IMS NEWSLETTER

No. 55

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INDIAN MATHEMATICAL SOCIETY

INDIAN MATHEMATICAL SOCIETY

(Founded in 1907; Reg. No. S-550, Delhi)
Registered Office: Department of
Mathematics, Savitribai Phule Pune
University, Pune-411007

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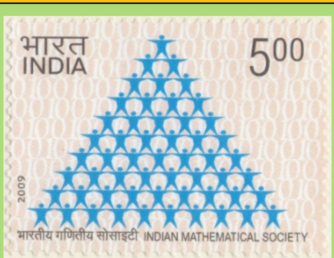

Facsimile of the Commemorative Postage Stamp on the 'Indian Mathematical Society' issued by the Department of Posts (Philately Division), Government of India, to mark the completion of 100 years of the Society. Released on the Inaugural day of the Platinum Jubilee 75th Annual Conference of the Society on 27th December 2009.

IMS Newsletter

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Contents

IMS FELLOWS FOR THE YEAR 2025

The IMS has started to honour/recognize Life Members of the IMS with IMS Fellowship for their contributions to Mathematics and/or the IMS from the year 2024. The following mathematicians have been selected as IMS Fellows in the year 2025.

1. Prof. R. Balasubramanian
Prof. R. Balasubramanian is a renowned Indian mathematician specializing in analytic number theory and cryptography. Formerly, he was a Professor and Director at the Institute of Mathematical Sciences (IMSc), Chennai. He is known for proving the 300-year-old Waring conjecture in 1986. He is a recipient of the Padma Shri (2006) and Shanti Swarup Bhatnagar Prize (1990). He was President of the IMS during the year 2023-24.

2. Prof. Peeyush Chandra
Prof. Peeyush Chandra is a distinguished Applied Mathematician in India. He served in the Department of Mathematics & Statistics at the Indian Institute of Technology (IIT) Kanpur for 33 years and retired as Professor in the year 2015. He is highly regarded for his extensive research in Biomathematics and, in particular, for his contributions to Mathematical Epidemiology and Mathematical Ecology. He is a Fellow of the National Academy of Sciences, India (NASI), and has received a Life-long Achievement Award from Vijnana Parishad of India. He was President of the Indian Mathematical Society (2009 - 2010) and also served the IMS as Academic Secretary (2018 - 2022) and Editor-in-Chief of JIMS (2022 - 2025).

3. Prof. B. Sury
Prof. B. Sury is a distinguished Professor in the Stat-Math Unit at the Indian Statistical Institute (ISI) Bangalore, specializing in algebraic number theory, algebraic groups, and K-theory. He is the national coordinator for the Mathematics Olympiad program in India and has authored numerous expository articles. He is a Fellow of the National Academy of Sciences, India. He was the President of the Indian Mathematical Society in the year 2020-21.

TRIBUTE TO PROFESSOR A. M. MATHAI

Late Professor A. M. Mathai
Emeritus Professor of Mathematics & Statistics, McGill University and Director, CMS
(28 April 1935 – 20 December 2025)

Eminent Mathematician Prof. A. M. Mathai passed away on December 20, 2025 at the age of 90. Prof. A. M. Mathai, an Emeritus Professor of Mathematics and Statistics at McGill University, Montreal, Canada, and Director of the Centre for Mathematical and Statistical Sciences, Kerala, India, served as the President of the Indian Mathematical Society during the year 2015-16.

Prof. Mathai was awarded the Founder recognition award from the Statistical Society of Canada, for which he was heavily involved in the foundation. He was a fellow of the National Academy of Sciences, India, and a Fellow of the Institute of Mathematical Statistics, USA.

Prof. Mathai has worked in statistics, applied analysis, applications of special functions, and astrophysics. Mathai established the Centre for Mathematical Sciences, Palai, Kerala, India. He was a rare blend of brilliance, humility, and institutional devotion, a legacy that will continue to guide and inspire the mathematical community.

The Indian Mathematical Society has instituted A. M. Mathai IMS Award for Applicable Mathematics (preferably having applications in other fields) from the year 2016.

His passing away is a big loss to mathematics and to the Indian Mathematical Society. The Indian Mathematical Society expresses deep sorrow at the passing away of Prof. A. M. Mathai.

May his soul rest in peace! Om Shanti.

A Brief Report on the 91st Annual Conference of the IMS -An International Meet

The 91st Annual Conference of the Indian Mathematical Society -An international Meet was organized at the Department of Mathematics and Astronomy, University of Lucknow, Lucknow, during December 26-29, 2025, under the presidency of Professor Shabd Sharan Khare, F. N. A. Sc., Former Pro Vice Chancellor, NEHU, Shillong. Prof. Vivek Sahai was the Local Organizing Secretary.

The inaugural function of the conference took place on December 26, 2025, from 10:00AM to 11:30AM by lighting of the lamp and the Saraswati Vandana. The function was presided over by the President of the IMS, Prof. S. S. Khare. Prof. Dipendra Prasad, Chairman, NBHM and Emeritus Fellow, IIT Bombay, Mumbai, was the chief guest for the occasion. Honourable Prof. Manuka Khanna, the Vice Chancellor of the University of Lucknow, Prof. M. M. Shikare, General Secretary, IMS, and Prof. G. P. Raja Sekhar, Academic Secretary, IMS, were the guests of honour. Prof. Vivek Sahai welcomed the guests and the participants. The General Secretary of IMS, Prof. M. M. Shikare, highlighted various activities of the Indian Mathematical Society. Prof. G. P. Raja Sekhar, the Academic Secretary of the IMS, reported on the academic programme of the conference. Various awards and prizes were presented to the award-winning candidates. Prof. Dipendra Prasad and Prof. Manuka Khanna inaugurated the conference and released the Souvenir cum Book of Abstracts. Prof. S. S. Khare delivered his presidential address titled, *"Relevance of Mathematical Sciences in National Development, its Current Status, Mathematics Phobia and its Prevention Strategies"*. The function concluded with a vote of thanks by Prof. Meena Sahai, Head, Department of Mathematics and Astronomy, University of Lucknow, followed by the National Anthem.

Details of the academic program

The academic program began with the President's Technical Address entitled: *Application of Algebraic Topology in Data Analysis and Latest Trends.* Following are the details of various plenary lectures, memorial award lectures and invited lectures:

1. The first **V. K. Patodi Plenary Lecture** was delivered by Professor Ezra Getzler, on *"Differential forms on triangulated manifolds and cubical complexes"*.

2. The second **Plenary Lecture** was delivered by Professor Dipendra Prasad, Emeritus Fellow, IIT Bombay, Mumbai, on *"Statistical behaviour of the dimension of irreducible representations"*.

3. **The 39th P. L. Bhatnagar Memorial Award Lecture** was delivered by Prof. Rajen Kumar Sinha, IIT Guwahati, on *"A space transformed finite element method for elliptic interface problems in $\mathbb{R}^n$"*.

4. **The 36th V. Ramaswami Aiyar Memorial Award Lecture** was delivered by Prof. Ramji Lal, University of Allahabad. The title of his talk was *"Universal commutator identities, Structures on groups, and Schur Theory"*.

5. **The 36th Srinivasa Ramanujan Memorial Award Lecture** was delivered by Prof. Saurabh Shrivastava, IISER Bhopal. It was titled, *"On the bilinear Bochner-Riesz problem"*.

6. **The 36th Hansraj Gupta Memorial Award Lecture** was delivered by Prof. Shrawan Kumar, University of North Carolina, on *"Tensor Product Decomposition of Compact Lie Group Representations"*.

7. **The 17th Ganesh Prasad Memorial Award Lecture** was delivered by Prof. S. Ponnusamy, IIT Madras, Chennai. His talk was titled, *"Coefficient Conjectures on Planar Harmonic Mappings"*.

8. **Invited Lecture 1:** Prof. Santosh B. Dhotre, Savitribai Phule Pune University, Pune, delivered a talk entitled *"Recent results concerning splitting operations on binary matriods"*.

9. **Invited Lecture 2:** Prof. Stephan Baier, Ramakrishna Mission Vivekananda Educational and Research Institute (RKMVERI), Kolkata, delivered a talk entitled, *"Old and new results on the large sieve"*.

10. **Invited Lecture 3:** Prof. Bhausaheb S. Desale, University of Mumbai, delivered a talk entitled *"Special Class of Solutions to MHD Flow of Fluids"*.

11. **Invited Lecture 4:** Prof. Usha K. Sangale, SRTM University, Nanded, delivered a talk entitled *"Hardy's Theorem Revisited: A New Approach"*.

12. **Invited Lecture 5:** Prof. Srinivas Kotyada, Institute of Mathematical Sciences, Chennai, delivered a talk entitled *"Euclidean algorithm in certain Number Fields"*.

13. **Invited Lecture 6:** Prof. D. Choudhuri, Indian Institute of Technology, Bhubaneswar, delivered an online talk entitled *"PDEs without derivatives in the classical sense"*.

Lectures given by the recipients of IMS awards.

The J. B. Shukla Award recipient, Dr. Ruchira Ray, University of North Bengal, delivered the talk entitled *Advanced Atherosclerosis and the Role of Cardiac Muscle Protein Markers*.

The A. K. Agarwal Award recipient, Dr. Shivam Singh Dhama, Indian Institute of Technology, Gandhinagar, delivered the talk entitled *Fluctuation analysis for a class of nonlinear systems with fast periodic sampling and small state-dependent white noise*.

The A. M. Mathai Award recipient, Dr. Tanmay Sarkar, Indian Institute of Technology, Jammu, delivered the talk entitled *Resistive Magnetic Induction Equation: IPDG Scheme and Error Estimates*.

The Subhash Bhatt Award recipient, Dr. Himadri Halder, IIT Bombay, delivered the talk entitled *Bohr radius for Banach spaces on simply connected domains*.

The A. Narasinga Rao Memorial Prize recipient, Dr. Namita Behera, Sikkim University, delivered her talk entitled *Linearizations and Backward Error Analysis for Rational Matrices*.

The P. K. Jain Award recipient, Dr. Chaitanya G K, Indian Statistical Institute, Bengaluru, delivered the talk entitled *Iterative roots of multidimensional maps*.

The Satya Deo Award recipient, Dr. Ayan Ghosh, Indian Association for the Cultivation of Science, Kolkata, delivered the talk entitled *Exploring Topologically Torsion Elements through the Lens of Arithmetic and Related Sequences*.

The P. L. Bhatnagar Memorial Prize was awarded to Mr. Kanav Talwar, New Delhi. He was winner of the Gold Medal and the top scorer of the Indian Team at the 66th International Mathematical Olympiad (IMO) that was held in Sunshine Coast, Australia, during July 10-20, 2025.

To encourage young researchers, the Indian Mathematical Society organizes a Paper Presentation Competition. The received papers were presented in the competition section. Dr. Ayushi Kapoor, University of Lucknow, and Ms. Samiksha Mahajan, SVNIT, Surat received IMS prizes for best paper presentation in Group-4 category. The V. M. Shah Prize was awarded to Mr. Ashish Bansal, Keshav Mahavidyalaya, Delhi.

As per the guidelines, laid down by the IMS to be eligible for the V. M. Shah Prize, the paper should not have been published in any journal. One of the contestants (who is not the winner) brought to the attention of the Academic Secretary that this condition has been violated by the winner of the prize and one more contestant.

A committee was constituted to review the claim of the contestant and take appropriate decisions. The committee found that the claim is true. Further, the committee made the following recommendations:

1. The V. M. Shah Prize that was announced stands withdrawn. A notification in this regard will be made available on the IMS website.
2. The participants concerned who suppressed information about the published work being submitted for the prize category will be debarred for participation in IMS events for a period of three years.
3. A summary of action taken has been given to the aggravated participant.

The recommendations have been implemented and the prize awarded to Mr. Ashish Bansal has been withdrawn.

For the IMS prize in Group-5 category, two papers were presented. However, these were adjudged not suitable for the award.

In all, six symposia were organized. The details are as follows:

1. **Symposium on Recent Advances in Algebra**
   (a) Prof. Meena Sahai, University of Lucknow, (Convenor),
   (b) Prof. Sudhir R. Ghorpade, IIT Bombay,
   (c) Prof. Victor Bovdi, United Arab Emirates University,
   (d) Prof. Tibor Juhász, Eszterházy Károly Catholic University,
   (e) Prof. R. K. Sharma, South Asian University,
   (f) Prof. Jugal K. Verma, IIT Gandhinagar,
   (g) Prof. Sukhendu Kar, Jadavpur University, Kolkata.
2. **Symposium on Operation Techniques**
   (a) Prof. S. K. Upadhyay, Indian Institute of Technology, Varanasi (Convenor),
   (b) Prof. Romesh Kumar, University of Jammu,
   (c) Dr. Ashish Pathak, Banaras Hindu University, Varanasi,
   (d) Prof. Lalit Kumar, Department of Mathematics, University of Delhi,
   (e) Prof. S. Ahmad Ali, Babu Banarasi Das University,
   (f) Prof. Vivek Sahai, University of Lucknow,
   (g) Prof. A. Swaminathan, Indian Institute of Technology Roorkee.
3. **Symposium on Inverse and Ill-posed Problems**
   (a) Prof Santhosh George, NIT Surathkal, (Convenor),
   (b) Prof. Pallavi Mahale, VNIT Nagpur,
   (c) Prof. M. T. Nair, BITS Pilani, Goa Campus,
   (d) Prof Robert Plato, University of Siegen,
   (e) Prof Ankik Kumar Giri, IIT Roorkee,
   (f) Dr. Manas Kar, IISER Bhopal.
4. **Symposium on Algebraic and Differential Topology**
   (a) Prof. Himadri Kumar Mukerjee, NEHU, Shillong, (Convenor)
   (b) Dr. Ardeline M. Buhphang, NEHU, Shillong,

(c) Dr. Kuldeep Saha, TCG CREST, Kolkata,
(d) Dr. Sainkupar M. Mawiong, NEHU, Shillong,
(e) Dr. Ajay Singh Thakur, IIT Kanpur.

5. **Symposium on Representation Theory of Lie Algebras**

(a) Prof. Punita Batra, HRI, Prayagraj, (Convenor)
(b) Dr. Tanusree Khandai, IISER Mohali,
(c) Dr. Saudamini Nayak, NIT Calicut,
(d) Dr. Umamaheswaran Arunachalam, SASTRA.

6. **Symposium on Function Theory**

(a) Prof. Swadesh Kumar Sahoo, IIT Indore, (Convenor)
(b) Dr. Sushil Gorai, IISER Kolkata,
(c) Dr. A. Sairam Kaliraj, IIT Ropar,
(d) Dr. P. Muthukumar, IIT Kanpur,
(e) Dr. Rakesh K. Parmar, Pondicherry University.

Special Session on How to make mathematics more palatable especially at High School and +2 level

(a) Prof. S. S. Khare, President IMS (Convenor)

(b) Prof. K. C. Sinha, Patna University,

(c) Dr. Ashok Rupner, IISER Pune,

(d) Mr. Jay Thakkar, IIT Gandhinagar,

(e) Prof. Shailesh Shirali, Sahyadri School, Pune

Contributed Papers.

As many as 325 papers were accepted for presentation in the Conference, including eight research papers for the paper presentation competition for various prizes. These papers were presented in 10 parallel sessions on December 26, 27, and 28, 2025. An online Paper Reading Session was organised on December 29, 2025, to accommodate registered participants who, due to various compelling circumstances, were unable to attend the conference in person. In all, 14 papers were presented in this online session. In all, 262 papers were presented. There were 63 absentees.

In all, 382 delegates attended the Conference.

On December 27, 2025, a colourful cultural programme comprising of classical singing and kathak dance performances was presented by the faculty and students of Bhatkhande Sanskriti Vishwavidyalaya, Lucknow. It was followed by the VC Dinner.

On December 27, and 28, 2025, excursion trips to Ayodhya were organised in collaboration with U.P. State Tourism Development Corporation Lucknow. In all, 74 delegates visited the holy city of Ayodhya.

The conference concluded with the general body meeting of the IMS, followed by the valedictory function. On behalf of the IMS and all the delegates, the President Prof. S. S. Khare and the General Secretary Prof. M. M. Shikare, expressed their appreciation and applauded the host university for successfully organizing the Conference.

Minutes of the 91st Annual General Body Meeting of the IMS

The Annual General Body Meeting of the Indian Mathematical Society (IMS) was held on Monday, 29th December 2025, at 12:00 noon in the Malviya Hall of the University of Lucknow, Lucknow. The meeting was presided over by Prof. S. S. Khare, the President of the Indian Mathematical Society. The meeting was attended by 103 Life members of the IMS.

The following deliberations took place in the meeting.

Item No. 1. To confirm the Minutes of the General Body meeting that was held on December 26, 2024, at 12.00 p.m. at MIT World Peace University, Pune.

The Minutes of the General Body meeting held on December 26, 2024, at 12.00 p.m. at MIT World Peace University, Pune, were circulated through IMS Newsletter Number 53 (May 2025) for the kind information of the members of the IMS. We did not receive any query/suggestion from the members of the IMS on the minutes. So, the minutes of the meeting are taken as confirmed.

Item No 2. To receive the report of the General Secretary for the year 2025

The General Secretary Prof. M. M. Shikare presented his report on various activities as follows.

1. **Newsletters**: The IMS newsletters, number 53 and number 54, were published in May 2025 and August 2025, respectively. The PDF files of the newsletters were also uploaded to the Indian Mathematical Society's website. The soft copies of the newsletters were sent by email to all the life members of the Society.

   Letters to the newly elected IMS office bearers, the president, and the three council members whose terms started with effect from April 1, 2025, were sent to them, and their acceptances were received.

2. **APC Meeting-2025:** A meeting of the Academic Planning Committee (APC) for deciding the academic program of the IMS Conference to be held at Lucknow University, Lucknow, was held on Friday, May 30th, 2025, from 11.00 a.m. to 1.00 p.m. at the Department of Mathematics and Astronomy, Lucknow University, Lucknow. The meeting was presided over by the President of the IMS, Prof. S. S. Khare. The names of the four memorial award lecturers, plenary speakers, invited speakers, list of symposia and their conveners were finalized. The Academic Secretary, in consultation with the General Secretary, has completed the task of contacting all speakers, inviting them to deliver the talks, and finalizing the full academic program of the conference.

3. **A. Narasinga Rao Memorial Prize for the year 2025:** The prize for the year 2025 has been given to Dr. Namita Behera (Department of Mathematics, Sikkim University, Gangtok-737102, Sikkim, India) for her paper entitled "Backward Error of Approximate Eigenelements of a Regular Rational Matrix" published in the Journal of Indian Mathematical Society (JIMS), Vol. 91 (1-2) (2024), 203 - 216.

   The Narasinga Rao prize of the IMS is given every year to the best paper published in JIMS or in Mathematics Student, published by the IMS. It carries a cash prize of Rs 4,000 (four thousand), a memento, and a citation.

4. **P. L. Bhatnagar Memorial Prize 2025:** The P. L Bhatnagar Prize 2025 has been awarded to Kanav Talwar, New Delhi. Kanav Talwar is the winner of the Gold Medal and the top scorer of the Indian team at the 66th International Mathematical Olympiad (IMO) that was held in Sunshine Coast, Australia, during July 10-20, 2025. The P. L. Bhatnagar Memorial Prize carries a cash prize of Rs 5,000 (five thousand), a memento, and a citation.

5. **A. K. Agarwal Award for the year 2025:** The A. K. Agarwal Award for the year 2025 has been awarded to Shivam Dhama* and Chetan D. Pahlajani (Discipline of Mathematics, Indian Institute of Technology Gandhinagar, Gandhinagar, India) for their paper entitled "Fluctuation analysis for a class of nonlinear systems with fast periodic sampling and small state-dependent white noise" that is published in Journal of Differential Equations, 362 (2023), 438–483.

   The award consists of Rs 10,000 and a citation. The Award is given every year to a young mathematician for the best paper published in the areas of Number Theory, Combinatorics, Discrete Mathematics, Analysis, or Algebra.

6. **A. M. Mathai Award for the year 2025:** The A. M. Mathai Award for the year 2025 has been awarded to Tanmay Sarkar (Department of Mathematics, Indian Institute of Technology Jammu, Jammu, India) for his paper entitled "Optimal error estimates of an IPDG scheme for the resistive magnetic induction equation" that is published in Partial Differential Equations and Applications, (2023), 4:25.

   The award consists of Rs 25,000 and a citation. The award is given every year to the author of the best paper published in the areas of Applicable Mathematics, such as Physical Sciences, Biological and Medical Sciences, Social Sciences, Probability and Statistics.

7. **Subhash Bhatt Award for the year 2025:** The award has been awarded to Vasudevarao Allu and Himadri Haldar* (School of Basic Sciences, Indian Institute of Technology Bhubaneswar, Bhubaneswar, Odisha, India) for their paper entitled "Bohr radius for Banach spaces on simply connected domains" published in Proceedings of the Edinburgh Mathematical Society, 67 (2024), 113–141. The award consists of Rs 25,000 and a citation. The award is given every year to the author(s) of the best paper in the areas of Functional Analysis, Harmonic Analysis, Operator Theory, and related areas.

8. **P. K. Jain Award for the year 2025:** The P. K Jain Award for the year 2025 is awarded to B. V. Rajarama Bhat and Chaitanya Gopalakrishna* (Stat-Math Unit, Indian Statistical Institute, Bengaluru, India) for their paper entitled "The non-iterates are dense in the space of continuous self-maps" that is published in Nonlinearity 36 (2023), 3419–3430

   The award consists of Rs 25,000 and a citation. The award is given every year to the author(s) of the best paper in the areas of Complex Analysis/Functional Analysis/ Harmonic Analysis/ Operator Theory and related areas.

9. **J. B. Shukla Award 2025:** The J. B. Shukla Award for the year 2025 has been awarded to Ruchira Ray* and Bibaswan Dey (Department of Mathematics, University of North Bengal, Raja Rammohunpur, Darjeeling, West Bengal, India) for their paper entitled "The role of biomarkers on hemodynamics in atherosclerotic artery" published in Physics of Fluids, 36, 101920 (2024); DOI: 10.1063/5.0232577.

   The award consists of Rs 25,000 and a citation. The award is given every year to the author(s) of the best research paper, published in the areas of Biomechanics, Bioinformatics, Mathematical Ecology, Mathematical Epidemiology, and related areas.

10. **Satya Deo Award 2025:** The Satya Deo Award for the year 2025 has been awarded to Pratulananda Das and Ayan Ghosh* (Department of Mathematics, Jadavpur University, Kolkata) for their paper entitled "Characterized Subgroups Related to some Non-arithmetic Sequence of Integers, which is published in Mediterranean Journal of Mathematics (2024) 21:164; https://doi.org/10.1007/s00009-024-02708-y.

11. We received one paper for B. N. Waphare Award 2025, but it was not found suitable to give the award. Also, no paper was received for the Satish Bhatnagar Award 2025. Therefore, these two awards are not being given to anyone in 2025.

12. **Digitization of the Back Volumes of The Mathematics Student:** All the volumes/ issues of The Mathematics Student which were available in the Library of the IMS housed at Ramanujan Institute of Advanced Studies in Mathematics, Chennai, have been digitized with the cooperation of Azim Premji University, Bangalore. This comprises about 90% of the total number of volumes. Attempts are being made to retrieve the remaining volumes of The Mathematics Student from the library of S. P. Pune University, Pune (or from elsewhere) and will be digitized soon. The Editor of the Mathematics Student, Prof. G. P. Youvaraj, is monitoring the digitization work. The digital archive will be made accessible to members of the IMS soon.

13. **IMS-Sponsored Conferences and Seminars:** Three events were organized as the IMS-sponsored conferences, seminars, and lectures in 2025. The details of the conferences and lectures are as follows.

    (a) International Conference: A three-day International Conference on Analysis, Discrete Mathematics and their Applications was organized at New Arts, Commerce and Science College (NACSC), Ahilyanagar, Maharashtra, during November 11-13, 2025, in honor of Prof. S. B. Nimse on the completion of 75 years of his age. The conference was organized in collaboration with the Indian Mathematical Society (IMS), the Department of Mathematics, Savitribai Phule Pune University (SPPU), Pune, and the Alumni Students Association of the College. Prof. Sudhir Ghorpade, Prof. Apoorva Khare, Prof. Hossein Jafari (University of South Africa), Prof. Robert Jamison (Clemson University, USA), Prof. Pawan Lingras (Saint Mary's University, Canada), Prof. Stephan Baier (RKMVERI), Prof. Jabbar Abbas Ghafil (University of Technology, Iraq), Prof. K. Srinivas (IMSc Chennai), Prof. Mohd Amin Sofi (University of Kashmir, Srinagar), Prof. P. Veeramani (IIT Madras), Prof. Prajakta Nimbhorkar (CMI Chennai), Prof. S. Shivaramakrishnan (IIT Mumbai) and Prof. Samir Chavan (IIT Kanpur) gave lectures in the conference. About 170 teachers and mathematics researchers attended the conference, and 95 researchers presented contributory papers during the conference.

    (b) National Conference: The Department of Mathematics, JSPM University Pune, organized a two-day National Conference in collaboration with the Indian Mathematical Society (IMS) on "Recent Advances in Pure, Applied and Industrial Mathematics Driven by Artificial Intelligence and Machine Learning" on 5th and 6th June 2025. The conference was organized in honor of Prof. S. B. Nimse on the completion of 75 years of his age. Prof. Bivudutta Mishra, BITS Pilani Hyderabad, Prof. Krishnedu Gangopadhyay, IISER Mohali, Dr. Makarand Sarnobat, The Parkar Avery Group, Pune, Dr. Prashant Arote, IISER Pune, delivered lectures in the conference.

    (c) A two-day webinar was organized at D. Y. Patil International University (DYPIU), Akurdi, Pune, on "Importance and Applications of Statistics and Mathematics" for faculty, research scholars, and students during August 29-30, 2025. Prof. B. Ramadoss, NIT Tiruchirappalli, Prof. Devendra Kumar, University of Technology and Applied Sciences, Shinas (Oman), Dr. Nabin Sen, UPES, Dehradun, Dr. Subhankar Dutta, MANIT Bhopal, Dr. Rakesh Kumar Saroj, JNU, New Delhi, gave lectures in the webinar.

    (d) A two-day seminar was organized by the Department of Computer Science, Department of Mathematics, and IQAC at S. S. V. P. S. L. K. Dr. P. R. Ghogrey Science College, Dhule, on "Application of Blockchains in Mathematics" on 27th and 28th April 2025. Dr. Minal S. Shukla, Blockchain Project Manager, MGI Group, Rajkot, served as the resource person, and the lectures were attended by faculty members, researchers, and students from the computer science and mathematics departments of the college.

14. **Guidance and help to the Local Organizing Secretary:** The usual guidance and help have been provided to Prof. Vivek Sahai, the Local Organizing Secretary of the 91st

Annual Conference of the IMS-An International Meet 2025, about various works like local arrangements, invitations, websites, certificates, and the inaugural function of the conference.

15. **Acknowledgments:** The General Secretary thanks Prof. M. M. Pawar for drafting the IMS newsletters 53 and 54 and for sending the volumes of the Mathematics Students and the copies of newsletters to all the life members of the IMS. I take this opportunity to express my gratitude to President Prof. S. S. Khare, the office bearers, and the Council members of the IMS for their support and help all along the way.

Item No. 3. To receive the report of the Academic Secretary, Prof. G. P. Raja Sekhar, for the year 2025

Report of the Academic Secretary, Prof. G. P. Raja Sekhar, for 2025.

I am elated that the 91st Annual Conference of the Indian Mathematical Society (IMS) - An International Meet is being organized at the University of Lucknow by the Department of Mathematics and Astronomy, from 26 – 29 December 2025. I extend a warm welcome to all IMS Council Members. It is with great pleasure that we gather here to review the conference arrangements and to discuss the agenda for the Council meeting. The Academic Planning Committee, IMS, has drawn up a rich academic program for this annual conference. We have Plenary talks, Memorial awards lectures, Invited talks, talks by distinguished award winners, and symposia on diversified themes.

The list is as follows:

Plenary Lectures:

V. K. Patodi Plenary Lecture: Prof. Ezra Getzler, Northwestern University, Chicago, USA.
IMS Plenary Lecture: Prof. Dipendra Prasad, IIT Bombay.

Memorial Award Lectures:

P. L. Bhatnagar Memorial Award Lecture: Prof. Rajen Kumar Sinha, IIT Guwahati.
Hansraj Gupta Memorial Award Lecture: Prof. Shrawan Kumar, Univ. of North Carolina.
Srinivasa Ramanujan Memorial Award Lecture: Dr Saurabh Srivastava, IISER Bhopal.
V. Ramaswamy Aiyer Memorial Award Lecture: Prof. Ramji Lal, University of Allahabad.
Ganesh Prasad Memorial Award Lecture: Prof. S. Ponnusamy, IIT Madras.

Invited Talks

Dr. Debajyoti Choudhuri, School of Basic Sciences, IIT Bhubaneswar, Bhubaneswar, India
Dr. S. B. Dhotre, Center for Advanced Study in Mathematics, Savitribai Phule Pune University, Pune, India
Prof. Stephan Baier, Ramakrishna Mission Vivekananda Educational and Research Institute, Howrah, Kolkata, India
Prof. B. S. Desale, Department of Mathematics, University of Mumbai, Mumbai, India
Prof. Usha K. Sangale, SRTM University, Nanded, India
Prof. Srinivas Kotyada, Department of Mathematics, IMSc, Chennai, India

Symposia Themes and the Conveners:

Inverse and Ill-posed Problems: Convenor: Prof. Santosh George, Department of Mathematics, NIT, Surathkal, India.
Algebraic and Differential Topology: Convenor: Prof. Himadri Kumar Mukerjee, Northeastern Hill University, Shillong, India.
Operation Techniques: Convenor: Prof. S. K. Upadhyay, Department of Mathematical Sciences, Indian Institute of Technology (Banaras Hindu University), Varanasi, India.
Representation Theory of Lie Algebras: Convenor: Prof. Punita Batra, HRI, Prayagraj, India.
Function Spaces: Convenor: Prof. S. K. Sahoo, Department of Mathematics, IIT Indore, India.
Recent Advances in Algebra: Convenor: Prof. Meena Sahai, Department of Mathematics and Astronomy, University of Lucknow, Lucknow, India.

There has been an extraordinary response to the conference, and we have received about 320 research papers for contributory presentations, which are accepted, and a total of 300 registered. There are 7 papers for various prize categories, three papers in Group 4, two papers in Group 5, and three papers in V. M. Shah Group that have been received for presentations for IMS prizes. There is a session on the Mathematics outreach event. This sets a record and increases responsibility. Such a great response reflects the spirit of “Mathematics for everyone- Mathematics everywhere”

when the world talks about AI & ML, and Quantum computing.
Appeal: I appeal to the APC that we may avoid repetition of speakers and topics to bring diversity.
I appeal to the Council to form a committee reviewing the IMS sectional themes, new model for the Prize category.
Acknowledgements: I take this opportunity to thank all the IMS Council members, in particular the General Secretary, for their continuous support. I thank the President of IMS for taking the initiative to arrange the Mathematics outreach event. I also thank the Organizing Secretary of IMS2025 for their continuous planning and support to arrive at this stage.

Wishing you all a Happy Festive Greetings.

Item No. 4. To consider the Audited Statement of Accounts for the year 2024-25, revised budget for 2025-26, and the budget estimates for the Financial Year 2026-27, presented by Prof. M. M. Pawar, the treasurer of the IMS.

The Audited Statement of Accounts for the year 2024-25, the revised budget for 2025-26, and the budget estimates for the Financial Year 2026-27 presented by Prof. M. M. Pawar, the treasurer of the IMS, have been approved by the General Body of IMS.

Item No. 5. To receive the report of the Editor-in-Chief of the JIMS, Prof. Pankaj Jain, for 2025.

Report of the Editor-in-Chief of the Journal of Indian Mathematical Society, Prof. Pankaj Jain, for the year 2025,

1. I assumed the charge of Editor-in-Chief of JIMS on 01.04.2025
2. Data received from the previous Editor-in-Chief, Prof. Peeyush Chandra, on 15.04.2025:
   (a) Status before 21.12.2024
      i. Articles Accepted - 53
      ii. Articles under review - 14
   (b) Status from 21.12. 2024 to 01.04.2025
      i. Articles received — 85
      ii. Articles Accepted - 1
      iii. Articles with Editor/ Referee - 26
      iv. Articles Rejected - 57
      v. Article not assigned - 1
   (c) Articles Published - 29 (Vol 92(1) - 15, Vol 92(2) - 14)
3. Consolidated Status as on 22.12.2025:
   (a) Articles accepted – 36
   (b) Articles under review – 53
   (c) Articles not assigned – 12
   (d) Articles Incomplete* – 87
   (e) Articles Published - 28 (Vol 92(3) - 14, Vol 92(4) - 14)
   (* Authors initiated submission, manuscript number was created, but the submission was not completed)
4. Volume 93(1) will be published in January 2026.

I wish to put on record my sincere thanks to the Members of the Editorial Board and Referees. Special thanks to Prof. M. M. Pawar, Managing Editor, who made it possible to bring out the JIMS issues well in time, and for his meticulous proofreading.

Item No. 6. To receive the report of the Editor-in-Chief of The Mathematics Student, Prof. G. P. Youvaraj, for 2025.
Report of the Editor in Chief of the Mathematics Student, Prof. G. P. Youvaraj, for the year 2025.

- **As per the 2024 report, there were fifty-eight papers under process.**

Accepted	20
Rejected	24
Under review	13
Withdrawn	1

- This year, 2025, the Mathematics Student has received, as of December 22, a total of 95 papers.

Accepted	11
Rejected	16
Under Review	61
Withdrawn	1
Under Process	6

- Volume 94 (1-2) 2025 was published in May, and Volume 94 (3-4) 2025 was published in November.
- As per the MOU between IMS and Azim Premji University on the digitization of the old volumes of The Mathematics Student, Professors Varadarajan and Mohan, from Azim Premji University, have collected 67 volumes of The Mathematics Student from the IMS library at Ramanujan Institute, University of Madras on April 26, 2024. They have finished digitizing these volumes, except for three volumes whose papers were fragile. They have returned all the volumes to the IMS library at Ramanujan Institute on July 27, 2024. They will give the IMS a copy of these digitized volumes in the first week of January 2025. In January, they plan to digitize the remaining volumes available at the Savitribai Phule Pune University, Pune.

Item No. 7. To consider the venue of the next (i. e., 92nd) Annual Conference of the IMS.

The IMS Council accepted the invitation received from the President of the South Asian University, New Delhi, for the organization of the 92nd Annual Conference of the Indian Mathematical Society. Therefore, the 92nd Annual Conference of the IMS-An International Meet will be held at South Asian University, New Delhi, and Prof. Pankaj Jain, Vice President, South Asian University, New Delhi, will be the Local Organising Secretary of the Conference.

Item No. 8. To receive the report of the Returning Officer for IMS elections for the year 2025.

Report of the Returning Officer, Prof. B. N. Waphare, for the year 2025. In the Council meeting of IMS held at MIT Pune in 2024, the Council nominated Prof. Mohammad Amin Sofi (Rtd. Professor), Kashmir University, Srinagar for election to the Office of the President of the Society for one year with effect from April 01, 2026 and also nominated Prof. P. P. Malavadkar (MIT World Peace University, Pune), Prof. Apoorva Khare (IISc Bangalore) and Prof. Ram Prakash Sharma (NIT, Jote Papum, Arunachal Pradesh) for election as the members of the Council for three years beginning from April 1, 2026. No other nomination was received from the members of the IMS for election to the office of the President and to the posts of Council member. Therefore, Prof. Sofi is elected unopposed. Further, Prof. P. P.Malavadkar (MIT World Peace University, Pune), Prof. Apoorva Khare (IISc Bangalore), and Prof. Ram Prakash Sharma (NIT, Jote Papum, Arunachal Pradesh) are elected as members of the Council for three years, with effect from April 1, 2026.

Item No. 9. Any other item with the permission of the chair.

There was no item to discuss or make decisions.

The meeting ended with thanks, by the General Secretary, to the Chair and the members of the IMS for attending the meeting and participating actively in the deliberations of the meeting.

Prof. M. M. Shikare
General Secretary, IMS
Date: January 16, 2026

Call for Applications for Various Awards to be Given by the IMS in the Year 2026

Applications are invited from researchers in Mathematics for the following Awards to be given by the Indian Mathematical Society (IMS) for the year 2026. The last date for receiving the applications is June 30, 2026. The applications should be sent to Prof. M. M. Shikare, the General Secretary of the IMS, along with a copy of the published paper and the proof of the age on the e-mail address: `gensecims@gmail.com`.

The awardee (younger one in case of joint authors) will be invited to deliver a lecture or a poster presentation based on the awarded paper in the Annual Conference of the IMS-An International Meet to be held at South Asian University, New Delhi in December 2026. Further, he/she will be reimbursed TA to the extent of AC-2 Tier return train fare from his/her place of residence in India to the venue of the Conference. The awardee will be provided with free local hospitality during the period of the conference by the host institute. The decision of the IMS in this regard will be final and cannot be challenged in any court.

A. K. Agarwal Award

Terms and Conditions for the Award:

(a) The paper should be in the areas of Number theory, Combinatorics, Discrete Mathematics, Analysis and Algebra.

(b) The paper should be under the authorship of at most two authors and at least one of them should be below the age of 45 years as on 31st December 2026.

(c) The paper should have been published online or in print in an internationally reputed journal either in the year 2024 or in 2025.

(d) The author(s) should be Indian citizen(s) and must have carried out the said research work in India.

(e) The paper must be submitted by the younger author. Only one publication can be submitted for this award, and the paper should not have been submitted for any other category of such awards. Further, an awardee in this category is not eligible to submit papers for consideration in later years. However, he/she can submit a paper for any other Award.

(f) The award carries a citation and a cash prize of Rs. 10,000/-. In the case of joint authorship of the awarded paper, the prize amount will be equally divided between the two authors.

A. M. Mathai Award

Terms and Conditions for the Award:

(a) The paper should contain significant contributions in Applicable Mathematics preferably having applications in other fields such as Physical Sciences, Biological and Medical Sciences, Social Sciences, Probability and Statistics.

(b) The paper should be under the authorship of at most two authors and at least one of them should be below the age of 45 years as on 31st December 2026.

(c) The paper should have been published online or in print in an internationally reputed journal either in the year 2024 or in 2025.

(d) The author should be associated with a university /college / institution in India where the work was done and the paper must have a mention of the name of that institution as affiliation (the person need not be an Indian citizen).

(e) The paper must be submitted by the younger author. Only one publication can be submitted for this award, and the paper should not have been submitted for any other category of such awards. Further, an awardee in this category is not eligible to submit papers for consideration in later years. However, he/she can submit a paper for any other Award.

(f) The award carries a citation and cash prize of Rs. 25,000/-. In the case of joint authorship of the awarded paper, the prize amount will be equally divided between the two authors.

Satish Bhatnagar Award

Terms and Conditions for the Award:

(a) The paper must be in the area of History of Mathematics focusing on a person, problems, region, system of education or government.

(b) The paper should be under the authorship of at most two authors and both of them should be above the age of 35 years as on 31stDecember 2026.

(c) The paper should have been published online or in print in an internationally reputed journal either in the year 2024 or in 2025.

(d) The author(s) need not be Indian citizen(s) and must have a Ph. D. degree in any subject.

(e) The Author(s) can submit only one publication for this award and the paper should not have been submitted for any other category of such awards. Further, an awardee in this category is not eligible to submit papers for consideration in later years. However, he/she can submit a paper for any other Award.

(f) The award carries a citation and a cash prize of Rs. 10,000/-. In the case of joint authorship of the awarded paper, the prize amount will be equally divided between the two authors.

(g) *Nominations for this award will also be considered.*

Subhash Bhatt Award

Terms and Conditions for the Award:

(a) The paper should be in the areas of Functional Analysis/Harmonic Analysis/ Operator Theory and related areas.

(b) The paper should have been published online or in print in an internationally reputed journal either in the year 2024 or in 2025.

(c) The paper should be under the authorship of at most two authors and at least one of them should be below the age of 45 years as on 31stDecember 2026.

(d) The author(s) should be Indian citizens and must have carried out the said research work in India.

(e) The paper must be submitted by the younger author and only one publication can be submitted for this award and the paper should not have been submitted for any other category of such awards. Further, an awardee in this category is not eligible to submit papers for consideration in later years. However, he/she can submit a paper for any other Award.

(f) The award carries a citation and a cash prize of Rs 25,000/-. In the case of joint authorship of the awarded paper, the prize amount will be equally divided between the two authors.

P. K. Jain Award

Terms and Conditions for the Award:

(a) The paper should be in the areas of Complex Analysis/Functional Analysis/ Harmonic Analysis/ Operator Theory and related areas.

(b) The paper should be under the authorship of at most two authors and at least one of them should be below the age of 45 years as on 31st December, 2026.

