5th International Conference

On Mathematical Modeling, Computational Intelligence Techniques, and Renewable Energy (MMCITRE-2025)

December 10 - 12, 2025

Mithilesh Kumar Chaube
Chandra Shekhar Nishad
Manoj Sahni
José M. Merigó Lindahl
Ernesto León-Castro

Prints Publications Pvt Ltd
New Delhi

Published by

Prints Publications Pvt Ltd
Viraj Tower-2, 4259/3, Ansari Road,
Darya Ganj, New Delhi-110002, India.
Phone : 91-11-45355555
E-mail: contact@printspublications.com

Edition: 2026

ISBN: 978-93-6697-083-7

Published and Printed by Mr. Pranav Gupta (Managing Director) on behalf of Prints Publications Pvt Ltd, New Delhi.

5th International Conference

on

Mathematical Modeling, Computational Intelligence Techniques and Renewable Energy (MMCITRE - 2025)

Organized By

Department of Science and Mathematics
IIIT Naya Raipur, Chhattisgarh, INDIA

in Association with

Forum for Interdisciplinary Mathematics (FIM)

and Sponsored by

SOUVENIR

Conference Dates

December 10 – 12, 2025

CONTENTS

Welcome

Dr. M. K. Chaube

Dr. C. S. Nishad

Prof. Manoj Sahni

Prof. Jose M. Merigo

Prof. Ernesto Leon-Castro

Prof. Fabio Raul Blanco Mesa

Dr. K. N. Vishwakarma

Dr. S. N. Mishra

MMCITRE-2025

Esteemed Speakers, Delegates, and Participants,

Warm greetings to everyone!

It is our privilege and honor to host the 5th International Conference on Mathematical Modeling, Computational Intelligence Techniques, and Renewable Energy (MMCITRE 2025) from December 10th to 12th, 2025. The previous four conferences were successfully held at Pandit Deendayal Energy University, Gandhinagar, Gujarat, India (twice), at the University of Technology Sydney, Australia, conducted online, and at Manipal University Jaipur, Rajasthan, India. This year, the conference will be held at IIIT Naya Raipur, Chhattisgarh, in association with Forum for Interdisciplinary Mathematics (FIM) from December 10th to 12th, 2025. This conference aims to foster the exchange of knowledge, leading to research collaborations with eminent researchers and generating a multitude of new ideas for future research.

The MMCITRE conference series is designed to provide extensive and valuable content on mathematical modeling, artificial intelligence techniques, renewable energy, and related fields. It serves to keep researchers and scientists abreast of the latest discoveries, innovations, and practical solutions, benefiting both academicians and industry professionals.

We extend a warm and enthusiastic welcome to all the esteemed scientists, academicians, young researchers, business delegates, and students from around the globe to this international conference. Our heartfelt thanks go out to all the well-wishers who have sent their best wishes and inspirational messages for the success of this event.

Any successful conference is enriched by a distinguished group of dignitaries and special events. We are honored to begin with a welcome message to our Honorary Chairs: **Prof. O. P. Vyas, Vice-Chancellor and Director of IIIT Naya Raipur; Prof. Srinivasa K G, Dean (Academics), IIIT-NR, and Prof. G. P. Raja Sekhar, Vice-Chancellor, Andhra University.** Although some of them are not able to join us in person, their influence and contributions resonate deeply within our community. We celebrate their remarkable achievements and the inspiration they provide. Their endorsement of this conference is a significant honor, and we are grateful for their support and recognition. We also extend our sincere thanks to our Advisory Committee members, organizing committee members, and dedicated students for their continuous support throughout the conference.

We are honored to feature an exceptional lineup of Keynote Speakers who are luminaries in the field of Applied Mathematics and Computational: **Prof. G. P. Rajashekhar, Prof. S. Natesan, Prof. Jose M. Merigo Lindahl, Prof. S.K. Pandey, Prof. Manoranjan Mishra, Prof. Ernesto Leon Castro, Prof. R.K. Pandey, Dr. Ranjana Vyas, Dr. Fabio Blanco-Mesa, and Dr. Dharmendra Tripathi.** Their messages and presence are a tremendous source of inspiration and encouragement for us all. This conference provides an invaluable platform for young researchers to interact with these eminent scholars and scientists from around the world. Over the course of three days, the conference will address numerous research challenges related to the mathematical modeling of various real-life phenomena, computational techniques, and research articles focusing on the mathematical modeling of renewable energy.

We warmly welcome all delegates to this international event, inviting you to exchange views and share experiences with internationally renowned professors, researchers, colleagues, and students from many esteemed universities and research institutions. Thank you for your participation.

Prof. Dhananjai Pandey
BOG Chairman, IIIT-NR
Chief-Patron

Professor Dhananjai Pandey is an internationally renowned educator and researcher in the field of Materials Science and Technology. His professional career started in 1977 as a Faculty Member in BHU/IIT (BHU) and he retired as Professor (HAG) in 2017 but continued as Institute Professor for another five years. He is presently a Distinguished Professor of BHU (for life) and IIT Bhilai.

A widely travelled scientist, Prof. Pandey has delivered Invited talks/Keynote addresses/ Plenary lectures at a large number of International and National Conferences held within India and abroad. He has published over 200 research articles in journals of international repute, books and book-series with over 8000 citations (14 papers with over 100 citations) and an h-index of 49. He also holds several patents to his credit. He is a Fellow of all the three premier science academies of India (Indian National Science Academy, Indian Academy of Sciences, National Academy of Sciences of India) and a Fellow of the Asia Pacific Academy of Materials. He is a recipient of several awards/medals (INSA Young Scientist Medal, Materials Research Society of India Medal, MRSI Annual Prize and MRSI Distinguished Lectureship award, Homi Bhabha Fellowship Award, DAE Raja Ramanna Award, Pt Jubilee Award of Indian Science Congress, J .C. Bose National Fellowship award etc).

He was Coordinator (Head) of the School of Materials Science and Technology at IIT BHU, first Director in the transition phase and Dean (Faculty Affairs) of IIT BHU. Under his leadership, the School of Mater Science & Technology emerged as an Internationally reputed Centre of research and teaching in advanced functional materials. As a Dean of Faculty Affairs, policy documents for Salary fixation, Faculty Recruitment and Promotion of deserving existing faculty members as per IIT norms were developed and successfully implemented. Professor Pandey has been Member of various committees of DST, CSIR, DRDO, UGC, INSA, IASc as well as Member of Governing Body/Council and Executive Council of IIT (BHU), BHU and SU, IUAC etc.

Professor Pandey has been Vice President and President of the Indian Crystallographic Association and Vice President of the Materials Research Society of India and is currently President of the Neutron Scattering Society of India.

Prof. Om Prakash Vyas
Vice Chancellor & Director, IIIT-NR
Patron & General Chair

Prof. O.P. Vyas has recently been appointed as the Director of Dr. Shyama Prasad Mukherjee International Institute of Information Technology (IIIT), Naya Raipur. He is a senior academician, researcher, and institutional leader with over three decades of rich experience in higher technical education, research, and academic administration.

Prof. Vyas holds an M.Tech. in Computer Science from IIT Kharagpur, and pursued his Ph.D. research at TU Kaiserslautern, Germany, under the prestigious DAAD Fellowship program. He has contributed significantly during his tenure as Dean of Technology Development, Professor of Information Technology at IIIT Allahabad, where he played a key role in academic innovation, including the conceptualization and launch of the B.Tech. (IT–Business Informatics) program. His areas of specialization include Data Science, Process Intelligence, Business Informatics, Explainable Artificial Intelligence (XAI) and Cyber Security. He has successfully led several national and international collaborative research projects, and served as Visiting Professor in countries such as France, Germany, Italy, Norway, and Japan.

Known for his academic vision, dedication to student-centric learning, and strategic leadership, Prof. Vyas aims to elevate IIIT Naya Raipur as a premier hub of technology, innovation, and multidisciplinary education aligned with the goals of India's National Education Policy (NEP) 2020, while also contributing meaningfully to the state's technological growth.

A native of Raipur, Chhattisgarh, Prof. Vyas is widely regarded as a pioneer of IT education in the region. As the Founding Head of the Department of Computer Science at Pt. Ravishankar Shukla University, Raipur, introduced the region's first formal academic program in Computer Science in 1992. This landmark initiative laid the groundwork for the expansion of IT education across Chhattisgarh. Committed to inclusive growth, Prof. Vyas worked tirelessly to extend the reach of IT education to rural and remote areas of the state, bridging the digital divide and empowering underserved communities

Messages

Prof. Om Prakash Vyas (Patron)

It gives me great pleasure to extend my warm wishes to all participants, speakers, and delegates attending the **5th International Conference on Mathematical Modeling, Computational Intelligence Techniques and Renewable Energy (MMCITRE-2025)** organized by the Department of Science and Mathematics, IIIT Naya Raipur.

Mathematics is a key for the development in Engineering, Natural and Social Sciences since it can provide models, analyzing tools and solution methods for problems arising in different fields of Science & Technology. Technological and industrial revolutions have proved that the role of Mathematics is not restricted to academic domain only. Modern mathematical modules, big- data, AI, Machine Learning, and high performance computing methods would play a vital role in futuristic research and innovation.

In this context, the theme of this conference is very appropriate and exciting. I am sure that the discussions during the conference would be beneficial to all and it would provide a platform for building new bridges of connecting ideas and people from different branches of Mathematics and Engineering Sciences.

I congratulate the organizers for taking this initiative and extend my best wishes for a great success of the conference.

Prof. O.P. Vyas
Vice Chancellor & Director
IIIT Naya Raipur,
Raipur, Chhattisgarh, India.

Prof. Srinivasa K G (Co- Patron)

It gives us great pleasure to welcome you to the **5th International Conference on Mathematical Modeling, Computational Intelligence Techniques and Renewable Energy (MMCITRE-2025).** This conference serves as a global platform for researchers, academicians, industry professionals, and students to share their latest findings, explore emerging trends, and exchange innovative ideas in the intersecting domains of mathematical modeling, intelligent computing, and sustainable energy solutions.

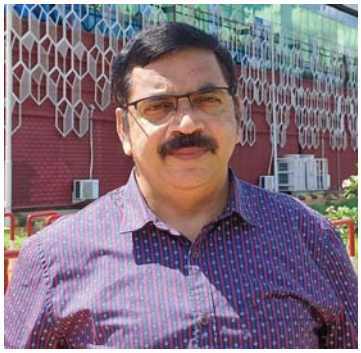
As the world continues to face complex scientific, technological, and environmental challenges, MMCITRE-2025 aims to inspire interdisciplinary collaboration and promote research that drives real-world impact. This year's edition brings together distinguished experts and young innovators whose contributions help shape the future of smart systems, renewable energy technologies, and data-driven decision-making.

We extend our heartfelt appreciation to our keynote speakers, presenters, reviewers, organizing committee members, sponsors, and all participants for their support and commitment. Your presence and contributions make this conference a dynamic and enriching forum for academic and professional growth.

We wish you an intellectually stimulating, collaborative, and memorable experience at **MMCITRE-2025**. **Welcome, and thank you for being a part of this inspiring journey.**

Prof. Srinivasa K G
Dean (Academics) & Registrar (I/C)
IIIT Naya Raipur,
Raipur, Chhattisgarh, India.

Prof. G P Raja Sekhar
Andhra University, Visakhapatnam, India



I am glad to learn that The Department of Mathematics and Statistics at Manipal University Jaipur, Rajasthan, India, is organizing the **5th International Conference on Mathematical Modeling, Computational Intelligence Techniques, and Renewable Energy (MMCITRE-2025)** in association with the Forum for Interdisciplinary Mathematics (FIM), Gujarat Chapter during December 10 - 12, 2025. With the Govt. of India taking initiatives to achieve Technology Vision 2047 (TV2047), the theme of this conference fits very well with the goals set by TV2047.

The organizers must be congratulated for bringing such eminent scientists to take part in this three-day event. I am sure many young researchers would be benefitted and get an opportunity to have fruitful scientific deliberations. I am happy to be part of this event and wish the organizers the best.

Prof. G P Raja Sekhar
Vice Chancellor
Andhra University, Visakhapatnam, India

Dr. Mithilesh Kumar Chaube (Convener)

It is our honour to extend a heartfelt welcome to the **5th International Conference on Mathematical Modelling, Computational Intelligence Techniques, and Renewable Energy (MMCITRE-2025)** association with Forum for Interdisciplinary Mathematics (FIM), Gujarat Chapter during December 10-12, 2025, organized by the Department of Science and Mathematics, IIIT Naya Raipur.

The aim of this conference is to create an intellectual constellation, where the brightest minds in the realms of fields like computational techniques, mathematical modelling, energy systems, and applications of fuzzy sets etc. come together and explore the vastness of knowledge. The conference program boasts enlightening keynote addresses, thought-provoking panel discussions, and a diverse array of research presentations, providing a platform for the exchange of innovative ideas and the exploration of current trends in the fields like Bio mathematics, Artificial Intelligence, Information and Coding theory, Computational Biology Computational Mathematics and many other areas of mathematics and engineering. The conference platform ensures that participants from around the world can actively engage, fostering collaboration and knowledge sharing regardless of geographical boundaries.

This is the great occasion for all of us to have an opportunity to interact with the leading scientists from across the globe and to bridge the collaborative efforts for the industrial sustainable development and better society. All submitted papers will be peer-reviewed and accepted papers will be published in a book of proceedings Lecture Notes in Networks and Systems (Indexed in Scopus). Some of the selected papers, post conference after peer review, will be considered for ESCI/ Scopus/WoS Indexed Journals.

We express our sincere appreciation to all participants, speakers, sponsors, and partners for their enthusiastic support and commitment. Such a vast event would not have been possible without the collective contribution of the Organizing committee members as well as eminent delegates and young researchers who have travelled far distance for their participation & faculty members, students and supporting staff of IIIT-NR. We further extend our gratitude to the Chief Patron, Patrons, Co-Patrons and Conference Chairs for their fruitful contribution for this conference.

We eagerly anticipate your participation and look forward to the dynamic discussions, collaborations, and insights that will unfold during this exciting event. It is hoped that this conference unveils a constellation of opportunities for researchers, academicians, and students alike. It will provide an excellent opportunity for the interaction of established scientists, practitioners and young researchers.

Let us join our hands together to share our knowledge and experience that shall go a very long way.

Dr. Mithilesh Kumar Chaube
Convener, MMCITRE-2025

Dr. Chandra Shekhar Nishad (Convener)

It is with great pleasure and profound enthusiasm that we welcome you to the **5th International Conference on Mathematical Modeling, Computational Intelligence Techniques, and Renewable Energy (MMCITRE-2025)**. This conference marks an important milestone in our ongoing commitment to advancing interdisciplinary research and fostering global collaboration among researchers, academicians, scientists, and industry professionals.

MMCITRE-2025 serves as a distinguished platform where innovative ideas meet practical applications. As the challenges of modern society grow increasingly complex—ranging from sustainable energy demands to the need for intelligent computational frameworks—the integration of mathematical modeling, AI-driven techniques, and renewable energy solutions becomes more essential than ever. This conference brings together brilliant minds from across the globe to share their expertise, present cutting-edge findings, and explore transformative technologies that can shape a more sustainable and intelligent future.

Over the course of this event, we hope you will engage in enriching discussions, participate in thought-provoking sessions, and form meaningful collaborations that extend far beyond this conference. Your presence and contributions are vital to the continued growth of this dynamic research community.

On behalf of the organizing committee, we extend our heartfelt gratitude to all participants, keynote speakers, reviewers, sponsors, and partners whose efforts have made MMCITRE-2025 possible.

We warmly welcome you to MMCITRE-2025 and wish you an inspiring, productive, and memorable conference experience.

Dr. Chandra Shekhar Nishad
Convener, MMCITRE-2025

Prof. Manoj Sahni (Convener)
PDEU Gandhinagar, India

Warm greetings to all of you as we come together for the **5th International Conference on Mathematical Modelling, Computational Intelligence Techniques, and Renewable Energy (MMCITRE 2025)**.

It is a moment of immense pride to witness the continued growth of this conference series, which has evolved into a significant platform for scholarly engagement and interdisciplinary dialogue. Each edition has brought renewed energy, fresh perspectives, and an expanding global presence, and this year's gathering further strengthens that legacy.

MMCITRE 2025 brings together a diverse community of researchers, academicians, and professionals who share a common commitment to advancing knowledge in mathematical sciences, intelligent computational methods, and sustainable energy solutions. The collective expertise represented here promises insightful discussions, innovative ideas, and meaningful collaborations that can shape future directions in research and practice.

We are privileged to host eminent speakers and contributors whose work continues to push the boundaries of their respective fields. Their participation enriches the conference and serves as a source of motivation for all attendees. We are equally appreciative of the authors whose contributions have added great academic value to this year's proceedings.

As we commence this edition of MMCITRE, I encourage each participant to engage openly, exchange ideas freely, and explore opportunities for collaboration. Conferences flourish when minds connect, and I am confident that the interactions over the next few days will spark new thoughts, inspire fresh inquiries, and strengthen our shared pursuit of excellence.

Thank you for joining us in this celebration of knowledge and discovery. I extend my best wishes for a productive, inspiring, and memorable conference experience.

With warm regards,

.

.

Prof. Manoj Sahni
Convener
(President, FIM, Gujarat Chapter)

Prof. José M. Merigó (Convener)
University of Technology Sydney, Sydney, Australia

I am very much delighted to send my best wishes for organizing this **5th International Conference on Mathematical Modeling, Computational Intelligence Techniques and Renewable Energy (MMCITRE-2025)**. It is indeed my honour and privilege to share my perspective for this prestigious event.

This conference will provide global viewpoints on the state of science, technology and sustainable development. Development of science and technology is regarded as one of the most effective means of enhancing the socio-economic development of nations. The techniques of science and technology have a deep and long term impact on almost every sphere of life, including social problems, problems related to economy, water resources and environmental engineering, structural engineering, thermal engineering, and many more. The Scientists, Technologists and Engineers are making a leading contribution to tackling these kinds of major problems.

I am happy with the theme of the conference as it provides a platform to all the educators, researchers and practitioners to discuss the development of ideas and emerging issues in the areas of Mathematical modeling of real world problems and also give the opportunity for the discussion in Emerging trends in Science and Engineering. I am sure that the conference will help all the delegates to gain a better insight into the emerging issues in the emerging areas of the current world scenario.

I wish this conference a grand success.

Sincerely,
Prof. Jose M. Merigo

Prof. Ernesto Leon Castro (Convener)
(Universidad Católica de la Santísima Concepción (UCSC), Chile)

I am very grateful to all the participants and keynote of the **5th International Conference on Mathematical Modeling, Computational Intelligence Techniques and Renewable Energy (MMCITRE-2025)** held at IIIT Naya Raipur from December 10 to 12, 2025. This year, we have different methodological proposals and applications of various computational techniques that allow progress in different areas, such as sustainability, business, and engineering, to mention a few. Without a doubt, this fifth meeting will generate new visions and future collaborative work among the event participants.

Prof. Ernesto Leon Castro
(UCSC, Chile)

Prof. Fabio Raul Blanco Mesa (Co-Convener)

It is a privilege to have been invited by the Dr. Shyama Prasad Mukherjee International Institute of Information Technology, Naya Raipur, in collaboration with the Gujarat section of the Interdisciplinary Mathematics Forum, to the **5th International Conference on Mathematical Modelling, Computational Intelligence Techniques and Renewable Energy (MMCITRE2025)**.

In the contemporary era, complexity and uncertainty are ubiquitous in many areas of society. This necessitates the implementation of bold and efficient responses to the problems engendered by these phenomena.

The MMCITRE2025 conference provides a forum for the dissemination of multidisciplinary knowledge, within which various modelled scenarios that deviate from the laws of linearity and certainty can be exhibited. These scenarios move towards asymmetry, divergence and complexity. In this sense, the ability to discuss complex and uncertain systems enriches academic discourse. It is imperative that such discourse goes beyond mere measurement and acknowledges the importance of understanding in order to identify inclusive solutions that benefit the majority of society. It is imperative to acknowledge that the interchange of concepts and the engagement of participants are instrumental in fostering novel prospects and avenues for research.

It is to be hoped that MMCITRE2025 will be a success, in which case it is to be expected that all participants will find the conference a stimulating and rewarding experience.

Prof. Fabio Raul Blanco Mesa
Universidad Pedagógica y Tecnológica de Colombia, Colombia

Dr. Sachchida Nand Mishra (Co-Convener)

Esteemed Participants,

Warm greetings to each of you as we gather for the **5th International Conference on Mathematical Modelling, Computational Intelligence Techniques, and Renewable Energy (MMCITRE 2025)**.

It is a matter of great pride to witness the remarkable growth of this conference series, which has become a distinguished platform for scholarly exchange and interdisciplinary dialogue. Over the years, MMCITRE has consistently infused fresh perspectives, renewed energy, and an expanding global footprint. This year's edition further strengthens that legacy.

MMCITRE 2025 brings together an exceptional community of researchers, academicians, and professionals united by a shared commitment to advancing knowledge in mathematical sciences, intelligent computational methods, and sustainable energy solutions. The collective expertise represented here promises insightful discussions, innovative ideas, and impactful collaborations that will shape future directions in research and practice.

We are honored to host eminent speakers and contributors whose pioneering work continues to push the boundaries of their respective fields. Their presence enriches this conference and serves as an inspiration to all attendees. We also extend our heartfelt appreciation to the authors whose valuable contributions have enhanced the academic depth of this year's proceedings.

As we embark on this edition of MMCITRE, I encourage every participant to engage wholeheartedly, exchange ideas openly, and explore opportunities for collaboration. Conferences thrive when minds connect, and I am confident that the interactions over the coming days will spark new insights, inspire fresh inquiries, and strengthen our shared pursuit of excellence.

Thank you for being part of this celebration of knowledge and innovation. Wishing you a productive, inspiring, and memorable conference experience.
With warm regards,

(Dr. Sachchida Nand Mishra)

Dr. Krishnanand Vishwakarma (Co-Convener)

On behalf of the organizing committees, I extend a warm welcome to all participants at Dr. S.P.M. IIIT Naya Raipur, Chhattisgarh for the **5th International Conference on Mathematical Modelling, Computational Intelligence Techniques, and Renewable Energy (MMCITRE 2025).** The MMCITRE is an annual international conference that has been held since 2020.

With the theme "Mathematical Modelling, Computational Intelligence Techniques, and Renewable Energy," the 5th International Conference on Mathematical Science and Engineering 2025 provides a unique opportunity for professors, researchers, and scholars worldwide to convene. The conference serves as a platform to present innovative research findings and discuss the latest trends and developments in mathematical modelling and engineering science.

All accepted and presented papers in this conference will have the opportunities to be published in Lecture Notes in Network and System (LNNS) proceedings and other journals after peer-reviewed and indexed by SCIE or Scopus. These papers on various topics are divided into different parallel sessions in the conference. To all members of the organizing committees, the international scientific committee, the reviewers, and the collaboration partners, we would like to thank all of them for their tremendous efforts to organize this conference successfully.

I wish you a very productive conference with exciting and encouraging discussions and exchange of knowledge so that together we can anticipate a future of groundbreaking knowledge, research, and technology in mathematical science.

We look forward to having a successful conference, and we hope that all the attendees enjoy and benefit from this conference.

Best Regards,

Dr. Krishnanand Vishwakarma
Co-Convener of MMCITRE 2025

ABOUT IIIT NAYA RAIPUR, CHHATTISGARH, INDIA

Dr. Shyama Prasad Mukherjee International Institute of Information Technology – Naya Raipur, established by the International Institute of Information Technology University Act, 2013 of the Government of Chhattisgarh, is a joint venture by the Chhattisgarh State Government and National Thermal Power Corporation (NTPC). The Institute is dedicated to excellence in higher education, research, and growth in information technology (IT) and related disciplines. It strongly believes in the dissemination of information and the provision of entrepreneurial skills to students to allow them to solve real-world problems. To enhance this vision, IIIT-NR encourages state-of-the-art development of interdisciplinary research laboratories and products to conduct research and product development efforts.

Dr. SPM IIIT-NR's 50-acre residential campus is located in the newly developed smart city of Atal Nagar, approximately 23 km from the town of Raipur. The IIIT-NR 's vibrant, lush green campus features Wi-Fi connectivity, CCTV surveillance, hi-tech security measures, and excellent sports and other recreational facilities. The futuristic architecture of the buildings and the serene surroundings of the campus cultivate an atmosphere of creativity and innovation for students.

Classrooms are equipped with state-of-the art teaching and learning technologies. The academic area includes smart classrooms and well equipped laboratories to facilitate practical learning. The campus also houses separate hostels for male and female students, providing comfortable and secure accommodation. A modern central library with a vast collection of resources further supports the students' scholarly pursuits.

ABOUT FORUM FOR INTERDISCIPLINARY MATHEMATICS (FIM)

PRESIDENT
Prof. Junzo Watada
(Professor Emeritus, Waseda University, Japan)
http://forum4interdisciplinarymathematics.org/

The Forum for Interdisciplinary Mathematics (FIM) is a registered trust in India. It is, in effect, an India based international society of scholars working in mathematical sciences and its partner areas (a partner area is defined as one where some knowledge of mathematical sciences is desirable to carry out research and development). The society was incepted in 1975 by a group of University of Delhi intellectuals led by Prof. Bhudev Sharma. In 2022, the FIM is running into 47th years of active standing.

Right from the beginning, FIM had the support and association of India's great mathematicians and also users of mathematics from different disciplines in the country and abroad. The FIM series publishes high-quality monographs and lecture notes in mathematics and interdisciplinary areas where mathematics has a fundamental role, such as statistics, operations research, computer science, financial mathematics, industrial mathematics, and biomathematics. It reflects the increasing demand of researchers working at the interface between mathematics and other scientific disciplines. Recently the first chapter of FIM in India was opened under the leadership of Dr. Manoj Sahni (President FIM Gujarat Chapter) and another chapter was formed in Japan.

FIM membership Annual / Life can be availed by filling membership form which is available on FIM Website:
(http://forum4interdisciplinarymathematics.org/)
Life Membership: Rs. 5000/-
Annual Membership: Rs. 500/-

Abstracts of Keynote Speakers

Prof. G P Raja Sekhar
Department of Mathematics,
Indian Institute of Technology Kharagpur, Kharagpur, India

Viscous flow attack on macroscopic cavities in a granular material: the story of two sufficiently distant spherical cavities of arbitrary configuration

Abstract

The effect of a void of characteristic size R_0 in a granular material with permeability k on an otherwise undisturbed uniform flow U_∞ is investigated analytically by GPRS et al. [1], [2]. The cavity region is assumed to be two-dimensional, and its cross section slightly deviates from a circle. They determined the flow field by matching the solution of the Stokes equation inside the hole with the generalized Darcy's equation or Brinkman's equation in the granular material. There it is shown that when the permeability parameter is much larger than unity, which corresponds to the case for typical groundwater flow, the velocity at the center of the circular cylindrical hole U_0 becomes $3U_\infty$. Based on these analytical investigations, Kaneko et. al. [3] conducted experiments on the viscous flows in a homogeneous porous permeability medium k with two-dimensional holes of equal radius R_0. They varied the center-to-center distance and the orientation of the holes concerning the undisturbed flow and analysed the flow field around these holes. They observed that the volume flux into each hole increases by about 30% when the center-to-center distance is $\approx 2{:}5R_0$ and the orientation angle is $\approx 30^\circ$ compared with the flux into a single circular hole. In contrast, it decreases by about 20% when the distance is $\approx 2{:}5R_0$ and orientation is $\approx 90^\circ$. For the audience's benefit, this talk summarizes the results in [1], [2] and [3] briefly. Consequently, the talk focuses on "Viscous flow around spherical macroscopic cavities in a granular material – focusing two distant spherical cavities of arbitrary orientation" [4], [5]. We consider Stokes equation inside and the Darcy-Brinkman equation outside the cavities. In particular, we focus on the interaction of two equal size cavities in tandem position where the other cavity's asymptotic effect. The present analysis gives a reasonable estimate on the volume flow into the cavity, and local enhancement of stresses. This work is applicable to predict the microscale waterway formation in that material, onset of landslides, collapse of cliffs and river banks, etc.

