It is with great enthusiasm that I lend my support to the 4th International Conference on Industrial Engineering & Mechanical Power (IEMPOWER-2025), hosted by the Institute of Engineering & Management (IEM), Kolkata, from July 18–20, 2025.

As humanity stands at the threshold of a new industrial era, the fusion of intelligent engineering and sustainable energy presents unprecedented opportunities to reshape the future.IEMPOWER-2025 emerges as a beacon for this transformation—bringing together visionary thinkers, innovators, and changemakers to explore pathways that will define tomorrow's global landscape.

Themes such as Industry 4.0, AI-powered innovation, energy-efficiency, and decarbonization are more than technological trends—they represent the foundation for a smarter, cleaner, and more resilient world. This conference is a catalyst for bold ideas and collaborative breakthroughs that transcend borders and disciplines.

To every delegate, scholar, and industry partner, I offer my heartfelt wishes for a conference that sparks inspiration, nurtures discovery, and ignites enduring partnerships. May your contributions illuminate new horizons and play a pivotal role in building a future powered by intelligence, sustainability, and shared purpose.

# MESSAGE

## Organizing Chair

*Prof. Dr. Arun Kumar Bar, Principal*
*Institute Of Engineering & Management, Kolkata, India*

With great enthusiasm and a deep sense of responsibility, I welcome you all to the 4th edition of the International Conference on Industrial Engineering & Mechanical Power (IEMPOWER-2025), hosted by the Department of Mechanical Engineering, Institute of Engineering & Management (IEM), Kolkata.

This year's conference has been thoughtfully structured around three transformative themes: Smart Manufacturing & Industrial Engineering, Sustainable Energy Transition, and Advanced Mechanical Systems Design. These areas are not just academic domains—they represent the future of global industry and technology. Our goal with IEMPOWER-2025 is to go beyond conventional knowledge-sharing and create a dynamic environment that inspires collaboration, sparks innovation, and bridges the gap between academia and industry.

Organizing this conference has been a journey of shared commitment and teamwork. I sincerely appreciate the efforts of our technical committee, reviewers, and organizing team who have worked diligently to ensure the quality and diversity of the conference program. My heartfelt thanks also go to our keynote speakers, session chairs, and international contributors who have enriched this platform with their insights.

IEMPOWER-2025 is not just a conference—it is a movement toward building intelligent, sustainable, and inclusive engineering solutions. I look forward to the engaging discussions, thought-provoking presentations, and new ideas that will emerge over these three days.

# MESSAGE

## Organizing Co-Chair

*Prof. Dr. Dwaipayan De,*
*HoD of Department of Mechanical Engineering*
*Institute of Engineering & Management, Kolkata, India*

As the Head of Mechanical Engineering, I am thrilled to lead IEMPOWER 2025, focusing on Decarbonization, Sustainability, Innovations, Artificial Intelligence, Machine Learning and Smart Manufacturing. Our department aims to drive technological advancements for a sustainable future. IEMPOWER 2025 provides a platform for experts to share knowledge, collaborate, and shape sustainable technologies.

I expect innovative ideas, interdisciplinary research and accelerated transition to a low carbon economy. We will engage with researchers, industry experts and policymakers to discuss cutting edge solutions and practical applications. Participants will explore latest developments in mechanical engineering and related fields, contributing to the global sustainability conversation.

I believe GenAI and smart manufacturing will play crucial roles in achieving sustainability goals. Let's harness innovation to create a better future. I look forward to engaging discussions and collaborations at IEMPOWER 2025.

# MESSAGE

Manoj Chakravorti

*Founder President ASHRAE East India Chapter*

It gives me immense pleasure to see the effort of Institute of Engineering and Management to stage 4th International Conference on Industrial Engineering & Mechanical Power. The theme of this year conference is "Energy Transition and Decarbonisation". It is in a broad way responsible to build environment and are burning issue of the society. I am sure this conference will create phenomenal awareness of the stakeholder of the society. Dissemination of knowledge and technology among the people will sure help our society. Various discussion and presentation from knowledgeable bank, viz. technical expert, researcher will enrich the knowledge level of the participant and reduce the gap in knowledge to a great extent. Papers on energy efficiency, renewable energy generation and application, low energy HVAC&R system and cooling solution, climate resilience-built environments, decarbonising and cold chain food processing, etc., will be very useful in the present era. I am sure that lot of answers of many questions will be cleared at the end of the conference.

I wish the conference a great success and productive.

# MESSAGE


Manish Tewari

*President , ASHRAE East India Chapter*


It is with great enthusiasm and honor that I welcome you all to the 4th International Conference on Industrial Engineering & Mechanical Power (IEMPOWER 2025), organized by the Mechanical Engineering Department, IEM and UEM Kolkata, in collaboration with ASHRAE East India Chapter.

At ASHRAE, we believe that collaboration is the cornerstone of innovation. This conference, themed around Energy Transition and Decarbonization, aligns perfectly with our mission to advance the arts and sciences of heating, ventilation, air conditioning, refrigeration (HVAC&R), and allied fields for the benefit of humanity and a sustainable world.

In an era defined by urgent environmental challenges and rapid technological advancement, this platform provides a crucial opportunity for industry professionals, researchers, faculty members, and students to come together to share insights, ignite ideas, and foster groundbreaking solutions. The hybrid mode of this conference ensures inclusivity and accessibility for global participation—something we deeply value in our chapter's vision.

IEMPOWER 2025 will serve as a hub for dynamic discussions around renewable energy systems, resilient infrastructure, low-energy HVAC&R solutions, and the vital role of AI and machine learning in sustainable design. I look forward to engaging with you all during the sessions, keynotes, and technical exchanges that promise to drive real-world impact.

On behalf of the ASHRAE East India Chapter, I thank IEM and UEM Kolkata for this collaborative effort, and I encourage each participant to immerse themselves fully in the spirit of learning, networking, and innovation that defines IEMPOWER.

Let us collectively commit to engineering a cleaner, smarter, and more sustainable future.

# MESSAGE

***Convenor***
*Dr. Bikash choudhuri*
*Associate Professor, Mechanical Engineering Dept., IEM*

I am delighted to extend a warm welcome to all participants of IEMPOWER 2025. This year, the conference has garnered remarkable global attention—reaching over 5000 researchers from 20+ countries and receiving 337 paper submissions. The conference is structured around three transformative tracks that reflect the evolving landscape of engineering and technology. The Industrial Engineering & Smart Manufacturing track explores cutting-edge developments in Industry 4.0, Industrial Internet of Things (IIoT), green and sustainable manufacturing practices, additive and hybrid manufacturing, and the integration of AI in production systems. The Sustainable Energy Transition and Decarbonization track focuses on clean and renewable energy technologies, smart energy systems, climate-resilient infrastructure, and data-driven approaches for decarbonization across sectors such as transportation, buildings, and agriculture. Meanwhile, the Mechanical Systems: Design & Analysis track brings attention to advanced innovations in intelligent diagnostics, robotics and automation, aerospace engineering, biomechanics, and smart materials, offering insights into both theoretical advancements and real-world applications. Following a rigorous peer-review process, 92 high-quality papers have been accepted for presentation.

This achievement reflects the growing impact and academic relevance of the conference. I thank all authors, reviewers, and contributors for their valuable support in making IEMPOWER 2025 a truly vibrant and collaborative platform.

# KEYNOTE SPEAKER

## KEYNOTE SPEAKERS

*Prof. Dilip Kumar Pratihar*

*Prof. Jayanta Kumar Dutt*

*Prof. Sudipta De*

*Prof. Fausto Pedro García Márquez*

*Prof. Len Gelman*

*Prof. Mustafizur Rahman*

## Industrial Session Talk

*Manoj Chakravorti*

*Manish Tewari*

*Dr. Himadri Guha*

*Dr. Arup Bhattacharya*

# SCHEDULE

4th International Conference
on
## Industrial Engineering and Mechanical Power
## (IEMPOWER-2025)
(18th - 20th July, 2025)
Mechanical Engineering Department
Institute of Engineering & Management, Kolkata

## PROGRAM SCHEDULE

# Day 1 (18.07.25)

| Time | Event |
|---|---|
| 04:00 PM-04:30 PM | **Registration** |
| 04:30 PM - 05:45 PM<br><br>*Meeting ID:*<br>Zoom Meeting Link<br>https://us06web.zoom.us/j/84003754681?pwd=TMfFO8frl1MB1XJEaiTJbatbTYa7KR.1<br><br>Meeting ID: 840 0375 4681<br>Passcode: 443319 | INAUGURAL SPEECH<br>**Prof. Dr. Satyajit Chakraborty, Director, IEM,**<br>Chief Patron- IEMPOWER2025 |
| | **Prof. Banani Chakraborty, President, IEM** |
| | WELCOME ADDRESS<br>**Prof. Dr. Arun Kumar Bar,** Principal, IEM,<br>Chair- IEMPOWER2025 |
| | CONFERENCE SUMMARY<br>**Dr. Bikash Choudhuri,** Convener- IEMPOWER2025 |
| | ASHRAE REPRESENTATIVE<br>**Mr. Debajoyti Dey**<br>AVP - ABS Fujitsu General Private Limited<br>**Mr. Shankha Bhattacharyya**<br>CEO Satya Aircon & Engg Services Pvt Ltd |
| | **AWARD CEREMONY**<br>**ENGINEERING EXCELLENCE AWARD**<br>**Prof. Dr. Dilip Kumar Pratihar** (Academy)<br>Professor, Mechanical Engineering Department<br>Indian Institute of Technology, Kharagpur<br>**Prof. Dr. Jayanta Kumar Dutt** (Academy)<br>Emeritus Professor, Mechanical Engineering Department,<br>Indian Institute of Technology Delhi, India<br>**Dr. Himadri Guha**, PhD (Industry)<br>Consultant, Author, Former faculty Jadavpur university,<br>**Dr. Arup Bhattacharya**, PhD (Emerging Engineer)<br>Holder of the Performance Contractors Professorship<br>Bert S. Turner Department of Construction Management<br>Louisiana State University |
| | **VOTE OF THANKS**<br>**Prof. Dr. Dwaipayan De**, HOD, ME, IEM, Kolkata & Co-Chair- IEMPOWER 2025 |
| (05:45 PM - 06:30 PM) | **KEYNOTE LECTURE 1**<br>Speaker: Prof. Dr. Dilip Kumar Pratihar |

# SCHEDULE

**4th International Conference**
**on**
## Industrial Engineering and Mechanical Power
## (IEMPOWER-2025)
**(18th - 20th July, 2025)**
**Mechanical Engineering Department**
**Institute of Engineering & Management, Kolkata**

| | |
|---|---|
| | Topic: Fundamentals of Drone Technology<br>**Session Coordinator:**<br>Dr. Aparajita Mukherjee |
| **06:30 PM – 07:00 PM** | HIGH TEA |

# Day 2 (19.07.25)

| | |
|---|---|
| 08:45 AM - 09:00 AM: | Registration<br>(1st Floor of IEM Management House) |
| 09:00 AM – 09:15 AM | TEA SESSION |
| **TECHNICAL SESSION 1** | |
| **09:15 AM - 11:30 AM**<br><br>*Meeting ID:*<br>https://us06web.zoom.us/j/89306235094?pwd=faQkJWuNh2DJtyV8fBR5LaI7n7DbaA.1 | **TECHNICAL SESSION 1A**<br>**Session Chairs:**<br>Prof. Dr. Debasish Das, Assistant Professor<br>Mechanical Engineering Department, IIEST Shibpur<br>**Session Co-Chair:**<br>Dr. Ruma Sen, Mechanical Engineering Department, IEM Kolkata<br>**Rapporteur:**<br>Prof. Barun Das, Mechanical Engineering Department, IEM Kolkata |
| **09:15 AM - 11:30 AM**<br><br>*Meeting ID:*<br>https://us06web.zoom.us/j/4109219194#success | **TECHNICAL SESSION 1B**<br>**Session Chairs:**<br>Dr. Shirshendu Mondal, Mechanical Department, NIT Durgapur<br>**Session Co-Chair:**<br>Dr. Sananda Pal, BSH Department, IEM Newtown, UEM Kolkata<br>**Rapporteur:**<br>Prof. Joydip Ray, Mechanical Engineering Department, IEM Kolkata |
| **09:15 AM - 11:30 AM**<br><br>*Meeting ID:*<br>https://us06web.zoom.us/j/89492854690?pwd=Dt40RIbp0CffXbDalmOOdaQRju5nL7.1 | **TECHNICAL SESSION 1C**<br>**Session Chairs:**<br>Dr. Anirban Mitra, Jadavpur University<br>**Session Co-Chair:**<br>Dr. Subho Mukherjee, IEM Kolkata<br>**Rapporteur:**<br>Kunal Dey, IEM Kolkata |
| **KEYNOTE SESSION** | |

# SCHEDULE

**4th International Conference**
**on**
## Industrial Engineering and Mechanical Power
## (IEMPOWER-2025)
**(18th - 20th July, 2025)**
**Mechanical Engineering Department**
**Institute of Engineering & Management, Kolkata**

| | |
|---|---|
| **11:30 AM – 01:30 PM**<br>*Meeting ID:*<br>Zoom Meeting Link<br>https://us06web.zoom.us/j/84003754681?pwd=TMfFO8frl1MB1XJEaiTJbatbTYa7KR.1<br>Meeting ID: 840 0375 4681<br>Passcode: 443319 | **KEYNOTE LECTURE 2**<br>**(11:30 AM - 12:15 PM)**<br>**Speaker: Prof. J. K. Dutt**<br>Topic: Aspects of Active Vibration Control of Rotors, Some Experiments and Effects of Novel Control Law(s) for Rotor Vibration Control<br>**Session Coordinator:** Dr. Subho Mukherjee |
| | **KEYNOTE LECTURE 3**<br>**(12:15 PM- 01:00 PM)**<br>**Speaker: Prof. Sudipta De**<br>Topic: Role of Distributed Hybrid Renewable Systems for Sustainable Energy Transition<br>**Session Coordinator:** Dr. Rahul Baidya |
| | **KEYNOTE LECTURE 4 (ONLINE)**<br>**(01:00 PM - 01:30 PM)**<br>**Speaker: Prof. Fausto Pedro García Márquez**<br>Full Professor (Catedrático de Universidad)<br>University of Castilla La Mancha (UCLM)<br>Topic: Intelligence in the Cloud, Insight in the Depths<br>**Session Coordinator:** Dr. Somnath De |
| 1.30 PM-2.15 PM | LUNCH BREAK |
| **TECHNICAL SESSION 2** | |
| **2:00 to 3:00 PM**<br>https://us06web.zoom.us/j/89306235094?pwd=faQkJWuNh2DJtyV8fBR5LaI7n7DbaA.1 | **TECHNICAL SESSION 2A**<br>**Session Chairs:**<br>Dr. Biplab Ranjan Sarkar, JU, Production Engineering dept.<br>**Session Co-Chair:**<br>Dr. Asim Dhar, Mechanical Engineering Department, IEM Kolkata<br>**Rapporteur:**<br>Mr. Pinaki Mukherjee, ME, IEM |

# SCHEDULE

**4th International Conference**
**on**
## Industrial Engineering and Mechanical Power
## (IEMPOWER-2025)
**(18th - 20th July, 2025)**
**Mechanical Engineering Department**
**Institute of Engineering & Management, Kolkata**

| | |
|---|---|
| **2:00 to 3:00 PM**<br>https://us06web.zoom.us/j/4109219194#success | **TECHNICAL SESSION 2B**<br>**Session Chairs:**<br>Dr. Dibakar Rakshit,<br>Mechanical Engineering Department, IIT Delhi<br>**Session Co-Chair:**<br>Dr. Kaustav Pradhan, IIEST Shibpur<br>**Rapporteur:**<br>Dr. Abanti Datta, IEM Kolkata |
| **2:00 to 3:00 PM**<br>https://us06web.zoom.us/j/89492854690?pwd=Dt40RIbp0CffXbDalmOOdaQRju5nL7.1 | **TECHNICAL SESSION 2C**<br>**Session Chairs:**<br>Dr. Bidyut Pal, IIEST Shibpur<br>**Session Co-chair:**<br>Dr.Aparajita Mukherjee, ME Department, IEM Kolkata<br>**Rapporteur:**<br>Prof. Ranit Karmakar, IEM Kolkata |
| **03:00 PM - 05:00 PM**<br>*Meeting ID:*<br>Zoom Meeting Link<br>https://us06web.zoom.us/j/84003754681?pwd=TMfFO8frl1MB1XJEaiTJbatbTYa7KR.1<br>Meeting ID: 840 0375 4681<br>Passcode: 443319 | **INDUSTRY SESSION**<br>**Industry Talk (03:00 PM- 04:15 PM)**<br>Mr. Manish Tiwari<br>**Manoj Chakravorti-** Founder President of ASHRAE East India Chapter<br>**Dr. Himadri Guha**<br>Consultant, Author, Former faculty Jadavpur university,<br>**Dr. Arup Bhattacharya**<br>Holder of the Performance Contractors Professorship<br>Bert S. Turner Department of Construction Management<br>Louisiana State University |
| | **Panel Discussion (04:15 PM- 05:00 PM)**<br>**Topic:** Decoding Decarbonization pathway for Indian Industry<br>Dr. Himadri Guha, PhD (Industry)<br>Consultant, Author, Former faculty Jadavpur university,<br>**Panelist:**<br>Manoj Chakravorti- Founder President of ASHRAE East India Chapter<br>Mr. Krishna Kumar Mitra- President- Lloyd Insulations<br>Sandipa Lahiri Anand- Head EHS and Sustainability, Vikram Solar<br>Dr. Sambhu Prasad Chakrabarty- Dean, Department of Law, University of Engineering and Management, Kolkata |
| **05:00 PM - 05:30 PM:** | **KEYNOTE LECTURE 5 (ONLINE)**<br>Speaker: Prof. Len Gelman |

# SCHEDULE

**4th International Conference**
**on**
## Industrial Engineering and Mechanical Power
## (IEMPOWER-2025)
**(18th - 20th July, 2025)**
**Mechanical Engineering Department**
**Institute of Engineering & Management, Kolkata**

| | |
|---|---|
| *Meeting ID:*<br>Zoom Meeting Link<br>https://us06web.zoom.us/j/84003754681?pwd=TMfFO8frl1MB1XJEaiTJbatbTYa7KR.1<br><br>Meeting ID: 840 0375 4681<br>Passcode: 443319 | Chair in Signal Processing and Condition Monitoring, The Director, the Centre for Efficiency and Performance Engineering, The Executive Director, the International Society for Condition Monitoring.<br>Topic: Step Forward in Higher Order Processing for Vibro-Acoustics: Novel Nonlinear Higher Order Frequency Response Functions<br>Session Coordinator: Dr. Subho Mukherjee |
| **05:30 PM- 06:00 PM** | TEA SESSION |

