INDIAN MATHEMATICAL SOCIETY

INDIAN MATHEMATICAL SOCIETY

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

http://www.indianmathsoc.org

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NEWSLETTER

NO. 49

April 2023

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.

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A BRIEF REPORT OF THE 88^{th} ANNUAL CONFERENCE OF THE IMS

The 88th Annual Conference of the IMS - An International Meet took place at Birla Institute of Technology (BIT), Mesra, Ranchi, Jharkhand during December 27-30, 2022. Inaugural function of the conference was held from 9.00 a. m. to 10.00 a. m. in the CAT hall of the Institute. Prof. S. D. Adhikari, the President of the IMS presided over the function and Prof. Manindra Agarwal was the Chief Guest. The dignitaries on the dias included Prof. Indranil Manna, the Vice Chancellor of the Institute, Prof. M. M. Shikare, the General Secretary of the IMS, Prof. Manindra Agrawal, IIT Kanpur, Prof. Raja Sekhar, the Academic Secretary of the IMS and Prof. S. Padhi, the Local Organizing Secretary of the Conference. Prof. Manna welcomed the participants, delegates and speakers of the conference in his introductory remarks. Prof. Shikare took a brief review of the activities of the IMS and made announcements of various prizes and awards given by the IMS. The Academic Secretary briefed about the highlights of the academic programme of the conference. Prof. Agrawal expressed his views as a chief guest of the function. Prof. Adhikari, gave a General Talk in the inaugural function. Prof. Padhi offered vote of thanks.

The academic programme of the conference was excellent. The programme included two plenary talks [by Peter Sarnak (Princeton Uni., USA) and Prof. Noga Alon (Princeton Uni., USA)], One popular talk, Four Memorial Award Lectures, Twelve invited talks and Six symposia. A special paper presentation session, for various prizes, was held on the first day of the conference. 133 research papers were received for contributory presentation in the conference. To encourage young scholars, 6 poster presentations were accepted.

Brief details of the academic activities are given below.

The first **plenary talk** was delivered by Prof. Peter Sarnak, Institute of Advanced Study, Princeton, USA., on "Prescribing the spectra of locally uniform geometries". The second **plenary talk** was given by Prof. Noga Alon, Princeton University, USA on "Constructive and non-constructive combinatorics". Prof. Manindra Agrawal, Department of Computer Science and Engineering, IIT Kanpur delivered a **popular talk** on "SUTRA: A model for COVID 19 pandemic".

The 36^{th} **P. L. Bhatnagar Memorial Award Lecture** was delivered by Prof. A. Adimurthi, TIFR-CAM, Sharadanagar, Bengaluru, India on "Critical point theory in PDE".

The 33^{nd} **V. Ramaswami Aiyar Memorial Award Lecture** was delivered by Prof. Debashish Goswami, Stat-Math Unit, Indian Statistical Institute, Kolkata, India on "Quantum symmetry of classical and noncommutative spaces ".

The 33^{nd} **Srinivasa Ramanujan Memorial Award Lecture** was delivered by Prof. Sudesh Kaur Khanduja, Indian Institute of Science Education and Research, Mohali, India on "A walk through irreducible polynomials ".

The 33^{nd} **Hansraj Gupta Memorial Award Lecture** was delivered by Prof. Apoorva Khare, Department of Mathematics, Indian Institute of Science, Bangalore, India on "Polymath 14: Groups with norms ".

A. K. Agarwal Award for the year 2022: This award has been given to Janaki Raman Babu and Prosenjit Das, Indian Inst. of Space Sc. and Tech., Thiruvanthapuram for their paper entitled Structure of A^2 fibrations having fixed point free locally nilpotent derivatives published in the Journal of Pure and Applied Algebra, Vol. 225 (12) (2021), 106763 (doi.org/10.1016/j.jpaa.2021.106763). The award consists of Rs 10,000 (Rs. 5000/- 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.

A. M. Mathai Award for the year 2022. This award was given to Timir Karmakar, NIT Meghalaya, Shillong, Meghalaya for his paper entitled Physics of unsteady Couette flow in an anisotropic porous medium published in the Journal of Engineering Mathematics, Vol. 130 (1),

Article id.: 8 (2021) (doi;10.1007/S10665-021-10165-9). The award consists of Rs. 25,000 and a citation. The award was given every year to author of a best paper published in the area of Applicable Mathematics (preferably having applications in other fields).

P. K. Jain Award for the year 2022: This award has been given to Gopal Datt, Department of Mathematics, Babasheb Bhimrao Ambedkar University, Lucknow for his paper Meromorphically Normal Families in Several Variables published in Computational Methods and Function Theory 22, 307-321 (2022). The award consists of Rs 25, 000 and a citation. The award is given every year to the author of the best paper in the areas of Functional Analysis, Complex Analysis, Harmonic Analysis, Function Theory and related areas.

Subhash Bhatt Award for the year 2022: This award has been given to Keshab Chandra Bakshi, Chennai Mathematical Institute, Chennai and Ved Prakash Gupta, Jawaharlal Nehru University, Delhi for their paper entitled Lattice of intermediate subalgebras published in J. London Math. Soc. (2) 104 (2021) 2082-2127 (doi: 10.1112 / jlms. 12492). The Award consists of Rs 25,000 (Rs 12500/- each) and a citation. The award is given every year for the best paper in the areas of Functional Analysis, Harmonic Analysis, Operator Theory and related areas.

Satish Bhatnagar Award for the year 2022: No suitable paper was received for this award. Therefore this award has not been given to anyone this year.

B. N. Waphare Award for the year 2022: No suitable paper was received for this award. Therefore this award has not been given to anyone this year.

A. Narasinga Rao Memorial Prize for the year 2022: This prize has been given to Chaitanya Ambi, Chennai Mathematical Institute, Chennai for his paper entitled An estimate of the growth of cohomology with coefficients published in The Journal of the Indian Mathematical Society, Volume 88 (nos. 3-4) (2021), 187-200. The Narasinga Rao prize of the IMS is given every year to the best paper published in JIMS or in Math Student published by the IMS. It carries a cash prize of Rs 4,000 (four thousand) and a citation.

P. L. Bhatnagar Memorial Prize for the year 2022: 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 (IMO). The award this year has been given to Mr Pranjal Srivastava, Bangalore, who was the top scorer of the Indian team at the IMO held at Oslo, Norway during July 6 16, 2022.

To encourage young researchers, the Indian Mathematical Society organizes Paper Presentation Competition which includes six IMS prizes, AMU Prize and V M Shah Prize.

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

IMS Prize - Group-1: One paper was received in this group, but it was not presented in the conference.

IMS Prize - Group-2: No papers were received in this group.

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

IMS Prize - Group-4: One paper was received in this group and it was presented in the competition. Prize is awarded to Rahul Barthwal, Department of Mathematics, IIT Kharagpur, Kharagpur, India

IMS Prize - Group-5: No papers were received in this group.

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

AMU Prize: One paper was received for AMU Prize, it was presented in the conference but prize was not given to the paper.

V. M. Shah Prize: No papers were received for V. M. Shah Prize.

The following Invited Lectures were delivered
(1) Prof. Mahesh Kakde, IISc, Bengaluru (one hour talk)
(2) Prof. Nitu Kumari, IIT Mandi
(3) Prof. R Radha, University of Hyderabad, Hyderabad
(4) Prof. A Swaminathan, IIT Roorkee
(5) Prof. Shiv Datt Kumar, MNIT Allahabad
(6) Prof. Pradyumn Kumar Sahoo, BITS Hyderabad
(7) Prof. Shalini Gupta, Panjabi University, Patiala

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

(1) Commutative Algebra: Convenor: Ramakrishna Nanduri, IIT Kharagpur
(2) History of Ancient Indian Mathematics: Convenor: Aditya Kolachana, IIT Madras
(3) Number Theory: Convenor: P. Sanoli Gun, IMSc, Chennai
(4) Water Wave Mechanics: Convenor: Swaroop Nandan Bora, IIT Guwahati
(5) Discrete Mathematics: Convenor: Vinayak Joshi, Savitribai Phule Pune University, Pune
(6) Financial Mathematics: Convenor: Anindya Goswami, IISER Pune

The convenors of various symposia identified all the speakers.

Obituary

It is with a deep sense of sorrow and grief that IMS informs the sad and sudden demise of Prof. S. K. Nimbhorkar on Saturday, 11^{th} February, 2023 early morning. May his soul rest in peace.

MINUTES OF THE 88^{th} ANNUAL GENERAL BODY MEETING OF THE IMS.

The Annual General Body Meeting of the Indian Mathematical Society was held on Friday, the 30th December 2022 at 12.00 noon in the meeting hall of the Birla Institute of Technology (BIT), Mesra, Ranchi, Jharkhand under the presidentship of Prof. S. D. Adhikari.

The following business was transacted.

Item No. 1. To confirm the Minutes of the General Body meeting held on December 7, 2021 at 12.00 noon by online mode from Mahatma Gandhi Mission University, Aurangabad (M. S.) using zoom meeting app.

The Minutes of the General Body meeting held on December 7, 2021 by online mode were confirmed.

Item No. 2 : To receive the report of the General Secretary.

Report of the General Secretary for the year 2022.

(i). Newsletters: The IMS newsletters number 47 and number 48 were published in March 2022 and in August 2022, respectively. These were also uploaded on the website of the Indian Mathematical Society. The soft copies of the 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 with effect from April 1, 2022 were sent to them and their acceptances were received.

2. APC Meeting-2022: An online meeting of the Academic Planning Committee (APC) for the IMS Conference 2022 to be held at Birla Institute of Technology (BIT), Mesra, Ranchi (Jharkhand) was held on Wednesday, the 1st June 2022 from 11.00 a.m. to 1.00 p.m. The meeting was presided over by the President of the IMS, Prof. S. D. Adhikari, Ramkrishna Missions Vivekanand Educational and Research Insitute, Belur, Kolkata. The academic programme of the 88th Annulal Conference of the IMS An International Meet was finalized.

3. A. Narasinga Rao Memorial Prize for the year 2022: This prize has been given to Chaitanya Ambi, Chennai Mathematical Institute, Chennai for his paper entitled An estimate of the growth of cohomology with coefficients published in J. Indian Math. Soc., Vol. 88 (nos. 3-4) (2021), 187-200. The Narasinga Rao prize of the IMS is given every year to the best paper published in JIMS or in 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 2022: This award has been given to Janaki Raman Babu and Prosenjit Das, Indian Inst. of Space Sc. and Tech., Thiruvanthapuram for their paper entitled Structure of A^2 fibrations having fixed point free locally nilpotent derivatives published in the Journal of Pure and Applied Algebra, Vol. 225 (12) (2021), 106763 (doi.org/10.1016/j.jpaa.2021.106763). The award consists of Rs 10,000 (Rs. 5000/- each) and a citation.

5. A. M. Mathai Award for the year 2022. This award is given to Timir Karmakar, NIT Meghalaya, Shillong, Meghalaya for his paper entitled Physics of unsteady Couette flow in an anisotropic porous medium published in the Journal of Engineering Mathematics, Vol. 130 (1), Article id.: 8 (2021) (doi;10.1007/S10665-021-10165-9). The award consists of Rs. 25,000 and a citation.

6. Subhash Bhatt Award for the year 2022: This award has been given to Keshab Chandra Bakshi, Chennai Mathematical Institute, Chennai and Ved Prakash Gupta, Jawaharlal Nehru University, Delhi for their paper entitled Lattice of intermediate subalgebras published in J. London Math. Soc. (2) 104 (2021) 2082-2127 (doi: 10.1112 / jlms. 12492). The Award consists of Rs 25,000 (Rs 12500/- each) and a citation.

7. P. K. Jain Award for the year 2022: This award has been given to Gopal Datt, Department of Mathematics, Babasheb Bhimrao Ambedkar University, Lucknow for his paper Meromorphically Normal Families in Several Variables published in Computational Methods and Function Theory 22, 307-321 (2022) [DOI:10.1007/s40315-021-00413-5]. The award consists of Rs 25, 000 and a citation.

8. Satish Bhatnagar Award for the year 2022: No suitable paper was received for this award. Therefore this award has not been given to anyone this year.

9. B. N. Waphare Award for 2022: No suitable paper was received for this award.

10. P. L. Bhatnagar Memorial Prize for the year 2022: 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 (IMO). The award this year has been given to Mr Pranjal Srivastava, Bangalore, who was the top scorer of the Indian team at the IMO held at Oslo, Norway during July 6 16, 2022.

11. Construction of Mathematics Bhavan in Pune. The Chairman of the Fundraising Committee, Prof. S. Arumugam, visited the Department of Mathematics, Savitribai Phule Pune university, Pune in the last week of May 2022. A meeting was held with him regarding the construction of the Ganit Bhavan on IMS land in Pune and raising the funds for the construction. It was decided to submit proposals to various funding agencies to get funds for construction of the Bhavan. Further, it was discussed that for the potential proposal we need to get the following information/documents ready.

1. Building plan as approved by the local competent authority; 2. Detailed financial estimate for the building; 3. Detailed financial estimate for other facilities such as computer lab, furniture requirements for conference hall, guest house, hostel; 4. A brief history of IMS highlighting its role in the field of education and research; 5. Present activities of the IMS which may include organization of annual conferences, publication of two Scopus indexed journals, various endowment lectures and other activities; 6. Future Plan: This is the most crucial section. This section should highlight the role of the IMS in all aspects of education and research, impact at all levels starting from school education to research, popularization of Mathematics, social relevance, steps for promoting multidisciplinary research and so on;

The plan of the building, provided by the architect, has been included in Newsletter No. 48 (released in August 2022) for the information of the life members of the IMS. Late Prof. Nimbhorhar wrote an article on activities of the IMS, facilities in the Ganit Bhavan and how the Bhavan will be beneficial to students, teachers and researchers of mathematics. The article was circulated to the members of the council for their perusal and feedback. The preparation of the proposal is in process.

12. Demise of Prof. Satya Deo: The General Secretary of the IMS, Prof. Satya Deo, passed away on 20th June 2022, Monday due to illness. A zoom meeting of the Council memebrs was arranged on June 24, 2022 at 4.00 p. m. to pay tribute to Prof. Satya Deo. Prof. S. K. Nimbhorkar was appointed the General Seceratry of the IMS by the Council in its online meeting held on June 27, 2022 at 4.00 p. m. However, in the first week of November, Prof. Nimbhorkar suffered from serious health problems and was hospitalized. It was realized that he will not be able to carry out the duties and the responsibilities of the General Secretary for the next few months. An online Council meeting was held on Nov. 16, 2022 at 12.45 p.m. to discuss the issue. The Council, after taking review of the situation, appointed Prof. M. M. Shikare the General Secretary (interim) in lieu of Prof. Nimbhorkar. Prof. B. N. Waphare was appointed as the treasurer of the IMS.

13. Other Activities : The Indian Mathematical Society always helps the other institutes to organize mathematical activities. The IMS, GUJCOST / DST, Govenrment of Gujarat and Dhirubhai Ambani Institute of Information and Communication Technology, Gandhinagar jointly organized an online workshop from May 30, 2022 to June 3, 2022 on Emerging Areas in Differential Equations and Real World Applications.

14. Acknowledgements:

The General Secretary thanks Prof. B. N. Waphare for drafting the IMS newsletters 47 and 48 and sending them to the General Secretary for finalization. The Editor of the Math. Student sent these newsletters to all the life members of the IMS and I thank him for this help.

I take this opportunity to thank Late Prof. Satya Deo, Prof. S. K. Nimbhorkar and Prof. Peeyush Chandra for their support and help all along the way.

Item No. 3 : To receive the Report of the Academic Secretary.

Report of the Academic Seceratary for the year 2022.

The Academic Programme for the 88th Annual Conference of the Indian Mathematical Soci-

ety an International Meet was considered and a tentative speakers and symposia convenors were finalized during the online meeting of the APC held on June 1, 2022. With further inputs from the President and the General Secretary, the Academic programme was finalized and is given below:

Plenary Speakers:

1. Prof. Peter Sarnak, Princeton University, USA.
2. Prof. Noga Alon, Princeton University, USA.

Memorial Award Lectures:

36th P. L. Bhatnagar Memorial Award Lecture: Prof A Adimurti, IIT Kanpur
33rd Hansraj Gupta Memorial Award Lecture: Prof. Apoorva Khare, IISc, Bengaluru.
33rd Srinivasa Ramanujan Memorial Award Lecture: Prof. Sudesh Kaur Khanduja, IISER Mohali
33rd V. Ramaswami Aiyer Memorial Award Lecture: Prof. Debasish Goswami, ISI Kolkata.

Invited Talks:

Prof. Mahesh Kakde, IISc, Bengaluru. (one hour talk)
Prof. Nitu Kumari, IIT Mandi
Prof. R Radha, University of Hyderabad, Hyderabad
Prof. A Swaminathan, IIT Roorkee
Prof. Shiv Datt Kumar, MNIT Allahabad
Prof. Pradyumn Kumar Sahoo, BITS Hyderabad
Prof. Shalini Gupta, Panjabi University, Patiala

Symposia:

(1) Commutative Algebra Convenor: Ramakrishna Nanduri, IIT Kharagpur
(2) History of Ancient Indian Mathematics Convenor: Aditya Kolachana, IIT Madras
(3) Number Theory Convenor: P. Sanoli Gun, IMSc, Chennai
(4) Water Wave Mechanics Convenor: Swaroop Nandan Bora, IIT Guwahati
(5) Discrete Mathematics Convenor: Vinayak Joshi, Savitribai Phule Pune University, Pune
(6) Financial Mathematics Convenor: Anindya Goswami, IISER Pune

The Speakers for symposia were finalized by the Convenors.

Only 3 research papers were received for various prizes AMU Prize (1), IMS Prize Group 1 (1) and IMS Prize Group 4 (1). There is need to give more publicity to these prizes. For contributory presentation 133 research papers have been received. To encourage young scholars, 6 poster presentations have been accepted. Based on the invitation by the Organizing Institute, in consultation with the General Secretary IMS, a Talk by Prof. Manindra Agrawal, IIT Kanpur was scheduled.

Efforts should be made to focus on attracting more paper presentations and also papers for Prizes and Award sessions. This needs discussion to come up with a concrete action plan.

Item No. 4. To receive the Report of the Administrative Secretary.

Report of the Administrative Secretary, Prof. B. N. Waphare, for the Year 2022.

