INDIAN MATHEMATICAL SOCIETY

THE INDIAN MATHEMATICAL SOCIETY

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NEWSLETTER

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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 hundred years of the Society. Released on the Inaugural day of the Platinum Jubilee 75th Annual Conference of the Society on 27th December 2009.

CONTENTS

A BRIEF REPORT OF THE 87^{th} ANNUAL CONFERENCE OF THE IMS

The 87^{th} Annual Conference of the Indian Mathematical Society- An international Meet was held virtually under the auspices of Jawaharlal Nehru Engineering College, Mahatma Gandhi Mission University, Aurangabad during December 4 - 7, 2021 under the presidentship of Prof. Dipendra Prasad, IIT Bombay. The conference was inaugurated by Hon. Shri Ankushrao Kadam, Chancellor, Mahatma Gandhi Mission University, Aurangabad. Prof. A. K. Nandkumaran, IISC, Bangalore was a guest of honor. Prof. Vilas Sapkal, Vice-Chancellor of Mahatma Gandhi Mission University, welcomed the delegates. The General Secretary of IMS, Prof. Satya Deo spoke about the Indian Mathematical Society and on behalf of the Society expressed his sincere and profuse thanks to the host for organizing the Conference. He also made the announcements of IMS prizes and awards. Prof. Peeyush Chandra, the Academic Secretary of the IMS, reported the academic programme of the Conference. The function ended with a vote of thanks by the local organizing secretary, Dr. Gajanan Lomte.

The Conference was attended by more than 200 delegates. Two presidential addresses (General and Technical), two plenary talks, five Memorial Award lectures, five IMS Award lectures and seven invited lectures were delivered in the conference. Also, six symposia were organized during the conference and thirty three invited speakers gave talks in the symposia. 131 research papers were accepted for presentation at the Conference including 9 research papers for the paper presentation competition for various prizes.

Brief details of the academic activities are given below.

The first **plenary talk** was delivered by Prof. Michel Waldschmidt, Sorbonne Universite, Paris, France, on "Multivariate Lidstone interpolation ". The second **plenary talk** was given by Prof. Siddharth Mishra, Professor of Applied Mathematics, ETH Zurich, Switzerland..

The 35^{th} **P. L. Bhatnagar Memorial Award Lecture** was delivered by Prof. Malay Banerjee, Indian Institute of Technology, Kanpur, on "Effect of slow-fast time scale on spatio-temporal pattern formation ".

The 32^{nd} **V. Ramaswami Aiyar Memorial Award Lecture** was delivered by Prof. Vijay Kodiyalam, The Institute of Mathematical Sciences, Chennai, on "Ramanujan graphs ".

The 32^{nd} **Srinivasa Ramanujan Memorial Award Lecture** was delivered by Prof. T. N. Venkataramana, TIFR, Mumbai on "Monodromy of hypergeometric functions ".

The 32^{nd} **Hansraj Gupta Memorial Award Lecture** was delivered by Prof. C. S. Rajan, TIFR Mumbai on "Gauss sums ".

The 15^{th} **Ganesh Prasad Memorial Award Lecture** was delivered by Prof. Kallol Paul, Jadavpur University, Kolkata on "Birkhoff James Orthogonality: Its role in the Geometry of Banach spaces ".

A. K. Agarwal Award was jointly awarded to Prof. Arjun Paul, Jadavpur University, Kolkata and

Ronnie Sebastian of IIT Bombay, Mumbai. One of the recipients, Prof. Arjun Paul, delivered a lecture on "Fundamental group schemes of Hilbert scheme of n points on a smooth projective surface".

A. M. Mathai Award recepient, Prof. Manil T. Mohan Indian Institute of Technology, Roorkee, delivered a lecture on "Well posedness, large deviations and ergodicity of the stochastic 2D Oldroyd model of order one ".

P. K. Jain Award was jointly awarded to Prof. Perumal Muthukumar, Indian Statistical Institute, Banglore, and Saminathan Ponnusamy, IIT Madras. One of the recipients, Prof. P. Muthukumar, delivered a lecture on "Composition operators on Hardy spaces of the homogenous rooted trees ".

Subhash Bhatt Award was jointly awarded to Prof. Kallol Paul and Arpita Mal, Jadavpur University, Kolkata. One of the recipient, Prof. Arpita Mal, delivered a lecture on "Characterization of $k-$smooth operators between Banach spaces ".

A. Narasinga Rao Prize recipient, Prof. Saroj Rani, S. A. Jain College, Ambala City, delivered a lecture on "On cyclic and negacyclic codes of length $8p^s$ over $\mathbb{F}_{p^m} + u\mathbb{F}_{p^m}$ ".

To encourage young researchers, the Indian Mathematical Society organizes Paper Presentation Competition:

There are six IMS Prizes, V. M. Shah Prize and AMU Prize.

For the IMS prizes 9 papers were received, two papers for V. M. Shah Prize and four papers for AMU Prize. The papers were presented in the competition section.

The following is the result for the award of these prizes.

IMS Prize - Group-1: No paper was received in this group.

IMS Prize - Group-2: Two papers were received in this group. The prize was awarded to **Dimpi**, University of Delhi, Delhi.

IMS Prize - Group-3: No paper was received in this group.

IMS Prize - Group-4: No paper was received in this group.

IMS Prize - Group-5: Two papers were received in this group. The prize was awarded to **Padmaja K.**, VIT Vellore.

IMS Prize - Group-6: No paper was received in this group.

AMU Prize: Five papers were received and presented and the prize was awarded to **Tapatee Sahoo**, Manipal Academy of Higher Education, Manipal.

V. M. Shah Prize: Two papers were received in this group. The prize was awarded to **H. J. Khachar**, M. S. University, Vadodara.

The following Invited Lectures were delivered

1. Prof. Sameer Chavan: Weighted shifts on directed graphs and their applications
2. Prof. Samrith Ram: Set partitions, tableaux, and subspace profiles of regular diagonal operators

3. Prof. Mohammad Sajid: Fractals and chaos in continuous and discrete dynamical systems
4. Prof. Sachi Srivastava: Stability of delay semigroups
5. Prof. Md Ali Zinna: On stably free modules over smooth real affine algebras
6. Prof. Geetha Venkataraman: Women in Mathematics: A long road ahead?*
7. Prof. S. K. Vaidya: Graph Energy - An emerging frontier between Mathematics and Chemistry

Symposia organized Six symposia were organized and the details are as follows.

(i) Fractional Differential Equations: Theory and Numerics
Convenor: Prof. Mani Mehra, IIT Delhi

(ii) Geometry and Topology
Convenor: Prof. Krishnendu Gongopadhyay, IISER Mohali

(iii) Optimization Theory and Applications
Convenor: Prof. C. S. Lalitha, University of Delhi, Delhi

(iv) Algebra
Convenor: Prof. Dinesh Kumar Khurana, Panjab University, Chandigarh

(v) Recent Advances in Geometry of Banach Spaces
Convenor: Prof. T. S. S. R. K. Rao, CARAMS, MAHE, Manipal

(vi) Deep Learning for Scientific Computing and Artificial Intelligence
Convenor: Prof. Ritesh Kumar, SRM, Chennai

The convenors of various symposia have identified all the speakers.

MINUTES OF THE 87^{th} ANNUAL GENERAL BODY MEETING OF THE INDIAN MATHEMATICAL SOCIETY -2021

The General Body Meeting of the Indian Mathematical Society was held on Tuesday, 7^{th} December, 2021 at 12 noon via online mode during the 87^{th} Annual Conference of the Society. It may be noted that the 87^{th} Annual Conference of the Indian Mathematical Society - An International Meet was held in online mode at Jawaharlal Nehru Engineering College, Mahatma Gandhi Mission University, Aurangabad during December 4 - 7, 2021.

First, the President of the IMS, Prof. Dipendra Prasad, welcomed all the members present for the meeting and then the General Secretary Prof. Satya Deo took up the agenda items for consideration as follows:

Item No. 1. To confirm the Minutes of the General Body meeting held on Sunday, the 20th December, 2020 at 12 noon in online mode from VIT, Vellore using zoom meeting app.
Since no comments were received from any member of the Society, the Minutes of the General Body meeting held on Sunday, the 20th December, 2020 at 12 noon in online mode from VIT, Vellore were confirmed.

Item No. 2: To receive the report of the General Secretary, Prof. Satya Deo.
The following is the Report of the General Secretary, Prof. Satya Deo, for the year 2021
1. Newsletters: The IMS newsletters No. 45 and No. 46 were published in April 2021 and in August 2021, respectively. These were also uploaded on the website of the Indian Mathematical Society. The soft copies of these newsletters have been sent by e-mails to all the life members of the Society. Letters to the newly elected IMS president and three council members whose terms started w.e.f. April 1, 2021 were sent to them and their acceptances were received.

2. APC Meeting-2021: A Zoom meeting of the Academic Planning Committee (APC) for the IMS Conference 2021 to be held online at MGM university, Aurangabad was held on Sunday, the 10th June, 2020 from 11.00 a.m. to 1.00 p.m. The meeting was presided over by the President of the IMS Prof. Dipendra Prasad of IIT, Bombay. 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 me, completed the job of contacting all the speakers, inviting them for all the talks and finalizing the full academic programme of the conference.

3. A. Narasinga Rao Memorial Prize for the year 2021: This prize has been given to Ms. Saroj Rani for her paper: "On cyclic and negacyclic codes of length $8p^s$ over $Fp^m + uFp^m$", JIMS, vol 87 (3, 4), 2020. The Narasinga Rao prize of the IMS is given every year to the best paper published in JIMS or Math Student published by the IMS. It carries a cash prize of Rs. 4,000 (four thousand) and a citation.

4. A. K. Agarwal Award for the year 2021: This award has been given to Arjun Paul and Ronnie Sebastian of IIT, Bombay, jointly for their paper entitled "Fundamental group schemes of Hilbert scheme of n-points

on a smooth projective surface", Bull. Sci. Math. 164 (2020) 102898 DOI: 10.1016/j.bulsci.2020.102898. The award consists of Rs 10,000 (Rs. 5,000 each) 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.

5. A. M. Mathai Award for the year 2021: This award has been given to Manil T. Mohan, Department of Mathematics, IIT Roorkee, Uttarakhand for his paper entitled "Well-posedness, large deviations and ergodicity of the stochastic 2D Oldroyd model of order one" Stochastic Processes and their Applications, 130 (2020) 4513-4562, DOI: 10.1016/j.spa.2020.01.007. The award consists of Rs 25,000 and a citation. The award is given every year for the best paper in applicable mathematics having applications preferably in Physical Sciences, Biological and Medical Sciences, Social Sciences or Probability and Statistics etc.

6. Subhash Bhatt Award for the year 2021: This award has been given to Arpita Mal and Kallol Paul, Department of Mathematics, Jadavpur University, Kolkata, jointly for their paper entitled "Characterization of k-smooth operators between Banach spaces", Linear Algebra and its Applications, 586 (2020) 296-307, DOI: 10.1016/j.laa.2019.10.013. The Award consists of Rs 25,000 (Rs 12500/- each) and a citation. The award is given every year for the best paper in areas of Functional Analysis/ Harmonic Analysis/ Operator Theory and related areas.

7. P. K. Jain Award for the year 2021: This award has been given to Perumal Muthukumar, Statistics and Mathematics Unit, Indian Statistical Institute, Bangalore, and Saminathan Ponnusamy, IIT Madras, jointly for their paper "Composition operators on Hardy spaces of the homogenous rooted trees",1 Monatshefte fur Mathematik (2020) 192:721743, DOI: 10.1007/s00605- 020-01410-x. The award consists of Rs. 25, 000 (Rs. 12,500 each) and a citation. The award is given every year for the best paper in the areas of Functional Analysis/ Complex Analysis/Harmonic Analysis/ Function Theory and related areas.

8. Satish Bhatnagar Award for the year 2021: The award consists of Rs. 10,000 and a citation. It is given for the best paper published in areas of History of Mathematics in India focusing on a person/ problems/ region/system of education/ government. None was found suitable for this award this year.

9. P. L. Bhatnagar Memorial Prize for the year 2021: This award consists of Rs. 1000 (one thousand) and a certificate. The award is given to the top scorer of the Indian Team participating in the International Mathematical Olympiad. The award this year has been given to Mr. Pranjal Srivastava, Bangalore, who got Gold medal in the IMO and was the top scorer. India won one gold, one silver and 3 bronze medals in 2021 IMO held at St. Petersberg, Russia during July 14-24, 2021.

10. Guidance and help to the Local Organizing Secretary: The usual guidance and help has been provided to Prof. V. M. Arole, Local Organizing Secretary and Dr. Gajanan Lomte, Coordinator of the 2021 IMS Conference -An International Meet, pertaining to various works like local arrangements, invitations, website, inaugural function of the conference etc.

11. Interim Appointment of the Chief Editor, JIMS.

The work of the JIMS was being looked after jointly by Prof. Ghorpade, Editor-in Chief, and Prof. Nimbhorkar, Prof. Ghorpade was unable to give enough time for the journal and a huge backlog of the papers piled up during all this time. Prof. Peeyush Chandra, the designated Editor-in-Chief from April 1, 2022, noticed this and drew a plan so that it can be cleared, but he had no authority, and expected co-

operation from the Editor-in-chief was not forthcoming the way it should have been. Hence, I requested the President IMS to appoint Prof. Peeyush Chandra (with the consent of Prof. Ghorpade) as the interim Editor of the JIMS so that the backlog can be cleared as soon as possible. Since then, the work is going on smoothly.

12. Raising Funds for the Ganit Bhawan complex through donations: I sent an appeal to all life members for making donations to the IMS for developing its headquarters in Pune. This appeal was also published in the newsletter no 46. The amount of money collected so far is approximately Rs. 18 lacs and the donations are still coming in.

Constitution of the Fund raising Committee of the IMS

The building plan of the Headquarters of the Indian Math Society at Pune has been finalized. The Society has to now start the construction activities for the development of the campus. According to the Architect of the campus "Design Group of India", the Society will need approximately 13 crores of Rupees in constructing the buildings and developing the campus. Therefore, it has been decided by the Council of the IMS that we should appeal for donations to the members and well-wishers of the Society, to the trusts, corporations, industrialists and the government agencies who will like to support the cause of mathematics in India.

It is for this purpose that the President of IMS, has constituted a fundraising committee having the following members:

1. Prof. S. Arumugam, Past President, IMS,
2. Prof. S. K. Nimbhorkar, Tresasurer, IMS,
3. Prof. B. N. Waphare, Administrative Secretary,
4. Prof. M. M. Shikare, Editor, Math. Student,
5. Prof. Peeyush Chandra, Academic Secretary, IMS,
6. Prof. Satish Bhatnagar, University of Nevada, USA,
7. Prof. N. K.Thakare, Past President, IMS,
8. Prof. Manish Gupta, Dhirubhai Ambani Institute of Information and Communication Technology,
9. Prof. Satya Deo, General Secretary, IMS (Convener).

Scope and terms of the Committee:

1. The Committee will meet virtually once in a while to assess the progress made in collecting the donations.
2. Members of the Committee will make suggestions for increasing the number of donors as also the amount of donation.
3. Every member of the committee will explore the possibility of reaching out to a possible donor and persuade her/him to make a suitable donation to the IMS. If necessary, the appeal of the General Secretary can be shared with the donor. A member can request the General Secretary of the IMS to write to the donor a suitable letter as suggested by the member. Donations by individuals can be made for the general purpose/ building fund and can be directly transferred to the account of the IMS. All the donors will be suitably acknowledged.
4. If the donor happens to be a trust, corporation, or a government agency and they need a formal request

or proposal from the Society that again can be done by the General Secretary following the suggestions of the member. Buildings like library, committee room, guest house, computer center, canteen etc. can be fully sponsored by a donor and in that case, these will be named after the donor's name. Even a lecture hall can be named after the donor's name if it is supported fully by the donor.
5. The tenure of the committee is for a period of three years w.e.f. August 1, 2021 which can be extended or a new committee can be formed. More members can be co-opted whenever desirable.

The committee members can share the appeal of the General Secretary, IMS to a possible donor. It has all the details of the proposed campus as well as how to transfer the donation amount to the bank account of the IMS.

According to the information given by the treasurer, IMS, the number of life members enrolled this year up to November 30 is 121. The number of sessional and annual members enrolled during the same period is 66 and 31 respectively.

Acknowledgements:

The General Secretary thanks Prof. Waphare for drafting the IMS newsletters 45 and 46 and sending them to him for finalization. Prof. Shikare sent these newsletters to all the life members of the IMS. The Pune team of the office bearers have always been helping me to carry out the important works of the IMS, and I thank them for all these helps.

Item 3: To receive the Report of the Academic Secretary.
The following is the report of the Academic Secretary.

In the 87th Annual conference, several lectures were arranged, which included Plenary lectures, Memorial Award Lectures and Invited talks. The details are given below:
Plenary Speakers:

1. Prof. Michel Waldschmidt, Sorbonne Universite, Paris, France.
2. Prof. Siddharth Mishra, Professor of Applied Mathematics, ETH Zurich, Switzerland.

Memorial Award Lectures

35^{th} P. L. Bhatnagar Memorial Award Lecture: Prof. Malay Banerjee, IIT Kanpur.
32^{nd} Hansraj Gupta Memorial Award Lecture: Prof. C. S. Rajan, TIFR Mumbai.
32^{nd} Srinivasa Ramanujan Memorial Award Lecture: Prof. T. N. Venkatara-mana, TIFR Mumbai.
32^{nd} V. Ramaswami Aiyer Memorial Award Lecture: Prof. Vijay Kodiyalam, IMSc, Chennai.
15^{th} Ganesh Prasad Memorial Award Lecture: Prof Kallol Paul, Jadavpur University Kolkata.

Invited Talks:

Prof. Sameer Chavan, IIT Kanpur.
Prof. Samrith Ram, IIIT Delhi.
Prof. Md Sajid, Qassim University, Saudi Arabia.
Prof. Sachi Srivastava, University of Delhi, Delhi.
Prof. Md Ali Zinna, IISER Kolkata.
Prof. Geetha Venkataraman, Dr. B. R. Ambedkar Univesity, Delhi.

Prof. S. K. Vaidya, Saurashtra University, Rajkot.

The following six symposia were arranged:

1. Geometry and Topology - Convenor: Prof. Krishnendu Gongopadhyay, IISER Mohali, Punjab. Speakers: Professors Pralay Chatterjee (IMSc Chennai), Subhojoy Gupta (IISc Bangalore), Pranab Sardar (IISER Mohali), Arpan Kabiraj (IIT Palakkad), Pranav Pandit (ICTS-TIFR Bangalore), Samik Basu (ISI Kolkata).

2. Recent Trends in Geometry of Banach Algebra - Convenor: Prof. TSSRK Rao, Adjunct Professor, CARAMS, MAHE, Manipal. Speakers: Professors P. Bandyopadhyay (ISI Kolkata), Arpita Mal (Jadavpur Univ. Kolkata), C. R. Jayanarayanan (IIT Palakkad), Tanmoy Pal (IIT Hyderabad), Priyanka Grover (Shiv Nadar University), T. S. S. R. K. Rao (MAHE, Manipal).

3. Optimization Theory and Applications Convenor: Prof. C. S. Lalita, University of Delhi, Delhi. Speakers: Professors Suresh Chandra,(IIT Delhi) S. K. Mishra (BHU, Varanasi), Vanita Verma (Panjab University), Joydeep Dutta (IIT Kanpur), Anurag Jayswal (IIT ISM Dhanbad), C. S. Lalitha (University of Delhi).

4. Algebra - Convenor: Prof. Dinesh Kumar Khurana, Panjab University, Chandigarh. Speakers: Professors J. K. Verma (IIT Bombay), A. Hariharan (IIT Bombay), Manoj Keshari (IIT Bomby), Mikhail Chebotar (Kent State Univ.), Pace P. Nielsen (Bingham Young University, USA.)

5. Fractional Differential Equations: Theory and Numerics Convenor: Prof Mani Mehra, IIT Delhi. Speakers: Professors Dumitru Baleanu (Cankaya University, Turkey), B. V. Rathish Kumar (IIT Kanpur), R. Sakthivel (Bharathiar University, Coimbatore), Praveen Agarwal (Anand International College of Engineering, Jaipur), Kuldip Singh Patel (IIIT Raipur).

6. Deep Learning for Scientific Computing and Artificial Intelligence - Convenor: Prof. Ritesh Kumar Dubey SRM, Chennai. Speakers: Professors Deep Ray (Univ. of Southern California), Anupam Gupta (Block Appss AI, Banglore), Buddhananda Banerjee (IIT Kharagpur), Sanjeev Kumar (IIT Roorkee), Yogesh Sudhakar Parte (Data Science Proficiency Citius Tech Healthcare Tech. Mumbai), Rajeev Mehajan (SERB, New Delhi).