# Day 3 (20.07.25)

| | |
|---|---|
| **08.45 AM - 09:00 AM:** | REGISTRATION<br>1st Floor of IEM Management House |
| **09.00 AM- 09.15 AM** | TEA SESSION |
| **TECHNICAL SESSION 3** | |
| **09:15 AM - 11:30 AM:**<br>https://us06web.zoom.us/j/89306235094?pwd=faQkJWuNh2DJtyV8fBR5LaI7n7DbaA.1 | **TECHNICAL SESSION 3A**<br>**Session Chairs:**<br>Dr. Ranjib Biswas, Associate Professor, JU<br>**Session Co-chair**<br>Dr. Asim Dhar, Mechanical Engineering Department, IEM Kolkata<br>**Rapporteur:**<br>Prof. Barun Das, Mechanical Engineering Department, IEM Kolkata |
| **09:15 AM - 11:30 AM:**<br>https://us06web.zoom.us/j/4109219194#success | **TECHNICAL SESSION 3B**<br>**Session Chairs:**<br>Dr. Aranyak Chakravarty, JU<br>**Session Co-Chair:**<br>Dr. Tina De, BSH, IEM Kolkata<br>**Rapporteur:**<br>Prof. Joydip Ray, Mechanical Engineering Department, IEM Kolkata |
| **09:15 AM - 11:30 AM:**<br>https://us06web.zoom.us/j/89492854690?pwd=Dt40RIbp0CffXbDalmOOdaQRju5nL7.1 | **TECHNICAL SESSION 3C**<br>**Session Chairs:**<br>Dr. Hareram Lohar, JU<br>**Session Co-Chair:**<br>Dr. Suman Pal, IEM Kolkata<br>**Rapporteur:**<br>Mr. Pinaki Mukherjee, ME, IEM |

# SCHEDULE

4th International Conference
on
## Industrial Engineering and Mechanical Power (IEMPOWER-2025)
(18th - 20th July, 2025)
Mechanical Engineering Department
Institute of Engineering & Management, Kolkata

| | |
|---|---|
| **11:30 – 12:00 PM**<br>*Meeting ID:*<br>Zoom Meeting Link<br>https://us06web.zoom.us/j/84003754681?pwd=TMfFO8frl1MB1XJEaiTJbatbTYa7KR.1<br>Meeting ID: 840 0375 4681<br>Passcode: 443319 | **KEYNOTE LECTURE 6 (ONLINE)**<br>Speaker: Prof. Mustafizur Rahman<br>Rtd. Professor, National University of Singapore,<br>Director, Mikrotools Pte Ltd.<br>Topic: Role of industrial and mechanical engineers for sustainable development through innovation<br>Session Coordinator: Dr. Anubhab Sinha |
| | |
| **TECHNICAL SESSION 4** | |
| **12:00 PM - 01:30 PM:**<br>https://us06web.zoom.us/j/89306235094?pwd=faQkJWuNh2DJtyV8fBR5LaI7n7DbaA.1 | **TECHNICAL SESSION 4A**<br>**Session Chairs:**<br>Dr. Mukesh Kumar, ME Department, IIEST Shibpur<br>**Session Co-chair:**<br>Dr. Rahul Baidya, IEM Kolkata<br>**Rapporteur:**<br>Prof. Ranit Karmakar, IEM Kolkata |
| **12:00 PM - 01:30 PM:**<br>https://us06web.zoom.us/j/4109219194#success | **TECHNICAL SESSION 4B**<br>**Session Chairs:**<br>Prof. Dr. Sourav Sarkar, JU<br>**Session Co-chair:**<br>Dr. Somnath De, IEM Kolkata<br>**Rapporteur:**<br>Dr. Partha Sarathi De, IEM Kolkata |
| **12:00 PM - 01:30 PM:**<br>https://us06web.zoom.us/j/89492854690?pwd=Dt40RIbp0CffXbDalmOOdaQRju5nL7.1 | **TECHNICAL SESSION 4C**<br>**Session Chairs:**<br>Dr. Masud Rana, CGEC<br>**Session Co-Chair:**<br>Dr. Tanima Bhowmik, CSE(AIML), IEM Kolkata<br>**Rapporteur:**<br>Mr. Kunal Dey, IEM Kolkata |
| 01:30 PM-02:30 PM | LUNCH BREAK |
| **02:30 PM - 03:00 PM:** | **App Design Challenge**<br>Dr. Aparajita Mukherjee |
| **03:00 PM - 04:00 PM:** | Workshop: Design for Decarbonization<br>Mr. Niladri Mukherjee |
| **04:00 PM - 05:00 PM:** | VALEDICTORY SESSION<br>CERTIFICATES AND AWARD DISTRIBUTION CEREMONY |

Note:

- The online presentations will be conducted via Zoom using the meeting link provided in the schedule.

# SCHEDULE

**4th International Conference**
**on**
## Industrial Engineering and Mechanical Power (IEMPOWER-2025)
**(18th - 20th July, 2025)**
**Mechanical Engineering Department**
**Institute of Engineering & Management, Kolkata**

- The programme schedule mentioned above follows Indian Standard Time (IST).
- Presentations must be delivered in PowerPoint format (.ppt or .pptx).
- Each presentation is allotted 10 minutes, followed by a 2-minute Q&A session.
- Participants are requested to join the Zoom session at least 10 minutes before their scheduled time.
- All the registered participants are expected to join all three days conference proceeding.

ORGANISED BY

Department of Mechanical Engineering,
Institute of Engineering & Management, Kolkata School of
University of Engineering and Management, Kolkata

IN COLLABORATION WITH

Smart Society, USA
ASHRAE East India Chapter
IIFR COE
Climate Change COE
Additive Manufacturing COE

Contact: Dr. Bikash Choudhuri (8787330883), Dr. Gunjan Kumar (8100684693), Dr. Tamonash Jana (9749963068)

# SCHEDULE

## IEMPOWER 2025- Technical Session Presentation Schedule
## Venue - 1st Floor Management House IEM Salt Lake

| | Technical Session No. | Session Chair | Abstract No. | Meeting Link |
|---|---|---|---|---|
| DAY 2 (19.07.25) | **1A (09:15 AM - 11:30 AM)** | Dr. Debasish Das, IIEST Shibpur | 77, 341, 130, 326, 136, 195, 175, 42, 132, 83 | https://us06web.zoom.us/j/89306235094?pwd=faQkJWuNh2DJtyV8fBR5LaI7n7DbaA.1 |
| | **1B (09:15 AM - 11:30 AM)** | Dr. Shirshendu Mondal, NIT Durgapur | 166, 117, 98, 185, 315, 248, 245, 317 | https://us06web.zoom.us/j/4109219194#success |
| | **1C (09:15 AM - 11:30 AM)** | Dr. Anirban Mitra, Jadavpur University | 125, 190, 197, 266, 314, 327, 342, 311 | https://us06web.zoom.us/j/89492854690?pwd=Dt40RIbp0CffXbDaImOOdaQRju5nL7.1 |
| | **2A (02:00 PM - 03:00 PM)** | Dr. Bipab Ranjan Sarkar, Jadavpur University | 205, 215, 92, 312, 208 | https://us06web.zoom.us/j/89306235094?pwd=faQkJWuNh2DJtyV8fBR5LaI7n7DbaA.1 |
| | **2B (02:00 PM - 03:00 PM)** | Dr. Dibakar Rakshit, IIT Delhi | 124, 321, 103, 157, 322 | https://us06web.zoom.us/j/4109219194#success |
| | **2C (2:00 to 3:00 PM)** | Dr. Bidyut Pal, IIEST Shibpur | 65, 198, 264, 287, 333 | https://us06web.zoom.us/j/89492854690?pwd=Dt40RIbp0CffXbDaImOOdaQRju5nL7.1 |
| DAY 3 (20.07.25) | **3A (09:15 AM - 11:30 AM)** | Dr. Ranjib Biswas, Jadavpur University | 196, 324, 209, 331, 329, 330, 334, 219, 106, 108, 254 | https://us06web.zoom.us/j/89306235094?pwd=faQkJWuNh2DJtyV8fBR5LaI7n7DbaA.1 |
| | **3B (09:15 AM - 11:30 AM)** | Dr. Aranyak Chakravarty, Jadavpur University | 39, 232, 159, 193, 101, 110, 288, 268 | https://us06web.zoom.us/j/4109219194#success |
| | **3C (09:15 AM - 11:30 AM)** | Dr. Hareram Lohar, Jadavpur University | 79, 139, 278, 283, 210, 271, 253 | https://us06web.zoom.us/j/89492854690?pwd=Dt40RIbp0CffXbDaImOOdaQRju5nL7.1 |
| | **4A (12:00 PM - 01:30 PM)** | Dr. Mukesh Kumar, IIEST Shibpur | 143, 96, 184, 170, 137, 255, 61, 37 | https://us06web.zoom.us/j/89306235094?pwd=faQkJWuNh2DJtyV8fBR5LaI7n7DbaA.1 |
| | **4B (12:00 PM - 01:30 PM)** | Dr. Sourav Sarkar, Jadavpur University | 148, 129, 165, 91, 319, 282, 100, 187, 156 | https://us06web.zoom.us/j/4109219194#success |
| | **4C (12:00 PM - 01:30 PM)** | Dr. Masud Rana, Cooch Behar Government Engineering College | 109, 71, 57, 241, 206, 180, 149, 53 | https://us06web.zoom.us/j/89492854690?pwd=Dt40RIbp0CffXbDaImOOdaQRju5nL7.1 |

**Registered offline presenters are required to be physically present at the venue for their presentation**

**No alteration will be done in Mode of Presentation**

**The online presentations will be conducted via Zoom using the meeting link provided in the schedule.**

**The programme schedule mentioned above follows Indian Standard Time (IST).**

**Presentations must be delivered in PowerPoint format (.ppt or .pptx).**

**Each presentation is allotted 10 minutes, followed by a 2-minute Q&A session.**

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**All the registered participants are expected to join all three days conference proceeding.**

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# KEYNOTE SPEAKER


## Prof. Dilip Kumar Pratihar

*Professor, Department of Mechanical Engineering*
*Indian Institute of Technology Kharagpur, India*


### Fundamentals of Drone Technology

Drone is an Unmanned Aerial Vehicle (UAV), which performs its tasks either through remote Human control or autonomously. Being a 3-D object in 3-D space (that is, in Air), a Drone has 6 dof – three are used for its position and the remaining three utilized for its orientation information. A Drone is required to navigate in the Forward or Backward direction; Upward or Downward direction; and take its Left or Right turn, as the situation demands, while performing some pre-specified tasks. The concept of flight and working principle of a Drone will be discussed in detail. The concept of flight for the Drones involves the principles of Aerodynamics (Lift, Drag, Dynamic Stability), Control, Propulsion, and Navigation. Drones have been developed in two different forms: one with the fixed wings, and the other one having the rotatable blades with tilting facility. The principle of generating the Roll, Pitch and Yaw movements of a Drone will be explained in detail. A Drone consists of various components like propellers, GPS (which provides position, altitude and speed information), IMUs (used to measure the change in the Drone's Velocity/Acceleration and orientation), Camera, Sensors (namely Lidar sensor, ultrasonic sensor, stereo-vision sensor, infrared sensor etc.), Battery, Barometer (to measure the pressure), Compass (to maintain its heading and orientation). Moreover, a Drone faces some difficult tasks during its navigation, as it moves through Air, which is compressible in nature. Therefore, the control of a Drone after maintaining its dynamic stability is not an easy task. The Drones can be used for the search and rescue operations, package delivery, aerial mapping, construction inspection, weather forecasting, agricultural activities, wildlife Monitoring, land surveying, others. A video related to the real experiments carried out by us at IIT Kharagpur will be played towards the end of this lecture.

# KEYNOTE SPEAKER

Prof. Jayanta Kumar Dutt
*Emeritus Professor, Department of Mechanical Engineering*
*Indian Institute of Technology, Delhi*

## Aspects of Active Vibration Control of Rotors, Some Experiments and Effects of Novel Control Law(s) for Rotor Vibration Control

I began my research work with the idea of stabilizing a rotor system, which is generally (though may not be always) a long continuous rotating body supported on bearings, and is subject to different forces of excitations, categorized under 'external' and 'internal' excitations, and under these the rotor tends to vibrate, sometimes within the acceptable bounds and sometimes, though seldom, beyond acceptable limits causing operational difficulties, unwanted noise and vibration, leading wear and tear, and sometimes failure of the rotor system. It may be noted that rotors find applications in household equipment as well as in turbines for power generations, ships and aeroplanes. I shall like to draw a line of difference between the rotors in household equipment and power plants and the same used in ships and aeroplanes, from the point of view of the reference frame they work, the former work in a frame of reference that does not move with time, but the latter work in a frame that move with time.So, the frame of working of the former is called an 'Inertial' frame of reference, whereas for the latterthe frame is 'Non-Inertial'. Since the rotor is a simultaneously rotating and vibrating continuum, so a proper understanding and control of the vibratory behaviour is of good technical importance. As rotor is a moving body, so, any portion of it should not be touched during operation and, so, the popular concept of providing dampers at supports came out to be a good solution to attempt rotor vibration control. To begin with, I followed this idea and mathematically investigated the usefulness of viscoelastic materials in controlling rotor vibrations better than conventional spring damper configuration of the supports. Though the concept of force displacement relationship of the viscoelastic materials was very useful, the ideas that viscoelastic materials would be difficult to insert, would be difficult to save from aging etc. inspired me to think about something different. The solution was found with the concept of providing electromagnetic suspension or electromagnetic actuator with the desired viscoelastic transfer function between the force of actuation and the displacement of the journal to preserve the viscoelastic nature. These gave rise to novel control laws. In both actuators and Active Magnetic Bearings (AMBs), the force is applied across air gaps. This is a great advantage. In this presentation, I have briefly discussed theories, some experimental results with active actuatorsand AMBs. The advantage of actuators is particularly that this may be placed at any convenient location along the shaft, as the force is applied over an air gap .

# KEYNOTE SPEAKER

Prof. Sudipta De
*Professor, Department of Mechanical Engineering*
*Jadavpur University, India*

## Role of Distributed Hybrid Renewable Systems for Sustainable Energy Transition

The global energy sector is undergoing a rapid transformation driven by the imperative to achieve net-zero emissions. Countries worldwide, including India, have committed to ambitious decarbonization goals. Traditionally, power systems have relied on centralized, coal-based generation and extensive grid networks to balance supply and demand. However, this model is no longer sustainable in the face of climate change and evolving policy landscapes. While nuclear power remains a contentious option globally, the expansion of renewable energy sources has emerged as a central strategy for decarbonization.

Despite their promise, renewables present significant technical and operational challenges. Many renewable resources are inherently intermittent and spatially diffuse, complicating efforts to match supply with dynamic demand profiles. Large-scale, efficient energy storage technologies and intelligent grid integration strategies are essential to ensure reliability and stability. Without careful planning, the variability of renewables could threaten grid resilience and even risk systemic failures.

This transition requires a paradigm shift in power system design, moving toward decentralized and flexible architectures. Distributed hybrid renewable energy systems—integrating multiple generation sources at smaller scales - are gaining traction as a viable alternative to large, centralized installations. These systems offer potential advantages in terms of resilience, local resource utilization, and reduced transmission losses. However, they also introduce new technical, regulatory, and economic challenges.

This presentation explores the opportunities and barriers associated with distributed hybrid renewable systems in the context of a sustainable energy transition. It will highlight recent findings from the speaker's research group, focusing on modeling approaches, system optimization, and policy implications relevant to India and other emerging economies

# KEYNOTE SPEAKER


Prof. Fausto Pedro García Márquez

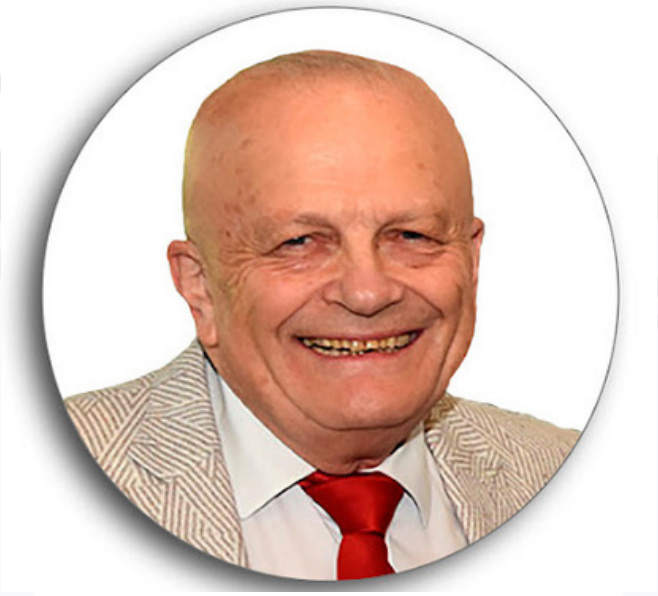
*Full Professor ( Catedrático de Universidad)*

*University of Castilla La Mancha ( UCLM*


**Deep Sea Galaxies: Intelligence in the Cloud, Insight in the Depths**

This speech explores the transformative role of autonomous submarines in underwater inspections and the integration of artificial intelligence (AI) with cloud computing to analyze the vast data they collect. As underwater environments become critical areas for monitoring infrastructure, ecosystems, and offshore installations, autonomous submarines equipped with high-resolution sensors and cameras offer an efficient, scalable solution for deep-sea exploration and maintenance. However, the complexity and volume of the collected data demand advanced processing capabilities. Here, AI algorithms—hosted on cloud platforms—are used to detect anomalies, classify objects, and generate actionable insights in near real-time. The speech presents real-world use cases, technical challenges, and the benefits of combining edge autonomy with centralized cloud intelligence, highlighting how this synergy enhances decision-making, reduces operational costs, and opens new frontiers in marine inspection and maintenance.

# KEYNOTE SPEAKER



Prof. Len Gelman

Chair in Signal Processing and Condition Monitorin
The Director, the Centre for Efficiency and Performance Engineering
University of Huddersfield, UK

Topic
Step Forward in Higher Order Processing for Vibro-Acoustics:
Novel Nonlinear Higher Order Frequency Response Functions

# KEYNOTE SPEAKER


## Prof. Mustafizur Rahman

*Rtd. Professor, National University of Singapore,*
*Director, Mikrotools Pte Ltd.*


## ROLE OF INDUSTRIAL AND MECHANICAL ENGINEERS FOR SUSTAINABALE DEVELOPMENT THROUGH INNOVATON

Economic development or growth of a country is directly linked to its production and manufacturing capabilities. As the functional requirements of products constantly evolve, engineers are tasked with improving their functionality to maintain sustainability and market competitiveness. Therefore, manufacturers must continuously introduce innovative concepts to either sustain existing products or replace them with newer, higher-performing alternatives. Sustainable production practices are fundamental in ensuring long-term sustainable development.

As Industrial and Mechanical Engineering serve as the common foundation for all forms of engineering, graduates from these disciplines predominantly lead the manufacturing and production sectors. Their capabilities act as a vital indicator of a country's developmental progress. Hence, their role becomes crucial in shaping the nation's sustainability trajectory.

In today's competitive landscape, it is essential for engineers to be equipped with innovative thinking to address the dynamic needs and expectations of consumers. This calls for a strong educational grounding in innovation and sustainability. This presentation aims to explore how nurturing an innovative mindset in engineering graduates can empower them to contribute effectively towards sustainable production, thereby facilitating the overall sustainable development of a nation.

# INDUSTRY SPEAKER

Dr. Himadri Guha
*Consultant, Author, Former faculty Jadavpur university*

## A Review of the Past and Present of Sustainable Buildings

Electricity was introduced hardly a hundred and fifty years ago. Piped gas in buildings came in only a quarter of a century before electricity, whereas large buildings have been in existence for thousands of years. Ancient architects had to deal with light and ventilation just like in modern times, but without access to power. By 1980, that is only a century after the introduction of electricity, the concept of abundant energy was found to be untrue. The world is moving fast towards an energy economy. The light and ventilation issues faced by the ancient architect resurfaced. The methods of using natural light and ventilation, which evolved over thousands of years, have become important in an energy-strained world. In this presentation, some of the real-life examples of natural light and ventilation in classical buildings will be studied. How modern architects are applying the same principles that have evolved over thousands of years will be presented. In addition, modern inventions like bio and nano materials are allowing us to propose energy-efficient techniques that could not have been done earlier. Finally, the progress of information technology, which has become a cornerstone of building energy management, shall be shown with examples.