[1] Raja Sekhar, G P & Sano, Osamu 2000 Viscous flow past a circular/spherical void in porous media—an application to measurement of the velocity of groundwater by the single boring method. *Journal of the Physical Society of Japan* **69** (8), 2479–2484.
[2] Raja Sekhar, G P & Sano, O 2003 Two-dimensional viscous flow in a granular material with a void of 426 arbitrary shape. *Physics of Fluids* **15** (2), 554–567.

[3] Kaneko, Yoshifumi & Sano, Osamu 2005 Collapse and merging of cavity regions in a granular material due to viscous flow. *Physics of Fluids* **17** (3), 033102.
[4] Sano, Osamu, Karmakar, Timir & Sekhar, GP Raja 2022 Viscous flow around three-dimensional macroscopic cavities in a granular material. *Journal of Fluid Mechanics* **931**.
[5] Sano, Osamu, Karmakar, Timir & Sekhar, GP Raja 2023 Viscous flow around three-dimensional macroscopic cavities in a granular material: asymptotic theory for two sufficiently distant spherical cavities of arbitrary configuration, *Journal of Fluid Mechanics* **964.**

Prof. Natesan Srinivasan

Indian Institute of Technology Guwahati

A Novel Operator-Splitting NIPG FEM for 2D Time-Fractional Diffusion Problem

Abstract

Here, we study the numerical approximate solution of the two-dimensional time-Fractional Diffusion Problem. First, we convert the 2D problem into two 1D problems by using the appropriate operator-splitting method. Then, we discretize the time-fractional derivative term on a non-uniform mesh by using the well-known L2-scheme, and for the discretization of the spatial derivatives, we use the Non-Symmetric Interior Penalty Discontinuous Galerkin (NIPG) method in both x and y directions on a uniform mesh. The stability and the error estimate of the proposed scheme are addressed. Finally, we give some numerical experiments to show the efficiency of the proposed method.

Dr. Dharmendra Tripathi
National Institute of Technology, Uttarakhand.

Immiscible Fluids Flows Driven by Peristaltic Pumping: Heat Transfer Analysis

Abstract

Immiscible fluid flows play a crucial role in various engineering applications, including energy, chemical, and biomedical industries. This talk will provide a comprehensive overview of heat transfer analysis in two-layered flows driven by peristaltic pumping, highlighting the flow analysis and pumping performance. This talk will also cover the interface analysis between the two layers (core layer and peripheral layers having immiscible fluids with different viscosities), exploring pumping characteristics, pressure distribution, streamlines, isotherms, and particle trajectories. The numerical results to be presented, emphasizing the challenges and opportunities in understanding immiscible fluid dynamics and multiphase exploring the new applications in immiscible fluid dynamics and heat transfer. Key insights from this analysis will provide the potential benefits and future directions in this field, fostering a deeper understanding of the physics and physiology of immiscible fluids and its practical applications.

Keywords: Immiscible Fluids; Peristaltic Pumping; Heat Transfer; Interface Analysis; Streamlines; Isotherms; Particle Trajectories.

Prof. José M. Merigó
University of Technology Sydney, Sydney, Australia

The ordered weighted average: Theory and applications

Abstract

The ordered weighted average (OWA) is an aggregation operator that provides a parameterized family of operators from the minimum to the maximum. In decision analysis, it unifies the classical methods for decision-making under uncertainty in the same formulation including the Laplace and the Hurwicz criteria. Thus, it is possible to establish the attitudinal character of the decision-maker according to a degree of optimism or pessimism. This presentation gives a general overview of the OWA operator and some of its main generalizations including the induced OWA, the probabilistic OWA and the OWA distance. The study goes through a wide range of extensions including cases that include the weighted average and some other key statistical concepts as particular cases of a more general framework. Therefore, the applicability of the OWA operator is very broad because all the previous studies that use one of these techniques can be revised with a more general formulation that considers more complex environments. But at the same time, it can be reduced to the classical approach if the available information is very simple. A general overview of decision-making applications with the OWA operator is also presented.

Prof. Manoranjan Mishra
Department of Mathematics,
Indian Institute of Technology Ropar, Rupnagar, Punjab, 140001, India.

Mathematical Modelling of Instability patterns in a convection-diffusion-reaction system

Abstract

The study of hydrodynamic instabilities in a stratified flow has gained significant attention in the scientific community for its applications in industries and environments [1, 2, 3]. Viscous fingering (VF) instability occurs when a less viscous fluid tries to push a more viscous one in the porous media or Hele-Shaw cell, where the flow equations are expressed by a simple empirical rule known as Darcy's law. Far from Darcy's flow regime, i.e., in a pressure-driven flow governed by the Navier-Stokes equations, if fluid flows in a channel uniformly in the vertical direction for a long time, the flow reaches a steady state with a fully developed parabolic velocity profile. Moreover, with this velocity profile that has a shear or a vertical gradient, if a less viscous fluid pushes a more viscous one, Kelvin-Helmholtz-type Instability (KHI) is encountered alongside the pure diffusive miscible VF [4]. Such KHI is found when a reactant A displaces another reactant fluid having the same viscosity following a simple A+ B→C reaction kinetics [5]. The governing equations become a set of coupled non-linear PDEs, which are solved using a diffuse interface finite volume method. Depending upon the product's viscosity, K-H billows occur at either A-C or C-B reaction front [4, 5]. Further, the onset times of Instability are found through direct numerical simulations as well as linear stability analysis [6] for various governing non-dimensional parameters such as the mobility ratio, Damköholer number, Péclet number, and Reynolds number. The detailed modeling phenomena in comparison to the corresponding Darcy's regime will be discussed in this talk, and how this chemo-hydrodynamic KHI enhances the mixing of the product fluid will be shown.

Sanjay Kumar Pandey

Department of Mathematical Sciences,

Indian Institute of Technology (Banaras Hindu University), Varanasi, India

A viscous model for single-cell tornado-like vortices

Abstract

The talk aims to generalize the Baker and Sterling's model (2017) by additionally considering viscous flow and introducing a cylindrical central zone of low pressure. Unlike other models, in which the azimuthal velocity is deduced as a special solution using the variables-separable approach, the novelty in this is that it yields a more general form. Design/methodology/approach – Flow is incompressible, steady, axisymmetric and viscous. Radial velocity is assumed similar to that of the Baker and Sterling model (2017) by incorporating a central low-pressure zone. The continuity and the Navier–Stokes equations are employed to obtain other velocity components and pressure. Unlike earlier models, azimuthal velocity is obtained from the radial and the axial momentum equations. Findings – Azimuthal velocity does not asymptotically vanish in the radial direction, it rather sharply reduces to zero, which is practically observed in real vortices occurring in nature. Also, with an increase in water content in tornado fluid, the vortex becomes slightly thinner with comparatively slower rotation. Furthermore, the consideration of a central low-pressure zone shifts the maximum of the axial velocity somewhat away from the boundary of the low pressure. Also, as the low-pressure zone narrows, pressure from the outer zone to the boundary of the low-pressure central zone drops more rapidly, representing a stronger vortex.

Prof. Ernesto Leon-Castro

Universidad Católica de la Santísima Concepción, Chile

Fuzzy logic and fuzzy sets, evolution of aggregation operators and their applications

Abstract

This paper aims to identify what fuzzy logic, fuzzy sets, and aggregation operators are and how they have evolved. It will also present some articles that have applied these methodologies to the analysis of different management problems.

Prof. Fabio Raul Blanco Mesa

Universidad Pedagógica y Tecnológica de Colombia, Colombia

Heterogenous Penalty-based Bonferroni OWA operators for application in multicriteria decision-making

Abstract

In the decision making process there are several characteristics that configure and determine its result. One of them is related to the absence of consensus or disagreement where decision makers can penalize information limiting the importance and atypical elements in the decision-making problem. The main aim is to propose new aggregation operators considering heterogenous Penalty function, distance measures and Bonferroni OWA. First, new heterogenous penalty-based functions are proposed called the penalty weight index of maximum and minimum level (P–WIMAM). Secondly, the proposed aggregation operators combine heterogeneous penalty-based functions with Bonferroni OWA operators, which and Bonferroni (double) penalty maximum and minimum level index ordered weighted average BP_{IMAM}–OWA and dBP_{IMAM}–OWA and extended with induced variables BP_{IMAM}–IOWA and dBP_{IMAM}–IOWA. Likewise, these operators and a vector of induced generalized aggregation operators are introduced. Furthermore, these methods can be used by decision-makers when they need to reflect disagreement, restrictions and asymmetries that could exist by being able to compare and interrelate soft information simultaneously. Finally, methods are applied to analyse information related to Colombia's five Porter forces in the Craft beer sector.

Dr. Rajesh K. Pandey

Department of Mathematical Sciences,

Indian Institute of Technology (BHU) Varanasi

On Retinal Blood Vessel Segmentation

Abstract

We will discuss a new fractional filter and a novel line detector based algorithm for retinal blood vessel segmentation. The fractional filter is designed with the help of a weighted fractional derivative and an exponential weight factor. Firstly, the image is denoised using a developed fractional filter. Then, a multi-scale line detector is used to compute the line responses at multiple lengths using a punctured window of fixed dimensions. The final response is computed as the arithmetic mean of all responses at different scales and the underlying image intensity. This enhances the retinal blood vessels and suppresses the background. Finally, hysteresis thresholding is applied to obtain the segmented vessels. Experiments are performed on two well-studied evaluation databases named RC-SLO, STARE, CHASE_DB1, and DRIVE, and the simulation results are discussed. This technique is on par with leading methods and surpasses many of them.

Keywords: Fractional calculus, Line detector, Retinal blood vessel segmentation

Abstracts of Invited Speakers

Dr. Sukhendu Ghosh
Department of Mathematics
Indian Institute of Technology Jodhpur, Rajasthan

Hydrodynamic Instability and Control of Rotating Flows

Abstract

In a large variety of physical systems, the fluid-flow properties are the function of space and time, and their variation can have a dramatic effect on the flow instability. The knowledge of instability behaviors of such complicated flows is essential for mathematical modeling, design and application of compact tools to ensure desired mechanical, optical properties and barriers of the products. Moreover, many intriguing and important fluid dynamic phenomena in nature and engineering tools are associated with complex spatio-temporal patterns. The study of hydrodynamic instability is a mathematical way to understand the overall dynamics of flow systems using perturbation theory. Flow geometry and applicable forces play an important role to control the flow dynamics. For instance, mixing in numerous medical and chemical applications, involving overly long microchannels, can be enhanced by inducing flow instabilities. This talk includes the discussion on the linear stability of rotationally actuated microchannel flows commonly deployed for biochemical and biomedical applications. I will discuss thoroughly how to derive the coupled system of Orr-Sommerfeld-Squire equations as well as the numerical solution procedure using spectral collocation method for the Coriolis force-driven complex flow systems. Further, I will explain the variation of rotational instability characteristics and associated instability mechanisms for different range of flow parameters.

References:

[1] S. Sengupta, S. Ghosh, S. Saha, and S. Chakraborty, “Rotational instabilities in microchannel flows”, Physics of Fluids, Vol-31, 054101 (2019).

[2] S. Ghosh, R. Usha and K. C. Sahu, “Double-diffusive two-fluid flow in a slippery channel: A linear stability analysis”, Physics of Fluids, Vol.-26, 127101 (2014).

[3] S. Sengupta and S. Ghosh “Linear stability of a rotating channel flow subjected to a static magnetic field”, Physics of Fluids, Vol.-33 (5), 054116 (2022).

[4] M. Madou, J. Zoval, G. Jia, H. Kido, J. Kim, and N. Kim, “LAB on a CD,” Ann. Rev. Biomed. Eng., Vol. 8, 601 (2006).

[5] M. Cherian, S. Ghosh, and S. Mukhopadhyay, “Hydrodynamic instability of flow through a rotating channel filled with isotropic porous media” Physics of Fluids, Vol.-34 (8), 094104 (2022).

[6] W. O. Criminale, T. L. Jackson and R. D. Joslin, “Theory and computation of hydrodynamic stability”, Cambridge University Press, New York (2003).

Dr. Bibaswan Dey
Department of Mathematics
University of North Bengal
Raja Rammohanpur, Dist. Darjeeling, West Bengal-734013, India

Mathematical Modelling of Human Atherosclerosis: Early and Advanced Stages

Abstract

Atherosclerosis is a chronic inflammatory cardiovascular disease in which fatty plaque builds up inside an artery wall. Early atherosclerotic plaque development is typically characterized by inflammatory tissue primarily consisting of macrophages and foam cells. We examine the roles of cytokines (particularly monocyte chemoattractant protein-1) and oxidized low-density lipoprotein (oxLDL) in the recruitment of monocytes and the formation of foam cells, respectively. The ingestion of oxLDL by macrophages results in the accumulation of intracellular cholesterol, and its excessive level becomes toxic to foam cells, leading to cell death beyond a threshold. We examine how intracellular cholesterol-induced toxicity impacts plaque development. Parameters associated with toxicity-induced cell death play a key role in reducing the plaque growth rate by promoting cell death. We show that raising the toxicity threshold increases the volume fraction of inflammatory cells, thereby accelerating plaque growth. At the latter stage, the smooth muscle cells migrated from deeper artery wall layers, contributing to the fibrous cap formation and plaque stabilizing. A developed plaque gradually enters the lumen and narrows down the lumen to impede blood flow.

Cardiac troponin, a high specificity and sensitivity biomarker, facilitates early detection of elevated myocardial infarction, ischemic stroke risks, etc. We aim at establishing a relationship between the troponin concentration in atherosclerotic arteries and their internal clearance, which could significantly improve our understanding of disease progression. The plaque undergoes rapid evolution in its initial stages, gradually slowing down over time to reach a stable state. A positive correlation exists between the maximum plaque depth and cardiac troponin concentration in the blood. The speed of blood cells slows down at an enhanced plaque depth within atherosclerotic arteries.

Dr. Vijay K. G.
Department of Ocean Engineering
Indian Institute of Technology Madras

Numerical and Experimental Works on Wave Energy Converters (WECs)

Abstract

A detailed investigation is essential to ensure the integrity of any engineering work. Both numerical and experimental studies are mandated for various reasons, including the overall project cost, novelty of the concept, stochastic nature, and uncertainty quantification. As we know, to demonstrate a proof of concept and implement it in a real-world field, we must achieve the required Technology Readiness Level (TRL). Numerical analysis comes with a certain set of advantages and disadvantages, and so does experimental analysis. In this talk, we discuss various analyses of water wave problems using the boundary integral equation (BIE). The leverage and shortcomings of using linear potential flow theory are taken up. Besides, the recent experimental investigations and the associated challenges are discussed.

Dr. Meraj Alam
Department of Mathematics
School of Engineering, Mahindra University, Hyderabad,

Existence and Uniqueness Analysis of Poro-Elasto-Hydrodynamics Models in Biological Tissues

Abstract

This work is concerned with the development and analysis of a mathematical model that is motivated by interstitial hydrodynamics and tissue deformation mechanics (poro-elasto-hydrodynamics) within an in-vitro solid tumour. The classical mixture theory is adopted for mass and momentum balance equations for a two-phase system. A main contribution of this study is that we treat the physiological transport parameter (i.e., hydraulic resistivity) as anisotropic and heterogeneous, thus the governing system is strongly coupled and non-linear. We derived a weak formulation and then formulated the equivalent fixed-point problem. This enabled us to use the Galerkin method, and the classical results on monotone operators combined with the well-known Schauder and Banach fixed-point theorems to prove the existence and uniqueness of results.

Dr. Atendra Kumar
Department of Mathematics,
National Institute of Technology Srinagar, J&K, India.

Heat Convection from Multiple Heated Entities placed in the Channel Flow

Abstract

Heat transfer enhancement through channels containing heated entities are of great importance in many thermal applications. Heat convection from heated square, triangular and plane shaped entities placed in a channel is analyzed in this paper. Multiple heated entities are placed in a staggered arrangement on the walls of the channel. The problem is studied for fixed Reynolds number (Re) as 100 and Prandtl number (Pr) in the range 0.5-1.0, by using a Higher Order Compact (HOC) finite difference scheme. The effect of Pr is considered on the heat convection phenomenon. Heat transfer is evaluated in terms of Nusselt number, average Nusselt number. The results show that the temperature distribution is strongly dependent on flow structure and varies with any change of flow pattern in different shaped entities. The significant effect of Pr has been concluded over heat convection.

Keywords: HOC scheme, Heated entities, Navier-Stokes equations.

Dr. Ambuj Pandey
Department of Mathematics
IISER Bhopal, India

Fourier Smoothed Windowed Trapezoidal Rule and Its Applications

Abstract

Numerical approximations of integrals play a crucial role in various fields, including science, mathematics, and engineering. Among existing methods, the trapezoidal rule is one of the most efficient quadrature techniques due to its simplicity, reliance on equispaced data points, and natural compatibility with the Fast Fourier Transform (FFT). For smooth, periodic functions, the trapezoidal rule is known to achieve spectral (or super-algebraic) convergence. However, for non-periodic yet smooth—even analytic—functions, the convergence rate declines to second order. This limitation often makes the method less effective in many practical situations. In this talk, we present a modified trapezoidal rule that retains high-order accuracy for non-periodic functions, maintaining this accuracy even when the function possesses jump discontinuities without compromising the FFT compatibility property. The method extends naturally to higher dimensions, facilitating accurate numerical integration over bounded and geometrically complex domains. A key feature is its ability to evaluate convolution integrals with a computational cost of O(N log N), which we leverage to develop a fast, high-order solver for wave scattering problems. This solver maintains an O(N log N) computational complexity, even for complex-shaped scattering obstacles.

Dr. Amita Soni
Dr. D. Y. Patil School of Science and Technology,
Dr. D. Y. Patil Vidyapeeth, Tathawade, Pune

Modern Statistical Techniques in Data Analysis

Abstract

Modern datasets are large, complex, and multidimensional, requiring advanced statistical methods beyond classical approaches. This talk provides an accessible introduction to modern statistical techniques, including multivariate analysis, robust/non-parametric methods, time-series modeling, and statistical learning. Brief illustrative examples and a simple demonstration will highlight how these techniques enhance inference and predictive accuracy in contemporary data analysis settings.

Dr. Anuwedita Singh

Department of Engineering Sciences, ABV-IIITM Gwalior, MP, India

A Novel Machine Learning Framework to Approximate Modified Bessel Functions

Abstract

This work presents the precise approximations for modified Bessel functions of the second kind. Building on a well-established method for function approximation, the enhanced approach, incorporating machine learning techniques, is used to approximate Bessel functions such as K_0, K_1, $K_{1/4}$, I_0, I_1, and $I_{1/3}$. These approximations are demonstrated to be highly effective in various applications, such as thermal average and partition function, providing a robust alternative to repeated numerical integration.

Dr. Raghav Prasad Parouha
Assistant Professor
Department of Mathematics, Indira Gandhi National Tribal University, Amarkantak (M.P.)

Improved Particle Swarm Optimization for Nonconvex / Nonsmooth Optimization

Abstract

In this talk, an Improved Time-Varying Particle Swarm Optimization (ITVPSO) algorithm is presented for solving nonconvex and nonsmooth optimization problems, with particular emphasis on the economic load dispatch problem. ITVPSO extends the traditional Particle Swarm Optimization (PSO) algorithm by introducing novel time-varying acceleration coefficients for the cognitive and social components in the velocity update equation. In the early stages of optimization, this mechanism enhances the global search capability of particles, while in the later stages it guides them more effectively toward the global optimum. Additionally, a dynamically decreasing inertia weight is employed—rather than a fixed constant—to maintain population diversity and reduce the risk of premature convergence. These improvements strengthen the algorithm's ability to escape local optima and accelerate convergence toward the global solution. The effectiveness of ITVPSO is validated on a set of complex benchmark functions. Furthermore, its efficiency, feasibility, and computational speed are demonstrated by applying ITVPSO to six economic load dispatch test cases, including 3-, 6-, 13-, 15-, and 40-unit systems, as well as a large-scale 140-unit Korean power system. Comparative analyses with state-of-the-art algorithms confirm that ITVPSO achieves superior performance in terms of solution quality, convergence behavior, and robustness.

Keywords: Nonconvex/nonsmooth optimization, inertia weight, economic load dispatch problem, particle swarm optimization (PSO), time-varying acceleration coefficients.

Dr. Ritu Sahni

Nirma University, Ahmedabad, India

From Convergence to Pattern Formation: Fixed Points and Fractal Applications in Artificial Intelligence

Abstract

Artificial Intelligence is underpinned by mathematical principles that shape both the stability of learning processes and the formation of structured patterns. Fixed point theory offers a rigorous framework for understanding convergence in iterative methods and provides conditions under which stable and unique solutions can be ensured. Fractal geometry, grounded in ideas of self-similarity and recursive construction, offers insight into the representation and generation of complex patterns arising from simple mathematical rules.

Bringing these perspectives together provides a broad conceptual foundation for interpreting the behavior of computational systems, linking notions of convergence with those of pattern formation. This combined viewpoint supports deeper theoretical understanding and opens pathways for further developments within mathematical and computational intelligence research.

Keywords: Fixed Point Theory, Convergence Analysis, Iterative Methods, Fractal Geometry, Self-Similarity, Pattern Formation, Mathematical Modelling, Computational Intelligence.

Dr. Govind Prasad Sahu

Center for Basic Sciences,

Pt. Ravishankar Shukla University, Raipur, Chhattisgarh, India

Modelling COVID-19 Dynamics Using Physics-Informed Neural Networks

Abstract

Mathematical modelling plays a crucial role in understanding infectious disease transmission and guiding public health interventions. While classical compartmental models such as SIR and SEIR provide mechanistic insight through systems of differential equations, their predictive capability is often limited when faced with sparse or noisy real-world data, as seen during the COVID-19 pandemic. Physics-Informed Neural Networks (PINNs) offers a powerful framework that unifies mechanistic epidemiological theory with data-driven learning.

This article presents a PINN-based approach for COVID-19 modelling that incorporates asymptomatic infections and vaccination dynamics. By embedding epidemiological governing equations into the neural network loss function, PINNs enable simultaneous parameter estimation, state reconstruction, and forecasting while preserving biological consistency. Results based on real COVID-19 data demonstrate that PINNs outperform traditional ODE fitting and statistical methods in predicting epidemic trends and evaluating intervention strategies. The article also highlights challenges, computational considerations, and future directions for integrating PINNs with real-time surveillance and uncertainty quantification.

Keywords: Infectious Disease Modelling; Scientific Machine Learning; PINNs; COVID-19

Dr. Rathan Samala
Indian Institute of Petroleum and Energy (IIPE) Visakhapatnam

Semi-Implicit Central Scheme for Hyperbolic Systems of Balance Laws with Relaxed Source Term

Abstract

Quasi-linear hyperbolic systems with source terms introduce significant computational challenges due to the presence of stiffness. To address this, a numerical scheme is developed and applied to benchmark models such as the Xin–Jin relaxation model, the Broadwell model, and the Euler equations with heat transfer to evaluate its effectiveness. The method extends the Nessyahu–Tadmor central scheme [1] to non-homogeneous systems via a non-splitting strategy [2], enabling consistent source term treatment. A second-order IMEX scheme [3] is formulated using cell-averaging, with the stiff source term handled implicitly through midpoint spatial discretization, trapezoidal time integration, and a backward semi-implicit Taylor expansion inspired by [4]. Theoretical analysis and numerical validation confirm the stability and accuracy of the method, highlighting its potential for efficiently solving stiff hyperbolic balance laws.

Keywords: Hyperbolic systems of balance laws, implicit-explicit scheme, stability and accuracy.

References

[1] Nessyahu, H. and Tadmor, E., Non oscillatory central differencing for hyperbolic conservation laws, J. Comput. Phys., 87, pp. 408–463, (1990).

[2] Liotta, S.F., Romano, V., and Russo, G., Central Schemes for Systems of Balance Laws, Internat. Ser. Numer. Math. 130, Birkh¨auser, Basel, pp. 651–660, (1999).

[3] Boscarino, S., Pareschi, L., and Russo, G., Implicit-explicit methods for evolutionary partial differential equations, 1st ed. In press to SIAM books, (2024).

[4] Macca, E., and Boscarino, S., Semi-implicit-type order-adaptive CAT2 schemes for systems of balance laws with relaxed source term, Commun. Appl. Math. Comput., vol. 7, pp. 151–178, (2025).

Dr. Partha Sarathi Mandal
National Institute of Technology, Patna

Sensitivity to Initial Infection Size: Branching Processes vs. Deterministic Outbreak Predictions

Abstract

Stochastic models play a crucial role in understanding disease dynamics, where transmission involves complex and variable interactions among animal reservoirs, vectors, and humans. Unlike deterministic models that rely on average behaviour, stochastic approaches capture the randomness inherent in transmission events, population fluctuations, and environmental variability. This is particularly important when dealing with small populations. When the number of infected populations is sufficiently small, the deterministic system fails to accurately depict the disease transmission dynamics. However, continuous time Markov chains (CTMC) can effectively describe these dynamic characteristics through state discretization for small population sizes. To this end, we first describe a stochastic system based on CTMC and then estimate the probability of disease extinction and outbreak by applying the Galton–Watson branching process (GWbp). A comparison analysis between the deterministic and stochastic systems yields the following insights: (1) when □_0 > 1, the deterministic system predicts infection outbreak, whereas the stochastic system indicates a nonzero probability of infection elimination; (2) In the deterministic system, the initial number of infected individuals does not significantly influence the long-term dynamics. In contrast, the stochastic system is highly sensitive to initial infection levels, and this sensitivity cannot be ignored.

Keywords: Bubonic plague, CTMC model, Seasonality, Extinction probability, Parameter estimation.

Dr. Gajendra K. Vishwakarma

Indian Institute of Technology, Dhanbad

Bayesian Models and Their Applications

Abstract

Bayesian methods have become a cornerstone of modern data science, offering a coherent framework for incorporating prior knowledge, updating beliefs with new evidence, and quantifying uncertainty in decision-making. By leveraging Bayes' theorem, these approaches provide flexible and interpretable solutions for complex problems such as predictive modeling, parameter estimation, hypothesis testing, and classification. Applications span diverse domains, including healthcare (disease risk prediction and clinical trials), finance (portfolio optimization and risk assessment), natural language processing, and machine learning (hierarchical modeling and Bayesian neural networks). Through illustrative examples, Bayesian methods demonstrate their power in handling high-dimensional data, missing information, and real-world uncertainty, making them indispensable tools for advancing data-driven insights and robust decision support.

Keywords: Bayesian approaches, data science, predictive modeling, high-dimensional data, machine learning applications.