1.The print copies of The Journal of the Indian Mathematical Society (JIMS) Volume 89, (Nos. 1-2) (January-June 2022), JIMS Volume 89, (Nos.3-4) (July-December 2022) and The Mathematics Student, Vol. 91 (Nos.1-2) (January-June 2022), The Mathematics Student Volume 91, (Nos.3-4) (July-December 2022) were received from Parashuram Process, Pune and preserved in the Library of the Mathematics Department, Savitribai Phule Pune University, Pune.

2. The copies of the JIMS Volume 89, (Nos. 1-2) (January-June 2022), JIMS Volume 89, (Nos.3-4) (July-December 2022) and The Mathematics Student Vol. 91 (Nos. 12) (January-June 2022), have been sent to the subscribing institutes and Universities by registered post. The account of corresponding expenses has been maintained.

3. Then IMS Newsletter No.s 47 & 48 were prepared by considering the directives and suggestion received from The General Secretary and the office bearers of the society. The softcopies of newsletters were sent by e-mails to the Life members of the IMS in cooperation with Prof. M. M. Shikare.

4. In respect of developing Indian Mathematical Societys plot at Golegaon, Pune, we received architectural plan from Mr. Warade. The IMS plot is under Pune Metropolitan Region Development Authority (PMRDA) Jurisdiction and in agriculture zone. We are taking steps towards getting approvals for the architectural plan. We are in process of collecting required documents (See attached Image). Meanwhile Prof Satish Bhatnagar, University of Nevada, visited the IMS plot and he mentioned that he was very satisfied with the location of plot and the step taken towards developing the IMS campus on the plot.

5. The records/documents such as minutes of meetings of the council, Academic planning committee and general body, copies of the Newsletters, copies of agenda for council meeting and General body meeting have been maintained.

6. We are receiving periodicals of the following journals under exchange scheme.

(i). Indian Journal of Pure and Applied Mathematics, Mar. 2022, Sept. 2022, Dec. 2022.

(ii). Journal of Mathematical Science, The University of Tokyo, Vol 29 Issues 1, 2 (2022)

(iii). Publications De LInstitute Mathematique, Vol 2021, Vol 2022

(iv). Rendiconti del Circolo Mathematico di Palermo, Vol 71, Issues 2, 3 (2022)

(v). Rendiconti del Seminario Mathematico Della Universita Di Padova, Vol 147 (2022)

(vi). The Mathematical Intelligencer, Vol 45- 2, (2022)

(vii). Kodai Journal of Mathematics, Vol 45- 2, (2022)

The issues of these periodicals are preserved in the Library of the Mathematics Department, Savitribai Phule Pune University, Pune.

Item No. 5: To consider the Audited Statement of Accounts for the year 2021 2022 and budget for the financial year 2023 2024.

The Audited Statement of Accounts for the year 2021 2022 and budget for the year 2023 2024 presented by the Treasurer, Prof. B. N. Waphare were approved.

Item No. 6: To receive the report of the Editor-in-Chief of The Journal of the Indian Mathematical Society for 2022.

Report of the Editor-in-Chief, the Journal of the Indian Mathematical Society for 2022.

1. Manuscript submission and Editorial processing was completely moved to the platform provided by IPL (Informatics Publishing Ltd.) in the last one year and we have cleared the backlog of about 100 manuscripts, pending on the JIMS platform.

1. The Status of Manuscripts as on Dec. 20, 2022 is as follows:

Manuscripts pending (as on 30.09. 2021):	74
Manuscripts received 1.12. 2021 to 20.11.2022:	172
Manuscripts pending with Prof. Nimbhorkar (under process/ with referee):	31
Total:	277
Manuscripts Accepted/(Published -15):	49
Manuscripts under revision:	02
Manuscripts Rejected/ Archived(duplicate/incomplete):	128
Manuscripts withdrawn (includes one where there is no response after Editors Comments):	6
Manuscripts with Editors:	46
Manuscripts to be processed:	16
Total:	247*

(*Due to unforeseen health condition of Prof Nimbhorkar, update on 31 manuscripts was not available).

3. Publication status: JIMS Vol. 90 (1-2) 2022 was published in January 2022. JIMS Vol. 90 (3-4) 2022 was published in Early August 2022. JIMS Vol. 91 (1-2) 2022 is under preparation and will be published in January 2023.

4. Acknowledgements I wish to put on record sincere thanks to the Members of the Editorial Board, Referees and Prof. S. K. Nimbhorkar, who were helpful in managing the processing of the manuscripts.

Item No. 7. To receive the Report of the Editor-in-Chief of the Mathematics Student for 2022.

Report of the Editor-in-Chief of the Mathematics Student for the year 2022

1**. Publication Status :** Volume 91 (Nos. 1-2) January-June, 2022 of The Mathematics Student was published in February 2022 while Volume 91 (Nos. 3-4) July-December, 2022 of The Mathematics Student has been published in September 2022. The soft copy of these volumes have been sent to all the life members of the IMS by e-mails. The soft copies of both the issues have been also uploaded on the website of the Indian Mathematical Society. Both the Volume have 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.

2. Status of the Manuscripts

	Total Number of Manuscripts received for Publication: till December 20, 2022	126
(a)	Number of Manuscripts accepted for Publication :	27
(b)	Number of Manuscripts not accepted for Publication :	70
(c)	Number of Manuscripts with the referees :	15
(d)	Number of Manuscripts withdrawn by the authors :	02
(e)	Number of Manuscripts to be processed :	12
	Total	126

3. 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. The volumes of the Mathematics Student published in 2021 and 2022 are available on EBSCOs website (https://mft.ebscohost.com).

4. Inclusion of the Journal in the MathSciNet database

The Mathematics Student was used to be referenced in MathSciNet database till 2019. However, it was not referenced in MathSciNet for the last 2-3 years. Prof. Dipendra Prasad, IIT Mumbai pursued the matter with the support team of the American Mathematical Society (AMS).

Mr. Eliot Johnson, the Citation Database Project Coordinator of AMS informed us that the processing of recent volumes of The Mathematics Student was delayed due to a technical problem that has now been resolved. Volumes 89 (2020), 90 (2021) and 91 (2022) of the journal are now in the process of possible inclusion in the MathSciNet. It is really a good thing that the Math. Student is being included in the MathSciNet database.

5. 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.

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 express our gratitude to Prof. B. N. Waphare, the Administrative Secretary of IMS, 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 No. 8: To consider the venue of the 89th Annual Session of the Society to be held in December 2023.

The IMS accepted the firm invitation from the Registrar, Birla Institute of Technology and Science (Pilani), Hyderabad Campus, Hyderabad, Telangana for organizing the 89th Annual Conference of the Indian Mathematical Society. Therefore, the 89th Annual Conference of the IMS will be held at Birla Institute of Technology and Science (Pilani), Hyderabad Campus, Hyderabad. Prof. P. K. Sahoo, Head of the Mathematics Department, BIT, Hyderabad campus will act as the Local Organizing Secretary of the Conference.

Item No. 9: Announcements of the results of the following elections:

(i) President for the year 2023-2024; and (ii) Three members of the Council for a period of three years w. e. f. April 01, 2023.

President for 2023- 24 : Prof. R. Balasubramanian, former Director, IMSc, Chennai, has been elecetd to the office of the President of Society for a period of one year with effect from April 1, 2023.

Members of the Council :

Dr. S. B. Nimse, Former Vice-Chancellor, SRTM University Nanded and Lucknow University, Lucknow; Dr. Shiv Datta, Motilal Nehru NIT, Allahabad; and Dr. Gajanan Lomte, MGM University, Aurangabad have been elecetd as Members of the Council of IMS for a period of three years w. e. f. April 1, 2023.

Item No. 10: Any other item with the permission of the chair
(i) Election to the office of the Administrative Secretary of the IMS.
It is resolved that the post of the Administrative Secretary of the IMS will be filled through elecetion, like the posts of the other office bearers, with the condition that the incumbent will be from Pune.
(ii) Operation of the Bank Account of the Indian Mathemtaical Society.
It is resolved that Prof. B. N. Waphare, the treasurer of the IMS, is authorised to operate the Indian Mathematical Societys bank account at Punjab National Bank, Adalat Road, Aurangabad (M. S.) with immediate effect.

The Meeting ended with a vote of thanks to the Local Organizers and the President of the Indian Mathematical Society.

Dr. M. M. Shikare
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 sponsored the **Meenakshisundaram–Patoudi lectures**. The information is available on the website of the IMS.

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. M. M. Shikare through their respective Head of the Department.

Call for Applications for Various Awards to be given by the IMS in the Year 2023

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, 2023. The applications should be sent to Prof. M. M. Shikare, the General Secretary of the IMS, along with the copy of the published paper and the proof of the age on the e-mail address : gensecims@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 31st December 2023.
(c) The paper should have been published either online or in print during the year 2022 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 preferablyhaving 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, 2023.
(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 2022 in an Internationally reputed journal.
(f) The author should be associated with any university/college/ institution in India wherethe 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 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 2023.
(c) The author(s) need not be Indian citizen(s) and must have a Ph D degree in anysubject.
(d) The author(s) can submit only one publication for this award and the paper shouldnot have been submitted for any award anywhere.
(e) The award consists of a citation and a cash prize of Rs. 10,000/-.
(f) 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/ OperatorTheory and related areas.
(b) The paper should have been published either online or in print in an internationally reputed journal during the year 2022.
(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 2023.
(d) The author(s) should be Indian citizen and must have carried out the said researchwork in India.
(e) The author(s) can submit only one publication for this award and the paper shouldnot 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/ OperatorTheory and related areas.
(b) The paper should have been published either online or in print in an internationally reputed journal during the year 2022.
(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, 2023.
(d) In the case of joint authorship of the awarded paper, the prize amount will be equally divided between the two authors.
(e) The author(s) should be Indian citizen and must have carried out the said researchwork in India.
(f) The author(s) can submit only one publication for this award and the paper shouldnot have been submitted for any other award anywhere.
(g)The award carries a citation and a cash prize of Rs 25,000.

6. B. N. Waphare Award
Tems and Conditons for the Award:
(a) The paper should contain significant contributions in the areas of
(i) Lattice Theory, Partially Ordered Sets and related areas
(ii) Graph Theory, Matroid Theory, Combinatorics and related areas and
(iii) Non-commutative rings and rings with involution, Baer *-rings and related areas.

Preference will be given to areas listed in (i), (ii) and (iii) above, respectively in the following years. In case a paper is not found suitable in the stipulated area of research then the paper for award may be considered from other areas also. The cycle will be repeated. This year the preference will be given to papers published in the areas listed in (i).

(b) The paper should have been published either online or in print in an internationally reputed

journal during the year 2022.
(c) The paper should be under the authorship of at most two authors and there is no age limit. In the case of joint authorship of the awarded paper, the prize amount will be equally divided between the two authors.
(d) The award is open to Indian Citizen or to a person of Indian Origin (PIO)
(e) The author can submit only one publication for this award and the paper should not have been submitted for any other IMS award.
(f) The award carries a citation and a cash prize of Rs 25,000.

7. J. B. Shukla Award
Tems and Conditons for the Award:
(a). The paper should contain significant contributions in the broad areas of Mathematical Biology e.g. Biomechanics, Bioinformatics, Mathematical Ecology, Mathematical Epidemiology and related areas.
(b). The paper should have been published either online or in print in an internationally reputed journal during the year 2022.
(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 35 years as on 31st December 2023. In the case of joint authorship of the awarded paper, the prize amount will be equally divided between the two authors.
(d). The award is open to Indian Citizen as well as to a Person of Indian Origin (PIO), however work should have been carried out 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 IMS award.
(f). The award carries a citation and a cash prize of Rs 25,000.

More details about the terms and conditions for each of the above awards are available on the website of the IMS.

Call for Research Papers for Various Prizes to be given by the IMS during the Annual Conference of the IMS in 2023

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 acadsecrims@gmail.com. The last date of receiving applications is August 15, 2023. 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, HarmonicAnalysis, 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 relatedareas.

(8) IMS Prize-group-6: Operations Research, Optimization, Computational Mathematics,Information Technology, Bio mathematics, History of Mathematics andrelated 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, 2023.
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; Print ISSN 0019-5839, Online ISSN 2455-6475) and The Mathematics Student (Print ISSN 0025-5742) both of which are quarterly. The details can be found on the website: www.indianmathsoc.org

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 get 15 % discount on their orders.

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 as a member to 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:

1. All Annual and Life members shall be entitled to receive communications about the activities of the Society and 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.

4. Membership Fees:

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

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

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

5. Application for membership should be made on the Membership form which is available on the website of the IMS.

The membership fee may be paid by online transfer to the IMS bank account whose details are given below.

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.

The scanned copy of completed Application along with Payment details should be emailed to Prof. B. N. Waphare, the Treasurer of the IMS, at treasurerindianmathsociety@gmail.com.

Business Correspondence and Payments:

All business correspondence be addressed to Prof. B. N. Waphare, Treasurer, IMS on the e-mail given above. All payments should be made by bank transfer to the IMS account whose details are given above. In case a bank transfer is not possible, then a DD drawn in favor of "The Indian Mathematical Society" should be sent to Prof. B. N. Waphare, Department of Mathematics, Savitribai Phule Pune Uniersity, Pune- 411007.

IMS Library:
The information pertaining to IMS library is available on the website https://www.indianmathsoc.org of the society.

Guidelines for acceptance of Donations to the Society:

The Indian Mathematical Society (IMS) is a nonprofit organization. It welcomes donations from Individuals as well as from Organizations who wish to promote Mathematics in the country. It may be noted that donations received after Oct. 1, 2021 are eligible for exemption under Section80 G of the Income Tax Act oftheGovtofIndia.Some guidelines for Acceptance of Donations:

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

2. The Society creates Corpus Fund out of the donation received. Presently there are three type of Corpus Funds (i) General Corpus Fund, (ii) Ganit Bhavan Corpus Fund and (iii) Corpus Fund for Instituting Awards.

3. General Corpus Fund : Donations made for a general purpose i.e. donation made without any specification and The Society can use it for any general purpose supporting mathematics.

4. Ganit Bhavan Corpus Fund : The Society has bought a plot of land in Pune to develop its permanent headquarter, and a master plan of various buildings is ready for the construction. The Society is collecting funds to develop that complex. One can make a donation to the Society for construction of a Lecture hall/ library/ computer centre etc. Donation for Ganit Bhavan Corpus Fund can also be made without any specific stipulation.

5. Corpus Fund for Instituting Awards : The Society also accepts donations for instituting an Award in mathematics to be given to an individual(s) who has published some outstanding work

in a particular area of mathematical sciences. Such Awards are sponsored by Donors and can be named after self/ wife/ husband/ mother/ father/ teacher or any relative as suggested by the donor. The Society gives these Awards every year in its Annual Conference and they carry a Cash Prize along with a Certificate. The minimum amount of Donation for sponsoring an Award is presently kept at Rs 5.00 Lakhs which can be revised upwards, depending on the inflation rate. The Terms and Conditions for such Awards and the mode of selection is decided by the Council of The Society in consultation with the Donor. For any Donation, a prospective donor should approach the General Secretary of The Society with an offer who will put it before the Council, if required.

6. All donations can be made online. The details of the IMS bank account are given on page number 15.

The Council reserves its right whether or not to accept a particular donation.

An Appeal for Support to The Indian Mathematical Society's 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. The estimated cost of the project is about Rs. 13 crores.

It may be noted that the IMS is 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 to the IMS bank account whose details are given above.

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. B. N. Waphare, Treasurer, IMS, Department of Mathematics, Savitribai Phule Pune Uniersity, Pune- 411007. I am sure your generous help will strengthen the Society to serve the cause of mathematics more efficiently.

Prof. M. M. Shikare,
General Secretary, IMS

88th Annual Conference of the Indian Mathematical Society
An International Meet
Birla Institute of Technology, Mesra, Ranchi
December 27 30, 2022

IMS President's Technical Talk

Some zero-sum constants and their weighted generalizations

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Abstract

Investigations into zero-sum problems were initiated by a result of Erdős, Ginzburg and Ziv, published in 1961, which says that every sequence of length $2n-1$ of elements of an abelian group G of order n contains a zero-sum subsequence of length n. A sequence $S = (g_1, g_2, \ldots, g_l)$ of elements of a finite abelian group G, is called a *zero-sum sequence* if

$$g_1 + \cdots + g_l = 0,$$

where 0 is the identity element of the group.

Soon after that (during 1963-66), Rogers, Davenport and others posed the problem of determining the smallest natural number k such that any sequence of k elements in G has a non-empty zero-sum subsequence; it is known as the *Davenport constant* in the literature and is denoted by $D(G)$. Defined originally in connection with non-unique factorization in algebraic number theory, it had applications in graph theory and in the proof of the infinitude of Carmichael numbers by Alford, Granville and Pomerance.

Weighted generalizations of some classical zero-sum constants were first considered about fifteen years back by the present author and his collaborators. Since then, many people got interested in this theme. Similar generalizations of other zero-sum constants were also considered and these gave rise to several conjectures and questions; some of these conjectures have been established, some of the questions have been answered. And, most interestingly, some applications of these weighted generalizations have also been found.

Here, after describing some results and open questions related to the classical zero-sum constants, we talk about some developments around their weighted generalizations.

Plenary Lectures

Prescribing the spectra of locally uniform geometries

Peter Sarnak
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Abstract

After reviewing recent developments (conformal bootstrap and random covers) concerning the Lalpace spectra of hyperbolic manifolds and of large regular praphs, we focus on rigidity features to creating spectral gaps.

Constructive and non-constructive combinatorics

Noga Alon
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Abstract

I will describe several old and new applications of topological and algebraic methods in the derivation of combinatorial results. In all of them the proofs provide no efficient procedures for solving the corresponding algorithmic questions. The problem of finding such procedures (or convincing reasons indicating that they are unlikely to exist) is an intriguing challenge and I will mention some progress in the study of this problem too.

Popular Talk

SUTRA: A model for COVID 19 pandemic

Manindra Agrawal
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Abstract

We describe SUTRA, a new model for pandemics. The most unique feature of the model is its ability to learn parameter values from daily new cases data, even when the parameters change. The model was thus able to capture the trajectory of COVID 19 pandemic very well. The model is also able to quantify the loss of different types of immunity, leading to inferences about it future trajectory.

S. Ramanujan Memorial Award Lecture

A walk through irreducible polynomials

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and
Indian Institute of Science Education and Research,
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Abstract

Criteria for irreducibility of polynomials have a long history. In 1797, Gauss proved that the only irreducible polynomials (in one variable) with complex coefficients are linear polynomials. However, for polynomials with rational coefficients, the Eisenstien Irreducibility Criterion, proved in 1850, implies that for each positive integer n, there are infinitely many irreducible polynomials of degree n. In this talk, we shall discuss some generalizations, discovered in recent years using the theory of valuations, of the classical irreducibility criteria of Eisenstein, Schönemann, and Dumas.