# INDUSTRY SPEAKER

Dr. Arup Bhattacharya

*Assistant Professor Bert S. Turner Department of Construction Management Louisiana State University*

## Evolution of Ventilation in Built Environments

The science of ventilation began with Florence Nightingale looking for fresh air to remove foul smell from a hall where wounded soldiers were healing, to modern-day systems that support human-grade exploration of extraterrestrial environments. Through this keynote address, we will explore how our understanding and priority for ventilation systems have changed over time. We will also discuss the role of research and industrial applications in specific scenarios that have pushed the knowledge boundaries. Finally, we will look into contemporary research and developments for the current challenges, such as the decarbonization of the built environment, and developing regenerative solutions for human exploration of the Moon and, eventually, Mars..

# Track 1

## Industrial Engineering
## &
## Smart Manufacturing

**ID 77**

# Performance analysis of EN31 alloy machining under sustainable condition using machine learning models.

Sutanu Misra[1], Subhankar Moulick[2], Suprim Sardar[3], Ratan Kumar Basak[4].

[1] Institute of Engineering and Management (IEM), University of Engineering and Management Kolkata.
[2] Institute of Engineering and Management (IEM), University of Engineering and Management Kolkata.
[3] Institute of Engineering and Management (IEM), University of Engineering and Management Kolkata.
[4] Institute of Engineering and Management (IEM), University of Engineering and Management Kolkata.

The growing demand for sustainable manufacturing has led to exploring advanced cooling and lubrication techniques in machining processes. EN31 alloy steel is machined under liquid $CO_2$-assisted minimum quantity lubrication (MQL) conditions to assess its impact on machining performance in this study. The investigation analyses the influence of key process parameters—flow rate, cutting speed, feed rate, and depth of cut—on two critical output responses: material removal rate (MRR) and surface roughness (Ra). Various machine learning algorithms are applied to model the complex relationships between input and output variables to enhance predictive capabilities and optimize machining parameters. The dataset consists of experimental results obtained from controlled machining trials, and the performance of machine learning models is evaluated. The models are assessed based on their predictive accuracy and ability to capture nonlinear dependencies between process parameters and machining responses. The study provides valuable insights into the effectiveness of liquid $CO_2$-assisted MQL in improving material removal rates while maintaining surface quality. The findings contribute to the advancement of sustainable machining strategies while demonstrating the potential of artificial intelligence in enhancing manufacturing efficiency.

Keywords: MQL, MRR, Surface roughness, machine learning

**ID 341**

# In-situ IoT-Based Tool Wear Monitoring and Coolant Flow Control During Turning Operation

Lidiya Priyadarsini K[1], Dr. Abhishek Mandal[2], Dr. Rajat Subhra Sen[3], Gaurav sharma[4]

[1] Department of Mechanical Engineering, Jadavapur University
[2] Netaji subhash engineering college, panchpota
[3] Netaji subhash engineering college, panchpota
[4] Netaji subhash engineering college, panchpota

This project presents a smart, sensor-integrated solution for real-time monitoring of tool wear and adaptive control of coolant flow in turning operations. Using infrared temperature sensing and acoustic emission data, the system detects tool degradation and dynamically adjusts coolant flow via an IoT-enabled closed-loop feedback mechanism. MATLAB is used for signal processing and pump control simulation. The approach reduces thermal stress, extends tool life, and minimizes coolant waste, contributing to sustainable and intelligent manufacturing practices here.

Keywords: Acoustic Signal, Coolant Flow Rate (CFR), IoT, Machining Temperature IR temperature Sensor, Microphone, Tool Wear

**ID 130**

# Real-time Remote Monitoring System for monitoring of external weather conditions of 40 KW GRID TIED Solar and wind hybrid Power Plant at BUIE

Dinesh Paswan[1], Dr. Ashwani Tapde[2]

[1] Research Scholar, Department of Electrical Engineering, Dr A. P. J. Abdul Kalam University, Indore, India
[2] Assistant professor Department of Electrical Engineering, Dr A. P. J. Abdul Kalam University, Indore, India

We need an automatic system for monitoring and improving the efficiency of the grid tied solar wind Hybrid power plant . This paper proposes the smart Hybrid renewable energy power plant monitoring system empowered by IOT sensors. In this paper we want to monitor and maintain 40 KW grid tied solar wind hybrid power plant. This power plant is located in pohabagan, Subhankarnagar, Bankura using IOT system. The objective of te poposed system are . It reduces human efforts and to know the fault condition of the hybrid power plant. It improves active power profile of grid tied energy system.In future wor, We will try to implement sensorless IOT system.We can modify the circuit parameters and arrangements by knowing the data obtained by remote monitoring system. Here, we use Raspberry Pi3-B, 64 bit quad core processor.

Keywords: Internet of thing system, MPPT, Plant Utilization factor, performance, plant, remote monitoring system

**ID 326**

# Electrochemical behavior and characterization of API X60 steel exposed in a simulated oil environment

Biplab Baran Mandal[1], Vikash Kumar[2], Binod Barai[3], Barun Das[4], Dr. Buddhadeb Oraon[5]

[1] Dept. of M.E, Jadavpur University
[2] Dept. of M.E, Jadavpur University
[3] Dept. of M.E, Jadavpur University
[4] IEM KOLKATA
[5] Dept. of M.E, Jadavpur University

API 5L Grade X60 pipeline steel is extensively used for crude oil transport due to its favorable mechanical and corrosion-resistant properties. This study investigates its electrochemical behavior in simulated oilfield environments with three different NaCl concentrations, under both aerated and CO2-saturated conditions. Potentiodynamic polarization and Tafel extrapolation were employed to determine corrosion kinetics, while Electrochemical Impedance Spectroscopy (EIS) assessed passive film stability and charge transfer resistance (Rct ). Results showed that corrosion rate and current density (icorr) increased significantly with $Cl^-$ ion concentration. Exposure to CO2-rich environments led to the development of a semi-protective layer, likely composed of iron carbonate, which contributed to limited passivation of the steel surface. Though this passive layer deteriorated with increasing chloride content, as indicated by decreased Rct and more negative corrosion potentials. SEM and EDS analyses revealed localized attacks and confirmed the presence of corrosion products and elements, including Fe, O, C, and Cl. Raman spectroscopy identified FeCO3 and iron oxide phases, with a decline in signal intensity at higher $Cl^-$ concentrations, suggesting a less stable protective layer.

Keywords: API X60 steel, EIS, Potentiodynamic polarization, Raman spectroscopy, SEM

**ID 136**

# AI-Enhanced High-Altitude Air Quality Monitoring for Industrial Pollution Control

Ankita Ray Chowdhury[1], Roshan Rateria[2], Rahul pal[3], Susovan Maji[4], Suraj Kumar Mahato[5], Amartya Mukherjee[6]

[1] Department of CSE(AIML),CSBS Institute of Engineering & Management, Kolkata, Kolkata, 700091

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Industrial areas are major sources of air pollution, yet continuous monitoring is hindered by the high cost, limited coverage, and short operational spans of conventional methods like UAVs and fixed stations. This paper introduces a low-cost, scalable air quality monitoring system using a high-altitude platform equipped with a multi-sensor array (DHT22, MQ135, MQ2, MQ4, MQ7) for real-time detection of toxic industrial pollutants. The high-altitude platform enables extended airborne operation, wide-area GPS-tagged spatial mapping, and real-time data transmission, addressing coverage and endurance gaps in traditional approaches. To translate raw environmental data into actionable insights, a Large Language Model (LLM) integrates sensor outputs with factory-specific metadata (e.g., machinery types, production cycles) and regulatory standards, generating targeted outputs such as health risk alerts, emission reduction strategies, and compliance reports for stakeholders. Field tests validate the system's ability to pinpoint pollution hotspots and correlate emission spikes with operational schedules, demonstrating its utility for dynamic industrial emission monitoring. By combining persistent aerial surveillance with AI-driven analytics, this solution offers a cost-effective tool for real-time environmental policy enforcement, enabling industries to mitigate risks and align with sustainability goals. The results highlight its potential to transform regulatory compliance and pollution management in industrial zones through scalable, data-driven interventions.

Keywords: LLM decision support, Real-Time Environmental Analytics, air quality monitoring, high altitude platform, industrial pollution monitoring, multi-gas detection

**ID 195**

# Comparative Study of Meta-Heuristic Algorithms for Multi - Objective Optimization of AWJM Parameters

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Abrasive Water Jet Machining (AWJM) is an advanced non-traditional machining process widely used for cutting complex geometries in hard-to-machine materials. The efficiency and precision of AWJM depend on several process parameters, necessitating an optimal selection to enhance performance measures such as material removal rate (MRR), surface roughness (SR), and kerf taper angle (TA). This study presents a comparative analysis of three meta-heuristic optimization techniques—Particle Swarm Optimization (PSO), Teaching-Learning-Based Optimization (TLBO), and Grey Wolf Optimization (GWO)—to determine the optimal process parameters for AWJM of Ti6Al4V alloy. Single-objective and multi-objective optimization approaches are implemented to achieve the best trade-off among key performance indicators. The results indicate that GWO outperforms PSO and TLBO in terms of solution quality and convergence speed. The optimal machining parameters derived from the GWO algorithm provide improved machining efficiency and accuracy. This study offers valuable insights into the selection of robust optimization techniques for AWJM, contributing to enhanced productivity in precision manufacturing applications.

Keywords: AWJM, GWO, Optimization, PSO, TLBO, Ti6Al4V

**ID 175**

# A Hybrid Approach to Optimizing Cooling Performance in Rolling Mill Bearings

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Rolling mill bearings are critical components in metal processing, where excessive heat generation can lead to premature failure and reduced operational efficiency. This study presents a hybrid approach combining experimental, computational, and industrial insights to optimize cooling performance in work roll and backup roll bearings. A computational fluid dynamics (CFD) model was developed to simulate thermal-fluid interactions, while experimental tests validated the cooling effectiveness under varying operational conditions. Industrial data from an operational rolling mill provided real-world benchmarks for performance evaluation. Key parameters such as coolant flow rate, nozzle configuration, and bearing material properties were analyzed to identify optimal cooling strategies. The results demonstrate that an integrated approach significantly enhances heat dissipation, reducing bearing operating temperatures by up to 15-20% compared to conventional methods. Additionally, the study highlights the importance of adaptive cooling control to accommodate dynamic load conditions. The findings offer practical guidelines for improving bearing longevity, reducing maintenance costs, and enhancing rolling mill efficiency. This research bridges the gap between theoretical modeling and industrial application, providing a robust framework for thermal management in heavy-duty rolling operations.

Keywords: Backup Roll Cooling, Computational Modeling, Heat Dissipation, Lubrication, Rolling Mill Bearings, Thermal Optimization

**ID 42**

# Experimental Investigation on Surface Property of Mild Steel Welded Joints using MMAW technique

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This experimental research is centered on the experimental investigation of the mechanical characteristics of the AISI 1010 mild steel following the application of the Manual Metal Arc Welding (MMAW) process. The main purpose of this research was to examine the effect of the parameters of welding and post-weld heat treatment (PWHT) on the hardness of the welded joints. 18 mild steel samples were prepared and welded with different parameters of current (100 A, 145 A, 190 A), electrode diameter (2.5 mm, 3.2 mm, 4.0 mm), and PWHT temperature (490°C, 540°C, 610°C) employing the Taguchi L9 orthogonal array. All the specimens were also put to a test for any surface defects and cracks by a dye penetration test. Brinell hardness test was performed for all the samples both pre and postheat treatment to analyze the hardness change induced by the process of welding as well as thermal exposure. The gathered information was analyzed with the help of Minitab software, wherein Taguchi DOE, analysis by regression as well as Taguchi analysis was carried out to identify the effect and contribution of each factor towards hardness. The analysis indicated that the effect of PWHT temperature and welding current was more pronounced towards hardness than the effect of electrode diameter. The best combination of parameters was also identified with the aim to get the highest hardness. This study offers a practical method for the optimization of welding conditions for enhancing the mechanical characteristics of weld joints of mild steel and is a valuable aid for related metallurgical studies.

Keywords: Dye Penetration Testing (DPT), Manual Metal Arc Welding (MMAW), Mild Steel, Post-Weld Heat Treatment (PWHT), Taguchi Design of Experiments (DOE)

**ID 132**

# Optimize Coax-feed Microstrip Antenna using Ant Colony Optimization

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This elementary paper represents a ultrawide-band (UWB) coaxial feed microstrip rectangular patch antenna. This rectangular patch antenna is optimized using ant colony optimization (ACO) algorithm. The operating frequency of this antenna ranges from 4 to 12 GHz operating on microwave band frequency of C-band, and X-band are designed and stimulated on a dielectric material with a dielectric constant of 4.5. The antenna is designed and simulated in CST Studio Suite developed by Dassault Systèmes Simulia aimed to use for 3D electromagnetic simulations. Optimizing the patch antenna in order to learn the best pathway for flow of electromagnetic waves was done with the help of Python. The results obtained for the functioning of antennas depicting its performance in areas of return loss and radiation pattern have been represented here.

Keywords: ACO, CST, Coaxial feed, MSPA

**ID 205**

# Tribological Behavior of Duplex Electroless Ni-P/Ni-B Coatings

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This study focuses on the development and characterization of duplex electroless Ni-P/Ni-B coatings on mild steel substrates. The influence of heat treatment temperatures (400°C-800°C, 1 hour duration) on the microstructure, microhardness, friction, and wear behavior of these coatings is thoroughly investigated. The results reveal that heat treatment at 400°C for 1 hour significantly enhances the coating's properties. Notably, the grain size increases, leading to improved compactness, wear resistance, and microhardness. The DCTA coating exhibits the highest microhardness after heat treatment at 400°C, with a remarkable increase of approximately 78%. This enhancement is attributed to the formation of crystalline $Ni_3P$ and $Ni_3B$ phases, which play a crucial role in improving the coating's mechanical properties. Furthermore, heat treatment leads to a substantial reduction in the coefficient of friction, with DCT-A achieving the lowest friction value at 400°C. The wear resistance of the coatings is also significantly improved after heat treatment at 400°C, owing to the formation of hard crystalline phases. A notable decline in wear resistance was observed at 600°C and 800°C, attributed to the formation of oxides. Overall, the duplex Ni- P/Ni-B coatings demonstrate optimal tribological properties at a heat treatment temperature of 400°C, rendering them suitable for various industrial applications that require enhanced surface properties, such as improved wear resistance and reduced friction. These findings highlight the potential of duplex electroless Ni-P/Ni-B coatings for advanced surface engineering applications.

Keywords: Duplex Coatings, Electroless, Microhardness, Ni-P/Ni-B, Tribological behavior.

**ID 215**

# Effect of Cooking Oil in Tribological Behavior of EN8 Steel

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This study investigates the friction and wear behavior of EN8 steel under dry sliding and lubricated conditions using a pin-on-disc tribo-tester. Mustard oil is used as a lubricant, and its effects on the tribological properties of EN8 steel are evaluated. Tests were performed under varying normal loads of 20 N, 30 N, and 40 N, with changes also made to the track diameter (50 mm, 60 mm, and 80 mm) and disc rotation speeds (50 rpm, 75 rpm, and 90 rpm). The results show that the coefficient of friction (COF) and wear rate are significantly reduced in the lubricated condition compared to dry sliding. The COF is reduced by up to 90%, and the wear rate is reduced by up to 80%. The study also finds that the tribological performance of EN8 steel is influenced by various parameters, including applied load, sliding speed, and track diameter. The optimal tribological performance is achieved at specific combinations of these parameters. The findings of this study suggest that mustard oil can be a potential lubricant for industrial applications, offering improved tribological properties and environmental benefits. Both adhesive and abrasive wear were observed in dry and lubricated conditions.

Keywords: tribology, dry sliding, lubrication condition

**ID 92**

# Hybrid Bamboo-Flax-Linen Composites: A Sustainable Approach to Lightweight High-Performance Materials

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The aim of this project is to make a natural fiber composite by reinforcing linen, bamboo, and flax fibers in an epoxy matrix. The use of graphene nanoplatelets (GNP) improved mechanical characteristics including surface hardness and compression strength. Using the hand lay-up process, the fibers were layered with epoxy and hardener in a silicone mold, and the composite was then allowed to cure at room temperature. Different GNP concentrations were used in two versions.

After curing, the samples were hand-cut and Brinell hardness and compression tests were performed. The strength and hardness of the composite were found to be enhanced by a larger GNP concentration. The study highlights the potential of hybrid natural fiber composites in engineering applications requiring lightweight and durable materials.

Keywords: Bamboo fiber, Compression strength, Epoxy matrix, Flax fiber, Graphene nanoplatelets, Linen fiber, Natural fiber composite, Surface hardness

**ID 312**

# Improving the Surface Roughness of electroless Ni-P-CNT coated copper substrate using hybrid Approach: Taguchi Method and Bonobo Optimizer

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In this present work a comparative study has been conducted to approximate the optimal values of the process parameters subject to the ranges at which they were varied to improve the surface property of carbon nanotube (CNT) reinforced electroless Ni-P coating. A L27 orthogonal array was considered to develop Taguchi Design of Experiment for obtaining optimized values of the process parameters. Biologically inspired Bonobo Optimization is considered to conduct parametric optimization by minimizing the surface roughness within the ranges of the main the elements of the chemical bath namely nickel sulphate, sodium hypophosphite and CNT. The two optimization processes were compared by depositing coating in a condition obtained from these two processes. A regression equation was developed to predict the surface roughness. The p-values concluded that the interaction of Sodium hypophosphite and CNT concentrations in the coating bath significantly controls the roughness of the coated surface. The parameters namely concentration of nickel sulphate, sodium hypophosphite and CNT corresponding to minimum roughness, were evaluated as 35 gm/litre, 6 gm/litre and 0.02 gm/litre using Taguchi analysis whereas 35 gm/litre, 18 gm/litre and 0.02 gm/litre have been obtained from Bonobo optimization. The coating deposited from both optimal conditions have shown reduced surface-roughness values.

Keywords: Bonobo optimization, Electroless coating, Ni-P-CNT, Surface Roughness, Taguchi

**ID 208**

# Study of electrical parameter to predict wire path during corner profile cutting in WEDM

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The basic parameters in corner profile cutting in wire-cut electrical discharge machining are researched. Corner cutting information is extremely important for getting a higher precision profile in the WEDM. The effect of the cutting speed on wire lag, sparking gap, sparking frequency, gap voltage, and current have been examined, and regression analysis has also been conducted. A mathematical model based on cutting speed variation at the corner has been developed to predict the wire path at right angle during corner cutting by taking into account the wire deflection phenomena. According to mathematical modelling, a software program has been formulated to determine the sparking frequency variation, gap voltage, and current variation for corner cutting. Experiments were conducted in the aim to support the presented model. The experimental and predicted data reflect to a very strong agreement. Thus, it is evident that this model is quite accurate and can be successfully utilized in path modification strategies for achieving enhanced profile accuracy in WEDM.

Keywords: WEDM; Wire lag; Corner cutting; Spark gap; Corner angle.