Dr. Moitri Sen
Department of Mathematics & Computing Technology,
National Institute of Technology, Patna, Bihar-800005, India

Exploring a spatiotemporal prey-predator model: local and nonlocal interactions

Abstract

Spatial heterogeneity in the environment significantly influences the population dynamics. In this study we investigate such types of spatially heterogeneous environments using local and nonlocal models. Initially, we scrutinize a local model, laying the groundwork for understanding system dynamics. Subsequently, different types of nonlocal interactions capture spatial heterogeneity effects, enriching our comprehension of ecosystem dynamics. During the study we have uncovered that nonlocal interactions significantly influence the stability of coexisting equilibrium states, thereby altering the emergence and characteristics of Turing patterns and other solution types. Ecological phenomena, such as the emergence of travelling waves, underscore the intricate interplay between predator and prey populations. Detailed numerical simulations revealed that increasing nonlocal interaction coefficients reduces the Turing domain while expanding the stable homogeneous solution domain. Our study highlights the complex dynamics behind predator-prey interactions, including the emergence of travelling waves connecting equilibrium states and the profound implications for ecological invasions. Additionally, chaotic solutions can be effectively mitigated by implementing nonlocal interaction.

Keywords: predator model, turing pattern, nonturring pattern, amplitude equation, weekly non-linear analysis.

Dr. Ajit Kumar Singh

STME, SVKM's NMIMS (Deemed-to-be University), Indore - 453112, Madhya Pradesh, India

Study of Synchronization in Chaotic Systems

Abstract

Synchronization in chaotic systems is a remarkable phenomenon in which two or more chaotic oscillators evolve in a coordinated manner despite their inherent unpredictability. This study examines different types of synchronization—including complete, lag, and generalized synchronization—using standard chaotic models such as the Lorenz and Rössler systems. Various coupling schemes and parameter settings are explored to understand the conditions under which stable synchronization occurs. Numerical simulations and stability analysis using Lyapunov exponents reveal the critical role of coupling strength and system parameters in achieving synchronized states. The findings provide useful insights for applications in secure communication, nonlinear control, and complex network dynamics. Future work may extend these results to fractional-order and networked chaotic systems.

Keywords: Nonlinear Dynamics; Chaotic Systems; Synchronization; Chaos Synchronization

Prof. A. K. Malik
School of Sciences, UP Rajarshi Tandon Open University, Prayagraj-211021

Sustainable Supply Chain model with Trade Credit under Preservation Technology

Abstract

In today's production industry, preservation technology plays a crucial role in slowing product deterioration, keeping perishable items fresh for longer periods, and reducing waste. It helps maintain product quality, lowers overall inventory costs, improves customer satisfaction, and supports sustainable and efficient business operations. This study develops an inventory model for eco-friendly, perishable products that deteriorate over time, incorporating learning effects, preservation technology, shortages, and an exponentially increasing demand rate. The model determines the optimal order quantity while considering inflation, carbon emissions, packaging costs, and trade-credit policies. Retailers provide delayed payment options, and buyers use preservation methods to reduce deterioration. The main objective is to minimize the total inventory cost over the product's life cycle. A numerical example is also included to demonstrate the model's practical applicability in real industrial environments.

Keywords: Inventory, Demand, Inflation, Carbon Emission, Supply Chain, Trade Credit, Preservation Technology.

Dr. Chandrakant Kumar Singh

School of Science
Uttar Pradesh Rajarshi Tandon Open University, Prayagraj

Importance of kernel trick in machine learning and AI

Abstract

In recent years, estimation and learning methodologies based on positive definite kernels have experienced substantial growth in popularity, particularly within the domain of machine learning. Due to their strong mathematical foundation, these approaches have also garnered considerable attention from the statistics and mathematics communities. This work provides an overview of machine learning and AI techniques that employ positive definite kernels. Such methods formulate learning and estimation problems within a reproducing kernel space, wherein functions defined on the data domain are expressed as expansions in terms of kernel functions. Operating within a linear function space offers notable advantages: it facilitates the systematic construction and rigorous analysis of learning algorithms while simultaneously accommodating a broad and expressive class of functions. We present several applications of kernel methods, many of which are based on replacing standard inner products with kernel functions, thereby extending linear geometric algorithms to nonlinear settings.

Dr. Branislav Djordjevic
Innovation Center of Faculty of Mechanical Engineering, Kraljice Marije 16, Belgrade, Serbia

Modeling the Size Effect in Ductile-to-Brittle Transition: A Statistical Approach

Abstract

Scatter in fracture toughness data within the ductile-to-brittle (DTB) region of ferritic steels necessitates statistical processing due to the stochasticity of fracture nature itself. The paper comparatively analyzes two novel statistical models developed by their authors based on (1) *scaling geometrically similar CT specimens* and (2) *Weakest Link Statistics*, for (elastic-plastic) equivalent stress intensity factor derived from the *J*-integral at the point of onset of cleavage fracture (simply critical stress intensity factor), namely K_{Jc} prediction. EURO dataset data (22NiMoCr37 at -60 °C) are used to demonstrate the accuracy of the estimates. Both models show good agreement with experimental results, but with different characteristics featuring different output. The main criticisms of the both methods primarily relate to their application domain and predictive capability concerning fracture toughness K_{Jc}. It is particularly important to emphasize that the estimation of the *Cumulative Distribution Function* (CDF) for the critical stress intensity factor K_{Jc}, obtained by extrapolation using the novel two-step scaling method, is sensitive to the statistical size of the input datasets, while the second one is more robust exhibiting conservative feature.

Keywords: ductile-to-brittle transition; ferritic steels; scaling; Weakest Link Statistics; fracture toughness; stress intensity factor

Dr. Abhijit Sutradhar

Department of Mathematics,
School of Applied Sciences, KIIT Deemed to be University, Bhubaneswar.

Magnetic Drug Targeting Therapy in the Human Body

Abstract

Magnetic drug targeting offers a site-specific alternative to conventional cancer treatments, reducing side effects associated with surgery or systemic chemotherapy. Its effectiveness depends on drug carriers with strong magnetic moments and on understanding the mechanisms that govern their motion in microvessels. This study outlines key magnetic nanomaterials, approaches to targeted delivery, and strategies for improving imaging-guided therapy. A concise mathematical model is developed that incorporates major forces such as magnetic, fluidic, inertial, particle-interaction, Saffman lift, and microvessel permeability under both single-phase and two-phase non-Newtonian blood flow. The framework aims to support the design of efficient magnetic drug-delivery systems for cancer treatment.

Abstracts of Paper Presentations

MMCITRE2025/005

Boundary Layer Convection in Casson Nanofluid over a Stretching/Shrinking Cylinder with Internal Heating

Rohit Kannaujiya*, B.S. Bhadauria
Department of Mathematics, School of Physical and Decision Sciences,
Babasaheb Bhimrao Ambedkar University, Lucknow-226025, India

Abstract: In this work, the convection of a Casson nanofluid over a shrinking and stretching cylinder with internal heating is investigated using a numerical approach. The governing equations in cylindrical coordinates are formulated for velocity, temperature, and concentration fields. By applying suitable similarity transformations, the momentum, energy, and concentration PDEs are reduced to a system of coupled non-linear ODEs. These equations are solved in MATLAB using the bvp4c solver, and the results are presented graphically for momentum, temperature and concentration profile. The numerical findings are reported in terms of the skin friction coefficient (Cf), Nusselt number (Nu), and Sherwood number (Sh), which represent the momentum, heat, and mass transfer rates, respectively. The primary aim of the study is to explore the effects of Casson nanofluid properties, internal heating, and other governing parameters on the flow and transport characteristics. Also it is emphasized that the cylindrical geometry provides a more generalized framework than the flat plate configuration. This highlights the broader applicability and physical significance of considering the cylindrical surface in convection studies.

Keywords: Casson Nanofluids, internal heating, stretching/shrinking cylinder, boundary layer, bvp4c.

MMCITRE2025/006

Machine learning based irreversibility analysis of Maxwell power law fluid

Abha Kumari
Centre for Data Science, ITER, Siksha 'O' Anusandhan (Deemed to be University),
Bhubaneswar 751030, India

Abstract: In industrial processes such as polymer extrusion, glass fibre drawing, coating, and welding, minimizing entropy generation translates into higher thermal efficiency, reduced energy losses, and better product quality. The influence of thermal and solutal-Marangoni convection is particularly relevant to thin-film technologies, crystal growth, and metallurgical operations where surface-tension-driven flows dominate. This work extends the theoretical investigation of entropy generation in unsteady two-dimensional magnetohydrodynamic flow of Maxwell power-law fluid past a stretching surface by integrating machine learning into the irreversibility analysis. The transport of heat and mass is modelled through the Cattaneo–Christov double-diffusion framework, and the governing equations are reduced via similarity transformations to a system of nonlinear coupled ordinary differential equations, solved using

the MATLAB Bvp4c routine. A high-fidelity dataset of entropy generation and Bejan number is then constructed over a wide range of nondimensional parameters. Supervised learning models and physics-informed neural networks are employed as surrogates to predict both integral and spatial distributions of irreversibility, providing significant computational speedup while preserving accuracy relative to the numerical solver. The results highlight the dominant roles of thermal and solutal Marangoni effects, the Eckert number, and magnetic parameter in shaping entropy generation. The proposed hybrid framework demonstrates the potential of machine learning to accelerate entropy-based optimization and deepen physical insight into non-Newtonian magnetohydrodynamic transport with finite-speed diffusion effects.

MMCITRE2025/007

Enhancing Decision Reliability with 2-D Linguistic Intuitionistic Fuzzy Power Aggregation Operators

Diksha Gupta[1], Madhu Gupta[2] and Ankit Kumar[2]

[1] Math and Science department, UTB, Salmabad, Kingdom of Bahrain
[2] Chitkara University School of Engineering and Technology, Solan, Himachal Pradesh, India.

Abstract. This study addresses challenging decision-making by taking into account both expert opinions and their level of confidence specially in healthcare waste treatment. The Generalized 2-Dimension Linguistic Intuitionistic Fuzzy Generalized Power Average (2-DLIFGPA) operator is a novel approach that is introduced in the present work. This approach efficiently integrates these expert evaluations, ensuring strong arguments have greater impact on the ultimate decision. Initially the 2-DLIFGPA operator, a novel approach to merging expert viewpoints in complicated decision-making—is introduced. In order to verify the efficacy of G2-DLIFPA, the present research investigates its mathematical characteristics and pinpoints particular scenarios in which it works exceptionally well. Finally a real-world example in healthcare waste treatment is also provided to illustrate how this strategy might be applied.

Keywords: linguistic intuitionistic fuzzy numbers; generalized power average operator; 2-dimension linguistic intuitionistic fuzzy variable (2-DLIFVs); MCDM

MMCITRE2025/008

Software Reliability Growth Modeling Using Human Related Factors: Learning and Fatigue

VIishal Pradhan , Shibani Sahoo , Satya K Mishra

Kalinga Institute of Industrial Technology Deemed to be University, Bhubaneswar, Odisha

Abstract: In this study, we proposed two advanced SRGMs that integrate these human factors into the modeling framework. The first model portrays the learning progression of testers using a hyperbolic sine function, while the second combines learning with fatigue modeled by an exponential decay. Using real-world dataset, we examine the performance of both models and compare with traditional models that do not take fatigue into consideration. As a result, we show that adding fatigue improves fitting and prediction accuracy. The model using the sinh function with fatigue consideration performs better than other models and provides a more realistic and comprehensive understanding of software reliability.

Keywords: Software Reliability Growth Model (SRGM), Non Homogeneous Poisson Process (NHPP), Fault Detection Rate (FDR), Mean Value Function (MVF)

MMCITRE2025/009

Wavelet Method for Distributed-Order Optimal Control Problem

Gunjan Dewangan
Department of Mathematics,
National Institute of Technology Rourkela, Rourkela, India

Abstract: This research presents a novel numerical method for solving a class of complex optimal control problems that feature distributed-order derivatives. The approach leverages the advanced mathematical properties of fractional-order Laguerre wavelets to transform the original continuous-time control problem into a more manageable discrete set of algebraic equations. This transformation is accomplished by utilizing Reimann-Liouville distributed-order operational matrices, which serve as the foundation for accurately representing the system's dynamics. In addition, the method incorporates a strategically chosen set of Newton-Cotes collocation points, which enhances the precision of the discretization process and ensures that the system's behavior is faithfully captured. Once the system is discretized, the optimized solution is determined by applying the Lagrange multiplier method. This powerful optimization technique is used to efficiently solve the resulting system of equations, ensuring that the solution adheres to the necessary constraints. The method not only facilitates the conversion of the original continuous-time problem into a discrete framework but also guarantees that the optimality conditions are systematically satisfied throughout the process. Finally, the effectiveness and versatility of the proposed numerical method are demonstrated through a series of illustrative examples. These examples are carefully selected to showcase the method's high precision, robustness, and broad applicability to a wide range of generalized distributed-order optimal control problems. The results highlight the method's ability to handle various

types of distributed-order dynamics, confirming its potential for tackling challenging problems in modern control theory and engineering practice. Overall, this study provides a significant contribution to the field by presenting a systematic and practical approach for solving distributed-order optimal control problems. The combination of fractional-order Laguerre wavelets, operational matrices, and advanced optimization techniques results in a highly effective computational tool that can be readily adapted for a variety of applications.

Keywords: Optimal control problem; Distributed-order derivatives; Laguerre Wavelets; Operational matrix; Lagrange multiplier.

MMCITRE2025/010

Performance Analysis of a Power Regression Model for Green Hydrogen Flow rate in a PEM Electrolyzer Utilizing Critical Dynamic Parameters

Minu Theresa Mathew and Diksha Gupta

College of Engineering, University of Technology Bahrain Salmabad, Bahrain

Abstract. Hydrogen energy production and storage system is a promising renewable energy system which opens up advanced and enhanced possibilities in the present era. Hydrogen is a highly combustible element and its generation, storage and transportation is highly critical considering safety and environmental constraints. In this regard a regression analysis incorporating a power regression model is employed in the paper, where in the experimental and theoretical values on the basis of set parameters incorporating compression pressure of hydrogen and current input of a PEM electrolyzer is utilized. The experimental data selected for the regression analysis is set to be for 1 bar, 5 bar, 10 bars etc. and the set values of electrolyzer current input values are incorporated to develop the hydrogen flow rate equations utilizing the power models. The error analysis is done to compare the theoretical (power regression model) and experimental values and the level of error is computed. A prediction of the hydrogen flow rate at the average normalized compressed pressure of 350 bar, 500 bar and 700 bar is determined using the power model computations using Matlab. The percentage relative error computed was found to be less than 0.5%.

Keywords: PEM, Regression Model. Power Model, Green Hydrogen.

MMCITRE2025/012

Mathematical Model of Standardising the Thermoelastic Characteristics of Materials: An Examination on Determining Material Parameters Based on Curve-Fitting

Ritesh Yadav[1], Bharti Kumari[2], Ajit Kr. Singh[3,□], and Gopal Kumar Gupta[4]

[1] Department of Mathematics, Jai Prakash University, Chapra, Bihar, India
[2] Department of Mathematics, Kamla Rai College, Gopalganj, Bihar, India
[3] School of Technology Management and Engineering, SVKM's Narsee Monjee Institute of Management Studies, Indore, Madhya Pradesh, India
[4] Symbiosis Institute of Technology, Nagpur Campus, Symbiosis International (Deemed University), Pune, Maharashtra, India

Abstract. This current study is planned and presented to aid in the standardisation of mathematical models set up for thermoelastic property analysis and improvement. The work illustrates an analytical approach to determining and adjusting the thermoelastic behaviour of composite materials, giving more importance to the curve-fitting mathematical model for determining material parameters. The study highlights the growing need for materials with thermoelastic properties and develops a reliable framework for assessing their performance. In the model, the integration of Helmholtz transformation is achieved through temperature dependence on material property and relations concerning stress and strains with curve-fitting techniques about densities, compositional variations, or even temperature-dependent elasticities and responsiveness to dynamic regimes, such as external stresses, among those properties that may become temperature-dependent under changing conditions. The study findings are very helpful for enhancing the accuracy of the assessments of the thermoelastic capacity. It provides a basis for high-performance composite material development in various engineering and manufacturing applications. There are suggestions for future improvements which can enhance the scope and the application of the model.

Keywords: Thermoelastic parameters · Curve-fitting · Multivariable parameters · Helmholtz transformation · Thermoelastic composites.

MMCITRE2025/014

Quantitative Portfolio Strategy Assessment: Incorporating penalty-based aggregation for more effective decision-making.

[1]Shruti Rathod, [2]Manoj Sahni, [3]Jose M. Merigo
[1,2]Department of Mathematics, School of Technology, Pandit Deendayal Energy University, Gandhinagar, Gujarat, India
[3]School of Computer Science, Faculty of Engineering and Information Technology, University of Technology Sydney, Australia

Abstract: This study addresses portfolio strategy selection using penalty-based aggregation, a multi-criteria decision-making methodology that comprehensively evaluates investment strategies beyond conventional approaches. We develop a framework incorporating return, risk, liquidity, market exposure, and ESG factors, defining ideal targets and using penalty functions to measure deviations from expected attributes. Seven investment strategies are evaluated: Long-Term Holding, Undervalued Asset Selection, High-Growth Focus, Broad Market Tracking, Income-Oriented Selection, Trend Following, and Contrarian Approach. The model assigns criterion weights based on investor preferences and market conditions, providing flexibility across investment scenarios. Results demonstrate that penalty-based aggregation effectively captures investment decision complexity, offering more robust recommendations than weighted sum approaches, especially in volatile markets. This framework enables quantitative balancing of multiple objectives and constraints, helping investors make informed decisions through a sophisticated yet intuitive approach. The study contributes to portfolio management by establishing a foundation for future research in dynamic strategy selection and machine learning optimization of penalty functions and weight assignments.

Keywords: Penalty Function, OWA operator, Penalty-based OWA operator, Multi criteria decision making, Portfolio investment.

MMCITRE2025/015

Selection of Best Renewable Energy Alternatives Utilizing Hamacher Aggregation Operator of p,q,r-Cubic Quasi-rung Orthopair Neutrosophic Fuzzy Sets

Bhavna Mahant[1,] Rakesh Kumar Bajaj[2], Vikas Baghel[3]

[1,2]Department of Mathematics,
Jaypee University of Information Technology, Waknaghat, Solan, PIN 173234,
Himachal Pradesh, IINDIA
[3] Department of Electronics and Communication Engineering,
Jaypee University of Information Technology, Waknaghat, Solan, PIN 173234,
Himachal Pradesh, INDIA.

Abstract. In the present communication, the notion of p,q,r- cubic quasi-rung orthopair neutrosophic fuzzy set (p,q,r-CQONFS), a useful framework for handling uncertainty and

imprecision in complex decision-making problems, has been utilized along with its Hamacher aggregation operator. Various important properties of the proposed operator have been studied to sync the uncertain information inherited in a decision-making model effectively. A modified methodology for solving a multi-criteria decision-making (MCDM) model has been presented by incorporating the information in p,q,r-CQONFS form. The proposed methodology has been illustrated effectively for selecting the most suitable renewable energy source/alternative for a local ecosystem. The evaluation process considers environmental, economic, efficiency, and social acceptance criteria. The ranking results have been graphically presented identifying the best renewable energy alternative and highlighting the benefits of applied framework.

Keywords: Renewable Energy Selection, MCDM, p,q,r -CQONFS, Hamacher Operators.

MMCITRE2025/016

Fuzzy Decision-Making Framework for Blockchain Technology Selection in Logistics and Supply Chain Management System

Arpit Kumar Rana, Ayush Gupta, Sidhant Gezta, Devyani Thakur, Kaushal Parmar, Rakesh Kumar Bajaj
Jaypee University of Information Technology, Waknaghat, Solan, PIN 173234, HP, INDIA

Abstract. Blockchain technologies offer transformational capabilities in the logistics and supply chain management (SCM) domain, improving transparency, traceability, and operational efficiency. However, selecting the most suitable blockchain platform under uncertain and fuzzy criteria remains a critical challenge. This paper proposes a decision-support methodology based on fuzzy information similarity measures to evaluate and rank blockchain technologies for logistics and SCM applications. The framework considers multiple criteria such as scalability, consensus mechanism, interoperability, security, and cost. An application case in the form of numerical illustration has been presented to demonstrate the efficacy of the proposed model.

Keywords: Blockchain, Supply Chain, Logistics, Fuzzy Sets, Similarity Measures, Multi-Criteria Decision Making, Technology Evaluation

---

MMCITRE2025/017

Disease Detection in Plants using Machine Learning Technique

Ravi Dhaundiyal[1], Ravi Shankar Jha[1], Punit Gupta[2]
[1]School of Computing, DIT University, Dehradun India.
[2]Department of Computer Science, Pandit Deendayal Energy University, India.

Abstract: Plant diseases can cause significant losses in crop yields and reduce the quality of agricultural products. Machine learning (ML) techniques have shown great potential in predicting plant diseases accurately and efficiently. In this review, we present a comprehensive overview of the recent research on disease prediction in plants using ML techniques. We start by discussing the importance of disease prediction in plant health management and the challenges associated with this task. We then provide a literature review of different authors in the field of disease detection for different plants. Furthermore, we provided a detailed analysis of the different types of ML techniques that have been applied to plant disease prediction, including supervised, unsupervised, and deep learning methods. We highlight the strengths and limitations of each technique and their performance on different plant species and diseases. Finally, we discuss the potential future directions in this field. Over-all, this review provides a comprehensive understanding of the current state-of-the-art in disease prediction in plants using ML techniques and outlines future research opportunities in this important area of agriculture.

Keywords: Machine Learning; CNN; YOLO; Agriculture; ResNet.

MMCITRE2025/020

The Use of Graph Neural Networks in Flight Delay Prediction and Air Traffic Analysis

Punit Gupta, Alauki Patel

Pandit Deendayal Energy University, Gandhinagar, Gujarat, India

Abstract - Analyzing flight information is instrumental for optimal air traffic management and prediction of the time of delayed flights, aviation, among others. Applications have been statistically based methods along with machine learning models, both lacking capability when handling complex dependencies in flight networks. Graph Neural Networks (GNNs) present an appropriate technique to alleviate the above drawbacks through learning about spatial and temporal dependencies among various types of data on aviation. This article presents some of the top GNN-based methods used in flight analysis, which include Graph Convolutional Networks (GCN), Graph Attention Networks (GAT), and Spatio-Temporal Graph Neural Networks (ST-GNN). The models mentioned above have been used for applications such as flight delay prediction, air traffic flow control, and route optimization. Regardless of their efficacy, challenges such as data availability, computational cost, and interpretability of models still exist. This paper reviews the current situation in flight analysis tasks by GNN, puts forward

limitations, and suggests directions of future research work in order to maximize performance and real-world application.

MMCITRE2025/021

Fuzzy-OWA Framework for Robust Risk Modeling in Manufacturing Enterprise Systems

[1]Sandeep Wankhade, [2]Manoj Sahni, [3] Ernesto León-Castro

[1,2]Department of Mathematics, School of Technology, Pandit Deendayal Energy University, Gandhinagar, Gujarat, India
[3] Universidad Católica de la Santísima Concepción, Concepción, Chile

Abstract: Effective risk management in enterprise systems, such as semiconductor manufacturing, demands innovative approaches to tackle uncertainty and complex decision-making. This study proposes a novel framework integrating Ordered Weighted Averaging (OWA) operators and fuzzy computational intelligence to enhance risk assessment and decision modeling. Fuzzy logic transforms noisy sensor data from manufacturing processes into interpretable risk profiles, addressing data imprecision, while OWA operators adaptively aggregate multi-sensor risk indicators, enabling tailored decision-making across optimistic to conservative risk preferences. Empirical assessments using real-world semiconductor manufacturing data compare the proposed Fuzzy-OWA framework against standard machine learning techniques (e.g., SVM, decision trees), revealing enhanced precision and reliability in identifying critical production risks, such as manufacturing defects. By optimizing risk mitigation, the framework promotes sustainable manufacturing by minimizing resource waste, aligning with renewable energy objectives. This work advances mathematical modeling through OWA aggregation and computational intelligence via fuzzy logic, offering a scalable solution for enterprise risk management.

MMCITRE2025/023

Spectral Study of Higher-Order Compact Schemes for Convection–Dispersion Equation

Lavanya V Salian

Department of Humanities and Sciences, Indian Institute of Petroleum and Energy, Visakhapatnam, India

Abstract: We present a detailed spectral analysis of the convection–dispersion equation to assess the accuracy and stability of high-order numerical schemes across a broad range of nondimensional parameters. This work is motivated by the need for accurate simulation of dispersive wave propagation and transport processes, where conventional numerical methods often introduce spurious oscillations and distort phase or energy transport. Three compact finite difference schemes are examined, one sixth-order and two eighth-order, covering both node-centered and cell-centered spatial formulations, each combined with a third-order strong stability-preserving Runge–Kutta (SSPRK3) time-stepping method. The spectral behavior is analyzed in terms of wavenumber, Courant–Friedrichs–Lewy number, and dispersion number, with key quantities such as amplification factor, normalized phase speed, and normalized group velocity evaluated over the complete spectral plane for one- and two-dimensional cases. This analysis identifies critical dispersion and Courant limits beyond which instability and nonphysical artifacts, including spurious waves, phase reversal, and incorrect energy transport, occur. Numerical experiments on both linear and nonlinear benchmark problems (KdV, mKdV) confirm the theoretical predictions and demonstrate the effectiveness of the spectral framework in guiding parameter selection. The findings provide practical guidelines for choosing spatial and temporal discretization parameters, enabling stable and accurate simulations of convection–dispersion equations and related wave propagation models.

Keywords: Spectral analysis; Convection–dispersion equation; High-order compact scheme; SSP Runge–Kutta methods; Dispersion error.

MMCITRE2025/024

An Intelligent Ensemble Framework for Tropical Crop Yield Prediction: Integrating Active Learning with Random Forest and XGBoost

Amol Bhilare[1], Debabrata Swain[2], Vishva Patel[2], Manish Kumar[2*]

[1]Vishwakarma Institute of Technology Pune
[2]Pandit Deendayal Energy University, Gandhinagar

Abstract: The agriculture industry in India is essential to maintaining both economic stability and nutritional security. It is a vital component of the food systems around the world. Even while farming methods and technology utilization have significantly improved, there are still plenty of opportunities for emerging technologies like machine learning to drastically change agricultural operations. One of the most important things agricultural practitioners may perform

before beginning cultivation is to forecast crop productivity under particular environmental circumstances. This need highlights the importance of developing smart, flexible frameworks that assist farmers in making educated agricultural decisions. To address this need, the research uses advanced analytical techniques, farming data, and meteorological data to apply computational learning algorithms that boost farm productivity and operational efficiency. This research provides farmers with evidence-based insights that lead to improved harvests, strategic resource management, and ecologically friendly farming practices by using forecasting algorithms to provide crop yield forecasts for warm-climate Kharif season varieties. With an ensemble approach using the Random Forest and XGBoost regression algorithms, this study introduces an active learning methodology that shows 97.13% prediction performance. The approach provides a versatile framework appropriate for modern precision farming applications by emphasizing thorough feature optimization and ongoing model improvement.