33rd Hansraj Gupta Memorial Award Lecture

Polymath 14: Groups with norms

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Abstract

Consider the following three properties of a general group G:

1. *Algebra:* G is abelian and torsion-free.
2. *Analysis:* G is a metric space that admits a "norm", namely, a translation-invariant metric $d(\cdot,\cdot)$ satisfying: $d(1,g^n) = |n|d(1,g)$ for all $g \in G$ and integers n.
3. *Geometry:* G admits a length function $\ell(\cdot)$ with "saturated" subadditivity for equal arguments: $\ell(g^2) = 2\ell(g)$ for all $g \in G$.

While these properties may a priori seem different, in fact they turn out to be equivalent. The nontrivial implication amounts to saying that there does not exist a non-abelian group with a "norm". We will discuss motivations from analysis, probability, and geometry; then the proof of the above equivalences; and if time permits, the logistics of how the problem was solved, via a PolyMath project that began on a blogpost of Terence Tao. (Joint – as D.H.J. PolyMath – with Tobias Fritz, Siddhartha Gadgil, Pace Nielsen, Lior Silberman, and Terence Tao.)

V. Ramaswamy Aiyer Memorial Award Lecture

Quantum symmetry of classical and noncommutative spaces

Debashish Goswami
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Abstract

Quantum groups are far-reaching generalizations of groups, both in the algebraic and functional-analytic set-up. In this talk, we'll give a brief introduction to the C^*-algebraic framework of compact quantum groups with relevant reference to the Hopf algebraic framework and then discuss how these arise naturally as symmetry objects of classical and noncommutative spaces, including noncommutative Riemannian manifolds a la Connes. In particular, we touch upon the speaker's work on the formulation and computation of the so-called quantum isometry groups and also certain rigidity phenomenon regarding co-action of compact quantum groups on compact smooth manifolds. The talk is based on joint work with J. Bhowmick, A. Skalski, B. das, S. Joardar, A. Mandal, T. Banica, P. Etingof, C. Walton, S. Bhattacharjee and A. Hossain.

36th P. L. Bhatnagar Memorial Award Lecture

Critical point theory in PDE

A. Adimurthi
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Abstract

From one dimensional Roll's theorem, how it can be generalized in Banach space to find critical points of a functional. This will lead to solving many nonlinear problems coming from Geometry and Physics.

Lecture by A. K. Agarwal Award Winner

Structure of $\mathbb{A}^2$-fibrations having fixed point free locally nilpotent derivations

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Abstract

Contributions by Rentschler (1968), Daigle-Freudenburg (1998), Bhatwadekar-Dutta (1997), Berson-van den Essen-Maubach (2001) and van den Essen (2007) established that a fixed point free locally nilpotent derivation (LND) of a polynomial algebra in two variables over a ring R containing $\mathbb{Q}$ has a slice. However, it was not known whether the conclusion hold true when the polynomial algebra over R is replaced by an $\mathbb{A}^2$-fibration over R.
Affirmative partial answers to the problem was given by Kahoui-Ouali in 2012 and 2016 respectively under the assumptions "R is a regular domain" and "the $\mathbb{A}^2$-fibration is a stably polynomial algebra".
In this article (2021) we give a comprehensive solution to the problem when R is Noetherian. The achieved result describes the complete structure of $\mathbb{A}^2$-fibrations over Noetherian rings containing $\mathbb{Q}$ having fixed point free locally nilpotent derivations. The main result of the article is the following.
Theorem: Let R be a Noetherian ring containing $\mathbb{Q}$ and A an $\mathbb{A}^2$-fibration over R with a fixed point free R-LND $D : A \longrightarrow A$. Then, $\mathrm{Ker}(D)$ is an $\mathbb{A}^1$-fibration over R and D has a slice, i.e., $A = \mathrm{Ker}(D)^{[1]}$.

Subhash Bhatt Award Winner Lecture

Lattice of intermediate subalgebras

Keshab Chandra Bakshi[a†], Ved Prakash Gupta[b]
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[†]: corresponding author

Abstract

Given an irreducible inclusion of simple C^*-algebras with finite Watatani index, the lattice of intermediate subalgebras form a finite set. We provide an upper bound for the cardinality of this set and in particular, we answer a question of Roberto Longo regarding the lattice of intermediate von Neumann subfactors of an inclusion of type III factors. The crucial ingredient in the proof is the introduction of a notion of angle between subalgebras and the systematic study of the Fourier theory on the relative commutants. This is a joint work with Ved Gupta.

A. M. Mathai Award Winner Lecture

Physics of unsteady couette flow in an anisotropic porous medium

Timir Karmakar
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Abstract

Unsteady Couette flow between two parallel plates filled with anisotropic porous material is investigated. The flow is driven by the combined pressure gradient and the oscillation of the upper plate in its own plane with a constant velocity. It is assumed that the lower plate is rough in nature and offers a slip. An exact solution of the flow problem is presented. Asymptotic cases for the low and high Darcy number are presented to strengthen the study. For large values of Darcy number, the flow problem is a regular perturbation problem, while the same is singular perturbation problem for a low Darcy number. We used matched asymptotic expansion to obtain a uniformly valid solution for singular perturbation problem. The anisotropic parameters of the porous medium have significant effects on the velocity and shear stress. A new modified Stokes layer thickness has been derived based on the anisotropic properties of the porous medium. The competition between the pressure pulsation and the wall oscillation is discussed in detail. As an application, we present some important findings based on the anisotropic properties of endothelial glycocalyx layer.We see that more permeability in vertical direction is favorable for blood flow as it produces lesser shear and prevents damage to an artery wall.

P.K. Jain Award Winner Lecture

Meromorphically normal families in several variables

Gopal Datt
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Abstract

Meromorphic normality is a notion of sequential compactness in the space of meromorphic category introduced by Fujimoto. In this talk, we shall discuss some sufficient conditions of meromorphic normality for families of meromorphic mappings taking values in a complex projective space. As a consequence of these sufficient conditions we shall, finally, see a meromorphic version of the Montel-Carathéodory theorem.

Narasinga Rao Prize Lecture

An estimate of the growth of cohomology with coefficients

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Abstract

For a connected reductive algebraic group over an arbitrary number field, we consider a finite dimensional algebraic, irreducible representation of the group of its real points. Each adlic locally symmetric space corresponding to a level structure constructed using the group has an associated sheaf induced by this representation. The purpose of this note is to estimate the rate of growth of the total dimension of the per- tinent cohomology with coefficients as either of the level structure or the associated sheaf varies. We obtain an upper bound on this total dimension. We also obtain a lower bound under certain topological conditions. Both the bounds are consistent with several classical dimension formulae as well as other known results.

Invited Lectures

On the conjecture of BrumerStark

Mahesh Kakde
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Indian Institute of Science, Bengaluru, India
Email: maheshkakde@iisc.ac.in

Abstract

I will recall a classical theorem of Stickelberger on the annihilation of class groups of abelian number fields by special L-values. The conjecture of BrumerStark is a generalisation of Stickelbergers theorem to CM number fields. We will present different formulations as well as refinements of the BrumerStark conjecture and give a sketch of their proofs. This is a joint work with Samit Dasgupta.

Central codes of dihedral 2- groups

Shalini Gupta
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Abstract

From last fifty years, construction of codes and finding their distances has been the problem of interest in the area of algebraic coding theory. The study of cyclic codes and abelian codes have been extensively done by various researchers. In this talk, central and non -central codes of Dihedral 2-groups will be discussed. The central and non central codes will be obtained with the help of primitive central idempotents of finite semisimple Dihedral group algebra. Further, the bounds on distances of the central and non central codes will be compared.

Quasi kernel orthogonal polynomials and ratio of hypergeometric functions involving chain sequences

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Abstract

The study of orthogonal polynomials can be interpreted from their three term recurrence relation (TTRR) as guaranteed by Favard's theorem. Linking the chain sequences with TTRR provides lot of information on the corresponding continued fractions and the measure associated with the orthogonal polynomials. A perturbation in their measure lead to the study of quasi kernel orthogonal polynomials which can be related to the corresponding Spectral transformation as well. The results obtained in this direction leads to the study of ratio of Gaussian hypergeometric functions in relation with the Kernel polynomials. Such ratio of hypergeometric functions is a link of study between the tridiagonal Jacobi matrices, certain geometric properties of holomorphic functions, functional equations and zeros of classical orthogonal polynomials. This talk gives an interlink between these topics and the recent research that are obtained in this direction.

Wormhole geometry: Science or science fiction?

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Abstract

A wormhole is a special solution to the equations describing Einstein's theory of general relativity, connecting two distant points in space or time via a tunnel. Ideally, the length of this tunnel is shorter than the distance between those two points, making the wormhole a kind of shortcut. Though they make for good science fiction as ways for faster-than-light-speed

travel between two extremely distant points in the universe. They are legitimate solutions to general relativity, but scientists have never figured out a way to maintain a stable wormhole in the real universe. Nowadays, one of the biggest arguments is ***"Wormholes are real Science or Science fiction"***. Here, we discuss the geometrical developments to present the wormhole structures and scientific measurements to test these types of theories.

Role of group defense on pattern formation analysis in a tritrophic food chain model

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Abstract

In this talk, a tritrophic food chain model with Ivlev-like nonmonotonic functional response, where prey is equipped with defense ability, will be discussed in detail. We will discuss its dynamical study and pattern formation analysis which lead to complex dynamics in the model. Stability and bifurcation analysis have been performed for the model system. Bifurcations of codimension-1, in particular, saddle-node, transcritical and Hopf bifurcation are observed. The model system also exhibits bifurcations of codimension-2 such as cusp, Bogdanov-Takens and generalized Hopf bifurcation. Interestingly, it is observed that the middle and top predator population become extinct due to defense ability of prey. Chaotic dynamics is observed via a period-doubling route to chaos with the change in the value of parameter. The quantification of chaotic dynamics is done, using Lyapunov spectrum and sensitivity analysis. Diffusion induced chaos is studied in the spatiotemporal model system. Hopf bifurcation is seen in case of spatially extended system. In the two-dimensional spatial domain, various non-Turing patterns such as hot-spot, cold-spot, labyrinth patterns are obtained. Ripple and stripe Turing patterns are obtained in case of one-dimensional spatial domain. Also, labyrinth and patchy Turing patterns are obtained in the two-dimensional spatial domain. The spatial distribution of the species shows both Turing patterns and non-Turing patterns.

Riemann problems for hyperbolic systems-differential constraints

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Abstract

Using the compatible theory of differential invariants, a class of exact solutions can be obtained for nonhomogeneous quasilinear hyperbolic system of partial differential equations (PDEs). These solutions exhibit genuine nonlinearity that leads to the formation of discontinuities such as shocks and rarefaction waves for solving generalized Riemann problems.

Representations of finite groups and algebras

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Abstract

Representation theory studies symmetry in linear spaces through group action on vector spaces and associative algebras, for example $End(V)$, group algebras and universal enveloping algebras of Lie algebras. Idea is to compare finite (abstract) groups with linear group $GL_n(K)$ and gain better understanding about them. The irreducible representations are the building blocks of all representations. Some basic problems in representation theory are (i) Classification of irreducible and indecomposable representations of a given algebra up to isomorphism (ii) Decomposition of naturally occurring representations in irreducible representations. The character of a representation uniquely determines it up to isomorphism. The character carries the essential information about the representation in a more condensed form. Representations are classified by their characters. The first task in building a theory of representations of Lie groups is to construct a translation invariant measure. Integrals of the class functions on compact groups is an important tool to describe irreducible representations of compact group. Haar proved that left or right invariant measures exist on every locally compact group while Von Neumann showed that such a measure is unique up to a multiplicative constant. The first crucial point for compact groups is that we need to consider only unitary representations. In this talk we will discuss basic notions, examples, results and challenges in the study of representation theory. Some applications of representation theory will also be discussed.

Symposium on Commutative Algebra

Subadditivity, strand connectivity and multigraded Betti numbers

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Abstract

Let $R = K[x_1, \ldots, x_n]$ and $I \subset R$ be a homogeneous ideal. In this talk, we first obtain certain sufficient conditions for the subadditivity of R/I. As a consequence, we prove that if I is generated by homogeneous complete intersection, then subadditivity holds for R/I. We then study a conjecture of Avramov, Conca and Iyengar on subadditivity, when I is a monomial ideal with R/I Koszul. We identify several classes of edge ideals of graphs G such that the subadditivity holds for $R/I(G)$. We then study the strand connectivity of edge ideals and obtain several classes of graphs whose edge ideals are strand connected. Finally, we compute upper bounds for multigraded Betti numbers of several classes of edge ideals.

The multiplicity conjecture and graded resolutions

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Abstract

The attempts to resolve the Herzog-Huneke-Srinivisan multiplicity conjecture lead to the development of Boij-Soderberg theory, which involves the study of graded Betti numbers through the lens of the Betti cone. In this talk, we discuss the original conjecture, and how it was resolved following works of Boij-Soderberg (2008), and Eisenbud-Schreyer (2009). If time permits, we will see some current related work. Definitions and results will be introduced via examples in an attempt to make the talk accessible to students who have had a course in commutative algebra.

Componentwise linear powers of vertex cover ideals

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Abstract

Let $S = K[x_1, \ldots, x_n]$ be a polynomial ring, where K is a field, and G be a simple graph on n vertices. Let $J(G) \subset S$ be the vertex cover ideal of G. Herzog, Hibi and Ohsugi have conjectured that powers of cover ideal $J(G)$ of a chordal graph are componentwise linear. In this talk, we resolve the conjecture for trees.

Linear type binomial edge ideals and the regularity of their powers

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Abstract

Let $S = k[x_1, \ldots, x_n, y_1, \ldots, y_n]$ be a polynomial ring over a field k. Let G be a finite simple graph on $[n]$ vertices. Given an edge $\{i, j\}$ in G, associate a polynomial $f_{ij} = x_i y_j - x_j y_i$ in S. We call f_{ij} an *edge binomial*. Denote by $J_G \subset S$ the binomial edge ideal generated by edge binomials. The binomial edge ideal naturally arises in commutative algebra, algebraic geometry, and statistics. There is a one-to-one correspondence between the binomial edge ideal of a finite simple graph and a set of 2-minors of $2 \times n$ matrix of indeterminates. If G is a complete graph, then S/J_G can be visualized as a Segre variety given by the image of Segre product $P^1 \times P^{n-1}$ of projective spaces. Villarreal proved that edge ideals are of linear type

if and only if the graph is a tree or has a unique cycle of odd length. Some special classes of graphs are known for which binomial edge ideal is of linear type. Jayanthan, Kumar, and Sarkar proposed the conjecture that "*If the given graph is a tree or a unicyclic graph, then the binomial edge ideal is of linear type.*" Huneke introduced the notion of d-sequence and proved that ideals generated by d-sequence are of linear type. We provide the necessary and sufficient

conditions for the edge-binomials of the tree forming a d-sequence in terms of the degree sequence notion of a graph. We study the regularity of powers of the binomial edge ideals of trees generated by d-sequence edge binomials. This is a joint work with Marie Amalore Nambi.

On regularity of symbolic and ordinary powers of certain ideals associated to graphs

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Abstract

In this talk, we will discuss about the Castelnuovo-Mumford regularity (or regularity) of symbolic and ordinary powers of edge and vertex cover ideals of finite simple graphs. For a simple graph G, we discuss the bigraded regularities of the symbolic Rees algebras $R_s(J(G)), R_s(I(G))$, of the vertex cover ideal $J(G)$ and the edge ideal $I(G)$ of the graph G respectively. We give various combinatorial upper bounds for those bigraded regularities. By using these upper bounds, we give general linear upper bounds for the regularities of symbolic powers of $J(G)$ and $I(G)$.

Symposium on History of Ancient Indian Mathematics

Spectrum of magic squares

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Abstract

Magic squares were of great cultural/religious/mythological significance in Ancient Indian Mathematics. Methods for constructing 'n' by 'n' magic squares are given in the Ganitakaumudī of Nārāyana. In our work, we interpret these 'n' by 'n' magic squares as matrices and obtain highly accurate approximations of eigenvalues and eigenvectors of magic squares discussed in Ganitakaumudī of Nārāyana. In addition, I will also briefly talk about other methods discussed by Ganitakaumudī of Nārāyana to construct different magic squares. This is a joint work with Dr. Hariprasad Manjunath (IIIT Dharwad).

Combinatorial techniques discussed by Munīśvara

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Abstract

Permutations and combinations have had applications in diverse areas since ancient times as evident from the texts on Sanskrit prosody, music, dance, etc. Extending the concept, Bhāskara (12th cent. CE) deals with the permutations involving a set of digits in a chapter named *Aṅkapāśa* in his *Līlāvatī*. While describing this topic, Munīśvara (16th cent. CE), in his commentary *Nisṛṣṭārthadūtī*, elaborates on combinatorial tools known as *pratyayas*, wherein he delineates the construction of the *prastāra* (enumeration rule of generating all possible patterns) and elaborates upon the *uddiṣṭa* (the process of finding row number of a given pattern) and *naṣṭa* (the converse of *uddiṣṭa*) processes. This contribution of Munisvara would be highlighted during our discussion.

The pedagogical significance of the Līlāvatī

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Abstract

The Līlāvatī of Bhāskarācārya (12th c. CE) is a celebrated mathematical treatise, composed in verse, dealing with elementary arithmetic and geometry. The text is renowned for its clear elucidation of rules, and demonstration of their application in daily life through evocative examples. The enduring charm of the Līlāvatī for more than eight centuries has to do with the brilliant blend of mathematical ingenuity, poetic beauty, and technical rigor that has been consistently displayed by Bhāskara throughout the work. In this paper, we will discuss the pedagogical insights from this text in making mathematics more accessible to current day students.

Physical mathematics in ancient India

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Abstract

Physical mathematics is a rather recent area of research in mathematics, even though its origins go back to antiquity. We will discuss its origins in Astronomy in ancient India, as well as in Mesapotemia. I began using this phrase in my lectures at the Max Planck Institute, in Leipzig, Germany in late 1998. It appeared in print in my paper in Springer's millenium publication 'Mathematics Unlimited: 2001 and beyond', in 2010. We will review recent progress in this field and also discuss some open questions.