**ID 196**

# A comparative meta-heuristic based multi-objective based parametric optimization of micro-EDM process

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Micro-electro discharge machining (EDM) emerges as a competent machining process to manufacture miniaturized components with complex shapes and geometries. To achieve the maximum performance of the machine, it's advisable to use it with the best combination of parameters. In this paper, popular metaheuristic algorithms for e.g. differential evolution (DE), grey wolf optimizer (GWO) and teaching learning-based optimization (TLBO) algorithms were applied to obtain the optimal parametric combination of micro-EDM drilling of Inconel 718 sheet material. As the results obtained and the derived convergence plot, it can be established that TLBO emerges as the best algorithm compared to DE and GWO in identifying the optimal parametric combination of the said micro-EDM drilling process.

Keywords: DE, GWO, TLBO, micro-EDM, parametric optimization, responses

**ID 324**

# A holistic approach for reduction of equipment failure applying TPM tools at XYZ Ltd.

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In a manufacturing industry, the output primarily depends upon three ‘M’s i.e. Man, Machine and Materials. Many of times, the failure of the machines or equipment, in comparison to other two, plays a significant role in poor performance and causes a threat in a competitive market. Therefore, a reliable health of machines is expected towards quality, productivity of the output and morale of workforce. The conventional maintenance practice normally restores the equipment through repairing or replacement of failed component or assembly and also follows a routine PM-Preventive Maintenance as the manufacturer recommends. But this philosophy does not help much to improve the availability of the equipment and maintain its sustainability. Present study or work shows that if the failures are identified with causes, through ‘Why-Why Analysis’ as TPM (Total Productive Maintenance) suggests, where human lack is also explored, then a long-term actions or strategies can be planned and implemented to take care human causes to reduce downtime and ensure a sustainable improvement. As TPM believes on 8-Pillar activities, so a holistic approach is applied involving relevant five Pillars to enhance knowledge, skill, discipline and improve operating environment in achieving organizational Targets.

Keywords: API X60 steel, EIS, Potentiodynamic polarization, Raman spectroscopy, SEM

**ID 209**

# Optimizing Autonomous Guided Vehicle Efficiency in Industry 4.0

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This study presents a comprehensive methodology for the structural and dynamic optimization of automated guided vehicles (AGVs), essential components in industrial material handling and logistics automation. The design framework incorporates advanced computational techniques, including finite element analysis (FEA) using Ansys, to assess structural integrity under diverse static and dynamic loading conditions. The AGV is engineered using high-performance materials such as high carbon steel and stainless steel for the chassis and frame, and high-impact polystyrene (HIPS) for wheels, offering a balance of strength, durability, and lightweight efficiency. Additionally, kinematic and vibrational analyses are conducted to evaluate the effects of operational constraints on key performance indicators. These insights drive iterative improvements in structural design and component selection. The study also explores an optimal loading/unloading strategy by integrating a robotic system with AGVs, enhancing automation efficiency. The proposed approach supports the evolving needs of precision automation within smart manufacturing systems.

Keywords: Automated guided vehicles (AGVs), dynamic load analysis, finite element analysis (FEA), smart manufacturing, structural optimization.

**ID 331**

# PARAMETRIC ANALYSIS OF ELECTRIC DISCHARGE MACHINING OF 6061-T6 ALUMINIUM ALLOY

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Electrical discharge machining (EDM) is one of the non-conventional machining processes widely practiced with high accuracy in cutting electrically conductive materials. Objectives of the present work are the parametric analysis of material removal rate (MRR), tool wire rate and surface roughness while EDMing aluminum alloy 6061-T6 that is used in diverse applications, including automotive, aerospace and structural components. This work uses a design of experiments (DOE) methodology named, Response surface methodology (RSM), to explore critical factors influencing targeted performance parameters. Results obtained are used to analyze the responses and the corresponding process parameters of EDM process and to obtain the optimal condition. Some process variables have a significant effect on MRR, tool wire-rate, erosion rate and surface roughness of aluminum alloy 6061-T6 during EDM process. Based on a detailed analysis on the experimental data, influence of each process parameter set on the responses of the EDM process is determined, paving the way towards finding out optimal performance of EDMing of aluminum alloy 6061-T6.

Keywords: Electric Discharge Machining, EDM, 6061-T6 Aluminium Alloy, Material Removal Rate, MRR, Surface roughness, Tool wire-rate.

**ID 329**

# Optimisation of Process Parameters for Machining Titanium Foam Grade V using WEDM

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Metal foams serve as crash energy absorbers, dampening insulators, and materials in dental implant in medical as well as in the aerospace industries. Based on cellular structure metallic foams can be closed-cell or open-cell. A minimum resistance is offered by the cellular structure against the cutting force applied by the cutting tool while machining metal foam material using conventional manufacturing technique. Thus, it causes surface dispersion along with disturbance in the cellular texture of the foam material. For an outstanding mechanical properties Titanium grade V foam material offers challenges for machining with conventional technique. Fabrication of micro-scale components are usually preferred by non-conventional process such as Wire-cut Electrical Discharge machining (WEDM). The purpose of this study is to investigate the possibilities of using the CNC Wire cut electrical discharge machining (WEDM) method to machine titanium foam. Closed-cell titanium foam grade 5 is designated as the workpiece, whereas pure brass is picked as the tool electrode material. Material removal rate (MRR), surface roughness (Ra), and electrode wear rate are recognized as result metrics, whereas the WEDM input variables pulse on(Ton), pulse off(Toff), arc on(Aon), arc off(Aoff), and servo voltage(SV)are marked as input metrics. Compared to servo voltage and pulse off, arc on and pulse on have a major effect on the electrode wear rate. It was observed that maximum MRR of 3.849mm3/min occurred when machining with maximum pulse on time of 24µs and optimal value of 16µs arc on and servo voltage of 90V. The best surface quality of 0.486 µm was achieved while machining with minimum pulse on time of 12µs and optimal value of 16 µs arc on and servo voltage of 90V. Pulse on time has been considered as one of the most effective parameters while using Box-Behnken method.

Keywords: ANOVA, Material Removal Rate, Optimisation, Surface Roughness, Surface plot, WEDM

**ID 330**

# Investigating the Effect of WEDM Parameters on the Surface Morphology of Hastelloy C276

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Geometrically difficult or complex-shaped and sized products cannot be machined accurately using conventional machining methods, including grinding, milling, etc. Wire Electrical Discharge Machining (WEDM) is one of the best non-conventional techniques for precise material removal. This work investigates several crucial features of surface topography and characterization of the machined surface for Hastelloy C276 material using the WEDM technique. A block of 5 mm width, length, and thickness was produced for this purpose. In this study, the Response Surface Methodology (RSM) with Box Behnken Design is employed to analyze the influence of various parameters such as pulse on time(Ton), pulse off time(Toff), arc on(Aon), arc off (Aoff) and servo voltage. Key output responses examined include material removal rate (MRR), surface roughness (SR), and surface topography, in relation to discharge energy in WEDM. At low discharge energy, the surface reveals random micro-voids, whereas at high discharge energy, the EDM surface topography exhibits dominant coral reef-like microstructures. Additionally, the thick white layers formed under high discharge energy are generally non-uniform and discontinuous. Although no microcracks were observed in the subsurface, the presence of micro-voids was limited. Investigating the small blocks for optimal surface quality and dimensional accuracy is essential for evaluating machining progression. RSM and Analysis of Variance (ANOVA) were used to validate the mathematical model and identify the most significant parameters affecting the output responses. RSM further utilizes experimental data to optimize output variables such as surface roughness and material removal rate for each response.

Keywords: Hastelloy C276, MRR, Optimisation, Recast layer, SR, Surface Topography, WEDM

**ID 334**

# Review Paper on Electro discharge Machining of Advanced Engineering Materials Ceramics

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Traditional machining processes like drilling, milling and turning are inefficient to machine hard, tough to machine, materials. Electro Discharge Machining (EDM) may solve such problem of difficult to machine materials. Alumina (Al2O3), one of the common ceramic materials used in research, has been machined utilising the assisting electrode approach. Another material NITINOL is a special type of materials that is very difficult to machine due to its high hardness and shape memory alloy properties. In this paper it is shown how the Electro Discharge Machining can be performed on Ceramic and NiTinol. The performance of machining depends mainly on various parameters like Ton (on time), Ip (Peak current), SV (Gap voltage). In the Laboratory the experiments were carried out using pure copper as electrode and NiTinol as workpiece.

Keywords: Electro Discharge Machining (EDM), Material Removal Rate (MRR), Peak current (Ip), Pulse on time (Ton)

**ID 219**

# Corrosion Resistance and Mechanical Behavior of Austenitic and Martensitic Stainless Steels in Industrial Applications

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The growing demand for durable and high-performance materials in aggressive industrial environments has intensified the focus on stainless steels, particularly austenitic and martensitic grades, due to their distinct microstructural and mechanical properties. This study investigates the corrosion resistance and mechanical behavior of these types of stainless steel to address the challenge of material degradation and performance inconsistency under difficult service conditions. A comparative analysis was conducted using standardized electrochemical corrosion tests and mechanical evaluations, including tensile strength, hardness, and impact resistance. Austenitic stainless steel demonstrated superior corrosion resistance due to its high chromium and nickel content, while martensitic stainless steel exhibited higher strength and hardness but lower corrosion resistance. Microstructural analysis further revealed the role of phase composition and grain morphology in influencing performance. The findings highlight that the selection between austenitic and martensitic stainless steels must balance corrosion resistance with mechanical demands, depending on the specific industrial application. This study provides critical insights for material selection and design optimization in industries such as chemical processing, power generation, and marine engineering, where both mechanical integrity and corrosion resistance are essential.

Keywords: Austenitic, Corrosion Resistance, Industrial Applications, Martensitic, Mechanical Properties, Stainless Steel

**ID 106**

# Designing of Harmony Search tuned PID controller

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An in-depth study has been conducted on heuristic search algorithms, focusing on their applications in artificial intelligence and optimization problems. This research examines various advanced methodologies, including A* search, genetic algorithms, and simulated annealing, emphasizing their efficiency in solving complex computational challenges. A key aspect of this study is the comparative analysis of these techniques, evaluating their performance, strengths, and limitations across diverse problem domains. Experimental evaluations showcase the practical advantages of heuristic search strategies, demonstrating their effectiveness in real-world scenarios. The study further explores potential enhancements to these algorithms, highlighting avenues for future research and optimization. By integrating AI-driven heuristics with problem-solving frameworks, this work presents a comprehensive perspective on the role of heuristic search in advancing computational intelligence.

Keywords: Chatbot, Experimental, framework, key

**ID 108**

# REVIEW ON ADVANCEMENTS IN HYDROFORMING USING MACHINE LEARNING

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This paper reviews the integration of artificial intelligence and machine learning (AI/ML) in hydroforming to optimize process parameters and predict material deformation. Leveraging neural networks and physics-informed neural networks (PINNs), the approach significantly enhances accuracy, reduces defects such as wrinkling and thinning, and reduces the need for trial runs. PINNs incorporate fluid dynamics and material behavior to predict final part geometry, enabling improved control and precision over traditional finite element analysis (FEA). By refining key variables—including input pressure, material thickness, temperature, and forming time—this method supports adaptive control for complex shapes and boosts computational efficiency. The integration of AI/ML promotes scalable, cost-effective and high-precision manufacturing of lightweight, high-strength components, particularly in the automotive and aerospace sectors. Key findings emphasize notable process optimization and advanced deformation prediction, opening avenues for future innovations in adaptive control systems and expanded applications across the recent state-of-the-art materials.

Keywords: Hydroforming, intricate shapes, lightweight, water pressure, accuracy, industrial applications.

**ID 83**

# Power contributional model in friction stir spot welding of Al-alloy and Cu-alloy bimetallic sheets at a controlled atmosphere

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This paper reviews the integration of artificial intelligence and machine learning (AI/ML) in hydroforming to optimize process parameters and predict material deformation. Leveraging neural networks and physics-informed neural networks (PINNs), the approach significantly enhances accuracy, reduces defects such as wrinkling and thinning, and reduces the need for trial runs. PINNs incorporate fluid dynamics and material behavior to predict final part geometry, enabling improved control and precision over traditional finite element analysis (FEA). By refining key variables—including input pressure, material thickness, temperature, and forming time—this method supports adaptive control for complex shapes and boosts computational efficiency. The integration of AI/ML promotes scalable, cost-effective and high-precision manufacturing of lightweight, high-strength components, particularly in the automotive and aerospace sectors. Key findings emphasize notable process optimization and advanced deformation prediction, opening avenues for future innovations in adaptive control systems and expanded applications across the recent state-of-the-art materials.

Keywords: Hydroforming, intricate shapes, lightweight, water pressure, accuracy, industrial applications.

**ID 254**

# Analyze the common failure modes of 14-inch diamond saw blades used for cutting marble and granite.

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Traditional methods for machining brittle materials like marble, granite, and kotastone heavily depend on the operator's skill, leading to inconsistent material removal rates, potential damage to the cutting tool, and safety hazards. This study presents a detailed experimental and computational analysis of the mechanical behavior of the cutting tools used in these processes. Specifically, we investigated how key operational parameters – the thickness of the blade, the cutting velocity (speed at which the blade moves), and the feed rate (how quickly the blade advances into the stone)– influence the distribution of internal forces (stress distribution) within the blade. Furthermore,we analyzed how these parameters contribute to different modes of tool failure. The findings of this research provide valuable insights into optimizing the machining of these stones. By understanding the relationship between cutting parameters and tool performance, we aim to contribute to the development of more reliable, efficient, and safer stone cutting techniques,reducing the reliance on operator expertise and minimizing tool wear.

Keywords: Tool failure, Tool damage, Tool wear, cutting tool, Marble cutting, Granite cutting

# Track 2

## Sustainable Energy Transition and Decarbonization

**ID 166**

# Optimum operation of CO2-propane mixture-based bottoming power cycle recovering waste heat from a single flash geothermal steam cycle (SFGSC)

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Single flash geothermal steam cycle's (SFGSC's) power output can be noticeably increased by incorporating a bottoming secondary power cycle (SPC). It is fairly challenging to select an appropriate working fluid (WF) for the bottoming cycle without compromising environmental and safety issues. Though CO2 is a naturally available, environmentally compliant inert WF, power cycles with CO2 are mostly operated in supercritical mode due to the unavailability of heat sinks at below 30°C. This reduces the energy conversion capability of the power cycle, as the compressor consumes an appreciable portion of the turbine power. In this study, propane is mixed with CO2 to address this issue. It is observed that the chance of accidental flame propagation of the mixture WF increases with the increasing mole fraction of propane. The mixture becomes completely inert as the CO2 mole fraction is raised above 0.85. However, to ensure a realistic condenser exit temperature (i.e., 35° C) in the specified ambient condition (1.013 bar & 25° C), a CO2-propane mixture with a CO2 mole fraction of 0.8 is selected as the WF of the bottoming cycle. For the bottoming power cycle, an ideal turbine inlet pressure that corresponds to a minimum UA-to-power ratio can be found

Keywords: Bottoming power cycle, CO2-propane mixture, Single flash geothermal steam cycle, UA-to power ratio., power output.

**ID 117**

# AI-Driven IoT Waste Management System with Real-Time Monitoring and Software Integration for Smart Cities

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Sustainable growth in the case of a smart city would thus demand effective waste management. Towards this, the paper introduces an IoT-enabled solution for optimized waste collection schedules along with reduced operating expenses through real-time monitoring and AI-driven predictive analytics. Sensor nodes will forward the data to scalable cloud platforms like AWS and Azure for processing and storage purposes, while at all times trash levels are being monitored. Through the implementation of TensorFlow, machine learning models are developed that classify trash with accuracy. This helps users make sound decisions about how to handle their waste. Furthermore, a mobile application for iOS and Android helps locals schedule collections and report overflows of waste. Sustainable features such as GPS tracking, solar-powered sensors, and LoRaWAN connectivity help ensure that the system is efficient in trash management in smart cities.

Keywords: AI, Tensor Flow, and IoT, cloud, waste management.

**ID 98**

# A Smart Control of Lean Blowout using Multistage Injection Systems in Gas Turbine Combustors.

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Sustainable growth in the case of a smart city would thus demand effective waste management. Towards this, the paper introduces an IoT-enabled solution for optimized waste collection schedules along with reduced operating expenses through real-time monitoring and AI-driven predictive analytics. Sensor nodes will forward the data to scalable cloud platforms like AWS and Azure for processing and storage purposes, while at all times trash levels are being monitored. Through the implementation of TensorFlow, machine learning models are developed that classify trash with accuracy. This helps users make sound decisions about how to handle their waste. Furthermore, a mobile application for iOS and Android helps locals schedule collections and report overflows of waste. Sustainable features such as GPS tracking, solar-powered sensors, and LoRaWAN connectivity help ensure that the system is efficient in trash management in smart cities.

Keywords: AI, Tensor Flow, and IoT, cloud, waste management.

**ID 185**

# Enhancing the effectiveness of Solar distillation using Nanoparticles

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Solar distillation is a sustainable and eco-friendly method for producing potable water, particularly in regions with limited access to clean water. However, the efficiency of traditional solar stills is often constrained by low thermal conductivity and inadequate solar energy absorption. This review explores the integration of nanoparticles into solar distillation systems as a novel approach to enhance their performance. Nanoparticles, such as metallic, metal oxide, and carbon-based materials, exhibit unique properties like high thermal conductivity, broad solar spectrum absorption, and increased surface area, which significantly improve heat transfer and evaporation rates. Experimental studies have demonstrated that the addition of nanoparticles can increase daily water yield by 20–50% and enhance thermal efficiency. Future research directions include optimizing nanoparticle concentration, developing hybrid systems with phase change materials, and exploring cost effective synthesis methods. This review highlights the potential of nanoparticles to address global water scarcity by improving the performance of solar stills, offering a sustainable solution for clean water production in resource-constrained regions.

Keywords: Nanoparticles, Solar Distillation, Sustainable Water Solutions., Thermal Efficiency

**ID 315**

# EFFECT OF INCORPORATING WIND POWER GENERATION FOR ECONOMIC AND EMISSION DISPATCH IN THERMAL POWER PLANTS USING PSO

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This study investigates the integration of wind power generation into the economic and emission dispatch of thermal power plants using Particle Swarm Optimization (PSO). By incorporating renewable energy sources, the approach aims to minimize both operational costs and emissions while maintaining system reliability. The PSO tackles the complexities of incorporation of wind power generation along with the conventional thermal powr generation systems, ensuring optimal load distribution across thermal and wind power units. The proposed method has been tested on a 6-unit and a 40-unit system. Results from simulations on the test systems demonstrate significant improvements in economic efficiency and emission reductions, highlighting the potential of incorporation of wind power generation in optimizing modern power systems

Keywords: EED, ELD, PSO, Weibull, Wind.

**ID 248**

# Design and Execution of a Floating Solar PV Panel Cleaning Robot for Sustainable Energy Solutions

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Comprehending the elements that influence the effectiveness of solar energy sources is crucial, especially given the growing importance of using solar energy to cut emissions of carbon. Dust buildup on PV panel for solar energy presents a considerable challenge, as it greatly diminishes light transmission and impacts plant development. The buildup of dust on PV panels' outside can lead to a significant reduction in their performance, with potential losses that range from 10% under moderate circumstances to more than 39.9 % in dry areas. In this paper seeks to Sort the dust collection into categories on Floating Solar Panels and to tackle this issue by developing, implementing, and assessing a cleaning robot system. Dust particles obstruct the passage of light, elevate cell temperatures, and heighten resistive losses, resulting in diminished output power. This study methodically examines how dust accumulation impacts the execution of FPV systems, highlighting the effects of environmental factors such as rainfall, velocity of wind, humidity and composition of the dust. The installation features, including the elevation of the FPV panels and their alignment, can either intensify or reduce the effects of soiling. This research has been structured to emphasize the importance of maximizing the efficiency of FPV systems, in light of the essential demands for achieving global renewable energy objectives. It Notable aspects several promising cleaning techniques and underscores the importance of a comprehensive approach to optimizing the design and maintenance of FPV systems, thereby facilitating the broader implementation of this revolutionary clean energy solution

Keywords: Floating Solar Photovoltaic (FSPV) Systems, Keywords: Renewable Energy, Solar Cleaning Robot.