It may be noted that apart from the speakers from USA, France, Switzerland, Saudi Arabia and Turkey, there were some speakers from Industry who participated in symposia.

Only 9 research papers were received for various prizes: AMU Prize (4), VM Shah Prize (2), IMS Prize Group 2 (2) and IMS Prize Group 5 (1). For contributory presentation 120 research papers were received.

Item No. 4: To consider the Audited Statement of Accounts for the year 2020 -2021 and the budget for the financial year 2022- 2023.

The Audited Statement of Accounts for the year 2020 -2021 and budget for the year 2022-2023 presented by the Treasurer, Prof. S. K. Nimbhorkar were approved.

Item No. 5. To receive the report of the Editor-in-Chief of the Journal of the Indian Mathematical Society for 2021.

Report of the Editor, the Journal of the Indian Mathematical Society for 2021.

I was appointed as Interim Editor-in-Chief on September 6, 2021 and took charge from Prof. Ghorpade. It was noted that the JIMS was receiving manuscripts in two modes: (i) through the online Informatics platform of JIMS and (ii) through email on jimsmorane@gmail.com

Prof. Nimbhorkar handled the manuscripts received through email and provided the following data:

No. of Manuscript pending at the end of 2020.	**25**
(The figure is shown from that of accepted and rejected papers)	
Papers received in 2021 (upto 13/11/2021)	**61**
Total	**86**

Papers accepted in 2021 (out of which 7 are from last year's pending papers) :		13
Papers rejected in 2021 (out of which 18 are from last year's pending papers) :		42
With referees :	13	
Under process:	18	
Total:	86	

On the Informatics JIMS platform there were about 100 articles (from Feb 2018 onwards) pending for processing. So, it was decided to clear the backlog with the help of Editors. Here, the current status is as follows:

Manuscripts pending (as on 07.09. 2021)	100
Manuscripts received after 07.09.2021 to 30.11.2021	13
Total	113

Manuscripts accepted	06*
Manuscripts under revision	09
Manuscripts Rejected	33
Manuscripts withdrawn	06
Manuscripts with reviewers	45
Manuscripts to be processed	14
Total	113

(includes two manuscripts which were also submitted through email)

Publication status:

JIMS Vol. 89 (1-2) 2021 was published in January 2021 and sent to the subscribers.
JIMS 89 (3-4) 2021 was published in July 2021 and was sent to subscribers.
JIMS 90 (1-2) 2022 is under preparation and will be published in January 2022.
It is proposed to completely move to the Informatics platform form April 2022. From January 2022, all authors submitting manuscripts through email, will be informed to upload their file on the Informatics JIMS platform. The Editorial Board will be made active, so that early decisions can be made.

I wish to put on record sincere thanks to members of Editorial Board and in particular to Prof. S. K. Nimbhorkar, who managed all the manuscripts received through email very efficiently and made suggestions whenever I approached.

Item No. 6: To receive the report of the Editor of the Mathematics Student for 2021.

Report of the Editor of the Mathematics Student for 2021.

The Volume 90 (Nos. 1-2) January–June, 2021 of The Mathematics Student was published in April 2021. The soft copy of the issue was sent to all the life members of the IMS by e-mail.
The Volume 90 (Nos. 3-4) July-December, 2021 of The Mathematics has also been published in November 2021. The soft copy of this issue will be sent soon to the life members of the IMS.
The soft copies of both the issues have been uploaded on the website of the Indian Mathematical Society.

The Volume 90 (1-2) 2021 has been printed out by Parshuram Process, Pune and the hard copies have been preserved in the Library of the Department of Mathematics, Savitribai Phule Pune University, Pune. The Volume 90 (3-4) 2021 is in press and will be printed out soon.

Status of the Manuscripts

Total Number of Manuscripts received for Publication : 134 till November 30, 2021

(a) Number of Manuscripts accepted for Publication :	21
(b) Number of Manuscripts not accepted for Publication :	45
(c) Number of Manuscripts with the referees :	19
(d) Number of Manuscripts withdrawn by the authors :	07
(e) Number of Manuscripts to be processed :	42
Total:	134

Agreement With EBSCO

EBSCO Information Services is a division of EBSCO Industries, Inc. , one of the largest companies in the United States. EBSCO is the leading provider of research databases, e-journals, magazine subscriptions, e-books and discovery service to libraries of all kinds.

We have signed an agreement in July 2021 with EBSCO in order to give a wide publicity to The Mathematics Student. We upload the published volumes of The Math. Student on the website (https://mft.ebscohost.com) of the EBSCO. The two volumes of The Math. Student Published in 2021 have been uploaded on this website.

Digitization of the Back Volumes

We seriously think to digitize the back volumes of the Mathematics Student with the help of Informatics Publishing Limited, Bangalore. The back volumes of the journal can be made available from the IMS library, Chennai and the Library of the Savitribai Phule Pune University, Pune. We would take some concrete steps in near future to materialize the plan.

Acknowledgements

We take this opportunity to put on record our sincere thanks and profuse gratefulness to the Members of the Editorial Board and the learned referees for their continuous support and assistance in timely publication of The Mathematics Student.
In particular, we would like to thank Prof. George E. Andrews (Pennsylvania State University, USA), Prof. M. Ram Murty (Queens University, Canada), Prof. B. Sury (ISI, Bangalore), Dr. Siddhi Pathak (CMI, Chenai) and Dr. Anup Dixit (IMSc., Chennai) for helping us to propose Problems for the Problem section, verifying solutions received from researchers and providing solutions to unsolved problems.
We are grateful to Prof. J. R. Patadia for extending his help to upload the soft copies of the volumes on the website of The Indian Mathematical Society. We thank the General Secretary Prof. Satya Deo and the Treasurer Prof. S. K. Nimbhorkar for reading the camera ready copies of the issues carefully.
We are also thankful to the Administrative Secretary Prof. B. N. Waphare for getting the issues printed from Parshuram Process, Pune and preserving the hard copies of the journal in the library of the Mathematics Department of S. P. Pune University, Pune.

Item 7. To consider the venue of the 88th Annual session of the Society to be held in December 2022.

The Council accepted the firm invitation from the Vice Chancellor, Birla Institute of Technology (BIT), Mesra, Ranchi for organizing the 88th Annual Conference of the Indian Mathematical Society. The 88th Annual Conference of the IMS will be held at BIT, Mesra, Ranchi during November/December 2022.

Item 8. Announcement of the results of the following elections.

(i) President for 2022–2023;
(ii) Three members of the Council for a period of three years w. e. f. April 01, 2022.
(iii) Other Office bearers of the IMS for a period of three years w. e. f. April1, 2022.

Annoucements:

(i) President :
Prof. S. D. Adhikari, Ramkrishna Mission Vivekanand Educational and Research Insitute, Belur, W. B. (formerly Professor at HRI) is declared elected unopposed to the office of the President of the IMS for one year with effect from April 01, 2022.

(ii) Election of three members to the Council of the Society:

The following mathematicians are declared elected unopposed to the Council of the Society for three years with effect from April 1, 2022.

(a) Prof. B. Rushi Kumar (VIT, Vellore),
(b) Prof. Pratulananda Das (Jadavpur University, WB)
(c) Prof. Ajay Kumar Shukla (SVNIT, Surat).

(iii). The following mathematicians are declared elected as office bearers of the IMS for a period of three years w. e. f. April 1, 2022.

General Secretary: Prof. Satya Deo, HRI, Allahabad,
Academic Secretary: Prof. G. P. Raja Sekhar, IIT, Kharagpur,

Treasurer: Prof. S. K.Nimbhorakar, Aurangabad,
Editor-in-Chief, JIMS: Prof. Peeyush Chandra, IIT, Kanpur,
Editor-in-Chief, Math. Student: Prof. M. M. Shikare, Pune,

Prof. B. N. Waphare, S. P. Pune University, Pune is appointed as the Administrative Secretary of the IMS by the Council of the IMS for a period of three years w. e. f. April 1, 2022 (Since the administrative secretary has to be from Pune, Prof. Waphare is appointed by the Council this time. In future, this position will also be nominated like others).

Item 9. Any other item with the permission of the chair.

The efforts put in by the Local Organizing Secretary Prof. V. M. Arole and the Coordinator Prof. Gajanan Lomte, their colleagues and the MGM University administration for successful organization of the online conference were appreciated by the office bearers and the members of the IMS.

It was informed to the house that the Indian Mathematical Society has got approval for its applications from the Income tax Department for exemption under section 12 (i.e. the income of the IMS is exempted from Income Tax) and under section 80*G* (i.e. the donor will get exemption as per the Income Tax rules under section 80 G w. e. f. 1/10/2021). The work for getting registration under FCRA (Foreign Currency Regulation Act) is under process.

Condolence Resolution: Prof. Satya Deo, GS, IMS recalled that Prof. I. B. S. Passi, who was a past President of the IMS, passed away this year. This is a great loss to the Society. The members of the IMS present for the meeting offered a condolence to Late Prof. Passi by standing and observing silence for two minutes.

The Concluding remarks were given by the President of IMS. Then the Meeting ended with a vote of thanks to the Chair, members of the IMS, and the local organizers of the conference.

Prof. Satya Deo
General Secretary
The Indian Mathematical Society

IMS Sponsored Lectures

To popularize mathematics and to create awareness regarding the Society and its activities in the Country, the Society has a Scheme of **Sponsored Lectures**. It provides a token support of Rs. 1000/- to a number of Departments / Institutions for organizing popular and semi technical lectures.

Prof. Ravi Kulkarni has donated Rs. 1,25,000/- to organize **Meenakshisundaram–Patoudi lectures**.

Members arranging such lectures are required to send the report of the arranged lectures to The Treasurer, IMS, with a copy to The Editor, `The Mathematics Student`.
Society intends to enhance this activity of organizing such lectures at more and more centers. Members desirous to organize such lectures at their centers may write to the General Secretary Prof. Satya Deo through their respective Head of the Department.

Call for Applications for Various Awards to be given by the IMS for the Year 2022

Applications are invited from researchers in Mathematics for the following Awards to be given by the Indian Mathematical Society for the year 2022. The last date for receiving the applications is June 30, 2022. The applications should be sent to Prof. Satya Deo, the General Secretary of the IMS, along with the copy of the published paper and the proof of the age on his e-mail address : sdeo94@gmail.com. The decision of IMS in this regard will be final and cannot be challenged in any court.

(1) **A. K. Agarwal Award**
Terms and Conditions for the Award: (a) The paper should be in the area of Number theory, Combinatorics, Discrete mathematics, Analysis and Algebra.
(b) The paper should be under the authorship of at most two authors and at leas one of them should be below the age of 45 years as on 31^{st} December 2022.
(c) The paper should have been published either online or in print during the year 2021 in an internationally reputed journal..
(d) The author(s) should be Indian citizen and must have carried out the said research work in India.
(e) The author(s) should not submit more than one publication for this award.
(f) The prize carries a certificate and a cash amount Rs. 10,000/-

(2) **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 etc.
(b) The paper should be a single-author paper. The paper sent for this award should not have been submitted or rejected for any other award.
(c) The upper age limit is 45 years as on December 31, 2022.
(d) The author should not submit more than one publication for this award.
(e) The papers must have been published either online or in print during the year 2021 in an Internationally reputed journal.

(f) The author should be associated with any 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).
(g) The award carries a certificate and cash amount Rs. 25,000/-

(3) **Satish C. 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 31st December, 2022.
(c) The author(s) need not be Indian citizen(s) and must have a Ph D degree in any subject.
(d) The author(s) can submit only one publication for this award and the paper should not have been submitted for any award anywhere.
(e) The award consists of a citation and a cash prize of Rs. 10,000/-.
Nominations for this award will also be considered.

(4) **Subhash Bhatt Award**

Terms and Conditions for the Award:
(a) The paper should be in the area of Functional Analysis/ Harmonic Analysis/ Operator Theory and related areas.
(b) The paper should have been published either online or in print in an internationally reputed journal during the year 2021.
(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, 2022.
(d) The author(s) should be Indian citizen and must have carried out the said research work in India.
(e) The author(s) can submit only one publication for this award and the paper should not have been submitted for any other award anywhere.
(f)The award carries a citation and a cash prize of Rs 25,000.

(5) **P. K. Jain Award**

Terms and Conditions for the Award:
(a) The paper should be in the area of Complex Analysis/ Functional Analysis/ Harmonic Analysis/ Operator Theory and related areas.
(b) The paper should have been published either online or in print in an internationally reputed journal during the year 2021.
(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, 2022.
(d) The author(s) should be Indian citizen and must have carried out the said research work in India.
(e) The author(s) can submit only one publication for this award and the paper should not have been submitted for any other award anywhere.

(f)The award carries a citation and a cash prize of Rs 25,000.

Call for Research Papers for Various Prizes
to be given by the IMS during the Annual Conference of the IMS in 2022

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 paper presented in different categories. This Special Session is organized as a part of the Academic Programme with no other parallel session. Each of the eight prizes listed below carries a Certificate and a Cash Amount of Rs. 1000/-

Interested researchers should submit their research paper (in pdf format), Abstract (not exceeding 250 words, in tex and pdf format), proof of age and CV along with the covering letter to The Academic Secretary, IMS via e-mail on acadsecrims@gmail.com. The last date of receiving applications is **August 15, 2022**.

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 upper age limit of a candidate is 40 years as on December 31, 2022.
3. (i) The paper to be presented for the competition has to be under single authorship.
(ii) The author should give a declaration that the work is unpublished and has not been submitted for competition anywhere else. In case of research scholars, the supervisor
should verify that the work has been carried out independently.
(iii) The work must have been carried out in India.

Periodicals published by the Society

The Society publishes two periodicals: `The Journal of the Indian Mathematical Society` (JIMS; the Journal; Print ISSN 0019-5839, Online ISSN 2455-6475) and **The Mathematics Student** (Math Student; the

Mathematics Student; Print ISSN 0025-5742), both of which are quarterly. The details can be found on the website:
www.indianmathsociety.org.in

Subscriptions

Annual subscription for the Journal / the Mathematics Student :
For each periodical

- Rs. 2500/- for Libraries of Educational Institutions in India - provided the subscription is direct.
- Rs. 3000/- for Libraries of Educational Institutions in India, if the subscription is through an agent who gives complete name and address of the subscriber. The supply will be made directly to the subscribing library.
- Rs. 12000/- for others or to the agents who do not supply the name and address of the end user.
- $200/- for personal use or for Libraries outside India.

The agents are entitled to 15 % discount on their orders.

From the 2012 issue of The Mathematics Student onwards, the life Members are given online access to `The Mathematics Student` / are sent the soft copy of `The Mathematics Student`, instead of supplying the hard copy, for their personal use (not for circulation) at their E-mail address registered with the Society.

Those Members who have not registered their e-mail address are requested to register it online on msgoesgreen@gmail.com

It may please be noted that the contents of `The Mathematics Student` will continue to be available on the Society's website www.indianmathsociety.org 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) for reference during office hours.

IMS MEMBERSHIP DETAILS

1. Membership terms:

1. Applicant should be a graduate and should have interest in the Objectives of the IMS.
2. All such persons as the Council of the IMS may admit from time to time to membership shall be the members of the Society.
3. Applications for membership should be made on the form available on the IMS website.
4. The Council of the IMS may refuse to admit to membership any person without assigning any reason for the refusal.
5. Member of good standing: A member is considered to be of good standing in a particular year if he/she has paid his/her Annual (or life) Membership fees by July 31 of that year.

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

1. 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 from time to time by the IMS.
2. Annual members; Any eligible person can be enrolled as an annual member by applying on the prescribed form and by paying the annual membership fees as prescribed from time to time by the IMS. This membership will come to end on March 31, irrespective of the date of paying the membership fees.
3. Sessional Members; Any person desirous of participating in the Annual Conference of the IMS will be enrolled as a sessional member by paying the membership fees as prescribed from time to time by the IMS. This membership is only for participating in one conference after paying the fees.

3. Rights and Obligations of the Members:
[.2cm] 1. All Annual and Life members shall be entitled to receive communications about the activities of the Society, to participate in its conferences.
2. A member with good standing shall attend the General Body Meeting and will be eligible to vote if necessary.
3. Only life members will be eligible to be elected as a member of the IMS Council At present anybody has free access to the Mathematics Student on IMS website.

4. Membership Fees:

With effect from January 1, 2021, the membership fees is follows.
i) Life Membership fee - For Indian citizens Rs. 3000/- For others US $150/- For members of the Societies having Reciprocity arrangement with the IMS,US $ 100/- For members form SAARC countries - US $ 50/-

ii) Annual Membership - Rs. 500/- (US $25/- for foreigners).

iii) Sessional Membership- Rs. 300/- (US $15/- for foreigners).

The membership fees can be paid either online or through DD/ payable at par Cheque. We prefer to have Online transfer of membership fee for which bank details are given 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: PUNB 0375900
5) Branch Name and Address : Adalat Road Branch, Aurangabad - 431001.

For Payment through DD or Cheque payable at par - it should be in the name of Indian Mathematical Society. In case, the demand draft is purchased from the State Bank of India, please use the branch code for Aurangabad, Maharashtra, as 1716.

5. Application for Membership: Application for membership should be made on the Membership form available on the IMS website.
The completed membership form can be sent to

Prof. S. K Nimbhorkar, Treasurer, IMS,
c/o Ankur Hospital,
Tilaknagar,
Aurangabad 431001

Or, one can send scanned copy of completed form to Prof S. K. Nimbhorkar by email at treasurerindianmathsociety@gmail.com (or sknimbhorkar@gmail.com)

Business Correspondence and Payments:

All business correspondence be addressed to Prof. S. K. Nimbhorkar, Treasurer, IMS; c/o Dr. Mrs. Prachi Kulkarni, Ankur Hospital, Tilaknagar, Aurangabad 431001. All payments should be sent to Prof. S. K. Nimbhorkar, Treasurer, IMS by DD / payable at par cheque drawn in favor of **"The Indian Mathematical Society"** payable at **Aurangabad** (Maharashtra), India at the address mentioned as above.

Members in good standing:
A member is considered to be of good standing in a particular year if he/she has paid his/her Membership dues by **July 31**st of that year.

IMS Library:
The information pertaining to IMS library is available on the website
www.indianmathsociety.org.in of the society.

Guidelines for acceptance of Donations to the Society:

There will not be any further institution of Memorial Award Lectures. (This point was discussed in the earlier meetings of the Council and such was the consensus).

The donation amount will not be less than Rupees Five Lacs. (There could be an upward revision of this amount from time to time).

The donor may be an individual or a trust or a group of individuals.

The Indian Mathematical Society will solely and independently own the amount donated to it.

A prospective donor should approach the General Secretary of the Indian Mathematical Society with a Offer. Keeping with the spirit of this Policy Guidelines and if so felt necessary, referring to the Council whether the proposal be negotiated or not, in his wisdom, the General Secretary will negotiate the terms and conditions for each donation proposal and will put it before the Council for its consideration and approval. The Council will deliberate on the proposal, and after modifications, if any, may accept the proposal through a special resolution with specific details mentioning the terms and conditions. This will be published in the IMS News Letter after the Donor agrees to the resolution of the Council.

Ordinarily during every Annual Conference of the Society there are several Invited Lectures and Symposia running in parallel sessions. One of these academic programmes may be permanently marked / identified as "so and so sponsored programme in the (fond) memory of " or "so and so sponsored programme in the honor of" as per the wish of each donor by the Council. This programme may be arranged in a parallel session during the Conference.

Not withstanding the above,

(A) An offer of a donation with a stipulated purpose (not as part of the corpus), may be accepted by the

Council on its merit.

(B) An offer of a donation of any amount in general, without any stipulated conditions, may be accepted by the Council on its merit as a part of the General Purpose Corpus.

The Council reserves its right whether or not a particular donation be accepted.

Appeal for Support to The Indian Mathematical Society Building Complex - Ganit Bhawan, Pune

The Indian Mathematical Society (IMS) is the oldest Scientific Society of our country which was founded in the year 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. A copy of the Master Plan designed by an eminent architect of Pune 'Design India' is attached herewith for your kind perusal. 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, therefore, 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, Aurangabad - 431001
5. IFSC Code: PUNB 0375900

Alternately donations can also be sent either in the form of Cheque/Draft (in the name of Indian Mathematical Society, payable at Aurangabad, Maharashtra) to: Prof. S. K. Nimbhorkar, Treasurer, IMS c/o Dr. Mrs. Prachi Kulkarni, Ankur Hospital, Tilaknagar, Aurangabad 431001
I am sure your generous help will strengthen the Society to serve the cause of mathematics more efficiently.