(c) The paper should have been published online or in print in an internationally reputed journal either in the year 2024 or in 2025.

(d) The author(s) should be Indian citizen and must have carried out the said research work in India.

(e) The paper must be submitted by the younger author and only one publication can be submitted for this award, and the paper should not have been submitted for any other category of such awards. Further, an awardee in this category is not eligible to submit papers for consideration in later years. However, he/she can submit a paper for any other Award.

(f) The award carries a citation and a cash prize of Rs 25,000/-. In the case of joint authorship of the awarded paper, the prize amount will be equally divided between the two authors.

B. N. Waphare Award

Terms and Conditions for the Award:

(a) The paper should contain significant contributions in the areas of (i) Lattice Theory, Partially Ordered Sets and related areas; (ii) Graph Theory, Matroid Theory, Combinatorics and related areas; or (iii) Non-commutative rings and rings with involution, Baer*-rings and related areas. Preference will be given to areas listed in (iii) above. In case a paper is not found suitable in the stipulated area of the research then paper for the award may be considered from other areas listed in (i) and (ii).

(b) The paper should be under the authorship of at most two authors and there is no age limit.

(c) The paper should have been published online or in print in an internationally reputed journal either in the year 2024 or in 2025.

(d) The award is open to Indian Citizens or to Persons of Indian Origin (PIO).

(e) The Author(s) can submit only one publication for this award and the paper should not have been submitted for any other category of such awards. Further, an awardee in this category is not eligible to submit papers for consideration in later years. However, he/she can submit a paper for any other Award.

(f) The award carries a citation and a cash prize of Rs. 30,000/-. In the case of joint authorship of the awarded paper, the prize amount will be equally divided between the two authors.

J. B. Shukla Award

Terms and Conditions for the Award:

(a) The paper should contain significant contributions in the broad areas of Mathematical Biology e. g. Biomechanics, Bioinformatics, Mathematical Ecology, Mathematical Epidemiology and related areas.

(b) The paper should be under the authorship of at most two authors and at least one of them should be below the age of 45 years as on 31stDecember 2026.

(c) The paper should have been published online or in print in an internationally reputed journal either in the year 2024 or in 2025.

(d) The award is open to Indian Citizens as well as to Persons of Indian Origin (PIO), however the work should have been carried out inIndia.

(e) The paper must be submitted by the younger author. Only one publication can be submitted for this award, and the paper should not have been submitted for any other category of such awards. Further, an awardee in this category is not eligible to submit papers for consideration in later years. However, he/she can submit a paper for any other Award.

(f) The award carries a citation and a cash prize of Rs 25,000/-. In the case of joint authorship of the awarded paper, the prize amount will be equally divided between the two authors.

Satya Deo Award

Terms and Conditions for the Award:

(a) The paper should be in the areas of Topology, Algebraic Topology and related areas.

(b) The paper should be under the authorship of at most two authors and at least one of them should be below the age of 45 years as on 31stDecember 2026.

(c) The paper should have been published online or in print in an internationally reputed journal either in the year 2024 or in 2025.

(d) The author(s) should be Indian citizen(s) and must have carried out the said research work in India.

(e) The paper must be submitted by the younger author. Only one publication can be submitted for this award, and the paper should not have been submitted for any other category of such awards. Further, an awardee in this category is not eligible to submit papers for consideration in later years. However, he/she can submit a paper for any other Award.

(f) The award carries a citation and a cash amount of Rs. 25,000/-. In the case of joint authorship of the awarded paper, the prize amount will be equally divided between the two authors.

S. B. Nimse Award

Terms and Conditions for the Award:

(a) Paper should be in the areas of Topology and Data Science, Fuzzy Mathematics, Computational Mathematics, Soft Computing and related topics.

(b) The paper should have been published online or in print in an internationally reputed journal either in the year 2024 or in 2025.

(c) The paper should be under the authorship of at most two authors and at least one of them should be below the age of 45 years as on 31st December 2026.

(d) The author(s) should be Indian citizens and must have carried out the said research work in India.

(e) The paper must be submitted by the younger author. Only one publication can be submitted for this award, and the paper should not have been submitted for any other category of such awards. Further, an awardee in this category is not eligible to submit papers for consideration in later years. However, he/she can submit a paper for any other Award.

(f) The award carries a citation and a cash prize of Rs 25,000/-. In the case of joint authorship of the awarded paper, the prize amount will be equally divided between the two authors.

R. S. Pathak Award

Terms and Conditions for the Award:

(a) The paper should be in the areas of Integral Transforms, Distribution Theory, Wavelets, Microlocal Analysis, and related fields.

(b) The paper should have been published online or in print in an internationally reputed journal either in the year 2024 or in 2025.

(c) The paper should be under the authorship of at most two authors and there is no age limit.

(d) The author(s) should be Indian citizens and must have carried out the said research work in India.

(e) The paper must be submitted by the younger author. Only one publication can be submitted for this award, and the paper should not have been submitted for any other category of such awards. Further, an awardee in this category is not eligible to submit papers for consideration in later years. However, he/she can submit a paper for any other Award.

(f) The award carries a citation and a cash prize of Rs 25,000/-. In the case of joint authorship of the awarded paper, the prize amount will be equally divided between the two authors.

Prof. M. M. Shikare
General Secretary, IMS

Call for Research Papers for Various Prizes to be given by the IMS in the year 2026

In order to encourage and inspire the young and budding researchers in mathematics, the IMS organizes a Special Session of Paper Presentation Competition during its Annual Conferences for various Prizes to be awarded to the best research papers presented in different categories. This Special Session is organized as a part of the Academic Programme. Each of the eight prizes listed below carries a Certificate and a Memento. Interested researchers should submit their research papers (in pdf format), Abstract (not exceeding 250 words, in LaTeX and pdf format), proof of age and CV along with the covering letter to Prof. G. P. Raja Sekhar, The Academic Secretary, IMS via e-mail: `acadsecrims@gmail.com`. The last date of receiving applications is August 31, 2026. The details of the prizes, groups and areas are as follows:

(1) A. M. U. Prize: Algebra, Differential Geometry and Functional Analysis.

(2) V. M. Shah Prize: Real Analysis, Complex Analysis, Fourier Analysis, Harmonic Analysis, Approximation Theory and related areas.

(3) IMS Prize-group-1: Discrete Mathematics (Combinatorics, Graph Theory, Posets), Lattice Theory, Set Theory, Logic, Number Theory and related areas.

(4) IMS Prize-group-2: Geometry, Algebraic Geometry, Topology, Algebraic Topology, and related areas.

(5) IMS Prize-group-3: Measure Theory, Probability Theory, Stochastic Processes, and related areas.

(6) IMS Prize-group-4: Differential / Integral / Functional equations and inequalities, Special Functions, Numerical Analysis and related areas.

(7) IMS Prize-group-5: Solid Mechanics, Fluid Mechanics, Electromagnetic Theory, Magneto-Hydrodynamics, Astronomy, Astrophysics, Relativity and related areas.

(8) IMS Prize-group-6: Operations Research, Optimization, Computational Mathematics, Information Technology, Bio-mathematics, History of Mathematics and related areas.

Terms and Conditions for the applicants to participate in the Competition:

1. Only the Members of the Society are eligible for participation in the Competition.
2. The paper should be under the authorship of at most two authors, and at least one of them should be below the age of 40 years as on 31st December 2026. However, the papers under single authorship will be preferred.
3. The author(s) should give a declaration that the work is unpublished and it has not been submitted for competition anywhere else till the award of the prize.
4. The work must have been carried out in India.

Prof. M. M. Shikare
General Secretary, IMS

IMS LIBRARY

The information pertaining to the IMS library is available on the website `www.indianmathsoc.org` of the society.

PERIODICALS PUBLISHED BY THE IMS

The Society publishes two periodicals: **The Journal of the Indian Mathematical Society** (JIMS; Print ISSN 0019-5839, Online ISSN 2455-6475) and **The Mathematics Student** (Print ISSN 00255742), both of which are quarterly. The details can be found on the website: `https://www.indianmathsoc.org/index.html`

Paper Submission:
The authors should prepare the manuscript in LaTeXby following the, 'Instruction to Authors' at

`https://www.informaticsjournals.co.in/index.php/jims/ia`

The pdf of manuscript should be submitted to the Journal of Indian Mathematical Society online after registration at

`www.informaticsjournals.co.in/index.php/jims/user/register`

In case of any problem in submission of manuscript, contact at `journal.ims1910@gmail.com`
For the Mathematics student, a manuscript can be submitted to the Editor-in-Chief on
E-mail: `msindianmathsociety@gmail.com`

Annual subscription for the Journal / the Mathematics Student :

The subscription rates for 2026 for each IMS periodical have been revised, as follows:

- For Life Members (for personal use and not for sale/resale)
  - Having a mailing address in India: Rs 3500.00
  - For other Life Members: US$ 100*. Only the Print copy will be available.
- For Educational Institutions in India:
  - Direct subscription
    Print Copy or Online Copy: Rs. 3500.00.
    Print and Online Copy: Rs. 6000.00.
  - Subscription through an agent
    Print Copy or Online Copy: Rs. 4000.00.
    Print and Online Copy: Rs. 7000.00.
    (Agency discount: 15 %. Name and address of the institute are to be provided.)
- For Foreign subscription:
  Print Copy or Online Copy: US $ 250.00.
  Print and Online Copy: US $ 350.00.
  (Agency discount: 15 %.)
- For all other subscribers:
  For personal use or for the agents who do not supply the name and address of the end user (the agents' discount is 15%): Rs 15000.00.
- For online Volumes:
  For the Complete Online Archive + Current Volume for one year: Rs 10,000.00

Note: For the Mathematics Student online copy is not available; only the Print Copy is available.

From the year 2012 onwards, the life Members of IMS are given online access to `The Mathematics Student`. Also, instead of supplying the hard copy, the soft copy of `The Mathematics Student` and newsletters are sent to their email addresses registered with the society.

It may please be noted that the contents of The Mathematics Student will continue to be available on the Society's website https://www.indianmathsoc.org/index.html and a physical copy of The Mathematics Student will continue to be available at the IMS Library (Ramanujan Institute of Advanced Study in Mathematics, Madras University, Chennai,) as well as at The Registered Office of the Society (Department of Mathematics, S. P. Pune University, Pune 411 007).

It is observed that emails of many life members have been bounced. So, to update the email address, all life members who have registered their membership before 2022 are requested to fill out the Google form attached herewith. Also, the members registered after 2022 and are not receiving any communication from IMS should also fill out the Google form available at

https://forms.gle/48ZifVEVs9UVWYHH6.

Memberships of the IMS

1. Membership terms:

i) Applicant should be a graduate and should have an interest in the Objectives and activities of the IMS.

ii) All such persons as the Council of the IMS may admit from time to time to membership shall be the members of the Society.

iii) Membership applications should be made on the Application form available on the IMS website.

iv) The Council of the IMS may refuse to admit to membership any person without assigning any reason for the refusal.

v) Member of good standing: A member is considered to be of good standing in a particular year if he/she has paid his/her student (or life) Membership fees by July 31of that year.

2. There are three types of members of the Society:

i) Life Members: Any eligible person can be enrolled as a life member by applying on the prescribed form and by paying the membership fees as prescribed by the IMS.

ii) Student Members: An unemployed person pursuing a Ph.D. programme can be enrolled as a student member by applying on the prescribed form along with the letter of Ph. D. registration from the concerned university and by paying the membership fees as prescribed by the IMS. . (For UG students, there is no membership for M. Sc. student only annual or life membership)

This membership will come to an end on March 31 of the financial year in which the member secures employment or completes a Ph.D. degree, or 5 years from the date of Ph.D. registration (whichever is earlier), irrespective of the date of payment of membership fees.

During the period of student membership, a member has the option to convert the student membership to a life membership by applying to the Treasurer and paying the remaining amount (i.e. difference between the Life membership fee prescribed by IMS at that time and the student membership fee paid by the member).

iii) Annual Members: Any eligible person can be enrolled as an annual member of the IMS by applying on the prescribed form and by paying the annual membership fees as prescribed by the IMS. This membership will come to an end on March 31 of the financial year in which he/she has registered as an annual member, irrespective of the date of payment of membership fees.

3. Rights and Obligations of the Members:

i) All Annual, Student, and Life members shall be entitled to receive communications about the activities of the Society, to participate in its conferences.

ii) Every year, all Life members, Annual members, and Student members with a validity certificate shall be entitled to receive soft copies of issues of the Mathematics student and IMS Newsletters published during that year.

iii) A member with good standing shall attend the General Body Meeting and will be eligible to vote.

iv) Only life members will be eligible to be elected as a member of the IMS Council.

v) (a) A life member will be issued a fee receipt and a Life membership certificate.

(b) A Student member will be issued a fee receipt and a student membership validity certificate for the year of registration. He/she must obtain a student membership validity certificate every year in April from the treasurer of the IMS. For this purpose, candidates must submit a letter from their research guide stating that the candidate is unemployed and a Ph.D. degree has not yet been awarded to him/her.

(c) An annual member will be issued a fee receipt. No certificate will be issued to an annual member.

4. Membership Fees:

With effect from May 01, 2026, the membership fee structure is as follows:
i) Life Membership fee -

For Indian citizens Rs. 4000/-

For citizens from SAARC countries - US$75/-

For citizens of the Societies having Reciprocity arrangement with the IMS, US$140/- For others (citizens from other countries) US $150/- .

ii) Students Membership fee -

For Indian citizens Rs. 2000/-

For members from SAARC countries - US$40/-

For members of the Societies having Reciprocity arrangement with the IMS, US$70/- For others US $75/- .

iii) Annual Membership -

For students, Rs. 500/- (US $25/- for foreigners).

For others, Rs. 1000 /- (US $50/- for foreigners).

To avail the student facility, students should attach a Bonafide certificate from the concerned University Department/College/Institute.

The membership fees should be paid online. The bank details for online transfer of the fees are as follows.

1) Name of the Account Holder : Indian Mathematical Society.

2) Account No. : 0981000100312287

3) Name of the Bank : Punjab National Bank.

4) IFSC Code: PUNB0375900

5) Branch Name and Address : Adalat Road Branch, Aurangabad - 431001.

The scanned copy of the completed membership application form should be emailed to the IMS treasurer at treasurerindianmathsociety@gmail.com for processing.

If someone has any difficulty regarding membership, he/she should contact the treasurer of the IMS at the email address given above.

If anyone applies for membership and does not receive any reply within one month from the date of application, then he/she can contact the General Secretary of IMS at gensecims@gmail.com

Appeal for Support to the IMS Building Complex - Ganit Bhawan, Pune

The Indian Mathematical Society (IMS) is the oldest Scientific Society of our country which was founded in 1907. It has been serving the cause of promoting mathematical research and teaching in the universities, colleges, research Institutes like IITs, IIERs etc. in the entire country. The Society had been instrumental in publishing the earliest work of the legendary mathematician Srinivasa Ramanujan which was instrumental in getting the attention of the world to his work in the beginning of his career. A large number of eminent Indian Mathematicians have been associated with the IMS and have also served the Society in the capacity of its President and/or other office bearers in the past. IMS continues to get the support mathematicians across the country. All its Council members work voluntary and do not receive any honorarium.

For a long time the IMS was planning for its own campus. I am glad to share that The Indian Mathematical Society has now purchased a plot of land near Pune Airport in Pune for having its permanent Headquarters. The land is about 44,000 sq ft in area with a cost of about Rs. 2.1 crore including registration and boundary fencing etc.

The Council of the IMS is now planning to develop a building complex (Ganit Bhawan) having all facilities like an office, an auditorium, a library, a computer center, meeting halls, and a guest house for small conferences, and so on. The main building on the campus is planned to be a 'four storey structure' accommodating all of these requirements. The estimated cost of the project is about Rs. 13 crores.

It may be noted that the IMS is a non-profit organization and not supported by any Government organization, and depends on the membership fees and a small amount of money coming from the subscription of its two periodicals. It is supported by the NBHM, DST and other agencies only for organizing its annual conferences. Therefore, the funds needed for developing this complex will depend mostly on the donations from well wishers and life members.

On behalf of the Council of the IMS, I am, making this appeal to all of you to generously support the IMS in building its complex by giving donations of any amount that you can conveniently give. It may be mentioned that donations received after Oct. 1, 2021 are eligible for exemption under Section 80 G of the Income Tax Act of the Govt of India. All donations will be acknowledged on the website of the IMS.

The donations can be made by bank transfer with the following details:

1. Name of the Account Holder: Indian Mathematical Society.
2. Account No.: 0981000100312287
3. Name of the Bank: Punjab National Bank.
4. Branch Name and Address: Adalat Road Branch, Chhatrapati Sambhajinagar - 431001
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Prof. M. M. Shikare
General Secretary, IMS

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The Council reserves its right to accept or decline any particular donation.

Awards, Prizes and Fellowships in Mathematics

Abel Prize 2026

The 2026 Abel Prize has been awarded to Gerd Faltings of the Max Planck Institute for Mathematics in Bonn, Germany. Faltings received the prize “for introducing powerful tools in arithmetic geometry and resolving long-standing Diophantine conjectures of Mordell and Lang,” work that reshaped parts of modern number theory and algebraic geometry. Mordell’s conjecture, after being proven by him, is now referred to as Faltings’ Theorem. Faltings is the first German mathematician to be awarded the Abel Prize. He is also recipient of the Fields Medal in the year 1986.

Abel Prize is an international mathematics award presented annually by the Government of Norway through the Norwegian Academy of Science and Letters, often regarded as the Nobel Prize of Mathematics. It recognises exceptional contributions to the mathematical sciences. The Abel Prize was first instituted in 2002. The Abel Prize was presented by His Royal Highness Crown Prince Haakon in Oslo, Norway. The prize is named after the Norwegian mathematician Niels Henrik Abel. The winner of the Abel Prize receives 7.5 million Norwegian Kroner, which is approximately $7,80,00,000/-$ Indian Rupees in 2026.

The only Indian mathematician to win the Abel Prize is S.R. Srinivasa Varadhan. He was awarded the prestigious prize in 2007 for his fundamental contributions to probability theory, specifically for creating a unified theory of large deviations.

Fields Medal

The 2026 Fields Medal winners will be announced at the opening ceremony of the International Congress of Mathematicians (ICM 2026), which takes place in Philadelphia, USA, from July 23–30, 2026.

The Fields Medal is a prize awarded to two, three, or four mathematicians under 40 years of age at the International Congress of the International Mathematical Union, a convention which takes place every four years. The name of the award honors the Canadian mathematician John Charles Fields.The prize was established in 1924 and first awarded in 1936.

The Fields Medal comes with a cash prize of CAD 15,000 (Approximately 10,40,000/- Indian Rupee) and a 14-karat gold medal. It is funded by a bequest from Canadian mathematician J.C. Fields.

No Indian citizen has ever won the Fields Medal, but two mathematicians of Indian origin have received the prestigious award.
The two Indian-origin recipients are:
Manjul Bhargava (2014): A Canadian-American mathematician of Indian descent who won the award for his profound contributions to the geometry of numbers.
Akshay Venkatesh (2018): Born in New Delhi, India, this Australian mathematician won the award for his synthesis of analytic number theory, homogeneous dynamics, topology, and representation theory.

Ganit Ratna Award

The Fifth Ganit Ratna Award has been awarded to Vamsi Pritham Pingali of the Indian Institute of Science, Bengalore for introducing new methods in the subject, such as vector bundle version of Monge-Ampere equation, concentration of mass method, the use of GIT for the existence and uniqueness of gravitating vortex, etc. and using these new methods to make astonishing progress in solving deep, longstanding problems such as the Griffiths conjecture, Lejmi-Szekelyhidi conjecture, and Collins-Jacob-Yau conjecture.

The Ganit Ratna Award (GRA) has been instituted by Professor Thakare Gaurav Sanstha (PTGS). The Ganit Ratna Award is a national honour conferred annually upon a Indian citizen for his/her original contributions to the area of mathematics. The Ganit Ratna Award is being given in the solemn memory of the late Professor Ratan Prakash Agarwal (15th June 1925 – 9th Feb 2008) of Lucknow University. The award consists of:

A cash prize of Inr 1,11,000/-, a commemorative plaque, and a citation

Nomination for the Sixth Ganit Ratna Award (2027)

The PTGS puts a specific request to nominate a researcher who has made pioneering, original and outstanding research contributions of international standard in mathematics for the Sixth Ganit Ratna Award (2027).

Pray, note that: (1) The last date for nomination is 31st August 2026.
(2) A self nomination is not permitted.
(3)There is no age limit and any person whom you feel is eligible could be nominated for this award.
(4)The evaluation committee of not less than 10 eminent mathematicians (with at least four foreigners) who shall have one or more of the honours to their credit.

For more details visit the website: https://ptgstrust.org

President's International Fellowship Initiative (China) awarded to Prof. P. K. Sahoo

A Life Member and Council Member of IMS, Prof. Pradyumn Kumar Sahoo of the Birla Institute of Technology and Science (BITS) Pilani, Hyderabad Campus, selected for Prestigious President's International Fellowship Initiative (PIFI) Visiting Scientist Fellowship (2027). He also serves the international scientific community as a council member of the BRICS Association of Gravity, Astrophysics, and Cosmology (BRICS-AGAC).

The CAS-PIFI fellowship is designed to foster high-level international scientific cooperation by inviting top-tier global researchers to institutions under the Chinese Academy of Sciences.

The IMS community extends its warmest congratulations to Prof. Sahoo for this remarkable milestone and wishes him immense success in this global collaborative venture.

Abstracts of Talks and Papers presented at the 91st Annual Conference of the IMS

Presidential Address

Relevance of Mathematical Sciences in National Development, its Current Status, Mathematics Phobia and its Prevention Strategies

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At the outset, let me thank the Council Members of IMS and its General Body for expressing their confidence and faith in me by electing me as the President of IMS for the year 2025-26.

Mathematics is considered one of the greatest and beautiful creations of the human race. It is the age of Mathematical Sciences. Not only we are getting more and more dependent on the fruits of Mathematical Sciences for scientific and technological advancement, and for economic, infrastructural and human resource development, but the tools of Mathematical Sciences are beginning to permeate our sociological, sports, medical, linguistic and artistic world as well.

A good knowledge of mathematics along with some computer proficiency is the basic requirement of good number of jobs including Banks, Insurance sector, Industries, Income Tax, Sales Tax, Accounts Sector, Financial Analyst, Data Analyst, Business Analyst, Census, System Analyst, Market Research Analyst, Operation Research Analyst, Cryptographer, Sales, Supply Chain Analyst, Actuarial specialist etc.

In addition to Mathematical Sciences having such a good job potential, in my view, the most important gift of Mathematical Sciences is that its proper training helps in enhancing critical, analytical, logical, imaginative and systematic thought process, which are key factors for success in any walk of life including Engineering, Technology sector, Medical Profession, Teaching, Scientific Sector, Business, Judiciary, Civil Services, Management Sector and even Politics. Even a good Mathematical training helps in becoming a good father/mother, a good brother/sister, a good son/daughter, a good husband/wife and a good friend as well. It also helps in becoming more truthful, law-abiding, disciplined, and unbiased with a universal mindset.

Despite such beautiful features of Mathematical Sciences, the general perception about Mathematics is that it is monotonous, uninteresting and hard nut to crack. This perception has caused ”Maths phobia” among students and parents. In my opinion, mathematics can be compared with a coconut having brown hairy coir outside the hard inner shell. It looks shabby from the outside and the shell is hard to crack. But once it is cracked with some effort, one gets sweet, pure, and nutritious water and sweet coconut flesh. Similarly, mathematics is a bit hard to crack, but once it is cracked, one can see its elegance, its inner beauty and its usefulness in our day-to-day life and for the scientific and technological development.

The need of the hour is to spread its beauty, elegance, and importance for national development. I would like to ponder on the following issues in the Presidential Address.

(A) Why should one study mathematics?

(B) Role of mathematics in enhancing disciplinary, cultural and moral values, and it’s role in enhancing critical, analytical, logical, systematic and imaginative thought process.

(C) Role of Mathematical Sciences in economic, scientific and technological development.
(D) Some emerging fields.
(E) Current status of mathematics.
(F) Some suggestions to help eradicate maths phobia.

Presidential Address (Technical)

Application of Algebraic Topology in Data Analysis and Latest Trends

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During the last two decades, the need for Machine Learning and Artificial Intelligence has grown dramatically. As the tasks to undertake become more and more ambitious, both in terms of size and complexity, it is imperative that available methods keep pace with these demands. A critical component of any such method is the ability to analyze very large, high-dimensional, unstructured and complex data. The existing traditional methods, like statistical techniques, data visualization by graphs or charts, and cluster analysis etc, were not able to capture the inherent shape and structure of such data. The traditional methods were best suited for structured, limited source data, but were struggling with unstructured, high-dimensional, complex data of big size, especially for continuous phenomena.

In order to meet this challenge, Topological Data Analysis (TDA) was originated in the early 2000 with the foundational work on Persistent Homology by Edelsbrunner et al, and Zomorodian and Carlsson. Topological Data Analysis could address the challenge of analyzing high-dimensional, unstructured, large, noisy, incomplete and complex data for even continuous phenomena successfully, by applying tools of Algebraic Topology.

Persistent Homology, a key tool of Topological Data Analysis, has been successful in analyzing multi-scale topological features like connected components, holes, and voids (high-dimensional holes), providing robust and reduced-dimensional representations of complex data. Persistent Homology is also able to capture those topological features of the data which persist with the change of scale or change of time span, and how long such features persist. Traditional methods were not able to capture such features.

The latest trends in Topological Data Analysis include extending beyond classical Persistent Homology with new tools, such as Persistent Combinatorial Laplacians, Persistent Dirac Operators, and other spectral techniques, which capture both topological invariants and geometric or Combinatorial features also. There is a growing integration with Machine Learning through Topological Deep Learning (TDL) which combines TDA shape abstraction with Deep Neural Networks to handle complex datasets, especially in Biology and the Medical field. Novel approaches addressing sequential data, data on manifolds, are also emerging alongside quantum computing algorithms for efficient Topological Data Analysis.

Significant applications of Topological Data Analysis span a wide range of fields, where complex, high-dimensional, big, noisy and incomplete data may be involved. Some of them are (1) Artificial Intelligence, (2) Machine Learning, (3) Biology and Neuroscience (4) Medicine and Oncology, (5) Material Science and Chemistry, (6) Image Analysis and Complex Vision, (7) Sensor Networks and Signal Processings, (8) Finance and Economics, (9) Social Networks and Complex Systems, (10) Urban Planning, (11) Robotics.

V. K. Patodi Plenary Lecture

Differential forms on triangulated manifolds and cubical complexes

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V. K. Patodi made important contributions to several areas of spectral theory and differential geometry. In this lecture, my starting point is his Invited Address to the International Congress of Mathematicians in 1976, a few months before his death. Building on Dodziuk's thesis, he laid out a program for proving the Ray-Singer conjecture, which is of fundamental importance in differential geometry and quantum field theory. Ray and Singer defined the torsion of the de Rham complex of a compact oriented Riemannian manifold and a local system by analogy with the Reidemeister-Franz torsion of the local system which is defined using finite triangulations of the manifold. Their conjecture, which is easily confirmed for the one-dimensional case of a circle, is that these two invariants are equal. The method of Dodziuk and Patodi consists of embedding simplicial cochains into differential forms using a map of complexes defined by Whitney.

Although Dodziuk and Patodi did not succeed in completing the proof of the Ray-Singer Conjecture, their approach was successfully used to give a proof of the conjecture the following year by Werner Müller. In the first part of the lecture, I will explain 2the definition of torsion of a cochain complex, and recall the definitions of the Ray-Singer and Reidemeister-Franz torsions.

In the second part of the talk, I study the replacement of differential forms on triangulated spaces by differential forms on spaces with a cubical decomposition. This gives an alternate version of Whitney's map that is in many ways easier to study. In my own work, I have used differential forms on spaces with cubical decomposition to extend the theory of Lie algebras and Lie groups to higher dimensions. Lie theory is the study of ordinary differential equations, which are differential equations on the unit interval, which is also the one-dimensional simplex as well as the one-dimensional cube. I will explain how Lie theory extends to higher dimensions through the study of the Whitney forms on higher-dimensional simplices, and the corresponding forms on higher-dimensional cubes.

IMS Plenary Lecture

Statistical behaviour of the dimension of irreducible representations

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This lecture about finite groups will discuss what the dimension data of irreducible representations of a finite group looks like. I will discuss the case of finite nilpotent groups, as well as finite groups of Lie type. I am mostly interested in the symmetric group, but for that perhaps I have nothing new to offer except to highlight some questions.

36th Srinivasa Ramanujan Memorial Award Lecture

On the bilinear Bochner-Riesz problem

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The convergence of Fourier series of functions in Lebesgue function spaces is a classical problem in Euclidean harmonic analysis. This problem motivates the study of Fourier multipliers in general. Among the vast class of Fourier multipliers, the Bochner-Riesz multipliers are of particular interest. They provide us with a suitable alternative to the convergence problems concerning the Fourier series. Despite being one of the central problems in harmonic analysis for the past several decades, the Bochner-Riesz conjecture in dimensions large or equal to 3 remains one of the most challenging open problems in the subject. This along with some of the recent developments in harmonic analysis in the theory of bilinear multipliers, motivates us to study the bilinear Bochner-Riesz problem. The Fourier analytic methods and their interplay with the geometry of spheres play crucial roles in the study of Bochner-Riesz multipliers. In this lecture, we shall discuss some of the recent developments on the bilinear Bochner-Riesz problem.

39th P. L. Bhatnagar Memorial Award Lecture

A space transformed finite element method for elliptic interface problems in $\mathbb{R}^n$

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This lecture introduces a new finite element method for solving elliptic interface problems in $\mathbb{R}^n$. Traditional finite element methods approximate the interface using either linear or curved elements, which often leads to a loss of accuracy in the solution. To overcome this, we employ a homeomorphic stretching transformation that reformulates the problem in a transformed domain, where it can be solved more easily. The solution is then projected back to the original domain through the inverse transformation. Compared with existing approaches, the proposed method effectively handles discontinuities across the interface and eliminates the need for interface approximation. We establish optimal a priori error estimates in the H^1 and L^2 norms, along with a quasi-optimal error estimate in the maximum norm. Numerical experiments further confirm the superior accuracy and convergence of this method relative to the standard finite element approach.

17th Ganesh Prasad Memorial Award Lecture

Coefficient Conjectures on Planar Harmonic Mappings

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The aim of this lecture is to address recent developments on planar harmonic mappings and some related conjectures on this topic. Our particular emphasis is to consider many recent conjectures on the family of K-quasiconformal harmonic mappings that are sense-preserving and univalent in the unit disk centered at the origin with radius 1. Also, we consider an affirmative answer in support of the recent coefficient conjecture by proving this conjecture for certain geometric subfamilies, which motivate many studies on geometric function theory. In addition, we verify this conjecture also for on the family of typically real K-quasiconformal harmonic mappings. and provide sharp coefficients estimate of convex K-quasiconformal harmonic mappings. By doing so, the lecture will provide an affirmative document in support of the main coefficient conjecture on this topic.

36th Hansraj Gupta Memorial Award Lecture

Tensor Product Decomposition of Compact Lie Group Representations

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Let G be a semisimple connected complex algebraic group. We study the tensor product decomposition of irreducible finite-dimensional representations of G. The techniques we employ range from representation theory to algebraic geometry and topology. This is mainly a survey of speaker's various results on the subject obtained individually or jointly with Belkale, Kapovich, Leeb, Millson and Stembridge.

36th V. Ramaswamy Aiyer Memorial Award Lecture

Universal commutator identities, Structures on groups, and Schur Theory.

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One of the most basic problem in group theory is to study the universal n-commutator identities which hold in all groups and on free groups all the commutator identities are derivable from universal commutator identities. For universal Lie product identities in $\mathbb{Z}$-Lie algebras, we have a theorem of Magnus which asserts that for a free group $G = F(X)$ on a set X, the natural Lie ring structure on $\oplus \sum_{n\in\mathbb{N}} L_n(G)/L_{n+1}(G)$ induced by commutator operation is free $\mathbb{Z}$-Lie ring $L\mathbb{Z}(X)$ on the abelianizer G_{ab} of G and which is free on the set $Y = \{xL_2(G) \mid x \in X\}$ in bijective correspondence with X such that the $L\mathbb{Z}(X)$-module $(L\mathbb{Z}(X))_n$ generated by the set of homogeneous Lie elements of degree n is $L_n(G)/L_{n+1}(G)$. This prompted Ellis to think of an structure, multiplicative Lie algebra structure * on a group which may describe universal n-commutator identities on a group the way the Theorem of Magnus describes universal Lie product identities. In this talk, we shall study structure theory, co-homology, and Schur theory in the category of multiplicative Lie algebras including Schur Hopf Formula. We shall also talk about Steinberg and Chevalley version of the multiplicative Lie algebra.

Invited Lecture

Recent Results concerning Splitting Operations on Binary Matroids

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Various splitting operations on graphs are of great importance. Various graph theorists have studied the effect of these splitting operations on graphs.

Fleischner introduced the splitting operation using two edges in graph theory. He then characterized Eulerian graphs and introduced an algorithm to find all Eulerian trails of Eulerian graphs. Tutte and Slater introduced the notion of n-point splitting operation and also characterized 3-connected and 4-connected graphs, respectively.

As an extension of the splitting operation using two elements in a graph, Raghunathan et al. defined the splitting operation with respect to a pair of elements for binary matroids. Shikare et al. generalized the splitting operation using more than two elements. Also, as an extension of n-point splitting operation, Azadi defined the element splitting operation for binary matroids. Later, Azanchiler defined the es-splitting operation, as an extension of n-line splitting in graphs.

The splitting operations do not preserve many properties of a binary matroid. Many researchers have studied the splitting operation and their properties, like connectivity, graphicness, cographicness, etc.

In this talk we will be exploring the effect of splitting operations on the various properties of binary matroids.

Invited Lecture

Old and new results on the large sieve

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The large sieve is an important tool in analytic number theory which has a variety of applications, such as results about the distribution of prime numbers in arithmetic progressions. Its classical form is based on an inequality comparing a discrete and continuous mean value of a trigonometrical polynomial. We discuss its significance for number theoretical questions and variants of the large sieve which are currently being investigated in active research.

Invited Lecture

Special Class of Solutions to MHD Flow of Fluids

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To provide an extensive mathematical analysis, we have considered the ideal Magneto hydrodynamic (MHD) equations, which represent the flow of fluid in the presence of a magnetic field. Alternatively, we can say that it represents the flow of electromagnetic fluids. We followed the procedure of Majda [1] that was implemented to find special solutions of the rotating stratified Boussinesq equations. Hence, we determine some exact solutions and nonlinear plane wave solutions of an ideal MHD equations. We see that in nonlinear plane wave solutions, we have a pressure zero for all time and these class of solutions are important to describe the Couette Flow. Also, these class of solutions are important in blood flow as well as in the high temperature plasma flow.

Furthermore, we obtained some special class of solutions that involved the quadratic dependence of the velocity and magnetic field on two horizontal (longitudinal) coordinates with the coefficients being functions of the vertical (transverse) coordinate and time. These are very interesting solutions of the ideal MHD equations which are quadratic in nature of space variables x_1 and x_2. We have provided two examples in support of these kind of solutions.

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Invited Lecture

Hardy's Theorem Revisited: A New Approach

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The Riemann zeta function $\zeta(s)$, first introduced by Euler and later extended to the complex plane by Riemann in 1859, occupies a central place in analytic number theory. Riemann's celebrated hypothesis (RH) asserts that all nontrivial zeros of $\zeta(s)$ lie on the critical line $\Re(s) = \frac{1}{2}$. A landmark result of G. H. Hardy in 1914 established that infinitely many zeros of $\zeta(s)$ lie on this critical line, known as Hardy's theorem.

In this talk, we present an elementary proof of Hardy's theorem that is simple and new.

Invited Lecture

Euclidean algorithm in certain Number Fields

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Let K be an algebraic number field and $\mathcal{O}_K$ be its ring of integers. Recall that K is said to be Euclidean, if there is a function $\phi : \mathcal{O}_K \to \mathbf{N} \cup \{0\}$ such that for all $a, b \in \mathcal{O}_K, b \neq 0$ there exists $q, r \in \mathcal{O}_K$ with $a = bq + r$ and $\phi(r) < \phi(b)$. An interesting question is to determine whether a given number field is Euclidean or not? We shall address this question, especially, with respect to Imaginary Galois quartic fields of class number 1. This talk is based on a joint work with M. Subramani and Usha K Sangale.

Invited Lecture

PDEs without derivatives in the classical sense

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In this talk, we will prove the existence of weak solutions for a nonlinear elliptic problem with a nonsmooth Neumann-type boundary data. The given problem is driven by a discontinuous nonlinearity. Some well-posedness estimates will be derived using which the uniqueness of the solution will be proved. More mathematical surprises await you in the talk.

Symposium 1: Recent Advances in Algebra

Minimal Free Resolutions and Fine Invariants of Linear Codes

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We will outline some interactions between linear error correcting codes and certain notions and results in commutative and homological algebra. In particular, we will discuss a relatively recent work of Johnsen and Verdure where they associate a fine set of invariants, called Betti numbers, to linear codes. These are obtained by considering certain Stanley-Reisner rings corresponding to linear codes and studying the graded minimal free resolutions of these rings. It turns out that these Betti numbers determine several important parameters of linear codes such as generalized Hamming weights and generalized weight enumerators. However, computing Betti numbers is usually a hard problem. But it is tractable if the free resolution is "pure". We will then outline an intrinsic characterization of purity of graded minimal free resolutions associated with linear codes. Further, we will discuss a characterization of (generalized) Reed-Muller and also projective Reed-Muller codes that admit a pure resolution.

This talk is based on joint works with Prasant Singh and with Rati Ludhani.

Unitary Units of Modular Group Algebras

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The group algebra is a classical object in mathematics. Let FG be the group algebra of a group G over the field F. The set $V_*(FG)$ of unitary units (under the classical involution $*$) of the group of normalized units of the algebra FG form a group which is called the unitary subgroup of the group algebra FG. In my talk we provide some recent results about the structure of the unitary subgroup $V_*(FG)$ such as nilpotency, locally nilpotency and so on (see [1, 2, 3, 6, 7, 8, 9]). We are discussing the connections of the structure of $V_*(FG)$ with other parts of mathematics (for example, see [4, 5, 10, 11]).

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On the derived length of the unit group of group algebras in characteristic 2

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Let FG be the group algebra of a non-abelian group G over a field F of prime characteristic p and let $U(FG)$ denote its unit group. The conditions under which $U(FG)$ is solvable were determined in a series of papers over many years, beginning with Motose and Tominaga (dealing with finite G) and concluding with A. Bovdi. However, very little is known about the derived length, $dl(U(FG))$, of $U(FG)$, especially when $p = 2$. One of the first results was due to Shalev, who classified the finite groups G for which $U(FG)$ is metabelian (that is, $dl(U(FG)) \leq 2$), when $p > 2$. The "delicate case" $p = 2$ was treated by Coleman and Sandling and independently by Kurdics. One of our goals is to look at what happens when G is infinite. Furthermore, we will pay special attention to the case where the commutator subgroup of G is a cyclic p-group. In this setting, Bagiński computed $dl(U(FG))$, provided G is a finite p-group with $p > 2$. In this presentation, we try to do the same without restrictions on G and p.

Group based Cryptography

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In this talk, we discuss cryptographic ciphers that are based on groups. These groups may be finite or infinite, cyclic, abelian or even non-abelian.

Adjoints of ideals in regular rings

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J. Lipman introduced adjoints of ideals in regular rings and showed that using adjoints, a stronger version of the Briancon-Skoda theorem can be proved.

Lipman conjectured that for any ideal I in a regular local ring, $adj(I^n)I = adj(I^{n+1})$ for all $n \geq \ell(I) - 1$ where $\ell(I)$ is the dimension of the special fibre under blowing of $\operatorname{Spec} R$ along the closed subscheme $V(I)$. We will survey what is known about this conjecture and report on a new proof of Lipman's conjecture in dimension 2 using the Hoskin-Deligne formula for the co-length of an integrally closed ideal in a two-dimensional regular local ring.

On m-clean ring

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There is a large literature of clean ring theory since many people are interested to study about clean ring and related areas. Certainly idempotents and units of a ring play very important role for determining the structure of the clean ring. An element of a ring is called clean if it is the sum of an idempotent and a unit of that ring. A ring R is called clean if every element of R is clean. On the other hand, a ring R is called unit regular if for any $a \in R$, $a = aua$ for some unit $u \in R$. Equivalently, one can say a ring R is unit regular if $a = eu$ for some idempotent e and unit u in R. Hence a ring R is unit regular if each element of R is the product of an idempotent and a unit. Surprisingly, every unit regular ring is a clean ring i.e. every element of a unit regular ring can also be written as the sum of a unit and an idempotent. Thus the "sum" analog of the unit regular condition is the notion of a clean ring. If we replace m-potent element in place of idempotent then we call this ring an m-clean ring.