Keywords: Machine Learning; Ensemble Learning, Active Learning; Tropical Crop; XGBoost; Random Forest

---

MMCITRE2025/026

Spline-Based Approximation for Two-Parameter Singularly Perturbed Systems with Large Time Delay with Applications in Science and Engineering

Parvin Kumari

Abstract: A numerical method, used for solving two-parameter singularly perturbed systems with large time delays, which are commonly encountered in a variety of scientific and engineering applications, is constructed and analysed in this work. To attain high precision and stability, the suggested approach combines the cubic spline interpolation with the Crank-Nicolson method. The two-parameter nature of the problem introduces significant challenges due to the presence of boundary layers and the interaction of small perturbation parameters with large time delays. The technique successfully captures the abrupt changes and steep slopes present in such systems by using cubic splines. According to theoretical analysis, the suggested scheme significantly outperforms current techniques by achieving second-order convergence in both spatial and temporal variables. The theoretical conclusions are corroborated in practice by numerical experiments, which show the method's robustness and its efficiency. Discussions of applications in fluid dynamics, heat transport, and control systems reflect clearly the approach's applicability in real-world scenarios. The findings show that the Crank-Nicolson method, together with the cubic spline approach, is an effective technique for precisely resolving two-parameter singularly perturbed systems with significant time delays, providing a solid foundation for practical scientific and engineering problems.

MMCITRE2025/029

AutoREAD: A Retrieval-Augmented Pipeline for README Generation

Pranav Kini, Jash Upadhyay, Abhishek Tripathi, Soni Sweta

Mukesh Patel School of Technology, Management and Engineering, Mumbai 400056, India

Abstract: The rapid growth of open-source software has led to an extensive use of GitHub repositories, many of which lack clear or comprehensive documentation. Good-quality README files are very important for software usage, collaboration, and maintenance, yet developers often neglect this task due to time and effort constraints. Recent advances in large language models (LLMs) have allowed for the development of automated documentation, but most existing approaches focus on single-file code summarization rather than directory-level descriptions. In this research, we present a retrieval-augmented generation (RAG) based automated README Generator. Our method involves indexing source files, chunking them into segments based on token size, and retrieving relevant content to construct context-aware prompts for the LLM API. This approach mitigates token size limitations and improves semantic coverage of multi-file projects. We evaluate our system across diverse repositories, comparing baseline LLM outputs against our RAG-enhanced method. Results demonstrate that RAG improves completeness, relevance, and coherence, while reducing hallucinations. This research highlights the potential of RAG-powered documentation tools to enhance software engineering workflows and lower the barriers to open-source contribution.

MMCITRE2025/030

Approximate Fixed Point Theory on Neutrosophic Topological Vector Spaces and Applications

Puspendra Kumar*, Tejaswini Pradhan, G. V. V. Jagannadha Rao

Department of Mathematics, Kalinga University, Naya Raipur, Chhattisgarh – 492101, India

Abstract: In this paper, we study the idea of approximate fixed points in neutrosophic topological vector spaces (NTVS), which are spaces that can handle uncertainty and indeterminacy. We introduce a new concept called the approximate fixed point property for certain types of functions in these spaces. Our results extend some well-known theorems from classical and fuzzy fixed point theory into the neutrosophic setting. We also provide examples and applications to show how this theory can be used in real-world problems that involve uncertain or incomplete information. This work helps build a foundation for further research in mathematical analysis under uncertain conditions.

Keywords: Neutrosophic topological vector space, approximate fixed point.

MMCITRE2025/031

SOME NEW FIXED POINT RESULTS FOR MONOTONE PARTIALLY NONEXPANSIVE MAPPING IN G-METRIC SPACE

Prince Kumar Namdev*, G. V. V. Jagannadha Rao, Tejaswini Pradhan

Department of Mathematics, Kalinga University, Naya Raipur, Chhattisgarh – 492101, India

Abstract: In this paper, we study monotone partially nonexpansive mappings within the framework of G-metric spaces, and establish new existence and convergence theorems under condition (E). Our results provide a significant generalization and extension of earlier work developed in the context of ordered Banach spaces. By reformulating these results within the broader and more flexible structure of G-metric spaces, we demonstrate the robustness of this framework in advancing fixed point theory and nonlinear analysis.

Keywords: Nonexpansive mapping; condition (E); uniformly convex space; G-metric space.

MMCITRE2025/032

Wear and Friction Optimization of Quasi-Isotropic Material Using TOPSIS and Fuzzy TOPSIS Frameworks

[1]Dharmik Chauhan, [2]Manoj Sahni

[1,2]Department of Mathematics, School of Technology, Pandit Deendayal Energy University, Raysan, Gandhinagar-382426, Gujarat, India

Abstract: This study investigates the optimization of wear and friction characteristics in quasi-isotropic materials developed through stir casting. To evaluate their tribological performance, a pin-on-disc tribometer was employed under systematically varied conditions of applied load, sliding velocity, and temperature. Since multiple parameters influence the performance simultaneously, a structured decision-making approach was necessary. For this purpose, the technique for order of preference by similarity to ideal solution (TOPSIS) and its fuzzy extension were adopted to rank the experimental outcomes. The classical TOPSIS framework operates by comparing the alternatives against a positive ideal solution (representing the best performance) and a negative ideal solution (representing the worst performance), thus providing a normalized ranking based on their relative closeness. However, in real-world applications, uncertainties and imprecision often arise due to measurement errors or subjective judgments. To address this, fuzzy TOPSIS was applied, which incorporates linguistic assessments and handles ambiguity in decision-making more effectively. A comparative evaluation between the two approaches revealed that both produced consistent ranking patterns across different experimental conditions. The fuzzy framework exhibited higher sensitivity to subtle variations in wear loss and the coefficient of friction, making it more robust for analyzing complex tribological behaviour. These findings underline the importance of mathematical decision-making tools in materials engineering. By integrating TOPSIS and fuzzy TOPSIS, this work

provides a systematic framework for optimizing tribological responses and selecting the most suitable process parameters for hybrid composites, ensuring improved performance in engineering applications.

MMCITRE2025/033

XFIN: Explainable AI for Financial Services and Banking Appliances

Rishabh Bhangale, Dhruv Parmar, Soni Sweta
Department of Computer Engineering, SVKM's NMIMS, Mukesh Patel School of Technology Management and Engineering, Mumbai Campus, India

Abstract: The research presents XFIN (Explainable AI for Financial Services and Banking Appliances), a comprehensive AI tool that combines various financial analytics features like credit risk, portfolio stress testing, and sustainable finance decision support with explainable machine learning and context-aware large language model (LLM) explanations (API-Based). By (1) offering model-agnostic SHAP/LIME explainers and privacy-preserving explanation interfaces for sensitive models, (2) offering a multi-scenario stress-testing engine with climate and ESG scenario integration, and (3) providing an automated context-detection and LLM-driven explanation layer includes these explanations that are dependent on various factors such as RAG (Blaze and Dive) for rules and regulations, user inputs, predictions, and charts that generates human-readable, regulation-aware decision narratives, XFIN tackles the technical, regulatory, and operational challenges associated with implementing transparent AI across financial institutions. The library also integrates production features including regulatory compliance reporting (ECOA / GDPR / SFDR / SEBI), interactive dashboards for stakeholder engagement, and real-time ESG data aggregation from different providers.

Keywords: Explainable AI; Financial Risk; ESG; Stress Testing; SHAP; LLM Explanations; Regulatory Compliance.

MMCITRE2025/034

A Review of Solutions using Generative Adversarial Networks in Medical Imaging for Lumbar Spine

Archit K Xavier, Punit Gupta

School of Technology, Pandit Deendayal Energy University, Gandhinagar, India

Abstract: The lumbar spine is an integral requirement for human mobility, and unfortunately, it is quite commonly prone to degenerative diseases like spinal stenosis and disk herniation. And so, since it has a high amount of soft tissue, the magnetic resonance imaging (MRI) scan would be the required method to diagnose these conditions. However, this manual evaluation by MRI like radiological methods can be subjective, time consuming and can cause a lot of discrepancies across various observers, and this is why automating this process is required, and the deep learning (DL) models offer us with revolutionary solutions that provides us with speeds,

accuracy and most importantly uniformity that was priorly unheard of. And since the MRI scans are medical images, segmentation and analysis for it will be required, and so deep learning models like U-Net, FCN, SegNet, and generative adversarial networks (GANs) can help. In this project we will assess their performances on the selected datasets that are both labelled and non-labelled, and we will also compare how various models will function on various data sets, their strengths, and drawbacks. The segmentation of the images is required in anatomical structures such as (nerves, vertebrae, and intervertebral disks) for recognising their different pathological features, and so we will be using a couple of datasets for a broader spectrum of images across the lumbar spine. And, to overcome the limitations such as the size of the dataset or its uniqueness and variety, we will also implement GANs for data augmentation. Thus, with the motive of developing a competent tool that helps health workers in diagnosis by cutting down on the assessment time and producing a standardized evaluation, our work expands and retraces the path of DeepSPINE and even more latest developments like SymTC. And so, the findings show that our models perform adequately when compared to common evaluation metrics, thus bolstering the potential of implementing DL solutions for enhancing patient's lives and the overall progress of computational radiology.

Keywords: MRI, GAN, SegNEt, U-Net, DeepSPINE.

MMCITRE2025/035

Augmented Reality Rehabilitation System for Enhanced Recovery in Post-Shoulder Surgery Patients

Madhusudhan HS [1], Punit Gupta [2], Pushkar V [3], Saanvi Ravi [4], Suparna DS [5], Ujwal R [6]

[1,3,4,5,6] Department of Computer Science and Engineering, Vidyavardhaka College of Engineering, Mysuru, India
[2] Department of Computer Science and Engineering, Pandit Deendayal Energy University, Gandhinagar, India

Abstract. Augmented Reality (AR) technology is transforming the rehabilitation system by solving the main problems of conventional therapy. Conventional rehabilitation has problems with patient compliance, motivation, and accessibility, especially in rural or underserved communities. AR technology provides new solutions, particularly in shoulder rehabilitation, where accurate movement and forms are essential. AR systems produce interactive, immersive environments that revolutionize the rehabilitation experience. An AR based recovery system is an innovative approach that encompasses augmented reality and artificial intelligence to improve the efficacy of recovery. AR based recovery system is a novel solution to post-operative rehabilitation using combined augmented reality (AR) and artificial intelligence (AI) technology for increasing patient engagement as well as the efficacy of recovery. The system is developed on Unity AR Core and incorporates Mixamo AR models in an intuitive way for interactivity related to exercises, MediaPipe AI mapping for tracking movement in real-time, and Google Maps API for finding local physiotherapists. These integrations enable patients to execute rehabilitative exercises with precise posture detection, feeding

back critical information and lowering reliance on face-to-face sessions. Shoulder recovery is facilitated through real-time feedback regarding the performance of exercises, movement patterns, and joint angles, excluding compensatory movements that can hinder recovery. Patients can track improvement, compare against past performance, and engage in multiplayer sessions with other patients to establish social interaction within the healing process. Home therapy sessions are facilitated by technology, improving accessibility while maintaining the quality of care.

Keywords: Augmented Reality (AR), Rehabilitation, Movement Tracking, Unity AR Core, Machine Learning, Pose Estimation.

MMCITRE2025/036

Identification of Ragas and Their Analysis Using Deep Learning Techniques

Madhusudhan HS [1] , Punit Gupta [2] , Anish S R [3] , Pramukh B V [4] , Shreyas V E [5] , Yashas M [6]

[1,3,4,5,6] Department of Computer Science and Engineering, Vidyavardhaka College of Engineering, Mysuru, India
[2] Department of Computer Science and Engineering, Pandit Deendayal Energy University, Gandhinagar, India.

Abstract: Raga identification plays a crucial role in Indian Classical music by supporting musicians, educators and researchers in the analysis and understanding of the raga composition. The task of identifying the raga is challenging due to the complex structure of ragas which include microtonal variations, pitch modifications and melody shifts. Traditional methods of raga identification which are based on rule-based systems often fail due to a wide
range of different songs and styles of performance. In this paper a comparison of two hybrid models CNN-LSTM and TDNN-LSTM is proposed for automated raga identification using an end-to-end pipeline of pre-processing, feature extraction and training the model for classification. The TDNN-LSTM model outperforms conventional methods by achieving an accuracy of 95.7%.

Keywords: Raga Recognition, Deep Learning, Indian Classical Music, Time-Delay Neural Networks, Long Short-Term Memory Networks

---

MMCITRE2025/038

Ensemble-Based Zero Day Detection using Host Memory Analysis

Manoj Kumar Singh [1], Jyotiprakash Patra [2], Siddharth Choubey [3]

[1] Shri Shankaracharya Technical Campus, Bhilai, India
[2] Chhattisgarh Swami Vivekanand Technical University (CSVTU), Bhilai, India.
[3] Shri Shankaracharya Technical Campus, Bhilai, India

Abstract. The development of security tools is still hampered by hidden or zero-day attacks. When cyberattacks of the zero-day nature go unnoticed, protecting digital assets becomes very difficult. Because security systems cannot identify the patterns of zero-day attacks, a more effective strategy is therefore needed to stop them. An attacker can initiate attacks that have the potential to harm the entire system once they get access to the host computer. This study uses the operating system#39;s memory activity to detect various forms of malicious intrusion attempts. In the proposed stacking ensemble model, logistic regression (LR) has been used as the base classifier and LightGBM as the meta classifier. Multi-level feature reduction techniques have been used to increase the model#39;s effectiveness. With an overall detection accuracy score of 99.58%, the proposed ensemble-based zero-day anomaly intrusion detection model has shown the best results when compared to other research in this area, detecting zero-day intrusions with a 98.35% detection rate.

Keywords: Anomaly Detection, Host-level security, Intrusion detection, Machine learning, Zero-day malware detection.

MMCITRE2025/039

Population model subject to geometric catastrophe with bulk killing

Shalini[1], Nitin Kumar[1*], Punit Jain[2]

[1]Department of Mathematics, Indian Institute of Technology Jammu, Jammu & Kashmir 181221, India.

[2]Department of Mathematics, School of Technology, Pandit Deendayal Energy University, Gandhinagar, Gujarat, 382426, India.

Abstract: This paper considers a population model where sudden disasters (called catastrophes) can kill groups of individuals. New individuals join the population following a renewal process, and catastrophe occurs as per the Poisson process. When a catastrophe occurs, it attacks the population in groups (or batches). Each batch has a probability ξ of being completely wiped out. This continues one batch at a time until either the whole population is extinct or a batch survives (which happens with probability $1-\xi$). This type of disaster process is called a geometric catastrophe with batch killing. We use the supplementary variable technique to set up the main equations that describe the system when it reaches a steady state. Then, using difference equations, we find the probability distribution of the population size at different points in time—random moments, just before a new individual arrives, and just after a

catastrophe. We also calculate some key performance measures for the system and show some numerical examples to demonstrate how the model works.

MMCITRE2025/040

A Mean-Variance Optimization Framework forPost-Disaster Non-Performing Asset Managementin the Indian Banking Sector

Prince Solanki[1], Sumit Malik[2], Sanjay Kumar[3,□] and Suyash Shukla[4]

[1] Department of Mathematics, School of Basic & Applied Sciences, IILM University, Greater Noida, 201310, Uttar Pradesh, India
[2] Department of Mathematics, School of Computer Science Engineering and Technology, Bennett University, Greater Noida, 201310, Uttar Pradesh, India
[3 □] Department of Mathematics, School of Computer Science Engineering and Technology, Bennett University, Greater Noida, 201310, Uttar Pradesh, India
[4] Department of Economics, Tata Institute of Social Sciences, Tuljapur, Maharashtra, India

Abstract. Natural disasters cause systematic surges in Non-Performing Assets (NPAs) that threaten regional financial stability. Indian banks lack quantitative frameworks to recalibrate lending strategies post-disaster despite strict regulatory NPA thresholds. We propose a Modern Portfolio Theory (MPT)-based optimization model treating expected interest income as 'return' and projected NPA rate as 'risk'. The multi-objective, non-linear constrained optimization maximizes portfolio return subject to regulatory NPA targets. Applied to a synthetic post-disaster portfolio with 36.81% initial NPA rate, our model reduces this to 3.09% (within 4.5% target) while achieving 10.95% portfolio return through strategic reallocation toward secured assets and risk-based pricing. Scenario analysis validates robustness under varying recovery speeds. This framework provides banks and regulators with a proactive, quantitative tool for strategic portfolio design, moving beyond reactive loss mitigation to ensure financial resilience during critical recovery phases.

Keywords: Non-Performing Assets (NPAs), Portfolio Optimization, Mean-Variance Analysis, Natural Disasters, Credit Risk Management, Indian Banking Sector, Regulatory Compliance.

MMCITRE2025/041

Verifiable ((k, n)) QSS with Polynomial Shares and Dense Coding

Vijay Kumar, Ramakrishna Bandi
Department of Science and Mathematics,
International Institute of Information Technology Naya Raipur, India

Abstract: Quantum Secret Sharing (QSS) is a cornerstone of secure multi-party quantum communication. Many early protocols, such as the 2009 scheme by Liu and Yanyan, were limited to fixed ((n, n)) threshold structures, requiring the cooperation of all participants to reconstruct a secret. This structural rigidity presents a significant practical limitation. This paper identifies this research gap and proposes a novel, flexible ((k, n)) threshold QSS protocol. Our construction hybridizes the classical robustness of Shamir's polynomial-based secret sharing with the quantum secure direct communication (QSDC) architecture of the Liu-Yanyan protocol, which utilizes GHZ states for channel security and dense-coded teleportation for information transfer. We provide a formal mathematical construction, against both external eavesdroppers and dishonest participant coalitions, and an illustrative example. The proposed protocol accomplishes a flexible ((k, n)) access structure while retaining the high channel capacity of the original scheme, thereby representing a substantial improvement in the practicality and versatility of QSDC-based secret sharing.

Keywords: quantum cryptography; quantum secret sharing; quantum secure direct communication; quantum teleportation; quantum dense coding.

MMCITRE2025/042

Common Fixed Point Theorems for Hybrid and Multivalued Mappings in Neutrosophic Fuzzy b-Metric Spaces with Applications

Sandhya Sahu[1*], Pushpendra Kumar[2], Tejaswini Pradhan[3]
[1,2,3] Department of Mathematics, Kalinga University, Raipur, Chhattisgarh 492101, India

Abstract: This paper establishes new common fixed point theorems for hybrid pairs consisting of single-valued and multivalued mappings in complete neutrosophic fuzzy b-metric spaces. By introducing an appropriate contractive-type condition, we provide sufficient criteria for the existence and uniqueness of common fixed points, thereby generalizing several classical results in fuzzy and neutrosophic metric spaces. The theoretical findings are illustrated through applications in nonlinear integral equations, equilibrium problems in game theory, multi-criteria decision-making under uncertainty, and control theory and signal processing. These applications demonstrate the utility of the proposed approach in modeling and solving problems involving indeterminacy, fuzziness, and multivalued mappings, providing a unified and robust framework for analyzing complex systems in mathematics, engineering, and applied sciences.

Keywords: Common fixed point, Hybrid mappings, Multivalued mappings, Neutrosophic fuzzy b-metric space, Fixed point theory, Applications.

MMCITRE2025/044

Dynamics of SH wave Propagation in fiber-reinforced Medium with power law model

Debashree Sahu, Tapas Ranjan Panigrahi

Department of Mathematics, GIET University, Odisha, Gunupur, 765022

Abstract: This study helps us to find the propagation characteristics of horizontally polarized shear waves (SH) within a fiber-reinforced viscoelastic composite medium subjected to initial stress. A comprehensive analytical framework is developed by emphasising a structural configuration in which the elastic moduli exhibit as a power law model with the depth parameter $\square_2$. A closed-form dispersion relation is rigorously derived, capturing the combined effects of viscoelasticity, fiber-reinforcement, and pre-stress. A rigorous numerical investigation has been made to survey the behavior of phase velocity (SH wave propagation). A numerical investigation is conducted to examine the behaviours of phase wave velocities, which are subsequently anticipated through graphical representations. The results not only show the significance of inhomogeneity parameters but also clarify the deviation from classical wave behaviour. The study may be helpful for the design and analysis of advanced engineering structures, seismic wave interpretation, and materials used in aerospace and geotechnical applications.

Keywords: SH-waves, Fiber-reinforcement, Initial stress, Half-space, Phase velocity, Dispersion equation, Viscoelastic medium.

MMCITRE2025/045

A Study of Different Deep Learning Techniques for Stroke Diagnosis and Rehabilitation

Himadri Sarma[1], Dibya Jyoti Bora[2]

[1.] Department of Computer Science, Darrang College Autonomous, Tezpur
[2] Department of Information Technology, School of Computing Sciences,
The Assam Kaziranga University, Jorhat

Abstract: Stroke is a leading cause of disability and mortality worldwide, necessitating rapid and accurate diagnosis and rehabilitation strategies. Deep learning (DL) has emerged as a transformative tool in stroke research, offering advancements in neuroimaging analysis, predictive modeling, and personalized rehabilitation. Convolutional Neural Networks (CNNs) and Transformer-based models have significantly improved stroke detection and classification using Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) scans. Many types of research are going on by predicting healthcare analysis or developing tests combining blood-based biomarkers with clinical scores. This review explores recent developments in deep learning applications for stroke diagnosis and rehabilitation, highlighting key techniques, challenges, and future research directions to enhance AI-driven stroke management.

Keywords: Stroke detection, Deep learning, AI in healthcare, CT, MRI.

MMCITRE2025/046

Enhanced U-Net Architecture with Dual-Pathway Processing for Robust Cloud Segmentation in Multispectral Satellite Imagery: A Majuli Island Case Study

Nawab Wasim Rahman, Dibya Jyoti Borah
School of Computing Sciences, The Assam Kaziranga University, Jorhat, Assam

Abstract. This study presents a refined U-Net architecture for accurate cloud segmentation in multispectral satellite imagery, addressing challenges in cloud-prevalent regions like Majuli Island, Assam. The enhanced model incorporates dual-pathway processing, guided-filter layers, and improved skip connections. Training utilized the 38-Cloud dataset, with validation on Landsat 8-9 imagery covering Majuli (94.1°E-94.3°E, 26.9°N-27.1°N). The proposed architecture achieved 95.36% accuracy, IoU of 0.85, and F1-score of 0.86, representing 5.36% improvement over existing F-mask methods. Results demonstrate significant enhancement in cloud detection for environmental monitoring applications in challenging atmospheric conditions

Keywords: Cloud Detection, Remote Sensing, U-Net Architecture, Multispectral Imagery, Landsat 8 And 9.

MMCITRE2025/047

Adoption and Impact of AI & Data-Driven Tools on Training and Performance among College Sports Students

Milankumar Bhatt, Sandip Pathak
School of Liberal Studies, Pandit Deendayal Energy University

Abstract: The seamless integration of Artificial Intelligence (AI) and data-driven technologies is rapidly transforming key sectors, including academic College sports and education. This paper investigates the adoption and impact of AI-driven tools—such as wearable hardware, performance analytics, and adaptive training software—on the training efficacy and athletic performance of college student-athletes. Through a primary survey of 135 College students who are athletes, this study assesses their awareness, acceptance, and utilization of AI-enabled training systems. A structured questionnaire was administered to gather data on perceived usefulness, ease of use, and performance improvements. The data were analysed using descriptive statistics, correlation analysis, and inferential tests, including the Chi-square ($\chi 2$) and t-test, to evaluate relationships and significant differences. The findings indicate varied adoption rates across different sports disciplines, with students utilizing AI-based training reporting significantly higher levels of efficiency, focus, and motivation compared to those using traditional methods. However, widespread adoption is hindered by challenges such as

high costs, inaccessibility, and a lack of technical proficiency. This research provides valuable insights into how data-driven interventions can support evidence-based training approaches, thereby contributing to the holistic development of student-athletes in higher education institutions.

Keywords: Artificial Intelligence (AI), Data-Driven Tools, Sports Training, Athletic Performance, College Students, Wearable Devices, Adaptive Learning Systems, Performance Analytics.

MMCITRE2025/049

Suspended Sediment Modelling with Exponential Mixing Length and Hindered Settling

Punit Jain
Department of Mathematics, School of Technology, Pandit Deendayal Energy University

Abstract: This work presents a modified version of Hunt's suspended sediment concentration model for turbulent open-channel flows. The classical Hunt model is enhanced by replacing its original sediment diffusivity with a modified mixing length expression that incorporates exponential turbulence decay with height. In addition, the hindered settling effect is introduced using the Richardson–Zaki formulation, allowing the model to better represent high-concentration sediment-laden flows. The resulting governing equation is solved numerically using a shooting method combined with the classical fourth-order Runge–Kutta scheme in Mathematica 12. Model predictions are compared with experimental datasets from both dilute and concentrated regimes, demonstrating improved agreement over the original Hunt model, particularly in the upper flow region where traditional formulations often deviate.

Keywords: Suspended Sediment Concentration, Open-Channel flow, Sediment diffusivity, Hinder settling velocity, Mixing Length.

MMCITRE2025/050

Neutrosophic Modeling and Solution of Elliptic PDEs under Uncertainty: A Gauss-Seidel Approach

Meghna Parikh [1], Manoj Sahni [2]

[1]Department of Mathematics, L J University, Ahmedabad-382210, Gujarat, India;
[2]Department of Mathematics, Pandit Deendayal Energy University, Gandhinagar-382426, Gujarat, India

Abstract. It is widely recognized that when formulating problems involving two or more independent variables, partial differential equations (PDEs) are employed. These equations are prevalent across various engineering and scientific disciplines, serving as fundamental tools for

simulating real-world physics-based phenomena. Information is gathered from diverse sources through experiments, measurements, and reconciling conflicting perspectives, which is then incorporated as inputs into our models based on differential equations. Due to the inherent imprecision, indeterminacy, and inconsistency in the collected data, the utilization of neutrosophic sets and neutrosophic triangular numbers becomes necessary. In neutrosophic modelling, each piece of information is characterized by three independent components: truth-membership, indeterminacy-membership, and falsity-membership functions, allowing for a richer and more nuanced representation of uncertainty compared to traditional fuzzy models.
This paper presents advancements in methods for solving sets of partial differential equations within a neutrosophic environment, accounting for different forms of uncertainty. Distinct types of partial differential equations parabolic, elliptic, and hyperbolic are considered, with a particular focus in this chapter on the elliptic form. The Gauss-Seidel iterative method is examined and adapted to solve elliptic differential equations under neutrosophic uncertain conditions. Our approach captures the degrees of truth, indeterminacy, and falsity in the solutions. Validation is provided through an illustrative example involving a temperature grid problem, where neutrosophic solutions across different time periods are computed and analysed. Discrepancies between the neutrosophic numerical solutions and classical crisp solutions are visually depicted in a table to highlight the effects of indeterminacy in the system.

Keywords: Neutrosophic triangular numbers, Gauss seidel method, Partial differential equation, Elliptical equation.

MMCITRE2025/051

An Approach to Estimate the Parameters of Nonlinear Growth Models and Their Role in Bamboo Growth Dynamics

[1]Dimpal Jyoti Mahanta, [1]Dipu Bora, [2*]Pallabi Saikia

[1]Department of Mathematics, Assam Kaziranga University, Jorhat, Assam, India, PIN 785006
[2]Department of Mathematics, Nanda Nath Saikia College, Titabar, Assam, India, PIN 785630

Abstract. Modeling growth is essential for capturing nonlinear biological and ecological dynamics, as the accuracy of parameter estimation greatly determines the reliability of predictions. In recent years, the relationship between Mathematical and forest has developed rapidly. In this work, we examine bamboo, a rapidly growing plant with significant ecological and financial worth. In this regard, we examine six nonlinear growth models namely Schumacher, Weibull, Gompertz, Logistic, Korf and Jhonson-Schumacher model and a few methods of estimation are introduced to estimate the parameters of different forms of these models. These models are typically fitted using certain conventional nonlinear optimization techniques, which necessitate a lot of calculations.