Satya Deo,
General Secretary, IMS

Important Change:
Beginning from the 84^{th} annual conference of the IMS the abstract of the papers accepted for presentation and invited talks etc. are being published in our newsletter and this policy will continue in future also. Such abstract will no longer be published in the Mathematics Student.

Abstracts of the Plenary talks, IMS Memorial Award Lectures, Invited Lectures, Talks in Symposia delivered at the 87^{th} IMS Conference, MGM University, Aurangabad, Maharashtra, India

Plenary talks

Multivariate Lidstone interpolation

Michel Waldschmidt
Sorbonne UniversitÃl', Institut MathÃl'matique de Jussieu. ThÃl'orie des Nombres Case courrier 2474, Place Jussieu tour 15-25 bureau 419, 75252 PARIS Cedex 05 FRANCE
Email: michel.waldschmidt@imj-prg.fr

Abstract: According to the classical theory of Lidstone interpolation, an entire function of a single complex variable having exponential type $< \pi$ is determined by it derivatives of even order at 0 and 1. This theory can be generalized to several variables. In this lecture, we will give an introduction to this generalization by explaining how it works for two variables.

Deep Learning for PDEs

Siddhartha Mishra
Director of Computational Science Zurich, and core Faculty at the ETH AI Center, Zurich
Email: siddhartha.mishra@sam.math.ethz.ch

Abstract: Machine Learning, particularly Deep Learning, algorithms are being increasingly used to approximate solutions of partial differential equations (PDEs). We survey recent results on different aspects of deep learning in the context of PDEs namely, 1. Supervised learning for high-dimensional parametrized PDEs 2. Operator learning for approximating infinite-dimensional operators which arise in PDEs and 3.Physics informed Neural Networks for approximating both forward and inverse problems for PDEs. We will highlight open questions in the analysis of deep learning algorithms for PDEs.

Memorial Award Lectures

35TH P. L. BHATNAGAR MEMORIAL AWARD LECTURE

Effect of slow-fast time scale on spatio-temporal pattern formation

Malay Banerjee
Department of Mathematics and Statistics, I. I. T. Kanpur
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Abstract: Analytical and numerical investigation of spatio-temporal pattern ormation is an active area of research under mathematical ecology. Most of the studies carried out so far overlooked the difference in the time scale for the growth rates of interacting species. Mathematical models incorporated with multiple time scales belongs to the class of singularly perturbed differential equations. In ecology, researchers have paid significant attention to study the slow-fast dynamics of interacting species, which are assumed to be distributed homogeneously over their habitat. However, the effects of the slowâĂŞfast time scales in the spatial-temporal setup remain poorly investigated. The main objective of this talk is to enlighten how the slow-fast time scale affects spatio-temporal pattern formation. The presence of slow-fast time scale can alter the speed of propagation of travelling wave, change the nature of spatio-temporal chaos, and patch sizes correspond to stationary patterns.

32ND HANSRAJ GUPTA MEMORIAL AWARD LECTURE

Gauss Sums

C. S. Rajan
School of Mathematics, TIFR Mumbai
Email: rajan@math.tifr.res.in

Abstract: Let p be a prime and $\mathbb{F}_p$ be the finite field with p elements. Given a (multiplicative) character χ of $\mathbb{F}_p^*$ and an (additive) character ψ of $\mathbb{F}_p$, the Gauss sum $G(\chi, \psi)$ is defined as,

$$G(\chi, \psi) = \sum_{a \in \mathbb{F}_q^*} \chi(a)\psi(a).$$

Gauss sums have remarkable properties: for example, if χ and ψ are non-trivial, then $|G(\chi, \psi)| = \sqrt{p}$. They appear in various contexts: in proof of quadratic reciprocity, counting number of solutions of certain polynomial equations over finite fields, Stickelberger's theorem, etc. They can also be considered in analogy with Γ and L-functions and are closely connected to L-functions. Generalizations of Gauss sums to the context of representations of finite groups of Lie type can be considered and their properties studied.
We will discuss some of these aspects about Gauss sums.

32ND SRINIVASA RAMANUJAN MEMORIAL AWARD LECTURE

Monodromy of Hypergeometric Functions

T. N. Venkataramana
School of Mathematics, TIFR, Mumbai
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Abstract: The Gauss hypergeometric functions are functions in one variable which satisfy a well known second order differential equation. There are two types of hypergeometric functions which generalise the Gauss hypergeometric functions,. One of them are the Lauricella functions which are higher variable analogues. These were intensively studied by Deligne and Moscow. We will discuss some questions related to the monodromy of these Lauricella functions.

32ND V. RAMASWAMI AIYER MEMORIAL AWARD LECTURE

Ramanujan graphs

Vijay Kodiyalam
Institute of Mathematical Sciences, Chennai
Email: vijay@imsc.res.in

Abstract: The talk is a gentle introduction to Ramanujan graphs and to a sketch of a proof of existence of infinite families of these.

15TH GANESH PRASAD MEMORIAL AWARD LECTURE

Birkhoff James Orthogonality: Its Role in the Geometry of Banach Space

Kallol Paul
Department of Mathematics, Jadavpur University Kolkata, 700032
Email: kalloldada@gmail.com

Abstract: Birkhoff-James orthogonality generalizes the concept of usual orthogonality in an Euclidean space, that we are familiar with from school days. In this article we discuss the notion of Birkhoff-James orthogonality in a Banach space and discuss its role in the geometry of Banach space, with a special emphasis to strict convexity, smoothness, reflexivity. We also explore the role of Birkhoff-James orthogonality in the study of smoothness in the space of bounded linear operators.

ABSTRACTS OF LECTURES DELIVERED BY WINNERS OF VARIOUS AWARDS

P. K. JAIN AWARD

Composition operators on Hardy spaces of the homogenous rooted trees

Muthukumar P.
Indian Statistical Institute, Statistics and Mathematics Unit, 8th Mile, Mysore Road, Bangalore, 560059, India
Email: pmuthumaths@gmail.com

Abstract: In this talk, we discuss about composition operators on discrete analogue of Hardy space $\mathbb{T}_p$ defined on a rooted tree. In particular, we discuss boundedness, compactness, isometry and invertibility of the composition operator C_ϕ on $\mathbb{T}_p$ spaces. We will also consider the composition operators on a separable subspace $\mathbb{T}_{p,0}$ of $\mathbb{T}_p$.

SUBHASH BHATT AWARD

Characterization of $k-$smooth operators between Banach spaces

Arpita Mal
Jadavpur University, Kolkata, India
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Abstract: We study $k-$smoothness of bounded linear operators defined between arbitrary Banach spaces. As an application, we characterize $k-$smooth operators defined from ℓ_1^n to an arbitrary Banach space. We also completely characterize $k-$smooth operators defined between arbitrary two-dimensional Banach spaces.

A. M. MATHAI AWARD

Well Posedness, Large Deviations and Ergodicity of the Stochastic 2D Oldroyd Model of ÂăOrder One

Manil T. Mohan
Department of Mathematics
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Abstract: In this talk, we discuss the unique global solvability of the stochastic two dimensional viscoelastic fluid flow equations, arising from the Oldroyd model for the non-Newtonian fluid flows perturbed by a multiplicative Gaussian noise. A local monotonicity property of the linear and nonlinear operators and a stochastic generalization of the Minty-Browder technique are exploited in the proofs. The Laplace principle for the strong solution of the stochastic system is established in a suitable Polish space using a weak convergence approach. The Wentzell-Freidlin large deviation principle is proved using the well known results of Varadhan and Bryc. The large deviations for a short time are also considered.ÂăWe also establish the existence of a unique ergodic and strongly mixing invariant measure for the stochastic system with additive Gaussian noise, using the exponential stability of strong solutions.

A. K. AGARWAL AWARD

Fundamental group schemes of Hilbert scheme of n points on a smooth projective surface

Arjun Paul
Department of Mathematics, Jadavpur University
Email: arjunpal.math@jadavpuruniversity.in

Abstract: The Hilbert scheme of n points on a smooth projective surface X, denoted as $\mathcal{H}ilb^n_X$, is an important moduli space to study. In this talk, we discuss on our recent joint work with Ronnie Sebastian on finding the S-fundamental group-scheme and the Nori's fundamental group-scheme of $\mathcal{H}ilb^n_X$.

A. NARASINGA RAO PRIZE

On cyclic and negacyclic codes of length $8p^s$ over $\mathbb{F}_{p^m} + u\mathbb{F}_{p^m}$

Saroj Rani
S. A. Jain College
Ambala City 134003, India
Email: iitsaroj@gmail.com

Abstract: Cyclic and negacyclic codes form important classes of linear codes containing many optimal codes, and have good error-correcting properties. Due to these properties, cyclic and negacyclic codes can be effectively encoded and decoded using linear shift registers, which justify their preferred role in engineering. In this paper, we establish the algebraic structure of all cyclic and negacyclic codes of length $8p^s$ over the chain ring $\mathbb{F}_{p^m} + u\mathbb{F}_{p^m}$ in terms of their generator polynomials, where $u^2 = 0$ and s is a positive integer and p is an odd prime. We also find out the number of codewords in each of these cyclic codes. Besides this, we determine duals of cyclic codes and list self-dual cyclic and negacyclic codes of length $8p^s$ over $\mathbb{F}_{p^m} + u\mathbb{F}_{p^m}$. Also, we determine μ and ν-constacyclic codes of length $8p^s$ over $\mathbb{F}_{p^m} + u\mathbb{F}_{p^m}$.

ABSTRACTS OF LECTURES DELIVERED IN VARIOUS SYMPOSIA

Symposia on
Fractional Differential Equations: Theory and Numerics

Convener: Prof. Mani MehraIIT Delhi

New challenges for the fractional calculus and its applications

Dumitru Baleanu
Department of Mathematics, Cankaya University, 06530 Balgat, Ankara, Turkey,
Institute of Space Sciences, Magurele-Bucharest, Romania
Email: dumitru@cankaya.edu.tr

Abstract: Fractional calculus is an important emerging field of mathematics with strong applications in solving several complex problems from various fields of science and engineering. In my talk I will present some new challenges for the fractional calculus and some of its applications.

Fractional Inpainting: Theory, Computation and Application

B.V.Rathish Kumar and Abdul Halim
IIT Kanpur
Email: bvrk@iitk.ac.in

Abstract: In this talk, we will begin with few traditional PDE based inpainting models and then move on to their fractional counterparts to understand the importance of the later over the former approach. In the process we will also attempt to get glimpses of the associated theoretical and computational components with few examples.

Reliable tracking control design for fractional-order control systems with disturbances

R. Sakthivel
Department of Applied Mathematics, Bharathiar University Coimbatore âĂŞ 641 046, India
Email: krsakthivel@buc.edu.in

Abstract: In this talk, an equivalent-input-disturbance estimator based fault-tolerant tracking control design problem for fractional-order nonlinear uncertain systems in the presence of actuator faults, uncertainties and external disturbances will be discussed. Precisely, the proposed disturbance estimator based tracking control scheme guarantees the robust tracking performance between the system and reference states. With the aid of Lyapunov technique, a set of sufficient conditions is derived in the form of linear matrix inequalities to obtain the required result. Finally, a numerical example with simulations is provided to show the effectiveness and applicability of the proposed control design. The result reveals that the proposed tracking control law provides strong robustness against external disturbances and uncertainties.

Fractional hypergeometric functions: a survey and future perspectives

Praveen Agarwal
Department of Mathematics, Anand International College of Engineering, Jaipur-303012, India.
Email: praveen.agarwal@anandice.ac.in

Abstract: The fractional calculus of special functions has significant importance and applications in various fields of science and engineering. Here, we aim to find the fractional integral and differential formulas of the extended hypergeometric type functions by using the Marchichev-Saigo-Maeda operators. Also, we established their composition formulas by using the Beta transform, Laplace transform and Whittaker transform, respectively.

Compact scheme for space fractional advectionâĂŞdiffusion reaction equations with variable coefficients

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Abstract: In this work, a new fourth order compact approximation is derived for Riemann Liouville space fractional derivatives. Modified wave numbers are obtained for various approximations of fractional derivatives. Considering these modified wave numbers, Fourier analysis of differencing errors is presented to quantify the resolution characteristics of various approximations. A novel fourth order compact scheme is developed for space fractional advectionâĂŞdiffusion reaction equations with variable coefficients in one and two dimensions. In the proposed compact scheme, the second derivative approximation of unknowns is approximated using the value of these unknowns and their first derivative approximations. This splitting of second derivative approximations allows us to obtain a similar system of linear equations as in Zhao and Tian (2017) which presents only second order accurate finite difference method for advectionâĂŞdiffusion reaction equations in one-dimension. The stability of the proposed compact scheme is demonstrated numerically. Furthermore, the proposed compact scheme is employed to space fractional BlackâĂŞScholes equation for pricing European options as an application of fractional derivatives in mathematical finance. Numerical illustrations are presented to validate the theoretical claims.

Symposia on
Geometry and Topology

Convener: Prof. Krishnendu GongopadhyayIISER Mohali

Lower dimensional cohomologies of homogeneous spaces of Lie groups

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Abstract: In our earlier joint work with Biswas and Maity we found computable explicit descriptions of the second and first cohomology groups of a general homogeneous space of a Lie group extending an earlier result of Biswas and Chatterjee. They turned out to be very useful in our computations related to the cohomology of nilpotent orbits. In this talk we describe, along the same line, the third and fourth cohomologies of a general homogeneous space. We will sketch earlier works in the subject, give our motivation, briefly talk about the proofs and mention some applications. This is a joint work with Indranil Biswas (TIFR Mumbai) and Chandan Maity (IISER Mohali).

Monodromy of Schwarzian equations on a punctured sphere

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Abstract: A Schwarzian equation on a punctured Riemann sphere $\mathbb{C}P^1 \setminus \{a_1, a_2, \ldots, a_k\}$ is a second order linear differential equation, involving a coefficient function that is holomorphic and has poles of order at most two at the punctures. The monodromy of its solutions determines a representation from $\pi_1(\mathbb{C}P^1 \setminus \{a_1, a_2, \ldots, a_k\})$ to $\mathrm{PSL}_2(\mathbb{C})$. It has been a long-standing problem to determine the representations that thus arise, when one is allowed the vary the positions of the punctures. This is the analogue of the Riemann-Hilbert problem in the classical theory of linear differential equations on the complex plane. I shall talk about the solution of the problem, in recent joint work with Gianluca Faraco, and its connection with the study of complex projective structures on surfaces. Our methods in fact work for any punctured surface, not just the sphere.

On some results about quasiconvex subgroups of Gromov hyperbolic groups

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Abstract: Let G be a Gromov hyperbolic group and H<G. Let X be the Cayley graph of G with respect to a finite generating set. Then H is called quasiconvex in G if there is D>0 such that for all g, h in H any geodesic of X joining g, h is contained in the D-neighborhood of H in X. In this talk we shall start with some basic results about quasiconvex subgroups of Gromov hyperbolic groups. Then we shallÂădiscuss some recent results in this context. The talkÂăis based on two joint papers written separately with Mahan Mj and with Swathi Krishna respectively

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Lie algebras associated to closed curves on a surface

Arpan Kabiraj
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Abstract: We will discuss various Lie algebras associated to closed curves on orientable surfaces (possibly with boundary and punctures) introduced by Goldman and Wolpert in 80âĂŹs. We will also explain their relation with the moduli space of representations. If time permits, we will discuss the relation between these Lie algebras and skein algebras of three-manifolds

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Categorical Picard-Lefschetz theory

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Abstract: I will introduce a categorical formalism for studying the symplectic geometry of Lefschetz fibrations, and discuss applications of this formalism. This talk is based on joint work with T. Spaide and L. Katzarkov.

The structure of (unstable) homotopy groups

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Abstract: I will describe how the homotopy groups of spheres may be generated using suspensions, Whitehead products and higher order operations starting from the identity map and the inclusion of wedge summands. This is joint work with David Blanc and Debasis Sen.

Symposia on
Optimization Theory and Applications

Convener: Prof. C. S. Lalitha University of Delhi, Delhi

Optimization Theory and Methods for Machine Learning

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Abstract: With the advancement in the field of Machine Learning, the concepts related to optimization have become more relevant than even before. The theory and algorithms used in optimization play a significant role in the development of machine learning algorithms to handle huge volumes of data, and make meaningful inferences. Here the binary data classification problem is discussed in the SVM framework to understand this perspective.

On Semidefinite Multiobjective Mathematical Programming Problems with Vanishing Constraints

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Abstract: In this talk we discuss Fritz John stationary conditions for nonsmooth nonlinear semidefinite multiobjective programs with vanishing constraints in terms of convexificator and introduce generalized Cottle type and generalized Guignard type constraints qualification to achieve strong S-stationary conditions from Fritz John stationary conditions. Further, we establish strong S-stationary necessary and sufficient conditions, independently from Fritz John conditions. Some examples are provided to validate our established results.

Integer Quadratic Fractional Programming Problems with Bounded Variables

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Abstract: This talk deals with development of an algorithm for solving quadratic fractional integer programming problems with bounded variables (QFIPBV). The method provides complete ranking and scanning of the integer feasible solutions of QFIPBV by establishing the existence of a linear or a linear fractional function, which acts as a lower bound on the values of the objective function of QFIPBV over the entire feasible set. The method involves ranking and scanning of the set of optimal integer feasible solutions of the linear or linear fractional program so constructed which requires introduction of various cuts at intermediate steps, for which, a new technique has been developed in the current paper. Numerical examples are included in support of the theory.

From Bilevel to Simple Bilevel : The Story of Bilevel Optimizaion

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Abstract: In this talk we outline the development of the theory of bilevel programming from its leader-follower format of Stackelberg games, with its optimistic and pessimistic formulation to the study of minimizing a convex function over the solution set of a convex programming problem, which is called the simple bilevel programming problem. We also mention new research directions in which this important area of optimization is heading towards.

A Modified Penalized Approach for Multi-dimensional Control Optimization Problems

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Abstract: The objective of the talk is to provide an interesting approach to solve the multi-dimensional control optimization problem involving first-order PDEs constraints (MCOP), especially with complex objective functions. Firstly, we apply the modified objective function approach to simplify the aforesaid problem (MCOP) and show that the solution sets of the original problem and its associated modified problem (MCOP) coincide under convexity assumptions. Further, we apply the absolute value exact penalty function method to transform the modified problem (MCOP) into an equivalent penalized problem (MCOP)'. We also prove that the relationship between a saddle-point of the modified problem (MCOP) and a minimizer of its associated penalized problem (MCOP)'. As a consequence, we also construct some examples to authenticate the theoretical results established in this paper.

Constant Positive Linear Independence Constraint Qualification in terms of Convexificators

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Abstract: Constraint qualifications and their inter-relations have been systematically studied quite extensively for smooth problems in literature. For nonsmooth problems constraint qualifications have also been studied in literature using various subdifferentials such as Clarke and Michel Penot subdifferentials. Convexificators and semi-regular convexificators which are closed sets, but is not necessarily bounded or convex, extend and unify most of these subdifferentials. There are many gaps in the study of constraint qualifications in terms of convexificators. In this direction we introduce the notions of constant positive linear dependence condition for nonsmooth problems in terms of upper semi-regular convexificators and study the relations with constant rank constraint qualification, quasinormality and local error bound property.

Symposia on Algebra

Convener: Prof. Dinesh Kumar KhuranaPanjab University, Chandigarh

An algorithmÂăfor computation of mixed multiplicities of ideals,Âămixed volumes of integral polytopes, and sectional Milnor numbers ofÂă isolated singularitiesÂă of a hypersurface

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Abstract: Mixed volumes of integral polytopes and sectional Milnor numbers of an isolated hypersurface singularity can be computed as mixed multiplicities of certain ideals. The mixed multiplicities of ideals were introducedÂăand studied by P. B. Bhattacharya, David Rees, and B. Teissier. N. V. Trung and J. K. Verma showed that mixed volumes of polytopes can also be calculated using certain mixed multiplicities. We describe a recent algorithm implemented in Macaulay2 which computes these numbers using the definingÂăequations of multi-Rees algebras. Our algorithm improves existingÂăalgorithms in Macaulay2 for computation of the defining equations of the multi-Rees algebras and mixed volumes of polytopes.
(joint work with Kriti Goel, Vivek Mukundan, and Sudeshna Roy)

Graded Betti Numbers

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Abstract: After a quick introduction to the concept of a graded resolution and graded Betti numbers, we will discuss the Boij-Soderberg conjectures over polynomial rings, and their resolution by Eisenbud-Schreyer. We will then see the difficulty in extending these results to general standard graded rings, and, if time permits, some cases where these difficulties can be overcome.