Symposium on Number Theory

An analogue of the Brun-Titchmarsh theorem

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Abstract

Dirichlet's theorem on primes in arithmetic progressions states that for any two integers a, q with $(a, q) = 1$ there are infinitely many primes of the form $a+qn$ as we vary n over the set of natural numbers. Reformulating the above Dirichlet's theorem states that the polynomial $qx+a$ with $x \in N$ takes infinitely many prime values. A natural question to ask if we can count the number of values of $x \leq x_0$ for some $x_0 \in R_{>0}$ such that $qx + a$ is prime. An asymptotic for this number was provided by de la Vallée Poussin. But in terms of fully explicit bounds the best known upper bound is given by the Brun-Titchmarsh theorem. We can now pose the question for a family of linear polynomials. It is possible to give non-trivial upper bounds in this case by application of sieve methods. In this talk we will address an analogue of this question where the polynomials are defined over an imaginary quadratic field.

This is a joint work with Prof. Sanoli Gun and Prof. Olivier.

An extension of Ramanujan-Serre derivative map and some applications

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Abstract

We obtain a simple extension of the Ramanujan-Serre derivative map and use it to derive a general method to evaluate convolution sums of the divisor functions. We also provide explicit examples for four types of convolution sums.

Ramanujan tau function and its prime divisors

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Abstract

In a seminal paper entitled 'On certain arithmetical functions', Ramanujan introduced the tau function and predicted multiplicative properties of it. Since then, study of the Ramanujan τ function has been a center of interest in number theory. In particular, understanding the arithmetic nature of the non-zero values of the function τ is of special interest. In this talk, we will give a brief overview of our recent work on the number of distinct prime factors and radicals of the values of Ramanujan τ function.

Sufficient conditions for classifying algebraic integers

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Abstract

Starting from Polya, there are several authors who studied the integrality condition of a given algebraic number α using the integral trace of α^n. In this talk, we classify the tuples $(\alpha_1, \ldots, \alpha_k)$ of algebraic numbers such that the sum $\lambda_1\alpha_1^n + \cdots + \lambda_k\alpha_k^n$ is an algebraic integer for n in a finite set or an infinite set. We will also present some interesting consequences of this result, one of such consequence is: If trace of the sum $\lambda_1\alpha_1^k + \cdots + \lambda_k\alpha_k^n$ is non-zero integer for infinitely many natural numbers n, then under some suitable assumptions each α_i is an algebraic integer. Our approach generalizes the classical question of sufficient conditions for algebraic integers using trace operators.

Recent developments of some non-homogeneous problems

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Abstract

Hermann Minkowski (known as father of Geometry of Numbers) proved the following result in 1899 :

Let $L_1(x_1, x_2), L_2(x_1, x_2)$ be two real linear forms of determinant $\Delta \neq 0$. Then given any real numbers c_1, c_2 there exist integers u_1, u_2 such that

$$|L_1(u_1, u_2) + c_1||L_2(u_1, u_2) + c_2| \leq \frac{1}{4}|\Delta|.$$

Further, equality is necessary if and only if $L_1 \sim \lambda_1 x_1,\ L_2 \sim \lambda_2 x_2$ for some numbers λ_1, λ_2. For these forms equality is necessary if and only if $c_1 = \frac{1}{2}\lambda_1 + m_1\lambda_1,\ c_2 = \frac{1}{2}\lambda_2 + m_2\lambda_2$, where $m_1,\ m_2$ are integers.

Its generalization to n variables is the famous classical **Conjecture of Minkowski** on the product of n linear non-homogeneous forms. This conjecture is so far known to be true for $n \leq 10$.

Minkowski's result for $n = 2$ can be reformulated in terms of non-homogeneous minima of indefinite binary quadratic forms.

Let $Q(x, y)$ be an indefinite binary quadratic form of determinant $D \neq 0$. Then given any real numbers x_0, y_0 there exist integers x, y such that

$$|Q(x + x_0, y + y_0)| \leq \big(\frac{1}{4}|D|\big)^{1/2}.$$

Further equality is needed if and only if $Q(x, y) \sim \rho xy$, $\rho \neq 0$ and $(x_0, y_0) \equiv (\frac{1}{2}, \frac{1}{2})(\text{mod } 1)$.

The above result can be generalized to indefinite quadratic forms $Q(x_1, \cdots, x_n)$ in n variables of determinant $D \neq 0$ and of the type (r, s), $n = r + s$ with signature $\sigma = r - s$.

Here I will talk on some recent developments on Minkowski's Conjecture on the product of n linear non-homogeneous forms and a conjecture of Bambah, Dumir and Hans-Gill on

positive values of non-homogeneous indefinite quadratic forms in n variables. (The conjecture of Watson on absolute value of non-homogeneous indefinite quadratic forms in n variables is completely solved.)

Symposium on Water Wave Mechanics

Hydroelastic analysis of very large floating structures in the context of blocking dynamics: an overview

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Abstract

In the last few decades, there has been a resurgence in the study of hydroelastic analysis of very large floating/submerged structures due to their wide applications in the maritime industry for the utilization of ocean space for various humanitarian and military activities. An analogous branch is the study of wave interaction with floating ice sheets, which finds application in cold region science and technology. The hydroelastic performance analysis of these kinds of floating structures leads to a class of boundary value problems satisfying higher-order boundary conditions on the structural boundaries, which are non-Sturm-Liouville type in nature. Recently, there is a keen interest in the study of the blocking dynamic of flexural gravity waves in which the associated dispersion relation possesses multiple propagating modes within primary and secondary blocking frequencies. Moreover, the coalescence of propagating modes of the dispersion relation occurs at the blocking and saddle points. The solutions to associated mathematical boundary value problems have answered many uncertain characteristics in the associated physical problems. A systematic study has been conducted in analysing a class of wave-structure problems in homogeneous and stratified fluids and many physical problems are being revisited for their solution in the context of blocking dynamics. The study reveals the occurrence of removable discontinuities in the scattering coefficients at blocking points and jump-discontinuities at a frequency where a change in incident wave mode occurs. A brief review of some of the recent progress in this class of problems will be presented followed by a discussion on future research direction.

A semi analytic approach to study the hydroelasticity of a container Ship under slamming and green water loading

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Abstract

Hydroelasticity of a container ship under slamming and green water load using a semi-analytic method is studied in the present paper. For the calculation of the global forces such as radiation-diffraction and wave excitation forces, Impulse Response Function-based approach is adopted. On the other hand, the local hydrodynamic forces such as the green water pressure and slamming forces are calculated by Buchners Dam Break Model and Generalized Wagner Model respectively. The structural part is dealt with Euler-Bernoulli beam theory and further solved with modal superposition technique. Duhamel Integral technique is used to get the elastic deflection and velocity of the structure. A parametric study has been performed to check how these external forces affect the structural behavior in terms of global responses such as Vertical Bending Moment. From the analysis, it is seen that the proposed methodology is capable of generating results within the range of engineering accuracy with negligible computational effort and hence could be a useful practical tool for calculating the design load of the container vessel under slamming and green water loading.

Mathematical techniques for solving some linear and nonlinear problems of water wave mechanics

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Abstract

Mixed boundary value problems occur in a natural way while modelling many problems of engineering, especially in water wave mechanics. While understanding the applications of such boundary value problems is of immense value to the engineers, determining their solutions by utilizing the most appropriate analytical or numerical method is a concern for applied mathematicians. In this talk, first, different techniques will be discussed to solve mixed boundary value problems arising in wave structure interaction problems involving a structure and/or arbitrary bottom topography. Next, the nonlinear problem involving inviscid flow over an arbitrary bottom topography will be discussed for its solution through integral equation approach.

Wave scattering by an array of floating and submerged circular structures

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Abstract

The use of flexible floating and submerged structures as breakwaters has gained popularity because they are inexpensive, reusable, environmentally friendly, and lightweight. Therefore, for a clear understanding of wave energy distribution and attenuation, modelling and simulation of wave interaction with these structures is a problem of fundamental interest. This talk briefs our study on wave interaction with an array of floating and submerged circular elastic porous structures. The physical problem is tackled using the eigenfunction expansion method and Graf's addition theorem. The Bessel and Hankel functions are extended in the plane wave representation form in order to determine the far-field scattering coefficients for the entire system. For various wave and structural characteristics, numerical findings for the scattering coefficients, power dissipation and hydrodynamic forces are investigated. Using a time simulation, the wave scattering from the circular structures is analyzed.

Ocean surface waves are influenced by slight water compressibility

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Abstract

A majority of ocean wave modelling considers the ocean water to be incompressible because of the very high value of sound speed in the water. However, water compressibility impacts the wave propagation when the water displacement scale turns out to be large, such as during submarine earthquakes, underwater landslides, meteor drops, etc. Under the assumption of linearized water wave theory, which is widely used to model ocean wave propagation, a slight ocean water compressibility impacts the dispersion relation the wave modes follow by introducing multiple propagating modes in addition to the already existing propagating mode. These newly generated waves are called acoustic-gravity waves (AGW) and consist of vertical oscillatory profiles. Consequently, they create pressure signatures at the ocean floor and the surface, leading to a possible detection mechanism for a submarine earthquake and an upcoming tsunami. In this talk, I will start by briefly covering the earlier preliminary works on ocean water compressibility, followed by glimpses of more recent works, specific.

Impact of porous structures in mitigating hydrodynamic coefficients acting on a floating elastic plate in a two-layer fluid

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Abstract

The interaction of oblique waves with a porous structure in front of a floating elastic plate is examined in this work. A semi analytical approach is used to address the boundary value problem. The solution is computed and the impact of porous structure on the hydrodynamic coefficients on the floating plate such as the deflection of the plate, bending moment, shear force, mooring line effect and wave scattering graphically illustrated. The suitable physical properties for ideal plate characteristics are shown by a comparison of various edge conditions. It is suggested that the appropriate breakwater width maximises wave reflection and minimises transmission. The waveload on the plate is reduced by appropriate porous breakwater values. The findings of the study could have an effect on how marine infrastructures can be designed to lessen the wave force.

Symposium on Discrete Mathematics

Super power graphs of finite groups

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Abstract

For a finite group G, the superpower graph S(G) is an undirected simple graph with vertex set G and two vertices are adjacent in S(G) if and only if the order of one divides the order of the other in G. In this talk, we will discuss the properties such as dominant set, connectivity, Hamiltonicity and its variations on the superpower graphs of finite abelian groups and non-abelian groups having an element of exponent order.
This is a joint work with Mr. Ajay Kumar.

On Laplacian eigenvalues of graphs and zero divisor graphs associated to the ring

of integers modulo n

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Abstract

Consider a simple graph $G(V, E)$ of order n, size m and having the vertex set $V(G) = \{v_1, v_2, \ldots, v_n\}$ and edge set $E(G) = \{e_1, e_2, \ldots, e_m\}$. The adjacency matrix $A = (a_{ij})$ of G is a $(0, 1)$-square matrix of order n whose (i, j)-entry is equal to 1 if v_i is adjacent to v_j and equal to 0, otherwise. Let $D(G) = diag(d_1, d_2, \ldots, d_n)$ be the diagonal matrix associated to G, where $d_i = \deg(v_i)$, for all $i = 1, 2, \ldots, n$. The matrix $L(G) = D(G) - A(G)$ is called the Laplacian matrix and its eigenvalues are called the Laplacian eigenvalues of G. Let $0 = \mu_n \leq \mu_{n-1} \leq \cdots \leq \mu_1$ be the Laplacian eigenvalues of G and let $S_k(G) = \sum_{i=1}^{k} \mu_i$, $k = 1, 2, \ldots, n$ be the sum of k largest Laplacian eigenvalues of G. For any k, $k = 1, 2, \ldots, n$, Brouwer conjectured that $S_k(G) = \sum_{i=1}^{k} \mu_i \leq m + \binom{k+1}{2}$. We discuss the bounds for $S_k(G)$ and the recent developments of the Brouwer's conjecture. Further, we investigate the Laplacian eigenvalues of the graphs associated to the ring of integers modulo n.

Graphs defined on groups

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Abstract

Over the last couple of years I have been involved in a large project investigating graphs defined on groups in terms of their algebraic structure. Typical examples are the *commuting graph*, in which x and y are joined if $xy = yx$, and the *generating graph*, in which x and y are joined if $\{x, y\}$ generates the group. It turns out that many interesting classes of groups are defined by requiring two of these graphs to be equal or complementary. For a simple example, if G is non-abelian, then the generating graph is the complement of the commuting graph if and only if G is a minimal non-abelian group. (These groups were classified by Miller and Moreno in 1904.) I will describe several further classes, including EPPO groups, Dedekind groups and 2-Engel groups. Two reasons for studying this topic are that important results about groups can be proved using graphs (for example, the celebrated Brauer–Fowler theorem), and interesting graphs can be constructed from groups. I will mention some examples, including a strengthening of an old theorem of Landau.

On the inter-relationships between graphs associated with algebraic structures and graphs associated with ordered structures

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Abstract

In this talk, we discuss the inter-relationships between graphs associated with algebraic structures and graphs associated with ordered structures. The zero-divisor graph of a reduced Artinian ring can be studied using the zero-divisor graph of a specially constructed poset (cf. [1], [3, Remark 3.4]). Recently, in [2], it is proved that the comaximal ideal graph, (co-)annihilating ideal graph of a commutative ring R with identity can be effectively be

studied via the zero-divisor graph of a specially constructed poset from R. Also, we (with Nilesh Khandekar, Peter Cameron and Pravin Gadge) proved that the comaximal graph of a ring, component graphs of a finite dimensional vector spaces, the total graph of a lattice is explored using the zero-divisor graph of a poset. Further, we (with Rahul Jejurkar) proved the comparability graph of the lattice of substructures of an algebraic structure is a tool to explore the inclusion graph on various algebraic structures, such as subspace inclusion graph of a finite dimensional vector space, submodule inclusion graph of a module, ideal inclusion graph of rings, etc. The weakly perfectness, perfectness, connectedness, chordal, Eulerian, Hamiltonian, planar etc. properties of graphs associated with algebraic structures is explored using the graph associated with ordered structures.

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Symposium on Financial Mathematics

On matrix exponential differentiation with application to weighted sum distributions

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Abstract

A European-type Asian option delivers a payoff depending on the average of the underlying asset price process over a pre-specified time. We propose a method of accurately approximating the probability distribution of a stochastic average (discrete and continuous) under general one-dimensional Markov processes via an approximating Continuous-time Markov chain (CTMC). It is shown that under the CTMC approximation, the Laplace Transform (LT) of the random average is a function of a matrix exponential. We derive a closed-form expression of the moments of the integral order from the derivatives of the LT. Finally, we obtain a moment-based distribution approximation based on a Pearson curve fit. We highlight the benefit from the new result by means of some numerical examples in the Asian option pricing context.

Regime Switching optimal growth model with risk sensitive preferences

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Abstract

We consider a risk-sensitive optimization of consumption-utility on infinite time horizon where the one-period investment gain depends on an underlying economic state whose evolution over time is assumed to be described by a discrete-time, finite-state, Markov chain. We suppose that the production function also depends on a sequence of i.i.d. random shocks. For the sake of generality, the utility and the production functions are allowed to be unbounded from above. Under the Markov regime-switching model, it is shown that the value function of optimization problem satisfies an optimality equation and that the optimality equation has a unique solution in a particular class of functions. Furthermore, we show that an optimal policy exists in the class of stationary policies. We also derive the Euler equation of optimal consumption. Furthermore, the existence of a joint stationary distribution of the optimal growth process and the underlying regime process is examined.

Numerical methods for option pricing: need and challenges

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Abstract

The unavailability of analytical solutions for option pricing equations motivates us to develop efficient and accurate numerical schemes. The stability analysis of such schemes is often challenging. We discuss a few approaches for proving stability in this talk. It is well known that the stability of a scheme is related to the spectral radius of the corresponding expansion matrix. In this talk, fourth order accurate compact schemes for variable coefficient convection-diffusion equations (as a special case of Black-Scholes equation) are considered. A sufficient condition for stability of the schemes has been derived using a difference equation based approach. The constant coefficient problems are considered as a special case, and the unconditional stability of compact schemes for such cases is proved theoretically. The condition number of the amplification matrix is also analysed, and an estimate for the same is derived. An example is provided using MATLAB to support the assumption taken to assure stability.

Data-driven option pricing using single and multi-asset supervised learning

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Abstract

We propose three different data-driven approaches for pricing European-style call options using supervised machine-learning algorithms. These approaches yield models that give a range of fair prices instead of a single price point. The performance of the models are tested on two stock market indices: NIFTY50 and BANKNIFTY from the Indian equity market. Although neither historical nor implied volatility is used as an input, the results show that the trained models have been able to capture the option pricing mechanism better than or similar to the Black-Scholes formula for all the experiments. Our choice of scale free I/O allows us to train models using combined data of multiple different assets from a financial market. This not only allows the models to achieve far better generalization and predictive capability, but also solves the problem of paucity of data, the primary limitation of using machine learning techniques. We also illustrate the performance of the trained models in the period leading up to the 2020 Stock Market Crash (Jan 2019 to April 2020).

Paper Presentation for AMU Prize

Common fixed point results in G-metric spaces using rational type cyclic contraction via $\mathcal{C}$-class function

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Abstract

Here, we have established the rational type cyclic contraction in G-metric spaces which can't be reduced to the contractive condition in standard metric spaces. The coincidence and common fixed point results are obtained for the pair of (A, B)-weakly increasing mappings in G-metric spaces.

Paper Presentations for IMS Prizes

On virtually D_1, D_2 and principally hollow lifting modules

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Abstract

Virtually extending module is a proper generalization of extending module. In this paper, we have introduced and studied another generalization of lifting module namely virtually lifting as the dual notion of virtually extending module. Various properties of this structure have been discussed and found that virtually lifting module is a D_{12} module. It is observed that for a V ring R, a module M is virtually lifting if and only if it is lifting. Moreover, we have defined virtually D_2 module as a proper generalization of D_2 module, and seen that the class of virtually D_2 modules are closed under direct summands. Finally, we have introduced principally $h-$lifting module and proved that finite direct sum of principally $h-$lifting modules are principally $h-$lifting if each components are principally relatively projective.

Study of a supersonic-sonic patch arising in axisymmetric relativistic transonic flows with general equation of state

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Abstract

We prove the existence and regularity of a global smooth solution for a supersonic-sonic patch arising in modified Frankl problem in the study of two-dimensional steady isentropic relativistic transonic flows with a general equation of state over a symmetric airfoil. Such types of patches appear in many transonic flows over an airfoil and flow near the nozzle throat. Using the characteristic decompositions method and a well-known partial hodograph transformation in terms of angle variables, we prove the existence and regularity of solutions in the partial hodograph plane first and then obtain the global solutions in the physical plane by using an inverse transformation.