In this talk, we discuss about m-clean ring and some of their properties.

Group and Lie commutator identities in group algebras

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It is well known that the Lie commutator identities in a ring have a deep influence on the group commutator identities in the unit group of that ring. Krasilinikov and Riley proved if a unital associative nil generated algebra over a field of characteristic 0 satisfies a multilinear Lie commutator identity, then its unit group also satisfies the corresponding group commutator identity. I will be surveying this correlation between Lie identities and group identities for group algebras, and also show that in the case of group algebras of infinite groups the situation may be different.

Symposium 2: Operation Techniques

On Boundedness of Weighted Composition Operators

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Let $\mathbb{D}$ denote the open unit disc in the complex plane $\mathbb{C}$. For $1 \leq p < \infty$, the classical Hardy space H^p consists of holomorphic functions f on $\mathbb{D}$ such that the norm

$$\|f\|_p = \left(\sup_{0 \leq r < 1} \int_0^{2\pi} |f(re^{i\theta})|^p \frac{d\theta}{2\pi} \right)^{\frac{1}{p}}$$

is finite. If $p = \infty$, H^∞ is the space of holomorphic functions f on $\mathbb{D}$ such that

$$\|f\|_\infty = \sup_{\mathbb{D}} |f(z)| < \infty.$$

If ϕ is an analytic function on $\mathbb{D}$ with $\phi(\mathbb{D}) \subset \mathbb{D}$, then the Littlewood Subordination Principle ensures the boundedness of composition operators C_ϕ on H^p given by

$$C_\phi f = f \circ \phi, \ \forall \ f \in H^p.$$

Given $h \in H^p$, we define for those $f \in H^p$ for which it makes sense the weighted composition operator

$$W_{\phi,h}f(z) = h(z)f(\phi(z)),\ z \in \mathbb{D}.$$

Note that $W_{\phi,h}$ need not be a bounded operator on H^p. In this talk we will discuss the boundedness of weighted composition operators which is in principle not known and also discuss its relation with Riemann Hypothesis and Invariant Subspace Problem.

Stockwell Transform Methods for Analyzing Wavefront Sets in Schrödinger Equations

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In this talk, I will present a detailed study of the wavefront set, both in its classical (Hörmander) and Sobolev variants, and explore their role in microlocal analysis, particularly in the context of dispersive equations. A central focus is on the Schrödinger equation with sub-quadratic perturbations, which arises in various quantum and semiclassical models. We introduce a novel representation of this class of Schrödinger equations using the Stockwell transform, a time-frequency analysis tool that combines features of both the Fourier and wavelet transforms. This representation not only preserves essential localization properties but also enables finer detection of singularities in the solution space. By leveraging this Stockwell-based formulation, we develop a method for identifying and characterizing the wavefront set of solutions, offering new insights into how singularities propagate under the evolution of sub-quadratic Hamiltonians.

The approach is particularly well suited for problems where standard pseudodifferential techniques face limitations due to the nature of the perturbations. Applications of the method include improved resolution in the analysis of wave packet dynamics and enhanced understanding of dispersive smoothing effects.

I will conclude by discussing the implications of these results for broader classes of partial differential equations and future directions for microlocal analysis using hybrid time-frequency methods.

Duffin and Schaeffer Inequality: Frames

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In the study of non-harmonic Fourier series, Duffin and Scheffer described the frame conditions for the first time. Frames are generalized bases that allow stable analysis and decomposition of signals (functions) in the underlying Hilbert space. In this talk, I'll present the construction of frames from some classes of operators acting on the space $L^2(\mathbb{R})$. Optimal frame bounds in terms of eigen-values of the frame operator and frame algorithms will be discussed.

Exploring Mock Theta Functions via Hypergeometric Methods, Continued Fractions, and Fractional Operators

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This talk presents a study of mock theta functions through the lens of basic hypergeometric series and continued fractions. A half-shift technique has also been used which facilitates novel insights into the structure and transformation properties of these intriguing q-series. Additionally, we explore use of some fractional operators on modified mock theta functions, unveiling new relationships and exploring the possibilities of further research in the theory of special functions and q-series.

Models of irreducible q-representations of Lie algebra $\mathcal{K}_5$

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We present models of irreducible q-representations of the 5-dimensional Lie algebra $\mathcal{K}_5$ in terms of q-derivative and q-dilation operators. These models are transformed to new models of $\mathcal{K}_5$ using the theory of fractional q-calculus and q-Euler integral transformation. The transformed models are in terms of inverse q-derivative operators and difference q-dilation operators. These models are further exploited to obtain interesting recurrence relations and matrix elements.

Generalized Polylogarithm in Function Spaces

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The generalized polylogarithm function, denoted as $\Phi_{p,q}(a,b;z)$, is defined by the following normalized expression:

$$\Phi_{p,q}(a,b;z) = \sum_{k=1}^{\infty} \frac{(1+a)^p(1+b)^q}{(k+a)^p(k+b)^q} z^k, \quad |z| < 1,$$

where p and q represent complex numbers with $\Re(p) > 0$ and $\Re(q) > 0$, while $a, b > 0$. This generalization includes many well-known special functions as particular cases, such as the Lerch transcendent function, the Hurwitz zeta function, the Riemann zeta function, and the polylogarithm function. This generalized polylogarithm is a particular case of generalized hypergeometric functions. It is known that the normalized form of this generalized polylogarithm $\Phi_{p,q}(a,b,z)$ is close-to-convex (univalent), starlike, and convex in the unit disc, for specific conditions on the parameters a, b, p, q.

In this talk, a new integral representation for $\Phi_{p,q}(a,b;z)$ and its consequence in obtaining the complete monotonicity and bounds of $\Phi_{p,q}(a,b;z)$ are provided. This results in $\Phi_{p,q}(a,b,z)$ belonging to the family of Pick functions. Besides various inclusion results, specific open problem is outlined for future research.

Weinstein Pseudo-differential Operators

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Pseudo-differential operators emphasise an impactful integral representation generated by the theory of integral transform and partial differential operators. This theory plays a significant role in addressing problems related to quantum mechanics, numerical analysis, and partial differential operators. In this talk, the concept and various properties of Weinstein pseudo-differential operators will be discussed in relation to the Weinstein transform.

Symposium 3: Inverse and Ill-posed Problems

Two-point gradient iterative methods for nonlinear ill-posed operator equations

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In this talk, we will discuss convergence analysis of the two-point gradient Lavenberg-Marquardt method with a convex penalty term for obtaining a stable approximate solution of nonlinear ill-posed operator equations in both Hilbert as well as Banach space frameworks. We will demonstrate the validity of our method by considering numerical experiments involving a parameter identification problem.

Regularization of Ill-Posed Heat Conduction Problems via a Fractional Calculus Method

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It is well-known that the backward heat conduction problem, namely, the problem of determining the temperature $u(\cdot, t)$ in a heat conducting body at a time $t \in [0, \tau]$ from the knowledge of the temperature $u(\cdot, \tau)$, is an ill-posed problem. However, the associated time-fractional backward heat conduction problem with fractional order α with $0 < \alpha < 1$ is well-posed if $0 < t < \tau$. This fact is properly used to obtain a regularization method for the original problem and convergence of the method is proved for the case $0 < t < \tau$ as $\alpha \to 1$, and for the case $t = 0$ as the parameter pair $(\alpha, t) \to (1, 0)$. Error estimates for the regularized solutions are also provided under an appropriate choice of the parameters in terms of the level of data errors.

The results are part of an ongoing work in collaboration with Vighnesh Alavani and Palla Danumjaya.

Regularization of linear ill-posed problems for low order smooth solutions in Banach spaces

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In this presentation we consider, in a Banach space framework, the regularization of linear ill-posed problems. Our focus is on the recovery of solutions that allow a logarithmic source representation which is also known as low order smoothness. Such cases typically occur in exponentially ill-posed problems like the backwards heat equation. For a class of regularization schemes, convergence rates are deduced, both for a priori and a posteriori parameter choice strategies. The considered class includes the iterated version of Lavrentiev's method and the method of the abstract Cauchy problem.

Data-Assisted Iterative Regularization via Graph Laplacians: Theory and applications

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We propose a data-assisted iterative regularization method for solving ill-posed inverse problems in Hilbert spaces. The scheme, denoted `IRMGL+Ψ`, integrates classical iterative techniques with a data-driven penalty term realized via an iteratively updated graph Laplacian. Starting from an initial reconstruction obtained by a baseline method, the graph Laplacian is constructed and then adaptively recalibrated during each iteration to capture the evolving structure of the solution.

A key contribution is the rigorous justification of the discrepancy principle as an effective stopping rule for the proposed method. Under standard assumptions, we establish stability and convergence when this principle is applied. Numerical experiments with four initial reconstructors—adjoint operator (Adj), filtered back projection (FBP), total variation (TV), and Tikhonov regularization (Tik)—demonstrate the robustness of the approach. In particular, `IRMGL+Adj` consistently outperforms the other variants, yielding accurate and stable reconstructions from even the simplest initial solutions.

Inverse problems for p-Laplace equation

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In principle, inverse problems involve recovering unknown parameters of a hidden system from external observations. Applications range from biomedical imaging for cancer detection, to locating oil and mineral deposits within the Earth's interior, reconstructing astrophysical images from telescope data, detecting cracks and interfaces in materials, shape optimization, and many more.

In this talk, I will give an introduction to the topic. We will begin with the basic conductivity equation as a model problem and then discuss the associated inverse problems. Finally, I will present some results on inverse problems for the p-Laplace equation.

On the selection of the regularization parameter in Laurantiev regularization for nonlinear ill-posed problems

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In the regularization theory, the researchers mainly used a priori, a posteriori, adaptive, and heuristic parameter choice strategies to choose the regularization parameter. In the a priori strategies, the regularization parameter is determined from the knowledge of the noise level (independent of the data) and the properties of the smoothness of the unknown solution. So, the a priori method is not suitable in practice. Moreover, in a priori parameter choice strategies, the known data is not used. In this talk, we introduce an a priori parameter choice strategy that depends on the known data and does not depend on the smoothness of the unknown solution for nonlinear ill-posed problems.

Symposium 4: Algebraic and Differential Topology

On the K_0 Group of Leavitt Path Algebras

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Given a graph E, the Leavitt path algebra $L_K(E)$ over a field K allows us to have an algebraic analogue of Cuntz–Krieger C^*-algebras [2, 4]. The computation of the K_0-group of $L_K(E)$ helps in classifying Leavitt path algebras up to Morita equivalence [3]. In this talk, the K_0-group is constructed as the Grothendieck group of the monoid of isomorphism classes of finitely generated projective $L_K(E)$-modules [1]. A crucial result is that $K_0(L_K(E))$ can be explicitly described using the graph monoid M_E, derived from the adjacency matrix of E. Specifically, for a finite graph E, the group $K_0(L_K(E))$ is the cokernel of the matrix $(I - A_E^t)$, where A_E is the adjacency matrix of E [3]. On another note, K_0 and its graded variant serve as algebraic invariants in the context of Leavitt path algebras and allows us to employ combinatorial tools to extract module-theoretic information.

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Open books and spun embeddings

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An open book decomposition of a closed manifold is a way to break the manifold in two parts: a codimension 2 closed submanifold and a mapping torus. A spun embedding is a smooth embedding between manifolds that preserves the open book structures. We shall discuss the background of these notions and some recent progress.

On Some Problems in the Algebraic Topology of Finite Spaces

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We address two problems in the algebraic topology of finite spaces. After a brief review of background and recent developments, we study minimal finite models and simplicial collapsibility.

First, we show that the minimal finite model of the Möbius band coincides (up to weak homotopy) with the minimal finite model of the circle S^1. We also give explicit constructions of minimal finite models for several small wedge sums: $S^2 \vee S^1$, $S^2 \vee S^2$, $S^1 \vee S^1 \vee S^2$, and $S^2 \vee S^2 \vee S^1$.

Second, we consider the simplicial join $K * L$ of two finite simplicial complexes K and L. It is known that a collapsible factor makes the join collapsible; we prove the converse: if $K * L$ is collapsible, then at least one of K or L must be collapsible.

On KO-Groups of Complex Milnor Hypersurface

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For $r > 0$ and $r \geq s$, the complex Milnor hypersurface $H_{r,s}$ is a complex Milnor hypersurface in $\mathbb{CP}^r \times \mathbb{CP}^s$ given by the equation $\sum x_i y_i = 0$, where x_i and y_i are homogeneous coordinates in $\mathbb{CP}^r$ and $\mathbb{CP}^s$, respectively. For $s = 0$, the hypersurface $H_{r,0}$ is the complex projective space $\mathbb{CP}^{r-1}$. The K-groups of $\mathbb{CP}^{r-1}$ were computed by J. F. Adams, and the KO-groups of $\mathbb{CP}^{r-1}$ were studied by M. Fujii. In this talk, we shall discuss the KO-groups of $H_{r,s}$. This work is joint with Devender Singh and B. Subhash.

Glimpses of some milestones in the evolution and progress of Algebraic and Differential Topology

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In the evolution and progress of Algebraic and Differential Topology, numerous mathematicians have made significant contributions. This talk very briefly highlights the contribution of a select few of these mathematicians which in the opinion of the author constitute important milestones.

Symposium 5: Representation Theory of Lie Algebras

Local Weyl modules of type A and their tensor products

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Local Weyl modules, introduced by Chari and Pressley in 2001, are a family of finite-dimensional graded representations of current Lie algebras. Through the work of Sanderson, Bogdan, Chari, and Loktev, it was discovered that their graded characters coincide with certain specialized Macdonald polynomials – central objects in algebraic combinatorics. In recent joint work with Divya Setia and Shushma Rani, we built on this connection and showed that tensor products of local Weyl modules, whose highest weights are multiples of the fundamental weights, admit a natural filtration by special fusion product modules.

In this talk, I will begin with some background and motivation before giving a preview of our results.

Weyl modules for Lie superalgebras

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The Weyl modules play important role in the representation theory of infinite-dimensional Lie algebras. However, in super setting the study of Weyl modules has less developed than the corresponding theory in Lie algebras. Calixto, Lemay and Savage study Weyl modules for Lie superalgebras of the form $\mathfrak{g} \otimes_{\mathbb{C}} A$, where A is an associative commutative unital $\mathbb{C}$-algebra and $\mathfrak{g}$ is a basic complex Lie superalgebra or $\mathfrak{sl}(n, n)$, $n \geq 2$. Particularly, they define Weyl modules (global and local) for the Lie superalgebras $\mathfrak{g} \otimes_{\mathbb{C}} A$ and prove that global Weyl modules are universal highest weight objects in a certain category and local Weyl modules are finite-dimensional. We define global and local Weyl modules for $\mathfrak{q} \otimes A$, where $\mathfrak{q}$ is the queer Lie superalgebra and A is an associative commutative unital $\mathbb{C}$-algebra. We prove that global Weyl modules are universal highest weight objects in certain category up to parity reversing functor Π. Then with the assumption that A is finitely generated, we show that the local Weyl modules are finite dimensional and further they are universal highest map-weight objects in certain category up to Π. Finally, we prove a tensor product property for local Weyl modules.

Stable Homology and Cohomology of Modules over Restricted Lie Algebras

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We investigate the notions of Tate homology and stable homology of modules over Restricted Lie algebras. Stable homology is a broad generalization of Tate homology. The main problem of this article is that we shall consider the homological dimensions of modules with Restricted Lie algebras. We show that vanishing of stable homology and cohomology detects modules of finite Gorenstein homological dimension over restricted universal enveloping algebras and restricted Lie algebras.

Integrable representations over map full toroidal Lie algebras

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I will discuss integrable, irreducible representations of map full toroidal Lie algebra with finite-dimensional weight spaces. They turn out to be single point evaluation modules.

Symposium 6: Function Theory

Runge domains in C^n

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A Runge domain is a domain in C^n where any holomorphic function can be approximated by holomorphic polynomials uniformly on every compact subset of that domain. Unlike in one variable, there is no topological characterization in higher dimensions. In this talk, I will present a characterization of Runge domains involving certain homotopy with approximation properties. This talk is based on a joint ongoing work with my student Gourab Paul.

Zeros of Harmonic Polynomials and a Novel Root-Finding Algorithm

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In this talk, we explore the distribution and localization of zeros of harmonic polynomials. In their seminal work, Khavinson and Świątek resolved Wilmshurst's conjecture by establishing a sharp upper bound on the number of zeros of harmonic polynomials of the form $h(z) - \overline{z}$, where $h(z)$ is an analytic polynomial of degree greater than one. Subsequently, Dorff et al. and Liu et al. determined, respectively, the number of zeros and a compact region containing all zeros of harmonic trinomials.

We extend these results by providing a complete characterization of the precise compact region that contains all zeros of general harmonic polynomials. Furthermore, by employing the harmonic analogue of the argument principle, we examine the distribution of zeros, supported with illustrative examples to aid intuition.

Sète and Zur introduced the pioneering iterative root-finding method for complex harmonic functions, generalizing Newton's method. However, their approach left unresolved questions regarding convergence and the choice of initial points. To address these issues, we present a novel root-finding algorithm for harmonic polynomials that guarantees convergence and successfully determines *all* zeros of a given harmonic polynomial. Our approach improves upon Sète and Zur's method, and is supported with concrete examples illustrating its effectiveness.

Finite-dimensional model spaces invariant under composition operators

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Finite-dimensional model spaces are quotient spaces of the Hardy space on the open unit disc, determined by finite Blaschke products. Composition operators, on the other hand, act by composing Hardy space functions with analytic self-maps of the open unit disc. Both are classical and well-studied objects in the theory of analytic function spaces. In this talk, we discuss a complete characterization of finite-dimensional model spaces that are invariant under composition operators.

On extended hypergeometric and related higher transcendental functions

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In this present talk, we present certain recent developments for extended hypergeometric type functions and give connections to extended higher transcendental functions such as the Beta function, Gauss's hypergeometric function, Kummer's confluent hypergeometric function, Bessel and modified Bessel functions, Struve and modified Struve function, Bessel Struve function, elliptic integrals, and so on. Further, various bounding inequalities are also described.

A hyperbolic-type metric beyond classical domains

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We introduce a new hyperbolic-type metric that extends the classical hyperbolic metric to arbitrary domains in $\mathbb{R}^n$ $(n \geq 2)$. This metric coincides with the hyperbolic metric in balls and with the quasihyperbolic metric in all unbounded domains.

It is bi-Lipschitz equivalent to the hyperbolic metric in simply connected planar domains and to the quasihyperbolic metric in bounded domains. Using this, we characterize uniform domains and John disks. We also study geodesics, closed curves in multiply connected domains, and distortion under Möbius transformations.

This is a joint work with Bibekananda Maji and Pritam Naskar.

Invited Lecture by Recipient of J. B. Shukla IMS Award 2025

Advanced Atherosclerosis and the Role of Cardiac Muscle Protein Markers

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Atherosclerosis is a chronic inflammatory cardiovascular disease characterized by the progressive narrowing of arteries due to the accumulation of lipids, cholesterol, and other substances within the arterial wall. Such plaque can rupture, leading to thrombosis that can obstruct major arteries and trigger myocardial infarction or ischemic stroke, etc. In the early stages, plaques are primarily composed of lipid-laden foam cells and macrophages. They are stabilized by the migration and proliferation of smooth muscle cells (SMCs) from the medial layer, which form a protective fibrous cap. Subsequently, the enlarged plaque gradually enters the arterial lumen and restricts blood flow. In this study, a two-phase model is developed to investigate the progression of plaque growth during its advanced stage and analyze the minimum gap (luminal clearance) within an atherosclerotic artery, which is required for the unobstructed passage of blood cells. Cardiac troponin (cTnT/cTnI), a particular and sensitive biomarker, facilitates early detection of elevated risks of heart attack or stroke. This study aims to establish a correlation between the cTnT/cTnI concentration in atherosclerotic arteries and its internal clearance. Based on our observations, we find that plaque evolves rapidly in the initial stages but gradually slows down over time. In contrast, luminal clearance exhibits the opposite trend: it decreases slowly in the early stages, and the rate of decrease increases as time progresses. Our study also indicates a positive correlation between plaque depth and cTnT/cTnI concentration in the blood, along with a negative relationship between troponin concentration and the clearance in atherosclerotic arteries.

Invited Lecture by Recipient of A. K. Agarwal IMS Award 2025

Fluctuation analysis for a class of nonlinear systems with fast periodic sampling and small state-dependent white noise

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We consider a nonlinear differential equation under the combined influence of small state-dependent Brownian perturbations of size ε, and fast periodic sampling with period δ; $0 \leq \varepsilon, \delta \ll 1$. State samples (measurements) are taken every δ time units, and the instantaneous rate of change of the state depends on both the current value and most recentsample. For the resulting stochastic process indexed by ε, δ, we obtain asymptotic approximations for the mean behavior and fluctuations about the mean. The former is described by an ordinary differential equation, while the latter is governed by a stochastic differential equation (SDE). This SDE varies depending on the exact rates at which $\varepsilon, \delta \searrow 0$. The key contribution involves computing the effective drift term capturing the interplay between noise and sampling in the limiting SDE. Connections with control systems with sampling are discussed and illustrated numerically through a simple example.

Invited Lecture by Recipient of A. M. Mathai IMS Award 2025

Resistive Magnetic Induction Equation: IPDG Scheme and Error Estimates

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This talk presents an error analysis framework for a fully discrete interior penalty discontinuous Galerkin (IPDG) scheme developed to solve the initial-boundary value problem associated with the resistive magnetic induction equation. Optimal error estimates are derived for both the semi-discrete and fully discrete formulations of the IPDG scheme, demonstrating convergence at optimal rates in both space and time.

Invited Lecture by Recipient of Subhash Bhatt IMS Award 2025

Bohr radius for Banach spaces on simply connected domains

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Bohr's power series theorem has been the subject of intensive investigation over the past two decades, with significant extensions across diverse areas of pure and applied mathematics (see, e.g., [1, 2, 5, 6, 7, 8, 9]).). Let $H^\infty(\Omega, X)$ be the space of bounded analytic functions $f(z) = \sum_{n=0}^{\infty} x_n z^n$ from a proper simply connected domain Ω containing the unit disk $\mathbb{D} := \{z \in \mathbb{C} : |z| < 1\}$ into a complex Banach space X with $\|f\|_{H^\infty(\Omega,X)} \leq 1$. Let $\phi = \{\phi_n(r)\}_{n=0}^{\infty}$ with $\phi_0(r) \leq 1$ such that $\sum_{n=0}^{\infty} \phi_n(r)$ converges locally uniformly with respect to $r \in [0, 1)$. For $1 \leq p, q < \infty$, we denote

$$R_{p,q,\phi}(f, \Omega, X) = \sup \left\{ r \geq 0 : \|x_0\|^p \phi_0(r) + \left(\sum_{n=1}^{\infty} \|x_n\| \phi_n(r) \right)^q \leq \phi_0(r) \right\}$$

and define the Bohr radius associated with ϕ by

$$R_{p,q,\phi}(\Omega, X) = \inf \left\{ R_{p,q,\phi}(f, \Omega, X) : \|f\|_{H^\infty(\Omega,X)} \leq 1 \right\}.$$

The Bohr radius and its characterization for Banach space valued functions on the unit disk $\mathbb{D}$ was first investigated by Blasco [3, 4]. In this talk, we discuss the extension of this line of research to a broader framework by considering Banach space valued functions defined on general simply connected domains in the complex plane. In particular, we discuss a detailed study of the Bohr radius $R_{p,q,\phi}(\Omega, X)$, both for an arbitrary complex Banach space X and for the operator algebra $X = \mathcal{B}(\mathcal{H})$ of all bounded linear operators on a complex Hilbert space $\mathcal{H}$. Our results encompass, as a special case, those obtained in [10]. In addition, we establish the Bohr inequality for the operator-valued Cesáro operator and Bernardi operator. The corresponding inequality for the classical (complex-valued) Cesáro operator was first studied by Kayumov, Khammatova, and Ponnusamy [11, 12].

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Invited Lecture by Recipient of A. Narasinga Rao IMS Memorial Prize 2025

Linearizations and Backward Error Analysis for Rational Matrices

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In this work, we consider a rational matrix $R(\lambda)$ in minimal realization form and investigate its linearizations- a standard approach for computing eigenvalues and eigenvectors of $R(\lambda)$. Linearization involves finding a matrix polynomial of degree at most one whose eigenvalues coincide with those of the original rational matrix.

We perform backward perturbation analysis to determine the smallest perturbation for which a computed solution is an exact solution of the perturbed problem. Explicit formulas for the backward error of approximate eigenvalues and eigenpairs of a regular rational matrix are derived. Additionally, we determine the minimal perturbations to all matrix polynomial coefficients, as well as selected realization parameters, such that the approximate eigenvalues become exact eigenvalues of the perturbed rational matrix.

Invited Lecture by Recipient of P. K. Jain IMS Award 2025

Iterative roots of multidimensional maps

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An *iterative root* of order $n \geq 2$ of a self-map f on a nonempty set is a self-map g on the set such that $g^n = f$. Most results on the iterative roots of continuous interval maps rely on tools such as the Intermediate Value Theorem and the monotonicity of bijections. Extending these results to higher dimensions or more general topological spaces is generally complex. In this talk we present some new combinatorial ideas that lead to new results on iterative roots of maps on arbitrary sets and continuous maps on topological spaces. These results, in particular, allow us to generalize some notable findings on iterative roots for continuous interval maps to the broader context of continuous multidimensional maps.

Invited Lecture by Recipient of Satya Deo IMS Award 2025

Exploring Topologically Torsion Elements through the Lens of Arithmetic and Related Sequences

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An element x of the circle group $\mathbb{T} := \mathbb{R}/\mathbb{Z}$ is said to be topologically torsion with respect to a sequence of integers (u_n) if $\lim u_n x = 0_{\mathbb{T}}$. The most well-established results concerning such elements are primarily associated with arithmetic sequences. In this study, we extend the investigation to some non-arithmetic and arithmetic-type sequences, conducting a comprehensive analysis of these elements and their corresponding characterized subgroups, with particular attention to their cardinality aspects. Given that arithmetic sequences constitute a special subclass of arithmetic-type sequences, our findings provide a more generalized framework, unveiling broader structural properties that encompass and refine several intriguing results known for arithmetic sequences as well as for some non-arithmetic sequences.

A Special Session

Challenges in School Education and Strategies for Effective Improvements

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As part of our ongoing endeavour, we aim to establish a nationwide ecosystem and roadmap designed to strengthen both teacher capacity and student excellence through coordinated programs and strategic partnerships. The current school education system faces several challenges, including limited analytical and problem-solving skills among students, outdated curricula, inadequate integration of technology, insufficient teacher training, and assessment practices that overemphasize rote learning. Collectively, these factors hinder the development of strong mathematical learning outcomes. To address these challenges, a multi-layered approach is essential–one that focuses on enhancing teacher competence, modernizing curriculum and pedagogy, integrating technology effectively, promoting conceptual clarity, developing logical reasoning and problem-solving abilities, fostering active learner engagement, and connecting mathematical concepts with real-life contexts, all within a supportive ecosystem. Achieving these goals requires comprehensive reforms in curriculum design, pedagogical methods, and assessment systems. Emphasis should be placed on activity-based learning, the purposeful use of digital tools, and continuous professional development for teachers. Additionally, establishing supportive infrastructure such as mathematics laboratories, resource centers, and student clubs can promote experiential and inquiry-based learning. Strengthening mathematics education through these initiatives will not only improve academic achievement but also nurture a generation of learners equipped with critical thinking, creativity, and decision-making skills essential for thriving in an increasingly data-driven world.

Fun with Hands-on Mathematics

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Activity-based mathematics is important for schools and the +2 level because it enhances conceptual understanding and knowledge retention, develops critical thinking and problem-solving skills, and fosters a deeper understanding of concepts beyond rote memorization. This hands-on and engaging approach makes learning more enjoyable, caters to diverse learning styles by incorporating visual and kinesthetic elements, and promotes both independent learning and collaboration. Ultimately, it prepares students for real-world challenges and nurtures them as lifelong learners of the subject.

In my hands-on demonstration of mathematics activities, I will explain basic concepts of mathematics and geometry through various activities and models. Participants will also have the opportunity to perform some activities themselves, experiencing mathematics in a joyful and interactive way.

How to make Mathematics more Palatable at Secondary level

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Mathematics is one of the most important subjects in the school curriculum at the school level. Mathematics, often taught in schools, results in learning rules and procedures without developing the connected understanding and the reasoning power among the students. The problem lies not with the students alone. It is mostly because of the defective/ faulty method of teaching mathematics. It has often been found that School children not only have learning difficulties in Mathematics, but teachers also face difficulties in the transmission of content. To improve secondary-level mathematics education, a structured state-wise plan to develop Master Trainers is crucial. In the first phase, at least five experienced and innovative educators should be selected from each district. Their training should focus on capacity building, communication skills, use of multimedia tools, engaging teaching models, and effective evaluation strategies aligned with competency-based learning. This paper focuses on some practical strategies to make Mathematics more palatable at the Secondary level of education in the Indian context.

Coloring A Triangle, Puzzles & History of Indian Mathematics: Making Math Visible

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The set of cards needs to be sorted and you can do that in $\log(n)$ time by using the math done by an Indian Mathematician Pingal (2 BCE) in his work ChhandShastra. The base of all current digital technology - binary arithmetic was defined by him in the context of language i.e. LaghuSwar (0) and GuruSwar (1). The magical way of sorting the punched cards lets younger children explore computational thinking while at the same time challenging problems around these cards engages graduates and professors as well !! Series of puzzles designed at Center for Creative Learning, IIT Gandhinagar hooks any one to start solving it (easier to understand the problem but absolutely non-trivial to solve them) and followed by exploring the underlying fundamentals having roots in Indian history. Take a triangle, divide it in 3 parts and you have 4 colors - how many unique ways of coloring. The basics of combinatorics rules are defined by Saarang Dev in his work - SangeetRatnakar for music.

Making mathematics engaging in high school and +2

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It is evident that there is an urgent need to reform and reformulate mathematics education at the high school and +2 levels. There is a major lack of exposure to open-ended exploration and to hands-on activities. There is also a marked lack of exposure to classroom practices that nurture the culture of collaborative problem-solving. Instead, there is a massive overexposure to drill problem-solving and to examination-oriented teaching and learning. Added to this is the huge importance given to the competitive exams that serve as entrance tests for premier engineering colleges. These are the systemic problems that plague mathematics education. To bring about any lasting change in such a situation requires sustained work in the area of teacher preparation and the availability of good study materials.) It also requires rethinking on the part of people everywhere.

In my talk, I will focus only on the following: nurturing the culture of exploration and the culture of collaborative problem solving.

Current status of mathematics at school level, factors and some suggestions

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Despite the fact that mathematics has a wholesome and universal role, the state of mathematics in our country does not appear up to the mark at High School and +2 level. There is a maths phobia among a good percentage of students. There is a general perception that mathematics is dry, boring, and a hard nut to crack.

Some of the important factors for this state of affairs are as follows:

1. Cramming-oriented, stereotypical, and mechanical teaching without focusing on understanding of concepts and their relevance in real life, and in turn making the subject uninteresting.

2. A good percentage of school mathematics teachers lack basics and good communication skills to make mathematics interesting.

3. Crude and stereotype examination system testing basically cramming ability.

4. Improperly written books flooded in the market, focusing on formula and mechanical procedures.

5. Some what heavy syllabus and undue pressure on teachers to somehow complete the syllabus and produce good results.

I strongly feel the necessity of regular workshops for secondary and higher secondary teachers on pedagogy, basics, technology integration, modes of assessment, focusing on understanding and on enhancing communication skills to make mathematics palatable.

Paper Presentations in Prize Category

On Models of q-Algebra Representations and Matrix Elements of $\mathcal{K}_5$

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We construct one and three variable models of Lie algebra $\mathcal{K}_5$ in terms of q-dilation, inverse q-dilation operators T_z and T_z^{-1}, respectively. Using q-exponential functions $e_q(z)$ and $\mathcal{E}_q(z)$, we obtain twenty-four types of q-matrix elements that are expressible in terms of certain q-hypergeometric series. Further, these matrix elements are exploited to obtain interesting recurrence relations, orthogonality and biorthogonality relations.

Note on generalized matrix Mittag-Leffler function

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The article aims to explore key properties of the generalized matrix Mittag-Leffler function, such as integral representations, derivative formulae, recurrence relations, and summation formulae. In addition, we discuss the composition of generalized fractional calculus operators with respect to a function with the generalized matrix Mittag-Leffler function.

On generalization of $L_n^\alpha(x;q)$ polynomial and its properties

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We discuss q-Laguerre polynomials for multiple variables and give some properties, viz. q-analogues of generating functions, integral representation, recurrence relations, and finite sum property have also been discussed.

Stability and Error Analysis of Barycentric Lagrange Interpolation on Jacobi Gauss Lobatto Nodes

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This paper presents a detailed study of Barycentric Lagrange interpolation with a focus on its application to the zeros of the function $(1-x^2)P_n^{(\alpha,\beta)}(x)$, where $P_n^{(\alpha,\beta)}(x)$ denotes the Jacobi polynomial of degree n. The Barycentric formula is derived from the classical Lagrange formulation, and its numerical properties are analyzed through error bounds and a convergence theorem. Special attention is given to the performance for higher values of n, where classical Lagrange interpolation becomes unstable. To validate the theoretical results, numerical experiments are carried out for different choices of α and β. The maximum interpolation errors are reported in tabular form and visualized through error plots, consistently highlighting the superior stability of the Barycentric approach even for large degrees. The findings confirm that Barycentric interpolation provides a reliable and robust framework for function approximation on Jacobi Gauss Lobatto nodes, particularly in high degree settings.

L^p-Gabor transform norm for certain locally compact groups

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For a locally compact group G of type I which is separable and unimodular, we study the L^p-Gabor transform and its norm. We prove an analogue of the Hausdorff-Young inequality for the L^p-Gabor transform and compute the best constants for the L^p-Gabor transform norm on several classes of locally compact groups.

Ideal Spaces of the Haagerup Tensor Product of Ternary Rings of Operators

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We characterize the primal, factorial, and Glimm ideals of the Haagerup tensor product $V \otimes^h B$ of a TRO V and a C^*-algebra B.

Numerical study of Richards' equation in heterogeneous sloping layer soil with time-dependent surface flux

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In the vadose zone, the movement of water is described by Richards' equation (RE). The transport of water in heterogeneous slope layer soil is solved numerically using RE in this research. The numerical findings are obtained by applying the Crank-Nicolson Finite Difference Method (CNFDM) with zero pressure head on a water level and time-dependent surface flux boundary conditions. Taylor series expansion is used to handle the discontinuity at the interface. We utilize the Picard iterative technique to address the nonlinearity. The effects of varying surface flux and slope angle on the pressure head are examined. For simplified circumstances, the numerical solution is verified against the analytical solution. The current method's convergence rate is closer to 2, which is theoretically true, and it is accurate.

PEO–Water (0.1 wt%) Based Maxwell Nanofluids: A Comparative Study of Base, Mono-, Hybrid-, Tri-, and Tetra-Hybrid Cases with Entropy Generation, Bejan Number, and Trade-Off Perspectives

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This study presents a comparative thermodynamic analysis of slip-influenced Maxwell magnetohydrodynamic (MHD) nanofluid flow over a stretching cylinder with a polymer-enhanced water base containing 0.1 wt% polyethylene oxide (PEO). Five fluid cases are considered—base fluid, mono-, hybrid-, tri-, and tetra-hybrid nanofluids, where the tetra-hybrid suspension comprises Ag, Cu, Al_2O_3, and TiO_2 nanoparticles. The formulation accounts for velocity and thermal slip, thermal radiation, and nonlinear heat generation/absorption. Using similarity transformations, the governing Maxwell-based boundary-layer equations are reduced to a system of coupled nonlinear ordinary differential equations, which are solved numerically via MATLAB's bvp4c solver. Comparative entropy generation and Bejan number analyses are performed to quantify irreversibility mechanisms, while Pareto-type plots between Nusselt number and integrated entropy provide a trade-off perspective between heat-transfer enhancement and thermodynamic penalty. Results confirm that the tetra-hybrid nanofluid achieves the most favourable balance, consistently delivering higher heat transfer with reduced entropy generation compared to the mono-, hybrid-, and tri-hybrid counterparts. These findings underscore the promise of polymer-assisted tetra-hybrid nanofluids for energy-efficient thermal management applications.

Contributed Papers

(A) Combinatorics, Graph Theory, Logic, Discrete Mathematics, etc.

A Generalization of Fuzzy Outerplanar Graphs

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A fuzzy graph ψ qualifies as a fuzzy outerplanar graph when ψ is embedded in the plane such that every vertex lies on the exterior boundary of the region. Let $i(\psi)$ represent the number of vertices in a planar embedding that do not depend on the boundary of the outer region. Therefore, $i(\psi) = 0$ for a fuzzy outerplanar graph. In this paper, we survey some classes of fuzzy graphs that are known as generalizations of fuzzy outerplanar graphs: fuzzy tree-structured graphs (e.g., fuzzy series–parallel graphs and fuzzy Halin graphs), fuzzy W-outerplanar graphs, and fuzzy k-outerplanar graphs. We also discuss some problems formulated by slightly modified versions of the statements that characterize fuzzy outerplanar graphs, such as the fuzzy largest face problem and fuzzy (independent) face covers in fuzzy plane graphs.

Resolving Ranking Ambiguities in Healthcare: An Enhanced Interval-Valued Picture Fuzzy Score Function for Treatment Method Selection

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The process of healthcare decision-making is typically hindered by the necessity to consider numerous alternative treatments with the uncertain, hesitant, and conflicting attributes. Interval-Valued Picture Fuzzy Sets (IVPFSs) give a sturdy blueprint for the depiction of such convoluted evaluations. Nevertheless, extant score and accuracy functions very often do not succeed in differentiating the competing treatments, which gives rise to the occurrence of ranking ties as well as the reliability of results. To solve this problem, we come up with a new enhanced ranking function (ERF) for IVPFSs that fuses the factors of positivity–negativity balance, neutrality, interval width as a sign of uncertainty, and a robustness measure gotten from bound separation. The presented ERF is implemented to a problem of treatment method selection, whereby the clinical and patient-centred attributes are the basis for comparison of the alternatives. The findings reveal that the ERF properly disambiguates the rankings as well as provides the stable and the openly decided outcomes, different from the traditional functions. The current research recognizes the ERF as a very effective vehicle for patient-centred healthcare decision support under uncertainty.

Graph-Theoretical Insights into Molecular Structures

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Topological indices have emerged as powerful mathematical descriptors for exploring the structural organization and connectivity of molecular graphs, providing crucial insights into chemical and biological behavior. In this work, we undertake a comprehensive analysis of a wide range of topological indices, including the ABC index, ABC_4 index, Randić index, sum connectivity index, GA index, GA_5 index, first and second Zagreb indices, multiple Zagreb indices, augmented Zagreb index, harmonic index, hyper Zagreb index, first, second, and third Zagreb polynomials, forgotten polynomials, forgotten topological index, and symmetric division index. By systematically computing these indices, we capture the intricate patterns of molecular connectivity and reveal important structural characteristics that underpin chemical activity. This study demonstrates the versatility of graph-theoretical approaches in characterizing molecular structures and provides a solid framework for future computational and theoretical investigations in molecular modeling.

On order 5 trace zero doubly stochastic matrices and the corresponding eigenvalue region

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A non-negative square matrix is called a doubly stochastic (DS) matrix if all its row and column sums are exactly equal to 1. A vast literature is known for such matrices concerning the eigenvalue region, inverse eigenvalue problem or entry-wise distribution of the non-negative numbers when matrix size or order of the matrix is restricted up to 4, whereas only a little is known for matrices of order 5 or more except for some sets of doubly structured matrices.

This talk concerns the following questions: What are those trace zero order 5 DS matrices whose k-times multiplications are also trace zero matrices for some values of k? What is the eigenvalue region of the set of trace zero order 5 DS matrices?

We address these questions by proposing a graph theoretic approach to determine the trace of the product of two permutation matrices through a weighted digraph representation for a pair of permutation matrices. Then, we derive the DS matrices of order 5 whose k-th power is also a trace-zero DS matrix for $k \in \{2, 3, 4, 5\}$. Then, we determine necessary conditions for the coefficients of a generic polynomial of degree 5 to be realizable as the characteristic polynomial of a trace-zero DS matrix of order 5. Using this, we approximate the eigenvalue region of trace-zero DS matrices of order 5.

Forbidden minors for cographic splitting of cographic matroid using three elements

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The splitting operation on binary matroids is an abstract transformation whose effect on certain well-known classes of matroids, such as graphic, cographic matroids, is not yet fully understood. In particular, it remains an open question whether this operation preserves the property of being cographic. In this paper, we focus on cographic classes of binary matroids and study the result of applying the splitting operation on them. Specifically, we identify and describe a collection of minimal minors of cographic matroids that produce non-cographic matroids, when the splitting operation is applied with respect to sets containing three elements. To ensure the accuracy of our findings, we have carefully verified all the results using Python and the Sage Math library.