Cancellation of projective modules

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Abstract: Let A be an affine algebra over an algebraically closed field. We will discuss the known results on the cancellation of finitely generated projective A-modules.

Polynomials over Nil Rings

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Abstract: The study of polynomial rings over nil rings is connected with some major open problems in Ring Theory. We will discuss some recent progress in this area.

Lifting periodic elements

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Abstract: An element x is periodic if $x^m = x^n$ for some natural numbers $m > n$.Âă Idempotents are the classical example, where $m = 2$ and $n = 1$.Âă Lifting idempotents modulo ideals, especially nil ideals, allows one to transfer ring structure from a factor ring back to the original.Âă We discover that more is true, by investigating situations where periodic elements do (or do not) lift modulo ideals, as well as investigating the relationship between periodic element lifting and idempotent lifting.

Symposia on
Recent Advances in Geometry of Banach Spaces

Convener: Prof. T. S. S. R. K. RaoCARAMS, MAHE, Manipal

On Uniform Mazur Intersection Property

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Abstract: The Mazur Intersection Property (MIP)—every closed bounded convex set is the intersection of closed balls containing it—is an extremely well studied property in Banach space theory. A complete characterisation was obtained by Giles, Gregory & Sims (1978), most well-known criterion stating that the w*-denting points of $B(X^*)$ are norm dense in $S(X^*)$. Chen and Lin (1995), introduced the notion of w*-semidenting points and showed that a Banach space X has the MIP if and only if every $f \in S(X^*)$ is a w*-semidenting point of $B(X^*)$.

A much less studied uniform version of the MIP (UMIP or UI) was introduced by Whitfield and Zizler (1987). Characterisations similar to Giles, Gregory & Sims were also obtained, but an analogue of the w*-denting point criterion was missing, which perhaps is a reason for its being less pursued.

In this talk, we show that a Banach space X has the UMIP if and only if every $f \in S(X^*)$ is a uniformly w*-semidenting point of $B(X^*)$, thus filling a long felt gap.

This is a joint work with Jadav Ganesh & Deepak Gothwal.

Extreme contraction and multi-smoothness of operators on polyhedral Banach spaces

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Abstract: In this talk we discuss a relation between extreme contraction and multi-smoothness of bounded linear operators on polyhedral Banach spaces. We show the usefulness of this relation to study extreme contractions on finite-dimensional polyhedral Banach spaces. We provide a large class of Banach spaces $\mathbb{X}, \mathbb{Y}$ such that for each extreme contraction $T : \mathbb{X} \to \mathbb{Y}$, there is an extreme point $x \in \mathbb{X}$ such that Tx is an extreme point of $\mathbb{Y}$.

Ball proximinality of M-ideals of compact operators

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Abstract: In this lecture, we will discuss the proximinality of closed unit ball of M -ideals of compact operators on Banach spaces. We will show that every positive (self-adjoint) operator on a Hilbert space has a positive (self-adjoint) compact approximant from the closed unit ball of space of compact operators. This is a joint work with Sreejith Siju.

Uniqueness of Hahn-Banach extension and related geometric properties in Banach spaces

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Abstract: The Hahn-Banach extension theorem for real cases datesback the papers by H. Hahn in 1927 and by S. Banach in 1929. Although the familiar trick deriving the theorem for other scalars by reduction to the real case was not forthcoming until 1938 due to H. F. Bohnenblust and A. Sobczyk (Complex scalars) and also by G. A. Soukhomlinoff (Complex or Quaternionic scalars). In this talk our prime concern is to correlate this theorem and its variants with other geometric properties in Banach spaces. In this connection we refer the works mainly from Eve Oja ([2]) and A. Lima ([1]). We establish a close connection of unique extension property with ideals in Banach spaces. In [3] R. R. Phelps introduced property-U, numerous strengthening of property-U are introduced in last few decades by Oja, Lima, Warner, Roy and many others. It is well-known that canonical embedding of a Banach space has propertyU in its bidual comes under the category of spaces whose duals has RadonNikodym property. In the first half of this presentation we discuss a few wellknown characterizations available in the literature, in the second we showcase a few of our observations. We study various strengthening and weakening of the uniqueness of Hahn-Banach extension property. The hyperplanes in c0 with these properties are completely identified. Our observations include various classical sequence spaces and function spaces demonstrating the applicabilities of our observations.

Characterizations for best approximations in C^*-algebras and Hilbert C^*-modules

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Abstract: Birkhoff-James orthogonality is directly related to best approximation problems in Banach spaces. In our talk, we will show some characterizations for an element of a C^*-algebra to be a best approximation to its subspace. We will explore similar results for Hilbert C^*-modules as well. Several known results and their extensions will be seen as applications of these results.

Orthogonality for bi-adjoints

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Abstract: An important direction of investigation in Operator theory of Banach spaces, is, to perform standard Banach space theoretic operations on spaces of operators and ask if the resulting object is again a space of operators (possibly between different Banach spaces). In this talk, we tackle this problem for the well-known geometric operation, Birkhoff-James orthogonality. For non-reflexive Banach spaces, X,Y, for a closed subspace M of operators, we investigate Birkhoff-James orthogonality of an operator T to M with that of T** with an appropriate subspace of M**.

Symposia on
Deep Learning for Scientific Computing and Artificial Intelligence

Convener: Prof. Ritesh KumarSRM, Chennai

Bayesian inference using generative adversarial networks

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Abstract: Inverse problems are notoriously hard to solve and are often ill-posed. Bayesian inference provides a principled approach to resolve this by posing the problem in a statistical framework. However, this approach can be challenging to implement when the field being inferred is high-dimensional, or when the prior information/data is too complex to represent using simple distributions. In this talk, we will discuss two strategies using generative adversarial networks (GANs) to overcome these issues. First, we demonstrate that by training a GAN to learn complex priors, and reformulating the inference problem in the low-dimensional latent space of the GAN, we can efficiently compute the solution of large-scale Bayesian inverse problems. Second, we show how a conditional GAN can be trained to directly learn and sample from the posterior distribution. We present several physics- based numerical experiments to demonstrate the efficacy of these deep learning approaches in the Bayesian framework.

Advances in Neuro-symbolic AI and Learning

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Abstract: eep Learning (DL) has become indispensable tool to buildÂăintelligent systems that leverage DL for its unprecedented advances in Computer Vision, Natural Language Processing, Robotics and Control. Despite this, it has critics for its brittleness, its opaqueness âĂŞ lack of explainability and trustworthiness, and its requirement of massive amounts of data. We focus on the need to overcome opaqueness – it is one of the main goals of the research in eXplainable AI (XAI), essentially aimed at making intelligent systems more understandable and explainable. This talk focuses on AI explainability by exploiting the idea of integrating symbolic and neural approaches to make intelligent systems understandable and explainable. These approaches define a relatively new area of AI research: Neurosymbolic Computing (NCS). We shall also glance over the recent progress in NCS.

Data-driven dimension reduction in functional principal component analysis identifying the change-point in functional data

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Abstract: Functional principal component analysis (FPCA) is the most commonly used technique to analyze infinite-dimensional functional data in finite lower-dimensional space for the ease of computational intensity. However, the power of a test detecting the existence of a change-point falls with the inclusion of more principal dimensions explaining a larger proportion of variability. We propose a new methodology for dynamically selecting the dimensions in FPCA that are used further for the testing of the existence of any change-point in the given data. This data-driven and efficient approach leads to a more powerful test than those available in the literature. We illustrate this method on the monthly global average anomaly of temperatures.

Deep Neural Networks for Imaging PDEs

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Abstract: Partial differential equations (PDEs) are used extensively to solve many ill-posed problems from Image Processing and Computer Vision. These PDE models are derived through empirical observations. The input image data is taken as a multivariate function, and the solution of the underlying PDE is treated as the output image. The availability of extensive volume data and high computational resources opens a new data-driven paradigm to model and solve these PDE models. This talk focuses on the two-fold relationship between neural networks and imaging PDEs. First, I will briefly discuss a couple of deep neural network models to solve imaging PDEs efficiently. Then, the power of deep learning architectures in the data-driven discovery of hidden physics of the PDE models will be presented. I will include some of our current work related to deep neural networks in solving problems from the imaging domain.

Privacy Preserving Synthetic Data Generation for Healthcare Applications

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Abstract: The demand for the deep learning based artificial intelligence technologies are growing within healthcare systems. These technologies make use of historical patient health, social and behavioral data to build predictive and analytical models for expediting prognosis, diagnosis of diseases and underlying ailment. The availability of these datasets in desired volume is often restricted owing to the privacy and compliance issues. Data anonymization techniques following Health Insurance Portability and Accountability Act (HIPAA) and General Data Protection Regulation (GDPR) legislation often result in removing the characteristics and complexity of the data essential for modeling. Privacy preserving synthetic data generation techniques offer methods that circumvent privacy issues by creating a realistic synthetic data that capture as many of the characteristics and complexities of the original data without including the original data. Privacy preservation layer ensures that the risk of reverse mapping from synthetic data to original data is minimum. In this talk, we will take a brief overview of different synthetic data generation techniques for healthcare applications. We will focus on application of Generative Adversarial Network (GAN) based techniques for generating synthetic electronic medical records (EMR) and how privacy preservation techniques are used in tandem. An evaluation metric set to gauge the quality of the generated synthetic data and privacy preservation will be discussed. Lessons learned from our experience in synthesizing different healthcare data sets will be shared in terms of a guidance on choice matrix, to select appropriate modeling technique for healthcare applications. Finally, some of the open issues and ongoing efforts in synthetic unstructured and imaging data set will be discussed.

ABSTRACTS OF PAPRES RECEIVED FOR COMPETITION

PAPERS RECEIVED FOR AMU PRIZE

On generalized derivations in prime rings with involution

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Abstract: Let R be a prime ring with involution $'*'$ and C be the extended centroid of R. An additive mapping $d : R \to R$ is said to be a derivation of R if $d(xy) = d(x)y + xd(y)$ holds for all $x, y \in R$. A generalized derivation of R means an additive mapping $F : R \to R$ such that $F(xy) = F(x)y + xd(y)$ for all $x, y \in R$. The aim of the present paper is to describe the structure of generalized derivations of prime rings with involution. In particular, we prove that if R admit generalized derivations F, G such that $[F(x), G(x^*)] = 0$ for all $x \in R$, then there exists $\alpha \in C$ such that $F = \alpha G$. Apart from the above mentioned result, we also discuss some other differential identities involving generalized derivations. Finally, we provide an example in the support of our hypothesis.

Characterization and properties of $FI-$semi injective modules

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Abstract: In this paper, we give some characterizations and properties of $FI-$semi injective modules and $FI-$self-p-injective ring. Also, we prove that the property of being $FI-$semi injective of a module is Morita invariant.

Ćirić type results via Simulation and C-class function in quasi-metric spaces and G-metric spaces

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Abstract: In this article, we have obtained some common fixed point theorems for admissible mappings via simulation function along with C-class functions in quasi-metric spaces.

Partial order in $M_n(N)$-group N^n

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Abstract: Let $M_n(N)$ be a matrix nearring over the nearring N with identity. We introduce a partial order in the $M_n(N)$-group N^n corresponding to the partial order in N-group (over itself). A positive cone in the $M_n(N)$-group N^n is defined and obtained a characterization theorem. For a convex ideal of N over N, the corresponding ideal in $M_n(N)$-group N^n is described; and conversely, if $\mathcal{I}$ is a convex ideal in $M_n(N)$-group N^n, then the ideal $\mathcal{I}_{**}$ is convex in N (over itself). This establishes the one-one correspondence between the convex ideal of p.o. N-group over N and those of p.o. $M_n(N)$-group N^n.

PAPERS RECEIVED FOR V. M. SHAH PRIZE

Order of multiple rational Fourier coefficients for functions of Akhobadze class

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Abstract: The order of magnitude of rational Fourier coefficients, for functions of Akhobadze variation class, $B\Lambda(p(n) \uparrow p, \varphi)$, is estimated. Akhobadze class of variation is further extended for functions of several variables and order of multiple Fourier coefficients for such functions is estimated.

Hypergeometric functions and a parametric family of cardioid domains

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Abstract: This paper uses several geometrical properties of the Gaussian and the confluent hypergeometric functions to determine the best possible values of the real β so that for some analytic function p defined in the open unit disk $\mathbb{D}$ satisfying $p(0) = 1$, the differential subordination implication

$$p(\xi) + \beta\xi p'(\xi) \prec \mathcal{P}(\xi) \implies p(\xi) \prec 1 + \alpha\xi e^{\xi}, \quad 0 < \alpha \leq 1$$

holds, where $\mathcal{P}(\xi)$ is any one of the univalent functions (i) $\sqrt{1+\xi}$, (ii) $1+\xi$, and (iii) e^{ξ}. For each $\alpha \in (0, 1]$, the function $\varphi_c(\xi, \alpha) = 1 + \alpha\xi e^{\xi}$ maps $\mathbb{D}$ univalently onto the interior of a cardioid which is symmetric about the real-line. As applications, we establish conditions which sufficiently ensure that a normalized analytic function f is a member of the Ma-Minda family $\mathcal{S}_c^*(\alpha)$ characterized by

$$f \in \mathcal{S}_c^*(\alpha) \iff \frac{\xi f'(\xi)}{f(\xi)} \prec 1 + \alpha\xi e^{\xi}, \qquad \xi \in \mathbb{D}.$$

PAPERS RECEIVED FOR IMS PRIZE GROUP 2

Star versions of Lindelöf spaces

Sumit Singh
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Abstract: A space X is said to be set star-Lindelöf (resp., set strongly star-Lindelöf) if for each nonempty subset A of X and each collection $\mathcal{U}$ of open sets in X such that $\overline{A} \subseteq \bigcup \mathcal{U}$, there is a countable subset $\mathcal{V}$ of $\mathcal{U}$ (resp., countable subset F of $\overline{A}$) such that $A \subseteq \mathrm{St}(\bigcup \mathcal{V}, \mathcal{U})$ (resp., $A \subseteq \mathrm{St}(F, \mathcal{U})$). The classes of set star-Lindelöf spaces and set strongly star-Lindelöf spaces lie between the class of Lindelöf spaces and the class of star-Lindelöf spaces. In this paper, we investigate the relationship among set star-Lindelöf spaces, set strongly star-Lindelöf spaces, and other related spaces by providing some suitable examples and study the topological properties of set star-Lindelöf and set strongly star-Lindelöf spaces.

Fixed Point Sets of Wedge of Spheres

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Abstract: Let X be a finitistic space having mod p, p a prime or rational cohomology of wedge of two spheres $S^n \vee S^m, n \leq m$ or wedge of three spheres $S^n \vee S^m \vee S^l, n \leq m \leq l$. In this paper, we determine the fixed point sets of $G = \mathbb{Z}_p$, p is a prime or $G = S^1$ actions on X.

PAPERS RECEIVED FOR IMS PRIZE GROUP 5

Optimization of MHD Nanofluid flow in a Rotating System

Padmaja K
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Abstract: With the presence of a magnetic field and chemical reaction, we investigate the flow of nanofluid past a vertical plate embedded in a porous medium under the influence of Dufour and Soret effects. An investigation of the heat and mass transfer of a rotating MHD nanofluid is presented. The study is subjected to the flow of a steady-state, incompressible fluid through a semi-infinite plate along with the impacts of viscous dissipation, joule heating, and a non-uniform heat source. The governing fluid flow equations are partial differential equations (PDEs) which are in turn converted into ordinary differential equations (ODEs) using similarity transformation variables. A MATLAB solver called bvp4c is used to solve the converted system of ODEs. The nanofluid $Al_2O_3H_2O$ is used to build a clear picture of the considered problem. By using graphs and tables, we examine the rates of heat and mass transfer. Various flow properties are analyzed with distinct numerical values for different physical quantities.

Abstracts of Contributory papers

Combinatorics, Graph Theory, Logic, Discrete Mathematics, etc.

n-elements in Multiplicative Lattices

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Abstract: This paper deals with introduction of a new class of elements in multiplicative lattices namely n-elements. Let $N(L)$ denotes the set of all nilpotent elements in multiplicative lattice L. A proper element i of multiplicative lattice L is an n-element of L if $aCdotb \leq i$ with $a \notin N(L)$ implies $b \leq i$ for all $a, b \in L$. We give examples of n-elements and study properties of n-elements analogous to prime elements in multiplicative lattice L. In fact, an ideal I of a commutative ring R with unity is an n-ideal of R if and only if I is an n-element of $Id(R)$, the ideal lattice of R.

Relation between the general Randic Index and general sum-connectivity index

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Abstract: The general Randic index is the sum of weights of $(d(u).d(v))^k$ for all edges uv of a molecular graph G. The general Sum-Connectivity index is the sum of the weights $(d(u) + d(v))^k$ for all edges uv of G, where k is a real number and d(u) is the degree of vertex u. Both the family of topological indices are well known and closely related. In fact the correlation coefficient value of these two family of indices for the trees representing the Octane isomers vary between 0.915 to 0.998. In the recent years these family of indices have been intensively explored and studied. The major research on these indices mostly consists of the application in QSPR/QSAR analysis, computation of these indices for various molecular graphs and bounds of the indices for certain graphs, satisfying certain conditions. Our main focus in this paper will be a comparative study on these two family of indices for various family of graphs. We obtain and derive a few inequalities and relations between general Randic index and general Sum-connectivity index of certain graphs.

Neural ring homomorphisms that preserve mandatory sets required for open convexity

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Abstract: The important question in the area of neural codes is whether a given code has an open convex realization. A lot of work has been contributed to solving this problem. A few of the authors looked at the topological obstructions in the code, which is barring the code being open convex. They have formulated a set M_H. If M_H is contained in the code, then it doesn't have any local obstructions. The set M_H is defined using homological properties of the code. We in this paper see that a code map associated with neural ring isomorphism preserves M_H. In other words if $\phi : \mathcal{R}_\mathcal{D} \to \mathcal{R}_\mathcal{C}$ is a neural ring isomorphism, then the associated code map $q_\phi : \mathcal{C} \to \mathcal{D}$ has the property that $q_\phi(M_H(\Delta(\mathcal{C}))) = M_H(\Delta(\mathcal{D}))$. Further if ϕ is just a surjective homomorphism we show that $M_H(\Delta(\mathcal{D})) \subseteq q_\phi(M_H(\Delta(\mathcal{C})))$. We solve this problem using the idea that for a given neural ring homomorphism, the associated code map has to be a composition of five different elementary maps only.

Wiener index of the atom based graph of a Boolean lattice

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Abstract: The atom based graph of a lattice L with 0, is a simple graph associated with L, where the vertex set is the set of nonzero elements of L and two distinct vertices x, y are adjacent if and only if $x \wedge y$ is an atom in L. In this paper we consider the atom based graph of L_n. We find order of a graph. We discuss the cardinality of neighbourhood of an element in the atom based graph of L_n. We also calculate the Wiener index of the graph $\Gamma_a(L_n^*)$. Also discuss the Eulerian of $\Gamma_a(L_n^{**})$.

A study of zero divisor graph of special lattices

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Abstract: Let L be a lattice. The zero divisor graph of L, denoted by $\Gamma(L)$, is a graph whose vertex set is the set of all nonzero proper elements of L and two vertices a and b are adjacent whenever $a \wedge b = 0$. In this paper we study the zero divisor graph of special lattices of all nonzero zero divisors of n, where n is any integer. Also, we investigate its properties like order, degree of vertices, diameter etc.

A Note on Comaximal Intersection Graph of Ideals

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Abstract: The comaximal intersection graph of ideals, $CI(R)$, of a ring R is an undirected graph whose vertex set is the collection of all non-trivial left ideals of R and two vertices I, J are adjacent if and only if $I + J = R$ and $ICapJ \neq 0$. Our study focusses on connectedness of $CI(R)$. We have also discussed independence number, clique number, domination number, chromatic number of $CI(R)$.

Special Values of the Riemann Zeta Function-Some Recent Developments

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Abstract: The **Riemann Zeta Function** (defined by $\zeta(s) = \sum_{i=1}^{\infty} \frac{1}{i^s}$), introduced by Leonhard Euler back in the early eighteenth century and made popular by Bernhard Riemann in his landmark 1859 paper titled "On the number of primes less than a given quantity", has received the attention of a large number of mathematicians over the centuries. Due to its far reaching property in predicting the distribution of prime numbers, it is often dubbed as the "the most important function in mathematics". Though we have a complete theory and a closed form expression for the even values of the function, much less is known about the nature of the odd values. The algebraic nature of the numbers seem to be one of the central problems in number theory. This area has been addressed by stalwarts like Ramanujan, Berndt, Apery(who proved the irrationality of $\zeta(3)$ in 1978), Nesterenko, Zudilin etc. In this paper, we shall briefly touch upon the famous Riemann Hypothesis and discuss several interesting results and generalizations related to the function and its values at integers, using methods of both number theory as well as analysis. We would also see some recent progress made in this field and some new identities.