Contributory Papers

Section A: Combinatorics, Graph Theory, Logic, Discrete Mathematics, etc.

On recent status of circulant partial Hadamard matrices

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Abstract

Circulant Partial Hadamard matrices have became very interesting as well as useful due the work of Craigen at el. over the past decate. And their applications in fMRI desing experiment shown by Lin at el. make them all the more valuable. This article covers the basic properties of CPHM and some currently unsolved problems on CPHM.

Weighted zero-sum constants

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Abstract

The study of zero-sum constants was initiated in 1961 after Erdős, Ginzburg and Ziv proved that any sequence of $2n-1$ integers contains a subsequence of n integers that add up to a multiple of n. A weighted generalization of classical zero-sum constants was introduced by Adhikari *et al.* in 2006 and has been an active area of research since then. In the last fifteen years, weighted zero-sum constants for $\mathbb{Z}_n$ with several interesting weight sets have been found.

Let G be a finite abelian group with $\exp(G) = n$. The smallest positive integer l such that any sequence S of l elements of G has a non-empty$A$-*weighted zero-sum subsequence* is called *weighted Davenport constant of* G *with weight* A. In this talk, we take up the problem of determining the exact values and providing bounds of *weighted Davenport constant* of $\mathbb{Z}_n$ with some new weight sets.

Next, we consider a weighted generalization of the *Erdős-Ginzburg-Ziv constant*. For a positive integer k and a non-empty subset A of $[1, n-1]$, the arithmetical invariant $\mathsf{s}_{kn,A}(G)$ is defined to be the least positive integer t such that any sequence S of t elements of G has an A-*weighted zero-sum subsequence* of length kn. We give the exact value of $\mathsf{s}_{kq,A}(G)$, for integers $k \geq 2$ and $A = \{1, 2\}$, where G is an abelian p-group with $rank(G) \leq 4$, p is an odd prime and $exp(G) = q$. Our method consists of a modification of a polynomial method of Rónyai.

On cographic splitting of graphic matroids using a set with three elements

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Abstract

In general, the properties of binary matroids, like graphicness and cographicness are not preserved by the splitting operation. In this paper, for the group of graphic matroids, we obtain a collection of minimal minors to get non-cographic splitting matroids using a splitting operation by a set containing three elements. We also provide a short and an alternate proof to the characterization, which was provided by Borse et al., when the set contains two elements.

Inverse problems corresponding to the weighted Davenport constant for cyclic groups

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Abstract

Let G be a finite abelian group of exponent m. Then for any non-empty set $A \subset [1, m-1]$, the *Davenport constant of G with weight A,* denoted by $D_A(G)$, is defined to be the smallest positive integer k such that every sequence $S = (x_1, \ldots, x_k)$ over G of length k has a non-empty *A-weighted zero-sum subsequence,* that is, there exist a subsequence $(x_{j_1}, \ldots, x_{j_t})$ of S and $a_1, \ldots, a_t \in A$ such that $\sum_{i=1}^{t} a_i x_{j_i} = 0$, where 0 is the identity element of G.

By the *inverse problem* corresponding to the weighted Davenport constant $D_A(G)$, we mean the characterization of all zero-sum free sequences over G of length $D_A(G) - 1$.

In this talk, our plan is to discuss about some fascinating inverse problems corresponding to the weighted Davenport constant $D_A(G)$ for some interesting weight sets for a finite cyclic group.

Extremal sequences for a weighted zero-sum constant

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Abstract

In the theory of zero-sum constant, Davenport constant $D(G)$ for a finite abelian group G was studied first and was defined as the smallest positive integer k such that any sequence of k elements in G has a non-empty subsequence whose sum is zero. Then generalization of this constant $D_A(G)$ was considered for some weight sets A not containing zero, where A-weighted sum is taken instead of ordinary sum of sequence elements.
Recently, we defined a new constant related to these constants namely $C_A(G)$, where we restrict ourselves to A-weighted zero-sum subsequence of **consecutive** terms i.e. $C_A(G)$ is the smallest natural no. k, such that any sequence of k elements in G has a subsequence of **consecutive** terms such that some A-linear combination of its terms is zero. If $C_A(G) = k$, then there is a sequence of length $k-1$ in G which does not have any A-weighted zero-sum subsequence of **consecutive** terms. We call such a sequence an **A-extremal** sequence for $C_A(G)$. In this paper, We characterize such **A-extremal** sequences for $C_A(G)$ of a finite cyclic group with some particular weights.

On a different weighted zero-sum constant

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Abstract

For a finite abelian group $(G, +)$, the constant $C(G)$ is defined to be the smallest natural number k, such that any sequence of k elements in G has a subsequence of consecutive terms whose sum is zero.

If the exponent of the group G is m and $A \subseteq \{1, 2, \ldots, m-1\}$, then an A-weighted version, $C_A(G)$, is defined to be the smallest natural number k such that any sequence in G of length k has a non-empty subsequence whose A-weighted sum is zero.

Let $U(n)$ denote the multiplicative group of units of $\mathbf{Z}_n$, and $U(n)^j = \{x^j : x \in U(n)\}$. For any positive integer n, $\Omega(n)$ denotes the number of prime divisors of n counted with multiplicities.

We prove:

1. For $A = U(p)^2$, where p is a prime, $C_A(\mathbf{Z_2}) = 2$ and $C_A(\mathbf{Z_p}) = 3$ when $p \neq 2$.
2. For $A = U(p)^3$, where $p \neq 7$ is a prime such that $p \equiv 1(mod\ 3)$, $C_A(\mathbf{Z}_p) = 3$. Also $C_A(\mathbf{Z_7}) = 4$.
3. For $A = U(n)$, where n is any odd natural number, $C_A(\mathbf{Z_n}) = 2^{\Omega(n)}$.
4. For $A = U(n)^2$, where every prime divisor of n is at least 7, $C_A(n) = 3^{\Omega(n)}$.

Determinant of a directed Boolean graph using Pfaffian

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Abstract

The Boolean graph is a graph whose vertex set is the set of non-zero zero-divisors of the finite Boolean ring and the two vertices x and y are adjacent if their product xy is zero. In this paper we consider the directed Boolean graph which is abtained by orienting the edges of the Boolean graph. We show that the determinant of the adjacency matrix of the directed Boolean graph is 1 and is independent of the choice of orientations on its edges. Using a classical theorem of Cayley which expresses the determinant of any skew symmetric matrix as a square of its Pfaffian, we show that for any directed Boolean graph, the characteristic polynomial has all its even degree coefficients strictly positive with the odd ones being zero. This is a joint work with Gahininath Sonawane and Y. M. Borse.

Component graphs of vector spaces and zero-divisor graphs of ordered sets

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Abstract

In this paper, nonzero component graphs and nonzero component union graphs of finite dimensional vector space are studied using the zero-divisor graph of specially constructed 0-1-distributive lattice and the zero-divisor graph of rings. Further, we define an equivalence relation on nonzero component graphs and nonzero component union graphs to deduce that these graphs are the graph join of zero-divisor graphs of Boolean algebra and some complete graphs. In the last section, we characterize the perfect and chordal nonzero component graphs and nonzero component union graphs.

Isomorphism theorem for comparability graphs

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Abstract

In recent years, researchers have actively contributed to the field of graphs associated with algebraic structures and ordered structures. It is a fundamental question to ask whether we can infer about algebraic or ordered structures from their associated graphs or vice versa. In this paper, we gave characterizations about comparability graphs and associated lattices. In particular, we answered two important problems.

1. What are the properties of lattices that are preserved under the graph isomorphism?
2. Determine the classes of lattices in which a graph isomorphism gives a lattice isomorphism.

In particular, we determine some properties of lattices that are preserved under the graph isomorphism and we also give a class of lattices in which graph isomorphism gives lattice isomorphism.

Spectra of zero-divisor graphs of product rings

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Abstract

Let $R_n = \mathbb{F}_m \times \mathbb{F}_m \times \cdots \times \mathbb{F}_m$ (n terms), where $\mathbb{F}_m$ is a finite field with m elements. Let $\Gamma(R_n)$ denote the zero-divisor graph of the ring R_n. The class of graphs $\Gamma(R_n)$ contains Boolean graphs as a sublcass and also contains the class of zero-divisor graphs of the ring $\mathbb{Z}_p \times \mathbb{Z}_p \times \cdots \times \mathbb{Z}_p$, p a prime. In this paper, we give recursive description of the graph $\Gamma(R_n)$ and use this to determine the determinant, rank and nullity of the adjacency matrix of $\Gamma(R_n)$. We associate two $(n-1)\times(n-1)$ sized matrices $P[m,n]$ and $Q[m,n]$ to the graph $\Gamma(R_n)$ having combinatorial entries and show that $\mathrm{Spect}(P[m,n]) \cup \mathrm{Spect}(-Q[m,n]) \cup \{0\} \subseteq \mathrm{Spect}(\Gamma(R_n))$. We propose that the other containment is also true.

Reciprocal degree distance and Hamiltonian properties of graphs

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Abstract

Topological indices are numerical descriptors associated with graphs of molecular chemistry. The first time H. Weiner found a boiling point of alkanes by calculating the sum of distances between every pair of vertices. Therefore study of different properties of molecules started based on the degree and distance of vertices.

Finding Hamiltonian properties of graphs is NP-complete. Therefore it is necessary to find sufficient conditions for a graph to have Hamiltonian properties. A path (or cycle) is said to be a Hamiltonian path (or cycle) if it traverses through all vertices of the graph exactly once. A graph is said to be traceable if it has a Hamiltonian path. Similarly, a graph is said to be Hamiltonian if it has a Hamiltonian cycle.

Initially, In 2013 Yang studied the traceability of graphs in terms of the Weiner index and extended to the Hamiltonian cycle. In this article, we have discussed sufficient conditions for Hamiltonian properties (Hamiltonian path, Hamiltonian cycle and Hamiltonian-connectedness) of graphs in the terms of Reciprocal degree distance (RDD). RDD is defined as

$$RDD(G) = \sum_{u \neq v} \frac{\deg_G(u) + \deg_G(v)}{d_G(u, v)} \tag{1}$$

A semi-constructive approach to non-standard and its impact on set theory

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Abstract

Our main aim is to introduce an alternative approach to nonstandard analysis that remains within the bounds of semi-constructive mathematics, i.e., does not assume any fragment of the Axiom of Choice beyond the Axiom of dependent Choices. we extend the F-hyperreal line *R as a possibility structure and show that it shares many fundamental properties of the classical hyperreal line, such as a Transfer Principle and a Saturation Principle. Non-standard analysis structure inspite go into a complete description of what this means, we use logical sentences constructed from sets, their elements, relations, functions, and logical connectives by A. Robinson(1). We also introduced definitions involving ϵs and δs by A. Levy (5).

On the metric dimension of a zero-divisor graph of a poset

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Abstract

In this paper, we study the metric dimension of a zero-divisor graphs associated with a special class of pseudocomplemented posets and its complement. Furthermore, these results are applied to calculate the metric dimension of a zero-divisor graph of a finite reduced commutative ring R with identity.

Decomposition of k-ary n-cube into paths and cycles of length k

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Abstract

For non-negative integers u, v and graphs H, K, G, an $\{H, K\}_{\{u,v\}}$-decomposition of G means a partition of the edge set of G into u copies of H and v copies of K. For an integer $k \geq 3$, let P_{k+1} and C_k be a path and a cycle of length k, respectively. The k-ary n-cube Q_n^k is a graph obtained by the Cartesian product of n copies C_k. In this paper, we prove that Q_n^k has a $\{P_{k+1}, C_k\}_{\{u,v\}}$-decomposition if and only if $u + v = nk^{n-1}$ and $u \neq 1$. The case $k = 4$ gives the corresponding known result for hypercubes.

Two-disjoint-cycle-cover pancyclicity of Augmented Cubes

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Abstract

Let $k_2 \geq k_1 \geq 0$ be two integers. A graph G is two-disjoint-cycle-cover vertex $[k_1, k_2]$-pancyclic if for any two vertices $u, v \in V(G)$ and any integer l satisfying $k_1 \leq l \leq k_2$, there exist two vertex-disjoint cycles C_1 and C_2 in G with $|V(C_1)| = l$ and $|V(C_2)| = |V(G)| - l$ such that $u \in V(C_1)$ and $v \in V(C_2)$. We study the two-disjoint-cycle-cover pancyclicity of the n-dimensional Augmented Cubes AQ_n, which is a hypercube-variant network and is superior to hypercube due to having high connectivity and a smaller diameter. We show that AQ_n is two-disjoint-cycle-cover $[3, 2^n - 3]$-pancyclic for $n \geq 3$.

On the A_α and RD_α spectrum of power graph over certain group

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Abstract

The power graph $P(\mathcal{G})$ of a finite group $\mathcal{G}$ is a graph with the vertex set $\mathcal{G}$ and two distinct vertices form an edge if and only if one is power of the other. Let $A(G)$, $D(G)$, $RT(G)$, and $RD(G)$ denotes adjacency matrix, degree diagonal matrix, diagonal matrix of the vertex reciprocal transmission, and Harary matrix of a graph G. Then the A_α and RD_α matrices of G are defined as $A_\alpha(G) = \alpha D(G) + (1 - \alpha)A(G)$ and $RD_\alpha(G) = \alpha RT(G) + (1 - \alpha)RD(G)$. In this conference, we determine the eigenvalues of A_α and RD_α matrices of the power graph of a split-meta cyclic group.

Section B: Algebra, Number Theory, Lattice Theory and History of Mathematics

Diophantine approximation with prime restriction in function fields

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with an appendix by Arijit Ganguly[c]
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Abstract

In the thirties of the last century, I. M. Vinogradov established uniform distribution modulo 1 of the sequence $p\alpha$ when α is a fixed irrational real number and p runs over the primes. In particular, he showed that the inequality $||p\alpha|| \leq p^{-1/5+\varepsilon}$ has infinitely prime solutions p, where $||.||$ denotes the distance to a nearest integer. This result has subsequently been improved by many authors. The current record is due to Matomäki (2009) who showed the infinitude of prime solutions of the inequality $||p\alpha|| \leq p^{-1/3+\varepsilon}$. This exponent $1/3$ is considered the limit of the current technology. We prove function field analogues of this result for the fields $k = \mathbb{F}_q(T)$ and imaginary quadratic extensions K of k. Essential in our method is the Dirichlet approximation theorem for function fields which is established in general form in the appendix authored by Arijit Ganguly.

Σ-dual-Rickart Modules

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Abstract

In this paper, we dualize the concept of Σ-Rickart modules as Σ-dual-Rickart modules. An R-module M is said to be a Σ-dual-Rickart if every direct sum of arbitrary many copies of M is a dual-Rickart module. We prove that each cohereditary module over the noetherian ring is a Σ-dual-Rickart module and discuss when a Σ-Rickart module is a Σ-dual-Rickart module and vice-versa. We also, study some properties of Σ-dual-Rickart modules and find its connections with semisimple artinian ring, regular ring, semi-hereditary ring. Further, we study the endomorphism ring of Σ-dual-Rickart modules.

Modules in which pure submodule is essential in a direct summand

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Abstract

In this paper, we introduce and study the class of pure extending modules, that is the module M in which every pure submodule is essential in a direct summand. We examine for which rings or under what conditions pure extending modules are extending modules. We study some properties of pure extending modules and characterize regular ring, semi-simple ring, local ring and PDS ring in terms of pure extending modules.

A study of constacyclic codes over non-chain ring

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Abstract

Let p be an odd prime, q be an power of an odd prime power and F_q be the field of q elements having characterstic p. The main aim of this article is to study of structural properties of constacyclic code over the ring $R = F_q[u, v]/\langle u^2 - 1, v^2 - 1, uv - vu\rangle$. We define a Gray map and decompose constacyclic code over the ring R as a direct sum of constacyclic code over F_q. As an application, we obtain quantum error correcting codes over the ring R.

Post-quantum signature scheme based on multivariate quadratic quasigroups (MQQs)

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Abstract

Multivariate public-key cryptography (MPKC) has been a promising area for the "post-quantum cryptography" for the past two decades. Multivariate public-key cryptographic schemes are based on solving the system of the multivariate quadratic equation over the finite field, famously known as multivariate quadratic (MQ) problem. In this paper, we design a multivariate digital signature scheme (MQQ-SIGv) based on the MQ problem, and we use the multivariate quadratic quasigroup to design the central function. We utilize the vinegar variables in the bilinear multivariate quadratic quasigroup (MQQ) to secure against the polynomial-time attack applied on the signature scheme MQQ-SIG. We prove that our signature scheme MQQ-SIGv is secure against the direct attack, Min-Rank and High-Rank attacks under specific conditions, and it is also secure against the chosen-message attack (CMA)

Weight distributions of some irreducible constacyclic codesl

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Abstract

Irreducible constacyclic codes form an algebraically rich family of error-correcting codes, and can be easily encoded and decoded using linear shift registers. They are building blocks for all the constacyclic codes, which are generalizations of cyclic and negacyclic codes. Their error-performance relative to various communication channels is measured by their Hamming weight distributions. In this paper, we determine weight distributions of irreducible constacyclic codes using the trace description of irreducible constacyclic codes of length n over the finite field $\mathbb{F}_q$ of order q in certain special cases, where n is a positive integer and q is a prime power coprime to n. We also derive a weight-divisibility theorem and obtain bounds on the non-zero Hamming weights in irreducible constacyclic codes. We also derive a necessary and sufficient condition for an irreducible constacyclic code to have the maximum number of non-zero Hamming weights, from which another weight-divisibility theorem is derived for this special class of irreducible constacyclic codes. From these results, the corresponding results for irreducible cyclic and negacyclic codes can be deduced on taking $i = 0$ and $i = \frac{q-1}{2}$ respectively. We also found some optimal codes within the family of irreducible constacyclic codes, which attain the distance bounds given in Grassl's Table.

Certain results on bicomplex linear maps and matrices

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Abstract

In this paper, matrices and linear maps on bicomplex numbers are discussed. We extend the concept of similarity of matrices, linear maps and rank to that of bicomplex space. We also establish an analogue of the result on relation between matrices of linear maps with respect to two different bases to the case of bicomplex space.