Cocircuits of Splitting p-matroids

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In the present work, we study the structure of cocircuits of the splitting p-matroids, where a p-matroid is defined as a matroid representable over the prime field GF(p). For a p-matroid K on a ground set D and two elements $a, b \in D$, the associated splitting matroid is denoted by $K_{a,b}$. It is shown that any cocircuit C^* of K either remains a cocircuit in $K_{a,b}$ or can be written as the union of two cocircuits of $K_{a,b}$. The main result provides a characterization of the cocircuits of the splitting matroid $K_{a,b}$ in terms of the cocircuits of the original matroid K.

Extreme Vertices of Superpower graph of Symmetric groups

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For a finite group G, the ***superpower graph*** $S(G)$ is an undirected simple graph with vertex set G and two vertices are adjacent if and only if the order of one divides the order of the other in G. A vertex is said to be ***extreme***, if its closed neighbourhood set forms a clique. In this talk, we will describe the some of the known structural characterizations of the superpower graph of non-abelian groups and characterize the existence of extreme vertices of the superpower graph of groups such as the symmetric group, alternating group and dihedral group.

Quadratic Fuzzy Numbers

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A significant body of work exists on the study of triangular and trapezoidal fuzzy numbers, and their operations are well-established using the extension principle, sometimes with approximations. These fuzzy numbers are used in numerous applications. However, their linear nature may not adequately represent real-world situations. A more effective approach is to replace this linearity with nonlinear membership functions. This article presents one such attempt, where linear membership functions are replaced with quadratic expressions. A generalized parametric representation of a quadratic fuzzy number on a given closed interval is obtained. The addition of two quadratic fuzzy numbers is defined, and some of their properties are discussed. It is observed that the membership function resulting from this addition is an irrational algebraic expression of degree two.

Spectra of the generalized reciprocal distance matrix of joined union graphs and their applications

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In this presentation, we will discuss the *generalized reciprocal distance matrix* of a graph, denoted by $RD_\alpha(\mathcal{G})$. This matrix is defined using a combination of the Harary (reciprocal distance) matrix and the diagonal matrix of reciprocal transmissions:

$$RD_\alpha(\mathcal{G}) = \alpha RT(\mathcal{G}) + (1-\alpha)RD(\mathcal{G}), \qquad \alpha \in [0,1].$$

We will first explain how this matrix behaves for graphs that are formed as joined unions of regular graphs. In particular, we will present a formula for the characteristic polynomial of $RD_\alpha(\mathcal{G})$ in this setting and describe the RD_α-spectra for some important graph families. Next, we will show that the power graphs of the dihedral group D_{2n} and the generalized quaternion group Q_{4n} can also be expressed as joined unions. This allows us to study their generalized reciprocal distance spectra in a unified way. Finally, we will apply these results to compute the RD_α-spectra of power graphs over some well-known finite groups.

Path Matrices and Path Energies of Line Graphs

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Vertex-disjoint paths quantify independent connectivity in a graph and serve as a key indicator of network robustness. The path matrix $P(G)$ captures this information by recording, for each vertex pair, the maximum number of internally vertex-disjoint paths between them. This work determines the path matrices, path spectra, and path energies for several significant graph families, including the line graphs of complete graphs, complete bipartite graphs, prism graphs, antiprism graphs, and star-like trees. A general max-flow-based method is developed for computing the path matrix of the line graph $P(L(G))$ for any connected graph G, supported by structural characterisations of edge-edge connectivity.

Prime-Sum Modular Graphs

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We introduce a family of graphs, namely, Prime–Sum Modular Graphs G_n, whose vertices are the elements of the cyclic group $\mathbb{Z}_n$ and where adjacency occurs precisely when the sum of two vertices is congruent modulo n to a prime in the interval $(n, 2n)$. This construction encodes analytic properties of primes in an interval into graph-theoretic structure.

We give necessary and sufficient conditions for simplicity (absence of loops and parallel edges) of G_n. We discuss the conditions when the graph is regular by determining the exact edge count in both simple and general settings. Also we show that G_n is connected for all $n \geq 6$ and discuss its diameter.

(B) Algebra, Number Theory, Lattice Theory and History of Mathematics

Efficient Cryptographic Undeniable Signatures via DLCSFP-Semiring Approach

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Chaum and Van first introduced the Undeniable Signature Scheme (USS) in 1989, where a unique feature is that the signer actively participates in the verification process, ensuring controlled authentication and preventing unauthorized verification. Building upon this foundation, our study introduces the Discrete Logarithm Conjugacy Search Factor Problem (DLCSFP) as a new hard problem to strengthen security in undeniable signatures. We analyze the mathematical structure of DLCSFP, highlighting its resistance to existing cryptographic attacks and evaluating its computational complexity. Using DLCSFP, we propose a novel undeniable signature scheme that leverages its hardness for enhanced security. The scheme ensures authenticity and undeniability while preserving efficiency in implementation. Our evaluation demonstrates that the proposed method achieves strong security guarantees against forgery and unauthorized validation. Additionally, the complexity analysis confirms its practicality for real-world applications. By combining the principles of USS with the hardness of DLCSFP, the scheme offers both robustness and performance advantages. This contribution thus expands the landscape of undeniable signatures with a secure and efficient construction.

Generating functions and Ramanujan-type Congruences for $\mathbf{b_{5^k}(n)}$

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We investigate the arithmetic properties of the function $b_{5^k}(n)$, which enumerates the partitions of n into parts not divisible by 5^k. By constructing and analyzing generating functions for $b_{5^k}(n)$ along specific arithmetic progressions, we establish a family of Ramanujan-type congruences. These results contribute to the broader study of partition functions and highlight new directions for exploring congruence phenomena in partition theory.

The structure space of $C_-(X)$ via that of Γ-semirings

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In this paper, the structure space, endowed with the hull kernel topology, of maximal regular congruences which are prime on a Γ-semiring as well as the structure space of prime congruences on a Γ-semiring have been studied via operator semirings. This study has been used to obtain some important results of the structure space of $C_-(X)$ of non-positive real valued continuous functions over a topological space X. It has been found that the structure spaces of the semiring $C_+(X)$ of non-negative real valued continuous functions and the Γ-semiring $C_-(X)$ are homeomorphic. Moreover, it has been shown that the structure space of $C_-(X)$ is the Stone-Čech compactification of X, where X is a Tychonoff space. Furthermore, the Γ-semiring analogue of the 'Banach-Stone Theorem' has been obtained.

Uniformly Bounded Harish-Chandra Modules for Map Extended Special Algebras

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In this talk, we present a classification of uniformly bounded Harish-Chandra modules over the map-extended Special Lie algebras, under a natural condition on the action of the Laurent polynomial ring. We demonstrate that these modules are irreducible for the underlying extended Special algebra.

Distribution of zeros of the Koecher–Maass series twisted by a real analytic GL_2- form on critical line

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In this talk, we will discuss the distribution of zeros of certain Dirichlet series. In particular, we discuss the distribution of zeros of Koecher–Maass series twisted by a GL_2-Maass eigenform on the critical line $\Re(s) = k/2$. These series appear as the spectral coefficients in the spectral decomposition of certain function f in $\mathcal{L}^2(SL_2(\mathbb{Z})\backslash\mathbb{H})$ in the work of Imai (1980) while proving the Hecke converse theorem associated to Siegel modular forms. More precisely, we prove that the twisted (by a Maass form) Koecher–Maass series associated to a Siegel cusp form of weight k and degree 2 vanishes infinitely often on the critical line $\Re(s) = k/2$. Moreover, we also prove that certain Rankin-Selberg L-series of degree 4 associated to GL_2-automorphic forms of half-integral weight and real-analytic forms have infinitely many zeros on the critical line $\Re(s) = k/2$. In this direction, this is the first ever result for Rankin-Selberg L-function, and the result are only known for the L-function of degree at most 2.

This work has been submitted for publication.

On radicals of semi-simple near-rings

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Here, the study of radicals of semi-simple of finite near-rings is initiated. Radicals in near-rings are similar to radicals in rings, but they are defined and studied within the context of near-rings. Near rings are algebraic structures similar to rings but without the requirement of left or right distributivity. Radicals in near ring are ideal-theoretic concepts which helps to classify and understand the structure of near ring. Generally, in an algebraic structure like a ring or near-ring is a special ideal which contain some important structural properties. Radicals are often used to identify bad or unwanted elements or ideals within the structure and their study helps in the good or well-defined parts. Radical be used to develop new results and theorems in near-ring theory, extending concepts from ring theory to near-rings. In this paper, we have generalized a few results in the radical classes of near-rings.

Zeros and S-units in sums of terms of recurrence sequences in function field

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Let $(U_n)_{n\geq 0}$ be a non-degenerate linear recurrence sequence with order at least two defined over a function field and $\mathcal{O}_S^*$ be the set of S-units. In this talk, we will discuss a result of Brownawell and Masser to prove effective results related to the Diophantine equations concerning linear recurrence sequences and S-units. In particular, we provide a finiteness result for the solutions of the Diophantine equation $U_{n_1} + \cdots + U_{n_r} \in \mathcal{O}_S^*$ in nonnegative integers $n_1, \ldots, n_r$. Furthermore, we will see the finiteness result of the Diophantine equation $U_n + V_m + W_\ell = 0$ in $(n, m, \ell) \in \mathbb{N}^3$, where $(U_n)_{n\geq 0}, (V_m)_{m\geq 0}, (W_\ell)_{\ell\geq 0}$ are simple linear recurrence sequences in the function field. This talk is based on joint work with Darsana N.

Public-key Encryption and Signature Scheme with Smaller Key Sizes

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The emergence of new complex technologies such as cloud and quantum computing has a heavy computational structure, which can compromise the security of traditional cryptographic protocols. It has been noted that traditional security systems utilize non-quantum resistance factorization and Diffie-Hellman (DH) hard problems for their security. Lattice-based cryptography appears to be a very potential post-quantum substitute for the presently employed public-key cryptography. As a result, we have been motivated to focus on increasingly sophisticated and challenging lattice hard assumptions capable of withstanding new modern technologies with quantum resistance properties. We devise a new lattice-based public-key encryption and signature scheme with a smaller key size. The proposed scheme also resists the quantum attack because of the lattice small integer solution problem and its variant. The security claim has also been proved in a well-suited model for quantum attacks. The performance analysis shows that the presented schemes outperform the DH-type schemes as well as compete with similar lattice-based schemes in terms of storage, transmission, key sizes, and computational overheads.

Near-Rings and its Properties

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A near-ring is a generalization of a ring in which addition is not commutative and multiplication is associative, but only one distributive law (either left or right) is required, but not both. Near-rings are used to describe the endomorphism of groups and have applications in many fields including cryptology and experimental design. In this paper, we have generalized few results on the arithmetical features and properties of near-rings.

Some Generalized Results on Fuzzy Ideals and Fuzzy Rings

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In this paper, we study the concept of fuzzy ideals and fuzzy rings which deals fuzzification of the results in the theory of classical rings and ideals. Fuzzy ideals in a ring are generalizations of traditional ideals in ring theory where fuzzy sets replace crisp subsets. Fuzzy ideal in a ring is characterized by a membership function which assigns a degree of membership represented by fuzzy subset to each element of the ring. We obtained a condition for ideal of a ring to be maximal fuzzy ideal and the condition for a fuzzy set defined on the ring of integers to be fuzzy prime ideal.

Ideals on von Neumann Regular Ring

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A von Neumann regular ring is one where every principal left (right) ideal is generated by a single idempotent. The principal left ideals in a von Neumann regular ring form a sublattice of the lattice of all left (right) ideals which is a complemented modular lattice. In this paper, we have introduced some generalized results on ideals of regular ring. We find that ideals in a regular ring are necessarily idempotent.

Analysis of Cyclotomic Numbers of Order l^3 in terms of Cyclotomic Numbers of Lower Orders

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Let l be an odd prime, and let $\mathbb{F}_q$ denote the finite field with q elements, where $q = p^r \equiv 1\ (mod\ l^3)$. This paper presents an explicit formula for cyclotomic numbers of order l^3, expressed in terms of cyclotomic numbers of lower orders, specifically l and l^2. An essential component of our methodology is a specific category of coefficients obtained from Jacobi sums of order l^3, which connect combinatorial representations with algebraic identities.This work establishes a framework for identifying the minimal set of cyclotomic numbers necessary to generate the complete cyclotomic matrix of order l^3. The findings enhance traditional cyclotomy theories and offer novel perspectives on the relationship between character theory and field structure.

On Root Capacity, Intersection Indicium, Minimal Generating Sets of Galois Closure & Compositum Feasible Triplets

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We develop the theory of root clusters and number fields further in this paper. We establish the Inverse root capacity problem for number fields as a generalization of Inverse cluster size problem for number fields proved earlier by the author and Bhagwat. We introduce the concept of intersection indicium as a generalization of the concept of ascending index (introduced by us) and then establish the Inverse intersection indicium problem for number fields (excluding certain cases) which is a generalization of Inverse ascending index problem for number fields (proved by us). We give a field theoretic formulation for the concept of minimal generating sets of splitting fields which was introduced by the author and Vanchinathan and generalize a result of ours for number fields and also establish the existence of field extensions over number fields for given degree and given cardinality of minimal generating set of Galois closure dividing the degree. We generalize a result of Drungilas et al. by establishing that a certain family of triplets is compositum feasible over any number field and we also list all the irreducible triplets in this family. We also prove a partial case of a conjecture of theirs. We improve on the inverse problems by proving that there exist arbitrarily large finite families of pairwise non-isomorphic extensions having additional properties that satisfy the given conditions. Our methods for all these problems are Galois theoretic in nature and heavily rely on the known cases of the inverse Galois problem.

On Posets of Classes of Automorphic Subgroups of Finite Groups

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In 2017, Marius Tarnauceanu studied the poset of isomorphic classes of subgroups of a finite group and proposed several questions for further research. In this paper, we study the classes of automorphic subgroups by introducing a partial ordering on the set of classes of automorphic subgroups of a finite group in order to tackle the question raised by Professor Tarnauceanu. We show that the property of complementation translates from this poset to the subgroup lattice. We prove that the poset of automorphic classes of subgroups of dihedral group and the more generalized quaternion group form distributive lattice. Moreover, we prove that cyclic p-groups, elementary abelian p-groups and quaternion group are the only groups whose poset of automorphic classes of subgroups form a chain. Finally, we conclude the paper by raising some open questions in this direction.

Existence and uniqueness of S-primary decomposition in S-Noetherian modules

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Let R be a commutative ring with identity, $S \subseteq R$ be a multiplicative set, and M be an R-module. We say that a submodule N of M with $(N :_R M) \cap S = \emptyset$ has an S-primary decomposition if it can be written as a finite intersection of S-primary submodules of M. In this paper, first we provide an example of the S-Noetherian module in which a submodule does not have a primary decomposition. Then our main aim of this paper is to establish the existence and uniqueness of S-primary decomposition in S-Noetherian modules as an extension of a classical Lasker-Noether primary decomposition theorem for Noetherian modules.

Normality of rings via singular ideals

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We introduce the notion of $\mathcal{Z}$-normal rings as a generalization of normal rings. We prove that the class of $\mathcal{Z}$-normal rings strictly contains the classes of $\mathcal{Z}$-reversible and $\mathcal{Z}$-semicommutative rings, and contained in the classes of left min-abel and Dedekind finite rings. Then, we show that a ring R is right $\mathcal{Z}$-normal if and only if $eR(1-e) \subseteq \mathcal{Z}_r(R)$ for any idempotent e of R. Further, we give characterization of $\mathcal{Z}$-normal rings using op-idempotents, potents and left projective elements. We also examine some of the $\mathcal{Z}$-normal rings' features and its extension rings.

On iso $C2$ and iso $C3$-modules

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In this paper, we introduce and study the concept of iso $C2$-modules and iso $C3$-modules as generalizations of the direct injective modules. We prove that M is an iso $C3$-module if for any two isosimple submodules A, B of M with $A \cong B, B \subseteq^{\oplus} M$ and $A \cap B = 0$ implies that $A \subseteq^{\oplus} M$. Also, if M is iso $C3$- module then $Imf \subseteq^{\oplus} B$, whenever $M = A \oplus B$ with A, B isosimple and $f : A \to B$ be an R-homomorphism. Furthermore, we provide a number of properties and characterizations of these new classes of modules.

Some Results on Distributively Generated Near-Rings

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Near-rings are generalized rings in which addition is not commutative and only one distributive law is postulated. Near-fields were the first near-rings considered in literature. Historically, the first step toward near-rings was an axiomatic research done by Dickson in 1905. He showed that there do exist "fields with only one distributive law" (near-fields) showing that the second distributive law does not follow from the remaining axioms for a skew-field. In the context of a division near-ring, a distributively generated near-ring is a specific types of algebraic structure where elements of near-rings are distributively generated by some subgroup. A distributively generated near-ring is a near-ring where every element can be written as a finite sum of elements which satisfy a form of distributive property which is a generalization of the distributive law in rings. Specifically in a distributive generated near-ring each element is a finite sum of right distributive elements or anti-right distributive elements. The elements in a near-ring can be expressed as a finite sum of elements which distribute over either a difference or sum. In this paper we shall generalize some result on distributively generated near-ring and also those types of near-ring which are still more "ring-like" than zero-symmetric near-rings. If N is a distributively generated near-ring then the ideals of N are exactly the normal N-subgroups.

Maurer-Cartan characterization and cohomology of equivariant Lie superalgebras

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In this article, we give Maurer-Cartan characterizations of equivariant Lie superalgebra structures. We introduce equivariant cohomology. We give some examples of Lie superalgebras with an action of a group. We construct a graded Lie algebra associated to a G-module V, and show that its Maurer–Cartan elements correspond precisely to G-equivariant Lie superalgebra structures on V. Building on this, we introduce an equivariant chain complex and the resulting notion of equivariant cohomology for Lie superalgebras. Several low-dimensional cohomology computations-specifically in degree are carried out to illustrate the theory.

Projective representations of Lie groupoids

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Projective representations first appeared in the study of finite groups through the work of Issai Schur (1904), who showed that such representations are governed by group 2-cocycles and central extensions. Later, Valentine Bargmann (1954) extended this idea to Lie groups, proving when a projective unitary representation of a Lie group can be lifted to a linear representation of its central extension. Lie groupoids generalize Lie groups by allowing symmetries that vary from point to point. They provide the natural framework for describing geometric structures such as foliations, orbifolds, and differentiable stacks, where a single global symmetry group is insufficient.

In this work, we extend the theory of projective representations from Lie groups to Lie groupoids by formulating a precise definition in terms of projective linear groupoids and multiplicative 2-cocycles. This description fits naturally into smooth groupoid cohomology. Using this framework, we address the lifting problem: when does a projective representation of a Lie groupoid lift to a linear representation of its central extension? We give an affirmative answer and provide explicit cohomological conditions for the existence of such a lift.

On The Canonical Construction of Simple Lie Superalgebras

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Axioms for generalization of root systems were defined and classified (irreducible) by Serganova, which are exactly root systems of classical simple Lie Superalgebras. Here, we present a unified way of constructing a simple Lie Superalgebras from the abstract root system with the choice of base having minimal number of isotropic roots.

A linear independence criterion for Infinite Products

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Let $\ell \geq 2$ be an integer, $\{a_n\}_{n=1}^{\infty}$ be a sequence of positive integers and $\alpha_1, \ldots, \alpha_\ell$ be real algebraic numbers greater than 1. We study the linear independence of infinite products of the form

$$\prod_{n=1}^{\infty} \frac{[\alpha_1^{a_n}]}{\alpha_1^{a_n}}, \ldots, \prod_{n=1}^{\infty} \frac{[\alpha_\ell^{a_n}]}{\alpha_\ell^{a_n}},$$

along with 1 over the field of algebraic numbers under some hypothesis on $\{a_n\}_{n=1}^{\infty}$ and $\alpha_1, \ldots, \alpha_\ell$. More precisely, we will prove that any $\overline{\mathbb{Q}}$ linear combination of such infinite products is transcendental. This result generalizes earlier work of Hančl and Corvaja. One of the key ingredients used in the proof is the Subspace Theorem.

A Study of Structural Properties of S-Noetherian and S-Artinian Rings

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The study of S-Neotherian and S-Artinian rings is a natural, necessary, and powerful generalization of classical concepts, aimed at extending finiteness and decomposition results to wider classes of rings and modules, especially where traditional theory does not apply. It enriches our structural understanding and lays the groundwork for deeper exploration in both algebraic theory and its applications.

A p-Converse Theorem for Real Quadratic Fields

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Let $p > 5$ be a rational prime. Let F be a real quadratic field such that p is inert in F. Denote by $\mathfrak{p}$ the unique prime of F lying above p. Suppose E is an elliptic curve defined over F having split multiplicative reduction at $\mathfrak{p}$. Further, assume that the algebraic rank of E/F is 1 and that the p-part of the Tate-Shafarevich group of E/F is finite. Then, under some technical assumptions, we show that the analytic rank of E/F is also 1.

Relative Central Extensions and Isoclinism of a Pair of Regular Hom-Lie Algebras

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A Hom-Lie algebra, introduced by Hartwig, is a non-associative algebra satisfying skew-symmetry and the Hom-Jacobi identity twisted by a linear map. In this paper, we show the relation among the relative central extensions in an isoclinism family of a particular relative central extension of Hom-Lie algebras. We define the notion of isoclinism on the relative central extensions of a pair of Hom-Lie algebras. Then, we figure out the concept of isomorphism in the equivalence class of isoclinisms on the relative central extensions of a pair of Hom-Lie algebras.

On Realizable Classes of Square root of inverse different

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In 1932, E. Noether proved that for a number field F and a finite group G, the integral closure $\mathcal{O}_L$ of $\mathcal{O}_F$ in a Galois G-algebra L over F is a locally free $\mathcal{O}_F G$-module exactly when L/F is tamely ramified. For abelian G, McCulloh's work in 1981, explicitly describes the set $R(\mathcal{O}_F G) := \{(\mathcal{O}_L) \mid L/F \text{ tame } G\text{-algebra}\}$ as the kernel of transpose Stickelberger homomorphism on the locally free class group $\mathrm{Cl}(\mathcal{O}_F G)$. Using relative algebraic K-theory and imposing mild conditions of F, Agboola and McCulloh in 2018 proved that $R(\mathcal{O}_F G)$ is a subgroup of $\mathrm{Cl}(\mathcal{O}_F G)$ for any G of odd order.

The square root of inverse different being self-dual with respect to trace is one of the central objects of study in Galois module theory. B. Erez in 1991, showed if $|G|$ is odd, the square root of inverse different $\mathcal{A}_{L/F}$ of L/F is a locally free $\mathcal{O}_F G$-module if and only if L/F is weakly ramified. For abelian G, C. Tsang proved $\mathcal{A}^t(\mathcal{O}_F G) := \{(\mathcal{A}_{L/F}) \mid L/F \text{ tame } G\text{-algebra}\}$ is a subgroup of $\mathrm{Cl}(\mathcal{O}_F G)$. Using the techniques of Agboola and McCulloh, and imposing some conditions on F, we proved if $|G|$ is odd then $\mathcal{A}^t(\mathcal{O}_F G)$ is a subgroup of $\mathrm{Cl}(\mathcal{O}_F G)$.

An Introduction to Cartan-Eilenberg Projectively coresolved Gorenstein flat Complexes

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In this article, we introduce the notion of Cartan-Eilenberg projectively coresolved Gorenstein flat (CE-PGF, shortly) complexes of Modules. Further, we give the characterization of these complexes and prove the equivalent condition for Cartan-Eilenberg complete projective resolution. In addition, we discuss the dimension of the CE-PGF complex of modules over a coherent ring.

An infinite number of arithmetic progressions possess a positive proportion of primes that are digital delicate primes

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Digitally delicate primes are prime numbers that lose their primality upon the alteration of any single digit of their decimal representation. Terence Tao proved that there are positive proportions of digitally delicate primes in any base. Dirichlet's theorem tells us that there exists an infinite number of arithmetic progressions in which the number of primes is infinite. In this paper, it will be discussed that an infinite number of arithmetic progressions have a positive proportion of digitally delicate primes.

Near-Rings and Related Concepts

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In this paper, we have generalized some properties of near-rings. We have characterised some results on near-rings which are closely related with near-rings. A near-ring is said to be left regular if for each $a \in R$, there exists $x \in R$ such that $a = axa$. The early concept of near-rings was introduced by Wielandt. The aim of his work was to obtain basic tool for group theory. An algebraic system with two binary operations- addition and multiplication, satisfying all the axioms of a ring except the commutative law of addition and one of the distributive laws is studied in literature under the name "Fastring". After the passage of time, "fastring" was named as "Near-Ring". Moreover, a near-ring satisfying the truncated distributive law $x(y + z) = xy + xz$ will be said to be a left Near-Ring to distinguish it from the near-rings satisfying the right distributive law $(y + z)x = yx + zx$ and to be called 'Right near-ring'.

Nonlinear Maps Preserving $XY^* + \lambda YX^*$ Products on Prime $*$-Algebras

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Let $\mathcal{M}$ be a factor von Neumann algebra acting on a complex Hilbert space H with $\dim \mathcal{M} > 1$ and λ be a nonzero scalar. In this paper, we prove that a map (without the assumption of linearity) $\psi : \mathcal{M} \to \mathcal{M}$ satisfies $\psi(L\Diamond_\lambda M\Diamond_\lambda, N) = \psi(L)\Diamond_\lambda M\Diamond_\lambda N + L\Diamond_\lambda\psi(M)\Diamond_\lambda N + L\Diamond_\lambda M\Diamond_\lambda\psi(N)$ for all $L, M, N \in \mathcal{M}$ is additive on $\mathcal{M}$. Moreover, it is demonstrated that ψ is an additive $*$-derivation and $\psi(\lambda L) = \lambda\psi(L)$ for all $L \in \mathcal{M}$, where $L\Diamond_\lambda M = LM^* + \lambda ML^*$, when $|\lambda|^2 = 1$.

Properties of constacycilc codes over the ring $R = \mathbb{F}_2[u, v]/\langle u^2, v^3 - v, uv - vu\rangle$

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We investigate λ-constacyclic codes over the finite commutative non-chain ring $R = \mathbb{F}_2[u, v]/\langle u^2, v^3 - v, uv - vu\rangle$. The ring R possesses 64 distinct elements, defined by the relations $u^2 = 0$ and $v^3 = v$. We focus specifically on codes generated using two distinct case $\lambda = (1 + v^2 + uv^2)$ and $(1+u+uv^2)$. We investigate the properties of the projected binary codes derived via this mapping for both values of λ. Our results compare the structure and generator properties of these codes over R, providing illustrative examples of how these algebraic structures translate into valid DNA codewords.

Cyclic Codes and their Gray Images over $Z_4 + uZ_4 + u^2Z_4$

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In this paper, we investigate cyclic codes over the finite commutative ring $R = Z_4+uZ_4+u^2Z_4$, where $u^3 = 0$. The ring R is isomorphic to $Z_4[u]/\langle u^3\rangle$ and has characteristic 4 and order 64. We examine the structure of the quotient ring $Z_4[u]/\langle u^3\rangle$ and show that it contains 13 distinct ideals, each corresponding to a cyclic code of length 3 over R. Moreover, the generator polynomials of all cyclic codes are determined, and their Gray images over Z_4 are analyzed.

Reversible double cyclic codes over a chain ring

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In this work, we investigate the algebraic structure of double cyclic codes of length (γ,δ) over the finite ring $\mathcal{R} = \mathbb{F}_q + u\mathbb{F}_q$ with $u^2 = 0$. We determine a minimal spanning set for such codes. Furthermore, we establish necessary and sufficient conditions under which a double cyclic code over $\mathcal{R}$ is reversible and reversible-complement. These structural results are then applied to the construction of DNA codes over the ring $\mathbb{F}_4 + u\mathbb{F}_4$, $u^2 = 0$.

A novel digital image encryption algorithm based on Elliptic Curve using Rotational Scrambling Technique and 3D Lorenz Map

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In the modern digital era, ensuring the security of image data is of great importance. This paper presents a novel image encryption scheme that integrates the principles of Elliptic Curve Cryptography (ECC) with advanced chaotic systems. A specialized mapping technique is designed to associate image pixel values with corresponding points on an elliptic curve, establishing a strong cryptographic foundation. To further reinforce security, distinct scrambling operations are applied independently to each color component of the image after ECC processing. Subsequently, additional substitution processes are performed using dynamic keys generated from the three-dimensional Lorenz chaotic map, significantly increasing the algorithm's resistance to attacks. The proposed method's robustness is rigorously assessed using comprehensive statistical analyses such as Mean Squared Error (MSE), Peak Signal-to-Noise Ratio (PSNR), Structural Similarity Index (SSIM), histogram analysis, and entropy measurement. The proposed algorithm delivers strong performance with a large keyspace of $10^{90} \approx 2^{299}$, zero MSE, infinite PSNR, and an ideal SSIM of 1. Entropy values reach up to 7.9584, and the Hamming distance is 0, confirming accurate decryption. Comparative investigations show that the proposed cryptosystem surpasses numerous existing image security approaches, providing superior protection and reliability for sensitive visual data.

The Lie Algebra $\mathcal{G}_{u,v}$ and its three Variable Models

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In this study, we framed three variable models of the irreducible representations of the Lie Algebra $\mathcal{G}_{u,v}$. These models are then transformed in terms of difference-differential operators using the Euler integral transformation. Then, various recurrence relations and generating functions are obtained using these models.

Strongly π-regular elements in rings

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In *Transactions of the American Mathematical Society*, Vol. 68 (1950), Kaplansky raised the following question:

> It is natural to ask what can be deduced from the assumption $a^{n+1}x = a^n$. For example, does this assumption enable one to construct idempotents?

In this talk, we discuss the subsequent developments and the current status of both the local and global versions of this question.

On The Lower Lie Nilpotency Index of a Modular Group Algebra

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Let G be an arbitrary group and let K be a field of characteristic $p > 0$. In this article, we prove that if the group algebra KG is Lie nilpotent, then its lower Lie nilpotency index $t_L(KG)$ equals k if and only if its upper Lie nilpotency index $t^L(KG)$ also equals k, where $k \in \{5p-3,\ 6p-4\}$. Thus, for these specific values of k, the lower and upper Lie nilpotency indices of KG coincide.

Fast Computation and Addition Chains for Point Addition on Elliptic curve $E(Q_p)(mod\ p^2)$

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Elliptic Curve Cryptosystems (ECC) provide security comparable to RSA while requiring significantly smaller key sizes, making them highly suitable for modern cryptographic applications. Since ECC operations fundamentally rely on point addition and point doubling, optimizing these computations is essential for improving both efficiency and security. Continuing our work on the arithmetic of points on elliptic curves $E(Q_p)$ over the p-adic number field Q_p, this paper derives explicit formulas for point addition on the elliptic curve $E(Q_p)(mod\ p^2)$ using Montgomery techniques. For any point $P = (x, y)$ on $E(Q_p)(mod\, p^2)$ expressed in projective coordinates $[X : Y : Z]$, we obtain formulas for computing the point kP based on Montgomery's approach, which requires only the evaluation of the X- and Z-coordinates. The corresponding affine coordinates can then be recovered through a single inversion. In this paper, we also derive optimized addition chains that enable efficient computation of kP for any scalar k and any point $P \in E(Q_p)(mod\ p^2)$. The associated algorithms, along with their implementations in Python, are presented to demonstrate the practical efficacy of our methods, thereby advancing the state of the art in elliptic curve arithmetic.

(C) Real and Complex Analysis (including Special Functions, Summability and Transforms, etc.) and Teaching of Mathematics

The Bohr's phenomenon for certain K-quasiconformal harmonic mappings

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The concept of the Bohr radius for a class of bounded analytic functions was introduced by Harald Bohr in 1914. His initial result received greater interest and was sharpened, refined, and generalized by several mathematicians in various settings, which is now called the Bohr phenomenon. In 1914, Bohr proved that if $f(z) = \sum_{n=0}^{\infty} a_n z^n$ is an analytic function in the open unit disk $\mathbb{D} := \{z \in \mathbb{C} : |z| < 1\}$ with $|f(z)| \leq 1$ in $\mathbb{D}$, then

$$\sum_{n=0}^{\infty} |a_n| r^n \leq 1 \quad \text{for} \quad |z| = r \leq 1/3. \tag{1}$$

Here, the number $1/3$ is known as the Bohr radius and it cannot be improved. The inequality (1) is known as the classical Bohr inequality. In fact, Bohr originally proved the inequality (1) only for $r \leq 1/6$. However, subsequently, Wiener, Riesz, and Schur independently proved that the inequality (1) holds for $r \leq 1/3$. In addition to the notion of the Bohr radius, there are another two concepts known as the Rogosinski radius and the Bohr-Rogosinski radius.

The primary objective of this paper is to establish several sharp versions of improved Bohr inequality, refined Bohr inequality, and Bohr-Rogosinski inequality for the class of K-quasiconformal and sense-preserving harmonic mappings $f = h + \overline{g}$ in the unit disk $\mathbb{D}$ using the subordination principle. In this setting, the analytic part of the harmonic mapping is subordinate to an analytic function ϕ in $\mathbb{D}$, where ϕ is either a convex or a general univalent function. In this setting, we employ the non-negative quantity $S_r(h)$ and the concept of replacing the initial coefficients with the absolute values of the analytic function and its derivative in the majorant series. Furthermore, we obtain the sharp Bohr radius and Bohr-Rogosinski inequality for sense-preserving K-quasiconformal harmonic mappings in which the analytic part of the harmonic mapping is subordinate to a function belonging to the family of concave univalent functions with opening angle $\pi\alpha$ at infinity, where $\alpha \in [1, 2]$.

On the matrix q-Kummer equation and its solutions

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In this paper, a general theory for second-order matrix differential equations of bilateral type is discussed. We introduced the matrix q-Kummer equation of bilateral type and presented the q-Kummer matrix function as a series solution. We also obtain the integral solution and the solution at ∞.

On Saigo-Hypergeometric Fractional Calculus involving the Extended Generalized Wright Function

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In this article, we have investigated Saigo-hypergeometric fractional operators on the extended generalized Wright function (EGWF). For particular values, we obtain the Erdelyi-Kober, Riemann-Liouville and Weyl fractional operators. Some special cases have been derived for specific parameter choices, which demonstrate the Saigo–hypergeometric fractional operators applied to several generalized versions of the Wright function, with the classical Wright function appearing as a particular instance. An investigation has also been carried out on a variety of integral transformation formulas associated with the fractional operators. A comparative numerical analysis was conducted to highlight the enhanced stability of the proposed Extended Generalized Wright Function (EGWF) and the numerical validation of the fractional operators. Additionally a comparative graphical analysis of the various fractional operators has been performed1 which shows the enhanced properties of the Saigo-hypergeometric operators relative to the classical operators.

On integral means for certain classes of univalent functions

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Let $\mathcal{A}$ be the class consisting of functions h that are analytic in the unit disk $\mathbb{D} = \{z : |z| < 1\}$ and normalized by the condition $h(0) = 0 = h'(0) - 1$. For $h \in \mathcal{A}$, estimation of the integral means

$$L(r,h) = \frac{r^2}{2\pi} \int_{-\pi}^{\pi} \left| \frac{1}{h(re^{i\theta})} \right|^2 d\theta$$

is an important quantity for certain problems in fluid dynamics, especially when the functions $f(z)$ are nonvanishing in the punctured unit disk $\mathbb{D} - \{0\}$. In this talk, we will discuss the integral means extremal problems of finding the maximum value of $L(r,h)$ as a function of r when h belongs to certain classes of univalent functions. For $\mu > 0$, we consider the non-vanishing analytic function $(z/h)^{\mu}$, where $(z/h)^{\mu}$ represents principal powers. In particular, we will also determine the maximum value of $L(r,h)$ for function of the form $(z/h)^{\mu}$ when h ranges over the classes of the starlike functions of order β and α-spiral-like functions of order β in $\mathbb{D}$. The maximum value of $L(r,h)$ comes in the form of Gaussian hypergeometric function ${}_2F_1(a,b;c;z)$. A particular case of the related theorem includes the solution of a problem of Gromova and Vasil'ev.

The Generalized Beta-Logarithmic Function: Properties, Poisson Distribution and Fractional Kinetic Equations

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Our main objective in this paper is to introduce a new type of generalization of beta-logarithmic function by utilizing the extended beta function involving the seven parameters of Mittag-Leffler function and discuss its various important properties. Moreover, we also define the beta-logarithmic hypergeometric function and confluent hypergeometric function with the help of the beta-logarithmic function and discuss its integral representation, derivative formulae, and recurrence relations. Finally, as applications of our main outcomes, we provide statistical properties (Poisson distribution, mean and variance) and further investigate fractional kinetic equations.

Recurrence Relation and Differential Equations of the four-Parameter Mittag-Leffler type Supertrigonometric Functions

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This paper is devoted to the establishment and rigorous examination of the four-parameter Mittag-Leffler type supertrigonometric functions. The analysis encompasses essential mathematical results, the evaluation of a definite integral, the derivation of a recurrence relation, and the governing differential equation. Empirical validation is provided through illustrative examples.

Uncertainty Principles for the Quadratic Phase Ripplet Transform

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The present study introduces a novel integral transform known as quadratic phase ripplet transform (QPRT) by embedding a quadratic-phase kernel into the classical ripplet transform. The fundamental properties of the QPRT, including translation, scaling, parity, and linearity are established. Furthermore, essential key results such as the inversion formula, a Rayleigh's energy formula, and characterization of the range of the QPRT are derived. Several classical uncertainty principles, including the Heisenberg, logarithmic, local-type, and Nazarov inequalities, are also extended to the QPRT domain. These results demonstrate the QPRT as a powerful mathematical tool for multidimensional signal analysis and geometric feature representation.

Generalized Riesz–Euler λ-Statistical Convergence of Fuzzy Number Sequences and Korovkin-Type Approximation Theorems

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In this paper, we introduce and investigate the concepts of Riesz-Euler λ-statistical convergence and λ-statistical Riesz-Euler summability for sequences of fuzzy numbers. Several fundamental properties of these new notions are established, and various inclusion relations between the proposed methods and existing summability techniques are examined in detail. Furthermore, by employing the λ-statistical Riesz-Euler summability method in the setting of fuzzy positive linear operators, we develop and prove a new Korovkin-type approximation theorem for sequences of fuzzy numbers. This result provides a generalized framework that unifies and extends several earlier Korovkin-type theorems in fuzzy approximation theory. To demonstrate the applicability and effectiveness of the proposed approach, we also present an illustrative example that verifies the validity of our main findings and highlights the advantages of the newly introduced methods.

On extended Jacobi matrix polynomial

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In this paper, we present certain properties of extended Jacobi matrix polynomial through fractional calculus. Furthermore, the recurrence relation, derivative formula, and integral representation have also been discussed.

On the Construction and Analysis of Fubini-Bell-Apostol Hybrid Polynomials

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In this paper, we introduce and investigate a novel hybrid family of special polynomials, termed the Fubini–Bell–Apostol hybrid polynomials. Utilizing the monomiality principle, we construct their generating functions and derive corresponding series representations. The associated quasi-monomial operators are identified, leading to the formulation of various differential and integral relations. In addition, several summation formulae involving this newly established family are obtained. Moreover, particular cases of the proposed class—namely, the Fubini–Bell–Apostol–Bernoulli, Fubini–Bell–Apostol–Euler, and Fubini–Bell–Apostol–Genocchi polynomials are examined and analogous properties and results are derived for each subclass.

Transforming Mathematics Assessment: From Traditional Methods to Innovative Practices

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Mathematics assessment is shifting from conventional examinations toward innovative practices that better reflect the needs of today's learners. Traditional methods, while effective in measuring procedural knowledge, often fail to capture higher-order thinking, creativity, and collaboration. This paper explores the transformation of mathematics assessment in blended learning environments, emphasizing the optimum use of Learning Management Systems (LMS) to create dynamic and interactive classrooms. LMS platforms enable innovative assessment through personalized learning pathways, real-time feedback, and data-driven insights, allowing teachers to design flexible and engaging evaluation strategies.

The study highlights the integration of Assessment for Learning (AfL), where continuous feedback empowers students to monitor progress and reduce mathematics anxiety. Cooperative learning models such as Student Teams - Achievement Divisions (STAD) embed assessment within collaborative problem-solving activities, fostering peer accountability and motivation. In addition, gamification techniques including classroom adaptations of Snakes and Ladders, Who Wants to Be a Millionaire?, and Hangman—are employed to enhance engagement, enjoyment, and conceptual reinforcement. These playful yet purposeful tools help ease mathematics anxiety by transforming assessment into a low-stress, interactive experience.