Key words: Growth model; Parameter estimation; Nonlinear model, Bamboo growth.

MMCITRE2025/052

A Comprehensive Review of Pregnancy-Related Domestic Violence against Women: The Silent Battle

Leena Saikia[1] , Pranab Barua[2] , Dimpal Jyoti Mahanta[1]

[1]Department of Mathematics, The Assam Kaziranga University, Jorhat, Assam, India
[2]Department of Statistics, Jagannath Barooah University, Jorhat, Assam, India

Abstract. Pregnancy-related domestic abuse is a prevalent maternal health concern with serious physical, psychological and financial repercussions. Despite international attempts to eradicate gender-based violence, pregnant women continue to be particularly vulnerable to domestic abuse because of physiological changes, their reliance on partners, and societal shame. The prevalence, risk factors, effects and treatments of domestic violence during pregnancy are the main topics of this review of the literature. It draws kindness to negative effects on the mother and fetus, such as low birth weight, premature birth and raised maternal morbidity. The study also looks at the psychological anguish that the impacted ladies went through, which resulted in anxiety, sadness and Post-traumatic stress disorder (PTSD). This analysis underscores the need for enhanced screening procedures, interdisciplinary treatments and supporting legislative frameworks to protect maternal health by pointing out gaps in policy and healthcare responses. Supporting awareness, education and integrated healthcare interventions are necessary to decline the impacts of domestic violence during pregnancy and to provide a safer environment for expectant mothers. Several internet databases were searched for these studies, which were conducted in various nations and published between 2001 and 2025. Relevant keywords were used to locate English-language articles and reference lists were manually reviewed. Both quantitative and qualitative studies were thoroughly and methodically examined.

Keywords: Domestic Violence, Pregnant women.

MMCITRE2025/053

Predictive Machine Learning Framework for Optimizing Hydrogen Storage in La–Ni–Al Hydrides

Kishor Kumar Sharma[1], Asif Nizam[1], Prem Kumar Chaurasiya[1],
Vinod Kumar Sharma[2], Vikas Pandey[3]
[1]Hydrogen Energy Research Lab, Mechanical Engineering Department,
National Institute of Technology Raipur, 492010, India
[2]Mechanical Engineering Department, National Institute of Technology Calicut, Kozhikode,
Kerala 673601, India
[3]School of Engineering, Babu Banarasi Das University, Lucknow, India

Abstract. Using an advanced predictive model to predict and optimize the H_2 concentration, this study examines the effect of thermal parameters on hydrogen storage capacity of $La_{0.9}Ce_{0.1}Ni_5$ and $LaNi_{4.6}Al_{0.4}$-based metal hydride. The study presents innovative scientific

advancements through the integration of machine learning approaches, including AdaBoost and Random Forest, to forecast the storage results for hydrogen and minimize reliance on experimental methods. The Random Forest model exhibits the lowest measurement error (MSE is zero, MAE = 0.0014, RMSE = 0.0031) and the greatest score of R^2 (0.9998), signifying exceptional predictive accuracy and highlighting the potential of machine learning to diminish dependence on testing. The aluminium-altered $LaNi_5$ alloy significantly improved thermal management, facilitating justifiable hydrogen storage possibilities. Optimisation of thermodynamic parameters such as hydrogen concentration, pressure and temperature are carried out after training of machine learning algorithms and error analysis. Bayesian optimization technique is used to carry out the optimization of above-mentioned parameters. The graphs obtained between experimental and machine learning algorithms-based parameters showed convergence and thereby validated. By fusing academic progress, practical applications, and machine learning-driven predictive analytics, this study fills the gaps. In order to create sustainable hydrogen storage systems, future research should concentrate on real-time data analysis, machine learning, and industrial applicability.

MMCITRE2025/055

Frugal Innovation at Scale: The Role of Low-Cost Tech in Public Health and Safety at the Maha Kumbh Mela

Aman Jolly[1], Vikas Pandey[2], Akhilesh Sharma[3], Shashikant[4], Manoj Sahni[5]

[1]Department of Computer Science and Engineering, Delhi Technological University, Bawana Road, New Delhi 110042, India
[2,4]Electrical Engineering Department, Babu Banarasi Das University, Lucknow, India
[3]SMIEEE; Electrical Engineering Department, NERIST Nirjuli, Arunachal Pradesh, India
[5]Department of Mathematics, School of Technology, Pandit Deendayal Energy University, Gandhinagar, Gujarat– 382426, India

Abstract. The Maha Kumbh Mela, one of the largest peaceful human gatherings on the Earth, presents unprecedented logistical, public health, and safety challenges. While often viewed through a socio-religious lens, this paper frames the event as a 'living laboratory' for frugal innovation, investigating the strategic deployment of low-cost, scalable technologies to manage this temporary megacity. Adopting a qualitative case study methodology based on secondary data from government reports, media archives, and academic literature, we analyze key technological interventions from the Prayagraj, Maha Kumbh 2025. The findings reveal a pattern of frugal innovation in practice, including the use of AI-powered analytics on existing CCTV networks for real-time crowd control, GIS-based tracking for optimizing sanitation logistics, and the development of an Integrated Command and Control Centre (ICCC) to unify disparate data streams for agile decision-making. This paper concludes that the Kumbh Mela offers a powerful counter-narrative to capital-intensive 'smart city' models. It provides a proven, replicable framework for public administration and disaster management in resource-constrained environments, demonstrating how to achieve safety and efficiency at a massive scale through accessible and adaptable technologies.

Keywords: Frugal Innovation, Mass Gathering Management, Public Health Technology, Case Study, Smart Cities, Crowd Control, India.

MMCITRE2025/057

AI-Enhanced Service Quality and Student Engagement in Higher Education: A Systematic Bibliometric Review of Recent Literature

Tishya Tripathi Shukla[1], Anchal Rastogi[2], Vikas Pandey[3], Aman Jolly[4], Manoj Sahni[5]

[1, 2] School of Management, Babu Banarasi Das University, Lucknow, U.P.

[3]Electrical Engineering Department, Babu Banarasi Das University, Lucknow, U.P

[4]Department of Computer Science and Engineering, Delhi Technological University

[5] Department of Mathematics, School of Technology, Pandit Deendayal Energy University, Gandhinagar, Gujarat

Abstract. The swift and increasing acceptance of artificial intelligence (AI) is remodelling entire higher educational services and its delivery, with consequential implications for student engagement. This study presents a systematic bibliometric review of 78 papers published in 2024–2025, mapping of AI, service quality, and student engagement. VOSviewer was used to carry out both author-based and text-based analysis, to generate co-authorship, co-occurrence, density, and overlay visualizations. The results show four prominent clusters: (1) AI in pedagogy and adaptive learning, (2) student engagement and experience, (3) frameworks and digital transformation, and (4) administrative services. Text-based maps further presented theoretical linkages around *teaching quality, engagement, virtual assistants,* and *cultural factors*. Overlay visualizations suggested a shift from institution-driven digital transformation in 2024 to student-oriented personalization and engagement in 2025. Research highlights personalized learning and engagement, while additional and supplementary peripheral areas such as administrative services and institutional culture are yet to be fully explored. This review offers theoretical alignment between bibliometric maps and higher education service quality dimensions and practically by guiding HEIs to adopt AI tools that increase responsiveness, personalization, and engagement. Future research should address factual validation, cross-cultural point of view, and the moderating role of institutional culture. The study also tries to align the results with HESQUAL quality dimensions by using NetworkX + Python to further confirm the objectives of the study

Keywords: Artificial Intelligence, Service Quality, Student Engagement, Higher Education, Bibliometric Review, VOSviewer, HESQUAL.

MMCITRE2025/059

Dynamics of a Monkeypox Epidemic Model Involving Human-Animal Transmission

Mehmet Gümüş[1], Kemal Türk[2]

[1,2]Zonguldak Bulent Ecevit University, Faculty of Science, Department of Mathematics, 67100, Zonguldak, Turkey

Abstract. Monkeypox is a viral infection with zoonotic characteristics. This virus was first detected in monkeys used for research purposes in Denmark in 1958. Initially, monkeypox was often mistaken for smallpox; however, following the first recorded human case in 1970, the two diseases were clearly distinguished, and the virus was named "monkeypox". Monkeypox (Mpox) is a zoonotic disease that has raised significant global public health concerns due to its recent outbreaks. This study proposes a deterministic model to investigate the transmission dynamics of the monkeypox virus in human and animal populations, incorporating reverse zoonotic transmission from humans to animals. A thorough mathematical analysis of the model is carried out, including the derivation of the basic reproduction number and the stability analysis of both the disease-free and endemic equilibria. Sensitivity analysis is performed to identify the most influential parameters affecting disease transmission. To assess intervention strategies, an optimal control problem is formulated, considering time-dependent efforts on public awareness and treatment of infected and hospitalized individuals. Numerical simulations support the theoretical results and demonstrate the potential impact of control measures in reducing disease burden. The proposed model offers valuable insights into the complex dynamics of Mpox transmission and supports the development of public health policies.

Keywords: Monkeypox virus, Epidemiology, Global asymptotic stability, Sensitivity, Optimal control.

MMCITRE2025/060

Dispersion of Love waves in a homogeneous fiber-reinforced layer lying over an initially stressed half-space with imperfect interface

Shikha Deep[a], Parth M. Pandya[b], Manoj Sahni[c]

[a] Unitedworld Institute of Technology, Karnavati University, Gandhinagar, Gujarat, 382422, India

[b]Department of Mathematics, ISHLS, Indus University, Ahmedabad, India
[c]Department of Mathematics, School of Technology, Pandit Deendayal Energy University, Gandhinagar, Gujarat 382426, India

Abstract: The problem investigates the dispersion of Love waves in a homogeneous fiber reinforced layer lying on an initially stressed half-space which are imperfectly attached to each other. An analysis has been done in two cases, first, when the layer and half-space both are imperfectly attached to each other, and, second, when they are perfectly attached to each other. Dispersion relations are derived for the cases separately, using effective boundary conditions. A detailed analysis has been done in both cases by studying the impacts of various parameters such as fiber reinforcement parameters, thickness of the layer, initial stresses in the half-space, imperfectness, initial stress on the phase velocity of Love waves.

MMCITRE2025/061

Shear vs. Pressure: Which Governs Thermocapillary Droplet Steering?

Arindam Basak[1*], Rajaram Lakkaraju[2], G P Raja Sekhar[1]

[1]Department of Mathematics, IIT Kharagpur, West Bengal – 721302
[2]Department of Mechanical Engineering, IIT Kharagpur, West Bengal – 721302

Abstract. Classical studies on surfactant-laden droplets in tubular Poiseuille flow established that cross-stream migration appears only as a second-order effect in the low surface Péclet number limit (Pe_s). In contrast, many biomedical lab-on-a-chip settings involve motion between parallel plates, where pressure-driven and shear-driven components coexist. Here we show that this combined Couette–Poiseuille profile enables stronger and more controllable lateral steering of droplets, with enhanced migration velocity relative to the purely Poiseuille case. Our model includes heat generation by living cells inside the droplet, represented as a thermal dipole embedded in a mildly non-isothermal environment. We find that, when thermocapillary (Marangoni) effects act together with a sufficiently strong internal thermal dipole, the cross-stream migration velocity can arise at leading order in Pe_s. A further contribution is a flow-control framework defined under constant volumetric flow rate, which directly governs the migration response and flow patterns. Within this framework, a continuous transition from Poiseuille toward Couette profiles provides optimal control of droplet steering, and rectangular (plate) geometries outperform tubular channels for precise trajectory regulation. These results

identify a practical route to accurate droplet manipulation in microfluidic platforms, especially those involving viable cell cargos.

Keywords: Marangoni effect, Stokes flow, Droplets

MMCITRE2025/062

Oxygenated Nanoparticles Influence on Performance, Combustion, and Emissions of Internal Combustion (IC) Engines

Bhojraj N Kale[1]*, Saroj V Borkar[2], Prakash V Dhopte[3], Vikas Pandey[4], Manoj Sahni[5], Jitesh Shinde[6], Paravin T Petkar[7]

[1]*Department of Mechanical Engineering, Jhulelal Institute of Technology, Nagpur (MH), India
[2]Department of Mechanical Engineering, Priyadarshini Bhagwati College of Engineering, Nagpur (MH), India
[3] Department of Mechanical Engineering, GH Raisoni College of Engineering, Nagpur, India
[4] Electrical Engineering Department, Babu Banarasi Das University, Lucknow-226028, India
[5] Department of Mathematics, School of Technology, Pandit Deendayal Energy University, Gandhinagar, Gujarat, India
[6] Electronics Engineering (VLSI Design and Technology), CSMSS Chh. Shahu College of Engineering, Chh. Sambhajinagar, Maharashtra, India
[7] Department of Mechanical Engineering, Jhulelal Institute of Technology, Nagpur (MH), India

Abstract. The integration of oxygenated nanoparticles as fuel additives in internal combustion (IC) engines has emerged as a promising strategy to enhance engine performance, optimize combustion characteristics, and reduce harmful emissions. These nanoparticles commonly are metal oxides such as Al_2O_3, CeO_2, TiO_2, and ZnO improves combustion through catalytic activity and act as localized oxygen donors during fuel oxidation. Their high surface area and thermal conductivity contribute to improved atomization, faster ignition, and enhanced heat release rates.

Experimental studies indicate that low-concentration additions (typically 30-150 ppm) of such nanoparticles to diesel, biodiesel, or blended fuels result in notable gains in brake thermal efficiency (BTE) and reductions in brake specific fuel consumption (BSFC). Emission analyses consistently show significant reductions in carbon monoxide (CO), unburned hydrocarbons (HC), and particulate matter (smoke), due to more complete combustion. However, a little bit increase in nitrogen oxides (NO_x) emissions is commonly observed, attributed to elevated in-cylinder temperatures and faster flame propagation.

Overall, the use of oxygenated nanoparticles offers a viable pathway for improving fuel economy and environmental sustainability in IC engines, particularly when used in synergy with biodiesel and exhaust gas recirculation (EGR) technologies.

Keywords: Nanoparticles Metal Oxide, IC Engine, Performance, Emissions.

MMCITRE2025 /063

Case-Wise Study of Torsional Wave Propagation in a Two-Layered Heterogeneous Media

Prafulla Kumari Panda[1], Tapas Ranjan Panigrahi[2]

Department of Mathematics, GIET University, Odisha, Gunupur, 765022

Abstract. The present article investigates the propagation of torsional waves through a two-layer structure in-homogeneous elastic medium, where the material parameters rigidity and as the depth parameter z changes, so does density. A case-wise study has been conducted for the upper inhomogeneous layer. In the first case, the variation of parameters is governed by a power-law model, while in the second case, it follows the outcome of a polynomial power and an exponential term. For the space in the lower half, the variation is modelled using the result of multiplying an exponential function by a linear one. A mathematical model is formulated based on the elastic theory of wave propagation. The technique for separating variables is employed in both layers to obtain the displacement fields. Applying intrinsic boundary conditions yields a closed-form expression regarding the frequency equation. The study reveals a significant influence of density and stiffness profiles on the torque-related phase velocity of torsional waves. Visual illustrations are provided to validate and support the observations obtained from the relationship of dispersion.

Key words: Inhomogeneous, half-space, torsional wave, phase velocity and dispersion equation.

MMCITRE2025/064

ScrumBench and Jason Mack: Scaling Agentic AI for Automation in Agile Software Teams

Walayat Hussain
Australian Catholic University, North Sydney NSW 2060, Australia

Ashvin Parameswaran
Emerging Technology, ReadyTech, Sydney NSW 2000, Australia, Jo Ingold
Peter Faber Business School, Australian Catholic University, North Sydney NSW 2060, Australia

Abstract. This paper presents the design, deployment, and evaluation of Jason Mack, an Agentic AI system developed at ReadyTech, a leading B2B SaaS provider, to augment Scrum Master Functions in agile software teams. Piloted across six production squads, Jason Mack combines multi-agent architectures and LLM-powered components to automate critical Scrum workflows, including backlog refinement, sprint planning, and retrospectives. Its performance was evaluated using ScrumBench, a custom benchmark assessing foundational automation, scenario-based reasoning, and long-term impact. At Level 1, Jason Mack autonomously executed 5 of 7 core responsibilities (71.4%), excelling in ticket quality, sprint goal setting, and

reporting. At Level 2, it achieved 62.9% success across complex scenarios like sprint failure and stakeholder pressure, with strong results in retrospectives and sprint closure. Gaps in backlog grooming and conflict resolution reveal current LLM limitations in socially nuanced tasks. Beyond automation, the agent's nudges influenced team behaviour, improving goal alignment and blocker resolution. Level 3 evaluations are underway to measure impact on velocity, defect rates, and team satisfaction. This work shows how Agentic AI can move beyond task automation to become a collaborative, decision-augmenting layer in agile delivery, offering a practical path toward scalable, human-aligned AI integration.

Keywords: Agentic AI; Scrum Automation; LLM-based Multi-Agent System; Agile Software Engineering; Workflow automation.

MMCITRE2025/065

Autonomous Learning Coach: A Text-Centered Agentic AI Approach to Effective Learning

[1]Md Nazmul Hossain AI in Decision Making Cluster, Peter Faber Business School, Australian Catholic University, Sydney, Australia
[2]Walayat Hussain
AI in Decision Making Cluster, Peter Faber Business School, Australian Catholic University, Sydney, Australia
[3]Mahmoud Bekhit AI in Decision Making Cluster, Peter Faber Business School, Australian Catholic University, Sydney, Australia
[4]Ashvin Parameswaran Emerging Technology, ReadyTech, Sydney, Australia

Abstract. This study presents the Autonomous Learning Coach (ALC), a lightweight, text based agentic AI tutor designed to help students not just get the right answers but think more deeply about how they learn. Unlike traditional systems that mainly give correctness feedback, the ALC detects cues in student text and adapts tactics such as reflective prompts, scaffolded hints, optional micro-steps, and a structured second attempt within a governed loop. In a within subject, randomized, interleaved evaluation on math word problems, first-try accuracy was matched across conditions (Agentic = 0.80; Baseline = 0.80), indicating no item-difficulty advantage. After agentic support, final accuracy increased to 0.93 compared to 0.80. The agentic pathway achieved universal reflection (1.00) and a wrong-to-right conversion of 0.20 among initially incorrect trials, with a modest time trade-off (mean first-response about 39.2 seconds vs. 26.5 seconds). Cue evaluation against human labels showed GPT closely tracks has explanation (F1 $\approx$ 0.92, $\kappa \approx 0.86$) and performs solidly on frustration (F1 $\approx$ 0.67), while a lightweight rules-based detector is adequate for minimal explanation checks but weak on affect. These results indicate that brief, structured metacognition can yield meaningful in-trial gains within a privacy-preserving, text- only workflow suitable for low-resource settings, motivating scaled studies on retention, transfer, and hybrid cue models.

Keywords: Agentic AI, Cue Detection, LLM, RAG

MMCITRE2025/066

Free Vibration Analysis of Porous Functionally Graded Plates using Carrera Unified Formulation

Satish Sahu[1], Rajana Suresh Kumar[1*], Vikas Pandey[2], Akhilesh Sharma[3]

[1]Department of Mechanical Engineering, National Institute of Technology Raipur, India.
[2]Electrical Engineering Department, School of Engineering, Babu Banarasi Das University, Lucknow, India.
[3]Electrical Engineering Department, NERIST, Nirjuli, Arunachal Pradesh, India.

Abstract. This study investigates the free vibration behavior of porous Functionally Graded Material (FGM) plates composed of metal (aluminum) and ceramic (alumina) phases using the Carrera Unified Formulation (CUF). The effective material properties are modeled through a power-law distribution along the thickness, with porosity effects incorporated via even and uneven porosity indices. A single-layer finite element model is formulated using the CUF, employing higher-order expansion functions to represent the displacement field throughout the structure. Mesh convergence analysis confirms that the proposed finite element model produces stable and accurate results with a user-defined number of expansion terms. Validation against benchmark solutions further demonstrates its reliability in predicting Non-Dimensional Natural Frequencies under clamped boundary conditions. The effects of aspect ratio, boundary conditions, and porosity on vibrational response are evaluated through parametric analysis. FGM Plates with all sides fixed (CCCC) achieve the highest Non-Dimensional Natural Frequencies due to increased stiffness, while free-edge configurations (CFCF) yield the lowest frequencies owing to reduced constraint. Increasing the power-law index (metal-rich content) and porosity both reduce stiffness and natural frequencies, whereas ceramic-rich distributions enhance them. Aspect ratio further impacts frequencies, with thinner plates yielding higher values. The findings demonstrate the effectiveness of CUF for accurate vibration analysis of porous FGMs and provide useful insights for designing advanced lightweight structural components.

Keywords: Functionally Graded Materials (FGMs), Porosity, Free Vibration Analysis, Finite Element Method (FEM), Carrera Unified Formulation (CUF), Power-law Distribution.

MMCITRE2025/067

The Application of the Matrix Method to Investigate Covid-19 Variants

Man Mohan Singh, Garima Agarwal
Department of Mathematics and Statistics, Manipal University Jaipur, India

Abstract. The matrix solution for a set of linear differential equations is the simplest basic method in linear algebra. In this study, the EICHD model for the solution with the ODE system and a generalized SEIR model are used to represent the virus propagation under different control strategies. The fundamental reproduction number R0 of this model, which comprises a five-dimensional nonlinear dynamical system, may be obtained using the next generation matrix technique. In this study, it is shown that the disease-free equilibrium point is asymptotically stable when $R0 < 1$, both locally and globally. The equilibrium's local and global asymptotic stability when $R0 < 1$ is ascertained using the second additive compound matrix technique and the stability criterion for real matrices put forth by Li-Wang (1998).

MMCITRE2025/068

Heat transfer enhancement compared to entropy generation by imposing magnetic field and hybrid nanoparticles in mixed convection of a Bingham plastic fluid in a ventilated enclosure

Subhasree Dutta[a*]; Somnath Bhattacharyya[b]; Ioan Pop[c]

[a]Department of Mathematics, University of Engineering & Management, Kolkata

[b]Department of Mathematics, IIT Kharagpur, Kharagpur 721302, India

[c] Department of Mathematics, Babeş-Bolyai University, 400084 Cluj-Napoca, Romania

Abstract. The purpose of this study is to analyse the nonhomogeneous model on the mixed convection of Al_2O_3–Fe_3O_4 Bingham plastic hybrid nanofluid in a ventilated enclosure subject to an externally imposed uniform magnetic field. Entropy generation and the pressure drop are determined to analyse the performance of the heat transfer. The significance of Joule heating arising due to the applied magnetic field on the heat transfer of the yield stress fluid is described. The ventilation in the enclosure of heated walls is created by an opening on one vertical wall through which cold fluid is injected and another opening on the opposite vertical wall through which fluid can flow out. This study finds that the inclusion of Fe_3O_4 nanoparticles with the Al_2O_3-viscoplastic nanofluid augments the heat transfer. This rate of enhancement in heat transfer is higher than the rate by which the entropy generation is increased as well as the enhancement in the pressure drop. The yield stress has an adverse effect on the heat transfer; however, it favours thermal mixing. The magnetic field, which is acting opposite to the direction of the inlet jet, manifests heat transfer of the viscoplastic hybrid nanofluid. The horizontal jet of cold fluid produces the optimal heat transfer. The objective of this study is to analyse the impact of the inclined cold jet of viscoplastic electrically conducting hybrid nanofluid on heat transfer from the enclosure in the presence of a uniform magnetic field. The combined effect of

hybrid nanoparticles and a magnetic field to enhance heat transfer of a viscoplastic fluid in a ventilated enclosure has not been addressed before.

Keywords: Entropy, Generation, MHD, Mixed Convection, Nonhomogeneous Model, Ventilated Enclosure, Viscoplastic Hybrid Nanofluid.

MMCITRE2025/071

Influence of Wall Roughness on Stokes Flow Past Staggered Cylinders in Rectangular Microchannel

Vishal Chhabra[a,1], Chandra Shekhar Nishad[b], Manoj Sahni[c]

a. Department of Mathematics, School of Basic and Applied Sciences, K. R. Mangalam University, Gurugram, Haryana, 122103, India
b. Department of Science and Mathematics, International Institute of Information Technology, Naya Raipur, Chhattisgarh, 493661, India
c. Department of Mathematics, School of Technology, Pandit Deendayal Energy University, Gandhinagar, Gujarat 382426, India

Abstract. Motivated by the complex flow interactions occurring around clots, emboli, and drug capsules within blood vessels, this study presents a hydrodynamic model describing the steady, pressure-driven flow of a viscous, incompressible fluid at low Reynold's number past an array of identically sized circular cylinders arranged in a staggered configuration within a rectangular microchannel. To model surface roughness along the impermeable walls, alternating Navier's slip and no-slip boundary conditions are applied in an in-phase configuration. The boundary element method (BEM), based on stream function and vorticity variables, is used to solve the Stokes equations governing viscous flow within the microchannel. The MATLAB software is used to implement the BEM for solving the boundary value problem. To better understand the flow characteristics, we thoroughly analyzed the streamlines, velocity profiles, pressure gradients, and shear stresses associated with the dimensionless flow parameters. We analyzed a noticeable change in the pressure gradient at the cross-sections where the slip boundary condition is implemented, which occurs due to the reduced wall resistance that alters the near-wall velocity and modifies the overall pressure distribution. The proposed model holds practical significance in various fields, including drug capsule delivery systems, hemodynamic flow analysis, bio-MEMS technology, and the design of lab-on-chip diagnostic devices.

Keywords: Boundary element method, Circular cylinder, Microchannel, Slip pattern, Stokes equation.

MMCITRE2025/072

Nutrient Transport in Cylindrical Perfusion Bioreactors fitted with Anisotropic Rigid Scaffolds

Athul S Murali[1], Bibaswan Dey[2]

[1]Department of Mathematics, SRM University – AP, Andhra Pradesh, India,
[2]Department of Mathematics, University of North Bengal, West Bengal, India.

Abstract. A mathematical model is developed to describe the hydrodynamics and mass transport within a cylindrical perfusion bioreactor containing a rigid, anisotropic porous scaffold. The hydrodynamics of the scaffold are governed by the Brinkman equation, while nutrient transport is modeled using an advection–diffusion–reaction mass balance. The scaffold is assumed to have a uniform cell distribution, and the steady-state Brinkman equation is solved analytically under the assumption of fully developed unidirectional flow. The aspect ratio of the cylindrical bioreactor is assumed to be very small, $\varepsilon \ll 1$, and the nutrient transport problem is solved up to $O(\varepsilon 2)$ using a perturbation method. A detailed analysis of the hydrodynamics and nutrient transport is conducted with respect to key non-dimensional parameters, including the anisotropic ratio ξ, aanisotropic angle ψ, Slip coefficient β, Peclet number Pe, and Thiele modulus Φ^2_m .The optimum value of pressure gradient is determined to prevent the formation of regions with insufficient or excessive nutrient concentrations, ensuring uniform and healthy cell growth. Impact of structural and transport parameters on total mass transfer is evaluated.

Keywords: Tissue engineering; anisotropy; nutrient transport.

MMCITRE2025/073

Analysis of Nonlinear Functionally Graded Rotating Discs for Enhanced Secondary Creep Resistance

Parth Dinesh Mehta[1] and Manoj Sahni[2]

[1]Brij Disa Centre for Data Science and Artificial Intelligence, Indian Institute of Management Ahmedabad, 380015, Gujarat, India.
[2]Department of Mathematics, School of Technology, Pandit Deendayal Energy University, Gandhinagar, 382426, Gujarat, India.