**ID 245**

# DeepBone: A Hybrid Deep Learning Model for Fracture Analysis

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Fracture is a prevalent disease for which the timely and accurate diagnosis is important to support successful treatment. X-ray Most of the conventional X-ray analysis techniques are radiologist dependent, time consuming and interpretational in nature. In this paper, we propose a deep learning-based method for the automatic detection of fractures using pretrained CNNs. In order to differentiate between fractured and non-fractured X-ray images, we consider four modern architectures — ResNet50, VGG16, MobileNetV2 and InceptionV3. In addition, we conduct an ensemble model by pooling the features in the four networks, combined with an attention mechanism for additional feature generation. We divided our data to train 70%, validation 15% all, and evaluation 15% with data augmentation for generalization. Accuracy, precision, recall and F1-score are calculated for model outputs. In the single model level, MobileNetV2 (98.5%) and InceptionV3 (93.4%) are better than ResNet50 and VGG16 with poor generalization. The best accuracy achieved by our proposed ensemble model (99.3%), indicates the effectiveness of the multi-network feature fusion. Our findings suggest that automated fracture diagnosis may be significantly enhanced, and radiological workloads may be dramatically reduced using deep learning with high diagnostic performance. Real-world adaptation, interpretability, and other types of robustness are also directions to pursue

Keywords: Attention mechanism, Automated diagnosis, Convolutional Neural Networks (CNNs), Deep learning, Ensemble model, Feature fusion, Fracture detection, InceptionV3, MobileNetV2, Model performance., Radiology workload reduction, ResNet50, Transfer learning, VGG16, X-ray imaging, medical image classification.

**ID 317**

# Design of Self-Complementary Meta-Surface for Polarization Separated Millimeter Wave Wireless Power Transfer Systems

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This paper presents the design and simulation of a novel self-complementary meta-surface (SCMS) tailored for high-efficiency, polarization-separated wireless power transfer (WPT) systems operating in the millimeter-wave (mm-Wave) band. The proposed structure incorporates a Vicsek fractal geometry implemented on an ultrathin FR-4 dielectric substrate (ε_r = 4.4, thickness = 0.2 mm) and utilizes Babinet's principle to achieve polarization-selective frequency filtering. This design demonstrates both angular stability and conformal adaptability, making it highly suitable for practical, miniaturized, and flexible WPT applications. The meta-surface is realized as a single-layer configuration comprising side-by-side arrangements of a metallic patch and its complementary aperture structure. The structure is optimized to simultaneously support two transverse electric (TE) mode passbands and one transverse magnetic (TM) mode passband. Specifically, the TE-polarized transmission bands are observed at 20.4–28.6 GHz and 36.2–42.3 GHz, while the TM-polarized passband spans 31.4–34.7 GHz. The out-of-band suppression levels are notably high, ensuring minimal cross polarization interference. The polarization-separated performance is substantiated through S-parameter (S21) simulation results using CST Microwave Studio. Surface current distribution analysis at resonant frequencies (26.1 GHz, 32.73 GHz, and 38.3 GHz) provides insight into the underlying electromagnetic behavior. The analysis shows strong Y-directed currents on the metallic strip for TE mode and X-directed currents for TM mode, with clear resonance separation between the two orthogonal polarizations. This behavior confirms the effectiveness of the Babinet-based complementary design in achieving distinct and isolated polarization responses.

Keywords: Wireless power transfer system, conformal., meta-surface, mm-Wave communication, polarization-separated

**ID 124**

# An investigation of energy savings potential due to daylight integration into building in Indian climatic condition

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Application of glazing is an integral part of modern building architecture. Window glazing system in building plays an important role for daylighting inside the building space and also improves the aesthetic view of the building. Daylight through the window glazing system significantly influences the energy consumption in the building. In the present study, window area on the building envelope has been distributed to different cardinal directions to form window combinations. Distribution of window into different walls of the building allows daylight into the working space of the building. The building models under study consist of eleven number of different window combinations. The building model with windows in east and west wall is termed as EW combination. In similar way NE, NS, NW, SE, SW, NSW, NSE, EWS, EWN, NSEW combination are formed. All the building models were simulated for energy performance with five different WWR (10%, 15%, 20%, 25% and 30%) and six different slat angle (00, 150, 300, 450, 600 and 750) to control daylight into the building space. The artificial lighting of the building is controlled according to available delight into the working space to reduce the energy consumption of the building. A continuous dimming control of artificial lightings is incorporated based on daylight through window combinations at reference points. Energy performance of all the window combinations with five different WWR and six different slat angles are evaluated for Kolkata located in India. Results of the study have been compared with the energy consumption of a reference building designed as per the guidelines laid down in ECBC and NBC code in India. The applicability of the results has been tested with two more locations for Indian climatic conditions. Energy savings in Kolkata, Delhi and Chennai due to integration of daylight varies from 9.3% to 21.2%, 13.7% to 24.9% and 9.6% to 22.6% respectively. Results shows substantial energy savings opportunity is there with controlled daylight integration into the building.

Keywords: Building energy, Daylight., Energy savings, Window glazing, Window-to-wall-ratio.

**ID 321**

# Climate Resilient Built Environment and Indigenous Solutions: Integrating Indigenous Knowledge for Sustainable Development; A Case of Sawantwadi, Maharashtra, India.

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The impact of climate change such as increases in temperature and change in ecological pattern creates serious challenges to build environment universally. Indigenous knowledge systems are the universally search for sustainable solutions, which is time tested practices in deep connections with climate, culture, socio-economic aspects. Integrating Indigenous knowledge systems with modern approaches provides a powerful concept for creating climate-resilient design. This research paper explores the integration of Indigenous knowledge systems of traditional houses into modern house design to encourage the climate-resilient built environments. The aim of this study is to explore the how indigenous knowledge and solutions can help to build the climate - resilient built environment. This study uses both qualitative and quantitative research methodology which includes plot survey of two hundred and sixty-nine houses, observation method, photographic inventory and discussions with house owners. Users' responses, chi square test and Cramer's V were conducted to identify the user's preferences, significant association and strength of the associations of architectural design features which can integrated with sustainable developments. The findings emphasize the indigenous solutions, derived from lived experience and ecological sensitivity, can meaningfully contribute to climate adaptation strategies. The paper concludes that the need of indigenous solutions to build the climate resilient built environment. Integrating indigenous solutions with modern approaches provides a powerful concept for creating climate-resilient design. Such an approaches help to enhance sustainability practices of the built environment also, help to maintain the culture identity of the place.

Keywords: Climate resilience, adaptation., built environment, indigenous knowledge, sustainable architecture.

**ID 103**

# Smart Energy optimization for Educational buildings Using Machine Learning: A Case Study of IEM Management House

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Energy optimization is essential for sustainability because energy expenditures make up about 40% of operating costs in many educational institutions. With the aim of cutting expenses and boosting productivity, this study offers a machine learning (ML)-based system for predicting and optimizing energy usage at the IEM Management House, Sector V, Kolkata. An extensive dataset that included more than a year's worth of historical data on weather, occupancy patterns, energy usage, and load fluctuations was used. To precisely forecast electricity demand, sophisticated machine learning techniques were used, such as LSTM models enhanced with calendar and meteorological data. Energy usage and expenses were reduced by 34% and 38%, respectively, as a result of the optimization technique. With a Mean Absolute Error (MAE) of 12.4 kWh, Root Mean Squared Error (RMSE) of 18.7 kWh, and Mean Absolute Percentage Error (MAPE) of 3.2%, the model showed excellent prediction accuracy. Furthermore, Page 19 including solar energy systems promoted sustainable behaviors by lowering dependency on traditional power sources. This study offers a data-driven, scalable method for managing institutional energy that has quantifiable positive effects on operations and the environment.

Keywords: Energy Optimization, Machine Learning (ML), Load Forecasting, Sustainable Energy.

**ID 157**

# Solar Tube Daylighting Systems: A Sustainable Approach to Energy-Efficient Illumination

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This study examines the efficacy and sustainability of solar tube daylighting systems as energy-efficient illumination solutions for buildings. It reviews design principles, performance metrics, and environmental benefits. Solar tube systems compared to traditional daylighting methods. Findings show solar tubes can reduce artificial lighting needs, reducing energy consumption by up to 30%. The impact on building energy performance, cost savings, and carbon footprint reduction is evaluated. Performance metrics such as luminous efficacy, light distribution, and seasonal daylight variations are analysed through case studies. Challenges include efficiency in low-light conditions, light loss over time, and installation issues. Future research directions involve advancements in optical materials, hybrid solar-electric systems, and AI-based adaptive controls. Solar tube daylighting systems are a promising sustainable technology for improving indoor lighting quality and reducing environmental impact. The findings offer implications for architects, engineers, and policymakers in promoting energy-efficient lighting strategies.

Keywords: Energy Efficiency, Illumination, Solar Tube Daylight system, Sustainable Energy.

**ID 322**

# Analysis of Building Life Cycle Energy: A state of Art Review to Evaluate the Embodied and Operational Energy Parameters.

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The present study aims to demonstrate and discuss the evaluation of building life cycle energy and critically investigate the significant parameters that contribute greatly to the lifecycle energy of the buildings. The building sector consumes energy in various stages of construction, operations, and maintenance of buildings. The carbon emissions from the building sector escalates each year as most of the energy is generated from the combustion of fossil fuels. In the building sector, lifecycle energy comprises two main components: embodied energy and operational energy. During building construction, embodied energy is expended through the use of building materials, construction products, and processes, as well as through associated activities such as transportation, administration, and management. Whereas, the operational energy refers to the use of energy utilized in the operational and maintenance purpose of the buildings, such as space heating or cooling, lighting, and supplying power to home appliances. In order to achieve a holistic reduction of energy footprint in the building sectors, diminution of both embodied and operational energy should be considered. Most of the literature has concentrated on downscaling the embodied or operational energy in seclusion, without considering the impact on the other. The energy footprint research of the building sector has mostly centered around the reduction of operational energy. This is primarily due to the fact that calculating embodied energy is more time- and resource intensive, as well as more complex, than assessing operational energy. Moreover, the embodied energy varies widely depending on geographical locations, methodology adapted in quantification, and manufacturing processes. This study presents a comprehensive literature review in order to examine these indicators and their influence on the evaluation of embodied energy. The study emphasizes the trade-offs between embodied and operational energy in building construction and advocates for the standardization of parameters to ensure consistency in lifecycle energy assessments of buildings

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Keywords: Embodied Energy (EE), Energy Footprint., Life cycle energy, Operational Energy (OE).

**ID 199**

# Integration of daylight and long term energy savings in air conditioned buildings in India

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Building sector is one of the major energy consumers in India. In recent years, growth of building floor area is very high and the same will be continued for the next few decades. Energy consumption in building sector in India will increase many fold due to the rapid growth of this sector. With economic growth of the country, requirement of air-conditioned building space is also increasing very fast. In the present study, integration of daylight through glass window of the buildings for Indian climatic condition is carried out to quantify the energy savings opportunity in buildings. The window glazing area in different walls are the source of daylighting in to the building. The effect of daylight may be positive or negative depending on the application strategy. Application of daylight considerably reduces lighting energy consumption of the building but increases heat gain into the indoor space. This heat gain of the building increases cooling energy requirement of the building. In this study, daylight is control through external shading to reduce heat gain and artificial lighting of the building is controlled according to the available daylight at the reference points of the building. Balance between heat gains and daylighting is achieved through parametric variation of slat angle of shading device. Energy savings due to daylight integration compared to reference building varies from 21-22.7% in three different study locations in India. This savings is used to find the long term energy savings and economic benefits in air-conditioned commercial buildings in India. Air-conditioned building floor area in India is predicted from building floor space prediction model based on available data. Estimated cumulative savings of electric energy consumption in the air-conditioned commercial buildings in India is more than 1331 billion units during 2020 to 2050. Cumulative savings of energy cost due to adaption of proposed strategy can save around 14912 billion INR up to 2050 and economic savings due to electric installation capacity avoid is estimated to 1267 billion INR for the same time span.

Keywords: Building energy, Daylighting, Energy savings, Long term benefits, Window glazing

**ID 39**

# Mangrove Leaf Analysis Through Modelling the Influence of Geometric Descriptors on Fractal Dimension and Spatial Entropy

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The study models the impact of geometric descriptors, Feret's diameter, and Area-Perimeter Ratio on Fractal Dimension (FD) in mangrove leaves of four different species Avicennia marina, Avicennia officinalis, Excoecaria agallocha, and Ceriops. Morphological variations in adaxial and abaxial surfaces are analyzed to reveal species-specific structural traits. The study investigates the influence of geometric descriptors on mangrove leaf Fractal Dimension (FD), emphasizing Feret's diameter, Area-Perimeter Ratio, and deviations from elliptical shapes. Key features affecting FD are identified using Shapley additive explanations (SHAP), permutation importance, and Spearman correlation, highlighting the significance of Feret's diameter and its quadratic term. Elastic Net with polynomial feature expansion, combined with SVR, Random Forest, and Gradient Boosting, optimizes FD predictive modeling. Results link FD to normalized spatial entropy, revealing complex interactions between descriptors and mangrove leaf geometry.

Keywords: Complexity, Fractal Dimension, Normalized Spatial Entropy, Sensitivity Analysis, Shape Descriptors

**ID 232**

# Numerical Investigation of Condensation Heat Transfer of R22 and R290 in Microchannels for Energy-Efficient Cooling

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The escalating concerns regarding environmental impacts of conventional hydrofluorocarbon refrigerants like R22 have intensified the search for sustainable alternatives in air conditioning and refrigeration systems. A hydrocarbon refrigerant, propane (R290) has been recognized as one of the most promising natural refrigerants owing to its low global warming potential and excellent thermal properties. In this study, computational fluid dynamics methods are utilized to compare the condensation performance of R22 and R290 within a horizontal microchannel. The analysis is conducted using a three-dimensional 100 mm long square microchannel with dimensions of 0.5 mm × 0.5 mm. Key performance indicators namely the heat transfer coefficient during condensation, Nusselt number, and Jakob number are evaluated. Results show that R290 achieves, on average, a 14% higher heat transfer coefficient and a 23% increase in Nusselt number compared to R22 across various inlet conditions. Additionally, R290 demonstrated a more efficient and stable condensation profile. The study supports the integration of R290 in microchannel condensers as a step towards sustainable, energy-efficient cooling and longterm decarbonization in the HVAC sector.

Keywords: Condensation, Jakob number, R290, heat transfer coefficient, microchannel

**ID 159**

# Recent Advances in the Use of R455A and R457A with Nanofluids in Refrigeration Systems: A Comprehensive Review

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This comprehensive review explores recent advancements in the use of low-global warming potential (GWP) refrigerants R455A and R457A in combination with nanofluids for refrigeration applications. Environmental concerns associated with conventional refrigerants have led to increased interest in alternative solutions. R455A and R457A are emerging as promising low-GWP options, offering reduced environmental impact while maintaining performance. Nanofluids, which are engineered colloidal suspensions of nanoparticles in base fluids, have demonstrated enhanced heat transfer properties in various applications. This review examines the synergistic effects of combining R455A and R457A with nanofluids in refrigeration systems, focusing on their thermo-physical properties, heat transfer characteristics, and overall system performance. The scope encompasses experimental studies, theoretical models, and practical applications, providing a comprehensive overview of the current state of research and potential future directions in sustainable refrigeration technologies.

Keywords: Nanofluids, low-global warming potential (GWP) refrigerants, refrigeration systems, sustainable refrigeration technologies

**ID 193**

# Structural analysis of Different Blade Profiles For H-Darrieus Vertical Axis Wind Turbines Using Finite Element Method

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Small-scale H-Darrieus vertical axis wind turbines (VAWTs) have gained traction in the renewable energy sector due to their simple design, cost-effective construction, and adaptability to unconventional installation sites. Among various parameters for optimizing VAWT designs, blade profile selection plays a critical role in enhancing performance and structural integrity. This study investigates the structural performance of H-Darrieus VAWTs using three different blade profiles like NACA0018, NACA0021 and NACA4412 considering structural steel as the blade material. Finite Element Method (FEM) was used in ANSYS Workbench 2024 to assess Von Mises stress, total deformation, and factor of safety (FOS) under uniform loading and defined boundary conditions. Results show that all blade profiles operate safely, with FOS values exceeding 1 and deformations within acceptable limits. Among them, the NACA4412 (unsymmetrical profile) demonstrated superior structural performance, with the lowest deformation (0.2862 mm) and the highest FOS (5.15), indicating excellent stiffness and load distribution. NACA0021 exhibited almost comparable Von Mises stress like NACA4412 and an FOS of 5.10. Despite showing the highest stress and deformation, NACA0018 maintained structural integrity with an FOS of 3.56. These findings provide valuable insights into optimal blade profile selection for improved durability and efficiency in VAWTs, supporting advancements in sustainable wind energy systems.

Keywords: FEA, H-Darrieus VAWT, airfoil, blade profile, small-scale wind turbine, structural analysis

**ID 101**

# A potential assessment for Decarbonization through operational energy audit and benchmarking of an educational building: A Case Study

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The building sector requires more attention in energy efficiency as they consume around 30% of total energy, with educational buildings accounting for 10-15%. Over 60% of educational buildings show energy inefficiency due to retrofit and design limitations. This study seeks to benchmark educational building energy use and advances audit methods using real-time data, usage insights, and decarbonization goals to bridge the performanceretrofit gap effectively. In this case study, an energy audit is conducted on a G+9 educational building located in Kolkata, which has warm & humid climate zone. The study involved the walkthrough data collection of the building with audit equipment's & CFD simulations of the wind flow. The data set is then categorized based on their initial cost implications—low, medium and high-cost measures & on the energy efficiency of lighting and comfort systems. The audit revealed that during 2023-24, the educational building consumed around 715,110 kW with 169652 kW gained from non-conventional energy. The analysis helped identify key areas of energy usage allowing for energy and cost savings, and accordingly, payback analysis ensures retrofit feasibility. Refined energy audits improve performance in existing buildings, offering sustainable and decarbonization pathways for the educational sector.