Furthermore, rubrics-based assessment provides transparent criteria, ensuring fairness and clarity in evaluating mathematical performance. Complementary methods such as group studies and poster presentations offer authentic opportunities for learners to demonstrate understanding through collaboration and creativity. Findings suggest that combining LMS-based tools, gamification, and rubric-driven evaluation not only improves achievement but also nurtures critical thinking, problem-solving, and communication skills. This paper argues that transforming mathematics assessment is essential for preparing learners to thrive in blended, technology-driven classrooms.

Approximate Common Fixed Points for Multivalued Mappings in Neutrosophic Cone Metric Spaces

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In this paper, we investigate the concept of approximate common fixed points for multivalued mappings within the framework of neutrosophic cone metric spaces (NCMS). We introduce the notions of approximate fixed points and approximate common fixed points tailored to NCMS and establish contractive conditions for multivalued mappings under this setting. By employing these contractive conditions, we prove the existence of sequences converging to approximate common fixed points. Illustrative examples demonstrate the applicability of the main results. Furthermore, potential applications in decision-making under uncertainty, control systems with uncertain dynamics, and information theory are discussed, highlighting the relevance of approximate common fixed points in modeling and solving practical problems involving neutrosophic uncertainty.

Quantum calculus in Harmonic function theory

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In 1990, Ismail, Merkes and Styer, used $q-$calculus in the theory of analytic univalent functions by defining a class of complex-valued functions that are analytic on the open unit disc $\mathbb{D}$, $f(0) = 0$, $f'(0) = 1$ and $|f(qz)| \leq |f(z)|$ on $\mathbb{D}$ for every q, $0 < q < 1$. They proved the Bieberbach conjecture for the $q-$starlike functions ($P\mathcal{S}_q$) through the Herglotz representation theorem for these functions. The purpose of this article is to investigate the classical results of geometric function theory from a quantum calculus point of view.

Bilateral Mock Theta Functions of Order Eleven and their Lerch Transcendent

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Bilateral mock theta functions related to Ramanujan's fifth order Mock Theta functions were studied by G N Watson. We have obtained and studied Bilateral Mock theta functions of order eleven and expressed them in terms of Lerch's transcendental function $f(x, \xi; q, p)$. We also express some bilateral mock theta functions as sum of other mock theta functions. We generalize these functions and show that these generalizations are F_q functions. We give integral representation for these generalized functions.

A Function-Sharing Criterion for Normal Functions

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In this presentation, I will discuss a function - sharing criterion for the normality of meromorphic functions. Let f be a meromorphic function in the unit disc $\mathbb{D} \subset \mathbb{C}$, ψ_1, ψ_2, and ψ_3 be three meromorphic functions in the unit disc $\mathbb{D}$, continuous on $\partial\mathbb{D} := \{z \in \mathbb{C} : |z| = 1\}$, such that $\psi_i(z) \neq \psi_j(z)$ $(1 \leq i < j \leq 3)$ on $\partial\mathbb{D}$. If ψ_1, ψ_2, and ψ_3 share the function f on $\mathbb{D}$, then f is normal. Building upon this, I will further discuss an additional criterion for normal functions.

Approximation efficiency of generalized Cesáro summable difference operator

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This current study encompasses with the construction of generalized Cesàro summable difference operator and related sequence spaces. In this regard, we study various topological properties along with some inclusion relations. Moreover, we propose Korovkin type approximation theorem over this developed operator. In addition, some numerical experiments along with some error estimations have been conducted. Furthermore, a result concerning the rate of approximations has been derived via Ditizian modulus of smoothness of order one.

Subordination results for subclass of multivalent function associated with Pascal distribution

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The aim of this paper is to present a new subclass of multivalent functions denoted by $\Omega_{\theta,p}^{(\alpha,m)}(\beta,\eta)$ through subordination, defined with the help of a linear differential operator $\mathcal{M}_{\theta,p}^{(\alpha,m)}$ on an open unit disk $\mathbb{D}$. Using the Pascal distribution with the aid of subordination, we investigate inclusion relations and Sandwich theorem for the defined subclass. The implications of subordination theory are explored in relation to electromagnetic wave redirection and cloaking structures.

Mann Iteration of Complex Functions with Mixed Polynomial and Transcendental Components

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The Mann iteration of complex functions comprising both polynomial and transcendental components, reveals intricate dynamics significantly influenced by the interplay and relative contributions of these components. We explore the impact of change in the polynomial and transcendental elements on the convergence, periodicity, and chaotic behavior of Mann iterates in the complex plane. We analyze how changes in the degree and coefficients of the polynomial component, as well as the contribution of the chosen transcendental functions perturb the behaviour of the iterated system. Initial findings suggest that the transcendental component often introduces a richer and more complex fractal structure compared to purely polynomial iterations, potentially leading to a greater number of basins of attraction and higher-order periodic orbits. Conversely, the polynomial component can dominate the large-scale behavior, dictating the overall structure and boundedness of the iterates. Understanding the effects of these two function classes within Mann iteration provides crucial insights into the stability and bifurcation phenomena in complex dynamical systems, with implications for fields ranging from numerical analysis to chaos theory and fractal geometry.

Evaluating Integrals involving Bessel Functions using Umbral method and its Applications to Feynman Diagrams

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The umbral method provides a unified framework for evaluating complicated infinite integrals involving exponentials, logarithms, and Bessel functions. We demonstrate its power by deriving both classical and novel integral formulas, with direct applications to Feynman diagrams and renormalization theory.

Innovations in Teaching Mathematics for Quantum Computing Course

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Quantum computing is a multidisciplinary domain that draws upon the foundational principles of physics, mathematics, and computer science. At its core, the field requires learners to develop a strong background in linear algebra, vector spaces, matrix operations, and linear transformations. While mastery of these mathematical concepts is essential, the challenge lies in connecting these abstract mathematical structures with the physical realization of quantum phenomena such as superposition, entanglement, probability distribution, and normalization.

This paper focuses on the innovative pedagogical approaches, particularly anchored in active learning strategies enriched by multimedia resources, can be the key to bridge the gap. By situating pedagogy at the intersection of mathematics and physics, the work demonstrates how learners can be guided to understand the matrix representations of fundamental quantum logic gates - including Pauli-X, Y, Z, Hadamard, and S gates and their operations involving scalar, vector, and tensor products. The discussion highlights how such integrative strategies can foster conceptual clarity, enhance learner motivation, and support the development of skills essential for designing novel quantum algorithms. Ultimately, the study suggests that innovative pedagogical design can be a powerful enabler in preparing students across disciplines to meaningfully engage with the emerging field of quantum computing.

Bivariate degenerate Hermite polynomials in the framework of Lie algebra $\mathcal{K}_5$

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In this article, the matrix elements of the representation $\uparrow'_{\omega,\mu}$ of the 5-dimensional Lie algebra $\mathcal{K}_5$ are obtained for the first time. The bivariate degenerate Hermite polynomials $\mathcal{H}_m(z_1, z_2|\tau)$ are considered within the context of this representation. Further, employing the Lie algebraic techniques, certain specific results concerning these polynomials are established. Some examples providing the implicit formulas for the polynomials related to the polynomials $\mathcal{H}_m(z_1, z_2|\tau)$ are considered. Integral equations for these polynomials are also explored.

Dirichlet averages of the Mittag-Leffler-confluent hypergeometric function

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In this article, we derive comprehensive representations for the Dirichlet averages of the Mittag–Leffler confluent hypergeometric function. These representations are formulated using the Pathway fractional integral operator and generalized hypergeometric functions of several variables. The study also considers specific cases in which the Dirichlet averages reduce to the classical confluent hypergeometric function and to generalized Wright hypergeometric functions.

A further result related to Brück conjecture and linear differential polynomial

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The Brück conjecture is greatly associated with Nevanlinna Theory which was invented by Prof. Rolf Nevanlinna in the year 1925. In 1996, Rainer Brück proposed Brück conjecture concerning value sharing with its first derivative.

In 1977, L. A. Rubel and C. C. Yang first considered the problem of value sharing by an entire function with its derivative. Inspired by their work a lot of researchers devoted themselves to explore such problems and extensions to different directions. In 1996 R. Brück proposed the following conjecture:

Brück's Conjecture: Let f be a nonconstant entire function such that $\sigma_2(f)$ is not a positive integer or infinity. If f and $f^{(1)}$ share one finite value a CM, then $f^{(1)} - a = c(f - a)$ for some nonzero constant c.

R. Brück himself resolved the conjecture for $a = 0$ but the case $a \neq 0$ is yet to be fully resolved.

For an entire function of finite order, G. G. Gundersen and L. Z. Yang and L. Z. Yang and in 2009 J. M. Chang and Y. Z. Zhu improved the Brück conjecture.

In this paper, we extended the conjecture sharing a polynomial with its linear differential polynomial.

Integral forms and functional bounds for certain extended Exton's double hypergeometric functions

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We extend and systematically investigate some particular Exton's double hypergeometric function $X^{A:B;B'}_{C:D;D'}[x, y]$, which is motivated by the recent integrated version of the Euler's Beta integral form with a Macdonald function $K_\nu(z)$ in the integrand. The newly introduced extended Exton's double hypergeometric functions $X^{A:B;B'}_{C:D;D'}[x, y; p, q, \nu, \lambda]$ is then represented by a number of integral representations of the Euler and Laplace types, including several further representations involving Bessel $J_\nu(z)$ and modified Bessel functions $I_\nu(z)$ of the first kind along with recurrence formulae. Using existing functional bounds for extended Euler's Beta function, various functional upper bounds are derived for particular extended Exton's double hypergeometric functions $X^{A:B;B'}_{C:D;D'}[x, y; p, q, \nu, \lambda]$. Also, plethora of bounding inequalities are established by virtue of Luke's, von Lommel's, Minakshisundaram and Szász and Olenko's bounds. The exposition ends with a newly introduced probability distribution applying extended Kummer and of Horn functions, for which moment inequalities of Turán type are proved.

Exploring rough weighted $\mathcal{I}$-convergence over locally solid Riesz spaces

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At the dawn of the 21st century, two innovative concepts of convergence emerged: rough convergence by Phu [Numer. Funct. Anal. Optim. 22 (1-2) (2001), 199-222] and $\mathcal{I}$-convergence by Kostyrko et al. [Real Anal. Exchange 26 (2) (2000/2001) 669-686]. Numerous researchers have expanded these concepts across various domains by considering the degree of roughness as a non-negative real number. In this study, we explore the notion of rough weighted $\mathcal{I}$-convergence over locally solid Riesz spaces by conceptualizing the roughness degree as a neighborhood rather than a non-negative real number. Our findings, although they diverge from some previous results regarding rough convergence, generate novel properties. Concurrently, we introduce the notion of rough weighted $\mathcal{I}$-Cauchy sequences in locally solid Riesz spaces and compare them with the following results:

(i) A rough convergent sequence with roughness degree r is also a rough Cauchy sequence with Cauchy degree ρ where $\rho \geq 2r$. The bound for the Cauchy degree cannot be generally decreased [Numer. Funct. Anal. Optim. 24 (3-4) (2003) 285-301];

(ii) An $\mathcal{I}$-convergent sequence invariably satiesfies the criterion of the $\mathcal{I}$-Cauchy sequence [Real Anal. Exchange 30 (1) (2004/2005) 123-128].

We provide examples demonstrating that, in this context, a convergent sequence does not necessarily satisfy the Cauchy condition. Furthermore, we delineate the conditions necessary for convergence and Cauchy equivalence.

A novel subclass of analytic functions defined by post quantum operator subordinated to epicycloid domain

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The purpose of the present work is to introduce a novel subclass of univalent functions defined by making use of post quantum operator, which maps the open unit disk $\mathbb{D} := \{z \in \mathbb{C} : |z| < 1\}$ onto domain bounded by the epicycloid curve. The left hand side of the subclass is defined by taking into account the ratio of the analytic representation of (p,q)-analogue of convex function to that of starlike function. We investigate the bounds of some of the initial coefficients, Hankel, Vandermonde and symmetric Toeplitz determinants of different orders for the said class.

(D) Functional Analysis, Measure Theory, Probability Theory and Stochastic Processes, and Information Theory

Some Common Fixed Point Results in Fuzzy b-Metric Space

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The fixed point theory as a part of non-linear analysis is a study of function equation in metric or non-metric settings. The famous classical Banach contraction principle in metric space is one of the fundamental results that has wide applications. Among several generalized forms of metric space, the study of common fixed point of mappings in Fuzzy metric space satisfying certain contractive conditions has been at the center of vigorous research activities.

In 2012, S. Sedghi and N. Shobe introduced the notion of fuzzy b-metric space which is wider and flexible than the fuzzy metric space relative to triangle inequality property. The main purpose of this presentation is to discuss some common fixed point results for self-mappings in fuzzy b-metric space which extend and improve similar results of fixed points.

Fixed point theorems for hybrid contraction

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Fixed point theorems are fundamental tools in various fields of mathematics, providing existence and uniqueness criteria for solutions to equations, integral equations, and differential equations. We begin by establishing the foundational concepts of metric spaces and introducing classical fixed point results.

The study of fixed points for hybrid contractions offers a robust framework for solving mixed-type mathematical problems. This talk aims to provide a comprehensive overview of the theory, presenting key results and opening avenues for future research in this dynamic and evolving field.

Dirichlet Convolution in Banach Lattices

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We study Dirichlet convolution operators $T_h : f \mapsto f * h$ on the weighted AM-space A_w of arithmetic functions and their adjoints on the order-continuous dual B_w. For any weight $w \geq 1$ and nonnegative kernel h, we obtain the exact operator norm $\|T_h\| = \sup_{n\geq 1} \sum_{d|n} h(d)\, w(n/d)/w(n)$. For completely multiplicative w this simplifies to $\sup_{n\geq 1} \sum_{d|n} h(d)/w(d)$. The resulting divisor-sum norm turns kernels into a commutative Banach lattice algebra under Dirichlet convolution and yields $\|T_h\| = \|T_{|h|}\|$. On B_w the adjoint acts by index shifts described by $(T_h^* b)(d) = \sum_{e\geq 1} h(e)\, b(de)$, while the norm-compatible product there is unitary convolution. Bands in A_w correspond to divisorially closed supports, and T_h carries the band generated by a set S to the one generated by $S\,\mathrm{supp}(h)$. Disjointness is preserved exactly when $\#\mathrm{supp}(h) \leq 1$; preserving every band forces a scalar operator. When $h \geq 0$ and w is completely multiplicative, the norm factors over the primes; for power weights $w(n) = n^\sigma$ with $\sigma > 1$ it equals an Euler product that also matches $\sum_{n\geq 1} h(n)/n^\sigma$. With multiplicative w, T_h is compact only when $h \equiv 0$. If $h \geq 0$ has finite support and T_h is bounded, then T_h is σ-order continuous. Finally, T_h is invertible precisely when the Dirichlet inverse h^{-1} lies in this divisor-sum class, and then $T_h^{-1} = T_{h^{-1}}$.

A brief introduction to probability transition matrices and Markov chains for quadripartitioned neutrosophic sets

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The real world is replete with several fascinating puzzles waiting to be modeled and analyzed. The one thing common in most of the cases is the lack of complete information. Such information gaps are usually referred to as uncertainty. The theory of fuzzy sets (Zadeh, 1965) brought about a path breaking approach for modeling uncertainty in the form of imprecision. This approach, unique in its own right and was quite different from the theory of probability which, till then, was the only theory that could represent uncertainty in the form of imprecision. Later on the theory of fuzzy sets went through several generalizations and extensions, out of which the theory of single valued quadripartitioned neutrosophic sets (Chatterjee et. al, 2016) was one.

The present study is based on the convergence of the concepts of probability as well as that of quadripartitioned neutrosophic (QN) sets. In that sense, the proposed theory can efficiently model random imprecision. Based on this framework few fundamental concepts regarding the probability of occurrence of a QN component are introduced. The basic concepts of states and state transition probabilities are introduced. Furthermore, the concept of a probability transition matrix is defined. The concept of communicating states and absorbing states are discussed. Finally, N-step transition probabilities are discussed at the end as a culmination to the proposed concepts.

Horizon Activation Mapping (HAM) for Interpretability in Neural Networks for Time Series Forecasting

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Neural networks for time series forecasting have relied on error metrics for model selection and architecture-specific interpretability approaches that often don't apply to other models. In order to interpret forecasting models agnostic to the types and numbers of layers, we introduce Horizon Activation Mapping (HAM), a visual interpretability technique inspired by grad-CAM that uses gradient norms to study models where grad-CAM studies attention maps over the data. We introduce causal and anti-causal modes to calculate gradient update norm averages by subseries at every timestep in the horizon using a binary mask but the technique allows for several variants of study based on different types of subseries in general. A line of proportionality that signifies a uniform distribution of norm averages by subseries per timestep is used for reference. The modes enable gradient equivariant point comparisons, studying the models based on differences between update activities across different subsets of the horizon, area plots with respect to the proportionality line of gradient updates across the horizon, interpolated area plots comparing models across multiple horizon sizes, difference plots between subseries of the horizon by a single timestep. The ETTm2 dataset with electricity load data in 15-min intervals is used for multivariate forecasting models CycleNet, N-Linear, N-HITS that are MLP-based, FEDformer, Pyraformer that are self-attention based, SpaceTime that is SSM-based and Multi-Resolution DDPM that is diffusion based that have been used for the studies.

A Chaos-Enhanced Graph Theoretic Approach for Image Data Security

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In today's digital age, a massive number of images are communicated, stored, and shared across various digital media platforms. Unlike textual data, images require high security against unwanted access, manipulation, and destruction. With the increased interchange of sensitive visual information via public networks, the development of secure and efficient image encryption algorithms has emerged as a critical field of information security. A mathematical model is developed by combining a graph-theoretic structure with chaotic map dynamics to improve the integrity, sensitivity, and overall security of image data. The suggested approach uses graph theory's structural complexity to describe image pixels or blocks as interconnected nodes, allowing for efficient permutation and connection mapping. This combination not only expands the key space but also improves resistance to cryptographic attacks. The randomness provided by chaos-driven graph operations ensures that even tiny changes in the encryption key result in maintaining high key sensitivity. The suggested method is tested on a few forensic images, and the findings show satisfactory performance across key assessment metrics. These results demonstrate that the model provides a strong and mathematically sound foundation for protecting sensitive photos in digital communication and forensic applications.

Schauder Bases for $C[0,1]$ Using ReLU, Softplus and Two Sigmoidal Functions

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The present article constructs new Schauder bases for $C[0,1]$ based on functions commonly used in machine learning. We apply these new bases to derive some approximation bounds of interest to the theoretical machine learning community.

We start with certain piecewise linear functions called the Rectified Linear Unit or ReLU, and a smooth variant called the Softplus. We construct Schauder bases for the space $C[0,1]$ using these two functions, and two more bases using sigmoidal versions of the ReLU and Softplus functions. This establishes the existence of a basis using these functions for the first time, and improves on the universal approximation property associated with them. We also show an $O(\frac{1}{n})$ approximation bound based on our ReLU basis, and a negative result on constructing multivariate functions using finite combinations of ReLU functions.

There is a lot of interest in the neural network community on understanding the expressive power and approximation capabilities of ReLU based networks. Our basis results can be applied towards these questions. For instance, we establish an $O(\frac{1}{n})$ approximation bound of the supnorm on $C[0,1]$ based on the first n (single-layer) basis functions improving upon the known L^2 norm bound, the currently known multilayered representation, and some recent infinite width ReLU network results.

This article has been accepted for publication at the Transactions on Machine Learning Research (TMLR).

A Class of Third-Order Iterative Methods for Ill-Posed Problems

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We introduce a novel unified family of iterative methods that achieve at least third-order convergence for computing approximate Lavrentiev-regularised solutions to nonlinear ill-posed equations. The local and semi-local convergence is established under a unified set of assumptions, without relying on Taylor expansions. We obtain the optimal order under the H"older-type source condition. An a priori regularization parameter choice strategy that depends on noisy data and is independent of unknown source condition parameter is used to obtain the regularization parameter. Numerical examples are provided to validate the theoretical results.

Variational Inequality Problems in Non-Absolute Cesaro Sequence Spaces

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In recent years classical variational inequality problem has been extended to study a wide class of problems arising in mechanics, physics, optimization and control, nonlinear programming, economics, finance, regional, structural, transportation, elasticity and applied sciences, and so forth. They have been extended and generalized in different directions by using novel and innovative techniques and idea. In recent decades the summability theory has played an important role to show the existence of the solution of the problems. The variational inequality problem (VIP) has been studied on different spaces such as Topological spaces, Banach space, Hilbert space, H-space and manifolds. The main purpose of our work is to introduce the variational inequality problems in non absolute Cesaro sequence spaces. We study the existence theorems the variational inequality problems in it.

Fixed Point Theorems in Quasi Partial b-Metric Space Using Interpolative Boyd-Wong-Type and Matkowski-Type-Contractions

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In this paper, we use interpolative Boyd-Wong and Matkowski type contractions to construct fixed point theorems in the context of complete quasi-partial b-metric spaces. Furthermore, a common fixed point theorem for a pair of mappings is shown using the interpolative Boyd–Wong contraction. The results proved here, expand and improve on various existing findings from the literature. In addition, examples are provided to demonstrate the efficiency of the stated theorems, as well as an application to integral problem.

Mathematics as the Function of Quantum Theory: Exploring Its Role in Formulating Principles and Predicting Phenomena

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Quantum theory, which is a major building block of modern science, has changed quite a lot over the last hundred years, completely altering how we see the physical world and influencing the path of scientific discovery. It's brought in a new and different perspective on physical things, moving away from classical physics, and it does a great job explaining lots of experimental results. Mathematics plays a vital role in quantum field theory. We focus on different concepts of Mathematics, which are used to develop the context of mathematical quantum theory and explain how particles in quantum system, making predictions and provide reasons for quantum phenomena. We explore fundamental mathematical concepts, including algebra and analysis, geometry and number theory, topology, differential equations, and probability, giving clear explanations and insights into these essential topics.

Bridging Concepts: The Interplay of Free Locally Convex Spaces and Nuclear Spaces

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This paper investigates the deep structural relationship that exists between the notions of FLCS, $L(X)$, and Nuclear Space in functional analysis, a field where topology and algebraic structures go hand in hand. It is motivated by the known, but far from trivial, result that any nuclear space is a FLCS. Given this fact, there is an important converse question: under what conditions will an arbitrary FLCS have the properties of a nuclear space? In addressing that core question, this present research goes on to provide a definitive, structural criterion that exactly delineates the boundary between these two classes of topological vector spaces.

The main contribution of the present paper is a rigorous proof that the free locally convex space $L(X)$ associated with a Tychonoff space X is non-nuclear iff the underlying space X contains an infinite compact subset. Let us emphasize that this result is not just a reformulation of what was known before but an important refinement. Indeed, we first establish the more general result that $L(X)$ is not multi-Hilbert under the assumption that X contains an infinite compact subset. This approach is decisive because it exploits the well-known fact that every nuclear locally convex space must be multi-Hilbert. We will make a step towards proving the non-nuclearity of $L(X)$ by proving that $L(X)$ fails to be multi-Hilbert. The latter amounts to constructing for a continuous

one-to-one mapping $f : X \to E$ to some Banach space E such that the image $f(X)$ cannot be contained in any ellipsoid.

The paper further illustrates these theoretical considerations by presenting specific examples. We consider in detail the case when X is a non-trivial countable convergent sequence and show that the corresponding $L(X)$ is not multi-Hilbert. Such a result provides an important counterexample, showing the limitations of the multi-Hilbert property in certain topological contexts and underlining the principal result. Consequences of the results are touched upon. They considerably sharpen the view on topological and structural properties of $L(X)$, including an exact boundary condition for its nuclearity, which was previously not so clearly defined.

These established criteria on non-nuclearity and non-multi-Hilbert properties of $L(X)$ are essential in the future study of many advanced mathematical domains. More specifically, the results obtained here provide the basic tools for the classification and investigation of topological vector spaces in both non-commutative geometry, where nuclearity is the decisive property defining amenable C^*-algebras, and in the theory of operator algebras, where the structure of $L(X)$ is fundamental. This work bridges such concepts, opening new ways of investigating generalized locally convex spaces, among which the bornological spaces contribute to an advanced and unified grasp of the complex landscape of functional analysis.

Common Fixed Point Results for Interpolative Reich–Rus–Ćirić Type Contraction in m-Metric Spaces

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In this study, we explore the existence of common fixed points for interpolative Reich–Rus–Ćirić type contractions within the framework of m-metric spaces. We analyze two separate scenarios depending on whether the sum of the interpolative exponents is less than one or greater than one. The results we establish not only generalize several known theorems but also demonstrate their effectiveness through a series of illustrative examples and an application to a system of integral equations, thereby emphasizing both the theoretical and practical significance of our findings.

Some Fixed Point Theorems For Interpolative Meir-Keeler-Hardy-Rogers Type Contraction in a Complete Metric Space

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This paper aims to extend the existing results on Meir–Keeler contractions to an interpolative Meir–Keeler type contraction in a complete metric space. Using this new class of contractions, we establish fixed point results under suitable conditions. To illustrate and support the findings, examples and an application are also provided.

Fixed Point result for multivalued mapping in Generalized Partial Metric Space

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A fixed-point theorem for multivalued mappings is established within the context of a generalized partial metric space. The findings presented in this work are substantiated by illustrative examples and extend the results given by Antal et al.

Absolutely Quasi Norm Attaining Operators

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The study of *norm attaining operators* has been a central theme in operator theory, tracing back to the classical work of Lindenstrauss and others. In our work, we introduced a refined class of bounded linear operators known as absolutely quasi norm attaining operators (AQNA). An operator T from a Banach space X to a Banach space Y is said to be *absolutely norm attaining* if T attains it's norm on every non trivial closed subspace of X whereas the class of *quasi norm attaining operators* from X to Y provides a natural extension of norm attaining criteria by replacing exact norm attainment with sequential norm attainment. An operator $T \in B(X, Y)$ is said to be *absolutely quasi norm attaining* if for every nontrivial closed subspace $M \subset X$, there exists a sequence of unit vectors (x_n) in M such that

$$T_M x_n \to y \quad \text{in} \quad Y \quad \text{such that} \quad \|T_M\| = \|y\|,$$

where T_M is the restriction map of T on M. This condition ensures that the norm of T is attained on every subspace in a quasi sense, thus generalizing the notion of norm attainment and connecting it to the geometric structure of the underlying space. We focused on essential structural properties, characterizations, and illustrative examples of various spaces. Relations with compact, bounded below, and uniformly norm attaining operators are examined. Many interconnecting theorems, results and counter examples constructed to understand the links among spaces.

Common fixed point theorems for alternative mappings in generalized complete metric space

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The aim of this paper is to establish some common fixed point theorems of alternative mappings in generalized complete metric space. Our result extends and generalizes the well-known result of Deepak Khantwal (Theorem of the alternative for a system of mappings in generalized complete metric space, The Journal of Analysis 33:253-265 (2025)).

Complex Symmetric Toeplitz Composition Operators on Generalized Derivative Hardy Space

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This paper studies Toeplitz composition operators on the generalized derivative Hardy space, extending earlier work on weighted composition operators by examining their self-adjointness, normality, and commutativity. It provides a full characterization of the complex symmetry of these operators for analytic, co-analytic, and harmonic symbols. In addition, the paper constructs Toeplitz graphs corresponding to operators with harmonic symbols.

On a generalization of weighted composition differentiation operators on Dirichlet-type space

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This paper introduces the concept of generalized weighted composition differentiation operators on Dirichlet-type spaces. We establish necessary and sufficient conditions for these operators to be C-symmetric and C-normal. Furthermore, we investigate their boundedness, norm estimates, compactness, and criteria for belonging to the Hilbert–Schmidt class. The study also provides a detailed characterization of the adjoint operators corresponding to linear-fractional self-maps of the unit disk.

Linear Complementary Pair of Codes over Semi-local Rings and its Application

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In this work, we define a linear complementary pair (LCP) of codes over the semi-local ring $S_t = \mathbb{F}_q + v_1\mathbb{F}_q + \ldots + v_t\mathbb{F}_q$, where q is an odd prime power and $v_i^2 = v_i,\ v_iv_j = v_jv_i = 0$ for $i, j = 0, 1, \ldots, t,\ i \neq j$, and establish the necessary and sufficient conditions for a linear codes pair to be an LCP of codes. Furthermore, we employ LCP of cyclic codes over S_t to construct entanglement-assisted quantum error-correcting codes (EAQECCs).

Exponential Sampling Type Deep Neural Network Operators

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In this study, we introduce a novel family of exponential sampling–type deep (multilayer) neural network (NN) operators and investigate their approximation capabilities across various function spaces. We establish boundedness results, pointwise and uniform convergence theorems, as well as modular convergence for both generalized and Kantorovich-type deep NN operators constructed via exponential sampling. The analysis is conducted within the classes of log-uniformly continuous functions and Mellin–Orlicz spaces defined with respect to the logarithmic measure. In addition to the theoretical developments, numerical illustrations are provided through graphical representations and approximation error estimates. Moreover, we demonstrate the effectiveness of the proposed operators in signal denoising, particularly in substantially reducing Gaussian noise.

Convergence Analysis for System of Cayley Generalized Variational Inclusion on q-Uniformly Banach Space

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This paper is devoted to the analysis of a system of generalized variational inclusion problems involving α-averaged and Cayley operators within the framework of a q-uniformly smooth Banach space. We demonstrate that the problem can be reformulated as an equivalent fixed-point equation and propose an iterative method based on the fixed-point approach to obtain the solution. Furthermore, we establish the existence of solutions and analyze the convergence properties of the proposed algorithm under suitable conditions. To validate the effectiveness of the proposed iterative method, we provide a numerical result supported by a computational graph and a convergence plot, illustrating its performance and efficiency.

Modified Levenberg-Marquardt-Kaczmarz Method for Nonlinear Ill-Posed Problems

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The Levenberg-Marquardt-Kaczmarz (LMK) method for system of nonlinear ill-posed operator equations is computationally expensive due to repeated derivative evaluations of $F'(x_k)$ at each iteration. To overcome the computational slowness of standard LMK methods, we propose an accelerated variant that: (1) incorporates extrapolation for faster convergence, and (2) evaluates Fréchet derivatives only once at initialization, i.e., $F'(x_0)$. This modification significantly reduces computational cost while maintaining convergence guarantees. Numerical simulations on parameter estimation problems confirm superior performance over standard LMK in both reconstruction accuracy and computational efficiency.

Well-posedness, Propagation of Chaos and Numerical Approximation of McKean-Vlasov SDE with super-linear coefficients

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We study McKean–Vlasov Stochastic Differential Equations (MV-SDEs) whose drift and diffusion coefficients are of superlinear growth in *all* their variables. Our contributions are following: (a) We establish well-posedness for this class of equations and the corresponding interacting particle system. (b) We prove the propagation of chaos results with explicit L^2-convergence rates where the rate degrades as the system's dimension d increases. (c) Unlike existing works—based on semi-implicit schemes or truncated Euler schemes—we propose a fully explicit tamed Euler scheme that has reduced computational cost (comparatively). The explicit scheme is shown to converge in strong L^p-sense with rate 1/2 (in timestep).

Characterize the conditions under which specific sequence spaces exhibit the property of regularity

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Köthe and Toeplitz have carried out works on sequence spaces, some of which were later developed by Allen and P. Dienes. An account of all these can be found in Cooke (Chapter 10). In this direction of study, efforts were made to establish some of the results. We observed that in sequence spaces, the $\alpha\beta$-limit implies the c-limit of the same sequence in a sequence space. But there we did not get an authentic signal for a c-limit to be an $\alpha\beta$-limit under $\alpha\beta$-convergence. In order to examine the problems of existence and the position of these limits, Dienes introduced the notion of regular sequence spaces. Our sincere effort in this paper is to study sequence spaces in detail to observe under what circumstances some of the sequence spaces fall to be regular.

On weighted bilinear inequalities of Hardy type

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We discuss the Hardy type inequalities involving bilinear operator by reducing the inequalities to the standard Hardy inequalities. Precisely, we study the inequality

$$\left(\int_0^\infty (H_2(f,g)(x))^q u(x)dx\right)^{\frac{1}{q}} \leq C\left(\int_0^\infty f^{p_1}(x)v_1(x)dx\right)^{\frac{1}{p_1}}\left(\int_0^\infty g^{p_2}(x)v_2(x)dx\right)^{\frac{1}{p_2}}$$

for all non-negative f, g on (a,b) and $1 < p_1, p_2, q < \infty$. We further show that the same reduction technique extends to a variety of related inequalities involving mixed Hardy-type integral operators.

Hardy Inequalities in Orlicz Spaces for Monotone Functions using Sawyer Duality Principle

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The classical Sawyer principle provides the necessary and sufficient conditions for the boundedness of linear integral operators in various function spaces. This principle is well known for weighted Lebesgue as well as for Orlicz spaces, providing both lower and upper bounds for the following expressions

$$I(g) := \sup_{0\leq f\downarrow} \frac{\int_0^\infty f(x)g(x)dx}{\left(\int_0^\infty f^p v\right)^{1/p}}$$

and

$$J(g) := \sup_{0\leq f\downarrow} \frac{\int_0^\infty f(x)g(x)dx}{\|f\|_{P(v)}}.$$

While discussing this principle, we shall also present the cases when f is replaced by its integral average $\frac{1}{x}\int_0^x f(t)dt$ and also by its adjoint $\int_x^\infty \frac{f(t)}{t}$.

New fixed point results via four-point contractions in metric spaces

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This study introduces a four-point analogue of the Banach contraction principle and establishes sufficient conditions under which such mappings admit fixed point(s) in complete metric spaces. The classical Banach contraction principle is recovered as a direct corollary. Several non-trivial examples are provided to validate the results and to demonstrate that quadrilateral perimetric contractions do not necessarily imply other well-known contraction types. The analysis is further extended to non-complete metric spaces, yielding new fixed point theorems in broader settings. In addition, we define and investigate Kannan-type and Chatterjea-type perimetric contractions on quadrilaterals, presenting conditions for the existence and uniqueness of fixed points. Relationships between these new classes and established contraction mappings are explored, offering deeper insights into their structural properties. To support the theoretical developments, illustrative examples are included. Finally, we provide a remark demonstrating that the arguments in [Karapınar, RNA, 8(1):115–123, 2025] contain a gap.

A Novel Geometric Approach for Secure Hashing

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The rise of information technology has made online communication swift and efficient, with e-documents replacing traditional paper documents for most official and personal exchanges. This development increases the need to safeguard sensitive data during storage and transmission. To address this, the paper presents a new geometric-based hash algorithm called PHA-160 designed to improve message authentication and integrity. The algorithm compresses each input block, divides it into sub-blocks, and computes quadrilateral areas to produce a distinct hash value. Statistical analysis using bit probability test, hamming distance test and series tests demonstrate the algorithm's effectiveness. PHA-160 performs better overall and has a better avalanche effect than ASH-160, SHA-1 and RIPEMD-160.

(E) Differential / Integral / and Functional Equations

Stability of Additive Functional Equations From A Hotel Model

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In this paper, the author explores the generalized Ulam–Hyers stability of a system of additive functional equations

$$\begin{aligned} &H_I\left(P_I+R_I+F_I+Q_I+S_I+T_I\right)\\ &=H_I\left(P_I\right)+H_I\left(R_I\right)+H_I\left(F_I\right)+H_I\left(Q_I\right)+H_I\left(S_I\right)+H_I\left(T_I\right)\end{aligned}$$

where $I = 1, 2, 3, 4, 5, 6$ in Banach spaces. An application of the functional equations is also studied.

Random Stability Analysis of a 4-Dimensional Quadratic Functional Equations

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This research interrogates the generalized Ulam-Hyers stability of a 4-dimensional quadratic functional equation of the form

$$\begin{aligned} &P\Big(\sum_{i=1}^{4} iu_i\Big)+P\Big(\sum_{i=1;i\neq 3}^{4} iu_i-3u_3\Big)+P\Big(\sum_{i=1;i\neq 2}^{4} iu_i-2u_2\Big)+P\Big(\sum_{i=2}^{4} iu_i-u_1\Big)\\ &+P\Big(\sum_{i=1;i\neq 2,3}^{4} iu_i-\sum_{i=2}^{3} iu_i\Big)+P\Big(\sum_{i=2;i\neq 3}^{4} iu_i-\sum_{i=1;i\neq 2}^{3} iu_i\Big)+P\Big(\sum_{i=3}^{4} iu_i-\sum_{i=1}^{2} iu_i\Big)\\ &+P\Big(-\sum_{i=1}^{3} iu_i+4u_4\Big)=128P(u_4)+72p(u_3)+32P(u_2)+8P(u_1)\end{aligned}$$

in a random Banach space utilizing popular direct and fixed point methods.

Stability of a Cubic Functional Equation Involving Mean Sum of Functions of Consecutive Variables in Neutrosophic Banach Space

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The main aim of this paper is to explore the generalized Ulam-Hyers stability of a cubic functional equation involving the mean sum of functions of consecutive variables

$$\sum_{a=1}^{m}\mathcal{B}\left(\frac{\sum_{b=1}^{a}u_b}{a}\right)=\sum_{a=1}^{m}\frac{1}{a^3}\left(\left\{\frac{(a-3)(a-2)}{2}\right\}\sum_{b=1}^{a}\mathcal{B}(u_b)+\sum_{1\le a<b<c}^{a}\mathcal{B}\left(u_a+u_b+u_c\right)-(a-3)\sum_{1\le a<b}^{a}\mathcal{B}\left(u_a+u_b\right)\right)$$

in Neutrosophic Banach Space using direct and fixed point methods.

Stabilities of an Additive Functional Equation Originating From the Sum of Powers of Constants in n Fuzzy Banach Spaces

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The authors investigate the generalized Ulam-Hyers stability of an additive functional equation derived from sums of powers of constants of the type

$$\mathbf{a}\left[\sum_{j=1}^{n}a_j^j u_j\right]=\sum_{j=1}^{n}\left[a_j^j\mathbf{a}\Big(u_j\Big)\right]$$

where a_j's are positive constants with $a_j \neq 0$ and $n \geq 1$ in n Fuzzy Banach spaces is analyzed.

Composite Additive Quadratic Functional Equation In Banach Space: A Fixed Point Approach

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In this paper, we first time introduce and determine the generalized Ulam-Hyers- Rassias stability of a composite additive - quadratic functional equation

$$\begin{aligned}&\Omega\left(2\Omega\left(\omega_1\right)-\Omega\left(\omega_2\right)-\Omega\left(\omega_3\right)\right)\\&=-2\Omega\left(\omega_1\right)-\Omega\left(\omega_2\right)-\Omega\left(\omega_3\right)-\left[\Omega\left(\omega_1\right)-\Omega\left(-\omega_1\right)\right]\\&\quad-\frac{3}{2}\left[\Omega\left(\omega_2\right)+\Omega\left(-\omega_2\right)\right]-\frac{3}{2}\left[\Omega\left(\omega_3\right)+\Omega\left(-\omega_3\right)\right]-2\left[\Omega\left(\omega_1\right)-\Omega\left(-\omega_1\right)\right]\\&\quad+\Omega\left(\omega_1+\omega_2\right)+\Omega\left(\omega_1+\omega_3\right)+3\Omega\left(\omega_1-\omega_2\right)+3\Omega\left(\omega_1-\omega_3\right)\\&\quad+\Omega\left(\omega_2+\omega_3\right)+\frac{1}{2}\left[\Omega\left(\omega_2\right)-\Omega\left(-\omega_2\right)\right]+\frac{1}{2}\left[\Omega\left(\omega_3\right)-\Omega\left(-\omega_3\right)\right]\end{aligned}$$

in a Banach Space with the help of fixed point method.

Hyers Type Stability of an Additive Quartic Functional Equation in Intuitionistic Fuzzy Banach Space

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The main scope of this article is to deliver the generalized Ulam-Hyers stability of a mixed A1Q4 functional equation

$$\begin{aligned} &G(2w_1+w_2+w_3)+G(2w_1+w_2-w_3)+G(2w_1-w_2+w_3)+G(-2w_1+w_2+w_3)\\ &\quad=8[G(w_1+w_2)+G(w_1-w_2)+G(w_1+w_3)+G(w_1-w_3)]\\ &\qquad+2[G(w_2+w_3)+G(w_2-w_3)]+32G(w_1)-30[G(w_1)-G(-w_1)]\\ &\qquad\;+7[G(w_2)-G(-w_2)]-9[G(w_3)-G(-w_3)]-16G(w_2)-16G(w_3)\end{aligned}$$

in an Intuitionistic fuzzy Banach space using Hyers method.