Abstract. This paper presents a comparative investigation of the secondary creep behaviour in rotating functionally graded (FG) thick discs reinforced with particulate composites. The study aims to establish an accurate and computationally efficient model for predicting the stress and strain-rate distributions under the combined effects of centrifugal body forces, internal pressure, and radial gradation in both geometry and material composition. Two reinforcement distribution profiles, namely quadratic and cubic, are formulated to model the variation of disc thickness and the volume fraction of reinforcement along the radius. The present study employs an incremental displacement rate approach, wherein the radial displacement rate is incrementally updated using the creep strain-rate relations and equilibrium equations for a

functionally graded rotating disc. The constitutive creep behaviour is modelled using Tresca's yield criterion with spatially varying creep parameters defined as functions of the local reinforcement content. The derived nonlinear governing equations are solved through an iterative numerical integration scheme to obtain the steady-state secondary creep stresses and strain-rate fields. To assess the accuracy of the analytical formulation, a finite element method (FEM) framework is developed and implemented for nonlinear creep analysis using equivalent incremental stress–strain relations. Comparative analysis is carried out for different angular velocities and combinations of internal/external compressive pressure. The validated iterative–FEM framework provides a reliable and computationally efficient design methodology for optimizing the geometry and material gradation of high-speed rotating FG components used in turbine, aerospace, and automotive applications, where enhanced creep resistance and long-term structural integrity are critical.

Keywords: Functionally graded materials; Creep analysis; Rotating disc; Finite element method; Nonlinear stress distribution; Composite structures.

MMCITRE2025/075

Signed Fuzzy Roman Domination in Graphs: A Unified Framework, Bounds, Algorithms, and Applications

Angshu Kumar Sinha[1], Sanchita Sarkar[2], Anita Pal[3]

[1,2] Department of Mathematics, NSHM Knowledge Campus Durgapur, Burdwan, India
[3] Department of Mathematics, NIT Durgapur, Burdwan, India

Abstract. This paper presents a unified domination framework in graph theory known as Signed Fuzzy Roman Domination (SFRD), which combines the principles of fuzzy graph theory, signed networks, and Ro man domination. A signed fuzzy graph is denoted by G_{sf}= (V, E, μ, v, σ), where $\mu : V \to [0, 1]$ and $v : E \to [0, 1]$ represent the vertex and edge membership functions satisfying $v(u, v) \leq \min\{\mu(u), \mu(v)\}$, and $\sigma : E \to \{+1, -1\}$ denotes the sign of each edge. A Signed Fuzzy Roman Dominating Function (SFRDF) $f : V \to \{0, 1, 2\}$ assigns reinforcement values so that every vertex u with $f(u) = 0$ is adjacent through a positive edge to a vertex v with $f(v) = 2$. The fuzzy-weighted cost is defined as $w_{SF\,R(f)} = \mathrm{P}_{u \in V} f(u)\mu(u)$, and the minimum such cost determines the *Signed Fuzzy Roman Domination Number* $\gamma_{SF\,R}(G_{sf})$.
An extended edge-based form, termed Signed Fuzzy Edge Roman Star Domination (SFER-SD), is also introduced, in which domi nation occurs through positively connected fuzzy star subgraphs. Two greedy approximation algorithms are developed: the first estimates $\gamma_{SF\,R}(G_{sf})$ using vertex-based reinforcement selection, while the second computes $\gamma_{SF\,ER}(G_{sf})$ by optimizing fuzzy edge reinforcement. Theoretical properties such as existence, upper and lower bounds, and NP hardness are established for both models. Exact and approximate results are derived for standard graph families including star, path, cycle, and Petersen graphs. Finally, the applicability of the proposed frameworks and algorithms is demonstrated in real-world domains such as trust–distrust social networks, cybersecurity planning, multi-agent co-operation, and uncertainty-aware sensor systems.

Keywords: signed fuzzy graphs; Roman domination; fuzzy membership functions; edge-based

domination; star domination; approximation algorithms; NP hardness

---

MMCITRE2025/076

Applications of Statistics in Industry: A Comprehensive Global and Indian Perspective

Sanchita Sarkar, Angshu Kumar Sinha, Rumi Khanra, Aniruddha Samanta, Srabani Guria Das

Department of Basic Science, NSHM Knowledge Campus Durgapur, 713212, West Bengal, India

Abstract. In today's industrial landscape, data-driven decision-making has become a cornerstone of operational excellence. The deployment of statistical methodologies empowers industries to enhance quality control, optimize supply chains, predict failures, and manage financial risk with greater precision. This paper explores how diverse industrial domains—spanning manufacturing, logistics, predictive maintenance, marketing, and public services—integrate statistical tools to drive performance. Drawing on global and Indian trends from 2013 to 2023, the study presents a comparative analysis that highlights regional maturity gaps and opportunities. While developed markets exhibit strong statistical integration, India is rapidly progressing through digital infrastructure upgrades and policy-led innovation. The study concludes by exploring the role of emerging technologies such as AI and cloud analytics in shaping the future of industrial statistics.

Keywords: Industry, Statistics, Application, Global vs India.

MMCITRE2025/081

A Hybrid Snow Geese–Nelder-Mead–Differential Evolution Algorithm for Global Optimization

Jolly, Pooja

Department of Electronics & Communication, University of Allahabad, Prayagraj, India

Abstract. Metaheuristic hybrids are widely recognized as robust and effective for global optimization. In this study, a three-phase hybrid, SGA+NM+DE, that integrates the Snow Geese Algorithm (SGA) for global exploration, Nelder–Mead (NM) for deterministic local refinement, and Differential Evolution (DE) for evolutionary polishing. Unlike its components, the hybrid first explores, then exploits, and initializes DE with the NM-polished population, improving the trade-off between fast convergence and robustness. Performance is validated on the CEC2022 benchmark testbed (F1–F12) under a unified protocol (20 independent runs, fixed evaluation budget, consistent bounds and dimensionality). Numerical evidence by means of convergence curves, comparative table and per-function ranks shows that the hybrid achieves faster early-stage descent and lower mean values on many functions. Pairwise tests show that

the hybrid clearly beats SGA, while against DE it is competitive. Overall, SGA+NM+DE demonstrates an effective balance between rapid convergence and robust search, supporting its use as a practical, general- purpose optimizer on global benchmarks.

Keywords: Snow Geese Algorithm, Nelder–Mead, Differential Evolution, Hybridization.

MMCITRE2025/083

An Unsupervised PINN-NTK Framework for Transport Phenomena in Complex Non-Newtonian Hybrid Nanofluid Confined Channel

Yujing Wang[1,2,*] and Puneet Rana[1,2]

[1]School of Mathematical Sciences, College of Science, Mathematics and Technology, Wenzhou-Kean University, Wenzhou 325060, China

[2]WKU Centre of Applied Mathematical Modelling and Computation, Wenzhou-Kean University, Wenzhou 325060, China

Abstract. This research analyzes flow and thermal transport in a confined channel, considering impact of thermal radiation and heat source/sink. The single-phase model for non-Newtonian hybrid nanofluids is governed by coupled, nonlinear differential equations from the momentum and energy balances. To solve the governing system, an unsupervised Physics-Informed Neural Network (PINN) framework is employed. Unsupervised PINNs integrate the governing physical laws into the loss function of a deep neural network, ensuring that the solution satisfies both the system of differential equations and boundary conditions. This offers a new alternative to traditional numerical methods like the Shooting method, FDM, and FEM, which are sensitive to initial guesses. At the same time, Neural Tangent Kernel (NTK) is introduced to dynamically adapt the weights of residual and boundary conditions and adjusting the training focus of PINNs, the loss fluctuation decreases at high epochs. The hybrid optimizers Adam and LBFGS are used to accelerate convergence and achieve high accuracy, with a loss threshold (Residual and Boundary loss) of at least 1e-6. This study systematically examines the influence of key parameters on velocity and temperature profiles. This research is relevant to practical applications including packed bed thermal systems, enhanced oil recovery, and hybrid nanofluid-based cooling technologies.

Keywords: Nanofluids, PINN, Neural Tangent Kernel, Channel, Radiation, Heat Source.

MMCITRE2025/084

An investigation of HIV transmission dynamics: Mathematical modelling approach

Roshni Somawar, Parthasakha Das

Department of Mathematics
Rajiv Gandhi National Institute of Youth Development, Sriperumbudur, Tamil Nadu

Abstract. Mathematical modelling plays a crucial role in understanding the spread of HIV and designing effective intervention strategies. The model uses differential equations to illustrate the complex interaction between susceptible and infected individuals within diverse groups. Therefore, these outcomes aid in actions and projections for the future and analysis of trends in epidemics. In this study, bifurcations are used to analyze how structural changes occur in the immune system and to describe time-dependent changes in virus spread with each cell. Sensitivity analysis is an effective method to understand the behavior of complex systems such as the HIV dynamics model. It helps guide the formulation of public health policies and intervention plans and provides practical information about the fundamental processes that cause viruses to spread. By investigating the stability analysis of the HIV model qualitative behavior is discussed. This study focuses on the dynamics models to investigate how viruses affect the immune system dynamically.

Keywords: HIV modelling; Stability Analysis; Bifurcation Analysis**.**

MMCITRE2025/086

An efficient image encryption technique based on singular value decomposition and compressive sensing

Rohit, Bhupendra Gupta, Subir Singh Lamba

Department of Mathematics, Indian Institute of Information Technology Design and Manufacturing, Jabalpur, India

Abstract. Digital images are increasingly shared over multimedia applications, heightening privacy risks and emphasizing the crucial role of image encryption technology in ensuring the confidentiality, authenticity, and integrity of these images. For enhanced security, parallel compressive sensing is employed to encrypt data and resize it without significant information loss. However, there is a trade-off in achieving satisfactory reconstruction quality at high compression ratios. In this paper, we present image encryption and compression techniques with the primary goal of achieving satisfactory image reconstruction quality at high compression ratios, such as CR = 0.0625 and 0.125. This technique involves obtaining a sparse matrix through singular value decomposition, and employing chaotic systems, SHA-256, and 1D compressive sensing to enhance security. Experimental results demonstrate the effectiveness of our proposed algorithm.

Keywords: Image encryption; Image decryption; Image security; Compressive sensing; Chaotic systems; Singular value decomposition.

MMCITRE2025/089

Mathematical Model and Solution Approaches for the Aircraft Recovery Problem

Abhishek Kumar Singh Sengar, Deepmala

Department of Mathematics, IIITDM, Jabalpur, India

Abstract. The Aircraft Recovery Problem (ARP) occurs when a flight schedule is disrupted due to unexpected events, affecting airline operations. This problem is common in the aviation industry and presents challenges in both practice and research. In this paper, we propose a mathematical model for the Aircraft Recovery Problem and discuss some optimization techniques to solve it. Our aim is to improve efficiency by reducing delays and optimizing aircraft usage. Finally, we discuss potential areas for future research in this domain.

Keywords: Airline Disruption Management; Aircraft Recovery Problem; Mathematical Model; Mixed Integer Programming; Optimization Techniques

---

MMCITRE2025/090

Sustainable inventory management with non-instantaneous deterioration: A Greenness integrated iso-elastic price and exponential time-dependent demand approach with partially backlogged shortages.

Shreya Kelkar[1], Niketa Trivedi[2, *]

[1,2] BSH Department, MPSTME, SVKM's Narsee Monjee Institute of Management Studies (NMIMS) Deemed-to-be-University, Mumbai-400056, Maharashtra, India.

Abstract. In recent years, sustainability and greenness have emerged as a key dimension in inventory management. Integrating greenness into inventory management reduces environmental impact as well as enhances product appeal among environment conscious consumers, thereby influencing demand, pricing and profitability. This study develops a sustainable inventory model incorporating an iso-elastic price and exponential time-sensitive demand function integrated with greenness levels. The model captures consumer responses to price, the dynamic nature of demand over time and the increasing preference for environmentally friendly products. It analyses how price elasticity, time sensitivity and greenness investment jointly influence optimal inventory decisions and total profit. By jointly optimizing price, time and greenness, firms can effectively balance environmental performance with economic returns. The proposed model considers a non-instantaneous deterioration

pattern, where shortages are allowed and partially backlogged. To find an optimal solution, an algorithm is provided and a numerical example is illustrated to highlight the significance of key parameters. Sensitivity analysis is performed to examine the model's behaviour and valuable managerial insights are provided to design a sustainable, profit-oriented inventory strategies that align economic efficiency with environmental responsibility

---

MMCITRE2025/091

Unsupervised Segmentation of Ovarian Cancer Histopathology Images Using Advanced Fuzzy Clustering Approaches: A Comparative Analysis

Dibya Jyoti Bora[1], Rimpa Deka[2], Mrinal Kranti Misra[3]

[1]Department of Information Technology, School of Computing Sciences, The Assam Kaziranga University, Jorhat
[2]Department of CSE, School of Engineering & Technology, The Assam Kaziranga University, Jorhat
[3]BML Munjal University

Abstract. Accurate segmentation of histopathology images is critical for computer-aided diagnosis of ovarian cancer, yet manual annotation is labor-intensive and prone to inter-observer variability. This study presents a comparative evaluation of three clustering-based segmentation approaches: Fuzzy C-Means (FCM), Spatially Weighted FCM (SFCM), and Possibilistic FCM (PFCM), applied to the publicly available ovarian cancer histopathology dataset from Kaggle. Segmentation was performed without ground truth annotations, and performance was assessed using cluster compactness, inter-cluster variance, and runtime. Across four representative images, PFCM achieved the lowest compactness (0.00757), highest inter-cluster variance (0.08852), and competitive runtime (2.06 s). Statistical analysis using paired t-tests and effect sizes confirmed that PFCM significantly outperformed FCM and SFCM ($p < 0.01$). Visualization results further demonstrated that PFCM produced cleaner and better-separated regions, facilitating improved tumor–stroma delineation. The proposed reproducible pipeline highlights the potential of soft computing approaches for histopathology image segmentation in scenarios where annotated datasets are unavailable.

MMCITRE2025/092

AI AND IOT-ENABLED PREDICTIVE ENERGY MANAGEMENT FOR RENEWABLE ENERGY CONVERSION SYSTEMS

Chitra K
MCA, Dayananda Sagar Academy of Technology and Management, Udayapura, Bangalore
Sahaya Brainy J
AI & DS, Jerusalem College of Engineering, Chennai
R. Bhavani
Mathematics Department, St.Peter's Institute of Higher Education and Research, Avadi
Vikas Pandey
Electrical Engineering Department, Babu Banarasi Das University, Lucknow, India
D Christo Stalin
Best Tech Company, Tamil Nadu, India
Aman Jolly
Department of Computer Science and Engineering, Delhi Technological University, Bawana Road, New Delhi, India

Abstract. The proposed paper captures an experimental study on the components of an integrated Artificial Intelligence (AI) and Internet of Things (IoT) system focused on predictive energy management in renewable energy conversion systems. The system utilizes LSTM (Long Short-Term Memory) Neural Networks and IoT sensors to get real time data to track and predict the generation of solar and wind energy accurately. The system uses 15 IoT enabled smart sensors in a hybrid renewable energy facility to derive the solar irradiance, wind, moisture, temperature, and other related data in real time. The AI model uses a set of 18-month historical data to make a model which is tested in a real life scenario for 6 months. The data shows that the system has an accuracy of 94.3% predictive accuracy for solar and wind energy with a MAE of 2.87% and RMSE of 3.42% which is much better than the standard energy forecasting systems. The model also shows a 23.6% energy saving and increased system stability during proactive load balancing. This work proposes a system that has demonstrated its efficiency in voicing load balancing on smart grids.

Keywords: Artificial Intelligence, Internet of Things, Predictive Energy Management, Renewable Energy Systems, LSTM Networks.

MMCITRE2025/093

Machine Learning–Driven Energy Auditing and Climate-Resilient Agricultural Modeling Using IoT-Integrated Frameworks

Chitra K
Master of Computer Applications, Dayananda Sagar Academy of Technology and Management, Udayapura, Bangalore
Lakshmi Roopa
Assistant Professor, CS & BS, Jerusalem College of Engineering, Chennai,
Malathy B
Assistant professor, CS & BS, Jerusalem College of Engineering – Chennai,
Vikas Pandey
Electrical Engineering Department, Babu Banarasi Das University, Lucknow, India
D Christo Stalin
Researcher, Best Tech Company, Tamil Nadu, India
Aman Jolly
Department of Computer Science and Engineering, Delhi Technological University, Bawana Road, New Delhi 110042, India

Abstract. Modern agricultural systems are increasingly challenged by the adverse impact of climate change and energy inefficiency. This research developed an integrated architecture in which machine learning algorithms are used in conjunction with IoT (Internet of Things) sensor networks for real-time energy auditing and climate-adaptive crop modeling. The setup used 150 IoT sensors deployed at 3 agricultural blocks (15 ha each) to collect data on soil moisture, soil temperature, humidity, and energy used for 8 months (March-October 2024). The sensors monitored the data in the 3 blocks. For irrigation, the models evaluated on energy prediction and yield optimization were Random Forest Regression (RFR), Support Vector Machine (SVM), Long Short-Term Memory (LSTM), and Convolutional Neural Network-LSTM hybrid (CNN-LSTM). The results showed that 28% of the water used was reduced and 32% of energy used was improved because of the performance of the CNN-LSTM model which was 96.8% accurate, with an RMSE reduced to 3.42%. This advanced the framework with machine learning in real-time IoT energy auditing to yield optimization for adaptive climate crop modeling which is of immense value to precision farming. This contributes to improved climate considered farming.

Keywords: Machine learning, IoT sensors, Energy auditing, Climate-resilient agriculture, Precision farming, CNN-LSTM.

MMCITRE2025/096

Performance Evaluation Framework for Tribological Behaviour in Quasi-Isotropic Material

Naman Kumar Tater, Dharmik Chauhan, Manoj Sahni

Department of Mathematics, School of Technology, Pandit Deendayal Energy University, Raysan-382426, Gujarat, India

Abstract. The present investigation applies the Fuzzy TOPSIS technique to assess the tribological performance of a quasi-isotropic material fabricated through the stir casting process. Pin-on-disc experiments were performed under varying operating parameters, including normal load (10 – 40 N), sliding velocity (0.5 – 2.0 m/s), sliding distance (500 – 2000 m), and rotational speed (239 – 956 RPM). The obtained experimental data were analysed using the Fuzzy TOPSIS framework, which effectively manages uncertainties and subjective judgments in decision-making. By integrating linguistic evaluations with quantitative measures, the method enables a more realistic interpretation of experimental variations. The closeness coefficient computed for each test condition facilitated the ranking of parameter combinations based on wear resistance and frictional behaviour. The fuzzy-based approach demonstrated high sensitivity in identifying the influence of operating conditions on surface degradation and interfacial friction. Overall, the findings establish Fuzzy TOPSIS as a robust decision-support and optimization tool for determining the most favourable tribological parameters in quasi-isotropic materials.

Keywords: Fuzzy TOPSIS; Decision-Making Framework; Quasi-Isotropic Material; Tribological Optimization; Wear Resistance.

MMCITRE2025/098

2D Floor Plan Generation via Constraint Satisfaction Problem Modeling

Siddharth[1], Rajgire Akhil Reddy[2], Utkarsh Gupta[2], and Avantika Singh[2]

[1] Department of Computer Science and Engineering
Dr. Shyama Prasad Mukherjee International Institute of Information Technology, Naya Raipur, India

[2] Department of Data Science and Artificial Intelligence
Dr. Shyama Prasad Mukherjee International Institute of Information Technology, Naya Raipur, India

Abstract. Floor plan design is a fundamental architectural task requiring simultaneous satisfaction of multiple spatial, geometric, and functional constraints. Traditional manual design is time-consuming and relies heavily on expert knowledge, while existing automated approaches using deep learning require extensive training datasets and lack interpretability.

This paper presents a novel constraint-based approach for automated 2D floor plan generation using Constraint Satisfaction Problem (CSP) formulation solved via Google OR-Tools CP-SAT optimizer. Our framework explicitly models room specifications, adjacency requirements, and geometric constraints as integer programming variables, ensuring satisfaction of hard constraints while optimizing soft constraints. Unlike data-driven methods, our approach requires no training data and produces deterministic, interpretable solutions. The system achieves complete hard constraint satisfaction, excellent space utilization, and high computational efficiency with solve times suitable for interactive architectural design applications. This makes it practical for real-world deployment.

Keywords: Constraint Satisfaction Problem · CP-SAT · Floor Plan Generation · Spatial Optimization

---

MMCITRE2025/099

An Explainable AI System Integrating Vitals and Clinical Notes for Outcome Prediction and Length of Stay in Cardiac ICUs

Ethan Rebeiro[1], Ketan Barkade[1], Yugansha Kabra1, Soni Sweta[1], Ajit Kumar[2]

[1] Department of Computer Engineering, NMIMS Mukesh Patel School of Technology Management and Engineering, Mumbai, India
[2] Department of Mathematics, NMIMS Mukesh Patel School of Technology Management and Engineering, Indore, India

Abstract. This study presents an explainable AI framework that integrates multimodal data sources including structured vitals time-series and unstructured clinical notes from electronic health records to predict patient outcomes and length of stay in cardiac intensive care units. Accurate and interpretable outcome prediction in cardiac intensive care units is critical for timely clinical decision-making and remains a major challenge due to the heterogeneous nature of patient data. Traditional risk scoring systems such as SAPS II and SOFA rely only on structured physiological variables and fail to exploit the wealth of unstructured information in clinical notes. Using the publicly available MIMIC-IV and MIMIC-IV-Note datasets, we construct an ICU cardiac cohort and derive features from aggregated vitals and discharge summaries. The cohort comprises 7,215 unique cardiac ICU patients, with approximately 65 numeric vital-summary features and 5,000 TF-IDF textual features, combined into a unified model input. Two gradient boosting models were trained, one for mortality classification and another for length-of-stay regression. To address memory constraints, the LOS model was trained using a chunked DMatrix approach. Models were evaluated with stratified group splits and standard metrics (AUROC, F1, R Square, RMSE, MAE). The proposed multimodal models achieved high accuracy and reliability across both mortality and length-of-stay prediction tasks. Explainability was provided with SHapley Additive explanations, which provided clinically meaningful insights into the most influential variables, such as heart rate variability, oxygen concentration, mean arterial pressure, and important note tokens like “cardiac arrest”. The results demonstrate that our early fusion multimodal approach outperforms unimodal baselines and offers actionable explanations.

MMCITRE2025/100

Analysis of the formation and evolution of two-dimensional steady shock waves in a real gas flow under thermal radiation effects

Akmal Husain

Department of Mathematics, Applied Science Cluster, School of Advanced Engineering,

University of Petroleum and Energy Studies (UPES), Dehradun-248007, India

Abstract. The current work presents a two-dimensional steady supersonic weak shock production and evolution analysis in a real gas flow (a highly generic van der Waals gas medium) under heat radiation for planar and axisymmetric scenarios. Wavefront expansion yielded the shock-evolution equation, which confirms discontinuities in physical variable normal derivatives and guides wave creation and development. The shock-evolution equation has been used to analyze the effects of shock-Mach number, thermal radiation, and van der Waals attraction and repulsion parameters on shock wave formation and evolution for planar and axisymmetric flow geometries. The results are shown in figures and tables using MATHEMATICA 11.0. The study found sustained shock generation distance retardation for high specific heat ratios. Compared to the flat example, weak discontinuity forms early in axisymmetric geometry, demonstrating the extraordinary influence of flow configuration on shock development and evolution. We also compared the shock creation distance in a simplified van der Waals gas with actual gas flow.

MMCITRE2025/101

Migration of a Viscous Spherical Droplet Driven by Potential Flow

Rupali Sharma[1], Arindam Basak[1], Rajaram Lakkaraju[2], G. P.Raja Sekhar[1]
[1]Department of Mathematics, Indian Institute of Technology Kharagpur, West Bengal-721302, India
[2]Department of Mechanical Engineering, Indian Institute of Technology Kharagpur, West Bengal-721302, India

Abstract. Fluid encapsulation structures, such as bubbles encapsulating a liquid drop, are emerging platforms for ultrasonic imaging, drug delivery, and microscale reactions, yet their fundamental hydrodynamics remain only partly understood. As a building block toward such a phenomenon, we present a non-axisymmetric analysis of flow around a viscous, spherical droplet suspended in an inviscid fluid medium. In the small capillary and Reynolds number limit, the exterior motion of non-deforming droplet is modeled as irrotational (potential flow), while the droplet interior obeys the steady Stokes equations with a finite viscosity relative to the ambient fluid. Explicit formulas are derived for the drag force and migration velocity. We utilize the sphere theorem to represent the most general potential flow outside a sphere. We expand the surface tractions in spherical harmonics and solve the interior problem by the Solenoidal decomposition method, enforcing stress-matching boundary conditions at the

interface. Results are presented for exterior flow as extensional flow and Poiseuille flow. The solution is evaluated to examine the flow field inside the droplet. The theory supplies benchmark solutions for validating numerical solvers and offers design guidance for microhydrodynamic manipulation of droplets when deformation and surfactant effects are negligible.

Keywords: Stokes flow, Inviscid flow, Droplets.

MMCITRE2025/102

Integrating Multimodal Neural TTS for Interactive LMS

Krishnanand Vishwakarma[1], Ch Tarun Kumar[2], Bhupesh Kumar Rajak[3], Mayank Dewangan[4]

[1,2,3,4]Department of Science and Mathematics, International Institute of Information Technology (IIIT), Naya Raipur, Chhattisgarh-493661, India

Abstract. The rapid growth of digital libraries has created a need for smart systems that present information in brief, easy-to-read formats. Traditional retrieval methods often drown users in too much text, making it hard to take in knowledge efficiently. This paper introduces a new framework that combines multimodal summarization with transformer based neural text-to-speech (TTS) models to improve interactivity in digital libraries. The proposed system starts by using multimodal summarization techniques. It looks at both text and visual metadata to create clear, concise summaries of digital content. These summaries are then turned into natural, human-like speech using transformer-based TTS models, so users can listen to scholarly material. By combining multimodal content understanding with better speech synthesis, our method aims to make information more accessible to different user groups, including those who are visually impaired and mobile learners. It also decreases the mental effort needed during information retrieval. Experimental evaluations show that the integrated system achieves significant improvements in summary clarity, speech quality, and user satisfaction compared to traditional text-only or speech-only methods. This work helps develop interactive, inclusive, and smart digital libraries, paving the way for the next generation of knowledge sharing platforms.

Keywords: Library Management System(LMS), ACCE, Database, Digital system, library

---

MMCITRE2025/103

Voice Instability Index and Clinically Grounded Prediction for Parkinson's Disease

Reeaa Rana[1], Diveyam Mishra[2], and Ajit Kumar Singh[3,□]

[1] Dept. of Artificial Intelligence and Data Science, SVKM's Narsee Monjee Institute of Management Studies, Indore, Madhya Pradesh, India

[2] Dept. of Electrical Engineering, Shri Govindram Seksaria Institute of Technology and Science, Indore, Madhya Pradesh, India

[3] School of Technology Management and Engineering, SVKM's Narsee Monjee Institute of Management Studies, Indore, Madhya Pradesh, India

Abstract. This paper represents an interpretable and clinically grounded research for a machine learning pipeline that detects Parkinson's disease using audio biomarkers. This paper utilises UCI Parkison dataset which is engineered into 36 features including a novel Voice Instability Index (VII). VII helps to quantify dysphonia using jitter, shimmer and negative HNR. Metrics like AUROC, PR-AUC, F1-Score, and Brier Score with isotonic regression and Decision Curve Analysis were assessed to judge the clinical utility. SHAP analysis and a simplified decision tree highlight key vocal features linked to Parkinson's. Logistic model with few spread 1, spread 2 and VII offers overall balance between performance and interpretability with clinical deployability. This paper achieves AUROC score of 0.982 using an ensemble model while a transparent model scores 0.894 enabling deployable screening.