Keywords: Decarbonization, Energy Audit, Energy benchmarking, Energy efficiency., Renewable Energy

**ID 110**

# Deep Reinforcement Learning and CNN-LSTM-Based Hybrid Architecture for real time Prediction and Control of Renewable Energy Sources

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[1] Assistant Professor

The incorporation of renewable energy sources like solar and wind in contemporary power grids is highly challenging owing to their natural variability and intermittence. Reliable forecasting and smart control are necessary to maintain grid stability, minimize curtailment, and maximize economic benefits. Here, we introduce a new hybrid framework that synergistically integrates Deep Learning (DL) methods with Reinforcement Algorithms (RL) to facilitate smart prediction and control of solar and wind energy systems. In the proposed architecture, a hybrid CNN-LSTM-based deep learning module is employed to predict short-term solar and wind power generations from SCADA historical data and meteorological conditions. Predictions are passed to a deep reinforcement learning (DRL) agent, to learn optimal energy dispatch, battery scheduling, and grid interaction policies. The RL agent accepts real-time predictions, battery state-of-charge, grid prices, and load demand as state variables, and aims to optimize operational costs, maximize system efficiency, and energy revenue. The model is validated using actual Indian solar and wind farm data and is demonstrated to have high prediction accuracy and improved control performance over baseline methods. The model i s also adaptable to a multiagent system that enables coordination between solar, wind, and storage sub-systems. The hybrid RL + DL system presented provides a scalable and adaptable solution to energy management in the smart grid that can be deployed with ease on edge or cloud infrastructure for real-time processing

Keywords: CNN-LSTM, DRL, Optimization, Solar Energy, Wind Energy

**ID 288**

# Modelling of an Evacuated Tube Solar Air Heater with Perforated Twisted Tape Through Least - Squares Support Vector Machines

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The modelling work of the Evacuated Tube Solar Air Heater with Perforated Twisted Tape (ETSAHPTT) system's performance using the least squares support vector machine (LSSVM) method is presented in this paper. An ETSAHPTT system is a complex, multiple-parameter system that is difficult to model using traditional methods. In this context, the LSSVM demonstrated a superior ability to generalize irrespective of the dimensionality of the data input. To achieve effective modelling, various mass flow rates in the evacuated-tube system were analyzed. Several analytical studies have been conducted to determine the optimal LSSVM parameters, including the regularization parameter, the best kernel function, and its associated parameters. The effectiveness of the proposed method was evaluated using various statistical validation metrics. For the projected linear kernel function, the root mean squared error (RMSE) was calculated to be 0.0068, the coefficient of multiple determinations (R2) was 0.08284, and the coefficient of variation (cov) was 2.02

Keywords: Evacuated tube air heater, Hole diameter ratio, Least-squares support vector machine, Predict, Twist ratio, erforated twisted tape

**ID 268**

# Synergistic Effects of Temperature and Catalyst on Biomass and waste Plastic Co-Pyrolysis for Sustainable Biofuel Production and Circular Bioeconomic

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Conventional biomass uses generate environmental concerns due to inefficient combustion in domestic settings and risks of overexploitation when replacing fossil fuels in power plants. Co-pyrolysis of biomass with waste plastics offers a promising alternative for producing sustainable, high-quality biofuels. Plastic materials share similar heating values and lack oxygenated compounds like fossil fuels, making them effective in enhancing the quality of bio-oils. In this study, co-pyrolysis was performed for a mixture of waste low-density polyethylene (LDPE) and Azadirachtaindica seeds with Aluminium oxide (Al2O3 ) as the catalyst. Similarly, co-pyrolysis was also performed for a mixture of waste Polypropylene (PP) and Delonix regia with Zeolite as the catalyst at different temperatures and catalyst ratios to derive the bio-oil. The oil yield and thermo-physical properties are analysed as compared to diesel. The highest liquid oil yield was achieved at 500°C for LDPE and Azadirachta indica seeds (93.91%) and at 550°C for PP and Delonix regia seeds (71%), with minimal gas and char production at these temperatures. The obtained liquid oils were then characterized through GC-MS, FTIR techniques, and thermo-physical properties were determined for the obtained fuels. The fuel properties are observed to be significant as compared to diesel. This study outlines the synergistic mechanisms of biomass–waste plastic coprolysis and emphasizes the significance of adopting circular bio economy frameworks for effective biomass and plastic waste management.

Keywords: Azadirachtaindica seeds, Co-pyrolysis, GCMS, LDPE, PP

**ID 143**

# Algae-Based Carbon Capture and Renewable Biofuel Production: A Dual Solution for Climate and Energy Challenges

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Microalgae-based systems present a dual solution to both climate change and sustainable energy in that they sequester carbon dioxide and convert it into biofuels or bioplastics. This strategy draws upon the natural photosynthetic competence of microalgae to uptake $CO_2$ from flue gases of industry or the atmosphere, as evidenced by up to 1.3 kg of $CO_2$ per kg of biomass yield sequestration rates reported in studies. Pilot-scale photobioreactor and open pond systems have been successfully coupled with thermochemical conversion processes such as hydrothermal liquefaction (HTL) to produce bio-crude oil and harvest residual energy by anaerobic digestion of aqueous byproducts. Model experiments indicate that certain algal strains can exhibit lipid productivity in the range of 2–3 g/m²/day under optimised conditions, which is suitable for biodiesel production. The process also facilitates wastewater remediation through the absorption of nutrients such as nitrogen and phosphorus. Economic studies identify cultivation costs as the main challenge (77% of overall costs), although the co-location of algae farms with power plants or wastewater treatment plants enhances feasibility. A pilot system integrating $CO_2$ capture from coal-fired flue gas with algal biofuel production achieved 90% carbon utilisation efficiency and annual biomass yields of 280 tons per hectare. These biorefineries showcase the circular bioeconomy in converting emissions to renewable fuels as well as reducing fossil resource reliance.

Keywords: Carbon sequestration, biodiesel, biomass, flue gas, wastewater remediation

**ID : 96**

# Addressing the shortcomings of Moran's I with Getis-Ord Gi * and Fuzzy Logic in Mangrove Spatial Pattern Analysis

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In this study, the spatial pattern analysis was conducted within the geographic boundaries of latitude 14.25°N to 26.25°N and 72.75°E to 88.75°E. Spatial pattern analysis reveals that mangrove species exhibit higher photosynthesis rates in the southern latitudes (~7.5°N) due to favourable warmer temperatures, while northern latitudes (~25°N) show lower rates, indicating less favourable growth conditions. Surface temperature shows clustering of higher temperatures towards the lower latitudes (~7.5°N - ~12.5°N), promoting mangrove growth as it is favourable for them, while the cooler temperature towards the northern latitudes (~25°N) restricts their presence. Soil moisture exhibits favourable growth conditions in southern latitudes (~7.5°N) as well as in western longitudes (~72°E), with spatial clustering ensured by the statistical method Moran's I. Precipitation also shows clustering pattern with higher levels in southern latitudes (~10°N) and western longitudes (~72°E), which are favourable for mangrove expansion. Although Moran's I has widely been used in different fields like species distribution modelling (SAC), ecological and geographical studies, it has several shortcomings. To examine and overcome the shortcomings of Global Moran's I, two methods have been used, out of which one method is the Getis-Ord *, which is specialized in the identification of small local clusters, and another is the application of fuzzy logic to handle the uncertainties related to the different environmental variables that influence the mangrove growth. This study explores how the problems of Moran's I have been addressed using the mentioned methods.

Keywords: Coldspots, Fuzzy logic, Getis-Ord *, Hotspots, Local clusters, Moran's I, Spatial Autocorrelation

**ID 184**

# Harnessing Hydel Power more - a newer method

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Modification of the control method of water descent by suitably tapping water from far upstream of a steeper river, stream or estuary by Senstock may improve flow conditions of water such as to favour running of more powerful hydraulic turbine vis-a-vis hydro electric station onshore even eliminating the need of dam, reservoir etc. Some rivers and streams contributories to the existing reservoir and the reservoir itself may become additionally useful for multi-tier hydel station. Also a chord-like feeder conduit (similar to Senstock) with favourable slope, off the bend of a big river, may potentially facilitate the installation of a hydel power station onshore downstream of the bend. Ordinarily available water head can be better utilized by converting the intake system from open channel flow to closed channel flow to facilitate improvement in hydroelectric power generation. Such modifications in matters of intake of water may significantly change the picture and map of hydel power or total energy potential of a country, of the world too. Regarding renewable energy, it is an innovative idea for the generation of Hydro-Electricity. Harnessing hydro-power additionally with cultivating the concept of close channel flow or Senstock principle towards gain in green and cheaper energy production from natural renewable energy resources and reserves, unfolding hitherto unestimated/underestimated / undeveloped potential may facilitate provident planning of energy strategy and missions. Non utilizing such simple wide-ranging applicable and purposeful novel postulate for generation of energy from renewable water resources with the advanced principle of close channel flow through Senstock, particularly when the growth of hydropower generation by way of application of conventional system with dam, reservoir like infrastructural construction work and Penstock at the depth of the reservoir tends to be limited or asymptotic, may amount to continuously keep the dent on the human world, by the human world and for the human world the mark of the unnoticed absence of poetic Justice.

Keywords: Hydel station, Senstock, hydropower, techno economy, viability

**ID 170**

# Evaluating the Reliability of Pixel-Based Composites for Mangrove Ecosystems: Methodology and Insights from Henry Island

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Remote sensing serves as a key source of information for monitoring dynamic mangrove ecosystems. Although free and open remote sensing data have become more accessible, a significant gap remains due to the lack of a standardised methodology for evaluating composite quality. The accuracy of surface reflectance retrieval is often compromised by atmospheric disturbances, including haze, clouds, and cloud shadows. This study introduces a pixel-based composite evaluation framework built upon five essential criteria: (i) the count of valid observations and areas lacking data, (ii) the occurrence of unfiltered atmospheric disturbances like clouds, shadows, haze, or smoke, (iii) the consistency of surface reflectance values in terms of radiometry, (iv) the temporal proximity of pixel acquisition dates, and (v) the spatial alignment of these acquisition dates. To validate this methodology, we processed over 12,000 Landsat images to create and analyse Best Available Pixel (BAP) and Medoid pixel-based composites for the period 2018–2020, focusing on the mangrove ecosystems of Henry Island, Sundarbans, India. Our results indicate that BAP generates composites with better temporal consistency, whereas the Medoid approach enhances radiometric stability. These findings highlight the effectiveness of our approach in systematically assessing the quality of pixel-based composites.

Keywords: Best Available Pixel (BAP), Medoid approach, Remote sensing, compositing algorithms, mangrove dynamics, mangrove ecosystems, multi-temporal images, pixel-based composites, radiometric consistency, statistical estimates, surface reflectance, temporal consistency

**ID 137**

# Developing a Controlled Ethylene-Based Mango Ripening Chamber for Enhanced Safety and Quality

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India contributes around 45% of global mango production, which yields nearly 21 million metric tonnes annually. However, 25-26% of mangoes produced are being wasted due to improper ripening and poor storage facilities. Artificial ripening with calcium carbide poses various health hazards like dizziness, vomiting, and skin ulcers, leading the FSSAI to ban the use of calcium carbide under Regulation 2.3.5. This study focuses on the design and development of a sustainable mango ripening chamber which utilises ethylene gas to ripen mangoes with real-time monitoring. The experimental setup incorporates VCRS for refrigeration purposes and is fitted with DHT11 and DHT22 sensors to monitor temperature and humidity, while an MQ2 sensor measures ethylene levels. The chamber also includes a linear actuator for ethylene release and a humidifier-exhaust system for optimal humidity control. Methods employed include sensor calibration, data acquisition, and system testing under varying operational conditions to fine-tune the ripening process. The experimental results demonstrate the effectiveness of the system in achieving uniform ripening, reducing spoilage, and improving safety standards. This study meets the urgent social requirement for a cheap, safe, and scalable solution to dangerous chemical-based mango ripening practices, providing a realistic solution for local vendors and small-scale traders.

Keywords: Ethylene gas, Humidity control, IoT, Mango ripening, Temperature regulation

**ID 255**

# Implementation and Application of NeuronMOS using Python

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This paper delves into the implementation of a CMOS-based three-input and five-input neuron MOS in 180nm CMOS technology. The circuit's behaviour is implemented through simulation by LTSpice and then further validated using Python codes. It uses capacitive coupling of the input signals, which is then fed to a CMOS inverter. The intrinsic parameters are fine-tuned, which adjusts the threshold voltage of this inverter, and it modulates the logical behaviour of the circuit. The overall circuit has great adaptability, which makes it a good candidate for implementing neuromorphic systems and other advanced logic-based applications.

Keywords: Capacitive coupling, Fine-tuning, Neuromorphic systems, Neuron MOS, Python, Threshold voltage

**ID 61**

# Mangrove Health Prediction using Neuro-Fuzzy Inference

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The study develops an adaptive system built with neuro-fuzzy elements to identify mangrove species while tracking their health status despite spectra blending, changing environmental conditions and scarce labelled data. The proposed system successfully groups mangroves into three different health clusters (Good to Moderate, to Poor) using neural network learning capabilities together with fuzzy logic uncertainty control. The method relies on multiband spectral data analysis, which integrates chlorophyll absorption wavelengths and red-edge reflectance with vegetation index calculations to optimise measurement precision. Data processing that involved fuzzified and encoded information allowed the neuro-fuzzy model to demonstrate 95.8% classification precision. Fuzzy rules developed from this system demonstrated remarkable success for identifying steady health with an accuracy rate of 98.01%. Through these rules, the model gained robustness in areas with dynamic tidal conditions and sparse field information because they explained how features affected health outcomes. Through this work, neuro-fuzzy systems demonstrate their ability to monitor and conserve large-scale mangrove ecosystems effectively with scalable precision and easy interpretation for the sustainable management of valuable ecosystems.

Keywords: Neuro-fuzzy networks, chlorophyll absorption wavelengths, environmental monitoring, fuzzy logic, health assessment, mangrove classification, spectral blending, sustainable ecosystem management, vegetation indices

**ID 37**

# Study On Battery Thermal Runaway Risks

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Thermal runaway in lithium-ion batteries (Li-ion) presents a significant safety concern due to their extensive use in mobile phones, laptops, and electric vehicles. It refers to an uncontrollable temperature rise in a battery, often resulting in fires, explosions, or releasing toxic gases. This phenomenon occurs when a series of chain reactions, triggered by factors like overcharging, physical damage, internal short circuits, or high ambient temperatures, lead to excessive heat generation within the battery. This paper delves into the theoretical mechanisms behind thermal runaway, focusing on the stages of heat buildup and the exothermic reactions that exacerbate the situation. Overcharging or rapid charging can cause the battery to generate heat faster than it can dissipate, creating the ideal conditions for thermal runaway. Physical damage, such as punctures or impacts, can compromise the battery's structural integrity, leading to short circuits. Internal short circuits, often due to manufacturing defects or degradation over time, are another major contributor to thermal runaway. External heat sources, including high ambient temperatures or exposure to fire, can further trigger these reactions. Existing theoretical models explain how these factors contribute to the thermal runaway process. These models typically involve heat transfer equations and electrochemical kinetics that describe how heat builds up and leads to a self-amplifying cycle of reactions within the battery. The paper also discusses potential preventive measures, including improved batterydesign, better charging protocols, and advanced thermal management systems.

Keywords: Catastopic failures, advanced thermal management system, charging protocols, safety protocols

**ID 148**

# INNOVATIVE SYSTEM TO ENHANCE SOLAR PANEL EFFICIENCY USING TRANSPARENT GLASS PANELS

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Transparent glass panels are a revolution in making solar power systems more efficient, all while still looking sleek and letting light through. These panels use smart optical tricks, like special lenses and concentrators, to redirect and focus sunlight onto the solar panels, so they can produce more energy. They also use special coatings and diffraction gratings that let in visible light but block or redirect harmful ultraviolet and infrared rays, which helps produce more power and keeps the panels cooler. Made from high-quality materials like fused silica and liquid glass, they can be microstructured to reflect internal light and scatter photons better, boosting performance. Surface treatments like anti-reflective coatings and smart thermochromic films can automatically adjust transparency and heat regulation based on the environment, without any manual adjustments. Accurate modelling helps align the panels perfectly with the sun's position all day, maximising sunlight capture. In real-world tests, these panels have shown impressive results, reaching up to 11% efficiency and allowing 68% visible light through—proof that they work well in practical settings. Transparent solar panels do beyond create electricity. They also help cool down cities by reducing heat buildup, save money on energy bills, and look nice without messing up a building's look. As cities aim to become smarter and greener, these innovative panels offer a versatile, eco-friendly solution that supports sustainability and offers many ecological and economic benefits for renewable energy's future.

Keywords: Light Redirection, Renewable Energy Solutions, Smart Optical Technologies, Solar Energy Efficiency, Sustainable Architecture, Transparent Solar Panels, UV and IR Blocking, Urban Heat Reduction

**ID 129**

# Development of Arduino-based smart water spray cooling technique applied to a photovoltaic panel to improve the active power of 40KWp solar wind Hybrid power plant using a switched reluctance motor

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In this paper an Arduino-based smart water spray chilling method was projected and tentatively tested on a Polycrystalline Photovoltaic panel in different weather environments of Bankura. Experimentally, there is an active increase in Active capacity of PV panel from 23 kWp to 27 kWp. It increases allure adeptness by about 11%. The average committee temperature was diminished from 76°C to 25°C and hostile attainable committee hotness was limited to 25°C, Finally, in accordance with win tentatively results. It maybe concluded that the projected method has received a approving effect on increase in output power.

Keywords: Solar energy; on grid power plant; size of plant; Educational Institutions; Load

**ID 165**

# GRID SYNCHRONIZED TRANSFORMERLESS SOLAR MICRO INVERTER IN N+1 CONFIGURATION

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In the past few years, with easy accessibility and sustainable propagation of solar energy in the environment, solar-powered machines have seen a good rise. This paper proposes a new way of harvesting and storing solar energy more efficiently and reliably. The proposed system envisages a distributed solar grid architecture, where each solar panel is connected to a dedicated micro-inverter. Micro inverters allow the extraction or harvesting of solar energy at the optimum price of DC voltage for conversion into AC power. All the micro inverters are synchronised to produce AC outputs with the same frequency and phase, which allows the summation of all combined outputs, resulting in a larger and more stable energy yield. In turn, we take care to maximise the solar panel power output by applying an advanced Maximum Power Point Tracking method for the optimisation of energy extraction under varying parameters, with temperature and irradiance as the most influential ones. The DC power is gained from the solar panels to be operated through a DC converter device, which regulates and stabilises the voltage level, feeding it to the micro-inverter stage. The inverter is operated with the Sinusoidal Pulse Width Modulation (SPWM) controller with a feedback circuit for the accurate control of output voltage and frequency in improving the power quality. Furthermore, an LC filter makes it possible to reduce harmonics and improve AC waveform purity." This overall procedure would thereby increase efficiency in energy conversion and distribution while guaranteeing the modularity, scalability, and easy maintenance of the solar power system. This unique design of micro inverters equipped with MPPT control, SPWM feedback, and LC filtering is an efficient method for distributed solar energy harvesting and meets the demands of present-day renewable energy applications.

Keywords: Efficiency, MPPT, Microinverters, PWM, SPWM, Solar, Solar Grid, Synchronisation.

**ID 91**

# Machine Learning Applications in Heart Disease Detection: A Comprehensive Literature Review

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The paper investigates various ML models for predicting heart disease, thus highlighting the critical role of these models in advancing medical systems. Machine learning provides powerful tools for early discovery of cardiovascular illness, assisting medical professionals in identifying at-risk patients before symptoms emerge. Given that coronary illness stays one of the main sources of mortality around the world, accurate prediction models are essential in clinical settings. This survey paper reviews several best-in-class ML methods used in predicting heart disease, providing an overview of methods and approaches that contribute to this vital area of healthcare.

Keywords: cardiovascular risk assessment, clinical decision support systems, feature selection for heart disease models, heart disease prediction, machine learning for healthcare.