Generalized derivations acting on multilinear polynomials in prime rings

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Abstract

Let $\mathcal{R}$ be a prime ring of characteristic not equal to 2, $\mathcal{U}$, $\mathcal{C}$ be the Utumi quotient ring and extended centroid of $\mathcal{R}$, and f be a non-central polynomial identity of $\mathcal{R}$. Also, let $\mathcal{G}$, $\mathcal{F}$, and $\mathcal{H}$ be three generalized derivations on $\mathcal{R}$ satisfying $\mathcal{F}(\mathcal{G}(u)u) = u(\mathcal{H}(u))$ for all $u = f(\chi)$, $\chi = (\chi_1, \ldots, \chi_n) \in \mathcal{R}^n$. Then one of the following holds:

1. $\mathcal{F} = 0$ and $\mathcal{H} = 0$.
2. Their exists $a, b \in \mathcal{U}$ and $\lambda \in \mathcal{C}$ such that $\mathcal{F}(\zeta) = a\zeta$, $\mathcal{G}(\zeta) = b\zeta$ and $\mathcal{H}(\zeta) = \lambda\zeta$ with $ab = \lambda$.
3. Their exists $a, c \in \mathcal{R}$ and $\lambda \in \mathcal{C}$ such that $\mathcal{F}(\zeta) = \zeta a$, $\mathcal{G}(\zeta) = \lambda\zeta$ and $\mathcal{H}(\zeta) = \zeta c$ with $a\lambda = c$.
4. Their exists $a, c \in \mathcal{U}$ and $\lambda \in \mathcal{C}$ such that $\mathcal{F}(\zeta) = \lambda\zeta$, $\mathcal{G}(\zeta) = \zeta a$ and $\mathcal{H}(\zeta) = c\zeta$ with $\lambda a = c$.
5. $f(\chi)^2 \in \mathcal{C}$, and one of the following holds:
   - Their exists $a, b, c \in \mathcal{U}$ such that $\mathcal{F}(\zeta) = a\zeta + \zeta b$, $\mathcal{G}(\zeta) = c\zeta$ and $\mathcal{H}(\zeta) = \zeta(ac + cb)$.
   - Their exists $a, b, \in \mathcal{U}$ and $\lambda \in \mathcal{C}$ such that $\mathcal{F}(\zeta) = \lambda\zeta$, $\mathcal{G}(\zeta) = a\zeta + \zeta b$ and $\mathcal{H}(\zeta) = \lambda(b\zeta + \zeta a)$.

   for all $\zeta \in \mathcal{R}$.

On regularity of powers of edge ideals of weighted oriented forests

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Abstract

Weighted oriented graphs are important because of their applications in coding theory and others. For a weighted oriented graph D, one can associate a monomial ideal, denoted by $I(D)$, known as the *edge ideal* of D. In this work we are interested to study an algebraic invariant Castelnuovo-Mumford regularity of $I(D)^k$, denoted as $\mathrm{reg}(I(D)^k)$. It is well known that $\mathrm{reg}(I(D)^k)$ is eventually a linear function of k.

In this talk, we explicitly give combinatorial formulas for the regularity of powers of edge ideals, $\mathrm{reg}(I(D)^k)$, of Cohen-Macaulay weighted oriented forests D whose leaves are sinks ($V^+(D)$ are sinks). This combinatorial formula is a piecewise linear function of k, for $k \geq 1$.

Primes of higher residue degree

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Abstract

For any prime number ℓ, Kummer proved that the class group of $\mathbb{Q}(\zeta_\ell)$ is generated by the ideal classes of prime ideals of $\mathbb{Q}(\zeta_\ell)$ of residue degree one. While for a general number field L, It is well-known that the class group of L is generated by the ideal classes of prime ideals $\mathfrak{P}$ of L of residue degree one. For a Galois extension $L/\mathbb{Q}$ of number fields, we study the ideal classes of prime ideals $\mathfrak{P}$ of L of residue degree bigger than one in the class group of L and we find many examples of the Galois extensions $L/\mathbb{Q}$ where the ideal classes of unramified prime ideals of fixed residue degrees $f > 1$ generate the class groups $C\ell(L)$. We use this study to show that for any two relatively prime integers $n > 1$ and p, where p is prime and n is an odd integer such that n and $p - 1$ are relatively prime then any cyclic extension $L/\mathbb{Q}$ of degree n can not have cyclic class group of order p.

Some results on nilpotent bicomplex matrices

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Abstract

In this paper, we have detailed the study of bicompllex matrices.The concept of nilpotent matrix is extended on the space of bicomplex numbers. We also investigate some results relative to nilpotent bicomplex matrices. Further we have given certain examples to establish these results.

Zero-divisors of Artinian rings

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Abstract

It is an interesting theme of research to study zero-divisor graphs associated to commutative rings. The prominent among the various zero-divisor graphs associated to a ring R are the usual zero-divisor graph $\Gamma(R)$, the compressed zero-divisor graph $\Gamma_E(R)$, and the associate class graph $\Gamma_U(R)$. In this paper we show that when R is Artinian, the graph $\Gamma_E(R)$ is isomorphic to $\Gamma_U(R)$ if and only if R is Gorenstein. As a consequence we obtain a lower bound on the number of elements of the compressed graph in terms of certain projective spaces if R is Artinian Gorenstein local ring. We also produce an example of an Artinian local ring of length 6 such that the clique number of the associated compressed graph is infinite. Further, in the non-Gorenstein case we investigate how the annihilator classes in Artinian rings split into associate classes. This is a joint work with Ganesh S. Kadu.

Mixed-multiple image encryption algorithm using RSA cryptosystem with fractional discrete cosine transform and 2D-Arnold transform

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Abstract

Nowadays, preserving image confidentiality, integrity, authenticity, non-repudiation and transmission over an unprotected channel has become complex. A strong image encryption method over an open network has drawn much interest. To provide secure image transmission, single image encryption (SIE) techniques based on matrix transform, modern cryptosystem etc., are developed. In the era of big data, multiple images can be repeatedly encrypted using SIE algorithm but this is not sufficient. Development of efficient and secure multimedia encryption for multiple image has received much attention. To enhance the efficiency of security of transmission of multiple images, this paper presents a novel multiple- image encryption (MIE) algorithm based on mixed image element associated with RSA cryptosystem, fractional discrete cosine transform (FrDCT) and 2D-Arnold Transform (AT). Firstly, combine n-original images into a big image using knowledge of matrix theory. The big image is extracted into three component i.e., red(R), green(G) and blue(B). The RSA cryptographic scheme is applied to each components R, G and B individually. Secondly, the FrDCT is used on each component with individual fraction. Thirdly, the 2D-AT is applied on three components to enhance the security as well as the key space. Finally, three components are concatenated to generate final encrypted image. The security of presented MIE algorithm depends on both secrete key and their proper arrangement. Simulation analysis and their results support the robustness and appropriateness of the introduced encryption algorithm. Sensitivity analysis confirms that the introduced algorithm is extremely sensitive to its private keys and their arrangement. The effectiveness and viability of our proposed cryptosystem are confirmed by statistical analysis including histogram analysis, MSE, PSNR, correlation coefficient, and entropy analysis.

Powers of edge ideals of weighted oriented graphs with linear resolutions

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Abstract

Let $G = (V(G), E(G))$ be a finite simple (no loops, no multiple edges) undirected graph. A weighted oriented graph D whose underlying graph is G is a triplet $(V(D), E(D), w)$ where $V(D) = V(G)$, $E(D) \subseteq V(D) \times V(D)$ such that $E(D) = \{(x, y) \mid \{x, y\} \in E(G)\}$ and w is a function $w : V(D) \longrightarrow N$. By identifying the vertices with the variables in the polynomial ring $K[x_1, \cdots, x_n]$, we can associate to each weighted oriented graph D a monomial ideal $I(D)$

generated by the set $\{x_i x_j^{w(x_j)} \mid (x_i, x_j) \in E(D)\}$. The ideal $I(D)$ is called the *edge ideal* of D. In this paper, we give a combinatorial characterization of $I(D)$ which has a linear resolution. As a consequence, we prove that if $I(D)$ is the edge ideal of a weighted oriented graph D, then $I(D)$ has a linear resolution if and only if all powers of $I(D)$ have a linear resolution. Also, we show that if D is a weighted oriented graph and $w(x) > 1$ for all $x \in V(D)$, then $I(D)$ has a linear resolution if and only if all powers of $I(D)$ have linear quotients. We provide a lower bound for the regularity of powers of edge ideals of weighted oriented graphs in terms of induced matching. Finally, we obtain a general upper bound for the regularity of edge ideals of weighted oriented graphs.

Nonlinear bi-skew Jordan-type derivations on factor Von Neumann algebras

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Abstract

Abstract. Let $\mathcal{A}$ be a factor von Neumann algebra acting on a complex Hilbert space with $dim(\mathcal{A}) \geq 2$. For any $X, X_1, X_2, \cdots, X_n \in \mathcal{A}$, define $p_1(X) = X$, $p_2(X_1, X_2) = X_1 \diamond X_2 = X_1 X_2^* + X_2 X_1^*$ and $p_n(X_1, X_2, \cdots, X_n) = p_{n-1}(X_1, X_2, \cdots, X_{n-1}) \diamond X_n$ for all integers $n \geq 2$. In this article, we prove that a map $\zeta : \mathcal{A} \to \mathcal{A}$ satisfies

$$\zeta(p_{\mathtt{n}}(X_1, X_2, \cdots, X_{\mathtt{n}})) = \sum_{\mathtt{i=1}}^{\mathtt{n}} p_{\mathtt{n}}(X_1, X_2, \cdots, X_{\mathtt{i-1}}, \zeta(X_{\mathtt{i}}), X_{\mathtt{i+1}}, \cdots, X_{\mathtt{n}})$$

for all $X_1, X_2, \cdots, X_{\mathtt{n}} \in \mathcal{A}$ if and only if ζ is an additive $*$-derivation.

On the x-coordinates of Pell equations which are Narayana numbers

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Abstract

Narayana numbers originated from a herd of cows and calves problem which was proposed by the Indian mathematician Narayana Pandit. The sequence of Narayana numbers $\{N_n\}_{n\geq 0}$ is recursively defined by $N_{n+3} = N_{n+2} + N_n$ with the initial conditions $N_0 = 0, N_1 = N_2 = 1$. Consider the Pell equation $x^2 - dy^2 = \pm 1$ with a square free integer $d > 1$. Many authors studied various Diophantine equations involving members of x-coordinates or y-coordinates of the Pell equation which belong to some interesting sequences such as Fibonacci sequence, Lucas sequence, Tribonacci sequence, Padovan sequence, etc. In this work it is shown that there exists at most one value of $x > 0$ satisfying the Pell equation $x^2 - dy^2 = \pm 1$, which is a Narayana number except for $d = 2$. Bakers theory of nonzero linear forms in logarithms of algebraic numbers, the Baker-Davenport reduction procedure, as well as the elementary properties of Narayana's sequence, are used to prove the main result. All computations are done with the help of a computer program in *Mathematica*.

Abstract of a note on an equivalent of the Riemann hypothesis

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Abstract

In this manuscript we denote by $\sum_\rho$ a sum over the non trivial zeros of Riemann zeta function (or over the zeros of Riemann's xi function), where the zeros of multiplicity k are counted k times. Using the Hadamard product of the Riemann xi function, we prove a result that the Riemann Hypothesis is true if and only if

$$\sum_\rho \frac{1}{|\frac{1}{2}-\rho|^4} = \frac{1}{2}\left(\frac{\xi''(\frac{1}{2})}{\xi(\frac{1}{2})}\right)^2 - \frac{1}{6}\left(\frac{\xi^{(4)}(\frac{1}{2})}{\xi(\frac{1}{2})}\right)$$

Diagonal subalgebras of Rees algebra of Pfaffian ideals

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Abstract

For a bigraded K-algebra R, R_Δ denotes the diagonal subalgebra of R corresponding to the diagonal $\Delta = \{(ci, ei) \mid i \in \mathbb{Z}\}$ for $c, e \geq 0$. We aim to understand an important class of bigraded algebras, Rees algebras, in terms of their defining equations and further study the Koszul and Cohen-Macaulay properties of its diagonal subalgebras. Some study is already done on the diagonals of Rees algebra of complete intersections and certain height two perfect ideals with linear presentation. We are interested in extending the study to ideals generated by d-sequence and further to the larger class of ideals of linear type. In this attempt, we look at the Pfaffian ideals generated by maximal order Pfaffians of a generic skew-symmetric matrix, since they correspond to a class of ideals of linear type. We give the explicit defining equations of Rees algebra and show that the defining ideal is an almost complete intersection. Moreover, in this case, we prove that all its diagonals are Koszul.

We also discuss algorithms for computing bigraded Betti numbers and checking if an ideal is generated by d-sequence in Macaulay2, a software system for research in algebraic geometry.

On the redefined notion of fuzzy algebras over fuzzy fields

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Abstract

The concept of fuzzy sets and their operations were first propounded by Lotfi A. Zadeh. Since then the theory of fuzzy sets has been developed in wide variety of theoretical and practical fields and is finding applications in various domains of knowledge. The notion of fuzzy algebra over a fuzzy field were introduced and studied by Sudarsan Nanda. Fuzzy fields and fuzzy linear spaces were also proposed by Nanda. The object of this paper is to redefine the

notion of fuzzy algebra and to show that it is more general than the classical algebra. Further, we have shown that from the notion proposed in this note, we can derive the notion proposed by Nanda but the converse is not true. Consequently, we have discussed several results based on our proposed notion and it is also possible to derive the results of Nanda under the proposed notion.

Jordan structure in semirings

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Abstract

Jordan ideals and Jordan derivations are studied by leading researchers as they play a vital role in the study of prime rings. In this paper we define Jordan ideals and Jordan derivations in semirings analogous to rings. In 1973, Awtar established the commutativity of Jordan ideals in prime rings. Here, we prove that in a semiring of characteristic different from two, a Jordan ideal (U) is in the centre of the semiring if $ud(u) = d(u)u, \forall u \in U$. We also generalize the classical result of Herstein (1957) in prime rings to prime semirings and also the result of Brešer (1988) in semiprime rings to semiprime semirings (Jordan derivation is just an ordinary derivation in both cases). The key tool which acts as bridge to go back and forth in these generalization is the derivation in ring of differences of a semiring induced by a derivation in the semiring.

On a certain differential identities of prime rings with skew b-derivations

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Abstract

Let R be a prime ring and Q be the maximal ring of quotients of R. Let $b \in Q$ and α be an automorphism of R. A skew b-derivation of R is an additive mapping $D : R \to Q$ which satisfy $D(xy) = D(x)y + b\alpha(x)D(y)$ holds for every $x, y \in R$. The primary goal of this study is to describe the skew b-derivations in prime rings that meet specific differential identities. We specifically expanded Herstein's approach for skew b-derivations [Canad. Math. Bull. 21(3), (1978), 369-370]. Additionally, we give several examples to show that the limitations put on the theory behind our findings are not superfluous.

Balancing and Lucas-balancing sedenions

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Abstract

In this paper, we introduce the Balancing and Lucas-balancing sedenions and investigate their properties. We give some interesting results, generating functions and Binet's formula. Furthermore, we obtain some well-known identities such as Catalan's identity and Cassini's identity for the Balancing and Lucas-balancing sedenions.

A note on connectivity preserving splitting operation for matroids representable over $GF(p)$

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Abstract

The splitting operation on a p-matroid does not necessarily preserve connectivity. It is observed that there exists a single element extension of the splitting matroid which is connected. In this paper, we define the element splitting operation on a p-matroids which is a splitting operation followed by a single element extension. It is proved that the element splitting operation on connected p-matroid yields a connected p-matroid. We give a sufficient condition to yield Eulerian p-matroids from Eulerian p-matroids under the element splitting operation. A sufficient condition to obtain hamiltonian p-matroid by applying the element splitting operation on p-matroid is also provided.

Classification of rings with unit graphs having Roman domination number at most four

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IMS Subject Classification: A, B

Abstract

Let R be a finite commutative ring with nonzero identity. The unit graph of R, denoted by $G(R)$, is defined on all elements of R; where two distinct elements x and y are adjacent if and only if $x+y$ is a unit in R. In this paper, a classification of finite commutative rings with nonzero identity whose associated unit graphs have Roman domination number at most four is obtained.

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

A subclass of harmonic functions for operators on Hilbert space

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Abstract

In this paper we introduce a new subclass of harmonic functions $S_H(\alpha, \beta, \mu; A)$ and derived some properties like coefficient bound, distortion theorem, extreme points.Also an application to fractional calculus operator for the class is investigated.

A new fixed point theorem in b-metric spaces

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Abstract

In this paper, we establish a new fixed point theorem in b-metric spaces in the set up of completeness. Our results improves recent result of Jayesh Tiwari et al. [Some fixed theorems of b-metric spaces, Bull. Pure Appl. Sci. Sect. E Math. Stat. 40 E(1), 18-25(2021)].

Note on the function $R_1\left[\mu, \delta, \delta'; \gamma; \nu, \tau, z_1, z_2\right]$

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Abstract

In this paper, we discuss the extenstion of ${}_pR_q(\nu, \tau; z)$ function, denoted as function $R_1\left[\mu, \delta, \delta'; \gamma; \nu, \tau, z_1, z_2\right]$ and its confluent functions. Also, we obtain their differentiation formulas, finite and infinite summation formulas.

Riesz-Euler λ-statistical Convergence for Sequences of Fuzzy numbers and its Applications to Korovkin Theory

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Abstract

In this proposed paper, we introduce and investigate the concepts of λ-statistical Riesz-Euler summability and Riesz-Euler λ-statistical convergence for sequences of fuzzy numbers. Following that, we establish some inclusion relations connecting these new and potentially useful methods. In addition, from the perspective of applicability, we establish and proved a new Korovkin-type approximation theorem via λ-statistical Riesz-Euler summability method for sequences of fuzzy numbers under the consideration of fuzzy positive linear operators. Finally, we consider an illustrative example to justify the effectiveness of our study.

Bohr radius for Banach spaces on simply connected domains

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Abstract

Let $H^\infty(\Omega, X)$ be the space of bounded analytic functions $f(z) = \sum_{n=0}^{\infty} x_n z^n$ from a proper simply connected domain Ω containing the unit disk $\mathbb{D} := \{z \in \mathbb{C} : |z| < 1\}$ into a complex Banach space X with $||f||_{H^\infty(\Omega,X)} \leq 1$. Let $\phi = \{\phi_n(r)\}_{n=0}^{\infty}$ with $\phi_0(r) \leq 1$ such that $\sum_{n=0}^{\infty} \phi_n(r)$ converges locally uniformly with respect to $r \in [0, 1)$. For $1 \leq p, q < \infty$, we denote

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

and define the Bohr radius associated with ϕ by

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

In this talk, we extensively discuss the Bohr radius $R_{p,q,\phi}(\Omega, X)$, when X is an arbitrary Banach space and $X = \mathcal{B}(\mathcal{H})$ is the algebra of all bounded linear operators on a complex Hilbert space $\mathcal{H}$.