On vector oscillation of 2-D nonlinear nonautonomous delay dynamic systems on time scales

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This work is concerned with the necessary and sufficient conditions for oscillation of a class of 2-D neutral dynamic system of the form:

$$\begin{bmatrix} u(t)+p(t)u(\theta(t)) \\ v(t)+p(t)v(\theta(t)) \end{bmatrix}^{\Delta} = \begin{bmatrix} \alpha_1(t) & \alpha_2(t) \\ \alpha_3(t) & \alpha_4(t) \end{bmatrix} \begin{bmatrix} \phi_1(u(\delta(t))) \\ \phi_2(v(\nu(t))) \end{bmatrix} + \begin{bmatrix} \chi_1(t) \\ \chi_2(t) \end{bmatrix}, \text{t} \in [t_0,\infty)_{\mathbb{T}}$$

on time scales $\mathbb{T}$, where $t_0 \in \mathbb{T}, \sup \mathbb{T} = \infty; \alpha_1, \alpha_2, \alpha_3, \alpha_4, p, \chi_1,\ \chi_2 \in C_{rd}([t_0,\infty)_{\mathbb{T}}, \mathbb{R})$ be such that $\alpha_1(t) < 0, \alpha_2(t) > 0, \alpha_3(t) > 0, \alpha_4(t) < 0, |p(t)| < \infty$. Here, $\theta, \delta, \nu \in C_{rd}([t_0,\infty)_{\mathbb{T}}, \mathbb{T})$ be such that $\theta(t) \leqslant t, \delta(t) \leqslant t, \nu(t) \leqslant t$ with $\lim_{t\to\infty} \theta(t) = \lim_{t\to\infty} \delta(t) = \lim_{t\to\infty} \nu(t) = \infty$ and θ has the inverse, that is, $\theta^{-1} \in C(\mathbb{T},\mathbb{T})$. $\phi_1, \phi_2 \in C_{rd}(\mathbb{T},\mathbb{R})$ with the properties $r\phi_1(r) > 0$ and $r\phi_2(r) > 0$ for $r \neq 0$, and for every right dense point r in $\mathbb{T}$. The discussion pertaining to the forcing vector is under a suitable choice of the components.

Oscillatory Vector Analysis of 2nd order 2-D Nonhomogeneous Nonautonomous Dynamic Systems

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We are concerned to discuss the necessary and sufficient conditions for vector oscillation of a class of 2nd order 2-D nonhomogeneous neutral dynamic systems of the form:

$$\begin{bmatrix} u(y)+p(y)u(\tau(y)) \\ v(y)+p(y)v(\tau(y)) \end{bmatrix}^{\Delta^2} = \begin{bmatrix} q_1(y) & q_2(y) \\ q_3(y) & q_4(y) \end{bmatrix} \begin{bmatrix} \xi_1(u(\alpha(y))) \\ \xi_2(v(\beta(y))) \end{bmatrix} + \begin{bmatrix} f_1(y) \\ f_2(y) \end{bmatrix}$$

on time scales $\mathbb{T}$, where $\tau(y) \leqslant y, \alpha(y) \leqslant y, \beta(y) \leqslant y$ for rd-continuous points $y \in [y_0,\infty)_{\mathbb{T}} = [y_0,\infty) \bigcap \mathbb{T}$ such that $y_0 \geqslant y_{-1} = \min\{\tau(y),\ \alpha(y),\ \beta(y)\}$.

Global Solutions to the Discrete Nonlinear Breakage Equations without Mass Transfer

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Coagulation–fragmentation processes arise naturally in the dynamics of cluster growth and describe how clusters merge to form larger ones or break into smaller ones. Such models appear in aerosol science, astrophysics, colloidal chemistry, polymer science, and biology. In the discrete framework considered here, each cluster is characterized by a single integer-valued size corresponding to the number of identical elementary units it contains; an i-cluster thus consists of $i \geq 1$ units. Coagulation is inherently nonlinear, since it results from binary or multiple interactions in which clusters combine to form larger ones. Fragmentation, however, may occur either linearly (spontaneously), due to intrinsic instabilities or external perturbations such as mechanical stress or radiation, or nonlinearly through collision-induced breakage, in which collisions lead to both mass exchange and splitting.

In this paper, we study a discrete model for collision-induced breakage and establish the global existence of mild solutions for a broad class of collision kernels, without requiring any growth assumptions. In addition, we construct classical solutions and prove their uniqueness for suitable kinetic coefficients and initial data. The long-time behaviour of solutions is analyzed, revealing qualitative trends in mass distribution among clusters. Numerical simulations are also presented to illustrate and support the theoretical results.

Overall, this work provides a rigorous mathematical framework for the analysis of collisional breakage phenomena in discrete coagulation–fragmentation systems, offering insights relevant to both modelling and applications.

On controllability of Hilfer fractional stochastic differential equation with delays in control

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In the present work, we prove the controllability of a class of nonlinear Hilfer fractional stochastic differential equations with control in delays in a separable Hilbert space. First, the existence of a mild solution is established by employing tools from fractional calculus, cosine operator theory, and the Banach fixed-point theorem. Next, we drive a novel set of sufficient conditions that guarantee the controllability of the system. Furthermore, the existence of an optimal control is demonstrated by applying Balder's theorem. To illustrate the effectiveness of the theoretical findings, an application to nonlinear Hilfer fractional differential equations with control delays is presented.

The Stress Intensity Factors for Three Collinear Griffith Cracks located Symmetrically in Stress-Free Elastic Strip and Opened by a Symmetrical System of Body Forces

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In this paper, the problem of determining the stress intensity factors (SIF) for three Collinear Griffith cracks located symmetrically in a stress–free elastic strip and opened by a symmetrical system of body forces have been discussed. The stress intensity factor is a key factor to quantify the stress state at the neighbourhood of a crack. Cracks are opened by the body forces (x, y), (x, y) applied symmetrical to the y-axis acting at crack faces. The cracks are situated symmetrically on the line perpendicular to the edges of the strip which are constrained in such a way that the normal displacement and the shearing stress both vanish along each edge. The problem considered here is split into two displacement boundary value problems and solved separately.

Sufficient Conditions for Oscillation of Vector Solutions of a Class of 2nd Order 2-D Difference Systems

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This piece of work deals with the sufficient conditions for oscillation of all vector solutions of a class of 2nd order 2-dim nonlinear neutral delay difference systems of the form:

$$\Delta^2 \begin{bmatrix} p(\varsigma) + r(\varsigma)p(\varsigma - l) \\ q(\varsigma) + r(\varsigma)q(\varsigma - l) \end{bmatrix} = \begin{bmatrix} d_1(\varsigma) & d_2(\varsigma) \\ d_3(\varsigma) & d_4(\varsigma) \end{bmatrix} \begin{bmatrix} \Phi(p(\varsigma - \delta)) \\ \Psi(q(\varsigma - \gamma)) \end{bmatrix},$$

where $l > 0, \delta \geq 0, \gamma \geq 0$ are integers, $d_1(\varsigma), d_2(\varsigma), d_3(\varsigma), d_4(\varsigma)$, $r(\varsigma)$ are sequences of real numbers for $\varsigma \in \mathbb{N}(\varsigma_0) = \{\varsigma_0, \varsigma_0 + 1, \varsigma_0 + 2, \cdots\}, \varsigma_0 \geq 0$ and $\Phi, \Psi \in \mathcal{C}(\mathbb{R}, \mathbb{R})$ with the properties $u\Phi(u) > 0, v\Psi(v) > 0$ for $u \neq 0, v \neq 0$. We verify some of our results with illustrative examples.

Multiple weak solutions for a class of singular equations involving the $p(y)$-Laplace operator

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In this work, we are interested in the multiple weak solutions for the following singular elliptic problem involving the $p(y)$-Laplacian with the Dirichlet boundary condition:

$$\begin{cases} -\Delta_{p(y)} w + m(y)|w|^{p(y)-2} w = g(y)|w|^{\xi(y)-2} w + \frac{\lambda h(y)}{w^{\eta(y)}}, & \text{in } \Omega, \\ w > 0, & \text{in } \Omega, \\ w = 0, & \text{on } \partial\Omega. \end{cases}$$

Here, the operator $\Delta_{p(y)} w = \operatorname{div}(|\nabla w|^{p(y)-2} \nabla w)$ represents the $p(y)$-Laplace operator, where $p(y)$ is a non-constant continuous function. The domain $\Omega \subset \mathbb{R}^N (N \geq 2)$ is bounded with a C^2 boundary, and λ is a positive parameter. The function $m(y)$ is positive, while $g(y), h(y) \in C(\overline{\Omega})$ are non-negative weight functions with compact support in Ω. Additionally, $\eta(y), p(y), \xi(y) \in C(\overline{\Omega})$ satisfy some appropriate conditions. We apply the Nehari manifold method to establish the existence and multiplicity of positive weak solutions.

Dynamical analysis of Coupled Drinfel'd Sokolov equation arising in Shallow water waves

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This research article investigates the nonlinear Drinfel'd-Sokolov system by constructing traveling wave solutions using a new two-variable $(G'/G, 1/G')$-expansion method. Closed-form soliton solutions-encompassing periodic, breather, dark, bright, kink, rogue wave, and multi-soliton structures are derived by balancing self-steeping effects with the highest-order dispersion. Additionally, 2D, 3D, and contour graphs of selected solutions are plotted for appropriate parameter values.

Some new summation theorems on product of hypergeometric functions and their applications

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In this paper, we establish some new (presumably) identities involving product of hypergeometric functions using fractional calculus technique. We derive some new summation theorems by using our main identities. For application purpose, we evaluate closed form formulae via Laplace transform. We discuss the generalizations of our main result and give some other new results in conclusion.

Comparative analysis of nonlinear Urysohn functional integral equations via Nyström method

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This work presents an in-depth investigation of a broad family of Urysohn-type nonlinear functional integral equations of Fredholm type, a framework that unifies several classical integral and functional equations as special cases. By imposing appropriate smoothness conditions on the associated kernels and functions, we rigorously establish the existence and uniqueness of solutions through fixed point theory. To obtain accurate numerical approximations, the Nyström method is employed, reducing the problem to a nonlinear system of algebraic equations, which is efficiently solved using the Picard iterative scheme. In parallel, the trapezoidal method is developed as an alternative numerical strategy. A novel Grönwall-type inequality is derived to guarantee the convergence of the proposed approaches, thereby providing a solid theoretical foundation. Comprehensive numerical experiments, supported by comparative analysis, demonstrate the rapid convergence, high accuracy, and clear superiority of the Nyström method over the trapezoidal approach, underscoring its enhanced robustness, practicality, and computational versatility.

Modeling and Mitigation of Thermal Stresses Induced by Heat Conduction

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This paper investigates the interplay between thermal conduction and stress generation in solid materials subjected to non-uniform temperature fields. Heat conduction often induces thermal stresses due to constrained expansion or contraction, leading to potential material deformation or failure. The study begins by deriving the governing equations that couple heat conduction with thermoelasticity theory, accounting for anisotropic and isotropic material properties. Analytical and numerical approaches are employed to solve the equations under various boundary and initial conditions. Case studies, including steady-state and transient thermal scenarios, illustrate the influence of temperature gradients, material properties, and geometric constraints on stress distribution. Results reveal critical thresholds where thermal stresses transition from elastic to plastic deformation, providing insights for designing materials and structures subjected to thermal loading. The findings contribute to improving the reliability of systems in aerospace, electronics, and energy sectors, where thermal stress plays a pivotal role in performance.

Exact Solutions of Kaup-Broer System for Capillary Waves using Lie Symmetry Analysis

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This study investigates the Kaup-Broer system, a nonlinear partial differential equation model for weakly nonlinear, long shallow water waves influenced by gravity and surface tension. Through Lie symmetry analysis, we derive five infinitesimal generators of the Kaup-Broer system for capillary waves and construct an optimal system of one-dimensional subalgebras using the commutator and adjoint tables. These symmetries enable similarity reductions that transform the governing system into the system of ordinary differential equations, yielding invariant solutions. These new results not only enhance the analytical understanding of the Kaup-Broer system but also highlight its applicability in coastal engineering, fluid transport, nonlinear optics and predicting phenomena, like tsunamis and rogue waves where dispersive and capillary effects are significant.

Lie symmetry analysis of (3+1)-dimensional modified Wazwaz-Benjamin-Bona-Mahony equation

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In this paper, we study the (3+1)-dimensional modified Wazwaz-Benjamin Bona-Mahony equation using Lie symmetry analysis. An optimal system is constructed with the help of a commutator table and an adjoint table. Similarity reductions are obtained on the basis of the optimal system, and the governing partial differential equation is transformed into another partial differential equations with a smaller number of independent variables. The solutions of these reduced partial differential equations give invariant solutions of the (3+1)-dimensional modified Wazwaz-Benjamin-Bona-Mahony equation. The 3D graphical plots are used to describe the dynamical characteristics of the solutions. Hence, by employing these graphs, physicists and mathematicians can more efficiently and successfully follow complex physical processes.

Existence of nontrivial weak solutions for a class of p & q elliptic problem with discontinuous nonlinearity and critical exponent

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In this work, we will study a quasilinear problem with critical exponent and two different kinds of discontinuous nonlinearity. By applying the critical point theory for nondifferentiable functionals, we will prove that our problem has at least one nontrivial weak solution for any value of positive parameters associated with the problem. We proved new results when one of the nonlinearities satisfied the Ambrosetti-Rabinowitz (AR) condition.

Oscillation and Nonoscillation of Delay Difference Equations with Continuous Arguments

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In this work, we investigate oscillation and nonoscillation criteria for delay difference equations with continuous arguments of the form:

$$y(t) + py(t-\sigma_1) + q(t-\sigma_2) = 0,$$

where p, q, σ_1 and σ_2 are real numbers such that $\sigma_1 > \sigma_2 > 0$.

Optimal classification of Lie sub-algebras and self-similar solutions for magnetogasdynamic shock waves in rotating self-gravitating ideal gas using Lie group invariance method

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In this article, we explore the optimal classification for cylindrical shock wave in a self-gravitating rotating ideal gas with variable density considering the influence of magnetic field for obtaining all possible similarity solution with the use of Lie group invariance method. The flow is considered as unsteady isothermal flow. Optimal classification of sub-algebras has been done for obtaining the inequivalence optimal classes for five-dimensional Lie algebra. We have analyzed optimal classes of sub-algebras where similarity solutions exist and identified three cases: power law shock path, exponential law shock path and a specific case of exponential law shock path. Using the Lie group method, we transformed PDEs into ODEs and solved them numerically with the 4^{th} order Runge-Kutta method in Mathematica. This study examine the effects of gravitation parameter, shock Cowling number, rotational parameter and ambient density variation index on the associated flow variables and shock strength. The method developed in this manuscript can be applied in analysis of data from exploding wire experiments, axially symmetric hypersonic flow problems and pinch effect. It is also applicable in theoretical physics, particularly for modelling astrophysical systems such as star-forming clouds, accretion disks, and neutron stars.

Existence, Uniqueness, and Stability of Random Impulsive Fractional Pantograph Integro-Differential Equations with Nonlocal Boundary Conditions

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This paper investigates the existence, uniqueness, and stability of solutions for random impulsive fractional pantograph integro-differential equations involving the Caputo fractional derivative. We employ the Banach fixed-point theorem to establish sufficient conditions for the existence and uniqueness of mild solutions. These solutions are studied under nonlocal boundary conditions. The stability of these solutions is further analyzed by combining fixed-point theory with appropriate inequality techniques. The theoretical results are validated and their practical utility is demonstrated through illustrative examples.

Existence of Mild Solutions for Impulsive Fractional Mixed Integro-Differential Equations with finite delay

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In this paper, we derive the existence of mild solutions for impulsive fractional functional mixed integro-differential equations in Banach spaces with finite delay. Standard fixed point techniques are used to obtain the existence results. An example is given to illustrate the theory.

A Computational Approach for Fuzzy Fractional Riccati Differential Equations under Riemann–Liouville fractional derivative

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The nonlinear fuzzy fractional Riccati differential equation formulated using the Riemann–Liouville fractional derivative is analysed. A solution procedure is developed based on the Residual Power Series Method (RPSM). By expanding the fuzzy solution in fractional powers and eliminating residuals term by term and the coefficients of the power series are obtained. This recursive framework ensures that the approximate solution approaches the exact solution with minimum error. Finally, examples were examined numerically and also presented a three-dimensional graph between the exact solution and the Riemann–Liouville based Residual Power Series Method for the fuzzy fractional Riccati differential equation.

Love Wave Dispersion in Fibre-Reinforced and Initially Stressed Poroelastic Layers over a Heterogeneous Half-Space

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This paper examines Love wave propagation in a layered structure consisting of a fibre-reinforced isotropic layer over an anisotropic poroelastic layer subjected to initial stress, on a depth-dependent heterogeneous half-space. The half-space inhomogeneity has a linear variation of elastic constants with depth. Using the variable-separable method and Whittaker functions, a dispersion relation for Love waves is derived. Numerical simulations carried out in Mathematica illustrate the variation of phase velocity with the non-dimensional parameter kH_1. Results show that phase velocity increases with increasing heterogeneity and initial stress in the half-space, while it decreases with increasing depth ratio, fibre-reinforcement parameter, and initial stress in the middle layer. The study highlights the significant influence of material anisotropy, poroelasticity, and reinforcement on Love wave dispersion in complex layered media.

A Second-Order Projection Neurodynamic Model for Solving Inverse Mixed Variational Inequalities

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In this paper, we introduce a new projection-based second-order neurodynamic system for solving inverse mixed variational inequalities (IMVIs) with time-dependent parameters. The proposed system ensures the existence, uniqueness, and global stability of its solutions when the underlying operators are strongly monotone and Lipschitz continuous. We further derive a discrete-time counterpart of the continuous model, resulting in an inertial projection algorithm that achieves linear convergence under appropriate parameter settings. The stability of the system is established through a Lyapunov function, and finally, numerical experiments are presented to validate the accuracy, convergence speed, and robustness of the proposed method in addressing IMVIs and related optimization problems.

Role of Fourier transform in quantum mechanics

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This paper explores the role of the Fourier transform in analyzing the quantum harmonic oscillator. By transforming the Schrödinger equation from position space to momentum space, we show that the momentum-space solutions mirror the familiar Hermite–Gaussian forms of the coordinate representation. The Fourier transform reveals the symmetry between position and momentum descriptions and preserves the energy spectrum. This work highlights the Fourier transform as a powerful tool for understanding conjugate variables and deepening insight into the structure of harmonic oscillator wavefunctions.

By Means of Fractional Heat Conduction to Approach Thermal Stresses in a Solid Cylinder Using FRDTM

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Heat conduction is a fundamental process with wide-ranging applications across numerous engineering disciplines. This study investigates a thermoelasticity problem within a fractional-order, focusing on a semi-infinite solid cylinder. The governing equation is the time-fractional heat conduction equation. We employ the Fractional Reduced Differential Transform Method (FRDTM), an efficient analytical technique for handling fractional differential equations, to obtain solutions for the temperature distribution and thermal stress. The behaviour of these fields is examined for different values of the fractional time derivative parameter. The analysis provides deeper insight into how the fractional order influences heat propagation and the subsequent development of thermal stresses within the cylinder.

Bright and dark soliton solutions of a (2+1)-dimensional nonlinear Schrödinger equation

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This work presents a comprehensive investigation into the analytical capabilities of the modified auxiliary equation (MAE) method for solving the (2+1)-dimensional nonlinear Schrödinger (NLS) equation in the anomalous dispersion regime. By implementing the method, we have derived closed-form exact solutions in the form of bright, dark, kink, bell-shaped, and stationary soliton profiles, and it also points out the existence of polarity switching parameters. The graphical representations have been plotted using MATLAB software, resulting in solutions that explain the physical dynamics, behaviour, and dependence of solitary waves on physical parameters. This work enhances the theoretical and analytical understanding of the nonlinear wave phenomena and provides a framework for future studies in nonlinear dynamics and mathematical physics.

Linear Control System on Superspace

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Although the dynamical systems appearing in day-to-day life are non-linear in nature, the linear systems are essential in studying those systems locally. Due to the advancement of supersymmetry, we encounter the dynamical systems whose dynamics involve both commuting and anticommuting variables such as quantum Kepler problems, quantum harmonic and (an-)harmonic oscillators, and sKdV equation to name some. With the motivation to study the control problems for such dynamical systems, we consider an elementary system such as the linear time-invariant control system in superspace, and discuss its controllability. We mathematically derive controllability conditions for such systems, which we call the extended Kalman rank condition in superspace, and illustrate this with the help of some simple but interesting examples like mixed bosonic-fermionic control systems.

Controllability of Fractional Order Langevin System with State-Dependent Delay and Impulse

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The field of fractional order differential equations (FDEs) is gaining scientific interest, due to its wide-ranging applications in engineering, medicine, and other areas. Hilfer developed a generalized Riemann-Liouville fractional derivative, often called Hilfer fractional derivative, by combining the Riemann-Liouville and Caputo fractional derivatives. A fractional delay differential equation (FDDE) is a differential equation that incorporates a fractional delay operator alongside ordinary derivatives. These equations are studied to model and comprehend phenomena with memory effects or hereditary properties, where the system's dynamics depend on a continuous history of past states, rather than just few fixed previous ones. Such phenomena are found in fields like population dynamics, epidemiology, control systems, and signal processing.

Since the groundbreaking advances in FDEs, the Langevin equations, originally proposed by Paul Langevin in 1908, have been incorporated in fractional calculus. It is a valuable tool for describing time evolution of velocity in Brownian motion and modelling physical phenomena within fluctuating environments. Numerous generalized versions of the Langevin equation have been created to model dynamical systems in fractal media. Because the standard, integer order Langevin equation cannot always describe the dynamics of systems in complex environments accurately, one common approach is to substitute the integer-order derivative with a fractional-order derivative, leading to the fractional Langevin equation. The main aim of this work is to develop a set of sufficient conditions and study controllability of fractional order Langevin system with state-dependent delay and impulse, where fractional derivative is considered in Hilfer sense in infinite-dimensional space.

$$^{H}D_{0^+}^{\alpha_1,\beta_1}\left({}^{H}D_{0^+}^{\alpha_2,\beta_2}+A\right)z(t)=Bu(t)+f(t,z(t),z_{\rho(t,z_t)}),\quad t\in[0,T];$$

with respect to the conditions,

$$\begin{aligned}\Delta I_{0^+}^{\sigma}z(\cdot)|_{t=t_n}&=K_n(z_n^-)),\quad n=1,2,\ldots k;\\ I_{0^+}^{\sigma}z(t)&=\phi(t),\quad t\in[-h,0];\\ {}^{H}D_{0^+}^{\alpha_2,\beta_2}z(0)&=\zeta_0;\end{aligned}$$

where, ${}^{H}D^{\alpha_i,\beta_i}$ denotes Hilfer fractional derivative of type $0\le\beta_i\le1$ and order $0<\alpha<1,\ i=1,2.$ $\sigma=(1-(\beta_1-\beta_2)(1-(\alpha_1-\alpha_2))$. The state function $z(t)$ takes value in Banach space B and control function $u(t)$ takes value in $L^2([0,T];U)$, a Banach space of admissible control functions with U.

The state-dependent delay function is represented as $z_{\rho(t,z_t)} = z(\rho(t, z(t + r)))$, where $r \in [-h, 0]$. Firstly, integral solution of the system is derived. Then, sufficient conditions for the controllability of the considered system are established by using fixed-point theory and the generalized fractional calculus. At the end, an example is discussed to validate the established results.

(F) Geometry and Topology

Remarks on functional Alexandroff spaces

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Let's recall that a topological space is called an Alexandroff space if the intersection of any nonempty collection of open sets is open, or equivalently each point has the smallest open neighbourhood. Some classes of Alexandroff spaces are finite topological spaces, functional Alexandroff (or primal) topological spaces, Khalimsky topological spaces and locally finite topological spaces.

For self–map $f : X \to X$ Alexandroff topology generated by topological basis $\{\bigcup\{f^{-n}(a) : n \geq 0\} : a \in X\}$ is called functional Alexandroff topology on X (generated by f) which has been considered for the first time in the talk "Dynamical system associated with an onto map $\lambda : A \to A$" presented by myself (F. Ayatollah Zadeh Shirazi) in "International Conference on Topology and its Application, July 6-11, 2009, Department of Mathematics, Hacettepe University, Ankara, Turkey". In this talk we will have a glance on some papers dealing with the subject and present also some new results.

Geometric Characterizations of Almost Yamabe Solitons with QSNM Connections

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In this paper, we investigate the geometric structure of almost Yamabe solutions on paracontact metric manifolds endowed with a quarter-symmetric non-metric connection We establish a series of classification results under specific assumptions, including collinearity with the Reeb vector fields, infinitesimal contact transformations, torseforming, conformal and - ic vector fields on the potential vector field. Furthermore, we derive conditions under which the solution is expanding, steady, or shrinking based on the relationship among the scalar curvature the solution function and the structure functions of the manifold. Finally, we present an example that illustrates our results.

Transformation of Cassini Ovals into Limacons: the elegance of analytic geometry

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The intricate beauty of plane curves often lies concealed within their algebraic expressions, awaiting revelation through analytic transformation. Among such curves, the Cassini Ovals and the Limacons of Pascal hold a distinguished place for their geometric richness and aesthetic symmetry. This paper presents an analytic exploration of the transformation of Cassini Ovals into Limacons within a quadratic mapping framework. Beginning with the canonical form of the Cassini Oval, a quadratic coordinate transformation is introduced, and the resulting locus is shown to correspond to a Limacon under specific parametric conditions. The study establishes a direct analytical correspondence between these two classical curves, illustrating how quadratic geometry bridges

algebraic representation and geometric intuition. The findings highlight the inherent elegance of analytic geometry—where equations unfold into shapes, and shapes reveal profound mathematical relationships–and offer a unified perspective for understanding curve transformations, opening avenues for further exploration among other families of algebraic curves.

Dual THA-surfaces in 3-dimensional Galilean space

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Galilean geometry belongs to the family of Cayley-Klein geometries and is characterized by a degenerate metric distinguishing it from Euclidean and Lorentzian spaces. In this paper, we focus on the classification of dual THA-surfaces in $\mathbb{G}^3$ and classify certain types of these surfaces under geometric conditions such as zero dual Gaussian and zero dual mean curvatures.

Set strongly star Rothberger and set star Rothberger spaces

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A space X is said to be set star-Rothberger (set strongly star-Rothberger) if for each nonempty set A of X and for each sequence $(\mathcal{U}_n : n \in \mathbb{N})$ of collections of sets open in X such that $\overline{A} \subset \cup\mathcal{U}_n$, $n \in \mathbb{N}$, there is a sequence $(U_n : n \in \mathbb{N})$ (resp., $(x_n : n \in \mathbb{N})$) such that for each $n \in \mathbb{N}$, $U_n \in \mathcal{U}_n$ (resp., $x_n \in \overline{A}$) and $A \subset \bigcup_{n\in\mathbb{N}} St(U_n,\mathcal{U}_n)$ (resp., $A \subset \bigcup_{n\in\mathbb{N}} St(x_n,\mathcal{U}_n)$). In this paper, we investigate the relationship among set star-Rothberger, set strongly star-Rothberger and other related spaces and study the topological properties of set star-Rothberger and set strongly star-Rothberger spaces.

Largest open balls contained in a subset of metric space

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In this talk, we present a study introducing a new framework for understanding geometric properties of subsets in metric spaces through the concepts of center and radius. These notions generalize the familiar ideas of the center and radius of open or closed balls in Euclidean spaces. We systematically develop this framework for arbitrary subsets of a metric space X, providing explicit characterizations for important constructions such as finite products and finite unions of subsets.

A key question addressed in the work concerns the identification of the largest open balls completely contained within a given subset $A \subseteq X$. To resolve this, we define and explore the notions of quasi-center and quasi-radius, which capture the intrinsic geometric "core" of the subset. We establish that the center of any largest open ball contained in A necessarily belongs to the quasi-center of A, and its radius coincides with the quasi-radius.

Twist like behavior in non-twist patterns of triods

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We prove a sufficient condition for a *pattern* π on a *triod* T to have *rotation number* ρ_π coincide with an end-point of its *forced rotation interval* I_π. Then, we demonstrate the existence of peculiar *patterns* on *triods* that are neither *triod twists* nor possess a *block structure* over a *triod twist pattern*, but their *rotation numbers* are an end point of their respective *forced rotation intervals*, mimicking the behavior of *triod twist patterns*. These *patterns*, absent in circle maps highlight a key difference between the rotation theories for *triods* and that of circle maps. We name these *patterns*: "*strangely ordered*" and show that they are semi-conjugate to circle rotations via a piece-wise monotone map. We conclude by providing an algorithm to construct unimodal *strangely ordered patterns* with arbitrary *rotation pairs*.

Geometric characterization of almost Ricci-Bourguignon solitons on Sasakian manifolds

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The aim of this paper is to find the geometric characterizations of almost Ricci-Bourguignon solitons and gradient almost Ricci-Bourguignon solitons within the background of Sasakian manifolds. If (M,g) is a (2n+1)-dimensional Sasakian manifolds and g represents an almost Ricci-Bourguignon soliton, then we find a sufficient condition under which the manifold M is Einstein(trivial). Next, we show that if g is an almost Ricci-Bourguignon soliton on M and the Reeb vector field ξ leaves $\lambda + \rho r$ invariant, then g reduces to Ricci - Bourguignon soliton on M. Finally, we prove that if g is a gradient almost Ricci-Bourguignon soliton, then the manifold M is either Einstein or g is a gradient η-Yamabe soliton on M. As a consequence of the results, we obtain several corollaries.

Various Convergences of Function Sequences

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The paper studies different types of convergences of sequences of functions from a metric space X to another metric space Y and their relationships. We consider the strong uniform convergence on bornology $\mathcal{B}$ (introduced by Beer and Levi in 2010) and strong Whitney convergence on bornology $\mathcal{B}$ (introduced by A. Caserta in 2012) which are defined using the notion of a bornology $\mathcal{B}$ on X, a family of subsets of X which is hereditary, closed under finite union and cover of X. We also consider the classical counterparts of these convergences, that is, uniform and Whitney convergences on $\mathcal{B}$, respectively. Finally, we study the relation of Whitney and strong Whitney convergence on $\mathcal{B}$ with the well-known continuous convergence of sequences of functions.

Point-wise Semi-Slant Riemannian maps from Riemannian manifolds into Kaehler Manifolds

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In this paper, we introduce $\mathcal{PSSRM}$ from Riemannian manifold to Kaehler manifolds. We provide examples and characterizations of these maps, along with an investigation into their harmonicity. Additionally, we derive a Chen-Ricci inequality for $\mathcal{PSSRM}$, and explore curvature relations in complex space forms, particularly involving the Casorati curvatures for $\mathcal{PSSRM}$.

Injective objects and Essential embeddings in the category of Topological systems

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In this paper we establish a relationship between injective objects and essential embeddings in the category **Topsys** of topological systems and **TopSys**$_0$ of T_0-topological systems.

Certain Classification of Almost Ricci-Bourguignon Solitons in Three-Dimensional almost α-Cosymplectic Manifolds

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In this talk we will talk about almost Ricci-Bourguignon solitons on almost α-cosymplectic manifolds, focusing on their classification and geometric properties. Key results include soliton type characterization (shrinking, steady, expanding) via the parameter ρ, and conditions under which these solitons become Einstein. We also show that Ricci semi-symmetric manifolds with η-parallel tensors reduce to almost cosymplectic structures.

On asymptotic points of k-type expansive $\mathbb{Z}^d$-action

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We define the concept of $k-$type expansive, $k-$type generator and $k-$type asymptotic points for $\mathbb{Z}^d-$action. Further, we prove several properties of $k-$type expansive $\mathbb{Z}^d-$action and relation between $k-$type asymptotic points. Also we study the asymptotic behavior of points near a non-isolated fixed point. We also show that the for the self-dense compact metric space and $k-$type expansive $\mathbb{Z}^d-$actions there is a pair of points which are $k-$type asymptotic.

Geometric Properties of Scalar Curvature in Two-Dimensional Finsler Spaces with Cubic Metric

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The (h)-scalar curvature is a fundamental invariant in Finsler geometry which is used to analyze the geometric structure of Finsler spaces. In this paper, we derive an explicit expression for the (h)-scalar curvature R of a two-dimensional Finsler space equipped with a cubic metric $L^3 = a_{ijk}(x)y^iy^jy^k$. To investigate its variation, we consider specific forms of the cubic metric and compute the (h)-scalar curvature R for all possible non-vanishing components in two-dimensional space. The dependency of R on both positional coordinates x and directional variables y is further examined through Python-based graphical visualizations, revealing distinct geometric patterns for various forms of cubic metric. The analysis demonstrates that scalar curvature in Finsler geometry is inherently direction-dependent and that singular behaviors emerge along specific directions determined by the structure of the cubic metric.

Geometry of Clairaut Riemannian warped product submersions

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In this paper, we introduce and investigate Clairaut Riemannian warped product submersions between Riemannian warped product manifolds. Extending the notion of Clairaut Riemannian submersions to this broader framework, we define such submersions by requiring the warping function to satisfy a Clairaut-type relation along geodesics. We then derive necessary and sufficient conditions for a Riemannian warped product submersion to fulfill the Clairaut condition, proving that it holds precisely when the associated girth function has a horizontal gradient, one component of the fibers is totally geodesic, and the other is totally umbilical with mean curvature vector determined by the warping function.

We further examine the geometric implications of this structure, including harmonicity conditions and the behavior of the Weyl tensor, and provide several non-trivial examples illustrating the theory. In the latter part of the paper, we conduct a detailed analysis of the curvature properties of such submersions. Explicit formulas are obtained for the Riemannian, Ricci, and sectional curvature tensors of the source manifold, expressed in terms of the geometry of the target and fiber manifolds, together with the warping and girth functions. These results yield insight into how warping and the Clairaut condition influence curvature phenomena, such as conformal flatness and the non-positivity of certain mixed curvatures. We also investigate conditions ensuring trivial warping of the source and local symmetry of the fibers, as well as various scenarios under which the Einstein condition is satisfied.

Ricci Solitons and Curvature Symmetries in Relativistic Spacetimes

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Curvature symmetries such as curvature collineations, Ricci collineations and conformal Ricci collineations capture higher-order geometric invariances beyond classical Killing fields, while Ricci solitons provide self-similar solutions to the Ricci flow with natural geometric significance. In this work, we investigate the interplay between Ricci solitons and these generalized curvature symmetries in relativistic spacetimes. We derive conditions under which a Ricci soliton vector field generates each type of symmetry and explore the structural constraints these conditions impose on the curvature and Ricci tensors. The results are applied to perfect fluid space-times, plane symmetric metrics and Bianchi types I–IX, yielding explicit classifications and rigidity properties. This study unifies aspects of symmetry analysis and Ricci soliton geometry, offering a coherent framework for understanding curvature-preserving structures in general relativity.

Singularity-Free Scalar-Tensor Spacetimes with Divergence-Free W_7 Curvature Tensor

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In this paper, we study singularity-free scalar–tensor spacetimes under the condition that the generalized Deszcz–Hotloś curvature tensor W_7 is divergence-free. Starting from the Pimentel–Mars class of regular Brans–Dicke solutions and extending to general scalar–tensor geometries, we derive new structural constraints from $\nabla^i W_{7\,ijkl} = 0$. Our analysis shows that this condition enforces constant scalar curvature, aligns the Hessian with the gradient of the scalar field, and restricts the scalar field to a separable form $\phi = \Phi(a_i x^i + b)$. We find that only the static Pimentel–Mars spacetime satisfies this condition, revealing a rigidity in scalar–tensor gravity: dynamic exponential evolution is incompatible with divergence-free W_7. These results offer a geometric framework for constructing regular, physically viable scalar–tensor models.

$\mathcal{M}$-Factorizable Topological Groups in the framework of proximity

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The theory of topological groups emerges from combining the structural aspects of group theory with the continuity properties of topology. Proximity spaces, in contrast, extend the notions underlying both metric and topological spaces. Formally, a proximity space is defined on a non-empty set X equipped with a proximity relation that specifies when subsets A and B of X are regarded as "near," subject to a prescribed set of axioms. Such structures, along with topological groups, have found extensive applications across diverse domains, including sociology, pattern recognition, image analysis, dissimilarity studies, machine learning, fluid dynamics, and related areas. Owing to the growing importance of proximity relations and group-theoretic methods in both theoretical and applied research, examining topological groups within the framework of proximity has become increasingly essential. In this direction, recent developments have introduced the notion of proximal groups: a combined structure of proximity spaces with algebraic groups, as a natural extension of topological groups. Previously, We have introduced quotient proximal groups which is not a natural generalization of quotient topological groups. Primarily focusing on the structure of quotient proximal groups, we have also introduced strongly $\mathbb{R}$-factorizable proximal groups by taking motivation from $\mathbb{R}$-factorizable topological groups.

In this paper, we introduce first countable proximal groups, second countable proximal groups, ω-narrow proximal groups, and strongly $\mathcal{M}$-factorizable proximal groups. We prove that every ω-narrow and first countable proximal group with a condition in the underlying proximity space is second countable. We also prove that every strongly $\mathbb{R}$-factorizable proximal group is strongly $\mathcal{M}$-factorizable and we present a counter example to disprove the converse. We also present a counter example to disprove that every ω-narrow and $\mathcal{M}$-factorizable proximal group is strongly $\mathbb{R}$-factorizable and we prove this result with an extra condition in the underlying proximity space.

Geometric properties of (W_6 and W_8) - Curvature Tensors on Lorentzian Para - Kenmotsu Manifolds w.r.t. quarter - Symmetric Metric Connection

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This paper deals with the geometric properties of study W_6 - curvature tensor and W_8 - curvature tensor in Lorentzian - para Kenmotsu manifold with respect to quarter - symmetric metric connection. First, we explore the non-flatness of $\bar{W}_6$ - curvature tensor and $\bar{W}_8$- curvature tensor on Lorentzian - para Kenmotsu manifold with respect to quarter - symmetric metric connection, respectively. Furthermore, we establish the relation between $\bar{W}_8$ - curvature tensor on Lorentzian - para Kenmotsu-manifold with respect to quarter - symmetric metric connection and W_6 - curvature tensor on Lorentzian - para Kenmotsu manifold with respect to Levi - civita connection. Lastly, we have shown that an Lorentzian - para Kenmotsu manifold with respect to quarter - symmetric metric connection satisfying $\bar{W}_6.\bar{R} = 0$ and $\bar{W}_8.\bar{R} = 0$.

Hyperbolic Ricci Solitons and the Geometry of Relativistic String Cloud Spacetimes in f(R)-Gravity

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We study the relativistic string cloud spacetime associated with hyperbolic and gradient hyperbolic Ricci solitons within the framework of $f(R)$-gravity. The model considers the influence of $\mathcal{Q}$-vector and bi-conformal vector fields that admit hyperbolic Ricci solitons. Employing a scalar concircular field, we evaluate the evolution rate of the gradient hyperbolic Ricci soliton and derive the corresponding energy conditions for the relativistic string cloud spacetime in $f(R)$-gravity.

(ϵ)-para Sasakian 3-Manifolds with $*$-η-Ricci Solitons

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In this paper, we investigate $*$-η-Ricci solitons on (ϵ)-para Sasakian 3-manifolds under several geometric constraints. We first examine the behavior of such manifolds when the curvature tensor satisfies special flatness conditions, including W_2-flatness, conformal flatness, and conharmonic flatness. Further, we study the geometry of (ϵ)-para Sasakian 3-manifolds that are ϕ-W_2 semisymmetric and ϕ-conharmonically semisymmetric and showed that the manifold is weakly ϕ-Einstein. Using these structures, we derive significant results characterizing $*$-η-Ricci solitons in this setting and obtain explicit relations between the soliton constants ρ and σ. In addition, we construct a concrete example of an (ϵ)-para Sasakian 3-manifold that satisfies the required curvature conditions and supports a $*$-η-Ricci soliton. This example illustrates the validity of our results and demonstrates the existence of nontrivial (ϵ)-para Sasakian structures admitting $*$-η-Ricci solitons.

Lightlike Submanifold of ϵ-LP-Sasakian manifold with Generalized semi-symmetric non-metric connection

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In this paper, we study lightlike submanifolds of an ϵ-LP-Sasakian manifold with generalized semi-symmetric non-metric connection. In this manner, the symmetry of the Ricci tensor in the lightlike submanifold admitting generalized semi-symmetric non-metric connection is obtained, and also the condition for integrability of the screen distribution is obtained for an ϵ-LP-Sasakian manifold with generalized semi-symmetric non-metric connection.

Bochner Flat Lorentzian Kähler Spacetime Manifold with (m, ρ)-quasi-Einstein Soliton

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In the present work, we characterize (m, ρ)-quasi-Einstein solitons in a Bochner flat Lorentzian Kähler spacetime manifolds. We have addressed various circumstances for ρ-Einstein solitons to be steady, shrinking or expanding in terms of isotropic pressure, the cosmological constant, energy density and gravitational constant in different perfect fluids such as stiff matter, dust fluid, dark fluid and radiation fluid.

(G) Numerical Analysis, Approximation Theory and Computer Science

Fractional Dynamics of Coupled Modified Korteweg-de Vries Systems with Generalized Caputo Derivatives: A Numerical Investigation

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In this study, we introduce a new modified coupled fractional Korteweg-de Vries system and a generalized time-fractional Hirota-Satsuma coupled KdV system incorporating a generalized Caputo fractional derivative. To obtain approximate solutions, we developed a conformable Laplace-Adomian Decomposition Method (ρ-LADM), which is a modification of the classical Laplace-Adomian approach. The effects of varying the fractional order α and the parameter ρ on the system's solution behavior were thoroughly investigated to better understand their influence on the system's dynamics. Numerical solutions are presented graphically to demonstrate the accuracy, reliability, and efficiency of the proposed method.