**ID 319**

# Harnessing Concentrated Solar Collectors for Eco-Friendly Fruit Drying: A Pathway to Lower $CO_2$ Emissions and Carbon Credit Acquisition

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The aim of this study is to explore the possibility of using Concentrated Solar Collector (CSC) systems as an alternative method of fruit drying, which consumes less energy than traditional thermal drying methods while maintaining product quality. This review covers advancements in recent years regarding CSC technology and practical applications in real world case studies, as well as performance evaluations of CSC-based dryers in the fruit processing sector. They were critical for reducing carbon footprints and the acquisition of carbon credits, and through multiple case studies across geographical and climatic scenarios, trends in operational efficiency, product quality, and sustainable environmental outcomes are shown with challenges such as high initial investment and maintenance costs highlighted before concluding with potential research directions and policy recommendations that could promote greater adoption and increase the economic feasibility of CSC fruit drying.

Keywords: Carbon Footprint Reduction, Concentrated Solar Collector (CSC), Solar Drying, Sustainable Fruit Processing

**ID 282**

# Novel Cost-Effective Evaporative Cooler for Performance Enhancement of Split Air-Conditioner

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This research paper presents the decarbonization by enhancing the cooling coefficient of performance of a split air-conditioner (SAC). Split air-conditioners are normally equipped with air-cooled in condensers in residential and commercial applications. Retrofitting of an evaporative cooler improves the cooling coefficient of performance by converting an air-cooled condenser to an evaporatively cooled condenser. The judiciously designed novel evaporative cooler provides better improvement in the performance of SAC with low initial and operating costs. Evaporation of water is promoted by increasing the surface area of water droplets. The carryover of water droplets is eliminated by using a droplet separator, which is installed at the entrance of the condenser. The pressure drops across the novel evaporative coolers are in the range of 10 to 12 Pa for the air velocity of 1 m/s to 2.5 m/s. It taps an option for energy saving of about 10 to 13%. Thereby reducing the 88.3 million tons of CO2e. Hence, it is a better solution for decarbonization. The performance of split air-conditioners improves drastically, which reduces the energy demands.

Keywords: Coefficient of performance, Decarbonization, Energy efficiency, Evaporative cooler, Residential cooling

**ID 100**

# A SMART SOLAR TRACKER LIGHT SYSTEM WITH MULTIPLE MONITORING SENSORS

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Solar energy stands out as one of the most abundant and sustainable sources of power available today. However, to maximise its potential, the efficiency of solar panels hinges on their orientation towards the sun. A solar tracking system is a game-changer, dramatically increasing energy capture by automatically adjusting the panel's position to follow the sun throughout the day. This paper introduces a cutting-edge solar tracker lighting system, seamlessly integrated with multiple temperature and humidity sensors to optimise performance. Our innovative design not only boosts energy efficiency but also monitors environmental conditions and enhances the lifespan of solar panels by adapting to changing weather patterns. The system features a single-axis solar tracker equipped with light-dependent resistors (LDRs) that detect sunlight intensity, paired with servo motors that precisely adjust the panel's orientation. Additionally, multiple temperature and humidity sensors, including the reliable DHT11, are strategically placed to monitor variations in the environment. The microcontroller (Arduino) processes this sensor data to determine the optimal tracking angles while accommodating fluctuations in temperature and humidity. This advanced system also incorporates an LED lighting setup, with the option for wireless data transmission, providing real-time monitoring and remote control capabilities. By implementing this state-of-the-art solution, we can achieve significantly higher energy efficiency compared to traditional fixed solar panels. The single-axis tracking mechanism ensures the solar energy absorption remains at its peak, and the integration of temperature and humidity sensors offers invaluable insights into the factors affecting panel performance and longevity. Embrace this technology to harness the full potential of solar energy and pave the way for a sustainable future. The dynamic LED lighting system is expected to reduce energy consumption. The proposed solar tracker light system, equipped with environmental sensing capabilities, represents a significant advancement in sustainable and intelligent solar energy use. By improving tracking accuracy, monitoring and environmental conditions, this system can enhance energy efficiency, optimise power output, and extend the lifespan of solar panels. Future developments may include AI-based predictive tracking and IoT integration to improve automation and data analytics.

Keywords: Environmental Monitoring, Light-Dependent Resistor (LDR), Renewable Energy, Smart Solar Lighting, Solar Tracker, Temperature and Humidity Sensors

**ID 187**

# Land Cover Segmentation on Satellite Images

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Land Cover Segmentation on Satellite Images is an extremely important task in remote sensing, which has applications in the field of urban planning and environmental monitoring. This study investigates two deep learning architectures—ResNet50-U-Net, along with a modified U-Net for high-resolution satellite image segmentation into six distinct land use categories. The ResNet50-U-Net leverages a pretrained ResNet50 encoder for hierarchical feature extraction, enhancing generalization and efficiency. The modified U Net, designed with additional convolutional layers and attention mechanisms, improves spatial feature refinement for precise segmentation. Both models are trained using categorical focal loss and dice loss to address class imbalance and improve segmentation accuracy. Extensive preprocessing, data augmentation, and post-processing techniques are applied to ensure robust performance. Experimental results demonstrate that integrating transfer learning with deep feature extraction significantly enhances segmentation quality, making these models suitable for real-world geospatial analysis and land cover classification.

Keywords: Landcover Segmentation · Remote Sensing · Deep Learning · Satellite Image Analysis · U-Net.

**ID 109**

# Assessing and mapping of urban areas for sustainable solutions using image processing

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To achieve effective urban sustainability assessment, it is crucial to analyse and map green spaces within urban environments. This paper presents an image-processing-based approach for evaluating urban areas using Python's OpenCV library alongside Matplotlib and NumPy. The methodology integrates satellite image analysis with HSV colour space transformation to enhance colour segmentation and detection of vegetation. In the paper, validation modules for green cover detection and area percentage calculation are introduced. This novelty enables the classification and quantification of urban vegetation through colour thresholding and masked segmentation. A unique approach is implemented, where the total area is discretised into 23 equal grid sections, allowing for localised green detection and percentage estimation before extrapolating total green cover. The analysis is conducted using PyCharm and Google Colab, with satellite images replaced by image paths within the code for adaptability. A field study was precisely conducted in Sector V, a newly developed urban area, to validate the method with real-world data. A comparative evaluation is performed against United Nations (UN) sustainability data, WHO Sustainable City, and Urban Design Framework for Implementation (UDPFI) guidelines to assess compliance with global urban green standards. Results show that the proposed method effectively identifies and quantifies green cover, providing a data-driven approach for sustainable urban planning. This work offers valuable insights for policymakers and urban planners in environmental monitoring and urban development.

Keywords: HSV colour space, OpenCV, Python, UN sustainability, Urban assessment, environmental monitoring, green cover detection, image processing, urban planning.

**ID 71**

# AI and ML in Solar Dryers: A Review of Recent Advances

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Silver Oak University

AI and ML are the technologies that are emerging in today's era. These are helping solar dryer systems revolutionize. The algorithms of AI and ML are helping the solar dryer systems by many means, such as predictive analysis, real-time monitoring, and control of environmental parameters such as humidity, air flow, and temperature. With the help of this that has been increased efficiency in drying the energy consumption is reduced, and the quality of dried products has been enhanced. IoT-enabled sensors and cloud-based Data analytics are another two other supportive factors. They facilitate remote monitoring decision making, which ensures consistent performance and helps scalability. All together, these technologies help in advancement and contribute to various sustainable agriculture practices, which ensures that the waste is minimised and the resource utilization is maximized. This, in turn, will make solar dryers more accessible and effective for various applications in food preservation and industrial processes.

Keywords: Artificial Intelligence (AI), Machine Learning (ML), Optimization Algorithms, Predictive Modelling, Solar Dryers

**ID 57**

# Assessing Cyclonic Impact on Mangrove Stability Using Change Detection and Lyapunov Trend Analysis

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The purpose of this study is to evaluate the stability and expansion of mangrove ecosystems on Henry Island, West Bengal, after the cyclone, in order to gain a better understanding of long-term ecological changes caused by climate disturbances. The analysis adopts a multi-temporal approach and covers three significant periods: Pre-Cyclone (2016–2018), During Cyclone (2019–2020), and Post-Cyclone (2021–2023). High-resolution imagery from Landsat 8 was used to calculate the Mangrove Vegetation Index (MVI) and Leaf Area Index (LAI) across a specified area of interest. A mean reducer supplied average values, and an ensemble method that combined Pruned Exact Linear Time (PELT) and Cumulative Sum (CUSUM) algorithms was used to identify significant change points, with Isolation Forest techniques employed to eliminate false positives. Moreover, the dynamic stability of the ecosystem was assessed through Lyapunov Exponent analysis, while Hurst Exponent trends were used to investigate the long-term persistence of vegetation patterns. Combining remote sensing with advanced analyses, this study robustly tracks mangrove resilience amid climate stress. It's innovative, indigenous conservation focus aligns with the "Climate Resilient Built Environment and Indigenous Solutions" domain, offering valuable insights for sustainable management and community adaptation strategies.

Keywords: Change Point Detection, Cyclonic Impact, Hurst Exponent., Lyapunov Exponent, Mangrove Stability, Time Series Analysis

**ID 241**

# Assessment and validation of Mangrove Health using Type-2 Fuzzy System in Henry Island, India

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Mangrove forests are essential ecosystems that grow along protected coastlines that support distinctive biodiversity and offer coastal residents vital services, including storm protection. Mangroves are threatened by urbanisation, natural disasters like cyclones, especially in India due to their location. The health of the mangroves on Henry Island along the latitude 21.577109 °N & longitude 88.274456 °E was assessed using the Type 2 fuzzy for the years 2021-2022. The Mamdani inference system had been employed. The original purpose of Mamdani fuzzy inference was to integrate a collection of language control rules acquired from seasoned human operators into a control system. Parameters such as contrast, dissimilarity, homogeneity, energy, and correlation were used to evaluate the health of the mangroves. The output of mangrove health of the Henry Islands was predicted as moderate during the chosen timeframe. MATLAB-generated graphs offer a visual depiction of theoretical predictions and illustrate how altering specific texture aspects may impact the overall prediction. MVI was used to validate the above prediction made by fuzzy system.

Keywords: Henry Island, MATLAB, MVI, Type-2 Fuzzy, cyclones, mangrove.

**ID 206**

# Improving Classification Performance with Hybrid Ensemble Learning Models

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Ensemble learning has recently received significant attention in machine learning due to its potential to enhance classification performance by combining several models. Bagging and boosting are well known to counter high variance and high bias, respectively, in classification problems. However, independent use of these techniques often suffers from generalization and robustness problems when applied to high-dimensional data. This paper presents a hybrid ensemble learning model that combines bagging, boosting, and stacking techniques. The proposed model, by combining these approaches, should achieve better classification performance across diverse datasets. The proposed hybrid model is tested on benchmark datasets, and the results are compared with those of the traditional models to demonstrate effectiveness. This paper introduces a hybrid ensemble learning model that integrates bagging, boosting, and stacking techniques. By combining these approaches, the proposed model aims to achieve improved classification performance across diverse datasets. The hybrid model is evaluated on benchmark datasets, and its results are compared with those of traditional models to demonstrate its effectiveness. In this paper, we propose an alternative approach to improving classification accuracy by utilizing a hybrid ensemble model comprising bagging, boosting, and stacking techniques. The proposed hybrid model leverages the strengths of these methods simultaneously, addressing typical bias and variance challenges in conventional machine learning models. Using benchmark datasets such as the Pima Indians Diabetes Dataset and the Wine Quality Dataset, we demonstrate that the hybrid ensemble model outperforms standard classifiers and standalone ensemble techniques. Additionally, we evaluate the hybrid model's computational complexity and generalization ability across various domains.

Keywords: Bagging, Boosting, Classification, Ensemble Learning, Hybrid Models, Machine Learning

**ID 180**

# Multimodal Mood Recognition: Using Facial and Text based Data for Mood analysis

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This work integrates text-based voice sentiment identification with face emotion analysis to propose a unique approach to multimodal mood recognition. Utilizing deep learning models, the system analyses textual sentiment using TripAdvisor reviews and face expression detection using the FER2013 dataset. Using a convolutional neural network (CNN) architecture with dropout regularization and ReLU activations, the facial model achieves an accuracy of 82.08%. Long Short-Term Memory (LSTM) layers were used to create a sequential model for text-based sentiment recognition, which achieved an accuracy of 91.05%. The outputs from both models are combined using a fusion averaging approach to provide the final mood forecast. Transcribed audio data and synchronized facial expression analysis allow for real-time mood assessment. Improved human-computer interaction, tailored content recommendations, and mental health monitoring are some possible uses for this study. The research suggests potential advancements in multimodal integration and ethical AI frameworks while addressing important issues, including cultural diversity, privacy concerns, and scalability.

Keywords: CNN, Deep Learning, Facial Emotion Analysis, LSTM, Multimodal Mood Recognition, Real-Time Emotion Detection, Sentiment analysis

**ID 156**

# Comparative study of real-time data and PVsyst model of a rooftop solar panel in Kolkata

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Solar energy driven power sources are emerging as prominent alternative for conventional energy due to advancement of solar cell and battery technology. Different government policies encourage domestic and commercial usage of solar rooftop panels in various states of India. The installation and operation of solar rooftop panels have been made mandatory for the bulk power consumers in many states like Kerala, West Bengal, etc. PVsyst is one of the most useful software which has been widely used to design the solar panel and its accessories for both off-grid and on-grid projects. In this paper, an existing off-grid rooftop solar panel project is replicated in PVsyst situated near Nazirabad, Kolkata. The real time data obtained from the 5 kW rooftop solar panel is compared with the simulated outcome obtained from PVsyst model. These comparative studies are helpful for analyzing different real time losses with the estimated losses (like soiling loss, solar cell degradation loss etc) and understanding the operational variances of the real system with the PVsyst model. Hence, it may be concluded that how PVsyst model could be modified to achieve the optimal performance of these types of solar panel systems.

Keywords: Solar panel, PVsyst, conventional energy, off-grid, real-time loss.

**ID 149**

# Document Similarity with Retrieval-Augmented Generation: A Generative AI Approach

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This paper introduces a new way to improve large language models by combining them with smart information retrieval techniques. My approach helps the model provide more accurate and up-to-date answers by searching for relevant information from external sources before generating responses. This solves common problems like making things up (hallucination) or using outdated facts. I tested my system on different tasks and found it gives better, more reliable results than traditional models. This work is important for anyone interested in building AI systems that can give trustworthy and useful answers. In energy transition, combining large language models with real-time access to external data sources, RAG enables more accurate, up-to-date, and context-aware decision-making for energy companies and utilities. RAG systems can analyse historical maintenance logs, sensor data, and technical reports to predict equipment failures in advance, reducing downtime and improving the reliability of energy infrastructure such as transformers, wind turbines, and solar panels. RAG can process vast datasets, including weather forecasts, satellite imagery, and historical generation data, to optimize the placement and operation of renewable assets like wind farms and solar plants. RAG empowers the energy sector to make smarter, data-driven decisions, streamline operations, and accelerate the transition to cleaner, more sustainable energy systems by providing timely, relevant, and actionable insights from a wealth of internal and external data sources.

Keywords: Factual Accuracy, Hallucination Mitigation, Information Retrieval, Knowledge Integration, Large Language Models (LLMs), Natural Language Processing (NLP), Prompt Augmentation, Retrieval Augmented Generation (RAG), Semantic Search, Vector Embeddings.

**ID 53**

# Smart Vegetable Cart: A Temperature-Controlled IoT-Based Solution for Reducing Post-Harvest Losses in India's Food Supply Chain

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In India, 31% of the retail food supply goes uneaten, and 18% of the country's fruit and vegetable production is wasted annually. This is due to several factors, including a lack of cold storage, a lack of refrigerated transport, lack of refrigerated transport contributes to food wastage and inefficient use of fruits and vegetables. The principal aim of the research paper is to develop a smart vegetable cart which reduces vegetable wastage, increases the shelf life of the vegetables and reduces bacteria generation by temperature and environmental analysis. The smart vegetable cart is built with a stainless steel or aluminium frame for durability, complemented by lightweight ABS or polycarbonate. PUF panels with phase change materials (PCM) provide superior insulation. A temperature control system with heat sinks, fans, and water sprinklers regulates heat and humidity, while IoT sensors monitor conditions. Powered by an EV motor, the cart runs on lithium-ion batteries, supplemented by solar panels for sustainability. A comparative analysis before and after implementation demonstrates a considerable reduction in wastage—potatoes from 2.594 kg to 1.83 kg, onions from 4.813 kg to 2.567 kg, and tomatoes from 5.063 kg to 3.984 kg. The overall cost of developing the cart is estimated at ₹1,51,900. PUF panels provide effective thermal insulation, further enhanced by Phase Change Materials (PCMs) for better energy efficiency and temperature control. PCMs use latent heat storage to adapt to environmental changes, reducing energy consumption and improving sustainability. Despite challenges like cost and durability, their integration holds great potential for the construction, refrigeration, and cold storage industries. This innovation not only minimises post-harvest losses but also contributes to improved food security and increased farmer profitability. By optimising temperature control and storage conditions, the Smart Vegetable Cart presents a viable solution for reducing food wastage in India’s agricultural supply chain.

Keywords: Cold Chain Management, IoT-Enabled Storage Systems, Phase Change Material (PCM) Insulation, Post-Harvest Food Loss, Sustainable Agricultural Supply Chain.

# Track 3

## Mechanical Systems: Design & Analysis

**ID 125**

# Image Processing for Coating Film Detection in Automobiles

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This market study examines the importance of ecological coatings in the automotive industry, focusing on their impact on customer satisfaction, resale value, and brand image. Coatings enhance the vehicle's appearance and protect against weather conditions, UV rays, mechanical damage, and wear and tear. However, maintaining high production quality is challenging due to defects such as scratches, sagging, and foreign inclusions. While robotic painting technologies have improved production processes, manual assessment of coating flaws remains labour intensive and prone to errors. This project aims to leverage machine learning and computer vision technologies to enhance defect detection in automotive coatings. By integrating these advanced technologies, the goal is to automate and improve the accuracy of identifying coating defects, leading to higher-quality finishes and more efficient production processes.

Keywords: automotive industry, brand image, computer vision, customer satisfaction, defect detection, ecological coatings, machine learning, resale value, robotic painting technologies

**ID 190**

# Measurement and analysis of the wall static pressure of a double-S shaped curved duct

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The findings of an experiment measuring the wall static pressure of a double S-shaped curved duct are presented in this study. To make the flow visualization study easier, the test duct is composed of clear Perspex sheets. An inclined manometer with a 35° inclination is used to measure wall pressures. At 0°, 11.25°, 11.25°, 11.25°, and 90° measuring sections, the pressure distribution along the duct's curved and parallel sides was measured. This investigation's primary goal is to demonstrate the emergence of secondary flow, which occurs when flow passes through a curvature bend. Three distinct speeds are used for the investigation: 20 m/s, 40 m/s, and 60 m/s. As the flow moves towards the curve, the centrifugal force operating along the curvature creates a high-pressure differential between the outside and inner faces, as demonstrated by the trend of wall static pressure growth on the walls of the Double S-shaped duct. In a plane perpendicular to the primary flow, secondary motion is generated, causing the flow's bulk shifting in the direction of the inside face.

Keywords: Double S shaped curved duct, High pressure gradient, Secondary motion., Wall pressure

**ID 197**

# Design and Development of a Low-Cost Picosatellite with Inter-Satellite Optical Wireless Communication

Prof. Indranil Basu[1], Rohit Maji[1], Jeet Chatterjee[1], Vishal Singh[1], Supratick Dutta[1]

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The rapid advancement in small satellite technology has significantly transformed the landscape of space-based applications by providing cost-effective, compact, and efficient alternatives to traditional large satellites. This study focuses on the design and development of a low-cost picosatellite system that incorporates inter-satellite optical wireless communication (IsOWC) to enable direct, high-speed communication between satellites. Unlike conventional radio frequency (RF)-based systems, this approach bypasses spectrum congestion and bandwidth limitations, offering a secure and scalable solution. The project includes a detailed conceptual design, structural framework, and the configuration of a compact optical communication module tailored for picosatellite platforms. Additionally, an experimental prototype setup has been developed to validate the feasibility and performance of the system under controlled conditions. The outcomes of this research aim to demonstrate the practicality of IsOWC in small satellites and to contribute to the future deployment of dense satellite constellations capable of supporting low-latency, high-data rate communication networks in space.