Vanishing coefficients of q^{5n+r} and q^{11n+r} in certain infinite q-product expansions

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Abstract: Recently, Mc Laughlin proved several new results on vanishing coefficients in certain q-product expansions by classifying the results into various families. Also, Mc Laughlin stated some families of results with negative signs for arithmetic progressions modulo 5, 7 and 11. We have already proved the families of results modulo 7. In this paper, we prove results for arithmetic progressions modulo 5 and 11. For instance, we prove that if $t \in \{1, 2, 3, 4\}$ and the sequence $\{A(n)\}$ is defined by

$$\sum_{n=-9}^{\infty} A(n)q^n := (-q^{2t}, -q^{5-2t}; q^5)_\infty^3 (q^{5-t}, q^{5+t}; q^{10})_\infty,$$

then $A(5n + 3t^2 + 3t) = 0$ for all n and if t is even, then $A(5n + 2t^2 + 3t) = 0$ for all n.
Also, if $t \in \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$ and the sequence $\{F(n)\}$ is defined by

$$\sum_{n=-81}^{\infty} F(n)q^n := (q^{3t}, q^{11-3t}; q^{11})_\infty^3 (-q^{11-t}, -q^{11+t}; q^{22})_\infty,$$

then $F(11n + 8t^2 + 10t) = 0$ for all n.

Some Results on Strongly Regular Rings

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Abstract: In this paper we have generalized some results on strongly regular rings. A ring R is called strongly Von-Neumann regular if for every element a in R, there exist an element x in R with the property a=aax. This condition is left right symmetric. Every strongly Von-Neumann regular ring is a direct product of division rings. The following conditions are equivalent: (a) R is Von-Neumann regular. (b) R is Von-Neumann regular and reduced. (c) R is Von-Neumann regular and ever idempotent in R is central. Special types of Von-Neumann regular rings include unit regular rings and strongly Von-Neumann regular rings. A ring is called unit regular if for every element a in R there is a unit u in R such that a= aua. Every semi simple ring is unit regular and unit regular rings are directly finite rings. An ordinary Von-Neumann regular ring need not be directly finite.

The index of the center of a group in terms of centralizers

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Abstract: A group G is said to be n-centralizer if its number of element centralizers $|\ \mathrm{Cent}(G)\ | = n$. For any n-centralizer group G, we prove that $|\ \frac{G}{Z(G)}\ | \leq max\{(n-2)^2, 2(n-4)^{log_2^{(n-4)}}\}$. A group G is said to be an F-group if every non-central element centralizer contains no other element centralizer. For a finite n-centralizer F-group G, we prove that $|\ \frac{G}{Z(G)}\ | \leq (n-2)^2 \leq \frac{|G|^2}{4}$. We also prove that if q is the largest prime divisor of a centerless group G, then $|\ \mathrm{Cent}(G)\ | \geq q+2$ with equality if and only if $G = C_q \rtimes C_n$ is a Frobenius group. A finite group G is said to be of conjugate type $(m, 1)$ if every proper centralizer of G is of index m. Let p be a prime. For a finite n-centralizer group of conjugate type $(p, 1)$, we have $|\ \frac{G}{Z(G)}\ | \leq (n-2)^2$, with equality if and only if $\frac{G}{Z(G)} \cong C_p \times C_p$ and for a finite n-centralizer group of conjugate type $(p^2, 1)$, we have $|\ \frac{G}{Z(G)}\ | \leq (n-2)^2$, with equality if and only if $\frac{G}{Z(G)} \cong C_p \times C_p \times C_p \times C_p$.

Classes of prime hyperideals in join hyperlattices

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Abstract: We consider a lattice with 0. The notion of prime ideals and its characterizations in classical lattices are well known. A generalization of lattice is a hyperlattice defined by M Konstantinidou and J Mittas (1977) wherein the operation join or meet or both is/are taken as hyperoperations. In this paper, we define the notions 2-absorbing hyperideal, primary hyperideal, 2-absorbing primary hyperideal, weakly prime hyperideal etc. We provide suitable examples to distinguish all these classes. Later we provide certain properties of these hyperideals in join hyperlattices. We give characterization for radical of a hyperideal to be prime, consequently we prove some results on join hyperlatttices.

On Ω-superfluous ideals of N-groups

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Abstract: We consider a (right) nearring N, which is a natural generalization of a ring, wherein addition need not be abelian and only one distributive law is assumed. The notion finite Goldie dimension (denoted by f.G.d.) of a module was defined by Goldie **[?]** in terms of uniform submodules. A dualization of this concept, namely the finite spanning dimension in modules was studied by Fleury **[?]**. In this paper, we consider an N-group81 G (or a module over a nearring) and discuss the notions such as small ideals, hollow ideals and supplements in N-groups. Further, we define Ω-small ideal of an N-group G where Ω is an ideal of G and obtain analogue results on finite spanning dimension with respect to an arbitrary N-subgroup or ideal of G. We provide necessary examples that justifies the existence of ideals which are Ω-small and strictly Ω-small but not small, Ω-hollow but not hollow, Ω-supplements which are not supplements.

The lattice of convex sublattices of $S(S(B_n))$

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Abstract: Subbarayan. R and Vethamanickam. A. have proved in their paper that $CS(B_n)$ the lattice of convex sublattices of a Boolean algebra B_n, of rank n, with respect to the set inclusion relation, is a dual simplicial Eulerian lattice.Subsequently, Sheeba Merlin.G and Vethamanickam. A. have proved in their paper that $CS[S(Bn)]$ is an Eulerian lattice under the set inclusion relation which is neither simplicial nor dual simplicial.
In this paper, we prove that $CS[S(S(Bn))]$ is an Eulerian lattice under the set inclusion relation and it is neither simplicial nor dual simplicial, if $n > 1$.

M-SP-Projective Modules

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Abstract: In this paper we studied M-small principally projective modules (In short, M-sp-projective modules) which is the dual notion of M-sp-injective module and the generalization of M-projective module and we provide an example of a M-sp-projective modules which is not M-projective. We also study some properties related to Summand Intersection Property(SIP) and Hopfian modules.

On Prime Pseudo Symmetric Ideals of a Partially Ordered Ternary Semigroup

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Abstract: In this paper, we define the notions of prime, strongly prime and semiprime pseudo symmetric ideals of a partially ordered ternary semigroup. We also studied the interesting properties of these special types of pseudo symmetric ideals and proved that the set of all strongly prime pseudo symmetric ideals is topologized.

I-adic completion of a Noetherian le-module

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Abstract: A. K. Bhuniya and M. Kumbhakar introduced and studied a new algebraic structure, which is called an le-module. An le-module M over a commutative ring R is a complete lattice ordered monoid $(M, +, \leq, e)$ with greatest element e and module like action of R on it. A. K. Bhuniya and M. Kumbhakar motivated to study abstract submodule theory from the study of abstract ideal theory, in particular multiplicative lattices and lattice modules. E. W. Johnson and J. A. Johnson established some properties of Noetherian lattice modules over semi-local Noether lattices and their completions. In this paper, we first establish the concept of a modular le-module, prove a version of Nakayama lemma for an le-module and then studied I-adic completion of a Noetherian le-module.

On sixth order mock theta functions $\lambda(q)$ and $\rho(q)$

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Abstract: Ramanujan introduced sixth order mock theta functions $\lambda(q)$ and $\rho(q)$ defined as:

$$\lambda(q) = \sum_{n=0}^{\infty} \frac{(-1)^n q^n (q;q^2)_n}{(-q;q)_n},$$

$$\rho(q) = \sum_{n=0}^{\infty} \frac{q^{n(n+1)/2}(-q;q)_n}{(q;q^2)_{n+1}}$$

listed in Lost Notebook. We provide some Ramanujan-like congruences and also find their infinite families modulo 12 for the coefficients of mock theta functions mentioned above.

Counting lattice points inside a triangle

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Abstract: Lattice point problems deal with counting points with integer coordinates inside a large closed domain. S. Ramanujan was interested in the estimation of lattice points inside a right angled triangle. In his first letter to G. H. Hardy, Ramanujan asserted that the number of integer points $u \geq 0$, $v \geq 0$ satisfying the inequality $u \log 2 + v \log 3 \leq \log n$ is approximately $\frac{\log^2 n}{2 \log 2 \log 3} + \frac{\log n}{2 \log 2} + \frac{\log n}{2 \log 3} + \frac{1}{2}$. G. H. Hardy and J. E. Littlewood generalized this problem and proved that for fixed positive real numbers ω, ω', the number of lattice points $(u, v), u \geq 0, v \geq 0$ satisfying $0 \leq u\omega + v\omega' \leq \eta$ is given by $\frac{1}{2}\left(\frac{\eta^2}{\omega\omega'} + \frac{\eta}{\omega} + \frac{\eta}{\omega'}\right) + O_\varepsilon(\eta^{1-\frac{1}{\alpha_0}+\varepsilon})$ where $\alpha_0 \geq 1$ is a constant. In this talk, we shall discuss this problem and show that $\alpha_0 = 2^{18} \log 3$ is admissible in the case of Ramanujan.

On the least primitive root of safe primes

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Abstract: A prime p is called a Sophie Germain prime if $2p + 1$ is also a prime and $2p + 1$ is called a safe prime. The infinitude of Sophie Germain prime is expected but yet to be proved. In 1969, Aulicino and Goldfeld have defined a permutation $(n!)$ which is the product of the first n cycles. And they also proved that $(n!)$ *is transitive if and only if* $2n + 1$ *is a prime with* 2 *as a primitive root*. Artin conjectured that for $a \neq \pm 1$ and not a perfect square, there are infinitely many primes for which a is a primitive root. Our motivation is to obtain the primes for which 2 is a primitive root which is a special case of Artin's primitive root conjecture. In this article, we present a necessary and sufficient condition for 2 to be a primitive root of $2p + 1$ for any odd prime p and also establish a relation with the number of orbit of $(p!)$.

On Symbol-Pair Distances of Repeated-Root Constacyclic Codes of Length $2p^s$ over $\mathbb{F}_{p^m} + u\mathbb{F}_{p^m}$ and MDS Symbol-pair Codes

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Abstract: Let $\mathfrak{R} = \mathbb{F}_{p^m} + u\mathbb{F}_{p^m}$ with $u^2 = 0$, where m, s are positive integers and p is an odd prime. For any invertible element Λ of $\mathfrak{R}$, the symbol-pair distances of all Λ-constacyclic codes of length $2p^s$ over $\mathfrak{R}$ are completely obtained. We identify all symbol-pair Maximum Distance Separable (MDS) constacyclic codes of length $2p^s$ over $\mathfrak{R}$. As examples, many new symbol-pair codes, as well as symbol-pair MDS codes are constructed.

Four Equalities Connected with Einstein Sum and Einstein Product of Intuitionistic Fuzzy Matrices

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Abstract: In the present work, we prove four equalities conneted with Einstein sum and Einstein product of intuitionistic fuzzy matrices.

Some rings which satisfy Kothe conjecture and their properties

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Abstract: It was conjectured by Kothe that if a ring has a non zero nil right ideal that it has atleast one non zero nil ideal. In 70 years various development has been on this conjectured and various equivalent conditions has been made. Some as "Sum of two nil right (or left) nil ideal is again a nil right (or left)ideal. In this paper we try to find some rings which satisfy Kothe conjecture.

A new approach to the proof of 0–supermodularity of CS[S(B_2)]

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Abstract: The concept of 0-Supermodular lattices was introduced in the thesis of J.Arivukkarasu. He proved there that the lattices $S(B_n)$ and $S(D)$ are 0-supermodular. In this paper, we prove that the lattice of convex sublattices of $S(B_2)$ with respect to the new ordering defined by S.Lavanya and S.Parameshwara Bhatta, is 0-supermodular

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Study of continuous and discrete wavelet transforms associated with the index Whittaker transform

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Abstract: The continuous wavelet transform (CWT) associated with the index Whittaker transform is defined and discussed using its convolution theory. Existence theorem and Reconstruction formula for CWT are obtained. Moreover, composition of CWT is discussed and its Plancherel's and Parseval's relations are also derived. Further the discrete version of this wavelet transform and its reconstruction formula are given. Furthermore, certain properties of the discrete Whittaker wavelet transform are discussed.

On Cauchy's Bound for Zeros of Transcendental Entire Functions

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Abstract: Fundamental theorem of algebra only gives information about the number of zeros of a polynomial but not location of the zeros. All zeros of a quadratic polynomial can be derived algebraically for all possible values of its coefficients. But, difficulty arises when degree of polynomial increases. So, it is desirable to know a region where the zeros of a polynomial lie. Problem of finding a region containing all the zeros of a polynomial has a rich old history. In 1829, Cauchy showed that if $P(z) = \sum_{j=0}^{n} a_j z^n$ is a polynomial of degree n, then all the zeros of $P(z)$ lie in $|z| \leq r$ where r is the unique positive root of the equation

$$|a_n|z^n - (|a_{n-1}|z^{n-1} + ... + |a_0|) = 0.$$

The prime concern of this paper is to derive bounds for the moduli of the zeros of a transcendental entire function. A few examples are given here to validate the results obtained.

Further investigations on the least cardinalities of unique range set under two minimum weights over non-Archimedean field

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Abstract: The study on the minimal cardinality of unique range set of meromorphic functions (URSM) is a famous problem in uniqueness theory over complex field. Introducing a new polynomial Frank-Reinders established URSM of cardinality ≥ 11. After that many researches tried to obtained URSM with cardinality less than 11 but without any extra suppositions no one can diminish the cardinality 11. On the other hand, Bartels found URSM-IM with cardinality 17. Very recently, considering the notion of weighted sharing, Banerjee obtained that the cardinality of unique range set with weight 1 (URSM1) is 12. Till now, the least cardinalities of URSM, URSM-IM (i.e., URSM0) and URSM1 over complex field are 11, 17 and 12 respectively. In this paper, we consider the base field as non-Archimedean field $\mathbb{F}$ instead of complex field. We introduce a new polynomial $P(z)$ of degree $m+n+1$ which accommodates all polynomials of Frank-Reinders type and shows that $S = \{z \in \mathbb{F} | P(z) = 0\}$ is URSM-IM and URSM1 with cardinalities greater than or equals to 16 and 11 respectively. Thus over non-Archimedean field our results improves the results over complex field as the cardinalitis of URSM-IM and URSM1 are reduces by 1.

Some properties of bilateral mock theta functions of order fifteen

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Abstract: Bilateral mock theta functions of order fifteen were obtained and studied by M Ahmad and Shahab Faruqi.We express 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 Fq functions. We give an integral representation for these generalized functions

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Non-existence of entire solutions of non-linear general difference equations

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Abstract: The main objective of this article is to investigate the solvability of a non-linear difference equation generated by general difference polynomial of a transcendental entire function of finite order.

Uniqueness of meromorphic functions with its k th derivative sharingsharing two small functions under different weights

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Abstract: In the beginning of nineteenth century R. Nevanlinna inaugurated the value distribution theory with his famous Five value and Four value theorems which can be regarded as the bases of uniqueness theory. Later in [Lecture Notes Math., **599**, Springer, Berlin, 101-103 (1977)], Rubel-Yang first investigated about the uniqueness of non-constant entire function f and f' sharing two values. Since then a large number of researchers investigated and found a number of results in this direction.
In the paper, we have exhaustively studied about the uniqueness of meromorphic function sharing two small functions with its k-th derivative. We have obtained some results which will improve and extend some recent results of Banerjee-Maity [J. Contemp. Math. Anal., **56**(**2**), 68-79 (2021)].

Kempner's curious convergent series in an extended form

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Abstract: There are many research articles on modified harmonic series and their convergence. Here my initial object is to discuss about Kempner's series which is also a modification of harmonic series. In KempnerâĂŹs article, it has been proved that in the harmonic series

$$\sum_{n=1}^{\infty} \frac{1}{n}$$

if we exclude those terms for which âĂŸn' contains at least one âĂŸ9âĂŹ in its decimal representation, then the resulting series converges. In the same article it has also been shown that, if instead of âĂŸ9âĂŹ, any other given integer in the set $\{0, 1, 2, 3, 4, 5, 6, 7, 8\}$ is excluded, then the resulting series converges. The main aim of this article is not to search for a better approximation towards the point of convergence of Kempner's series, but to generalize the result of Kempner's series to some extent.

Some Integrals Involving ${}_pR_q(\alpha, \beta; z)$ Function

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Abstract: In this paper, we express the integral of product of ${}_pR_q(\alpha, \beta; z)$ function with some algebraic functions, Hermite polynomial, Legendre polynomial, Legendre function, Jacobi polynomial, Galue type Struve function in terms of ${}_pR_q(\alpha, \beta; z)$ function.

Properties of a new product of planar harmonic mappings

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Abstract: For two harmonic functions $f_1 = h_1 + \bar{g_1}$ and $f_2 = h_2 + \bar{g_2}$ in the open unit disk of the complex plane, the harmonic convolution $f_1 * f_2$ is defined by

$$f_1 * f_2 = h_1 * h_2 + \overline{g_1 * g_2}.$$

Unlike the analytic case, the harmonic convolution of two normalized sense-preserving convex harmonic mappings may not be even locally univalent. Due to this limitation of harmonic convolutions, several authors have worked in this direction and studied the convolution properties of half-plane and strip mappings. Since the harmonic convolution does not give the analogous results for analytic convolution, it is imperative to define other products for harmonic mappings that can serve as better generalizations of analytic convolutions. In this paper, we have defined a product $\otimes$ of two harmonic mappings and discuss its analytic and geometric properties. We have proved that the product $f_1 \otimes f_2$ of two normalized sense-preserving harmonic mappings f_1, f_2 is univalent and convex in the direction of the real axis when the sum of the analytic and co-analytic parts of each f_i is convex. This theorem, in turn, gives a useful technique of constructing univalent harmonic mappings convex in the direction of the real axis. Sufficient conditions are obtained for the product to be univalent and convex in the direction of the real axis. In addition, a convolution theorem, coefficient inequalities and closure properties for the product $\otimes$ are proved.

Common fixed point theorems in complex valued metric spaces satisfying E.A. property and intimate mapping

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Abstract: In this paper we prove the common fixed point theorems in complex valued metric spaces satisfying E.A. property and intimate mapping. Our result generalizes some recent results in the literature due to Azam et al.(2011) . Also we improve the results of Rajput & Singh(2014) satisfying E.A. property and Meena(2015) regarding intimate mapping. Some concepts have been taken from the results obtained by Choi et al.(2017) and Jebril et al.(2019) to improve our results. Also some examples are given to illustrate our obtained results.

Entire function with its linear differential polynomial normally or weakly share a set and some related topics

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Abstract: In 1999, probably Li-Yang [J. Math. Soc. Japan, 51(4)(1999), 781-799] were the first two authors who initiated the study about the relation of an entire function and its derivative sharing a doubleton as follows:

Theorem: *Let f be a non-constant entire function and a_1, a_2 be two distinct complex numbers in $\mathbb{C}$. If f and f' share the set $\{a, b\}$ CM, then one and only one of the following conclusions holds:*

1. $f = f'$,
2. $f + f' = a + b$,
3. $f = c_1 e^{cz} + c_2 e^{-cz}$ *with* $a + b = 0$, *where* c, c_1 *and* c_2 *are non-zero constants which satisfy* $c^2 \neq 1$ *and* $4c_1c_2 = a^2(1 - c^{-2})$.

In 2005, to extend the above theorem, Li [J. Math. Anal. Appl., 310(2005), 412-423] replaced the derivative of an entire function by the linear differential polynomial.

In our paper, we strive to find different forms of an entire function sharing a doubleton of small functions CM with its linear differential polynomial to improve Li's result in [J. Math. Anal. Appl., 310(2005), 412-423]. In our another attempt, we have conveniently first time answered an open question raised in [J. Math. Anal. Appl., 310(2005), 412-423] under weakly sharing environment. We also put two open questions and a handful number of examples relevant to the content of the paper.

Meromorphic functions sharing values partially with their derivatives and shifts

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Abstract: The uniqueness of entire and meromorphic functions when they share values with their shifts or differences play a cardinal role and profound a significant results of the theory of uniqueness problem. Supporting the restraint of hyper order, we procure three uniqueness events of a meromorphic function f(z) with the derivative of its shift f(z + c); outstanding to a unique procedure of examine the complex differential-difference equation f(z)= fâĂŹ(z + c. Many famous researchers studied uniqueness theory and made a remarkable works and contribution to the development of the uniqueness theory of meromorphic function.