Keywords: AUROC, PR-AUC, HNR, Brier, Isotonic.

MMCITRE2025/104

A Scalable ETL Framework for Historical Cryptocurrency Trend Analysis Using Binance API

Junaid Mundichipparakkal[1], Ramandeep Kaur[1], Danthuluri Sudha[1], Santosh Kumar J[1], S Srushti[1], S. N. Mishra[2*], Prolay Biswas[3]

[1]Department of Computer Science and Technology, Dayananda Sagar University, Bengaluru, India

[2]Department of DSAI/Mathematics, IIIT-Naya Raipur, India

[3]Department of Computer Science and Engineering, Dayananda Sagar University, Bengaluru, India

Abstract: The fast pace of change and unpredictable nature of the cryptocurrency market require comprehensive means of performing historical trend analysis. This paper describes a scalable and automated Extract, Transform, and Load (ETL) system implemented in Python for collecting, storing, and displaying historical data on the price performance of cryptocurrencies using the Binance API. Our example ETL system targets five cryptocurrencies: Bitcoin, Ethereum, Binance Coin, Dogecoin, and Solana, and provides daily OHLCV (Open, High, Low, Close, Volume) values going back to 2017 and up to the present. Data transformations provide

a clean, structured format prepared for analysis as needed over time, with each asset stored in its own relational database table. The pipeline contemplates automation and scheduling when new data is captured, making for an efficient refresh. Visualization will be done with Seaborn and Matplotlib and will emphasize market indicators of interest such as price spreads, volume of trading, and time series activity. Additionally, amongst other visualizations will be a correlation heatmap of closing prices across the various assets, highlighting interrelations amongst markets and trading activities. The primary contributions of this work are in its automation, modular architecture, and integrated visual analytics, which together increase accessibility to cryptocurrency data engineering and analysis. The current implementation is focused on descriptive analytics; however, the system is designed for extensibility and can thus serve as a platform for incorporating predictive modeling and sentiment analysis in the future.

MMCITRE2025/105
Higher-order Statistical Features-based Machine Learning Approach for Evaluating Advertisement Effectiveness through Eye-Tracking Data Analysis

Chokkakula Karthik[1], Tankala Sri Vedanarayana[1], Anurag Singh[1], Sresha Yadav nee Ghosh[2]
[1] Dept. of ECE, IIIT Naya Raipur, Raipur, India
[2] Dept. of SHM, IIIT Naya Raipur, Raipur, India

Abstract: Evaluation of the effectiveness of digital advertisements is very crucial for optimizing marketing strategies that resonate with a large number of people. However, this faces the constraints of having precise and quantifiable methods to evaluate the effectiveness of digital advertisements, and hence, very limited works are available in this area. In this study, we have followed a novel approach using the eye-tracking data collected from different participants who viewed effective and ineffective advertisements using a Tobii Pro eye-tracking device. Data were processed to extract different features such as eye movement metrics, including saccade counts, saliency maps, average pupil diameter, and higher-order statistics, including entropy, kurtosis, and skewness, which helped differentiate effective and ineffective advertisements. The problem was posed as a binary classification problem, where feature engineering was performed on data acquired through eye tracking technology to extract relevant features, and state-of-the-art machine learning models were used for classification. Furthermore, the relationship between advertisement effectiveness and other metrics, such as the average pupil diameter (indicating cognitive load) and entropy, kurtosis, and skewness (reflecting gaze pattern distributions), was also investigated. The analysis revealed that the average pupil diameter was the most important feature in determining the effectiveness of the advertisement, followed by entropy, kurtosis, skewness and number of saccades. The Decision Tree machine learning model achieved the highest accuracy of 84% followed by Logistic Regression and Random Forest. These results highlight the relevance of eye-tracking features in identifying engaging advertisements and underscore the potential of machine learning in enhancing targeted marketing strategies.

Keywords: eye-tracking, visual attention, saccades, saliency maps, pupil diameter, entropy, kurtosis, skewness

---

MMCITRE2025/106
Multimodal Graph-Based Framework to Model Alzheimer's disease Progression

Reeaa Rana[1], Vidhi Gharia[2], Ajit Kr. Singh[1]
[1]School of Technology Management and Engineering, SVKM's NMIMS, Indore, India
[2]Dept. of Mathematics, Manipal University Jaipur (MUJ), Jaipur, India

Abstract : We present a graph-based MRI modeling pipeline that transforms structural volumes of 96×96×96 into approximately 1,575-node, 21k-edge patch graphs and then applies a two-layer GraphSAGE classifier, which is optimized with focal loss and cosine annealing, to train. The model reaches an AUC of 0.918, which is better than 3D CNN (0.911) and ResNeXt-50 (0.905), and the results are further explained through interpretable UMAP and node-relevance analyses.

Keywords: Graph Neural Networks, GraphSAGE, Deep Feature Aggregation, Non-Euclidean Representation Learning.

MMCITRE2025/107
Safe Ride with IoT: Designing a Smart-Helmet for Detecting Accurate Accident Location and Automating Alerts via SMS and A Social Media Platform

Md. Reazul Islam[1], Md. Owafeeuzzaman Patwary[2], Huzzatullah Sazzad[3], Md. Nashiruddin[4], Rishat Ryan[2], Aneem Al Ahsan Rupai[2], Rajarshi Roy Chowdhury[2]

[1]Department of Computer Science, University at Albany, State University of New York, USA
[2]Department of Computer Science, American International University-Bangladesh, Dhaka 1229, Bangladesh
[3]Department of Computer Science, Jahangirnagar University, Bangladesh
[4]Department of ICT, Govt. Shahid Suhrawardy College, Bangladesh

Abstract. Bike accidents are increasing rapidly each day. Every area experiences bike accidents regularly. Many existing studies aim to prevent such accidents using different technologies. Often absence of frequent medical services or emergencies leads to bikers losing individual lives. This is due to the delayed arrival of ambulances, the absence of people in the accident area, and incidents occurring in isolated locations. This study proposed a smart-helmet acts as a quick response device. It sends help messages through Short Message Service (SMS) alerts, including accident longitude and latitude values (location), to the selected numbers, including hospitals and friends and family numbers. Nowadays, many people are active on various social media platforms, such as Facebook, the proposed approach can also post help message on Facebook and send messages to selected friends via Messenger. This project utilized a Raspberry Pi Zero W, Global Positioning System (GPS), Global System for Mobile Communications (GSM), a buzzer, and cloud storage for developing and designing a prototype. The device is activated when a biker is involved in an accident and performs different operations automatically. It provides the accident location vai GPS, and GSM is used for the SMS system. It immediately updates a help post on the user's Facebook account and sends a message via

Messenger. Additionally, it activates a buzzer to attract the attention of nearby people. This smart helmet can be used in various environments, including bike riding, bicycle riding, construction, and mining areas, to improve the safety of individuals.

Keywords: Smart-Helmet, Messenger, Internet of Things, Global Positioning System, and Facebook.

MMCITRE2025/108

Optimization of Phasor Measurement Unit Placement in Toeplitz Network

Shoba Pandian[1], Mohana N[2]

[1,2] Department of Mathematics, School of Advanced Sciences,
Vellore Institute of Technology, Chennai Campus, Tamilnadu, India

Abstract. The electrical grid functions as a complex interconnection network that facilitates the generation, transmission, and distribution of electrical power to end-users. A vital element in ensuring the efficient operation of these grids is the Phasor Measurement Unit (PMU), a specialized instrument designed to assess the electrical waves present within the power system. PMUs deliver real-time measurements of voltage and current phasors, representing the sinusoidal components of alternating current, and play an essential role in monitoring and maintaining the electrical grid's stability. However, the substantial costs associated with the installation of PMUs make implementing them at every busbar throughout all grid stations impractical. This challenge can be framed within the context of graph theory, specifically through the concept of power-dominating sets. The power dominating problem is classified as NP-complete, which implies that effectively finding a minimum power dominating set in a graph remains an open challenge. Furthermore, comprehending the efficient operation of these grids necessitates an understanding of their integrity. In this paper, we determine the power dominance set, vertex cover, independent set and integrity of a toeplitz network, determining it in linear time by modeling the network as an electrical grid.

Keywords: electrical grid · independent set · phase measuring units · power domination · toeplitz network · vertex cover integrity.

MMCITRE2025/109

Similarity Measure Based Feature Selection for High-Dimensional Data Using Intuitionistic Fuzzy Sets

Reeta Mondal[1]*, Tejaswini Pradhan[1]

[1]Department of Mathematics, Kalinga University, Raipur, Chhattisgarh 492101, India

Abstract. High-dimensional datasets often contain many features that are irrelevant or redundant, which can reduce the performance of machine learning models. Intuitionistic Fuzzy Sets (IFSs) provide a way to handle uncertainty using membership,non-membership, and hesitation values. In this paper, we propose a new feature selection method based on a similarity measure for IFSs. The method evaluates both how relevant a feature is to the target and how redundant it is compared to other features. We introduce an IF Similarity Measure (IF-SM) Feature Ranking Index and test it on three types of datasets: facial image classification, software

defect prediction, and gene expression analysis. The results show that our approach effectively selects the most important features, improves classification accuracy, and demonstrates the usefulness of combining fuzzy techniques with modern machine learning.

Keywords: Similarity Measure; Intuitionistic Fuzzy Sets; Feature Selection; High-Dimensional Data.

MMCITRE2025/110

A Multimodal Prediction Model for Smartphone Addiction among Children Using Continuous Authentication through Behavioral Biometrics

Aneem Al Ahsan Rupai[1], Sudeep Mondal Deep[1]*, Sazzad Hossain[1], Md. Reazul Islam[1]

[1]Department of Computer Science, American International University-Bangladesh (AIUB), Kuratoli, Dhaka 1229, Bangladesh

Abstract: The problem of smartphone addiction in children has become increasingly critical, and signing in to the device excessively leads to emotional, cognitive and behavioural problems. Conventional question and answer based instruments like the Smartphone Addiction Scale (SAS) are helpful, yet they are intensive to opinions and do not reflect dynamic patterns of interaction. This paper suggests a sensor-driven system based on the principles of Continuous Authentication (CA) to monitor the levels of smartphone addiction based on the natural touch and motion patterns of children. An application created in Android took into account touchscreen, acceleration, and gyroscopes data of children and then underwent formal pre-processing and statistical feature extraction. Three machine learning models including XGBoost, random forest and SVM were trained and assessed using the same features. As experimental outcomes show, XGBoost performed the best with an accuracy of 95%, an AUC of 0.99, and a misclassification rate of 83 true and 88 true. On the whole, the results show that behavioral biometrics may be used as an objective and a continuous method of early identification of smartphone addiction in children which can be utilized by parents, educators and researchers.

Keywords: Smartphone Addiction Children, Continuous Authentication, Behavioral Biometrics, Touch Gesture Analysis, Hand-Waving Patterns, Machine Learning, Multi-modal Authentication, Smartphone Sensors.

MMCITRE2025/112

Magnetohydrodynamic hybrid nanofluid flow across a wedge surface with radiation effects

Manoj Kumar, Amit Kumar, Anupam Bhandari
Department of Mathematics, School of Advanced Engineering, UPES, Dehradun, 248007, Uttarakhand, India

Abstract: This research examines the flow and heat transfer characteristics of a micropolar hybrid nanofluid over a wedge surface. The study includes the effects of thermal radiation,

magnetic field, and exponentially varying heat sources. The governing equations, derived from the Navier–Stokes framework, are transformed from partial differential equations (PDEs) into a system of nonlinear ordinary differential equations (ODEs) by similarity transformations and then solved numerically using MATLAB's bvp4c solver. The results indicate that increasing the micropolar material parameter slows down the fluid flow because it reduces drag. However, increasing the Eckert number, radiation parameter, magnetic parameter, and heat source/sink intensity widens the temperature distribution. The effect of nanoparticle shape is studied, and it is shown that blade-shaped nanoparticles have the highest Nusselt number and greatly improve heat transfer, whereas spherical nanoparticles are the least effective. These findings demonstrate the potential of micropolar hybrid nanofluids in advanced thermal management applications, such as energy storage systems, solar collectors, aviation thermal protection, and the cooling of microelectronic devices.

Keywords: Hybrid nanofluids, Shape factor effects, MHD, Radiation effects, Heat source/sink.

MMCITRE2025/113

Magnetohydrodynamic Hybrid Nanofluid Flow and Irreversibility Analysis in a Square Cavity with Circular Obstacle

Amit Kumar[1], Priyabrata Sethy[2]
[1]Department of Mathematics, School of Advanced Engineering, UPES, Dehradun, India
[2]Centre for Data Science, ITER, Siksha 'O' Anusandhan (Deemed to be University), Bhubaneswar 751030, India

Abstract: The ability of heat to transfer within an enclosure has been exploited in many ways, such as in heat exchangers, solar collectors, and electrical devices. Compared to mono nanoliquids, hybrid nanoliquids transmit heat better. This research investigates the thermal transfer efficacy inside a square container filled with a hybrid nanofluid with a heated inner circular barrier. The hybrid nanofluid employed is a uniform and equal combination of MgO and Ag nanoadditives in water, which is the base liquid. The Lorentz force has an effect on the square chamber. The bottom surface of the chamber heats it evenly, while the vertical surfaces cool it down. The top wall is protected from heat. We used a complex simulation program called Comsol Multiphysics to solve the linked partial differential equations. Comsol Multiphysics is a program that can do finite element analysis. We look closely at how important elements like the production of entropy, the Rayleigh and Hartmann numbers, the fraction of nanoparticles, and the angle of inclination of the Lorentz force on thermal convection, is examined in depth. The computational study has been conducted over a wide range of critical parameters, namely $Ra = 10^3 - 10^6, Ha = 0 - 100$, and $\varphi = 0.01, 0.02$. With a higher Ra, the strength of the streamlines goes up a lot. At an arc length of $L = 1.5$, the maximum velocity magnitude occurs. As Ha rises, the isotherms set up at the left and right walls become smaller. The angle of inclination of the Lorentz force has a big effect on how energy flows. The angle of the magnetic field that is applied has a big effect on the production of entropy and the Bejan number. The study is relevant to improving the cooling of electrical systems inside devices,

since reducing temperature is essential to prevent overheating and guarantee the reliability of electronic equipment. The findings show that they might be useful for cooling electronics and heat exchangers.

Keywords: Natural convection; Entropy generation; Hybrid nanofluid; Uniform magnetic field; Heated circular body; Isothermal surfaces.

MMCITRE2025/114

Font Type Analysis for Online Reading using Eye Tracking Technology

Dhyanendra Tripathi, Yash Raj, Anurag Singh, and Sresha Yadav nee Ghosh

IIIT Naya Raipur, Raipur, India

Abstract: This study uses eye-tracking technology to investigate different font types' impact on online reading efficiency. Data is collected from different subjects reading text in seven different fonts (Algerian, Oswald, Impact, Times New Roman, Comfortaa, Arial, Lobster) using a Tobii Pro Spark eye tracker device at a font size of 12. The text was presented for 180 seconds. Key metrics analyzed include the count of saccades, and number of lines read. Results indicate significant differences in reading patterns across font types, with implications for optimizing font selection in digital contents. The study also suggests an optimized new algorithm to calculate the number of saccades from eye tracking data.

Keywords: Eye Tracking · Font Type · Online Reading · Saccades · Tobii Pro Lab

Organizing Committee

Conference Chairs

Dr. Mithilesh Kumar Chaube	Associate Professor, Department of Science and Mathematics, IIIT Naya Raipur, Raipur, Chhattisgarh, India.
Dr. Chandra Shekhar Nishad	Assistant Professor, Department of Science and Mathematics, IIIT Naya Raipur, Raipur, Chhattisgarh, India
Prof. Manoj Sahni	Professor, Department of Mathematics, School of Technology, PDEU Gandhinagar, Gujarat, India.
Prof. José M. Merigó Lindahl	Professor, University of Technology Sydney, Sydney, Australia
Dr. Enesto Leon Castro	Professor, Universidad Católica de la Santísima Concepción (UCSC), Chile
Dr. Krishnanand Vishwakarma	Assistant Professor, Department of Science and Mathematics, IIIT Naya Raipur, Raipur, Chhattisgarh, India
Dr. Sachchida Nand Mishra	Assistant Professor, Department of Data Science and Artificial Intelligence, IIIT Naya Raipur, Raipur, Chhattisgarh, India
Dr. Fabio Raúl Blanco Mesa	Professor, Universidad Pedagógica y Tecnológica de Colombia

Scientific Advisory Committee

- Prof. J.T. Chen, National Taiwan Ocean University, Taiwan
- Prof. G. P. Raja Sekhar, IIT Kharagpur, Kharagpur, India
- Prof. S. Sundar, IIT Madras, Chennai, India
- Prof. S.K. Pandey, IIT (BHU) Varanasi, India
- Dr. S. Karmakar, Director General CCOST, Raipur, India

- Prof. Jure Ravnik, University of Maribor, Slovenia
- Prof. Udaya Parampalli, University of Melbourne, Australia
- Prof. Mikhail Sheremet, National Research Tomsk State University, Russia
- Prof. Sudhakar Kumar Chaubey, UTAS, Shinas, Oman
- Prof. Dinesh Singh, K. R. Mangalam University, India
- Prof. Mohan Krishen Kadalbajoo, LNMIIT Jaipur, India
- Prof. S. Natesan, IIT Guwahati, India
- Prof. Rafikul Alam, IIT Guwahati, India
- Prof. Satyajit Roy, IIT Madras, India
- Prof. (Retd.) Peeyush Chandra, IIT Kanpur, India
- Prof. Maheshanand Bhaintwal, IIT Roorkee, India
- Prof. Manoranjan Mishra, IIT Ropar, India
- Prof. T. P. Singh, PDEU Gandhinagar, India
- Prof. D.S. Hooda, GJUST, Hisar, India
- Prof. R.K. Pandey, IIT (BHU) Varanasi, India
- Prof. Sk. Safique Ahmad, IIT Indore, India
- Prof. Neeraj Sukla, IIT Indore, India
- Prof. Archana Sharma, IIIT Naya Raipur, India
- Prof. Rajarshi Mahapatra, IIIT Naya Raipur, India
- Prof. P.P. Paltani, IIIT Naya Raipur, India
- Prof. Debajyoti Choudhury IIT Bhubaneswar, India
- Prof. Dharmendra Tripathi, NIT Uttarakhand, India
- Prof. Ankit Chaudhary, JNU New Delhi, India
- Prof. Satya Deo, University of Allahabad, India
- Prof. R. K. Upadhyay, IIT (ISM) Dhanbad, India
- Dr. P. Kalika, Govt. Engineering College Bhojpur, India
- Prof. P.K. Yadav, MNNIT Allahabad, Prayagraj, India

Organizing Committee Members

- Prof. O. P. Vyas, Vice-Chancellor and Director, IIIT Naya Raipur, India
- Prof. Srinivasa K G, Dean (Academics) and Registrar (I/C), IIIT Naya Raipur, India
- Dr. Mithilesh Kumar Chaube, Dean (R & I), IIIT Naya Raipur, India
- Dr. Ramakrishna Bandi, HoD, Science and Mathematics, IIIT Naya Raipur, India
- Dr. Chandra Shekhar Nishad, IIIT Naya Raipur, India
- Dr. Krishnanand Vishwakarma, IIIT Naya Raipur, India
- Dr. Sachchida Nand Mishra, IIIT Naya Raipur, India
- Prof. Manoj Sahni, President, FIM, Gujarat Chapter
- Dr. Ritu Sahni, Nirma University, Gujarat, India
- Prof. Archana Sharma, IIIT Naya Raipur, India

- Prof. Rajarshi Mahapatra, IIIT Naya Raipur, India
- Prof. P. P. Paltani, IIIT Naya Raipur, India
- Prof. Ernesto Leon-Castro, Universidad Catolica de la Santisima Concepcion, Chile
- Prof. Fabio Raul Blanco Mesa, Universidad Pedagógica y Tecnológica de Colombia
- Prof. Jose Maria Merigo Lindahl, University of Technology Sydney (Australia)
- Mr. Mustaque Alam, Research Scholar, IIIT Naya Raipur, India
- Mr. Sanjeev Dwivedi, Research Scholar, IIIT Naya Raipur, India
- Mr. Md Mentu, Research Scholar, IIIT Naya Raipur, India
- Mr. Vijay Kumar, Research Scholar, IIIT Naya Raipur, India
- Mr. Shashank Nirmalkar, Research Scholar, IIIT Naya Raipur, India
- Mr. Aayush Yadav, Research Scholar, IIIT Naya Raipur, India
- Mr. Ritik Kumar Dewangan, Research Scholar, IIIT Naya Raipur, India
- Ms. Bhavika Gupta, Research Scholar, IIIT Naya Raipur, India
- Ms. Chanchal, Research Scholar, IIIT Naya Raipur, India
- Ms. Shaoni Chakraborty, Research Scholar, IIIT Naya Raipur, India
- Mr. Sumit Ku Sahoo, UG Student, IIIT Naya Raipur, India
- Mr. Aaditya Soni, UG Student, IIIT Naya Raipur, India

Schedule of
5th International Conference
on
MATHEMATICAL MODELING, COMPUTATIONAL INTELLIGENCE TECHNIQUES AND RENEWABLE ENERGY (MMCITRE-2025)
DECEMBER 10-12, 2025

Organizers:

International Institute of Information Technology, Naya Raipur (IIIT-NR), Chhattisgarh, India

Forum for Interdisciplinary Mathematics (FIM), Gujarat Chapter, India

Day-1 10-12-2025	
Time	
09:00 am - 10:00 am	**Registration**
10:00 am - 11:20 am	**Inauguration Schedule** Prof. S.K. Pandey, IIT (BHU) Varanasi, India (Chief Guest) Prof. Ernesto Leon-Castro, Universidad Católica de la Santísima Concepción Mexico (Guest of Honor) Prof. Fabio Raul Blanco Mesa, Universidad Pedagógica y Tecnológica de Colombia, Colombia (Guest of Honor) Prof. O. P. Vyas, VC & Director, IIIT-NR, India (Hon. General Chair) Prof. Srinivasa K G, Dean (Academics) & Registrar (I/C), IIIT-NR (Chair) Venue: IIIT-NR Auditorium Google Meet Link: meet.google.com/ewz-ujtr-ftt
11:20 – 11:25 am	Group Photo
11:25 – 11:35 am	High Tea
(IST) 11:35 am – 12:20 pm (GMT) 06:05 am - 06:50 am	Keynote Talk - 1 Prof. Manoranjan Mishra, IIT Ropar, India Session Chair: Prof. Dharmendra Tripathi Venue: Room no. 121, Academic Building, IIIT-NR Google Meet Link: meet.google.com/ewz-ujtr-ftt
(IST) 12:20 pm - 1:05 pm	Keynote Talk - 2 Prof. S. K. Pandey IIT (BHU) Varanasi, India

(GMT) 06:50 am - 07:35 am	Session Chair: Prof. S. Natesan Venue: Room no. 121, Academic Building, IIIT-NR Google Meet Link: meet.google.com/ewz-ujtr-ftt
(IST) 1:05 pm – 2:00 pm (GMT) 07:35 am - 08:30 am	Lunch Break
(IST) 2:00 pm – 02:45 pm (GMT) 08:30 am - 09:15 am	Keynote Talk – 3 Prof. Dharmendra Tripathi NIT Uttarakhand, India Session Chair: Prof. R. K. Pandey Venue: Room no. 121, Academic Building, IIIT-NR Google Meet Link: meet.google.com/ewz-ujtr-ftt
(IST) 2:45 pm – 03:30 pm (GMT) 09:15 am - 10:00 am	Keynote Talk - 4 Prof. R. K. Pandey IIT (BHU) Varanasi, India Session Chair: Prof. Ernesto Leon-Castro Venue: Room no. 121, Academic Building, IIIT-NR Google Meet Link: meet.google.com/ewz-ujtr-ftt
(IST) 03:30 pm – 03:45 pm (GMT) 10:00 am - 10:15 am	Tea Break
(IST) 3:45 to 6:30 pm (GMT) 10:15 am - 01:00 pm	Invited Talk (2 invited_talk * 20 minutes for each talk) Paper Presentations (8 pres * 12 minutes for the paper presentations)

Session 1: (Room No. 138)	Session 2 (Room No. 135)	Session 3 (Room No. 122)	Session 4 (Room No. 121)	Session 5 (Room No. 206)
(Mathematical Modelling) Session Chairs: Prof. Gajendra K. Vishwakarma IIT (ISM) Dhanbad, India & Dr. Atendra Kumar, NIT Srinagar, India (2 invited talk+8pres) Co-chair: Dr. Sachchida Nand Mishra (Student Coordinators: Mr. Mustaque Alam & Mr. Aayush Yadav) Google Meet Link: meet.google.com/qeg-iezb-ugb	(Computational Mathematics) Session Chairs: Dr. Sukhendu Ghosh, IIT Jodhpur, India & Dr. Ambuj Pandey, IISER Bhopal (2 invited talk + 8 pres) Co-chair: Dr. Vijaya J (Student Coordinators: Mr. Md Mentu & Mr. Ritik Dewangan) Google Meet Link: meet.google.com/zhp-qzyy-hkf	(Optimization and Graph Theory) Session Chairs: Dr. Bibaswan Dey, North Bengal University, Siliguri, India & Dr. Arvind Kumar Sinha, NIT Raipur (2 invited talk + 8 pres) Co-chair: Dr. K. N. Vishwakarma (Student Coordinators: Ms. Chanchal & Ms. Shraddha Jha) Google Meet Link: meet.google.com/ewz-ujtr-ftt	(AI and Machine Learning) Session Chairs: Dr. Ritu Sahni, Nirma University, Ahmedabad, India & Prof A K Malik, UP Rajarshi Tandon Open University Prayagraj (2 invited talk + 8 pres) Co-chair: Dr. Ruhul Amin (Student Coordinators: Mr. Vijay Kumar & Shashank Nirmalkar) Google Meet Link: meet.google.com/kng-itpk-yjo	(Fuzzy Mathematics and applications, Information Theory) Session Chairs: Dr. Ajit Kumar Singh, SVKM's NMIMS & Dr. Amita Soni, Dr. D. Y. Patil School of Science and Technology Pune, India (2 invited talk + 8 pres) Co-chair: Dr. Vinay Kumar (Student Coordinators: Mr. Sanjeev Dwivedi & Ms. Aparajita) Google Meet Link: meet.google.com/svw-jtrn-jee