Keywords: CubeSat, Inter-satellite communication, IsOWC., Low-cost satellite, Optical Wireless Communication, Picosatellite

**ID 266**

# Mathematical Modelling of Bearing Of Spinning Machine Using Exponential Form and ANN Simulation

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Artificial neural network is based on the biological nervous system. Neural networks are adjusted, or trained, so that a particular input leads to specific target output. Neural network adjusted such that comparison between output and target should be there until the network output matches target. Neural networks are trained to solve complex problems. The purpose of this research is to examine the effect of vibration on the bearings of spinning machine. Usually vibrations are not desirable for any machine. There are various causes by which vibrations are generated in spinning machine, of which study has been made in this research. So for that various independent variables has been chosen to analyze and formation of mathematical model has been done. Along with this ANN Simulation is also done for validation of the model.

Keywords: ANN, Vibrations, mathematical model, spinning machine

**ID 314**

# Fault Diagnosis of Machines using FFT Based Vibration Analysis

Prajapati Naik[1], Smitirupa Pradhan[2], Siba Padarbinda Behera[2], Saswat Sekhar Panigrahi[2]

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This study investigates fault diagnosis in machines through FFT-based vibration analysis, aiming to address the critical need for efficient and timely identification of mechanical faults. The significance of this project lies in its potential to enhance predictive maintenance strategies, thereby minimizing downtime, reducing maintenance costs, and preventing catastrophic failures. The objectives are to develop a robust methodology for fault detection using FFT analysis of vibration signals and to demonstrate its effectiveness in diagnosing various machine faults. The methodology involves acquiring vibration data from machinery, processing it using FFT techniques, and analyzing frequency spectra to identify abnormal patterns indicative of specific faults. Preliminary results demonstrate the feasibility of the approach in accurately detecting faults such as imbalance, misalignment, and bearing defects. This research offers valuable insights into advancing condition monitoring techniques for ensuring the reliability and operational efficiency of industrial machinery.

Keywords: Condition monitoring, Fast Fourier Transform, Frequency Spectrum, Predictive maintenance, Vibration analysis

**ID 327**

# Tribological Assessment of Sustainable Composites Reinforced with Carbonized Bio-waste

Prajapati Naik[1], Saswat Sekhar Panigrahi[2], Smitirupa Pradhan[2], Raj Saurav Parida[2], Siba Padarbinda Behera[2]

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This publication examines the abrasive wear characteristics of raw and bio-char reinforced polymer composite materials. The bio-char reinforced composite material is produced utilizing the hand-lay-up method with varying filler material compositions of 10%, 15%, and 20%. A series of studies were conducted utilizing a pin-on-disc tribometer to investigate the wear behavior under various processing settings compliant with ASTM requirements. The Taguchi method is employed to investigate the wear characteristics of these composites under various operational settings, including loads in N (10, 15, and 20) and sliding velocities in meters per second (1.047, 1.571, and 2.091). The aim is to identify the ideal parameters for the process. This experiment reveals that bio-char produced at elevated temperatures is more effective for wear analysis than the raw filler materials. The wear severity has escalated from abrasion to delamination, accompanied by heightened applied load and sliding velocity. The fillers underwent EDX analysis and SEM for characterization. The SEM is employed to examine the microstructural characteristics of the worn surface. This study demonstrates that bio-char produced at elevated temperatures exhibits favorable filler properties, enhancing the sliding wear resistance of composite materials.

Keywords: Bio-char, Optimization process, SEM analysis, Taguchi analysis, composite material

**ID 342**

# Numerical insights into the propagation of relativistic jets from supermassive black hole inside uniform interstellar medium

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In this present study, the numerical simulation of relativistic astrophysical jet propagation inside an uniform interstellar medium (ISM) has been carried out by solving relativistic magnetohydrodynamic equations (RMHD) in higher order finite volume method in astrophysics CFD solver[Mignone et al. 2007], which is developed in C programming platform. The relativistic jet is primarily issued from the pole of supermassive black hole inside an active galactic nuclei (AGN). The details flow physics associated to relativistic jet propagation inside the uniform interstellar medium has been thoroughly discussed in this study.

Keywords: astrophysics CFD solver, interstellar medium, relativistic jets, uniform interstellar medium

**ID 311**

# A Lightweight Zero-Trust Framework for Edge-Based Intrusion Detection Using Ensemble Learning and Anomaly Detection

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With young technologies like IoT and edge computing in use, the attack surface of modern networks has widened. As a result, trust-based Intrusion Detection Systems (IDS) are now unable to meet the challenge. This work plans a two-layer, effective and efficient Zero Trust IDS that fits into smaller edge networks. The initial stage contains a supervised stacked ensemble classifier of Random Forest, XGBoost and LightGBM which are fitted to identify recognized threats even better. The second layer uses an automatic "DBSCAN" detector for detecting zero-day attacks within the benign traffic selected by the ensemble. Reducing the input data by removing many redundant features has only slightly reduced the accuracy of the pipeline. Experiments on CIC-IDS2017, CIC-DoS2017, CSE-CIC-IDS2018, and CIC-DDoS2019 datasets indicate that the framework is highly effective, tolerant to mistakes and still has low overhead for processing and storage. The combination of these two layers follows strict zero-trust guidelines and provides an adaptable answer for catching intrusion threats in distributed edge networks.

Keywords: DBSCAN, Edge Computing, Ensemble Learning, Feature Reduction, Intrusion Detection System, IoT Security, Network Anomaly Detection, Zero Trust Architecture

**ID 65**

# Fully Turbulent Non-Newtonian Flow Characteristics in Polygonal Ducts

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Non-circular ducts are used extensively in the process industry, turbomachinery, and heat exchangers to improve compactness and efficiency. While rectangular and hexagonal ducts are common, other polygonal cross-sections find limited applications in fluid engineering systems. The ducts are prone to totally turbulent flows, which result in turbulence-driven secondary flows. This research investigates the behaviour of turbulent flow through polygonal ducts, using computational fluid dynamic simulations across cross-sectional shapes from triangles to decagons, all standardized by the same hydraulic diameter for effective comparison. The realizable k-epsilon model is implemented using computational fluid dynamics at high Reynolds numbers ($10^5$-$10^6$). The Ostwald-de-Waele power-law model is applied to simulate the pseudoplastic, dilatant and Newtonian fluids. Validations with benchmark correlations and experimental results ensure the correctness of the numerical methodology. Results demonstrate distinct convexities in primary velocity profiles with the formation of secondary flows, which decays downstream. Counter-rotating vortices form near the duct corners, influencing the flow dynamics. Spatial development of the turbulent kinetic energy demonstrates a three-stage trend: high value near the inlet, downstream reduction, and subsequent reorganization leading to increased turbulent kinetic energy before stabilization. The turbulence dissipation rate demonstrates the trend, transferring the energy to the boundary walls from the core stream.

Keywords: Computational model, Non-Newtonian fluids, Polygonal ducts., Simulations, Turbulent flow

**ID 198**

# Next-Gen Sensors for Non-Invasive Blood Glucose Tracking

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The development of non-invasive glucose monitoring technologies is gaining momentum as a safer and more convenient alternative to traditional finger-prick methods. This research explores next-generation sensor systems that leverage principles of biomechanics to enable real-time, continuous blood glucose tracking without penetrating the skin. The study focuses on integrating advanced biosensors with wearable devices that utilize optical, electromagnetic, and biochemical signal analysis to detect glucose concentration from interstitial fluid, sweat, or other biological media. Key innovations include the use of photoplethysmography (PPG), near-infrared spectroscopy (NIRS), and bio-impedance sensing—all optimized through biomechanical modeling for improved accuracy and adaptability to individual physiological variations. A prototype wearable system is developed and tested for signal reliability under various physical activities and skin conditions. The findings highlight the potential of biomechanics-driven sensor design in revolutionizing diabetes management by providing accurate, painless, and continuous glucose monitoring solutions suitable for daily use.

Keywords: NIR technology, Non-invasive glucose monitoring, continuous glucose monitoring (CGM), diabetes management, electrochemical biosensors, glucose sensing, microwave sensors, optical spectroscopy, transdermal sensing., wearable sensors

**ID 264**

# CropAid: A Deep Learning Framework with Attention Mechanisms for Disease Diagnosis in Agriculture

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Crop diseases have shown to have a big impact on crop yield and food security in the world and thus the need for their early and accurate detection being important in controlling its spread. The study tackles the disease classification of four main crops, namely, corn, potato, rice and wheat by resorting to state of the art deep learning technologies. The proposed approach consists of ensemble models of the MobileNetV2 and InceptionV3 architectures supplemented with attention mechanisms that enable to dynamically highlight the important areas of the images. EfficientNetB1 was selected for rice to capture complex disease patterns. A variety of data augmentation was performed to enhance robustness and generalization, such as rotation, shearing, and brightening. The data was divided into customized training, validation, and test sets for each of the crops. The test accuracies of the ensemble models were 95.68% for corn, 96. 33% for potatoes and 95.61% for wheat. The EfficientNetB1 model for rice yielded an impressive accuracy of 98.44%. These findings suggest that the combination of transfer learning, attention, and data augmentation is effective for the accurate crop disease detection. This strategy offers a powerful tool for precision agriculture, with the promise of timely interventions and better crop management.

Keywords: Attention mechanisms, Crop disease detection, Data augmentation, Deep learning, EfficientNetB1, Ensemble models, InceptionV3, MobileNetV2, Precision agriculture

**ID 287**

# Aerodynamic Performance Evaluation of Helix-inspired and Conventional Wind Turbine Blades Under Steady Wind Conditions: A Comparative Approach

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Aerodynamic design principles from gas turbines have guided wind turbine blade design, enhancing performance efficiency in sustainable energy systems. This study conducts a comparative analysis of aerodynamic performance of helix-inspired wind turbine blade against traditional straight-blade design under steady-state wind conditions. Utilizing computational fluid dynamics simulations, both configurations were assessed based on critical performance metrics. The aim is to evaluate impact of blade geometry on turbine efficiency and aerodynamic behaviour. The helix-inspired blade demonstrates improved airflow continuity, diminished wake interference, and superior performance at lower wind speeds making it suitable for residential settings, where noise reduction and consistent torque output are paramount. Conversely, conventional straight-blade turbine achieves higher peak efficiency at optimal pitch angles but exhibits diminished stability under fluctuating wind conditions. The simulations reveal that traditional blade designs are highly effective in stable, high-speed wind environments, while helix-inspired design provides wider operational range and stable torque generation characteristic for installations in regions with variable wind patterns. Furthermore, helix blade displays smoother pressure gradients and more uniformly distributed mechanical stresses, indicating extended operational lifespan and reduced wear over time. Referencing from gas turbine design, it highlights the integration of aerodynamic shaping and CFD tools that drive progress in renewable energy.

Keywords: Aerodynamic design, blade geometry, computational fluid dynamics, helix-inspired blade, stability, wind turbine

**ID 333**

# A critical evaluation of the design and mechanics of Indian Cycle-Rickshaw with respect to the anthropometric measurements of passengers

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Public transportation in India encompasses a wide range of vehicles, from bicycles to buses, with cycle-rickshaws playing a significant role, especially on the inner roads of towns and cities. This diverse mix creates complex challenges for both vehicle operators and traffic managers in ensuring smooth traffic movement. This study examines the design of cyclerickshaws, focusing on how well they accommodate the anthropometric characteristics and seating postures of passengers. A survey involving over 250 users from different areas of South Kolkata was conducted to gather relevant insights. Findings revealed that the current design is unsafe for most users. To enhance passenger safety, the study proposes certain design improvements and the addition of specific accessories. These insights may also be applicable in designing industrial transport and material-handling vehicles.

Keywords: Anthropometric measurements, Transportation, Vehicle design, passenger ergonomics

**ID 79**

# A study on the Design and Development of dies and Punches for Bending Metal Sheets.

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Sheet metal working is the most commonly used process in the manufacturing industry. Several different components are produced in the sheet metal working process. It is a very economical process to develop parts. The press tool design is an integral part of making a component in this process. The main two types of sheet metal working processes are the cutting and non-cutting processes. The various operations are carried out in the press. This paper is related to the bending die design, which is efficient and more effective. Hydraulics has proven to be the most efficient and economic system adaptable to aviation. First used by the ancient Greeks to elevate the stages of their theaters, the principles of hydraulics were explained scientifically by the seventeenth-century scholar's Pascal and Boyle. The laws discovered by these two men regarding the effects of pressure and temperature on fluids and gases in confined areas form the basis of the principle of mechanical advantage; in other words, the "why and how" of hydraulics.

Keywords: Bending Force, Bending Machine, Die and Punch, Low cost, Sustainable.

**ID 139**

# Aerial Fuel Station: On-Demand Fuel Delivery Using Unmanned Aerial Vehicles

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Motorists often face unexpected fuel shortages and vehicle breakdowns, especially on longdistance routes. To address this issue, an on-demand fuel delivery system using drone technology integrated with a user-friendly mobile application is proposed. The application enables users to request fuel delivery by specifying their location and fuel requirements. Upon confirmation, the nearest fuel station dispatches a drone equipped with a secure fuel tank. A robust verification process ensures that fuel is reserved and delivered only for authorized users. Once verified, the user undergoes a simplified refuelling process. The system measures the dispensed fuel, processes payment through an integrated mobile payment gateway, and upon confirmation, the drone returns to the station. This system offers a convenient, efficient, and contactless solution to roadside fuel emergencies.

Keywords: Drone, Fuel Delivery, IoT, Mobile Application

**ID 278**

# Experimental studies to evaluate the influence of tool wear on the chip morphology and vibration signals in milling process

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The milling process has a wide range of applications in several important industries such as automobile, aerospace, aeronautics, biomedical, etc. Milling process monitoring plays a crucial role in obtaining better quality products, which in turn maximizes productivity and manufacturing efficiency. The assessment of tool wear in the milling process plays a key role in evaluating the quality of machined products, minimizing machine downtime, and enhancing the overall performance of machine tools. In this work, efforts were made to assess the wear of an end milling tool employed in the machining of general-purpose AISI 1045 steel under dry conditions. The tool wear and its corresponding effect on machining performance were analysed by considering chip morphology, surface roughness of the workpiece, and vibration response of the machining process. The results obtained from the experimental investigations provided reliable diagnostic information about the milling process carried out under dry cutting conditions.

Keywords: Milling, chip morphology, surface roughness, tool wear, vibration analysis

**ID 283**

# Experimental studies to evaluate the effect of variation in oil film stiffness on the performance of a helical geared system lubrication

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Gear drives, which are used in several types of rotational machinery and control systems, are widely used in applications for power and motion transmission. Various parameters, including design lubrication, operating conditions, etc., affect a geared system's service life. However, the changes in circumferential conditions, i.e., variation in load and rotational speed of the pinion gear, result in a significant variation in crucial operating parameters, viz., viscosity, temperature, lubricant film stiffness, gear tooth surface roughness, etc. The findings of experimental studies conducted to assess the helical geared system's performance while taking tribological factors like friction, film thickness, and oil film stiffness into account are presented in this study. A single-stage helical gearbox running under constant load and speed situations was employed to conduct fatigue tests over 400 hours. The tribological parameters were analysed at regular intervals to understand the operating conditions of the helical geared system. The surface fatigue wear developed on the gear teeth contact surface led to altered film thickness, film stiffness, and vibration response. The results obtained from both tribological, and vibration parameters proved to be a promising diagnostic tool for evaluating the operating conditions of the helical geared system.

Keywords: Condition monitoring., Helical gear, Oil film stiffness, Oil film thickness, Vibration analysis

**ID 210**

# Recent Ballistic Protection Materials – A Review

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The rapid advancement of firearm technology has significantly influenced the development of materials utilized for personal and vehicular protection. Finite Element Analysis (FEA) has become an essential methodology, allowing researchers to effectively simulate the dynamic behaviour of bullet-resistant materials subjected to high-velocity impacts, thereby minimizing the reliance on costly experimental testing. This review focuses on recent FEA studies that explore both traditional materials, such as Kevlar, and cutting-edge materials, including Graphene, Ultra-High Molecular Weight Polyethylene (UHMWPE), and Dyneema. It delves into various simulation strategies employed in these studies, examining how different material architectures impact performance. This review also explores the advantages of multi-layered configurations, incorporating functionally graded and hybrid architectures, which have demonstrated the potential to enhance ballistic resistance. Furthermore, it highlights the challenges faced in the field, such as accurately modelling complex material behaviors and the need for validation through experimental data. The review concludes by outlining future research directions, emphasizing the importance of integrating advanced materials and innovative design approaches to develop nextgeneration ballistic protection systems. By leveraging FEA, researchers can continue to push the boundaries of armor technology, ensuring that protective gear remains effective against evolving threats in an increasingly dangerous world.

Keywords: Ballistic protection, Bullet-resistant materials, Finite Element Analysis (FEA), Graphene, Kevlar, Multi-layered configuration

**ID 271**

# Real-Time automated Target Tracking in Light Armoured Vehicles Using ML and Language Models

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This report explores the development and implementation of an automated tracking system for light-armoured vehicles (LAVs). The primary goal is to enhance the operational efficiency and safety of LAVs by providing real-time tracking capabilities in both combat and noncombat environments. The report discusses various tracking technologies, including GPS, inertial measurement units (IMUs), and computer vision, evaluating their integration into a unified automated system. Additionally, it outlines the challenges associated with system accuracy, reliability, and adaptability in dynamic terrains, as well as the potential for reducing the human workload and increasing situational awareness. Key considerations for system design, such as sensor fusion, data processing, and communication protocols, are analyzed. The findings suggest that automated tracking systems can significantly improve mission outcomes by providing enhanced mobility, minimizing risks, and supporting autonomous operations in diverse operational scenarios. Future improvements in sensor technology and artificial intelligence are expected to further optimize the system's performance and scalability.

Keywords: Armoured Vehicles, Computer Vision, Gyroscopic Sensors, IOT, Large Language Models. YOLO

**ID 253**

# Secure Data Communication via Cryptography and Steganography Fusion Techniques.

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While both cryptography and steganography play key roles in securing data, each comes with its own set of limitations. In cryptography, although the data is encrypted, the resulting ciphertext appears suspicious due to its unreadable format, which might attract unwanted attention or deeper inspection by potential attackers. On the other hand, steganography hides information within other files, like images, but once the existence of hidden content is suspected, the secret may be compromised. To address these challenges, this paper introduces a hybrid approach that combines the strengths of both techniques to enhance data security. The proposed method utilizes a modified version of the Advanced Encryption Standard (AES) to encrypt the original message. The encrypted data is then concealed using the Least Significant Bit (LSB) steganographic method. This layered security approach not only strengthens the protection of sensitive information but also ensures minimal distortion of the cover image, maintaining its quality. Moreover, the technique offers a high embedding capacity, making it practical for real-world applications where both confidentiality and subtlety are crucial.

Keywords: Advanced Encryption Standard (AES), Cryptography, Images., Least Significant Bit (LSB), Steganography

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