New Subclasses of Analytic and Bi-Univalent Functions Using Catas Operator

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Abstract: By using Catas operator, we introduce two new subclasses $\mathcal{B}_{\Sigma}(i,\beta,m,\alpha,\lambda)$ and $\mathcal{H}_{\Sigma}(i,\beta,m,\alpha,\delta)$ of analytic and bi-univalent functions in the unit disc $\mathbb{U} = \{z \in \mathbb{C} : |z| < 1\}$. We obtain coefficient estimates $|a_2|$ and $|a_3|$ for functions belongs to $\mathcal{B}_{\Sigma}(i,\beta,m,\alpha,\lambda)$ and $\mathcal{H}_{\Sigma}(i,\beta,m,\alpha,\delta)$

Convergence of a special class of infinite continued fractions

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Abstract: In this note, we discuss the convergence of a special class of infinite continued fractions. There are some beautiful results [Toni Beardon, The Golden Ratio, Fibonacci Numbers and Continued Fractions, NRICH Project, Published June 2005, February 2011.https://nrich.maths.org/2737], [https://www.quantamagazine.org/solution-puzzles-inspired-by-ramanujan-20160808/] on infinite continued fractions. Also there is rigorous discussion on geometry of Continued fractions [Oleg Karpenkov, Geometry of Continued Fractions, Vol.26, Springer Science & Business Media, 2013.]. In this note we visually as well as mathematically discuss and establish few results on a special class of infinite continued fractions. We use some basic results from standard books [Brian Bradie, A Friendly Introduction to Numerical Analysis, Pearson Education India, 2006.], [David M. Burton, Elementary Number Theory, Tata McGraw-Hill Education, 2006.] of undergraduate level. (*)

Characterization of exponential polynomial as solution of certain type of non-linear delay-differential equation

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Abstract: Throughout the paper, by f we mean an entire function in $\mathbb{C}$. We have used the symbols $\rho(f)$, $\lambda(f)$, $\tau(f)$ to denote order of f, exponent of convergent and type of f respectively. Also, we have used the concept of convexity such as convex set, hull, polyhedron and various basic theorems. For, $c \in \mathbb{C}\backslash\{0\}$, the shift operator of a function f is represented by $f(z+c)$.
The exponential polynomial $f(z)$ is defined by

$$f(z) = P_1(z)e^{Q_1(z)} + \cdots + P_k(z)e^{Q_k(z)},$$

where P_j's and Q_j's are polynomials in z.
Now-a-days, to find the form of exponential polynomials as solution of certain non-linear differential-difference equation has become an interesting topic among researchers. In this regard, the first attempt was made by Wen-Heittokangas-Laine [Acta Math. Sin., 28(2012), 1295-1306]. In 2012, they considered the equation

$$f(z)^n + q(z)e^{Q(z)}f(z+c) = P(z),$$

where $q(z)$, $Q(z)$, $P(z)$ are polynomials, $n(\geq 2) \in \mathbb{N}$, $c \in \mathbb{C}\backslash\{0\}$ and classified the finite order entire solutions. After that many researchers strove to improve the above mentioned result.
In this paper, we have characterized the nature and form of solutions of certain non-linear delay-differential equation. Different special cases of our result will accommodate all the results of some previous papers. Thus our result can be considered as an improvement of all of them. We have also illustrated a handful number of examples to show that all the cases as demonstrated in our theorem actually occurs.

Some growth analysis of entire functions of several complex variables based upon (p,q)-φ relative Goldberg order and (p,q)-φ relative Goldberg type

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Abstract: During the past decades, several authors [A. A. Gol'dberg, B. A. Fuks, Mondal et al. etc.] made closed investigations on the growth properties of entire functions of several complex variables using different growth indicator e.g., Gol'dberg order, (p; q)-th Gol'dberg order, relative Gol'dberg order, etc. In this paper, I use some new kind of growth indicators such as (p,q)-φ relative Gol'dberg order, (p,q)-φ relative Gol'dberg type, (p,q)-φ relative Gol'dberg weak type etc. as tools to study the comparative growth behaviour related to entire functions of several complex variables with the consideration of a class $L(R)$ of nondecreasing unbounded functions $\varphi(R) : [0,+\infty) \to (0,+\infty)$ always satisfying $\lim_{R\to+\infty} \frac{\log^{[q]} \varphi(\alpha R)}{\log^{[q]} \varphi(R)} = 1$ for all $\alpha > 0$, where p and q are positive integers. The results of this paper significantly extend some earlier results in this regard.

Certain Estimates of Univalent functions associated with functions with positive real part

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Abstract: In this note, some classes of univalent functions associated with functions with positive real part are considered which are defined on open unit disk $\mathbb{D}$. The best possible estimates on Hermitian–Toeplitz determinant of third order and a bound on third and fourth order Hankel determinants are computed for such functions. In addition, some radius estimates and subordination inclusions are also examined.

Rough weighted $\mathcal{I}$-$\alpha\beta$-statistical convergence by neighborhood approximation

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Abstract: In this study we set forth with the new notion of $\mathcal{I}$-$\alpha\beta$-statistical convergence which becomes more generalized version of $\mathcal{I}$-statistical convergence. Successively to compare with the following important results of Balcerzak et al. [Indagations Mathematicae 31 (1) (2020) 83-95]

(i) Let $\mathcal{I}$ be an ideal such that $\mathcal{I} \subseteq \mathcal{Z} = \left\{A \subseteq \mathbb{N} : \lim_{n\to\infty} \frac{|A \cap [1,n]|}{n} = 0\right\}$. Then $\mathcal{I}$-statistical convergence coincides with statistical convergence,

(ii) $\mathcal{I}$-statistical convergence coincides with statistical convergence if $\mathcal{I} = \mathcal{I}_{\frac{1}{n}} = \left\{S \subseteq \mathbb{N} : \sum_{n\in S} \frac{1}{n} < \infty\right\}$,

(iii) Let $\mathcal{I}$ be a maximal ideal. Then $\mathcal{I}$-statistical convergence does not coincide with statistical convergence,

we produce significant results that elucidate incongruity between $\mathcal{I}$-$\alpha\beta$-statistical convergence and $\mathcal{I}$-statistical convergence. Also, following the line of works of Aytar [Numerical Functional Analysis Optimization 29 (3-4) (2008) 291-303], Savaş et al. [Periodica Mathematica Hungarica 71 (2015) 135-145] and Ghosal et al. [Mathematica Slovaca 70 (3) (2020) 667-680], we propose a new notion, namely rough weighted $\mathcal{I}$-$\alpha\beta$-statistical convergence over locally solid Riesz spaces. The core factor "***degree of roughness***" had been conventionally treated as a non-negative real number where as we invent the idea of neighborhood approximation.

Iteration of $z \mapsto \frac{1}{e^z+z} + \lambda,\ \lambda \geq 1$

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Abstract: For a general meromorphic map $f : \mathbb{C} \to \widehat{\mathbb{C}}$, a point $b \in \mathbb{C}$ is called an *omitted value* of f if $f(z) \neq b$ for any $z \in \mathbb{C}$. If each complementary component of the pre-image of an open ball containing b is bounded then b is called a bov. The set of points $z \in \widehat{\mathbb{C}}$ for which $\{f^n(z)\}_{n=0}^{\infty}$ is defined in a neighbourhood of z is called the Fatou set of f. The complement of the Fatou set is called the Julia set. A maximal connected subset of the Fatou set is called a Fatou component. A Fatou component U is called completely invariant if $f(U), f^{-1}(U) \subseteq U$. A point z_0 is called a fixed point of f if $f(z_0) = z_0$. It is called attracting, indifferent or repelling if $|f'z_0| < 1, = 1$ or > 1 respectively. For $g_\lambda(z) = \frac{1}{e^z+z} + \lambda$, $\lambda \geq 1$, it is shown that λ is the bov of g_λ and g_λ has two real fixed points $x_\lambda > 0$ and $\tilde{x_\lambda} < 0$. Furthermore, x_λ is attracting and $\tilde{x_\lambda}$ is repelling. Moreover, the Fatou component corresponding to x_λ contains the bov and is compltely invariant.

Chebyshev's Method and its Symmetry Group of the Julia Set

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Abstract: The complex dynamical system deals with the study of iterations of points in $\widehat{\mathbb{C}}$ under a non-constant function. For a rational map R of degree at least two, the set containing points $z \in \widehat{\mathbb{C}}$ which has a neighborhood where $\{f^n\}_{n>0}$ is normal, is called the Fatou set of R, denoted by $\mathcal{F}(R)$. The compliment is the Julia set, denoted by $\mathcal{J}(R)$. The Julia set of R possesses many interesting properties, specifically, it may show self-similarity with respect to various scales. There may exist maps that keep $\mathcal{J}(R)$ invariant. The collection of such maps is called the symmetry group of Julia set of R, denote it as ΣR. Beardon classified the symmetry group of Julia sets of polynomials. But, the rational case is yet to be investigated completely. We consider the Chebyshev's method which is a well known root-finding method. For a polynomial p of degree at least two, the Chebyshev's method C_p of p is defined as

$$C_p(z) = z - \left[1 + \frac{1}{2}L_p(z)\right]\frac{p(z)}{p'(z)}$$

where $L_p(z) = \frac{p(z)p''(z)}{(p'(z))^2}$. We show that ΣC_p contains Σp. Also, we prove that $\mathcal{J}(C_p)$ can never be a line, which concludes that ΣC_p does not contain a translation.

On the uniqueness of a meromorphic function and its higher difference operator under the purview of two shared sets

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Abstract: The notion of set sharing for the uniqueness of meromorphic functions was trail-blazed by Gross in 1976. After that a large amount of research have been added in this literature during the last four decades. Recently the analogous study for a meromorphic function and its shift or difference operator via shared set(s) have become a matter of prime interest to the researchers. A number of results in this direction have also been obtained by many researchers throughout the last decade. In this paper, we walk along this new direction and prove a theorem which improve a recent result by Chen-Chen.

Extended Generalized Bessel Matrix Functions

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Abstract: In this paper, we give the Extended Generalized Bessel Matrix functions. Some properties of Extended Generalized Bessel Matrix function including the integral representations have also been obtained.

Elementary Properties of α- Sumudu Transform and Applications

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Abstract: Elementary properties of α - Sumudu transform of some functions are studied. The α - Sumudu transform of Bessel function and error function is obtained and also results are obtained for α - Sumudu transform. These results are applied to obtain α - Sumudu transform of periodic functions and to evaluate improper integrals

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The Matrix Polynomial in Two Variables $L_n^{(M,N,\delta,\xi,\lambda,\eta)}(x,y)$

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Abstract: In this article, we introduce a matrix polynomial in two variables $L_n^{(M,N,\delta,\xi,\lambda,\eta)}(x,y)$ and establish some results viz, the Kampé de Fériet matrix series representation, generating matrix functions, integral representations, finite summation formulas and recurrence relations.

Some Transform of Fractional Derivative of Incomplete τ-Hypergeometric Functions

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Abstract: In this paper, authors established the some new integral and derivative formulas of generalized τ-hypergeometric functions ${}_3\Gamma_2^{\tau}(z)$. Furthermore by applying some integral transforms as Beta-transform, Verma transform, Whittaker transform, Laplace transform and P-transform on the resulting formulas. Some interesting special cases and consequences of our main results are also considered.

Note on a k-generalised fractional derivative

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Abstract: In this paper, we introduce the k-generalised fractional derivatives with three parameters which reduced to k-fractional Hilfer derivatives and k-Riemann-Liouville fractional derivative as an interesting special case. Further, we have also introduced some presumably new fascinating results which include the image power function, Laplace transform and composition of k-Riemann-Liouville fractional integral with generalized composite fractional derivative. The technique developed in this paper can be used in other situation as well.

New subclasses of analytic-bi-univalent functions encompassing q-derivative

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Abstract: In the present investigation, by using the q-derivative operator, we introduce two new subclasses $\mathcal{T}_{q_\Sigma}(\mu)$ and $\mathcal{T}_{q_\Sigma}^{\alpha}$ of analytic-bi-univalent function class Σ defined in the open unit disk $\mathcal{D} = \{z \in \mathbb{C} : |z| < 1\}$. Further, for functions belong to these subclasses we obtain estimates on the first two Taylor-Maclaurin coefficients $|a_2|$ and $|a_3|$. Finally, we pointed out connections with some of the earlier known results.

Generating fuction for the new class of Bernstein type operators

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Abstract: In this paper we give main properties of generating fuction for a class of new Bernstein type operators introduced by N.Deo,M.A.Noor and M.A.Siddiqui, and show that Lipchitz constants is preserved by these operators if function to be approximated is Lipschitz continuous.

Fixed Point theorems in tvs- cone metric spaces and its application in tvs A-cone Metric Space

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Abstract: In the year 2011, Cho et al. [2] has presented the new idea of c-distance in cone metric spaces. At that point after Dubey, A.K. et al.[4] demonstrated a few after effects of fixed point results using c-distance with contractive conditions in cone metric spaces. As of late, Tiwari, S.K. et al. [17] has demonstrated the expansion of fixed point hypothesis for contraction mappings applying c-distance. The motivation behind this paper is to build up a speculation of the outcomes demonstrated by Tiwari, S.K. et. al.[17] for contraction mappings applying c-distance. Moreover, we prove a theorem for such mapping applying c-distance in tvs $\mathscr{A}$-cone metric space as an application that extends the results of M.Abbas,et.al. [14].The outcomes here sum up and expand a portion of the notable outcomes present in the literature [1,5,6,7,8,9,10]

Finite triple series relations involving the multivariable A function

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Abstract: The aim of this paper is to establish four finite triple series relations involving the A- function of several complex variables introduced by A. S. Asgar, B. P. Gautam and A. N. Goyal. These relations are quite general in nature, from which a large number of known or new relations can be obtained simply by specializing the parameters of the multivariable A- function.

Functional Analysis, Measure Theory, Probability Theory and Stochastic Processes, and Information Theory

Iterative Algorithm for a Class of Random Generalized Variational Inclusions with Random Fuzzy Mappings

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Abstract: In this presentation, first we will consider a class of random generalized nonlinear mixed variational inclusions with random fuzzy mappings and random relaxed cocoercive mappings in real Hilbert space. Using resolvent operator and Nadler's technique, we will propose an iterative algorithm for finding the approximate solution of this class of inclusions. Further, we will discuss convergence analysis of iterative algorithm under some appropriate conditions. Some examples and applications will be also discussed.

Dunkle - Hausdorff Operator

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Abstract: In this talk we discuss the boundedness of Dunkle - Hausdorff operator in weighted Lebesgue space and precise value of its norm in some special cases in one dimension as well as in two dimensions. We also talk about a relation of Hausdorff operator and its adjoint with linear canonical sines as well as linear canonical cosines.

Generalized duality in Grand X^p-spaces

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Abstract: In this paper presentation, we introduce grand X^pspaces and study its space properties. Further, we define small X^pspace and prove that its generalized associate space with respect to Banach function space X is grand X^pspace.

LDP for the SGBH equation Large deviation principle for occupation measures of stochastic generalized Burgers-Huxley equation

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Abstract: In this talk we will discuss the global solvability as well as asymptotic analysis of stochastic generalized Burgers-Huxley (SGBH) equation perturbed by space-time white noise in a bounded interval of $\mathbb{R}$. We first prove the existence of unique mild as well as strong solution to SGBH equation and then obtain the existence of an invariant measure. Later, we establish two major properties of the Markovian semigroup associated with the solutions of SGBH equation, that is, irreducibility and strong Feller property. These two properties guarantees the uniqueness of invariant measures and ergodicity also. Then, under further assumptions on the noise coefficient, we discuss the ergodic behavior of the solution of SGBH equation by providing a Large Deviation Principle (LDP) for the occupation measure for large time (Donsker-Varadhan), which describes the exact rate of exponential convergence.

Wong-Zakai Approximation and Support Theorem for 2D and 3D stochastic convective Brinkman-Forchheimer equations

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Abstract: In this talk, I am going to present the Wong-Zakai approximation results for two and three dimensional stochastic convective Brinkman-Forchheimer (SCBF) equations forced by Hilbert space valued Wiener noise on bounded domains. Even though the existence and uniqueness of a pathwise strong solution to SCBF equations is known, the existence of a unique solution to the approximating system is not immediate from the solvability results of SCBF equations, and it is proved by using Faedo-Galerkin approximation technique and monotonicity arguments. Moreover, as an application of the Wong-Zakai approximation, the support of the distribution of solutions to SCBF equations is also obtained.

Rubio de Francia Extrapolation Theorem in Variable Lebesgue Spaces for $B_{p(\cdot)}$ weights

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Abstract: In this presentation, we shall talk about the Rubio de Francia extrapolation results for pair of non-increasing functions with $B_{p(\cdot)}$-weights. Also, we shall mention an application to obtain an extrapolation result in the framework of variable exponent Lebesgue space $L^{p(\cdot)}_w$ with Luxemburg norm.

Some fixed point theorems for interpolative rational type contraction in 2-metric spaces

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Abstract: In this paper, we have established fixed point theorems for 2-metric spaces. Here we have generalized the result of Olatinwo *et al.*[15] and extended it to 2-metric space. Some interesting particular cases of this theorem are also obtained.

Gahler introduced the notion of 2-metric space. Iseki establishes fixed point theorem in 2-metric space. Later on several authors establishes analogue of metric fixed point theorems in 2-metric spaces such as Lal *et al*. [14,18,19] and others. Recently Tiwari and Pandey [21] establishes a fixed point theorem for rational type contraction as follows:

"Let (X, d) be a complete 2-metric space and $T : X \to X$ a mapping satisfying for all $x, y, a \in X$ such that

$$d(T(x), T(y), a) \leq \alpha \frac{[p + d(x, T(x), a)][d(y, T(y), a)]^r [d(y, T(x), a)]^q}{1 + \mu d(y, T(x), a) + \eta d(x, T(y), a) + d(x, y, a)} + \beta d(x, y, a)$$
$$+ \gamma[d(x, T(x), a) + d(y, T(y), a)] + \delta[d(y, T(x), a) + d(x, T(y), a)],$$

where $p, q, r, \mu, \eta, \alpha, \beta, \gamma, \delta \in \mathbb{R}^+, \beta + 2\gamma + 2\delta \leq 1$. Then T has a unique fixed point in X."

In this paper we have generalized the above contraction mapping by increasing the number of parameters and extending it for two map and four map.

Some new results on ideal convergence of sequences in gradual normed linear spaces

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Abstract: The convergence of sequences has many extensions with the aim of providing deeper insights into summability theory. In 2001, the idea of $\mathcal{I}$ and $\mathcal{I}^*-$convergence of sequences in the metric space settings was introduced by Kostyrko et. al. mainly as an extension of statistical convergence. Recently, Choudhury and Debnath investigated this convergence concept in the gradual normed space settings. In the current paper, our goal is to introduce some more new results in this direction.

On Convergence of Complex Uncertain Series

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Abstract: We often encounter situations in our daily lives where there is scant or no evidence of the events, not only for the technical and economic problems but also for other unexpected events. Those inadequate data make it difficult to apply the probability distribution of events. To identify such issues, Liu first presented the idea of uncertainty theory. The idea of various convergence concepts of complex uncertain sequences was introduced by Chen et. al. in 2016. In this presentation, we shall introduce complex uncertain series and study some convergence concepts namely convergence in measure, convergence in mean, converges in distribution of complex uncertain series. We have observed that converges in mean does not imply converges in measure in case of complex uncertain series, although it is true for complex uncertain sequences.

Further generalization of $\theta - \phi$-contraction and fixed point results in G-metric spaces

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Abstract: We generalize further the concept of "generalized $\theta - \phi$-contraction" into three types and prove new fixed point results under these contraction conditions in the frame of G-metric spaces.
Method of fixed point is frequently used to find out solution of differential and integral equations. Mustafa Z. and Sims B.introduced G-metric space in 2006 as a generalization of metric space structure, and many fixed point results and results regarding coincidence point under several contraction conditions have been developed later on. θ-contraction was introduced by Jleli and Samet in 2014 in the frame of generalized metric spaces, $\theta - \phi$-contraction was introduced by D. Zheng *et al.* in2017 in the frame of metric spaces, which is a kind of generalization of θ-contraction. Recently, generalization of $\theta - \phi$-contraction has been done by D. Zheng in2018, named "generalized $\theta - \phi$-contraction" in G-metric space and developed a fixed point theorem under "generalized $\theta - \phi$-contraction". Development of fixed point theorems is usually done in many ways, one of which is- generalization or extension of contraction conditions. Motivating in this way, here we further generalize "generalized $\theta - \phi$-contraction" into three types and prove three new fixed point results under these three contraction conditions in the frame of G-metric space.