Paper ID	Paper ID	Paper ID	Paper ID	Paper ID
MMCITRE2025/005	MMCITRE2025/023	MMCITRE2025/009	MMCITRE2025/006	MMCITRE2025/007
MMCITRE2025/010	MMCITRE2025/026	MMCITRE2025/014	MMCITRE2025/017	MMCITRE2025/008
MMCITRE2025/012	MMCITRE2025/030	MMCITRE2025/020	MMCITRE2025/029	MMCITRE2025/015
MMCITRE2025/035	MMCITRE2025/042	MMCITRE2025/032	MMCITRE2025/034	MMCITRE2025/016
MMCITRE2025/044	MMCITRE2025/046	MMCITRE2025/040	MMCITRE2025/036	MMCITRE2025/021
MMCITRE2025/051	MMCITRE2025/050	MMCITRE2025/055	MMCITRE2025/038	MMCITRE2025/031
MMCITRE2025/052	MMCITRE2025/067	MMCITRE2025/062	MMCITRE2025/047	MMCITRE2025/041
MMCITRE2025/059	MMCITRE2025/071	MMCITRE2025/073	MMCITRE2025/114	MMCITRE2025/060

(IST) 7:30 pm	Cultural Event & Gala Dinner

Day-2

11-12-2025

Time	
(IST) 8:30 – 9:30 am	**Break-Fast (At Cafeteria)**
(IST) 09:30 am - 10:15 am **(GMT) 04:00 am - 04:45 am**	Keynote Talk - 5 **Prof. Ernesto Leon-Castro** **Universidad Católica de la Santísima Concepción, Chile** **Session Chair: Dr. Ambuj Pandey** **Venue: Room no. 121, Academic Building, IIIT-NR** **Google Meet Link: meet.google.com/ewz-ujtr-ftt**
(IST) 10:15 am - 11:00 am **(GMT) 04:45 am - 05:30 am**	Keynote Talk – 6 **Prof. Jose M. Merigo,** **University of Technology Sydney, Australia** **Session Chair: Dr. Partha Sarathi Mandal** **Venue: Room no. 121, Academic Building, IIIT-NR** **Google Meet Link: meet.google.com/ewz-ujtr-ftt**
(IST) 11:00 am – 11:15 am (GMT) 5:30 am - 5:45 am	Tea Break
(IST) 11:15 am - 12:00 pm **(GMT) 05:45 am - 06:30 am**	Keynote Talk - 7 **Prof. Fabio Raul Blanco Mesa,** **Universidad Pedagógica y Tecnológica de Colombia, Colombia** **Session Chair: Dr. Rathan Samala** **Venue: Room no. 121, Academic Building, IIIT-NR** **Google Meet Link: meet.google.com/ewz-ujtr-ftt**
(IST) 12:00 pm - 12:45 pm **(GMT) 06:30 am - 07:15 am**	Keynote Talk - 8 **Prof. S. Natesan** **IIT Guwahati, India** **Session Chair: Dr. Meraj Alam** **Venue: Room no. 121, Academic Building, IIIT-NR**

	Google Meet Link: meet.google.com/ewz-ujtr-ftt
(IST) 12:45 pm – 1:45 pm (GMT) 07:15 am - 08:15 am	Lunch Break
(IST) 2:15 pm - 3:00 pm **(GMT) 08:45 am - 09:30 am**	Keynote Talk - 9 **Prof. G. P. Raja Sekhar** **IIT Kharagpur, India** **Session Chair: Dr. Bibaswan Dey** **Venue: Room no. 121, Academic Building, IIIT-NR** **Google Meet Link: meet.google.com/ewz-ujtr-ftt**

(IST) 3:00 pm – 4:30 pm (GMT) 09:30 am - 11:00 am	Invited Talk (2 invited_talk * 20 minutes for each talk) Paper Presentations (8 pres * 12 minutes for the paper presentations)

Session 1 (Room No. 138)	Session 2 (Room No. 135)	Session 3 (Room No. 122)	Session 4 (Room No. 121)	Session 5 (Room No. 206)
(Mathematical Modelling) **Session Chairs:** **Dr. Partha Sarathi Mandal** **NIT Patna, India** **&** **Dr. Govind Prasad Sahu, PRSU Raipur, India** **(2 invited talk + 8 pres)** **Co-chair: Dr. Abhishek Sharma** **(Student Coordinators: Mr. Mustaque Alam & Mr. Aayush Yadav)** **Google Meet Link: meet.google.com/qeg-iezb-ugb**	**(Computational Mathematics)** **Session Chairs:** **Dr. Rathan Samala IIPE Visakhapatnam, India** **&** **Dr. Raghav Prasad Parouha, IGNTU Amarkantak, India** **(2 invited talk + 8 pres)** **Co-chair: Dr. Ramakrishna Bandi** **(Student Coordinators: Mr. Md Mentu & Mr. Ritik Dewangan)** **Google Meet Link: meet.google.com/zhp-qzyy-hkf**	**(Optimization and Graph Theory)** **Session Chairs:** **Dr. Meraj Alam, Mahindra University, Hyderabad, India** **&** **Abhijit Sutradhar, KIIT, Bhubaneswar** **(2 invited talk + 8 pres)** **Co-chair: Dr. Deepika Gupta** **(Student Coordinators: Ms. Chanchal & Ms. Shraddha Jha)** **Google Meet Link: meet.google.com/ewz-ujtr-ftt**	**(AI and Machine Learning)** **Session Chairs:** **Dr. Chandrakant Kumar Singh, UP Rajarshi Tandon Open University Prayagraj** **&** **Dr. Branislav Đorđević ICME, Serbia** **(2 invited talk + 8 pres)** **Co-chair: Dr. Avantika Singh** **(Student Coordinators: Mr. Vijay Kumar & Shashank Nirmalkar)** **Google Meet Link: meet.google.com/kng-itpk-yjo**	**(Fuzzy Mathematics and applications, Information Theory)** **Session Chairs:** **Dr. Moitri Sen NIT Patna, India** **&** **Dr. Anuwedita Singh, ABV-IIITM Gwalior, India** **(2 invited talk + 8 pres)** **Co-chair: Dr. Soni Sweta, MPSTME, SVKM's NMIMS, Mumbai** **(Student Coordinators: Mr. Sanjeev Dwivedi & Ms. Bhavika)** **Google Meet Link: meet.google.com/svw-jtrn-jee**
Paper ID MMCITRE2025/049 MMCITRE2025/061 MMCITRE2025 /063 MMCITRE2025/066 MMCITRE2025/084 MMCITRE2025/089 MMCITRE2025/101 MMCITRE2025/112	**Paper ID** MMCITRE2025/068 MMCITRE2025/072 MMCITRE2025/083 MMCITRE2025/086 MMCITRE2025/094 MMCITRE2025/100 MMCITRE2025/104 MMCITRE2025/109	**Paper ID** MMCITRE2025/039 MMCITRE2025/076 MMCITRE2025/081 MMCITRE2025/090 MMCITRE2025/096 MMCITRE2025/098 MMCITRE2025/106 MMCITRE2025/107 MMCITRE2025/108	**Paper ID** MMCITRE2025/033 MMCITRE2025/053 MMCITRE2025/057 MMCITRE2025/092 MMCITRE2025/093 MMCITRE2025/099 MMCITRE2025/105 MMCITRE2025/045 MMCITRE2025/110	**Paper ID** MMCITRE2025/024 MMCITRE2025/064 MMCITRE2025/065 MMCITRE2025/075 MMCITRE2025/091 MMCITRE2025/102 MMCITRE2025/103 MMCITRE2025/113

(IST) 04:30 pm – 04:45 pm (GMT) 11:00 am - 11:15 am	Tea Break
(IST) 4:45 pm – 5:45 pm (GMT) 11:15 am - 12:15 pm **Valedictory Session and Award Distribution** **Venue: Room no. 121, Academic Building, IIIT-NR**	
Day-3 **12-12-2025** 1 Day Raipur Tour	

List of Accepted Abstracts

Sl. No.	Conference Paper ID	Authors	Title
1	MMCITRE2025/005	Rohit Kannaujiya, B.S. Bhadauria	Boundary Layer Convection in Casson Nanofluid over a Stretching/Shrinking Cylinder with Internal Heating
2	MMCITRE2025/006	Abha Kumari	Machine learning based irreversibility analysis of Maxwell power law fluid
3	MMCITRE2025/007	Diksha Gupta, Madhu Gupta and Ankit Kumar	Enhancing Decision Reliability with 2-D Linguistic Intuitionistic Fuzzy Power Aggregation Operators
4	MMCITRE2025/008	Alok Bhargava and Ravi Kumar Jain	Some New Results on Fractional Integration of I – Function
5	MMCITRE2025/009	Gunjan Dewangan	Wavelet Method for Distributed-Order Optimal Control Problem
6	MMCITRE2025/010	Minu Theresa Mathew and Diksha Gupta	Performance Analysis of a Power Regression Model for Green Hydrogen Flow rate in a PEM Electrolyzer Utilizing Critical Dynamic Parameters
7	MMCITRE2025/012	Ritesh Yadav, Bharti Kumari, Ajit Kr. Singh and Gopal Kumar Gupta	Mathematical Model of Standardising the Thermoelastic Characteristics of Materials: An Examination on Determining Material Parameters Based on Curve-Fitting
8	MMCITRE2025/014	Shruti Rathod, Manoj Sahni, and Jose M. Merigo	Quantitative Portfolio Strategy Assessment: Incorporating penalty-based aggregation for more effective decision-making.

9	MMCITRE2025/015	Bhavna Mahant, Rakesh Kumar Bajaj, and Vikas Baghel	Selection of Best Renewable Energy Alternatives Utilizing Hamacher Aggregation Operator of p,q,r-Cubic Quasi-rung Orthopair Neutrosophic Fuzzy Sets
10	MMCITRE2025/016	Arpit Kumar Rana, Ayush Gupta, Sidhant Gezta, Devyani Thakur, Kaushal Parmar, and Rakesh Kumar Bajaj	Fuzzy Decision-Making Framework for Blockchain Technology Selection in Logistics and Supply Chain Management System
11	MMCITRE2025/017	Ravi Dhaundiyala, Ravi Shankar Jhaa,Punit Guptab	Disease Detection In Plants Using Machine Learning Technique
12	MMCITRE2025/020	Punit Gupta, Alauki Patel	The Use of Graph Neural Networks in Flight Delay Prediction and Air Traffic Analysis
13	MMCITRE2025/021	Sandeep Wankhade, Manoj Sahni, and Ernesto León-Castro	Fuzzy-OWA Framework for Robust Risk Modeling in Manufacturing Enterprise Systems
14	MMCITRE2025/023	Lavanya V Salian	Spectral Study of Higher-Order Compact Schemes fo Convection–Dispersion Equation
15	MMCITRE2025/024	Amol Bhilare, Debabrata Swain, Vishva Patel, Manish Kumar	An Intelligent Ensemble Framework for Tropical Crop Yield Prediction: Integrating Active Learning with Random Forest and XGBoost
16	MMCITRE2025/026	Parvin Kumari	Spline-Based Approximation for Two-Parameter Singularly Perturbed Systems with Large Time Delay with Applications in Science and Engineering.
17	MMCITRE2025/029	Pranav Kini, Jash Upadhyay, Abhishek Tripathi, and Soni Sweta	AutoREAD: A Retrieval-Augmented Pipeline for README Generation
18	MMCITRE2025/030	Puspendra Kumar, Tejaswini Pradhan, G. V. V. Jagannadha Rao	Approximate Fixed Point Theory on Neutrosophic Topological Vector Spaces and Applications
19	MMCITRE2025/031	Prince Kumar Namdev, G. V. V. Jagannadha Rao, Tejaswini Pradhan	Some New Fixed Point Results For Monotone Partially Nonexpansive Mapping In G-Metric Space
20	MMCITRE2025/032	Dharmik Chauhan, and Manoj Sahni	Wear and Friction Optimization of Quasi-Isotropic Material Using

			TOPSIS and Fuzzy TOPSIS Frameworks
21	MMCITRE2025/033	Rishabh Bhangale, Dhruv Parmar and Soni Sweta	XFIN: Explainable AI for Financial Services and Banking Appliances
22	MMCITRE2025/034	Archit K Xavier and Punit Gupta	A Review of Solutions using Generative Adversarial Networks in Medical Imaging for Lumbar Spine
23	MMCITRE2025/035	Madhusudhan HS , Punit Gupta, Pushkar V, Saanvi Ravi, Suparna DS , and Ujwal R	Augmented Reality Rehabilitation System for Enhanced Recovery in Post-Shoulder Surgery Patients
24	MMCITRE2025/036	Madhusudhan HS, Punit Gupta, Anish S R, Pramukh B V, Shreyas V E, and Yashas M	Identification of Ragas and Their Analysis Using Deep Learning Techniques
25	MMCITRE2025/038	Manoj Kumar Singh, Jyotiprakash Patra and Siddharth Choubey	Ensemble-Based Zero Day Detection using Host Memory Analysis
26	MMCITRE2025/039	Shalini, Nitin Kumar, Punit Jain	Population model subject to geometric catastrophe with bulk killing
27	MMCITRE2025/040	Prince Solanki, Sumit Malik, Sanjay Kumar and Suyash Shukla	A Mean-Variance Optimization Framework forPost-Disaster Non-Performing Asset Managementin the Indian Banking Sector
28	MMCITRE2025/041	Vijay Kumar and Ramakrishna Bandi	Verifiable ((k, n)) QSS with Polynomial Shares and Dense Coding
29	MMCITRE2025/042	Sandhya Sahu, Pushpendra Kumar, and Tejaswini Pradhan	Common Fixed Point Theorems for Hybrid and Multivalued Mappings in Neutrosophic Fuzzy b-Metric Spaces with Applications
30	MMCITRE2025/044	Debashree Sahu, Tapas Ranjan Panigrahi	Dynamics of SH wave Propagation in fiber-reinforced Medium with power law model
31	MMCITRE2025/045	Himadri Sarma, Dibya Jyoti Bora	A Study of Different Deep Learning Techniques for Stroke Diagnosis and Rehabilitation.
32	MMCITRE2025/046	Nawab Wasim Rahman, and Dibya Jyoti Borah	Enhanced U-Net Architecture with Dual-Pathway Processing for Robust Cloud Segmentation in Multispectral Satellite Imagery: A Majuli Island Case Study

33	MMCITRE2025/047	Milankumar Bhatt, and Sandip Pathak	Adoption and Impact of AI & Data-Driven Tools on Training and Performance among College Sports Students
34	MMCITRE2025/049	Punit Jain	Suspended Sediment Modelling with Exponential Mixing Length and Hindered Settling
35	MMCITRE2025/050	Meghna Parikh and Manoj Sahni	Neutrosophic Modeling and Solution of Elliptic PDEs under Uncertainty: A Gauss-Seidel Approach
36	MMCITRE2025/051	Dimpal Jyoti Mahanta, Dipu Bora, and Pallabi Saikia	An Approach to Estimate the Parameters of Nonlinear Growth Models and Their Role in Bamboo Growth Dynamics
37	MMCITRE2025/052	Leena Saikia Pranab Barua and Dimpal Jyoti Mahanta	A Comprehensive Review of Pregnancy-Related Domestic Violence Against Women: The Silent Battle
38	MMCITRE2025/053	Kishor Kumar Sharma, Asif Nizam, Prem Kumar Chaurasiya, Vinod Kumar Sharma, and Vikas Pandey	Predictive Machine Learning Framework for Optimizing Hydrogen Storage in La–Ni–Al Hydrides
39	MMCITRE2025/055	Aman Jolly, Vikas Pandey, Akhilesh Sharma, Shashikant, and Manoj Sahni	Frugal Innovation at Scale: The Role of Low-Cost Tech in Public Health and Safety at the Maha Kumbh Mela
40	MMCITRE2025/057	Tishya Tripathi Shukla, Anchal Rastogi, Vikas Pandey, Aman Jolly, and Manoj Sahni	AI-Enhanced Service Quality and Student Engagement in Higher Education: A Systematic Bibliometric Review of Recent Literature
41	MMCITRE2025/059	Mehmet Gümüş	Dynamics of a Monkeypox Epidemic Model Involving Human-Animal Transmission
42	MMCITRE2025/060	Shikha Deepa, Parth M. Pandyab, Manoj Sahnic	Dispersion of Love waves in a homogeneous fiber-reinforced layer lying over an initially stressed half-space with imperfect interface
43	MMCITRE2025/061	Arindam Basak, Rajaram Lakkaraju, and G P Raja Sekhar	Shear vs. Pressure: Which Governs Thermocapillary Droplet Steering?
44	MMCITRE2025/062	Bhojraj N Kale, Saroj V Borkar, Prakash V Dhopte, Vikas Pandey, Manoj Sahni, Jitesh	Oxygenated Nanoparticles Influence on Performance, Combustion, and Emissions of Internal Combustion (IC) Engines

		Shinde, and Paravin T Petkar	
45	MMCITRE2025 /063	Prafulla Kumari Panda, and Tapas Ranjan Panigrahi	Case-Wise Study of Torsional Wave Propagation in a Two-Layered Heterogeneous Media
46	MMCITRE2025/064	Walayat Hussain Ashvin Parameswaran Jo Ingold	ScrumBench and Jason Mack: Scaling Agentic AI for Automation in Agile Software Teams
47	MMCITRE2025/065	Md Nazmul Hossain Walayat Hussain Mahmoud Bekhit Ashvin Parameswaran	Autonomous Learning Coach: A Text-Centered Agentic AI Approach to Effective Learning
48	MMCITRE2025/066	Satish Sahu, Rajana Suresh Kumar, Vikas Pandey, and Akhilesh Sharma	Free Vibration Analysis of Porous Functionally Graded Plates Using Carrera Unified Formulation
49	MMCITRE2025/067	Man Mohan Singh and Garima Agarwal	The Application of The Matrix Method to Investigate COVID-19 Variants
50	MMCITRE2025/068	Subhasree Dutta; Somnath Bhattacharyya; and Ioan Pop	Heat transfer enhancement compared to entropy generation by imposing magnetic field and hybrid nanoparticles in mixed convection of a Bingham plastic fluid in a ventilated enclosure
51	MMCITRE2025/071	Vishal Chhabra, Chandra Shekhar Nishad, and Manoj Sahni	Influence of Wall Roughness on Stokes Flow Past Staggered Cylinders in Rectangular Microchannel
52	MMCITRE2025/072	Athul S Murali, and Bibaswan Dey	Nutrient Transport in Cylindrical Perfusion Bioreactors fitted with Anisotropic Rigid Scaffolds
53	MMCITRE2025/073	Parth Dinesh Mehta and Manoj Sahni	Analysis of Nonlinear Functionally Graded Rotating Discs for Enhanced Secondary Creep Resistance
54	MMCITRE2025/075	Angshu Kumar Sinha, Sanchita Sarkar, and Anita Pal	Signed Fuzzy Roman Domination in Graphs: A Unified Framework, Bounds, Algorithms, and Applications
55	MMCITRE2025/076	Sanchita Sarkar, Angshu Kumar Sinha ,Rumi Khanra , Aniruddha Samanta, and Srabani Guria Das	Applications of Statistics in Industry: A Comprehensive Global and Indian Perspective
56	MMCITRE2025/081	Jolly and Pooja	A Hybrid Snow Geese–Nelder-Mead–Differential Evolution

			Algorithm for Global Optimization
57	MMCITRE2025/083	Yujing Wang and Puneet Rana	An Unsupervised PINN-NTK Framework for Transport Phenomena in Complex Non-Newtonian Hybrid Nanofluid Confined Channel
58	MMCITRE2025/084	Roshni Somawar, and Parthasakha Das	An investigation of HIV transmission dynamics: Mathematical modelling approach
59	MMCITRE2025/086	Rohit, Bhupendra Gupta, Subir Singh Lamba	An efficient image encryption technique based on singular value decomposition and compressive sensing
60	MMCITRE2025/089	Abhishek Kumar Singh Sengar, Deepmala	Mathematical Model and Solution Approaches for the Aircraft Recovery Problem
61	MMCITRE2025/090	Shreya Kelkar and Niketa Trivedi	Sustainable inventory management with non-instantaneous deterioration: A Greenness integrated iso-elastic price and exponential time-dependent demand approach with partially backlogged shortages.
62	MMCITRE2025/091	Dibya Jyoti Bora, Rimpa Deka, and Mrinal Kranti Misra	Unsupervised Segmentation of Ovarian Cancer Histopathology Images Using Advanced Fuzzy Clustering Approaches: A Comparative Analysis
63	MMCITRE2025/092	Chitra K, Bangalore Lakshmi Roopa, Malathy B, Vikas Pandey, D Christo Stalin, and Aman Jolly	Ai And Iot-Enabled Predictive Energy Management For Renewable Energy Conversion Systems
64	MMCITRE2025/093	Chitra K, Bangalore Lakshmi Roopa, Malathy B, Vikas Pandey, D Christo Stalin, Aman Jolly	Machine Learning–Driven Energy Auditing And Climate-Resilient Agricultural Modeling Using Iot-Integrated Frameworks
65	MMCITRE2025/096	Naman Kumar Tater, Dharmik Chauhan, and Manoj Sahni	Performance Evaluation Framework for Tribological Behaviour in Quasi-Isotropic Material
66	MMCITRE2025/098	Siddharth, Rajgire Akhil Reddy, Utkarsh Gupta, and Avantika Singh	2D Floor Plan Generation Via Constraint Satisfaction Problem Modeling

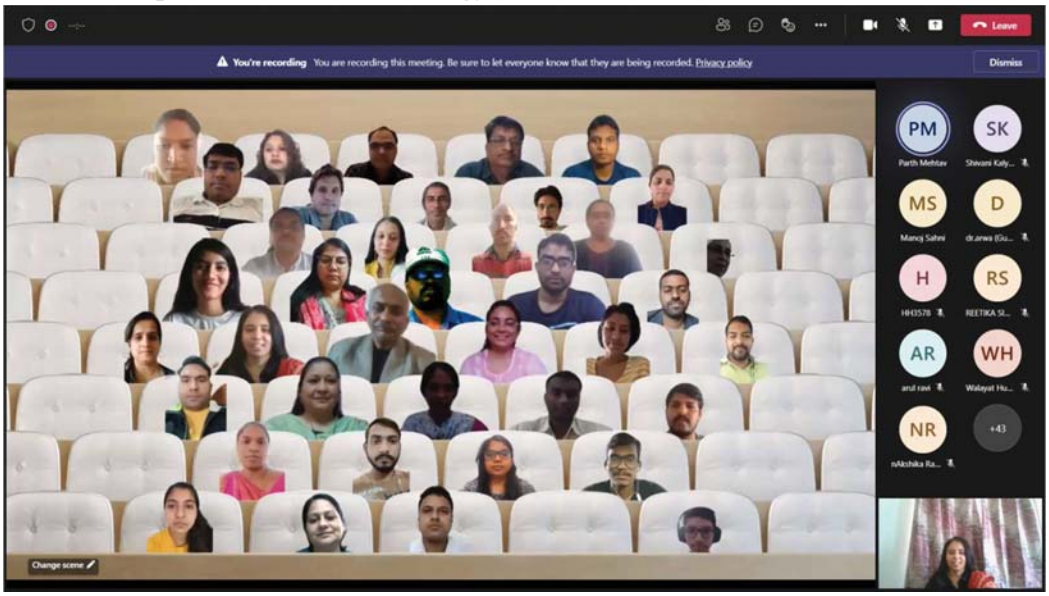
67	MMCITRE2025/099	Ethan Rebeiro ,Ketan Barkade, Yugansha Kabra, Dr.Soni Sweta, and Dr. Ajit Kumar	An Explainable AI System Integrating Vitals and Clinical Notes for Outcome Prediction and Length of Stay in Cardiac ICUs
68	MMCITRE2025/100	Akmal Husain	Analysis of the formation and evolution of two-dimensional steady shock waves in a real gas flow under thermal radiation effects
69	MMCITRE2025/101	Rupali Sharma, Arindam Basak, Rajaram Lakkaraju, and G. P.Raja Sekhar	Migration of a Viscous Spherical Droplet Driven by Potential Flow
70	MMCITRE2025/102	Krishnanand Vishwakarma, Ch Tarun Kumar, Bhupesh Kumar Rajak,and Mayank Dewangan	Integrating Multimodal Neural TTS for Interactive LMS
71	MMCITRE2025/103	Reeaa Rana, Diveyam Mishra, and Ajit Kumar Singh	Voice Instability Index and Clinically Grounded Prediction for Parkinson's Disease
72	MMCITRE2025/104	Junaid Mundichipparakkal, Ramandeep Kaur, Danthuluri Sudha, Santosh Kumar J, S Srushti, S. N. Mishra, Prolay Biswas	A Scalable ETL Framework for Historical Cryptocurrency Trend Analysis Using Binance API
73	MMCITRE2025/105	Chokkakula Karthik, Tankala Sri Vedanarayana, Anurag Singh, and Sresha Yadav nee Ghosh	Higher-order Statistical Features-based Machine Learning Approach for Evaluating Advertisement Effectiveness through Eye-Tracking Data Analysis
74	MMCITRE2025/106	Reeaa Rana, Vidhi Gharia, Ajit Kr. Singh	Multimodal Graph-Based Framework to Model Alzheimer's Disease Progression
75	MMCITRE2025/107	Md. Reazul Islam, Md. Owafeeuzzaman Patwary, Huzzatullah Sazzad, Md. Nashiruddin, Rishat Ryan, Aneem Al Ahsan Rupai, Rajarshi Roy Chowdhury	Safe Ride with IoT: Designing a Smart-Helmet for Detecting Accurate Accident Location and Automating Alerts via SMS and A Social Media Platform
76	MMCITRE2025/108	Shoba Pandian and Mohana N	Optimization of Phasor Measurement Unit Placement in toeplitz network

77	MMCITRE2025/109	Reeta Mondal, Tejaswini Pradhan	Similarity Measure Based Feature Selection for High-Dimensional Data Using Intuitionistic Fuzzy Sets
78	MMCITRE2025/110	Aneem Al Ahsan Rupai, Sudeep Mondal Deep, Sazzad Hossain, Md. Reazul Islam	A Multimodal Prediction Model for Smartphone Addiction Among Children Using Continuous Authentication Through Behavioral Biometrics
79	MMCITRE2025/112	Manoj Kumar, Amit Kumar, Anupam Bhandari	Magnetohydrodynamic hybrid nanofluid flow across a wedge surface with radiation effects
80	MMCITRE2025/113	Amit Kumar and Priyabrata Sethy	Magnetohydrodynamic Hybrid Nanofluid Flow and Irreversibility Analysis in a Square Cavity with Circular Obstacle
81	MMCITRE2025/114	Dhyanendra Tripathi, Yash Raj, Anurag Singh, and Sresha Yadav nee Ghosh	Font Type Analysis for Online Reading using Eye Tracking Technology

Photographs of the 1st International Conference on Mathematical Modeling, Computational Intelligence Techniques and Renewable Energy (MMCITRE2020) – February 21 – 23, 2020

Photographs of the 2nd International Conference on Mathematical Modeling, Computational Intelligence Techniques and Renewable Energy (MMCITRE2021) – February 06 – 08, 2021

Photographs of the 3rd
International Conference on Mathematical Modeling, Computational Intelligence Techniques and Renewable Energy (MMCITRE2024) – March 04 – 06, 2022



Photographs of the 4th
International Conference on Mathematical Modeling, Computational Intelligence Techniques and Renewable Energy (MMCITRE2024) – May 29 – 31, 2024

Photographs of the 5th
International Conference on Mathematical Modeling, Computational Intelligence Techniques and Renewable Energy (MMCITRE2025) – December 10 – 12, 2025

Contact Details:
Dr. Mithilesh Kumar Chaube, Phone: (+91) - 7771009332
Dr. Chandra Shekhar Nishad, Phone: (+91) - 8887518935
Prof. Manoj Sahni, Phone: (+91) - 7874441820
Email ID. mmcitre2025@iiitnr.ac.in, mmcitre2020@gmail.com