Unified convergence analysis of a class of iterative methods

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In this paper, unified convergence analyses for a class of iterative methods of order three, five, and six are studied to solve the nonlinear systems in Banach space settings. Our analysis gives the number of iterations needed to achieve the given accuracy and the radius of the convergence ball precisely using weaker conditions on the involved operator. Various numerical examples have been taken to illustrate the proposed method, and the theoretical convergence has been validated via these examples.

Convergence rate of Taylor means of Fourier series in the generalized Hölder metric

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In this paper, we obtain the convergence rate of Taylor means applied to the partial sums of the Fourier series of a function in the generalized Hölder classes introduced by Das et al. Further, we present a few corollaries that connect our main theorems with some of the well-known results for the Lipschitz-type functions and the classical Hölder classes introduced by Prössdorf.

Exponential Stability Analysis of Switched Recurrent Neural Networks under Interval Time-Varying Delays

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This paper investigates the exponential stability problem of switched recurrent neural networks with interval time-varying delays. By constructing an appropriate set of augmented Lyapunov–Krasovskii functionals and employing the Newton–Leibniz formula, a switching rule ensuring exponential stability is proposed. The stability criteria are formulated in terms of linear matrix inequalities (LMIs), which provide new sufficient conditions for guaranteeing exponential stability. Numerical examples are presented to demonstrate the validity and effectiveness of the proposed results.

Jarratt-type methods and their convergence analysis without using Taylor expansion

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In this paper, we study the local convergence analysis of the Jarratt-type iterative methods for solving non-linear equations in the Banach space setting without using the Taylor expansion. Convergence analysis using Taylor series required the operator to be differentiable at least $p+1$ times, where p is the order of convergence. In our convergence analysis, we do not use the Taylor expansion, so we require only assumptions on the derivatives of the involved operator of order upto three only. Thus, we extended the applicability of the methods under study. Further, we obtained a six-order Jarratt-type method by utilising the method studied by Hueso et al. in 2015. Numerical examples and dynamics of the methods are presented to illustrate the theoretical results.

Improved convergence analysis of a fifth order multi-step method

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A multi-step method introduced by Raziyeh and Masoud for solving nonlinear systems with convergence order five has been considered in this paper. The convergence of the method was studied using Taylor series expansion, which requires the function to be six times differentiable. However, our convergence study does not depend on the Taylor series. We use the derivative of F up to two only in our convergence analysis, which is presented in a more general Banach space setting. Semi-local analysis is also discussed, which was not given in earlier studies. Unlike in earlier studies (where two sets of assumptions were used), we used the same set of assumptions for semi-local analysis and local convergence analysis. We discussed the dynamics of the method and also gave some numerical examples to illustrate theoretical findings.

Novel Genocchi Wavelet Computation for Nonlinear Elliptic PDEs

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This study presents a unified numerical strategy that eliminates higher-order partial derivatives by employing Genocchi wavelets, their operational matrix of integration, and the collocation method for derivative terms. This approach serves as an alternative to traditional iterative methods, which often struggle to handle highly nonlinear problems effectively. The analysis and numerical solution of elliptic partial differential equations are discussed within the framework of the Genocchi Wavelet Collocation Method (GWCM). In this study, we examine the convergence, error estimation, and rapid applicability of the proposed method to a diverse range of problems. The effectiveness of the approach is demonstrated through detailed numerical experiments, with results presented in both tabular and graphical formats for clear comparison. The findings confirm the superior performance of GWCM over traditional methods, particularly under various parameter variations. One of the key advantages of this method is its ease of implementation and computational efficiency. The obtained solutions closely match the exact solutions, and an interesting observation is that for elliptic differential equations with polynomial solutions of finite degree, the method produces zero error. All computations are carried out using the latest version of MATLAB, ensuring accuracy and reliability.

Convergence rate of Taylor means of Fourier series in the generalized Hölder metric

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This paper aims to explore the degree of approximation of signals (functions) in the generalized Zygmund class (GZC) using the Taylor summability method. Moreover, a few corollaries are presented that connect the results of the paper with some of the previous known theorems for classical Zygmund classes.

Optimal order error bound for weak Galerkin mixed method of parabolic problems with discontinuous coefficients

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The main aim of this talk is to present a priori error analysis for the fully discrete weak Galerkin (WG) mixed method combined with the Crank-Nicolson scheme for parabolic problems with discontinuous coefficients. The key idea of the WG method is to approximate the underlying differential operator in the weak sense. With a proper utilization of the elliptic projection operator combined with the approximation results for local L^2-projection operators, we have derived optimal order a priori error bounds for both the solution and the flux variables, respectively, in the $L^\infty(L^2)$ norm. Numerical experiments are reported to confirm the theoretical results.

On Asymptotic expansion of Certain Operators Associated with Some Special Functions

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In the last few decades the study on linear positive operators is an active area of research. Several such new operators have been constructed using different methods and their convergence behaviour have been discussed. In the present paper, we study an approximation operator based on Charlier polynomials and discuss its convergence properties. We further provide the integral variants of such operators and establish asymptotic expansion.

Graph Laplacian assisted regularization method under noise level free heuristic and statistical stopping rule

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In this work, we address the solution of nonlinear ill-posed inverse problems by developing a graph-based regularization framework, where the regularization term is formulated through an iteratively updated graph Laplacian. The proposed approach operates without prior knowledge of the noise level and employs two distinct stopping criteria namely, the heuristic rule and the statistical discrepancy principle. To facilitate the latter, we utilize averaged measurements derived from multiple repeated observations. We provide a detailed analysis of the method in statistical prospective, establishing its stability and regularization properties under both stopping strategies. The algorithm begins with the computation of an initial reconstruction using any suitable techniques like Tikhonov regularization (Tik), Filtered Back Projection (FBP) or total variation (TV), which is used as the foundation for generating the initial graph Laplacian. The reconstruction is

made better step by step using an iterative process, during which the graph Laplacian is dynamically re-calibrated to reflect how the solution's structure is changing. Finally, we present numerical experiments on X-ray Computed Tomography (CT) and phase retrieval CT, demonstrating the effectiveness and robustness of the proposed method and comparing its reconstruction performance under both stopping rules.

$q-$Analogue of the generalized Bernstein-type operators

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In this paper, we define a $\mathtt{q}-$analogue of the generalized Bernstein-type operators. We study approximation properties of these operators using Peetre's K- functional and the Ditzian Totik modulus of smoothness. We investigate approximation of functions in Lipschitz-type spaces and those having a continuous derivative. Furthermore, we discuss Voronovskaja and Grüss-Voronovskaja type asymptotic results.

An Optimization Framework for Affinely Structured and Sparse Polynomial Matrix Inverse Eigenvalue Problems

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We examine the inverse eigenvalue problem for affinely structured and sparse polynomial matrices with prescribed distinct eigenvalues. Such problems arise naturally in system identification, structured modeling, and control design, where both structural constraints and spectral information must be simultaneously respected. Our aim is to understand how polynomial matrices can be constructed or modified so that they satisfy a given spectrum while maintaining a specified affine form or sparsity pattern in their coefficient matrices. First, we characterize the complete family of polynomial matrices that possess the desired eigenvalues and adhere to the imposed structure. This characterization provides insight into the allowable degrees of freedom when working within structured polynomial settings. Further, given an initial structured polynomial matrix, we determine the minimal structured perturbation to its coefficients required to achieve the prescribed eigenvalues while staying as close as possible to the original matrix. This leads to a structure-preserving approximation problem that balances eigenvalue assignment with model fidelity.

Modeling and Simulation of Fractional Order Heat Transfer Using Finite Difference Techniques

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This paper explores the study which presents a comprehensive investigation into fractional order heat equations by integrating a robust theoretical foundation in fractional calculus with advanced computational methods. Both explicit and implicit finite difference schemes are developed and analyzed, considering a range of fractional orders and boundary conditions, to address the challenges of simulating anomalous diffusion. Extensive numerical experiments evaluate the accuracy, stability, and efficiency of these schemes, demonstrating their capability to model real-world diffusion phenomena beyond classical approaches. The results provide new theoretical insights and validate the practical value of finite difference methods for fractional models, supporting their adoption in engineering applications and advancing the broader understanding of heat conduction in complex systems

Rational interpolation on the unit circle with pole at the center

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This research article studies the Lagrange and Hermite rational interpolation processes using equidistant nodes on the unit circle. The interpolants are constructed within a rational function space with a fixed pole at the center ($z = 0$). We establish convergence theorems for both schemes, proving uniform convergence on a suitable domain. The theoretical results are confirmed through graphical visualization.

Characterization and Optimal Convergence of Mixed-Type Interpolatory Polynomials

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The aim of this paper is to study the mixed-type polynomial interpolation problem. The method uses a structured nodal system derived directly from the zeros of the Integrated Legendre Polynomial, $\pi_n(x)$ and its derivative, $\pi'_n(x)$. It is shown that such nodes determine a unique interpolating polynomial of degree atmost 3n-3. An explicit representation of this polynomial is developed, revealing intrinsic connections between orthogonal systems and mixed-type interpolation. The formulation extends the classical theory of interpolation and provides a systematic approach for studying derivative dependent approximation methods. Furthermore, this study establishes the requirements for existence and proves the uniqueness of the solution, followed by a demonstration of its convergence properties.

Analysis of ion-acoustic soliton of KdV equation for plasma in Venus ionosphere: Homotopy analysis method

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The Venusian upper ionosphere contains a multi-ion plasma composed of H^+ ions, O^+ ions, and solar-wind protons. The Korteweg–de Vries (KdV) equation describes nonlinear ion-acoustic wave in such an environment. In this work, we obtain its approximate regular soliton solution using the Homotopy Analysis Method (HAM). The obtained HAM solution is further validated by comparison with the known analytical soliton form of the KdV equation, showing excellent agreement. This study highlights the applicability of HAM for analyzing nonlinear wave structures in planetary ionospheres.

On the Approximation Properties of Weighted Interpolation Schemes Based on Polynomial Zeros

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The construction and characteristics of a (0; 0, 2) Pál-type interpolation scheme are examined in this study, with a focus on the roots of Laguerre polynomials $L_n^{(k)}(x)$ and their derivative $L_n^{(k)'}(x)$. Our goal is to provide an interpolation framework that improves convergence behavior while maintaining the analytical integrity of the original function by utilizing the structural properties of Laguerre polynomials. Deriving explicit formulations for the interpolating polynomials with their uniqueness is the main goal of this enhanced Pál-type interpolation.

An Interpolation Framework Using The Roots of Pál-Type Interpolatory Polynomials

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This paper presents a detailed investigation of an interpolation framework based on the roots of a polynomial $\pi_n(x)$, its derivative $\pi'_n(x)$, and an additional node $x_0 = 0$. Specifically, we consider two sets of nodes $\{x_i\}_{i=1}^{n}$, representing the roots of $\pi_n(x)$, and $\{x_i^*\}_{i=1}^{n-1}$, which are the roots of the polynomial $\pi'_n(x)$. The study focuses on the existence, uniqueness, explicit representation, and order of convergence of the corresponding interpolatory polynomials.

Strong Convergence Analysis of the Cayley-Yosida Variational Problem Involving the XOR Operation

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This work focuses on a generalized Cayley–Yosida inclusion problem governed by the XOR operation. By introducing a Cayley–Yosida approximation operator associated with the XOR structure, we show that the problem is equivalent to a suitable fixed-point formulation. Based on this equivalence, we develop an iterative scheme to establish results on existence, strong convergence, and stability. We also provide a numerical example with graphs and tables to confirm our results.

An evaluation of weighted interpolation on roots of Ultraspherical polynomials along with Hermite [boundary] conditions

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This paper investigates the weighted $(0, 2; 0)$ interpolation polynomial defined on the interval $[-1, 1]$, incorporating the boundary points. The core of the scheme uses the zeros of the Ultraspherical polynomial $P_n^{(k+1)}(u)$ to define the function value (0) and the weighted second derivative (2) (with weight $(1-u^2)^{\frac{k+1}{2}}$). An additional function value (0) is defined on the zeros of the polynomial $P_{n-1}^{(k)}(u)$. We establish the existence, uniqueness, and explicit representation of this polynomial. Furthermore, we provide estimations for the fundamental polynomials and prove a convergence theorem for the interpolatory process.

(H) Solid Mechanics, Fluid Mechanics, Astrophysics and Relativity, and related areas

Love-Type-Wave Dispersion from a Point Source in a Magneto-Transversely-Isotropic/Functionally-Graded (MTI/FG) Composite Structure

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We investigate the propagation of Love-type waves generated by a point source disturbance. The source is located at the interface between a transversely isotropic layer of finite thickness and an underlying Functionally-Graded-Isotropic (inhomogeneous) semi-infinite half-space. The layer is modeled under the influence of an external magnetic field and hydrostatic stress. By incorporating Maxwell's equations and generalized Ohm's law, we calculate the Lorentz force induced in the layer. We use Green's function technique and Fourier transform to determine the interior deformations of the model, which yields a closed-form dispersion relation for the Love-type wave. We present a numerical analysis considering six transversely isotropic materials (beryl, magnesium, cadmium, zinc, cobalt, and isotropic) to observe the combined effects of the magneto-elastic coupling parameter, hydrostatic stress, and material inhomogeneity on wave propagation.

Predicting thermal transfer rate in Nanofluid Flow Over a Cylinder using artificial neural networks

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This study presents a detailed analysis of nanofluid flow and thermal transfer over a cylindrical surface, accounting for the coupled effects of thermal radiation and nanoparticle deposition. The flow is modeled using steady, two-dimensional boundary layer equations, which are reduced to a system of nonlinear ordinary differential equations via similarity transformations. These equations are numerically solved using the fourth-order Runge-Kutta method. A novel contribution of this work lies in the use of artificial neural networks (ANN) to predict the thermal transfer rate by adjusting key parameters such as radiation, deposition rate, and magnetic parameter. The combined effect of radiation and deposition significantly alters the thermal boundary layer, potentially reducing heat transfer efficiency. However, through ANN-based prediction, a considerable enhancement in thermal performance is achieved. The results demonstrate that while particle deposition negatively impacts thermal transport, its effect can be mitigated through optimal design strategies. This integrated approach provides a new perspective for improving thermal systems in industrial and engineering applications involving nanofluids, particularly where radiative and particulate effects are prominent.

Electro-Osmotic Peristaltic Transport of Casson Fluid with Thermal Radiation and Entropy Generation under the Influence of Ciliary Motion

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This work examines electro-osmotic peristaltic transport of Casson fluid in a two-dimensional channel under the influence of thermal radiation, entropy generation, and ciliary motion. The governing equations account for electrokinetic forces, non-Newtonian rheology, and cilia-induced

wall motion, with thermal radiation modelled via the Rosseland approximation. Using long wavelength and low Reynolds number assumptions, analytical and numerical solutions are obtained for velocity, temperature, and entropy profiles. The effects of electro-osmotic strength, Casson parameter, thermal radiation, Brinkman number, and ciliary activity are analysed, showing enhanced transport and thermal regulation, with notable impacts on velocity distribution and entropy generation. This comprehensive study provides insights into optimizing microscale fluid transport in biomedical and engineering.

Flow thin hybrid nanoliquid film over an unsteady stretching sheet

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Development of thin hybrid nanoliquid (HNL) film on an unsteady stretching sheet is investigated by taking the full Navier-Stokes equations. Using similarity transformations, the entire set of momentum and energy equations is transformed into a set of coupled non-linear partial differential equations. Finally, the numerical solutions of these equations are acquired by the implicit finite difference scheme. The influence of the magnetic field, thermal radiation, thermocapillarity, and different nanoparticles like Cu, Ag and Al_2O_3 are incorporated in this analysis. The result showed that the film height of the HNL enhances for increasing values of nanoparticles volume fractions, Hartmann number, respectively. It is further seen that the film thinning rate is more for pure water and it goes down for Cu/water nanoliquid, $Cu - Ag$/water HNL and Ag/water nanoliquid respectively. It is also noticed that the thermocapillary effect has opposite results for heating and cooling of the sheet, respectively. It is found that the temperature of the HNL film increasing in nature with raising nanoparticles volume fractions. It is further observed that the film temperature attains highest values for Ag/water nanoliquid and it decreases for $Cu-Ag$/water HNL, Cu/water nanoliquid and base liquid water respectively for heating of the sheet whereas the opposite trend is seen for cooling.

Special Solutions to the Space Fractional Flow of Incompressible Fluids Coupled With Magnetic Field

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We investigate the space-fractional magnetohydrodynamic (MHD) equations of order $\alpha \in \mathbb{R}$, $\alpha \in (0, 1]$ through a detailed mathematical analysis. By reducing the system to six coupled ordinary differential equations, we derive a set of special solutions. A critical point analysis reveals that the system exhibits a degenerate saddle point. Moreover, a unique solution to the initial value problem is obtained. The results are consistent with a particular case of the ideal MHD equations, and illustrative examples are provided to demonstrate the applicability of the solutions.

Wave reflection in pre-stressed FGPM structure under thermal effect

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The present study investigates the reflection of plane waves from a traction-free boundary in a piezothermoelastic half-space, with a focus on the coupled effects of initial stress and functional grading. The theoretical framework accounts for four coupled wave modes: quasi-longitudinal (qP), quasi-shear vertical (qSV), electroacoustic (EA), and thermal (T) waves. A system of linear equations is derived from the boundary conditions, enabling the formulation of closed-form expressions for the amplitude ratios. These solutions are analyzed numerically for a functionally

graded medium Barium Titanate ($BaTiO_3$) and a comparative analysis is conducted under two generalized thermoelastic theories: Lord–Shulman (LS) and Green–Lindsay (GL). A key finding is that as the initial stress increases, the qP wave becomes stronger and remains dominant, whereas the qSV wave shows only a small increase. However, increasing the gradation parameter slightly weakens both waves. The results, presented graphically, elucidate how initial stress and material gradation parameters profoundly influence wave behavior, providing essential insights for the optimized design of smart materials and wave-based sensing technologies.

Effect of Thermal Radiation and Concentration Modulation on Salt Fingering Chaotic Convection Along an Inclined Plane

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This study explores how time-dependent solute concentration and thermal radiation affect double-diffusive convection over an inclined surface. Using nonlinear theory and solvability conditions, a Ginzburg–Landau equation is derived to describe the amplitude of convection near onset. Analytical expressions for the Nusselt and Sherwood numbers are obtained, linking heat and mass transfer to key parameters such as the Rayleigh and Lewis numbers. Also the Lorenz model is utilized to examine chaotic convection near the onset, revealing transitions from steady to chaotic flow states. The results show that inclination weakens convection compared to a horizontal layer, while out-of-phase and upper-boundary modulations significantly enhance heat and mass transfer. Time-dependent solute effects are found to reduce heat transport but promote mass diffusion, consistent with the salt-finger mechanism.

Application of Backpropagation Neural Networks to Solve 2D Navier-Stokes-Brinkman Flow with Suction and Injection Effects

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The Berman problem for two-dimensional viscous laminar flow in a channel fully saturated with an isotropic porous medium, governed by the Navier-Stokes-Brinkman equation, is studied under the influence of suction (or injection) at the channel walls. By introducing a similarity transformation for the velocities, the flow problem is reduced to a fourth-order nonlinear boundary value problem (BVP) that depends on the Reynolds number, viscosity ratio, and Darcy number. Complemented with the existence and uniqueness analysis, we present approximate, numerical, and asymptotic solutions. We determine the threshold Reynolds number as a function of Darcy number and viscosity, below which a unique solution exists. Above this threshold, the solution is predicted for a specific range of Reynolds numbers using the Artificial Levenberg-Marquardt Method with a Backpropagated Neural Network (ALMM-BNN) approach. The reference dataset for training, testing, and validation is numerically generated within the identified range where a unique solution is possible. The ALMM-BNN performance is assessed through mean squared error, error histograms, and regression analysis. The predicted results are in good agreement with those obtained numerically and asymptotically, at least up to a certain Reynolds number, demonstrating the effectiveness of the ALMM-BNN method.

Central composite design-based response surface analysis of hybrid fluid flow over a microchannel with the impact of partial slip

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A lot of people are interested in making mixed nanofluids because they have better thermophysical qualities and could be used in future cooling technologies. The goal of this study is to look at how a combined nanofluid system made up of Zinc oxide (ZnO) and graphene nanoparticles mixed in ethylene glycol affects the flow and heat transfer properties of microchannel arrangements. The governing equations for magneto-hybrid nanofluid flow with partial slip and convective boundary conditions can be summed up in a set of dimensionless, nonlinear differential equations that are transformed based on similarity. The MATLAB bvp4c solver is used to find numerical solutions to these equations. This solver efficiently handles nonlinear boundary value problems, while RSM optimizes heat transfer to achieve maximum thermal efficiency. The results show that adding graphene to ZnO-based nanofluids makes them much better at transferring heat and conducting heat convectively than single nanoparticle suspensions. A magnetic field slows things down but makes heat movement faster. The slip parameter lowers wall shear stress but doesn't have a big impact on thermal efficiency. Also, RSM optimisation shows that there is a volume fraction of nanoparticle amounts that makes heat transfer work better. These results show that ZnO–graphene/ethylene glycol mixed nanofluids could play a useful role in microscale temperature control systems.

Testing curvature-matter coupling gravity via swampland conjectures

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The manuscript explores the study of the compatibility of curvature-matter coupling gravity theory within the framework of swampland conjectures. We considered the de-sitter swampland conjecture in relation to the inflationary solution generated by the curvature-matter coupling gravity. We derive the slow-roll conditions for the specific case of $f(\mathcal{R}, \mathcal{L}_m) = \frac{\mathcal{R}}{2} + \alpha(\mathcal{L}_m)^n$ model. Our results show that the swampland conjectures are at odds with the slow-roll condition for curvature-matter coupling gravity theory. Thereby, we conclude the swampland conjectures and the curvature-matter coupling gravity appear to be inconsistent with each other within the context of an inflationary profile of curvature-matter coupling gravity theory.

Plane waves in a micro-mechanically modelled magneto-electro-elastic structure with imperfect interfaces

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The focus of the present work is to analyze the reflection/transmission of plane waves in a micro-mechanically modelled structure of Piezo-Electro-Magnetic-Fiber-Reinforced-Composite(PEMFRC) material considering imperfectly bonded interfaces. The PEMFRCs considered for the two half-spaces comprise $BaTiO_3$ as the fiber constituent and $CoFe_2O_4$ as the matrix constituent for different volume fractions. Due to the electro-magnetic properties of the material, an incident wave creates four reflected/transmitted waves, viz., quasi-longitudinal (qP), quasi-transverse (qSV), electro-acoustic (EA), and magneto-acoustic (MA) waves, respectively. Due to accumulative damages at the interface adjoining structures some amount of imperfection arises at the interface, affecting the performances of the related structural components utilized in several fields. In view of

this fact, plane wave reflection/transmission phenomena are analyzed for different types of interfaces which exist due to the material properties of PEMFRC. The analysis of the natures of the reflected/transmitted waves requires the derivation of the amplitude and energy ratios at the considered interfaces. For this purpose, the closed-form amplitude & energy ratio are derived using the secular equations and the admissible boundary conditions & the energy flux relation considering the different interfaces. Along with the energy ratios of bulk & surface waves, the energy ratio of all interaction waves is also derived. Validation of this work is found in the conservation of energy for each interface. Moreover, some particular cases are analyzed, and the obtained results are matched with pre-existing results in the literature. For the considered data, numerical and graphical demonstration of the reflected and transmitted angles, amplitude ratios, and energy ratios are performed for incident waves. Critical angles for reflected/transmitted waves are also reported.

A Wiener-Hopf solution for surface wave propagation in a fluid with a surface discontinuity

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The problem of water wave scattering by an elastic bed in the presence of a surface discontinuity is investigated in this study. Under the assumption of linear water wave theory, we addressed the impact of the flexible base surface on the problem of water wave propagation. The elastic seafloor is represented as thin elastic plate that follows the Euler-Bernoulli beam equation. The reflection and transmission coefficients are analytically computed in terms of two unknown functions by applying the Wiener-Hopf method along with the Fourier transform technique. The main objective is to determine these two unknown functions, which are referred to as Wiener-Hopf functions. The behavior of the transmitted and reflected energy is also discussed in relation to varying the stiffness parameter of the bed surface against incoming wave frequency. The primary advantage of the present study is that the transmission and reflection coefficient values found nearly satisfy the energy-balance relation.

Heat and Constant Accelerated Flow Analysis of Unsteady Hydro-magnetic Third Grade Fluid: A Numerical Approach

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This study presents an implicit finite difference scheme to analyze energy transfer and unsteady MHD flow in a third-grade fluid confined between two parallel plates. The fluid is considered unidirectional, incompressible, viscous, and time-dependent. The governing momentum and energy equations are formulated as a set of coupled non-Newtonian partial differential equations, which are then transformed into algebraic form using the implicit finite difference method. Numerical solutions are obtained through the Newton iterative technique, and MATLAB is employed to simulate, generate, and visualize the results graphically. The investigation focuses on key parameters such as the elastic parameter, third-grade parameter, Prandtl number, Eckert number, and Hartmann number. The findings demonstrate that an increase in the Hartmann number suppresses the fluid velocity, while higher third-grade parameter values significantly elevate the temperature but reduce the flow profile. Moreover, increasing the Prandtl number lowers the rate of energy transfer, whereas higher Eckert numbers contribute to thermal enhancement within the flow.

Entropy analysis On Unsteady Casson Fluid Flow in Concentric Annuli with Induced Magnetic effect

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The present work investigates the entropy generation effects on time dependent Casson fluid flow in between two non-conductive concentric annuli. The induced magnetic field produced by the motion of an electrically conducting fluid is taken into account. A mathematical model for velocity, induced magnetic field and temperature field are constructed.The non-dimensional governing equations are solved numerically and computed using MATLAB.The effects of various parameters on velocity, induced magnetic field, temperature profiles, skin friction,the Nusselt number are analyzed graphically. The influence of different parameters involved in the problem on Bejan number is also shown with the aid of graphs. The overall entropy generation number reaches high values in the vicinity of the inner wall of the annulus, which becomes significant for low non-Newtonian parameters. Increasing the Brinkman number improves the entropy generation number.

Mathematical Modeling for Fluid Structure Interaction: Analyzing the Classical Mechanics Fluid Dynamics

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Fluid Structure Interaction (FSI) refers to the interaction between a fluid and a solid structure in which the fluid affects the deformation or velocity of the structure and/or the structure affects the fluid. This research aims to develop a mathematical model for fluid structure interaction. FSI is used to predict and study the tradeoff between fluid flow and structural behavior. It integrates classical mechanics and fluid dynamics to model real conditions and understand stress, deformation, and fluid forces on structures. Despite much progress in mathematical modeling of FSI, there are still some areas where research is lacking. Research is lacking in the integration of multi-scale and multi-physics approaches. Existing models struggle to capture the full range of fluid-induced structural responses, especially in complex or non-linear situations. Models often rely on oversimplified boundary conditions and material properties which are different from real conditions, particularly under extreme dynamic environments. The primary objective of this research is to develop a coupled fluid structure model using the Finite Element Method. The fluid dynamics will be modeled using the Navier–Stokes equations. The Finite Element Method and Computational Fluid Dynamics will discretize both the fluid and structural compartments to assess coupling effects. The study will also evaluate important parameters such as drag, lift, pressure distribution, and stress–strain behavior in the interacting system. The expected outcome is to create a reliable numerical model that integrates all aspects of fluid interaction with a flexible structure.

Biomedical Heat and Mass Transfer Analysis in Tri-hybrid(Fe_3O_4 + blood, Au + blood, and SiO_2 + blood) Jeffery Nanofluid with various type of Gravity Modulation

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This study examines the thermal instability of a tri-hybrid Jeffery nanofluid consisting of (Fe_3O_4 + blood, Au + blood, and SiO_2 + blood) under various gravity modulation conditions within three enclosure geometries. The linear and nonlinear stability analysis are conducted using the normal mode technique and the truncated Fourier series method, respectively. Results indicate

that increasing the Jeffery parameter accelerates the onset of convective motion. Numerical simulations using Mathematica's NDSolve confirm that the heat and mass transfer rates are identical in both stability regimes. Comparative analysis reveals that tall enclosures exhibit an earlier onset of convection and enhanced transport characteristics compared to square and shallow enclosures. The findings, supported by graphical and tabular representations, elucidate the combined influence of enclosure geometry and gravity modulation on the stability and transport behaviour of tri-hybrid Jeffery nanofluids.

Effects of Surface Tension and Current on Waves over Flexible Seabed

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In this study, we investigate how waves scatter when they encounter an uneven elastic seabed and a steady current, using the Green's function method. Instead of propagating in a single pattern at a given frequency, the fluid motion divides into two distinct wave modes. By combining perturbation theory with the Green's function approach, we derive the first-order potential function and calculate the reflection and transmission coefficients for both modes. We then analyze the effects of surface tension, seabed flexibility, and uniform current on wave reflection and transmission. The results show that reflection becomes stronger as the seabed becomes more flexible, and the maximum reflection increases with a higher Froude number. Interestingly, even when the seabed approaches a rigid state, the transmitted energy remains almost unchanged in the presence of a steady current. For both wave modes, higher surface tension significantly increases the reflected and transmitted energy.

A Scientific Machine Learning Framework for Nanofluid Flow and Heat Transfer Analysis Over a Rotating Disk

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Energy storage, heat transfer, and machinery cooling systems are critical for sustainable industrial processes. Engineered nanofluids offer a promising alternative to conventional heat transfer fluids. The governing Navier–Stokes and energy equations are employed to describe the fluid flow and heat transfer characteristics in various applications; however, solving these equations for advanced computational fluid dynamics (CFD) tools remains challenging due to the high computational costs and handling time required for errors. Additionally, in this third industrial revolution period, everyone is looking for methods to apply artificial intelligence and machine learning to address this kind of complex problem formulation. The nanofluid boundary layer flow over a rotating disk is the main concern of the present paper. Unlike the traditional Von Karman problem in which a Newtonian regular fluid is assumed, water-based nanofluids containing nanoparticle volume fraction of Cu is taken into account. The governing equations of motion are reduced to a set of nonlinear differential equations by means of the conventional similarity transformations which are later treated by physics Informed neural networks (PINN) with automatic hyper-parameters tuning and validate the results using spectral Chebyshev collocation numerical integration scheme. The nanofluid flow, temperature fields and heat transfer characteristics are computed for certain values of the nanoparticle volume fraction. Although the physical features highly rely on the volume fraction of the considered nanoparticle.

To test Integrability of the Conformable Fractional Lorenz System through the Painlevé Approach

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This paper investigates the Conformable Fractional Lorenz System to examine its complete integrability using Painlevé analysis. Employing the Ablowitz–Ramani–Segur (ARS) algorithm, the system's singularity structure is analyzed to establish conditions for integrability. The results indicate that, for specific parameter values, the system satisfies the Painlevé property, implying the existence of analytic and integrable behavior in the fractional sense. This work provides analytical insight into the structure and integrability characteristics of fractional-order Lorenz-type systems.

Similarity solutions behind an exponential shock wave in a gas under the effect of viscosity and heat conduction

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Similarity solutions have been investigated to describe the propagation of planar shock waves in a non-ideal gas generated by a piston under viscous stress and heat flux. The equation of state for non-ideal gas incorporates the correction in pressure and volume of the gas. The piston position and ambient density vary exponentially with time. Newton's law of viscosity is used for the viscous stress, and Fourier's law of heat conduction is taken for heat flux. The viscosity coefficient is taken as constant, whereas the thermal conductivity coefficient varies with temperature and density following the power law. The shock jump conditions have been derived for the viscous non-ideal gas using the integral form of conservation laws. The shock Reynolds number Re_s has been introduced to study the effect of viscosity on shock propagation in non-ideal gas. It is found that similarity solution exists only in an ideal gas under the condition that the ambient density exponent is equal to twice the shock position exponent. This study shows that shock Reynolds number Re_s and heat conduction parameter Γ_c can be used to control the variation of the flow variables and piston position significantly. The shock strength decreases with an increase in the value of shock Reynolds number Re_s but is independent of the heat conduction parameter Γ_c. The pressure, density, and adiabatic compressibility have significant deviations from high to low viscous flow of an ideal gas, but the velocity and heat flux undergo negligible change. The results do not support the claim of negligible effect of viscosity in earlier studies and establish the impact of viscosity and heat flux on shock propagation in an ideal gas.

Unsteady Flow of a Rotating Elastico-Viscous Liquid past a Vertical Porous Plate

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The unsteady free convection and mass transfer flow of an isotropic incompressible elastico-viscous liquid through porous media bounded by an infinite vertical porous plate with constant suction velocity has been investigated. It takes into consideration a cartesian coordinate system that rotates equally with the fluid. The impacts of significant parameters including the porosity parameter (K_p), the rotation parameter (R) and the Grashof number (Gr) on the primary and secondary velocity profiles have been examined with the help of graphs, and analytical equations for velocity, temperature, and concentration are generated.

Effect of wall slip on the stability of decaying flow in suddenly blocked channel

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The linear stability of the decaying flow in a suddenly blocked channel is investigated considering the Navier slip boundary condition at the wall. The Laplace transform method is employed to analyze the laminar decay of the velocity profiles following a sudden blockage within the channel. The velocity after the blockage has been taken as the base flow for the linear stability analysis. A quasi-steady approach is adopted to evaluate the instantaneous stability characteristics of the flow. Due to the liquid slip the instability occurs for lower critical Reynolds number compared to the case of a no-slip case. The critical Reynolds number Rec obtained approximately 125.8 for a slip length equivalent to 1/10-th of the channel height, whereas in the no-slip case Rec is approximately 150 for the most unstable velocity profile. We also obtained the $\mathrm{Re}\,\alpha$ neutral stability curves and the corresponding critical parametric values with the variation in time and slip length.

Entropy analysis of magnetohydrodynamic flow of nanofluid in a porous medium under the influence of heat source

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The present study examines the effect of time-dependent nanofluid flow and heat transfer over a vertical plate in a porous medium, incorporated with heat source. The entropy generation due to heat transfer and fluid flow has been carried out. The fluid is assumed to be electrically conducting water based Cu-nanofluid. The method of finite difference is applied for the solution of transport equations along with the appropriate boundary conditions. The impact of different parameters on velocity and temperature distribution are shown graphically and analyzed. The influence of relevant parameters on Bejan number and entropy generation is also discussed graphically. The obtained outcomes are compared with the earlier available results. The physical quantities of engineering interest such as skin friction and Nusselt number are also computed. It is found that velocity and temperature profiles enhance by enhancing the value of heat source. By varying nanofluid volume fraction, the flow and heat transfer characteristics could be controlled. Entropy generation and Bejan number accelerate with rise in the Brinkman number and magnetic parameter.

Slip and convective effects on MHD hybrid nanofluid flow over a radiated extending surface: A sensitivity analysis of heat transport

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With the rising demand for efficient cooling processes and the growing industrial applications of nanotechnology, this study investigates the heat transfer behavior of a steady, two-dimensional magnetized flow of a water-based hybrid nanofluid over a permeable extending surface. The hybrid nanomaterials, silver (Ag) and single-walled carbon nanotubes (SWCNT), exhibit excellent thermal conductivity, significantly enhancing heat transfer efficiency. The energy profile is influenced by heat radiation and a non-uniform heat source. Additionally, the effects of velocity partial slip and mixed convective thermal boundary conditions are incorporated at the surface. The governing equations are converted into a dimensionless system and numerically solved employing the bvp4c approach in MATLAB. A sensitivity analysis is conducted to assess the impact of key input constraints on heat transfer performance. Results indicate that increasing magnetization slows energy distribution, while heat source/sink effects and the Biot number enhance fluid temperature.

Predicting the heat transfer in Casson nanofluid flow under position-controlled squeezing porous slider with thermal radiations

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Permeable sliders are very important to the clutch and transmission systems because they help support loads better and waste less energy in friction. This study examines the flow of Casson nanofluid through a variable slider, along with the influence of thermal radiation, and heat source/sink. This study introduces a slider-position-dependent fluid injection approach to enhance levitation control. The governing partial differential equations (PDEs) are changed into dimensionless ordinary differential equations (ODEs) using similarity transformations. Runge Kutta Fehlberg's fourth-fifth order (RKF-45) numerical method is then used to answer the ODEs. The study also uses an artificial neural network (ANN) model with the Levenberg-Marquardt backpropagation learning technique to look at the rate of heat transfer. Visual observation indicates that an increase in wall dilation results in a decrease in velocity curves. The thermal profile expands as the radiation measurement increases. The numerical model performs effectively, as evidenced by Nusselt number assessments and documented mean square error estimates.

Exploring Cosmic Acceleration through Higher-Derivative Holographic Dark Energy: Interacting and Non-Interacting Scenarios

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This paper examines a class of generalized dark energy (DE) models in which the DE density depends on higher–order time derivatives of the Hubble parameter H. Employing a hyperbolic expansion law of the form $a(t) = \sinh^{1/n}(\beta t)$, we derive analytical expressions for several cosmological quantities, including the dark energy Equation of State parameter ω_D, the deceleration parameter q, and the fractional DE density Ω_D. Both non–interacting and interacting dark sector configurations are considered, with the interaction term assumed to be proportional to the dark matter (DM) energy density. Using observational constraints applied to the hyperbolic scale factor model, we estimate the present age of the Universe t_0 and compare the results with the observed value of approximately 13.8 Gyr. The analysis confirms that the model supports an accelerated expansion phase ($q < 0$) driven by a quintessence–like dark energy component satisfying $\omega_D > -1$. However, despite capturing late–time acceleration, the model yields noticeable deviations in the calculated age of the Universe relative to observational benchmarks. Additionally, the emergence of a narrow range of negative values in the reconstructed expansion function $h^2(z)$ indicates inherent limitations in the phenomenological consistency of the considered DE framework. These findings highlight the need for refined model parameterizations or additional physical mechanisms to reconcile the generalized DE model with cosmological observations more effectively.

Machine learning based prediction of MHD Casson nanofluid flow over a stretching cylinder with the Soret-Dufour effects

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The laminar, axisymmetric, steady boundary layer flow of an incompressible magnetohydrodynamic Casson nanofluid over a horizontal stretching cylinder has been investigated. The mathematical model accounts for the effects of thermal and solutal buoyancy, Soret-Dufour, Brownian motion, thermophoresis, viscous dissipation, and first-order chemical reactions. A convective thermal boundary condition characterized by a Biot number is imposed at the cylinder surface. The

governing equations are transformed into a system of ODEs by using similarity variables. Finally, this system of ODEs is solved numerically by MATLAB's bvp4c solver. In addition to comprehensive numerical analysis, this work introduces a machine learning based multiple linear regression framework to predict the skin friction coefficient, Nusselt number, and Sherwood number from key dimensionless parameters. The predictions demonstrate strong agreement with numerical solutions, achieving high predictive accuracy with R^2 (Coefficient of Determination) values between 0.973 and 0.991. The analysis confirms that skin friction increases due to the Lorentz force, which intensifies the wall shear. The Nusselt number shows dependence on the Prandtl number. Mass transfer exhibits a positive dependence on Schmidt number, with a minor negative contribution from the Magnetic parameter.

Analysis of Solute Dispersion and Transport Phenomena in a Composite Channel: Impact of Anisotropic Permeability and Diffusivity

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The dispersion of solute and mass transport phenomena have been examined in a composite channel partially filled with a fluid layer with variable viscosity, situated between two anisotropic porous layers. An analytical expression for the dispersion coefficient in the fluid layer is derived in relation to the channel matrix parameters, including anisotropic permeability ratio, angle, stress-jump coefficient, and viscosity ratio. We delineate the asymptotic behavior of the dispersion coefficient for the fluid layer in relation to the corresponding clear flow and pure Darcy situations. The influence of the anisotropic characteristics of the porous medium, stress-jump coefficient, and viscosity ratio on the normalized dispersion coefficient is examined. We have noticed that the effect of different parameters is more prominent in the convective zone. The model offers significant insights into solute transport inside blood vessels, where elements like variable viscosity of blood and the anisotropic characteristics of the endothelial glycocalyx play an important role in solute mobility.