The Octonionic Moritoh transform

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Abstract

In this presentation, the difference between Moritoh and Murenzi wavelet and some basic properties of Moritoh wavelet are discussed. Representation of octonion in term of complex numbers are derived and discussed. Inner product of octonions in complex setup, L^2 inner product of octonion valued function on $\mathbb{R}^n$, convolution of octonion valued functions are discussed. Furthermore, the octonionic Moritoh wavelet transforms is defined and characterization of range space of octonionic Moritoh Transform is discussed. The inner product relation and uncertainty principle for octonion Moritoh wavelet transform are proven.

Degree of approximation of functions in the generalized Lipschitz class via $(E, q)A$-product summability means of conjugate Fourier series

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Abstract

Degree of approximation of Fourier series and conjugate Fourier series for Lipschitz classes of functions play an important role in the study of approximation theory as well as summability theory. Recently dealing with the degree of approximation of Fourier series of a function of Lipchitz class Nigam *et al.* (Int. J. Pure Appl. Math., 82, 365375) and Padhy *et al.* (Int. J. Math. Comp., 29, 7178) have established certain theorems. Extending their results in this paper, we have established and proved a theorem based on the degree of approximation of a function $f \in Lip(\xi(t), r)$ via the $(E, q)A$ product summability means of Conjugate Fourier series.

Brück conjecture and homogeneous differential polynomial

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Abstract

In connection to Brück conjecture we prove a uniqueness theorem for entire functions concerning differential polynomials.

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

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

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

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

In this paper, we extended the conjecture sharing small functions with differential polynomial.

Section D: Functional Analysis, Measure Theory, Probability Theory and Stochastic Processes, and Information Theory

Geraghty-Fisher type rational contraction in controlled fuzzy metric spaces

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Abstract

In this paper, we define a new rational contraction condition of the Geraghty-Fisher type in controlled fuzzy metric spaces, which is an extension of controlled fuzzy metric spaces. We provide an appropriate illustration with graphics which validates our result. We also employ an application to substantiate the utility of our established result to find the unique solution of the second order differential equation's emerging two-point boundary value problem arising in the electric circuit equation. The presented theorem extends, generalizes, and improves the corresponding results given in the literature.

Monotone generalized α-nonexpansive mappings in partially ordered hyperbolic spaces

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Abstract

The class of monotone generalized α-nonexpansive mappings contains the class of monotone α-nonexpansive mappings, monotone Sujuki's generalized nonexpansive mappings and monotone nonexpansive mappings. The aim of this article is to discuss convergence results for monotone generalized α-nonexpansive mappings in partially hyperbolic space employing SP iterative algorithm. Moreover, some examples and useful results related to the monotone generalized α-nonexpansive mapping are provided. Our result extends and generalizes some existing results in literature.

Relation-theoretic weak contractions and applications

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Abstract

In this article, we discuss the relation theoretic aspects of weakly contractive mappings to prove fixed point results in the setting of metric space endowed with an arbitrary binary relation. We also provide an example and an application to the validity of our results. Our newly proved results generalize, extend, unify, enrich, sharpen and improve some well-known fixed point theorems of existing literature.

On partial monotonicity of some extropy measure

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Abstract

Shannon (1948) introduced entropy which is a measure of uncertainty that plays an irresistible role in the field of communication theory. Since the proposal of the Shannon entropy, many entropies have been proposed later and found to be useful in different areas. Recently, Frank et al. (2015) gave a complementary dual of the Shannon entropy and named it extropy. Gupta and Chaudhary (2022) introduced general weighted extropy and studied its properties. In this paper, we study conditional extropy and define the monotonic behaviour of conditional extropy. Also, we provide results on the convolution of general weighted extropy.

Common fixed point theorem for triangular α-admissible mappings in partial metric spaces

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Abstract

The purpose of this paper is to establish common fixed point theorem for triangular α-admissible mappings satisfying C-class functions on (ψ, φ)-contractive condition in partial metric spaces. We adopt an example to highlight the utility of our main result. Our main result extends and improves various results appeared in the current literature. As an application, we provide the existence of solution of system of nonlinear integral equations.

Some results related to Gabor frames on local fields of positive characteristic

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Abstract

In this paper we present characterisations of Gabor frames on local fields of positive characteristics. In 1946, Gabor first proposed the study of systems $\{E_{mb}T_{na}g(\cdot) = e^{2\pi imb\cdot}g(\cdot - na) : m, n \in \mathbb{Z}\}$ with $ab = 1$. The systems $\{E_{mb}T_{na}g : m, n \in \mathbb{Z}\}$ are potential tools for the decomposition and handling of signals, like speech and music, that have well-defined frequencies over short intervals and it change with time. Similar to Fourier analysis, wavelets are also based on the idea of expressing signals in some basis. However, here the basis is not fixed and it provides a general framework for different types of bases. In recent years wavelets have become an indispensable tool in signal processing.
A frame in an inner product space is a generalization of a basis of a vector space to sets that may be linearly dependent. A frame provides a redundant, stable way of representing a signal. Frames are used more generally in applied mathematics, computer science and engineering. It is also an interesting area of research in abstract mathematics.
The Zak transform was discovered by several people working in different fields. However, it has been established that Zak was the first to systematically study the transform in more generalized settings. Zak transform was successfully employed to study the orthogonality and completeness of the Gabor frames at critical density.
In this paper, we present basic definitions and results related to frames and LFPC and discuss different characterizations of Gabor frames along with its generating function. As per our knowledge Zak transform in relation with Gabor systems are not studied in LFPC. Definition of Zak transform and some results related to Gabor system and Zak transform are also studied.

A study of amenability criteria in Banach space and Hilbert space

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Abstract

Our aim is to derive amenability criteria of Banach space the convergence, completeness and the regularity of a semimetric space is invariant with respect to the equivalence of the semimetrics by Y. Zhang. We analyse here contractivity by a weaker but still effective property to extend the contraction principle for such complete semimetric spaces that extra regularity property. Banach Space is applied in linear and non-linear function, operator theory, real and complex algebra, linear operator and isomorphism linear operator and compact algebra known Banach contractive principle approximation of fix point, amenability, and wave length also used properties of Banach Space. Banach Space is complete non-vector space by H. G. Dales and F. Edward Felly. We also suggest that KS2 is a more appropriate Hilbert space for quantum theory. It satisfies the requirements for the Feynman, Heisenberg and Schrodinger representations, while the conventional choice only satisfies the requirements for the Scheimberg and Schrodinger representations S is application. We extend here the contraction principle combining these two directions: we consider the method due to Matkowski, while the underlying space is a complete semimetric space that fulfills an extra regularity condition.

Section E: Differential / Integral / and Functional Equations

On the existence of positive solutions of general Hemmerstein integral equations

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Abstract

This paper is concerned with the study of the existence of an eigen value and corresponding positive solution to the following operator equation of the type

$$u(t) = \lambda \left(Su(t) + \gamma_1(t)\alpha[Su(t)] + \gamma_2(t)H[u(t)] \right),$$

where $\alpha[u] = \int_0^1 u(t)\, dA(t)$ represents Riemann- Stieltjes integral, A is a nondecreasing function with function of bounded variation, $Su(t) = \int_0^1 G(t,s)f(s,u(s))\, ds$, $\gamma_i : [0,1] \to [0,\infty), i = 1,2$ are continuous, and $H[u]$ is a suitable compact operator defined on $[0,1]$. The main tool used is Birkhoff - Kellogg type theorem in cones in Banach space. The obtained results are applied to fourth order differential equations.

Existence of solutions to a nonlinear fractional differential equation with boundary conditions

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Abstract

This paper deals with study of existence of solutions to a type of nonlinear fractional differential equation of the form

$$D^{\alpha}(u) + a(t)f(u) = 0, \quad 0 < t < 1,\ 1 < \alpha \leq 2$$

$$u(0) = 0, u'(0) = 0,$$

where D^{α} represents the α-th order Riemann-Liouville type differential operator.
$f : [0,\infty) \to [0,\infty)$ is a continuous function, and a is a positive continuous function on [0,1]. The main tool used is a fixed point theorem due to Avery and Peterson in cone in a Banach space.

Numerical validation of a two-phase Stokes-Cahn-Hilliard model in a porous medium

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Abstract

We study a phase field model addressing two-phase incompressible immiscible fluid mixture in a porous medium. The model leads to a system of Stokes-Cahn-Hilliard equations coupled via the surface tension term. We assume an evolving interface between the fluids separating them from one another, and instead of a sharp interface, a partial mixing of both the fluid phases at the interfacial region leading to a diffuse interface case having a finite thickness depending on the scale parameter ε. Firstly, we derive some *a-priori* estimates to further use them to homogenize the model from micro to macro scale. Then, we perform the numerical computations to compare the outcome of the effective model with the heterogeneous micro model via MATLAB simulations.

Error analysis of weakly singular non-linear Volterra Urysohn integral equations based on graded mesh

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Abstract

Many physical problems represented as boundary value problems are usually solved by transforming them into integral equations. Therefore, the proposed study discusses the Galerkin method for Volterra-Urysohn integral equations with weakly singular kernels. In addition, to get better convergence rates, iterated versions of Galerkin and multi-Galerkin methods are applied in the space of piecewise polynomials subspaces. We also compute the superconvergence results for the proposed integral equation and demonstrate that iterated Galerkin method outperforms the Galerkin method in terms of order of convergence. To support the proposed theoretical framework, numerical examples are provided.

Strong comparison principle for a p-Laplace equation involving singularity and its applications

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Abstract

In this talk, we prove a strong comparison principle(SCP) for radially decreasing solutions $u, v \in C_0^{1,\alpha}(\bar{B_R})$ of the singular equations $-\Delta_p u - \frac{\lambda}{u^\delta} = f(x)$ and $-\Delta_p v - \frac{\lambda}{v^\delta} = g(x)$ in B_R. Here we assume that $1 < p < 2$, $\delta \in (0,1), \lambda > 0$ and f, g are continuous, radial functions such that $0 \leq f \leq g$ but $f \not\equiv g$ in B_R. For the case $p > 2$, a counterexample is provided where the strong comparison principle is violated. We also consider the elliptic problem $-\Delta_p u = \lambda(\frac{1}{u^\delta} + G(u))$ in a bounded open set Ω in $\mathbb{R}^N$ for $u > 0$ in Ω, and $u = 0$ on $\partial\Omega$. We assume that $0 < \delta < 1$ and the function $G : \mathbb{R} \to [0, \infty)$ is monotonically increasing in $\mathbb{R}^+$ with $G(0) = 0$ and then prove that this problem has three solutions. Finally, we illustrate the three solution theorem through an example of an application of SCP.

This work has been accepted for publication in Applied Mathematics Letters.

Boundedness and well-posedness of a reaction-diffusion systems with mass control

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Abstract

We study a reaction-diffusion system for any arbitrary number of mobile species with different diffusion coefficients. The question of the global existence of solutions for such systems is a dedicated issue for a long time. In the present work, we didn't restrict the order of the nonlinearities and the dimension of the domain. We establish the existence of global classical solutions for the system and also have shown that the solution is bounded uniformly in time. The main motivation of this work is that we don't need the diffusion coefficients to be close to each other. We establish the existence by using the duality method and the regularization of the heat operator. Applications of the results include the validity of the Global Attractor Conjecture for complex balanced reaction systems.

An existence result for two dimensional implicit fractional order integral equations in tempered sequence spaces

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Abstract

In this article we establish a new fixed point theorem using measure of noncompactness (MNC) and a new contraction operator which generalized the Darbo's fixed point theorem (DFPT) and apply this theorem to prove the existence of solution for two dimensional infinite system of implicit fractional integral equations (FIE) in tempered sequence spaces c_0^α and ℓ_p^α, $(p \geq 1)$. We have justified the finding results of these sequence spaces with the help of a numerical example.

Analysis of diffusive size-structured population model with stochastic perturbation

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Abstract

In this work, we introduce a diffusive stochastic size-structured population model. After formulating the problem in an abstract framework, we derive mild solution to the given model. We show the existence and uniqueness of the mild solution to the given model in a Hilbert space. We use the Burkholder-Davis-Gundys lemma to prove the uniqueness of the mild solution. We also show that the system is quasi invariant in the second moment and also mean square dissipative.

Dynamical Behavior and Chaos control of Conflicting Information Spreading Model on Homogeneous Social Network

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Abstract

Political parties do campaigning, publicity, and oppose the opinions of other par- ties using social networks. They always try to create agenda against the opposi- tion and protect their opinion until voting. It is interesting to see the dynamics of two opposite news spread. Here, we presented a mathematical model of conflict- ing information spread in a homogeneously mixed population on social networks. We incorporated no co-operation with other parties opinion ability and no loss of enthusiasm of users. We obtained fixed points, their existence, and stability conditions. The system experiences flip bifurcation and Hopf bifurcation when both kinds of users exist in a social system results disbelief among users. Also, the system is chaotic, which is a significant cause of the unpredictability of data. Moreover, we suggested a strategy for controlling complex dynamics and securing information for emergencies.

Periodic homogenization of an optimal control problem associated to multispecies diffusion -reaction equation

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Abstract

This article discusses an optimal control problem associated to particle (chemical) transportation phenomenon in a porous medium. We consider that Particles are transported within the porous medium by the effects of diffusion and they are connected via chemical reaction (single step) i.e, transportation phenomena is governed by diffusion-reaction equations. Here optimal control problem is a connected system of cost functional (Energy or Dirichlet) and state equations (diffusion-reaction equations) with control (variable) acting on the porous part of the medium. We characterize a given control to be an optimal control by minimizing the cost functional with respect to the state equations. We obtain a relation between optimal control and the solution of the adjoint state. Finally, we do homogenization of optimal control problem as well as its adjoint state to obtain the convergence of optimal control and the cost functional by two-scale convergence method and periodic unfolding method.

Existence and uniqueness of periodic solutions of a bioeconomic model of fishery dynamics

with harvesting

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Abstract

In this article we study the existence and uniqueness of positive periodic solutions of the following bioeconomic model in fishery dymanics

$$\frac{dn}{dt} = n\left(r(t)\left(1-\frac{n}{k}\right) - \frac{q(t)E}{n+D}\right) - F(t)n(t),$$

$$\frac{dE}{dt} = E\left(\frac{A(t)q(t)}{\alpha(t)}\frac{n}{n+D} - \frac{q^2(t)}{\alpha(t)}\frac{n^2E}{(n+D)^2} - c(t)\right) - G(t)E(t),$$

where the functions r, q, A, c and α are continuous positive T-periodic functions. The considered system of equations is a model of a coastal fishery represented as a single site with $n(t)$ is the fish stock biomass, and $E(t)$ is the fishing effort. We have used Schauders fixed point theorem and Banach contraction principle to show the existence of a unique nonegative T-periodic solutions of the above model. On the other hand, an application of Krasnosel'skii's fixed point theorem yields a sufficent condition for the existence of a positive T-periodic solution of the model. An example is given to strengthen our result.

Positive Solutions for a Cantilever Beam Equation Depending on a Parameter

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Abstract

In this paper, we study the existence of at least one positive solution for the fourth-order two-point boundary value problem

$$\begin{cases} u''''(t) = \lambda q(t) f(t, u(t)), \quad 0 < t < 1, \\ u(0) = u'(0) = u''(1) = u'''(1) = 0, \end{cases} \tag{2}$$

which models a cantilever beam, where one end is kept free. Here, $f \in C([0,1] \times R_+, R_+)$. The proposed sufficient conditions are interesting, new, and easy to verify. The approach is based on a revised version of a fixed point theorem of Gustafson and Schmitt.

Positive periodic solutions of a stage-structured Predator-Prey model with Crowley-Martin type functional response with harvesting

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Abstract

This paper deals with the positive T-periodic solutions of the system of equations

$$\frac{dx_1(t)}{dt} = s(t)x_2(t) - r(t)x_1(t) - d(t)x_1(t),$$

$$\frac{dx_2(t)}{dt} = r(t)x_1(t) - \alpha(t)x_2^2(t) - \frac{\beta(t)x_2(t)y(t)}{(1+ax_2(t))(1+by(t))} - d_1(t)x_2(t) - \lambda_1(t),$$

$$\frac{dy(t)}{dt} = \frac{\beta_1(t)x_2(t)y(t)}{(1+ax_2(t))(1+by(t))} - d_2(t)y(t) - \gamma(t)y^2(t) - \lambda_2(t),$$

where $x_1(t)$ and $x_2(t)$ are the population density of immature and mature prey at time t, $y(t)$ is the population density of predator at time t, the coefficients are positive T-periodic functions and $\frac{\beta_1(t)x_2(t)y(t)}{(1+ax_2(t))(1+by(t))}$ is a Crowley-Martin type functional response, and $\beta_1 < \beta$, $\lambda_1(t)$ and $\lambda_2(t)$ are the harvesting relared to $x_2(t)$ and $y(t)$ with $0 < \lambda_1(t) \leq x_2(t)$ and $0 < \lambda_2(t) \leq y(t)$.

Global existence of solutions to the discrete Safronov-Dubovskiĭ coagulation equations and failure of mass-conservation

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Abstract

Coagulation is one of the mechanisms that cause cluster expansion, in which clusters (or particles) grow in size through successive mergers. Some areas where coagulation phenomena play a significant role include aerosol research, raindrop creation, astrophysics (formation of planets and galaxies), and animal herding. In 1917, Smoluchowski, a Polish physicist, made one of the first contributions in that direction when he developed an infinite system of ordinary differential equations, now known as the Smoluchowski coagulation equations. In 1999, Dubovskiĭ investigated a dispersed system and proposed the discrete Safronov-Dubovskiĭ coagulation model, in which only binary collisions between particles can occur simultaneously, and the mass of each particle is assumed to be proportional to some $m_0 > 0$, which is the smallest particle in the system. Particles grow in the system when two particles with masses of im_0 and jm_0 collide. If $j \leq i$, a collision between a i-mer and a j-mer causes the j-mer to split into j monomers. The rate at which i-mers collide with j-mers is determined by the coagulation kernel, $\Lambda_{i,j}$ (with $i \neq j$), which is non-negative and symmetric. This paper presents the existence of global solutions to the discrete Safronov-Dubvoskiĭ coagulation equations for a large class of coagulation kernels satisfying $\Lambda_{i,j} = \theta_i\theta_j + \kappa_{i,j}$ with $\kappa_{i,j} \leq A\theta_i\theta_j, \quad \forall \quad i,j \geq 1$ where the sequence $(\theta_i)_{i\geq 1}$ grows linearly or superlinearly with respect to i. Moreover, the failure of mass-conservation of the solution is also addressed, confirming the gelation phenomenon's occurrence.