Result of fixed-point theorem in ordered quasi-partial metric space by using contraction mapping

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Abstract: In the current literature, we study in a right and left K-sequentially *O*-complete ordered partial-quasi metric space and find the result of fixed-point theorem by using quasi contraction mapping under the condition of a closed ball . In this article, the centre of our work is on fixed-point theorem in quasi-partial metric spaces. And it enhance so many popular results.

Operator norm attainment and Birkhoff-James orthogonality

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Abstract: In this paper we study orthogonality of bounded linear operators in the sense of Birkhoff-James on Banach spaces. Using this we explore the role of norm attainment set in the study of smoothness of bounded linear operators between two Banach spaces.

Stability Results Of Small Diameter Properties In Banach Spaces

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Abstract: In this talk we study three different versions of small diameter properties of the unit ball in a Banach Space. We introduce a new geometric property of Banach space, the Ball Huskable Property (*BHP*), namely, the unit ball has relatively weakly open subsets of arbitrarily small diameter. We compare this property to two related geometric properties, *BSCSP* namely, the unit ball has convex combination of slices of arbitrarily small diameter and *BDP* namely, the closed unit ball has slices of arbitrarily small diameter. We show *BDP* implies *BHP* which in turn implies *BSCSP* and none of the implications can be reversed. We prove similar results for the w^*-versions. We prove that all these properties are stable under l_p sum for $1 \leq p \leq \infty, c_0$ sum and Lebesgue Bochner spaces. Finally, we explore the stability of these with properties in the light of three space property. We show that *BHP* is a three space property provided X/Y is finite dimensional and same is true for *BSCSP* when X has *BSCSP* and X/Y is strongly regular.

Control and synchronization between non-identical chaotic systems

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Abstract: In this article, synchronization between two non-identical chaotic systems has been discussed. The Simple chaotic system is considered as drive system and Lu chaotic system is taken as response system. Nonlinear control method has been used to study the synchronization between chaotic systems. ABM method has been used for numerical simulations.

Soliton solutions of the (2+1)-Coupled DLW equations

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Abstract: The (2+1)-coupled dispersive long wave equations usually occur in the open sea or in wide channels. Some invariant solutions are derived by using the similarity transformations via the one-parameter Lie group of transformations. Solution profiles are represented through their animations to make them physically meaningful. The dynamics of solutions exhibit multisolitons, single and doubly solitons, kinks, and parabolic behavior. Results derived from this article are compared with the earlier results.

Some more invariant solutions of Coupled Equal Width Wave Equation

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Abstract: The coupled equal width wave equation in normalised form is reduced into a system of ordinary differential equations and then the Sine-cosine function method is employed to solve it further. A new variety of four solutions are obtained, which are supplemented by their animation profiles and show single hyperbolic and trigonometric wave nature.

An inverse problem for 2D and 3D convective Brinkman-Forchheimer equations Well-posedness of an inverse problem for two and three dimensional convective Brinkman-Forchheimer equations with the final overdetermination

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Abstract: In this talk, we consider an inverse problem for the following convective Brinkman-Forchheimer (CBF) equations:

$$\boldsymbol{u}_t - \mu\Delta\boldsymbol{u} + (\boldsymbol{u}\cdot\nabla)\boldsymbol{u} + \alpha\boldsymbol{u} + \beta|\boldsymbol{u}|^{r-1}\boldsymbol{u} + \nabla p = \boldsymbol{F} := \boldsymbol{f}g, \quad \nabla\cdot\boldsymbol{u} = 0,$$

in bounded domains $\Omega \subset \mathbb{R}^d$ $(d = 2, 3)$ with smooth boundary, where $\alpha, \beta, \mu > 0$ and $r \in [1, \infty)$. The CBF equations describe the motion of incompressible fluid flows in a saturated porous medium. This inverse problem aims to reconstruct the vector-valued velocity function $\boldsymbol{u}$, the pressure field p and the vector-valued function $\boldsymbol{f}$, from the measurement described as the final over determination condition. For arbitrary smooth initial data, the well-posedness result (existence, uniqueness and stablility) for the inverse problem for the 2D and 3D CBF equations are obtained by using Schauder's fixed point theorem. The well-posedness results hold for $r \geq 1$ in two dimensions and for $r \geq 3$ in three dimensions.

Some More Travelling Wave Solutions of the Rosenau Equation

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Abstract: The Rosenau equation (RE) arises in the dynamics of dense discrete systems. The Tanh method is utilized to solve the RE. Solutions have traveling wave nature and their profiles are represented through animation supplemented with the help of symbolic software MATLAB. Results are compared with existing Literature to show existence of novelty of the work.

Study of Chaotic Behaviour of a Third Order Wein Bridge Oscillator under Periodic External Force

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Abstract: The qualitative behaviour of the solution of a third order Wein bridge oscillator under periodic external force is studied. The bifurcation of thenature of the solution for different range of the parameters of the system reveal that the external periodic force generates an added layer of security which can be used to build a secure communication channel using the synchronization of chaos. Some specific windows of the parameters are identified over which such secure channel can be established.

Semi-Analytic Method for Studying Liver Metastases

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Abstract: Liver metastases, also known as secondary liver cancer, are cancerous tumors that spread to the liver from another region of the body. The majority of liver metastases begin as cancer in the colon or rectum, and up to 70 percentage of patients with colorectal cancer develop liver metastases (Rothbarth et al. 2005). In this study we will look at the existing reaction-diffusion model and the impact of drug therapy on liver metastatic disease. We shall utilize the variational iteration method (VIM), a well-known semi-analytical approach for solving linear and nonlinear ordinary and partial differential equations. The results provided by variational iteration method will be compared with the results of the existing model.

Existence of solution of nonautonomous systems with general nonlocal conditions

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Abstract: At present, the requirements of differential inclusion are kept in mind, in this article, we discuss existence of solution of nonautonomous differential inclusions with general nonlocal conditions in the reflexive Banach spaces. The condition considered here is fairly general and includes the initial value problem, the periodic and anti-periodic problem and more general two point problems as well as several nonlocal conditions. Also, we use a most general growth condition on the nonlinear function which generalises several growth condition such as sublinear or superlinear growth condition etc. Finally, an example is given related to the application in population biology.

Approximate controllability of nonlocal delay differential equations of fractional order using an approximating technique

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Abstract: In this paper, we apply an approximating technique to derive the existence and controllability results for nonlocal fractional differential equations with finite delay in a Hilbert space. To establish the results, we take some weaker conditions on the nonlocal initial condition, that is, the nonlocal initial condition is taken as continuous functions only instead of Lipschitz continuous function. The main tools applied in our analysis are semigroup theory, fractional calculus, approximating technique, and fixed point theorems. Finally, we illustrate the main results with the help of an example.

A Fuzzy Non-Linear Model for Reservoir Management System Using Numerical Simulation

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Abstract: The fundamental component of water-management systems is reservoirs. Uses of storage water conservation, flood control, water treatment, and the aquatic environment are the most common functions of the reservoir. Reservoir management must follow a dynamic process, aims to identify the uncertainties affecting behavior and reduce their impact on the field performance. We attempt to formulate a fuzzy model of a reservoir system and its operations. Representation of reservoir operations expresses by a system of fuzzy non-linear differential equations. For generalization, consider the rate of supply as a function of temperature, soil fertility, and reservoirâĂŹs topographic location (altitude from sea level). Derive the reproduction number at the equilibrium point for a fuzzy parameter. Discuss the local and global stability analysis with the use of variation in a fuzzy parameter. Simulate the derived model that describes the typical operation of the reservoir system that gives the stable utility solution for the various reservoirs.

On Ricci semi-symmetric super quasi-Einstein Hermitian manifold

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Abstract: The present paper deals the study of a Bochner Ricci semi-symmetric super quasi-Einstein Hermitian manifold and a holomorphically projective Ricci semi-symmetric super quasi-Einstein Hermitian manifold.

Geometry on Kaehlerian Weyl-conformal and Weyl-coharmonic recurrent curvature manifolds

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Abstract: Ozdemir & Yildirim (2005) has premeditated on conformally recurrent Kaehlerian weyl spaces. Also, Negi et al. (2019) has studied analytic HP-transformation in almost Kaehlerian spaces. In this paper, we have calculated geometry on Kaehlerian weyl-conformal and weyl-conharmonic recurrent curvature manifolds and some theorems are obtained.

Index of certain Stiefel manifolds

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Abstract: Kakutani's theorem in geometry states that every convex subset of $\mathbb{R}^3$ may be inscribed in a cube. Earlier proofs of this theorem and it's generalizations were one of the first important results in topological combinatorics. We discuss a new proof of this result using equivariant cohomological index of Stiefel manifolds.

Certain observations on Bornological covering properties

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Abstract: Using the idea of strong uniform convergence (Beer and Levi, 2009; Caserta et al., 2010) on bornology, Caserta et al. (2012) studied open covers and selection principles in the realm of metric spaces (associated with a bornology) and function spaces (w.r.t. the topology of strong uniform convergence). Following in this direction, we present certain observations on bornological covers of X and investigate selection principles related to these bornological classes covers. We present a diagram describing implications among these selection principles on X. Game theoretic characterization of certain selection principles are presented. We also introduce the notion of strong-$\mathfrak{B}$-Hurewicz property and investigate some of its consequences. Characterization of some topological properties of $(C(X), \tau^s_{\mathfrak{B}})$ are also presented.

Index of free $\mathbb{S}^1$ and $\mathbb{S}^3$-spaces and equivariant maps

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Abstract: Conner and Floyd defined index and co-index for paracompact Hausdorff spaces X equipped with free involution. We extend these definition of indices for free G-spaces X, where $G = \mathbb{S}^1 d, d = 1$ or 3. The cohomology classification of the orbit space X/G for the spaces X whose cohomology ring is the same as product of spheres $\mathbb{S}^n \times \mathbb{S}^m, 1 \leq n \leq m$ are also discussed. Using these calculations, we discussed non-existence of equivaraiant maps between space X and sphere $\mathbb{S}^{(d+1)k+d}, d = 1$ or 3.

Pseudo-generalized projectively symmetric Ricci-recurrent space-time

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Abstract: The object of the present paper is to study pseudo generalized projectively sym- metric Ricci-recurrent space-time. In this paper, it is proved that on pseudo gen- eralized projectively symmetric Ricci-recurrent manifold of dimension n ($n \geq 4$) if $r \neq 0$, then $\frac{r}{2}$ is an eigenvalue corresponding to the eigen vector μ. Also, it is ob- served that if in a pseudo generalized projectively symmetric Ricci-recurrent perfect fluid space-time obeying EinsteinâĂŹs field equation with cosmological constant and non-zero constant scalar curvature having matter content as a perfect fluid whose velocity vector field is the vector field corresponding to the 1-form A, then the accel- eration vector of fluid and expansion scalar must vanish. Finally, it is proved that a pseudo generalized projectively symmetric Ricci-recurrent dust fluid space-time obeying EinsteinâĂŹs field equation without cosmological constant is vacuum.

Projective change between two (α, β)-metrics

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Abstract: In the present paper, we find the conditions to characterize the projective change between Finsler spaces with (α, β)-metrics such as exponential metric $F = \alpha e^{\beta/\alpha}$ and Kropina metric $\bar{F} = \frac{\bar{\alpha}^2}{\bar{\beta}}$ on a manifold M with dimension $n > 2$, where α and $\bar{\alpha}$ are two Riemannian metrics, β and $\bar{\beta}$ are two non-zero one-forms. Moreover, we consider this Projective change when exponential metric has some special curvature properties.

Hypersoft matrices

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Abstract: In this paper, Hypersoft matrices are defined based on hypersoft set and we have extended some ideas from soft matrices to hypersoft matrices. The fundamental operations AND, OR, Union, Intersection of hypersoft matrices are defined with suitable example. Idempotent, Commutative, Associative, Distributive, DemorganâĂŹs laws of hypersoft matrices are examined.

Some inequalities on null hypersurfaces of a Lorentzian manifold

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Abstract: We study null hypersurfaces of a Lorentzian manifold with a closed rigging for the hypersurface. We derive inequalities involving Ricci tensors, scalar curvature, squared mean curvatures for a null hypersurface with a closed rigging of a Lorentzian space form and for a screen homothetic null hypersurface of a Lorentzian manifold. We also establish a generalized Chen-Ricci inequality for a screen homothetic null hypersurface of a Lorentzian manifold with a closed rigging for the hypersurface.

(ϵ)-Kenmotsu maniford admitting canonical paracontact connection

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Abstract: The purpose of the present paper is to study various geometric properties of (ϵ)-Kenmotsu manifold with respect to canonical paracontact connection. A unique relation between curvature tensors of canonical paracontact connection and Levi-Civita connection have been developed. We study quasi-M-projectively flat as well as M-projectively flat (ϵ)-Kenmotsu manifold with respect to canonical paracontact connection. Moreover, it is shown that a ϕ-M-projectively flat (ϵ)-Kenmotsu manifold with respect to canonical paracontact connection is an η-Eienstain Manifold. Also, we study (ϵ)-Kenmotsu manifold with respect to canonical paracontact connection satisfyiny $\bar{M}(\xi, U).\bar{R} = 0$, where $\bar{M}$ and $\bar{R}$ denotes M-projective curvature tensor and curvature tensor with respect to the canonical paracontact connection respectively.

On M-projective curvature tensor of para-Kenmotsu manifold admitting Zamkovoy connection

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Abstract: The purpose of the present paper is to study various geometric properties of para-Kenmotsu manifold with respect to Zamkovo connection. A unique relation between curvature tensors of Zamkovo connection and Levi-Civita connection have been developed. We study quasi-M-projectively flat as well as M-projectively flat para-Kenmotsu manifold with respect to Zamkovo connection. Also, we study para-Kenmotsu manifold with respect to Zamkovo connection satisfying $\bar{M}(\xi, U).\bar{R} = 0$, and $\bar{M}.\bar{S} = 0$ on para-Kenmotsu manifold admitting Zamkovoy connection, where $\bar{M}$, $\bar{R}$ and $\bar{S}$ denotes M-projective curvature tensor, curvature tensor and Ricci tensor with respect to the Zamkovo connection respectively.

Generalized conformal curvature tensor of LP-Sasakian manifold

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Abstract: The object of the present paper is to generalize conformal curvature tensor of LP-Sasakian manifold with the help of a new generalized $(0, 2)$ symmetric tensor $\mathcal{Z}$ introduced by Mantica and Suh. Various geometric properties of the generalized conformal curvature tensor of LP-Sasakian manifold have been studied. It is shown that a generalized conformal ϕ-Symmetric LP-Sasakian manifold is an η-Einstein manifold.

Geometry of lightlike submanifolds

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Abstract: We study radical screen transversal lightlike submanifolds of an indefinite Kaehler manifold admitting a quarter-symmetric non-metric connection. We also obtain a necessary and sufficient condition for the screen distribution of a radical ST-lightlike submanifold to be integrable. Further we study totally umbilical radical ST-lightlike submanifolds and obtain some characterization theorems for a radical ST-lightlike submanifold to be a lightlike product manifold. Finally we establish some results regarding the vanishes of null sectional curvature

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The geometry of pointwise slant lightlike submanifolds of indefinite hermitian manifold

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Abstract: We introduce pointwise slant lightlike submanifolds of indefinite Hermitian manifolds and obtain characterization theorems for their existence. We obtain some conditions for a pointwise slant lightlike submanifold to be a slant lightlike submanifold of an indefinite Kaehler manifold $\bar{M}$. We provide some non-trivial examples of pointwise slant lightlike submanifolds and also study totally umbilical pointwise slant lightlike submanifolds of $\bar{M}$. Finally, we emphasize on the study of minimal pointwise slant lightlike submanifolds of $\bar{M}$.

Numerical Analysis, Approximation Theory and Computer Science

Galerkin Finite Element Method for BenjaminâĂŞBonaâĂŞMahonyâĂŞBurgers equation

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Abstract: In this paper Galerkin finite element method (FEM) is constructed to compute approximate solutions of BenjaminâĂŞBonaâĂŞMahonyâĂŞBurgers (BBMB) equation. Firstly we obtained second order explicit scheme in time variable by taking time discretization of BBMB equation using Taylors series expansion. After that Galerkin FEM based on cubic B-splines is developed. Stability of proposed method is studied by Von-Neumann analysis. The applicability and accuracy of this method is demonstrated by comparing computed numerical solutions of some test examples by the present method with the exact and numerical solutions available in literature.

Convergence analysis of Tikhonov regularization with oversmoothing penalty for nonlinear statistical inverse learning problems

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Abstract: In this paper, we study the Tikhonov regularization scheme in Hilbert scales for the nonlinear statistical inverse problem with a general noise. The regularizing norm in this scheme is stronger than the norm in Hilbert space. We focus on developing a theoretical analysis for this scheme based on the conditional stability estimates. We discuss the high probability estimates of the direct and reconstruction error in terms of sample size. The rates of convergence are established over regularity classes defined through appropriate source conditions using the reproducing kernel approach. Our results improve and generalize previous results obtained in related settings.

Fractal Functions on Weighted Sobolev Spaces and Fractional Order Integral of Fractal Functions

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Abstract: Fractal interpolation function (FIF) is a special type of continuous function defined on a compact interval I of $\mathbb{R}$ which interpolates a certain data set and whose graph is of fractal nature. But α-fractal function is a special type of FIF which is fractal analogous corresponding to any continuous function f defined on the interval I. This article researches the existence of α-fractal function corresponding to any function from the weighted Sobolev space $\mathcal{W}_{\rho}^{r,2}(I)$ defined on a compact interval I. The convergence of sequences of α-fractal interpolation functions corresponding to functions from the space $\mathcal{W}_{\rho}^{r,2}(I)$ with respect to uniform norm and Sobolev norm are discussed. Also in this paper it is shown that Riemann-Liouville fractional order integral of α-fractal function of any function in $\mathcal{W}_{\rho}^{r,2}(I)$ is also a fractal interpolation function.

A priori error analysis for EHL point contact problem using interior-exterior penalty

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Abstract: In the present study, an interior-exterior penalty discontinuous Galerkin finite element method (DG-FEM) is analyzed for solving Elasto-hydrodynamic lubrication (EHL) point contact problems. The existence of discrete penalized solution is examined using Brouwer's fixed point theorem. Furthermore, the uniqueness of solution is proved using Lipschitz continuity of the discrete solution map under light load parameter assumptions. A priori error estimates are derived in L_2 and H_1 norms which are shown to be optimal in mesh size h and sub-optimal in polynomial degree p theoretically.

An efficient algorithm to solve damped forced oscillator problems by Bernoulli operational matrix of integration

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Abstract: An asymptotic perturbation solution for a linear oscillator of free damped vibrations in fractal medium described by local fractional derivatives was obtained in Yang and Srivastava (Commun Nonlinear Sci Numer Simul 29(1âĂŞ3):499âĂŞ504, 2015). In this paper, we obtain the numerical solution of damped forced oscillator problems by employing the operational matrix of integration of Bernoulli orthonormal polynomials. The operational matrix of integration is determined with the help of the integral operator on Bernoulli orthonormal polynomials. Numerical examples of two different problems of spring are given to delineate the performance and perfection of this approach and compared the results with the exact solution.

Solid Mechanics, Fluid Mechanics, Astrophysics and Relativity, and related areas

Effects of suction and blowing on generalized Von Kármán swirling flow

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Abstract: In this paper we have considered the rotating flow of a viscous fluid near a rotating disk of large radius. The disk rotates with uniform angular velocity Ω and the fluid far away from the disk rotates with an angular velocity ω. Depending on whether $\Omega > \omega$ or $\Omega < \omega$, one gets the Kármán flow profiles or the oscillatory Bödewadt flow profiles respectively. If we denote $\sigma = \frac{\Omega}{\omega}$, then unique solution exists for $\sigma > 0$. Computational challenges arise when $\sigma < 0$. For different ranges of values of $\sigma < 0$, there may exists unique solution, multiple solutions or no solution. Apart from these mathematical or computational challenges, this swirling flow problem has drawn the attention due to its immense industrial and practical applications. In this study we have focused on the heat transfer due to the generalized swirling flow for $\sigma > 0$. It is observed that when $\Omega < \omega$ (i.e when $0 < \sigma < 1$), the similarity equation for temperature does not admit a feasible solution, satisfying the asymptotic boundary condition. However, with the application of suction at the surface of the disk, the heat transfer equation admits feasible self-similar solution. On the other hand, heat transfer equation admits self-similar solution for all $\sigma > 1$. The numerical findings are supported by the physical interpretations.