Magnetohydrodynamic (MHD) Flow and Heat Transfer of Nanofluids over a Vertical Cone in a Porous Medium with Pressure Work Effects

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This study investigates the magnetohydrodynamic (MHD) flow and heat transfer characteristics of nanofluids containing Cu, Ag, and TiO_2 nanoparticles suspended in water over a vertical cone embedded in a porous medium, while accounting for the effects of pressure work. The governing partial differential equations describing the conservation of mass, momentum, and energy are constructed under boundary layer approximations and translated into a set of dimensionless nonlinear ordinary differential equations using proper similarity transformations. The governing equations are solved using the finite difference method in conjunction with MATLAB's bvp4c solver to perform a geometrical and graphical analysis of the effects of key parameters—such as magnetic field strength (M), nanoparticle volume fraction (φ), permeability of the porous medium (Da), thermal radiation parameter (N_R), heat generation parameter (δ), Hall current parameter (m), Eckert number (E_C), and pressure work—on the velocity and temperature profiles. The results reveal that both the magnetic field and pressure work have a significant influence on the momentum and thermal boundary layers, while the inclusion of nanoparticles enhances thermal conductivity and heat transfer rates. This study provides valuable insights for applications in thermal management systems, energy transmission, and magneto-convective engineering processes.

MHD Radiative Nanofluid Flow over a Moving Wedge in a Porous Medium with Heat Generation and Chemical Reaction

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The present study investigates the magnetohydrodynamic (MHD) boundary layer flow of an incompressible nanofluid over a moving wedge embedded in a porous medium, considering the combined effects of thermal radiation, internal heat generation, and chemical reaction. The governing equations for the conservation of mass, momentum, energy, and nanoparticle concentration are formulated under the boundary layer approximations. By applying appropriate similarity transformations, the coupled nonlinear partial differential equations are reduced to a set of ordinary differential equations, which are then solved using the finite difference method with MATLAB's bvp4c solver. The effects of key controlling parameters—such as the magnetic field parameter, porous permeability, radiation parameter, heat generation coefficient, Brownian motion, thermophoresis, and chemical reaction parameter—on the velocity, temperature, and concentration fields are analysed in detail. The results show that increasing the magnetic field and porous resistance parameters suppresses the fluid velocity, while thermal radiation and heat generation enhance the temperature within the boundary layer. Additionally, the chemical reaction parameter decreases the nanoparticle concentration, resulting in a thinner concentration boundary layer. The findings further reveal that stronger Brownian motion and thermophoretic effects significantly increase temperature and nanoparticle diffusion. Overall, the study provides valuable insights for practical applications in porous heat exchangers, nanofluid-based energy systems, and magnetic flow control devices.

MHD Couette Flow in a Porous Channel of variable permeability with Suction/Injection at the walls

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This article is concerned with the study of steady state, fully developed, MHD Couette flow of a viscous, incompressible, electrically conducting fluid in a channel filled with a porous medium of varying permeability bounded by two infinite porous walls with constant suction/injection through the walls. Permeability of the porous channel is varying transversely with distance y. Numerical solution of the problem is obtained for two cases of permeability variation (i) linear variation $k = k_o(1+\epsilon y)$ and (ii) quadratic variation $k = k_o(1+\epsilon y^2)$ by using Brinkman equation. Galerkin's method is used to determine the filtration velocity, volumetric flow rate and skin friction on the walls. Effects of various parameters on the flow are discussed and presented graphically.

Gravastar Configurations in Rastall Gravity with Quintessence Effect under the Krori-Barua Metric

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In this work, we construct a comprehensive gravastar model within the framework of Rastall gravity, incorporating the effects of quintessence under the Krori-Barua (KB) metric ansatz. The Rastall modification, which allows a non-conserved energy-momentum tensor through a matter-geometry coupling parameter ξ, provides a natural extension to General Relativity suitable for strong-field regimes. The inclusion of quintessence introduces an additional repulsive component that significantly influences the structure and thermodynamics of the configuration. The model is divided into three regions: an interior de Sitter-like core with the equation of state (EoS)

$p = -\rho$, a thin intermediate shell composed of stiff matter ($p = \rho$), and an exterior vacuum region described by different geometries such as the Schwarzschild, Reissner-Nordström–de Sitter, Reissner–Nordström–de-Kiselev, and Ayon–Beato–García metrics. Junction conditions at the thin shell are established via the Israel-Darmois-Lanczos formalism, ensuring smooth matching across the boundaries. The resulting surface energy density $\varrho < 0$ and pressure $p > 0$ reveal the presence of exotic matter, which generates the necessary repulsive force preventing gravitational collapse. Physical quantities such as proper length, entropy, and energy of the shell are analyzed, showing that charge and quintessence increase the shell thickness and enhance thermodynamic characteristics. Overall, the model demonstrates that the combined influence of Rastall coupling, charge, and quintessence yields a horizon-free, singularity-free compact configuration that can serve as a viable alternative to classical black holes.

Evolutionary dynamics of weak shock wave in magnetogasdynamic under the effect of thermal radiation

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In this paper, we have analysed the evolutionary dynamics of weak shock in an ideal gas for an unsteady, one-dimensional cylindrical symmetric flow under the effect of magnetic field, and thermal radiation.The analysis is carried out using a series expansion near the wavefront, assuming the wave strength to be small.This ray-based approach leads to a set of coupled first-order evolutionary equations that describe how the wave strength and the first-order discontinuities develop with time.The obtained evolutionary equations capture the wave behavior and allow us to determine the critical value of the initial jump discontinuity's strength and the position at which the compression wave steepens into the weak shock wave.From the evolutionary equation the decay of the expansion wave is also discussed.The results further show how important parameters such as the adiabatic index, magnetic field strength, and thermal radiation affect the evolution of the wave.

Neural Network Modeling of Fluid Flow Through a Porous Cone–Disk System with Dissipative Effects

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Disk–cone systems play an important role in many engineering and scientific applications. They are used to determine fluid viscosity and to examine the gradual deformation of fluids. This work presents a numerical investigation of optimization in a nanofluid confined between a rotating cone and an expanding disk embedded in a porous medium. The cone rotates above the disk, and the fluid motion within the narrow region separating them is described using the Darcy–Brinkmann formulation. The study assumes a steady-state environment and incorporates a uniform magnetic field along with three forms of dissipation, i.e. Darcy, viscous, and Joule. The bvp4c solver is used to generate the graphical results, and the classical fourth-order Runge–Kutta method is applied for numerical integration. To further improve the accuracy of predicting heat transfer coefficients by using a supervised artificial neural network model.

Shock wave propagation in a self-gravitating rotating gas with magnetic field for isothermal flow using Lie group theoretic method

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The Lie group theoretic method is employed to obtain all possible similarity solutions for one-dimensional unsteady isothermal flow behind a shock wave in a self-gravitating, rotating non-ideal gas subjected to axial or azimuthal magnetic fields. Using Lie symmetry analysis, the optimal system of one-dimensional Lie subalgebras corresponding to the governing equations is constructed. Based on these solvable subalgebras, we derive all possible similarity solutions of the problem for the first time. Through the optimal classes, the similarity variable and the corresponding similarity transformations are determined, which reduce the system of PDEs to a system of ODEs. Five solution cases arise for the non-ideal gas, while nine cases are obtained for the perfect gas. Among these, similarity solutions exist for two non-ideal gas cases and for three ideal gas cases with exponential law shock path. The analysis reveals the effect of variations in the magnetic field strength, non-idealness parameter, rotational parameter, adiabatic index, and gravitational parameter on the strength of the shock along with the flow variables behind the shock front in the flow field region.

Rayleigh-Taylor stability of Rivlin-Ericksen fluid layer in porous medium with heat-mass transfer under a normal magnetic field

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In the present paper, a linear stability analysis is carried out at the interface between a Rivlin–Ericksen viscoelastic fluid and a Newtonian viscous fluid in a porous medium taking into consideration the transport of heat and mass across the interface simultaneously along with a normal magnetic field. The two fluids are arranged so that the Rivlin–Ericksen fluid lies over the viscous fluid, and hence the interface will always be Rayleigh–Taylor unstable as it is a configuration wherein a heavier fluid lies over a lighter one. Using the theory of irrotational flow of fluids and normal mode analysis, a quadratic dispersion relation governing the growth of perturbations at the interface has been obtained. The above analysis carries important physical significance. It is observed that porosity of the medium and a normal magnetic field both act to enhance the disturbances and, therefore, cause destabilization of the disturbed interface. However, the transport of heat across the interface exerts a stabilizing effect by reducing the growth rate of perturbations. Hence, these results bring out the competing roles of magnetic, porous, and thermal effects in determining the net stability characteristics of the fluid–fluid interface.

Similarity solution for magnetogasdynamic shock wave in a viscous flow with heat conduction

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This study investigates the propagation of cylindrical and spherical shock waves in an ideal gas under the effect of viscosity, heat conduction, and a magnetic field, driven out by a moving piston. The density and magnetic field in the ambient medium are assumed to vary and obey a power law. The heat conduction is expressed in terms of Fourier's law, and the viscous stress is stated following Newton's law of viscosity. Similarity solutions are obtained for the unsteady, one-dimensional adiabatic flow field behind the shock using similarity assumptions. Further, the effect of the physical parameters is observed on the flow variables, shock strength, and the position

of the piston. The increase in the magnetic field strength has a decaying effect on compressibility; hence, shock strength decreases. The effects of the variation of the physical parameters on the flow variables and on the shock waves are also analyzed graphically.

Phase lag and memory impact in hyperbolic two temperature thermoelastic circular plate with temperature-dependent properties

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This paper explores the effects of memory and phase lags on an infinite elastic circular plate with finite width subjected to axisymmetric thermal and mechanical loadings, utilizing the hyperbolic two-temperature three-phase lag model of generalized thermoelasticity with temperature-dependent material properties. For the two-dimensional problem under consideration, governing equations are determined. At uniform temperature, the plate is first thought to be unstressed and unstrained. The governing equations are reduced to a non-dimensional form and simplified using potential functions. The combined Laplace and Hankel transforms are employed to simplify the problem into ordinary differential equations. The eigenvalue approach is utilized to address the problem, and the arbitrary constants in the solution are determined by applying the loading conditions on the boundary surfaces. In the Laplace and Hankel transform domain, the temperature fields and normal stress are calculated analytically in compact form. To obtain the field quantities in the original region, a numerical inversion technique is employed.

Study of Two-Phase Jeffrey Fluid Flow and Heat Transfer Through an Inclined Porous Structure

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This study examines the two-phase flow of a Jeffrey fluid through an inclined channel. The two fluid layers are characterized by different densities, viscosities, and electrical conductivities. The flow, driven by a constant pressure gradient, moves through a channel inclined at an angle ϕ relative to the horizontal. The Jeffrey fluid in phase I is considered electrically non-conducting, ensuring that the applied uniform transverse magnetic field B_0 acts only on the conducting Jeffrey fluid in phase II. The governing equations are solved using a perturbation technique, and the effects of physical parameters on the velocity and temperature distributions are investigated with the help of Mathematica and displayed through a series of graphical results.

Study of Magnetic Field Influence on Micropolar Fluid Flow in Porous Coaxial Rotating Cylinders

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This study examines the influence of a uniform magnetic field on the flow of electrically conducting micropolar fluids within a porous annular region between two coaxial rotating cylinders. The investigation is motivated by its relevance to engineering applications such as magnetohydrodynamics and porous media transport. The primary objective is to analyze how different boundary conditions—specifically spin and no-spin—affect the velocity and microrotation profiles of the fluid. An analytical approach is employed to derive exact solutions for velocity, microrotation, shear stress, and couple stress under varying physical parameters. Key dimensionless quantities, including the permeability parameter, micropolar parameter, and Hartmann number, are systematically explored. Their effects on flow behavior are illustrated through theoretical analysis and

graphical representation. Results reveal that these parameters significantly influence the fluid's motion and stress distributions, offering insights into the control and optimization of micropolar fluid systems in porous environments. This work contributes to a deeper understanding of complex fluid dynamics in magnetically influenced, porous geometries and provides a foundation for future studies in related engineering fields.

Unsteady Flow inside a Cavity with a Discrete Heater at High Rayleigh Numbers

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This study numerically investigates two-dimensional natural convection in a square cavity with a centrally placed discrete heater as the Rayleigh number varies from 10^6 to 10^8. The governing equations are discretized using a finite-volume method on a uniform staggered grid with QUICK scheme for advection and central-difference for diffusion terms. A TDMA-based algorithm is used to compute the flow and thermal fields. The transition from steady to unsteady flow is identified through streamlines, isotherms, and Nusselt numbers. At lower Rayleigh numbers, the flow reaches a steady state with stable convection rolls. As the Rayleigh number increases, this steady state becomes unstable and periodic oscillations emerge. These oscillations exhibit a clear limit-cycle behavior of the system. Surface radiation is included then to assess its influence on the flow dynamics. It is found that radiation does not change the qualitative nature of the transition to unsteadiness when the emissivity $\varepsilon = 0.25$ and 0.75. However, it modifies oscillation amplitudes and transition thresholds, demonstrating its suppressive role.

Boundary-Layer Flow of Copper and Silver Nanofluids over Permeable Moving Plate: MHD and Porous Effects

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This work explores the magnetohydrodynamic boundary-layer flow and heat transfer of copper (Cu) and silver (Ag) nanofluids over a permeable moving flat plate embedded in a porous medium under a uniform magnetic field. The model incorporates key physical effects, including thermal radiation, viscous dissipation, nanoparticle volume fraction, and suction/injection. Governing partial differential equations are transformed into ordinary differential equations via similarity transformations and solved numerically using the Runge–Kutta fourth-order method combined with a shooting technique. Results highlight distinct behaviors of the two nanofluids: Ag–water exhibits enhanced temperature profiles, while Cu–water demonstrates higher skin friction and heat transfer rates. Increasing magnetic field strength, porosity, nanoparticle concentration, and suction/injection reduces velocity, whereas thermal boundary-layer thickness grows with magnetic and porosity parameters but diminishes under stronger suction. The Nusselt number rises with nanoparticle concentration, temperature increases with viscous dissipation, and decreases with thermal radiation. These findings provide new insights into nanofluid transport phenomena in porous media under magnetic influence, with implications for advanced thermal management systems.

Non-linear propagation of waves between two Immiscible fluids

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Interfacial instability occurs when disturbances at the boundary between two fluids amplify, generating complex surface patterns. These instabilities are driven by factors such as density differences (Rayleigh–Taylor), velocity shear (Kelvin–Helmholtz) and magnetic field effects in ferrofluids (Rosensweig effect). This is modeled through the classical linear stability analysis using momentum transport equations and interfacial stress and kinematic boundary conditions. In this study, we take into account the effect of surface tension and viscosity. Using multiple scales analysis, we derive a pair of partial differential equations for wave packets at the interface of two semi-infinite fluids with arbitrary densities, including surface tension and viscosity effects. These reduce to two nonlinear Schrodinger equations describing finite-amplitude wave packet evolution. The first equation describes stability of uniform finite amplitude wave trains, whereas the second, holding near the cutoff wavenumber, determines how cutoff wave number varies with amplitude.

Instability Analysis of a Nanofluid saturated Porous Medium under Gravity Modulation

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In this study, we specifically focus on the onset of convection in water-based nanofluids containing two types of nanoparticle, viz., metallic and metal-oxide particles. In the presence of vertical gravity modulation of arbitrary amplitude and frequency, the onset of convection exhibits a higher level of complexity. Although several studies have analysed the influence of time-dependent gravity modulation in fluids and fluid-saturated porous media, methodological limitations have confined their results to either small-amplitude or low-frequency or high-frequency regimes. Here, we extend the analysis to a broad and arbitrary range of frequencies and amplitudes. We adopt the Brinkman model which describes the porous-medium flow and the KVL nanofluid model. A linear stability analysis is performed and the results show that vibrations can either stabilize or destabilize the porous layer depending on amplitude and frequency.

Torsional Waves through a Multilayered Medium with Heterogeneity, Initial Stress and Porosity

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This paper studies torsional wave propagation in a multilayered medium consisting of exponential heterogeneity with transverse isotropy in rigidity and density for both elastic upper layer and lower half-space, sandwiching an anisotropic poroelastic layer under initial stress. The governing equations for each region are formulated using the appropriate stress–strain relations and solved in terms of Whittaker and Bessel functions. By enforcing boundary and continuity conditions at the interfaces, a general dispersion relation is derived. Numerical analysis is performed to examine the sensitivity of torsional wave behaviour to key parameters, including rigidity heterogeneity, density heterogeneity, and initial compressive stress. The results indicate that rigidity heterogeneity exhibits the strongest impact on phase velocity, followed by density variation and initial stress. Specifically, an increase in rigidity or compressive pre-stress significantly enhances torsional wave speed, whereas density heterogeneity produces a moderate increase. These findings offer a deeper understanding of how heterogeneity and pre-stress govern torsional wave characteristics, with implications for seismic exploration, subsurface imaging, and geotechnical applications.

Effect of Inclined Magnetic Field on Transport Characteristics of Casson Nanofluid Between Rotating Cylinders

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This study enhances the understanding of Casson nanofluid flow, a class of non-Newtonian fluids, within complex geometries under the influence of an inclined magnetic field. The primary objective is to examine how variations in the magnetic field inclination affect the flow characteristics. To this end, the governing modified Bessel differential equations are solved analytically. The findings reveal distinct relationships between fluid velocity and key governing parameters. Specifically, the velocity increases with higher Darcy numbers, radius ratios, and angular velocity ratios, while it decreases with increasing Casson and Hartmann numbers. Additionally, an increase in the magnetic field inclination angle leads to a velocity reduction of up to 34.38%. Graphical representations illustrating the effects of varying magnetic field inclinations further support these observations. Overall, the results provide valuable insights into flow modulation in magnetohydrodynamic (MHD) systems, with potential applications in engineering and industrial processes.

(I) Mathematical Modelling, Bio-Mathematics, Operations Research, etc.

Sustainable Closed-Loop Supply Chain Inventory Model for Smart Products using Green Technology

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In recent years, growing awareness of environmental degradation has highlighted the problem of early spoilage in smart products. To protect the environment, firms have increasingly adopted green technologies in their production and procurement processes. Consequently, capturing the market that provides the best quality products at a reasonable price in any economy is challenging for the firm manager. This study developed a sustainable closed supply chain model utilizing green technologies to minimize spoilage and carbon emissions. Within the model, used products are collected from consumers, and a proportion of the assembled products is remanufactured. After undergoing a screening process, the remanufactured items are allocated to either primary or secondary markets, depending on their quality. To further reduce spoilage and carbon emissions, the manufacturers incorporate liquid-cooling technology as an environmentally friendly production strategy. The numerical result indicates that the production store experienced a decrease in spoiled items following the adoption of this technology, which is also a positive sign for the environment. In this study, a setup is proposed to determine and minimize the total system cost. Additionally, the study includes numerical experiments and sensitivity analyses supported by graphical visuals to verify the model's accuracy.

gH-Gradient and gH-Product for Interval-Valued Functions

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In this paper, we show by a counterexample that the *gH-partial derivative* of interval-valued functions (IVFs) may exist even when the partial derivative of the end point functions do not. Next, we introduce the *gH-partial derivative* in terms of *gH-derivative* and discuss its complete characterization. Furthermore, we introduce the *gH-product* of a vector with an n-tuples of intervals and illustrate by a suitable example that our definition refines the definition existing in the literature. To illustrate and validate these definitions, we provide several non-trivial examples.

Chaos Control in Food Chain Dynamics Incorporating Fear Effect and Prey Refuge

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Controlling chaos in plankton-fish dynamics has been predominantly remained a rationale of many ecologists for managing and preserving ecosystem. In this paper, we have introduced a mathematical model consisting of phytoplankton, zooplankton, and fish population with a motive to study the simultaneous impact of prey refuge and fear effect on the model system. We have determined the existence of all feasible biological equilibria and derived the conditional local stability of the given system around it. The Hopf-bifurcation analysis is carried out by considering phytoplankton refuge, zooplankton refuge, and fear effect as significant bifurcation parameters. It is seen that fear of top predator mitigates the unpredictable (chaotic) behavior of the plankton system and induces system stability. Further investigations reveal that the defense mechanism developed by prey species due to the fear of the predator population can also terminate chaos from the system. All analytical findings are substantiated using numerical simulation.

Harmonizing Mathematical and Physical Modeling: Harnessing Artificial Intelligence for Sustainable Development through a Spiritual Lens

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This paper integrates mathematical and physical modelling with Artificial Intelligence (AI) and spiritual philosophy to promote sustainable development. Using two-dimensional Laplace and heat equations, it derives a length-independent temperature model and a transportation equation to describe energy flow. AI techniques are applied to enhance predictive and optimization capabilities. Uniquely, the concept of 'OM' is interpreted through sequence and series behavior—linking convergence, divergence, and oscillation to universal harmony. This interdisciplinary approach unites mathematics, physics, AI, and spirituality, illustrating that sustainable progress arises from balancing analytical intelligence with the deeper order of nature and consciousness.

An integrated decision support model for Over-the-Top platform subscription in a single-valued neutrosophic environment via CRITIC-MABAC approach

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The growth of internet speed and lack of quality time drives Gen Y and Z to the customized video streaming platforms. Over-the-top (OTT) services signify a substantial advancement in internet video streaming, providing viewers with choice-driven entertainment alternatives. This study provides a comprehensive analysis of the characteristics associated with OTT platforms, enabling optimal selection. The multi-criteria decision-making (MCDM) approach is designed to achieve this goal by combining CRiteria Importance Through Intercriteria Correlation (CRITIC) with a neutrosophic version of the multi-attributive border approximation area comparison (MABAC) technique. The single-valued neutrosophic set (SVNS) quantifies the linguistic characterisation of criteria in an uncertain multi-criteria decision-making (MCDM) situation. The CRITIC method assesses the significance of criteria inside the neutrophilic decision matrix, hence mitigating bias towards certain criteria. The proposed neutrosophic MABAC method is used to evaluate the alternatives. The proposed technique evaluates the value of current OTT platforms in India by

identifying their essential characteristics. The neutrosophic MABAC approach identifies the optimal OTT platform according to viewer perspectives. The study's results reveal that viewers value the availability of varied languages, combined with appropriate national and international content and multi-device connection. The proposed method is evaluated against existing neutrosophic techniques for consistency, while sensitivity studies are conducted for robustness.

A novel Decision support system for Electric Vehicles purchase using Hesitant bi-fuzzy Dombi operator-based CODAS Approach

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The transportation sector is primarily responsible for air pollution due to the usage of fossil fuels. Electric vehicles (EVs) are a sustainable mode of transportation that may help reduce air pollution caused by fossil-fuel-powered automobiles. The previous studies overlook non-technical issues, such as environmental concerns and social responsibility, in the EV selection process, which might influence EV adoption. This study investigates the EV selection process using a hesitant bi-fuzzy framework, taking into consideration both technical and non-technical EV characteristics. We developed a multi-criteria group decision-making technique for rating EVs that use a modified hesitant bi-fuzzy Combinative Distance-based Assessment method. This study offers a novel hesitant bi-fuzzy Dombi weighted average operator that combines the decision maker's viewpoints and their relative weights. The recommended approach considers the importance of the criteria based on how their removal impacts the Euclidean and Taxicab metrics. This study stresses the relative importance of charging time, cost, and range in the choosing of EVs over other factors. The study's findings demonstrate that customers continue to prioritize the technological components of an electric vehicle. These findings will assist regulators and others in the EV industry determine whether to focus on altering EVs. A comparative study with existing decision-making models evaluates the suggested strategy's applicability, whilst a sensitivity analysis demonstrates the recommended approach's robustness.

Integrated Neutrosophic MEREC–TOPSIS Model for MSME Location Prioritization in West Bengal

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The site selection for Micro, Small, and Medium Enterprises (MSMEs) has become an increasingly complex decision-making challenge due to diverse, uncertain, and often conflicting criteria. This study proposes an integrated multi-criteria group decision-making (MCGDM) strategy by incorporating neutrosophic information into the MEREC–TOPSIS framework to address uncertainty in evaluating MSME location alternatives. Single-Valued Neutrosophic Sets (SVNSs) are utilized to assess both the attributes of the alternatives and the quality of decision-makers (DMs). The neutrosophic evaluation determines the relative importance of DMs based on professional designation, experience, and expertise. The collective judgments of DMs are aggregated using the single-valued weighted average operator to generate a unified attribute appraisal. To minimize subjectivity in criteria weighting, the Method based on Removal Effects of Criteria (MEREC) is applied, establishing objective preference weights from the combined evaluations. The weighted decision matrix is then formulated by integrating neutrosophic assessments and derived attribute weights. The TOPSIS method is extended under the neutrosophic environment to rank the potential locations using truth, indeterminacy, and falsity closeness measures. A real-world case study considering ten promising MSME sites in West Bengal, India, is presented to demonstrate the applicability of the proposed approach. The results highlight that low land costs, highway accessibility, and large, flexibly zoned industrial areas are the most influential factors in MSME location planning. Validation through comparison with existing crisp and neutrosophic methods confirms the robustness and adaptability of the proposed decision-making model.

Third-order mixed symmetric duality in non-linear mathematical programming scenarios

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A class of broad mathematical programming problems, a pair of mixed symmetric duality models are developed. Under the generalised convexity assumptions, the weak, strong, and converse duality results are demonstrated. Also, it is observed that several of the specific case of the current investigations is the earlier works documented in the literature. Several numerical examples are discussed to justify the results.

Optimality conditions for the nonlinear programming problems using Caputo fractional derivatives

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The present context defines new types of convexities, where the functions are allowed to be differentiable in the Caputo fractional derivative sense. Again, these definitions are used in general nonlinear programming problems. Further, the Karush Kuhn Tucker conditions are established and studied as sufficient optimal conditions. Additionally, suitable counterexamples are supplied to support the significance of the new findings.

A Duality Model for Nonlinear Mathematical Programming via Caputo Fractional Derivatives

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In the present investigation, we introduce a novel duality model for nonlinear programming problems based on the left Caputo fractional derivative. By incorporating fractional-order derivatives into classical duality theory, our approach extends traditional optimization frameworks to a more generalized setting. We analyze duality results under fractional order convexity assumptions. The theoretical foundations of the proposed model are explored in detail, and its effectiveness is demonstrated through numerical examples. This work not only broadens the scope of fractional calculus in optimization but also opens new avenues for future research in fractional-order mathematical programming.

Biomathematical Study of Cabbage Pest Control through Natural Predators

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Natural predators are especially essential for maintaining ecosystems in stability due to the fact they keep insect pests below manage, which promotes farming that is beneficial for the surroundings. This research introduces a nonlinear mathematical model to delineate the interactions among cabbage plants (C), insect larvae (L), and their natural predators (H). The system of differential equations is analyzed for stability and persistence to determine the parameters that promote the harmonious coexistence of all three populations. The results show that stable coexistence happens

when the interaction rate between the cabbage and the larvae (α_1) and the intrinsic growth rate of the larvae (η) stay below 0.4. Bifurcation evaluation demonstrates the importance of predator efficiency by using illustrating that the device turns into volatile whilst this performance exceeds unique threshold values. Numerical simulations monitor that unchecked larval outbreaks can appreciably decrease cabbage biomass, whereas successful predation can repair ecological stability and decorate crop sustainability. This research work shows that the use of predators for organic manage is probably a reliable and environmentally friendly manner to take away pests. It also makes important theoretical contributions to sustainable farming techniques.

Geometrical interpretation of Convex functions through Caputo fractional derivatives

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The classical derivatives and integrals of integer order have clear geometric and physical interpretation which eases the understanding of readers and also simplifies its use in various problems encountered in mathematics. Whereas, generalisation of the integer order calculus that is the fractional calculus lacks the geometric and physical interpretation. The present investigation demonstrates a survey on the geometrical and physical interpretation of fractional order derivatives and integrals. Also, we have discussed the geometrical interpretation of convex functions in Caputo fractional derivative sense. Here, we have taken a function that is classically non-convex, but convex in Caputo fractional derivative sense to validate the theory.

Two-Warehouse Inventory System with Time-Varying Demand and Weibull Deterioration in Crisp and Fuzzy Frameworks

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This paper develops a comprehensive two-warehouse inventory model for deteriorating items following a Weibull distribution, where the demand rate is time-dependent, and shortages are completely backlogged. The inventory system consists of two storage facilities: a limited-capacity own warehouse (OW) and an additional rented warehouse (RW) with unlimited capacity. To address uncertainty in system parameters, the model is formulated under both crisp and fuzzy environments. In the fuzzy framework, parabolic fuzzy numbers are employed to represent imprecise parameters, and the Graded Mean Integration Representation (GMIR) method is used to defuzzify the total cost function. The primary objective is to determine the optimal replenishment policy that minimizes the total inventory cost, incorporating holding, shortage, deterioration, and ordering costs. Numerical examples are solved using Mathematica 13.0.1 to illustrate the solution procedure, and a detailed sensitivity analysis is performed to examine the influence of key parameters on the optimal policy. The results highlight the model's practical applicability and offer valuable managerial insights for decision-making under uncertainty in multi-warehouse inventory systems.

Role of data assimilation on numerical simulation of tropical cyclone induced rainfall

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Prediction of rainfall associated with tropical cyclones over the North Indian Ocean (NIO) is challenging and essential to help in early warning and disaster preparedness. In the present work, the numerical simulations are conducted using numerical weather prediction model specially WRF model and initial conditions are improved through data assimilation technique of three dimensional variation (3DVAR) method. Several NIO cyclones, which formed over the Bay of Bengal and Arabian Sea, were considered for simulations using with and without data assimilation. The simulated rainfall was compared with Global Precipitation Measurement Mission (GPM) and suggested that results was better with data assimilation experiments. Results also suggested that significantly improved the storm track, and intensity. The several statistical analysis including root mean square error, correlation coefficients, probability of detection, false alarm and critical success index were computed and compared with available observations. Overall, the study concluded that data assimilation is important for rainfall forecast.

EOQ Model for Ameliorating and Deteriorating Items having Price and Advertisement Demand under Preservation Technology

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This study develops an optimal inventory framework for products that experience both time-dependent amelioration and deterioration, where demand is influenced by the selling price and the level of advertising effort. The model incorporates investment in preservation technology to reduce deterioration rate, as well as a trade credit policy to stimulate demand and improve financial flexibility. The analysis is carried out under both crisp (deterministic) and fuzzy environments, with parameter uncertainties represented by triangular fuzzy numbers. The graded mean integration representation method is employed to convert fuzzy outcomes into actionable decision values. Numerical experiments performed with Mathematica 13.0.1 confirm the efficacy of the proposed methodology and demonstrate discrepancies in optimal decisions between crisp and fuzzy contexts. A comprehensive sensitivity analysis investigates the influence of key parameters, providing valuable managerial insights for managing perishable or quality-sensitive products. The proposed framework is particularly applicable to industries such as fresh produce, food processing, and high-technology goods, where maintaining quality while minimizing deterioration is essential for profitability.

EOQ Inventory Model for Deteriorating Items having Time-varying Demand and Learning Effect under Imprecise Costs

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This study proposes a comprehensive inventory model for deteriorating items subject to a power-form demand pattern, incorporating the influence of learning effects and allowing for completely backlogged shortages. The model addresses real-world inventory management challenges where demand changes over time and all unmet demand is fully backordered, providing an effective framework for retailers. The inclusion of the learning effect captures progressive improvements in handling and management practices, leading to reduced operational costs and increased efficiency. To account for uncertainty in practical environments, the model is developed under both crisp and fuzzy frameworks. In the fuzzy setting, triangular fuzzy numbers are employed, and the signed

distance method is applied for defuzzification. Numerical illustrations are performed using Mathematica 13.0.1 software to validate the model, and a sensitivity analysis is conducted to examine the impact of critical parameters on inventory decisions. Furthermore, the study provides valuable managerial insights to assist decision-makers in optimizing inventory operations. The model is particularly applicable to perishable goods such as food and pharmaceutical products, where demand and shortages are highly time-sensitive.

A Deterministic Inventory Model for Deteriorating Items with Time-Varying Holding Cost and Price Dependent Demand

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In this paper, a deterministic inventory model is developed for deteriorating items where holding cost is time varying and demand is selling price dependent. The deterioration rate of items follows the Modified Exponential Distribution function. Shortages are allowed and completely backlogged. The most important factors influencing the inventory systems are deterioration, demand and holding cost. In traditional inventory systems deterioration rate is considered constant but in general deterioration is not constant. They can be time dependent, stock dependent and random. Model is solved analytically by maximizing the total profit function. Also, the numerical example is given to illustrate the model and verified graphically. Keyword: Inventory, deterioration, modified exponential distribution function, demand rate, shortages.

Thermal Damage in Human Biological Tissue for Fractional Bioheat with RDTM

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The effect of high and low temperatures can cause thermal damage to biological tissues. An important thing in assessing tissue injury is not only the temperature level but also the period of contact. The extent of thermal injury is closely linked with both the temperature and the time required during the contact. In the theory of thermal damage, high temperature affects on cells which will burn and cannot be repaired and the low temperature creates disturbance in blood flow. Bioheat transfer deals with the study of the transport of thermal energy in the living system with regard to the development of medical therapy. The study of bioheat transfer includes blood circulation, metabolic heat production etc. The bioheat transfer has an important role in the connection of the study of physics, mathematics and biology. Bioheat transform has many more applications in the engineering field. The present research work gives the study of thermal damage in biological tissue with aid of the recent mathematical technique, reduced differential transform method. The fractional bioheat equation has been used to determine the thermal damage in biological tissue. The numerical results are explained through graphical representation.

Predator–Prey Model with Infection in Predators

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This study presents a three-dimensional eco-epidemic model describing the interaction between prey, susceptible predators, and infected predators. We derived all biologically feasible equilibria and analyzed their local stability using the Jacobian matrix and Routh–Hurwitz criteria. The model exhibited a transcritical bifurcation with respect to the natural death rate of susceptible predators, demonstrating a stability exchange between the prey-only and infection-free equilibria. Numerical simulations further reveal stable coexistence of all populations and the emergence of oscillatory dynamics, confirming the presence of a Hopf bifurcation. These findings highlight how predator infection influences long-term ecological dynamics.

Approximate analytical solution to stream-aquifer interaction with surface infiltration in an unconfined horizontal aquifer

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The problem of stream-aquifer interaction with surface infiltration is considered for a horizontal aquifer, and the analytical solution of the governing nonlinear equation is obtained by applying the Laplace transform homotopy perturbation method under the specified conditions. From the solution obtained, it is observed that, considering the effect of surface infiltration, there is a significant effect on the height of the water table. The solution obtained behaves well with the physical phenomena of the problem. From the sensitivity analysis of the parameters, it is observed that the physical characteristics of the parameters are preserved. Thus, the applied method is easy, efficient, reliable, and accurate.

The combined effect of additional food and Allee effect in predator reproduction model with constant harvesting under Beddington-DeAngelis functional response

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In ecological systems, the availability of additional food and the presence of Allee effects play a crucial role in determining species survival and reproductive success. Understanding how these factors interact with harvesting pressure is essential for predicting long-term predator-prey dynamics. We study a predator reproduction model with constant harvesting by incorporating additional food to predator under Beddington-DeAngelis functional response. A complete investigation of boundary equilibria is carried out, followed by the determination of interior equilibria through the intersection of prey and predator nullclines on the positive axis, which reveals the possibility of multiple interior equilibrium points. he local stability of each equilibrium is examined using eigenvalues of the Jacobian matrix. The analysis highlights how supplemental food enhances population survival and supports predator persistence even under harvesting pressure. We further explore the combined influence of additional food and harvesting on the system dynamics. A detailed bifurcation analysis is presented to understand the roles of additional food, constant harvesting, and Allee effect in shaping qualitative system behaviour. Both saddle-node and Hopf bifurcations are identified, and their biological implications are discussed in relation to population persistence and oscillatory dynamics.

Performance Analysis of an M/G/1 Queue with Two-Phase Heterogeneous Service, Server Failures, and Bernoulli-Scheduled Vacations

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In this paper, we investigate an M/G/1 queue offering two-phase service, one after the other, with heterogeneous rates. The server is subject to random failure during any phase of service. As soon as the server fails, it is sent for repair. After repair, the server completes the remaining service of the unit already in service prior to failure. Further, it is assumed that after completion of both phases of a service, the server may go on vacation with a Bernoulli schedule. The customers are balking in nature and may not join the queue if the server is not available for service. To investigate the model, we apply the probability generating function and supplementary variable technique and obtain the performance measures associated with the present queueing model. Finally, we analyze the sensitivity of the performance measures using numerical illustrations.

Vector Optimization with Non-Solid or Empty-Interior Cones

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Vector optimization problems typically rely on ordering cones with nonempty interior to guarantee separation, scalarization, and strong optimality results. However, many important applications, particularly in infinite-dimensional spaces and Banach lattices—lead naturally to non-solid or empty-interior cones, for which classical optimality theory breaks down. This study develops a generalized framework for vector optimization under such weakened cone structures. We introduce refined concepts of efficiency, proper efficiency, and approximate optimality that remain meaningful without interiority. New separation principles, based on weak topologies and support functionals, are established to characterize efficient points when standard interior-based arguments fail. We derive necessary and sufficient optimality conditions for cone-constrained vector problems in locally convex spaces, using tools from convex analysis, dual pairings, and order theory on Banach lattices. The theoretical results unify and extend existing interior-free approaches and allow treatment of practical problems arising in infinite-dimensional optimization, multi-criteria control, and functional-analytic models. Applications illustrate how efficient solutions can still be identified and approximated even when the ordering cone lacks interior, demonstrating the robustness and applicability of the proposed framework.

Stochastic Fractional-Order SEIR Approach to HIV/AIDS Transmission: A Dynamical Systems Perspective

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HIV/AIDS transmission is affected by delays in infection progression and changes in behavior over time, which create memory effects in the disease spread. It also involves random variations in contact rates and treatment adherence that classical models cannot reflect. To capture both memory and uncertainty, this study develops a stochastic fractional-order SEIR model, offering a more realistic way to describe HIV/AIDS transmission.

Methods: A SEIR framework utilizing Caputo fractional derivatives is developed, and noise factors in the transmission rate are used to add stochasticity. In order to accurately simulate the stochastic fractional dynamics of the system, the model is analyzed both analytically using MATLAB and numerically using a fractional predictor–corrector technique.

Discussion: HIV transmission's random fluctuations and long-term memory effects are both captured by the combined fractional-stochastic approach. The model improves our capacity to predict epidemic patterns and facilitates the development of more successful intervention and control methods by incorporating these practical elements.

Result: The model shows that fractional orders slow the epidemic peak and extend the infectious period, while stochastic effects create variability in outbreak size. Together, they reproduce more realistic HIV/AIDS transmission patterns than the classical SEIR model

Computational algorithm for multiobjective programming based on neutrosophic set

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A multiobjective programming problem plays a very interesting role in engineering, economic, and agricultural sectors, and therefore it is a need to build a computational algorithm for its solutions. Numerous deterministic methods have been successfully applied in many sectors by ignoring uncertainty, vagueness and hesitation. Also, stochastic techniques have been applied to the decision-making of such problems. But stochastic methods are fitted to address uncertainty only. Zadeh (1965) introduced the fuzzy set, which is capable of dealing with uncertainty and fuzziness of the problem. Moreover, the hesitation involved in the problems naturally, and it cannot be resolved by ordinary fuzzy set. An intuitionistic fuzzy set of Atanassov (1986) is one of the recent generalization of ordinary fuzzy set by incorporating a nonmembership function. From last decades many computational algorithms based on intuitionistic fuzzy sets are developed but they captured partially to the uncertainty, hesitation, imprecision involved in the problems. Smarandache (1998) initiated the concept of neutrosophic set theory, and it provides a broad outline for combining several existing sets into one. Indeterminate and unpredictable data cannot be dealt with by either the fuzzy set theory or intuitionistic fuzzy set theory, it motivates me to develop a better computational algorithm for better solutions under neutrosophic framework.

The main work of the present proposed computational algorithm is to transform a neutrosophic multiobjective programming problem into a single crisp version of a linear programming problem, and it can be solved easily by the simplex method. Moreover, the developed computational method has been implemented in production planning problem, and the results of the computational algorithm are compared with solutions of the existing methods.

Impact of carbon dioxide emissions and related temperature rise on wildlife population: A modeling study

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As the climate undergoes rapid changes, it unleashes far-reaching and profound consequences for various living organisms. Climate change is driven by the increase in carbon dioxide (CO_2) levels, leading to a rise in the global average temperature. In this research work, we formulate a nonlinear mathematical model to perceive the impact of rising temperature on the wildlife species. In formulating the model, we took into account the dynamic interplay where atmospheric carbon dioxide levels rise due to both natural processes and human-driven emissions, and are subsequently mitigated by forest uptake. The escalating carbon dioxide concentration contributes to a rise in the global average temperature, thereby impacting the growth rates of human population, forestry biomass, and wildlife populations. The stability theory of differential equations is applied to scrutinize the formulated model. Analyzing the proposed model, we have identified the sufficient conditions under which all considered dynamical variables attain their coexisting equilibrium levels. Our model analysis reveals a spectrum of bifurcations. In particular, the examination of transcritical bifurcation led to the identification of a critical reduction rate of wildlife species due to human activities above which the wildlife population may teeter on the brink of extinction under the considered stressor of temperature rise. Study of the proposed model reveals that for a considered set of parameter values, if the initial density of human population is high and forest biomass is low in the considered region, then the system stabilizes to the forest and wildlife-free equilibrium.

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