Free Integrated Heat Dissemination through Radiating MHD Casson Fluid via Stretched Surface Thick Parameter

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Abstract: Through means of this specific paper, an endeavor is made towards dealing with Free Integrated Heat Dissemination in a $2D$ Magneto Hydrodynamic stream of Casson liquid over a Non-uniform thickness extending sheet within the sight of heating radiation alongside Non-uniform source or sink of Heat, particularly. In addition, various administering conditions pertaining to Dissemination of Heat and flow will likely be transformed into resource of non-linear ODEs and settled mathematically utilizing bvp4c package, specifically. Further, impact of appropriate boundaries, to be specific, attractive field boundary, Casson boundary, Heat radiation boundary, Non-uniform Heat source or sink boundaries, pertaining towards heat as well as flow dissemination will thereby be worked upon through means of mathematical applications, including diagrams as well. Thus, through means of such application, various relevant outcomes are figured for subsequent grinding factor alongside diminished Nusselt number, from where it shall be concluded that radiative properties of Heat, results in improving temperature aspects of Casson liquid, respectively.

MHD pulsating flow Au-blood micropolar nanofluid in a channel with thermal radiation and heat source/sink

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Abstract: The present work deals with the pulsating flow of Au-blood micropolar nanofluid with the presence of thermal radiation and Joule heating. Micropolar fluid is addressed as blood (base fluid) and Au(gold) as a nanoparticle. A perturbation technique is used to convert the partial differential equations (PDEs) is used to convert the PDE system into ordinary differential equations (ODEs), which are subsequently solved by using the shooting method with the Runge-Kutta fourth-order method. The impacts of various parameters on velocity, microrotation, temperature, and heat transfer rate of Au-blood micropolar nanofluid are presented graphically. The considered model is useful for nano-drug delivery, biological fluid modeling, and so on. The obtained results bring out that the velocity of nanofluid decreases over increasing the values of coupling parameter, magnetic field, and volume fraction of nanoparticles. The temperature profiles are reducing with an increment of radiation parameter, frequency parameter, and magnetic field. Further, the Nusselt number against frequency distribution is increasing by giving higher values of the Eckert number.

Pulsating hydromagnetic flow of couple stress nanofluid in a channel

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Abstract: The current study deals with the magnetohydrodynamic pulsating flow of blood-carrying alumina nanoparticles in a channel with the viscous dissipation and Joule heating effects. Couple stress fluid is treated as blood which is the base fluid. The Maxwell Garnett model for thermal conductivity of nanofluid is considered. The thermal radiation and heat source/sink impacts are taken into account. Analytical expressions for dimensionless flow variables are obtained by employing the perturbation method. In the view of broad applications in biological, engineering and emerging next generation technologies, we made an attempt to study the impacts of Joule heating and viscous dissipation on pressure driven flow of couple stress nanofluid in a channel in the presence of the magnetic field. The impression of active parameters on flow variables is graphically presented. The obtained results show that there is an enhancement in temperature of nanofluid with increasing viscous dissipation, whereas there is a decrease in temperature with an increase in the applied magnetic field. The Nusselt number rises with an enhancement in volume fraction of nanoparticles and Hartmann number at both the walls.

Joule heating and thermal radiation effects on hydromagnetic pulsating flow of alumina blood Oldroyd-B nanofluid in a channel

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Abstract: In this present study, investigated the influence of the hydromagnetic pulsating flow of alumina blood Oldroyd-B (non-Newtonian) nanofluid in a channel with presence of Joule heating and thermal radiation. Magnetic field and viscous dissipation effects are taken into account. Alumina taken as nanoparticles and blood as base fluid (Oldroyd-B fluid). The present study is important in engineering and biological models. Assumed that the flow is fully developed and induced by a pressure gradient. Analytical solutions for flow variables are obtained using the perturbation method. The impacts of different parameters on temperature and rate of heat transfer have been analysed through graphical results.

MHD pulsatile flow of third grade nanofluid in a channel with thermal radiation and Joule heating effects

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Abstract: The current exploration deals with the third grade hydromagnetic pulsating flow of blood-gold nanofluid in a channel with the presence of Ohmic heating, viscous dissipation and radiative heat. In the present analysis, blood (base fluid) is considered as third grade fluid and gold (Au) as nanoparticle. Perturbation method is employed to transform the set of governing partial differential equations (PDEs) into the ordinary differential equations (ODEs) and then solved by employing the fourth order Runge-Kutta method with the aid of the shooting technique. The impacts of emerging dimensionless parameters of velocity, temperature, and heat transfer rate of blood-Au nanofluid are analysed via pictorial outcomes in detail. The obtained results depict that the improvement in viscous dissipation and heat sink/source enhanced the temperature of third grade nanofluid. Intensifying the volume fraction of nanoparticle dwindles the velocity and temperature of nanofluid. Enhancing volume fraction accelerates the heat transfer rate of nanofluid. The velocity, temperature, and heat transfer rates are decreased by an escalation of the magnetic parameter. Further, enhancing the radiation parameter reduces the heat transfer rate and temperature of nanofluid.

Analytical cosmological solutions and growth index of matter perturbations in symmetric teleparallel gravity

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Abstract: Geometrically, besides the curvature, torsion and non-metricity are also the fundamental objects associated with the manifold's connection determining the gravity. Depending on the choice of connection, one can classify the theories of gravity into three classes. The symmetric teleparallel gravity uses a curvature and torsion-free connection, which is not metric compatible. In this theory, one considers a flat and vanishing torsion connection where gravity is described by a non-metricity scalar Q The singularity structure analysis pioneered by Kovalevskaya, PainlevÃl', and contemporaries plays an increasingly important role. In this work, we analyze the behavior of the field equations for the Friedmann universe in the gravity mentioned above from the viewpoints of dynamical system and singularity analyses.
Finally, for a direct confrontation with growth data and to distinguish between different scenarios that may lead to the same background evolution, we shall compute the growth of matter perturbations. The investigation reveals that the varying growth index is different from that of the standard model throughout the evolution. This deviation is an essential observational signature, which can be related to the nature of gravity.

An exact solution of vibration of simply supported isotropic rectangular plate

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Abstract: In this paper, Krylov-Duncan functions method is adopted to obtain the exact solution for the free vibrations of simply supported isotropic rectangular plate based on KirchhoffâĂŹs plate theory. This method provides an explicit expression to compute the dimensionless frequencies of the plate for any mode of vibration which is useful to visualize the vibration behaviour of the simply supported rectangular plates. The well-known HamiltonâĂŹs energy principle is used to derive the governing equation of motion. The exact solutions are acquired for various values of aspect ratio of the plate. To validate the present results, comparisons are made with those available in the literature. An excellent agreement of the results shows the versatility of the method. To the best of the authorâĂŹs knowledge, this exact method is used first time to obtain the frequency of simply supported isotropic rectangular plate.

Higher Dimensional Bianchi Type-V Magnetized Dark Energy Cosmological Models in Barber's Second Self Creation Theory of Gravitation

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Abstract: We have studied the five-dimensional LRS Bianchi type-V universe filled with magnetized dark energy in Barber's second self-creation theory. We have considered Energy momentum tensor constitutes of anisotropic fluid with EoS parameter ω and energy density ρB with the uniform magnetic field. The volumetric expansion and power-law expansion are taken into account to get exact solutions to the field equations. The mathematical expressions for all the physical and kinematical parameters have been obtained for exponential and power-law models. Also, we have discussed the behaviour of these parameters with graphical representation.

Interactions of magneto micropolar thermoelastic rotating medium with Memory dependent derivative

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Abstract: In this paper, a novel approach to magneto - micropolar thermoelasticity is developed in the framework of a heat conduction equation having memory - dependent derivative. The governing equations have been employed in a half - space which is subjected to ramp - type thermal shock. Normal mode analysis along with the potential displacement approach has been used to obtain the solution and derive components of temperature distribution, displacement components, force stress components and couple stress components.

Unsteady Hydromagnetic Viscoelastic Fluid Flow and Heat Transfer due to Heat Flux and Thermal Radiation over a Stretching Permeable Sheet in Porous Medium

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Abstract: The study intends to examine the impact of heat flux and thermal radiation on unsteady hydromagnetic viscoelastic fluid and heat transfer past a stretching permeable sheet in porous medium with mass suction/blowing. The viscoelastic nature of the fluid is exhibited by non-Newtonian Walters Liquid (Model *B'*), a non-Newtonian fluid model. The fluid motion is governed by the time dependent boundary layer momentum and energy equations along with suitable boundary conditions. The coupled and highly non-linear governing equations are reduced to self-similar form employing appropriate similarity variables. The MATLAB solver `bvp4c` is utilized to obtain the numerical solutions of fluid guided equations. The evaluated results of velocity and temperature are plotted for discussion from physical standpoint to observe the impacts of heat flux, thermal radiation, viscoelasticity, magnetic field, permeability, applied suction on the unsteady flow and heat transfer. It is noticed that the velocity profile enhances with the growth of viscoelastic, unsteadiness, magnetic and permeability parameters whereas temperature of the fluid reduces with the growth of same parameters. The applied suction and blowing diminishes the fluid motion as well as temperature of the fluid. The growing values of Prandtl number hinders the transition of thermal energy but radiation parameter enhances the temperature of the fluid.

Three Dimensional Conducting Flow of Chemically Reactive Eyring-Powell Fluid Over a Porous Stretching Sheet with Heat generation/absorption and Soret Effects.

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Abstract: The three-dimensional hydromagnetic flow of an Eyring-Powell non -Newtonian fluid on a bilinear stretching sheet embedded porous medium has been considered to investigate the thermal radiation , heat generation/absorption, soret effect and first ordered chemical reaction . The corresponding non-linear partial differential equations (PDEâĂŹs) are transmuted into set of ordinary differential equations (ODEâĂŹs) by means of similarity transformations. The resulting coupled non-linear equations are evaluated numerically by employing boundary value problem default solver in MATLAB bvp4c package. Pertinent results are graphically represented in the analysis of various physical parameters of velocity, temperature and concentration distributions. Moreover, the numerical values of skin-friction factor, rate of heat and mass transfers are tabulated.

Reflection phenomena of plane wave on pre-stressed piezoelectric-orthotropic substrate with stress-free/rigid boundary

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Abstract: This study delves with the reflection phenomenon of plane-waves due to incidence of quasi-longitudinal (QL) wave at a semi-infinite structure comprising of pre-stressed piezoelectric-orthotropic substrate (POS) with stress-free (Case-I) and rigid (Case-II) bounding surfaces. The compact-form expressions of reflection-coefficients (RCs) of reflected quasi-longitudinal (QL) wave, quasi-transverse (QT) wave and evanescent-electroacoustic (EA) wave for different cases of pre-stressed POS are deduced. To unravel effects of higher anisotropy in substrate, comparative analysis in pre-stressed transversely-isotropic piezoelectric substrate (TIPS) medium with stress-free (Case-III) and rigid (Case-IV) boundaries is carried out. PVDF and ALN materials are considered for numerical computations. For validation

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Emergence of various firing activities in excitable neuron model

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Abstract: In this article, we have considered a fractional order slow-fast excitable neuron model that generates elliptic bursting, mixed mode oscillations and fast- spiking for different parameter regimes. We investigate the bifurcation analysis of the model by considering external stimulus as predominant parameter. The fractional-order dynamics of the model helps in understanding the memory dependent phenomenon the excitable model. It can generate various firing patterns for certain types of excitable neuron models. We also explore how the complex firing activities of integer order system changes to different oscillations and for lower fractional-order the system converges to quiescent state. The firing frequency of the fractional-order excitable neuron model is less than the integer order model, although the first spike latency exists there. Further, we consider the two fractional-order neuron models and coupled them via electrical coupling to investigate the complete synchronization in the model.

A nonautonomous model for the effects of refuge and additional food on the dynamics of phytoplankton-zooplankton system

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Abstract: In this paper, a mathematical model for the interacting dynamics of phytoplankton-zooplankton is proposed. The phytoplankton have ability to take refuge and release toxins to avoid over predation by zooplankton. The zooplankton are provided some additional food to persist in the system. The phytoplankton are assumed to be affected directly by an external toxic substance whereas zooplankton are affected indirectly by feeding on the affected phytoplankton. We incorporate seasonal variations in the model, assuming the level of nutrients, refuge and the rate of toxins released by phytoplankton as functions of time. Our results show that when high toxicity and refuge cause extinction of zooplankton, providing additional food supports the survival of zooplankton population and controls the phytoplankton population. Prey refuge and additional food have stabilizing effects on the system; higher values of the former results in extinction of zooplankton whereas phytoplankton disappear for larger values of the latter. Seasonality in nutrients level and toxins released by phytoplankton generates higher periodic solutions while time-dependent refuge of phytoplankton causes the occurrence of a period-three solution. The possibility of finding additional food for zooplankton may push back the ecosystem to a simple stable state from a complex dynamics.

Delay induced chaos and its possible control in a seasonally forced eco-epidemiological model with fear effect and predator switching

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Abstract: Fear of predation risk may assert privilege to prey animals by restricting their exposure to potential predators, meanwhile it can also impose costs by constraining the exploration of optimal resources. In this article, we investigate the impact of fear on the dynamics of an eco-epidemiological switching model. We observe that both the force of infection and the fear factor affecting prey's reproduction carry out destabilizing role, while the system regains stability if the level of fear on disease transmission exceeds a certain threshold. We obtain an explicit expression for the basic reproduction number $\mathcal{R}_0$ and show that $\mathcal{R}_0 < 1$ leads to the total eradication of infection from the system. We extend our model by considering the fact that after sensing the predatory signals, prey takes some time for assessing the acute predation risk. To capture a more realistic scenario, we construct the forced model by seasonally varying the costs of fear, disease transmission rate and the degree of preference of predator. Seasonal patterns in these intrinsic parameters add complexity to the ecosystem functioning by inducing higher periodic and chaotic oscillations. The chaotic behaviour is also observed in the forced system for the delay in the fear effect on prey's reproduction. However, time lag in the fear effect on the infection dynamics potentially suppresses the prevalence of such chaotic disorder. Thus, our findings may help to provide important ecological insights into the dynamics of predator-prey interactions involving parasites.

A distribution-free continuous review production-inventory model with service level constraint

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Abstract: In this study, we consider a continuous review production inventory model that assembles lost sales and backorders with service level constraint. The study under consideration assumes that the distribution of demand during the lead-time is known partially. Consequently, the distribution-free procedure is applied to obtain a closed-form global optimal solution of production quantity, reorder level and lead-time in the random framework. Additionally, some results are presented using basic mathematical analysis to support the developed method. Numerical example is provided to illustrate the methods. Furthermore, sensitivity analysis is performed to present some managerial inferences.

An application of the three species predator-prey model under the influence of the Caputo fractional derivative

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Abstract: We have applied the dynamics of the three species model to depict the spread of pest in tea plants and their control by natural enemies in the frame of a fractional-order model. To minimize the damage on tea plants, harvesting term is introduced in the equation projecting the growth of tea leaves. Nature of interaction is presented in terms of Beddington-DeAngelis functional response. Dynamics of the projected model is surveyed with regard to boundedness, uniqueness and existence of the solutions. We analyze various points of equilibrium of the projected model and derived the conditions for the stability of these equilibrium points. Chaotic dynamics is examined by changing the values of various parameters and fractional derivative. Numerical computations are conducted to strengthen the theoretical findings.

Modified method to solve intuitionistic fuzzy programming

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Abstract: The objective of this paper is to introduce a modified method to solve intuitionistic fuzzy (I-fuzzy) linear programming problems. Using min-operator, Angelov's approach for I-fuzzy linear programming is non-compensatory and not provides a non-dominated solution in general. Present work introduces a two phase method to obtain a non-dominated and balanced solution. The validity and effectiveness of the proposed study is given through a numerical example.

Impact of screening and saturated treatment on spread of COVID-19 in India: A mathematical study

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Abstract: The spread of COVID-19 has devastating effect on world population. The spread of infection via individuals not showing symptoms is one of the peculiar characteristic of the COVID-19 which is causing hurdle in controlling the disease among other factors. In this work, we propose and analyse a compartmental mathematical model which accounts for screening of the asymptomatic individuals and providing treatment to actively infected cases. The screening is having two components: one - a baseline constant screening and another- infective density induced additional screening (IDIAS). The IDIAS is additional screening which is based on number of infective cases reported. The model is analyzed analytically and fitted with the data set for two states of India with high infection load. The effective contact rate and treatment rate are estimated. Based on these estimations the effect of the epidemic for the next three months are projected. We also provide the effect of various control factors on the spread of disease. It is observed that the availability of treatment and screening of asymptomatic people play major role in reducing the disease burden.

Painleve property satisfied two types of three species self interacting food chain models

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Abstract: Painleve Property analysis of eleven parameters dependent self interacting two types of three species food chain models are studied. Unlike known three species models, these models are of Painleve types. One of them is strongly Painleve type having long time scale stability whereas, the other type is weakly Painleve type with weak long time scale stability. The strong Painleve type model depends on two parameters as control parameters, so the system may produce instability leads to chaos when the control parameter varies, then goes to a weakly Painleve type system. As such these systems can be used to demonstrate healthy body with strong immunity to any diseases and a weak body that prones to diseases and its curing process.

Method for Solving Fully Fuzzy Linear Programming Problems using symmetric Trapezoidal Fuzzy number

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Abstract: This paper exhibits a novel approach for solving Fully Fuzzy Linear Programming Problems with Symmetric Trapezoidal Fuzzy Numbers and the obtained results are compared with the results of existing approaches. In the proposed method We convert the FFLP problem into an equivalent crisp Linear Programming problem (LPP) by defuzzifying symmetric Trapezoidal Fuzzy Numbers. We show that the method proposed in this study is simpler and computationally more efficient than FLP methods used in the literature.
At the end of the paper a numerical example is incorporated to approve the proposed approach.

The PrisonerâĂŹs Dilemma for India and China: Ladakh LAC Dispute

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Abstract: Abstract- The well-known PrisonerâĂŹs Dilemma game is as often as possible applied to arms races between two nations. It is expected that every nation has a decision between a high or low degree of arms. Every nation's most-favored result is thought to be the place they pick high arms and their enemies low, increasing an unmistakable military preferred position. The present paper deals with application of prisonerâĂŹs dilemma among two Asian Giants India and China to establish peace at the LAC. In this paper, we have discussed the strategies of both countries in the war field. When two opponents are facing each other, they have several options to adopt and they choose the best option at their end. We have analysed the options of both countries of opposing forces of actions and also compared the available courses of action to maintain peace.

Advantage of First-mover in a Game

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Abstract: The purpose of this paper is to explain the advantages of the first mover game. In the first mover game theory, the player can get higher payouts by playing the first trick and he can change the game sequentially to get the first payout provided he takes the initiative in the game first. First-mover advantages exist if a company is better off, on average, by entering a certain market first rather than entering later (Lieberman and Montgomery 1988). The first-mover advantage can be derived from initial purchase of resources or technical leadership. One can gain competitive advantage through control of resources if the first participant enters the market. If these branches of game theory the first mover sequential game, to helps us decide for more profit, when we have a lot of time, and which decision is right for us so that we get the best outcome.

A Two-Phase Model of Fluid Injection Inside Subcutaneous Tissue

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Abstract: Being motivated by the delivery of drugs and vaccines through injection in human bodies, we theoretically investigate a two-dimensional mathematical model of drug delivery through subcutaneous injection. As most of the biological tissues behave as deformable porous material with anisotropic hydraulic conductivity, one can use biphasic mixture theory equations to describe the behaviour of the interstitial fluid and adipose cell present in the subcutaneous layer considering both of them as similar continuum. While injecting a drug to a patient, a medical staff used to lift the skin between the thumb and two fingers with one hand to pull the skin and fat away from the underlying muscle. When the skin is pulled up, the ratio of the mean depth of the subcutaneous layer to the average distance is supposed to be small enough. As a result, such ratio (denoted as δ) can be chosen as a perturbation parameter with $\delta^2 \sim 0.01$. The field equations are solved by the perturbation approximation up to $O(\delta^2)$. The mechanical response of the subcutaneous tissue is investigated in terms of the variation of anisotropic hydraulic conductivity, the viscosity of the injected drug, the mean depth of subcutaneous tissue, etc. The injected drug along with interstitial fluid create eddy structures near the line of injection (primary eddy) and at the crest region (secondary eddy) where the skin is lifted. The creation of such primary eddy structure is due to the hight pressure around there whereas the secondary one is resulted due to larger anisotropic ratio and lower viscosity ratio. Moreover, this study gives an impression on the pain realized by a patient with the help of pressure gradient and shear stress.

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