Neural networks learning approach for solving Cauchy's differential equations

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IMS Subject Classification: Differential / Integral / and Functional Equations

Abstract

The present work reports neural networks learning process to solve Cauchy's differential equations. In the current studies, the network is trained using a three-layer feed-forward artificial neural architecture. An error backpropagation algorithm based on the gradient descent method using unsupervised learning is used to train the network. Further, we have used MERLIN software to train the network and optimize the connecting weights of different layers of the network. The comparison of the solutions obtained using the ANN model with the exact solution of the Caucy's differential equation shows high accuracy of this method.

Moving boundary problem the current state

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IMS Subject Classification:

Abstract

The importance of moving boundary problem or the Stefan Problem is large enough to be considered by researchers as its applications are in melting of ice slabs, solidification of metal alloys, drug release process in human body and oxygen absorption in human tissues etc. These problems are therefore inherent in nature and scientific and engineering areas of applications. These problems are modelled by differential equations particularly partial differential equations mostly parabolic. Because of non-linearity of these problems, limited analytical solutions namely similarity solutions, heat balance integral method, Perturbation method, Fractional derivative method, Fourier series method and Refined integral method etc are used. Numerical solutions have been used extensively to study possible solutions of moving boundary problem satisfying initial and boundary conditions of Dirichlets, Neumann or Mixed type. The successfull numerical methods used recently in solving the moving boundary problem are Enthalpy method, Mess free method and Wavelet galerkin method etc. The aim of this paper is to present different types of possible solutions be it exact/analytic or numerical method during last few years which have been applied in the new application areas using new generation analytical or numerical methods so that it is an exhaustive review. The review is not limited to the methods but physical properties are also considered such as latent heat, Thermal variation, densities variations and specific heat etc.

Section F: Geometry and Topology

The $SL(2;\mathbf{R})$-generated parabolic geometry of dual numbers

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Abstract

We have studied the associated parabolic geometry of the $SL(2;\mathbf{R})$-action on dual numbers using Klein's Erlangen Program. We have also discussed the different orbits under this action and their various geometric and invariant properties in the upper-half plane. Analogous to the Euclidean geometry, we have also studied the concepts of length and orthogonality in dual numbers under this geometry.

A common fixed point theorem in extended rectangular b-metric spaces

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Abstract

In this paper, we establish a common fixed point theorem for quadruple weakly compatible mappings satisfying a new generalized contraction condition. Our result generalizes the corresponding result of B. Nurwahyu, M. S. Khan, N. Fabiano, S. Radenovic, Common Fixed Point on Generalized Weak Contraction Mappings in Extended Rectangular b-Metric Spaces. Faculty of Sciences and Mathematics, University of Nis, Serbia. Non-trivial examples are further provided to support the hypotheses of our results.

An Erlangen approach to study the action of the subgroups of $\mathrm{SL}(3,\mathbb{R})$ on the real projective plane

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Abstract

Following Felix Kleins Erlangen program, we have studied the projective action of the subgroups of $\mathrm{SL}(3,\mathbb{R})$ on non-degenerate conics in the two-dimensional homogeneous space $\mathbb{RP}^2$. After investigating the subgroup of $\mathrm{SL}(3,\mathbb{R})$ that fixes the projective unit circle, we use the adjoint map to show that the fix subgroup of the projective unit circle is isomorphic to the Lie group $\mathrm{SL}(2,\mathbb{R})$. As a next step, we consider the Möbius action of $\mathrm{SL}(2,\mathbb{R})$ in the elliptic, parabolic, and hyperbolic (abbreviated as EPH) cases. This action of $\mathrm{SL}(2,\mathbb{R})$ in EPH cases yields three homogeneous spaces $\mathrm{SL}(2,\mathbb{R})/H$ isomorphic to the elliptic, parabolic, and hyperbolic upper half plane for the one-parameter subgroups K, N', and A' of $\mathrm{SL}(2,\mathbb{R})$ (up to conjugacy), respectively. Subsequently, we employ the isomorphic copies of the elliptic, parabolic, and hyperbolic subgroups of $\mathrm{SL}(2,\mathbb{R})$ inside $\mathrm{SL}(3,\mathbb{R})$ to obtain the corresponding maps from the EPH upper half plane to the boundary, the interior, and the exterior of the projective unit circle. For further study in a unified fashion, we have also consolidated the maps into a single expression which is given by

$$f(w) = f(u,v) = \left(\frac{u}{v}, \frac{1+\sigma v^2 - u^2}{2v}, \frac{1-\sigma v^2 + u^2}{2v}\right),$$

where $w = u + \iota v = (u,v)$ and $\iota^2 = \sigma = -1,\ 0,\ 1$ for elliptic, parabolic and hyperbolic cases, respectively.

Pairwise Hausdorff soft fuzzy bitopological space: approach of quasi-coincidence

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Abstract

In this paper, three notions of Hausdorff property in fuzzy soft bi-topological spaces in the sense of quasi-coincidence for fuzzy soft points have been introduced and studied. And relationship among the notions have been established with some examples. Good extension property has been satisfied by the given notions. Also hereditary, productive and projective properties are satisfied by these notions. Moreover, it is observed that all these concepts are preserved under one-one, onto, fuzzy open and fuzzy soft pairwise continuous mappings. Finally, initial and final fuzzy soft bitopological spaces have been studied with interesting results.

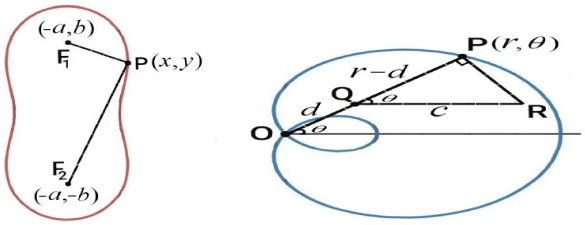

Figure 1: (a), (b)

Cassini oval to Limacon : an analytic conversion

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Abstract

A *Cassini Oval* is a quartic plane curve defined as the locus of a point in the plane such that the product of the distances of the point from two fixed points is a constant. The fixed points are called foci. The curve was first investigated by *Giovanni Cassini* in 1680 when he was studying the relative motions of the Earth and the Sun.

A *Cassini Oval* [Fig. 1(a)] with foci at $(-a, b)$, $(-a, -b)$ and the constant product of the distances k^2 can be represented by the Cartesian equation

$$((x+a)^2 + (y-b)^2)((x+a)^2 + (y+b)^2) = k^4 \tag{3}$$

On the other hand, a *Limacon* is a quartic plane curve defined as the locus of a point fixed to a circle when the circle rolls around the outside of a circle of equal radius. The earliest formal research on *Limacon* is generally attributed to *Etienne Pascal*, father of *Blaise Pascal*. However the curve was later named by *Gilles Personne Roberval* in 1650 when he used it as an example for finding tangent lines.

A *Limacon* [Fig. 1(b)] is usually expressed in Polar coordinates as $r = d + c\,cos\,\theta$. The same can be represented by the Cartesian equation

$$(x^2 + y^2 - cx)^2 = d^2(x^2 + y^2) \tag{4}$$

This paper illustrates how a *Cassini Oval* can be converted to a *Limacon* using analytic geometry.

CS*-Normal spaces

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Abstract

In this paper,we introduced the concept of Normal spaces called CS*- Normal spaces by using CS*- open set and obtained several properties moreover we obtained some new characterization and preservation theorem of CS*- Normal Space.

A study on new operator of primal topological spaces

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Abstract

Our main aim is to derive Primal topological spaces structure in topology, Primal is the duel structure of grill. we introduce an operator using primal and extend some of its fundamental properties. we define the notion of topology suitable for a primal. we extend some applications of new notion, but also investigate many properties. Kuratowskis introduce a new operator using primal, which satisfies closure axioms. we extend some basic structure of primal topology is finer than the topology of a primal topological space. A. Al-Omari and T. Noiri introduced ψ operator using primal topological space and it extend some fundamental properties of topology.

A critical study on countably-compact topological spaces

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Abstract

Our main aim is to extend application of countably α-compact topological spaces among countably α-compact, Tychonoff, and α-Hausdorff spaces is derived by Altawallbeh Z(6). The countably α-compact space iff every locally finite family of non-empty subsets of such space is demonstrated. We develop the applications of countably α-compact space with weight greater than or equal to N_0 is the α-continuous image of a closed subspace of the cube D^{N_0} derived by Maheswary S N(2). The boundedness of α-continuous functions mapping, α-compact spaces to other spaces is shown. However, the α-continuous function mapping space X to the countably α-compact space Y is an α-closed subset of $X \times Y$ is derived. We also derive α-continuous functions mapping and topological space to a countably α-compact space may be extended over its domain under some constraints. We shown here that the property of α-compact is countably α-compact but the converse is not and the countable union of countably α-compact subspaces of X is also countably α-compact. Hasanein T(3) proposed that each open set is an α-open set. Tyagi(5) derived that the g-closedness property is closed under arbitrary union and a topological space is $T_{1/2}$ provided that every g-closed set is closed.

Warped product skew semi-invariant submanifolds of locally golden Riemannian manifolds

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Abstract

In this paper, we define and study warped product skew semi-invariant submanifolds of a locally golden Riemannian manifold. We investigate a necessary and sufficient condition for a skew semi-invariant submanifold of a locally golden Riemannian manifold to be a locally warped product. An equality between warping function and the squared normed second fundamental form of such submanifolds is established. We also construct an example of warped product skew semi-invariant submanifolds.

Topological sensitivity on hyperspaces

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Abstract

In this paper we define and study topological asymptotic sensitivity, Li-Yorke topological sensitivity, pointwise topological sensitivity for general topological spaces. We study relations among these variants of topological sensitivities and $\mathcal{F}$ topological sensitivity, strong topological sensitivity and multi topological sensitivity. We prove that strong topological sensitivity (respectively multi topological sensitivity) on the induced hyperspace dynamical system is equivalent to strong topological sensitivity (respectively multi topological sensitivity) of the dynamical system for uniform compact spaces and Li Yorke sensitivity and Li-Yorke topological sensitivity are equivalent on compact metric spaces. We also show that on compact Hausdorff topological spaces topological sensitivity implies topological asymptotic sensitivity. Moreover, we provide necessary examples and counterexamples.

Lebesgue number and total boundedness

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Abstract

A generalization of the Lebesgue number lemma is obtained. It is proved that, if each countably infinite locally finite open cover of a chainable metric space X has a Lebesgue number, then X is totally bounded. A property of metric spaces which is a generalization of connectedness and Menger convexity is introduced. It is observed that Atsujiness and compactness are equivalent for a metric space with this introduced property as well as for a chainable metric space.

On gradient Ricci soliton space-time warped product

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Abstract

In this article we give some results on space-time manifold $(B \times I, g_B + (R + \frac{N}{2t})dt^2)$. We introduce the notion of space-time warped product $\tilde{M} = (B \times I) \times_f F$ with potentially infinite metric $\tilde{g} = (g_B + (R + \frac{N}{2t})dt^2) + f^2 g_F$. Then we discuss Space-time warped product Ricci curvature upto $O(N^{-1})$ and potentially gradient Ricci soliton for space-time warped product. Next we emphasis Space-time warped product Deturck's trick and study Variation of metric $\tilde{g}$ on $(B \times I) \times_f F$. We prove Existence conditions for the gradient Ricci soliton space-time warped product. We investigate several results for when $(\tilde{M}, \tilde{g}, \tilde{\nabla}\phi, \lambda)$ be an expanding or

steady gradient Ricci soliton and shrinking gradient Ricci soliton with compact base and fiber with dimension at least two. Finally we discuss the compactness of space-time manifold when space-time warped product satisfy some identity. Furthermore, we give some examples of generalized black hole solutions whose metrics can be written as a space-time warped product.

Proper helix of order 6 and LC helix in pseudo-Euclidean space E_4^8

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Abstract

In this paper, we used the result that complex hyperbolic spaces $CH^2(-\frac{4c}{3})$ with holomorphic sectional curvature $\frac{-4c}{3}$ are isometrically embedded in E_4^8. By considering a circle in $CH^2(-\frac{4c}{3})$, we prove that the image of the circle by isometric embedding is a proper helix of order 6 in E_4^8. Moreover, we define a generalized LC helix on a submanifold of E_4^8. Also, we show that the image of a circle by isometric embedding from complex hyperbolic plane $CH^2(-\frac{4}{3})$ to pseudo-Euclidean space E_4^8 is a generalized LC helix on some submanifold of E_4^8.

A study on some generalized notions of I-convergence

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Abstract

In this paper, we deal with certain topological properties using ideal convergence. Some earlier results involving ideal convergence are generalized and unified by using some kind of functions (from an infinite set S to X). This functional approach provides the most general setting which extends the proofs of several old and recent results about sequential spaces, Fréchet-Uryshon spaces, quotient maps and covering maps.

A critical study of separation axioms and compactness in topological spaces and its fuzzy applications

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Abstract

Our main aim is to analyse the Separation axiom in topological and semi-topological group. The topological spaces satisfying separation axioms T0, T1, T2, T3 and regular and we study its properties to find conditions under which a topological semigroup has the Souslin property. Separation axioms are one of the important topological properties derived by A.M. Khattak(9) and H. Herrlich(1). It is significance to derive some relevant separation axioms in soft set theory. The separation axioms of soft topological space for any two different basic elements incompatible soft sets with more information can be found. We have considered in our results topological semigroups with open shifts, these are studied in by Tyagi B(7) and T. Banakh.

Section G: Numerical Analysis, Approximation Theory and Computer Science

Numerical study of time dependent elastohydrodynamic lubrication (EHL) problem using interior-exterior penalty approach

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Abstract

We study a time dependent free boundary problem issued from EHL model. The cavitation phenomenon take place and is described by the Elrod-Adoms model. The main result of this work is existence and uniqueness of the solution of discrete time dependent EHL problem using interior-exterior penalty method. The proof of the result based on comparison principle permitting compare two discrete solutions of the problem.

Effectiveness of symmetric Gauss-Seidel methods in preconditioning for linear system

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Abstract

In this paper, preconditioned Symmetric Gauss-Seidel (SGS), New Symmetric Gauss-Seidel (NSGS), and Parametric Symmetric Gauss-Seidel (PSGS) methods for solving the linear system $Ax = b$ are considered. This system is preconditioned with precondition of the type $I + S$. Convergence properties are analysed with standard procedures and numerical experiment is undertaken to demonstrate the efficiency of the matrix. Computational efficiency is enhanced with MATLAB software. The results indicate that SGS, NSGS, and PSGS methods in preconditioning for linear system are convergent.

Human face recognition using eigenvector based recognition system

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Abstract

Face recognition is an algorithm that can recognize or verify a query face among a large number of faces in the enrolment database. Face recognition is a crucial and difficult area of computer vision. This study demonstrates a system that can recognize a human face by comparing the facial structure to that of another individual or a well-known individual, which is accomplished by the use of frontal several summarizations. We made use of an eigenvector-based recognition system as a method for recognizing faces. The eigenvectors of the covariance matrix represent the given image space. Then, any new face image can be represented as linear. The set of eigenvectors are also known as Eigen faces. These Eigen faces are combined. This makes it simpler to face recognition is achieved by matching any two given images. This makes it easier to match any two given images and thus face recognition process. The implemented eigenvector-based technique classified the faces approximately 95% correctly. Face recognition system is highly accurate and is one of the most powerful surveillance tools ever made. But this face recognition technology is quite costly and also difficult for developing countries like Bangladesh. In this study, we are going to use a face recognition system as our security purpose using an eigenvector based face recognition system with the help of MATLAB software and Raspberry Pi camera as security purpose which will minimize cost and this process will be quite affordable.

PPA With Bregman distance for quasiconvex pseudomonotone equilibrium problems

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Abstract

In this paper we propose a proximal point method using Bregman distance to solve quasiconvex pseudomonotone equilibrium problems. Under suitable assumptions, we prove that the composed algorithm is well defined and converges to a solution of the equilibrium problem, whenever the bifunction is strongly quasiconvex in its second argument. Our method goes beyond the usual assumption of the bifunction's convexity in the second argument, extending the validity of the convergence analysis of proximal point methods for equilibrium problems. For a particular choice of the Bregman function, our method reduces to the traditional proximal point method. In addition, we formulate optimization and variational inequalities from the considered problem. At the last we illustrate the numerical applications.

Legendre-wavelet collocation technique for Lane-Emden-Fowler equations with local boundary conditions

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Abstract

The Lane-Emden-Fowler equation with Neumann-Robin boundary conditions is dealt with Legendre wavelets collocation technique. Firstly, the concerned problem is transformed into the second kind Fredholm integral equation to avoid singular behavior (at $x = 0$). Approximation of y' and y'' are not required in the present method, and hence, an improved accuracy is achieved. Next, the Legendre wavelet collocation technique is implemented to generate a system of nonlinear equations. Finally, the Newton-Raphson method is carried out to obtain the numerical solution. The error bound of the current method is provided. The robustness and efficiency are validated from maximum absolute error, L_2-norm error, and residual error of several real-life applications. The results thus obtained are compared with existing techniques like the Haar wavelet and the Adomian decomposition methods. The advantage of the Legendre wavelets collocation method is that it gives better accuracy for a smaller number of collocation points.

Local convergence analysis of family of third order iterative methods under a majorant condition in Riemannian manifolds

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Abstract

A local convergence analysis of Newton's method for finding a singularity of a differentiable vector field defined on a complete Riemannian manifold, based on the majorant principle, is presented in this paper. This analysis provides a clear relationship between the majorant function, which relaxes the Lipschitz continuity of the derivative, and the vector field under consideration. It also allows us to obtain the optimal convergence radius and the biggest range for the uniqueness of the solution.

Dual function threshold based pincer searching optimization algorithm for feature selection optimization in imbalance data structure for big data stream iining

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Abstract

A dataset nowadays contains a vast number of characteristics, many of which are redundant and unnecessary. In order for machine learning algorithms to perform better, feature selection is necessary. Data reduction in stream based analytics, which focuses on the selection or extraction of the most instructive features or occurrences in the data, is another crucial activity, especially when working with huge data sets.Among several methods, feature selection is gaining popularity as a key instrument for locating pertinent features on huge datasets, both in terms of the number of occurrences and features. This puts into practice a feature selection approach based on evolutionary computation that employs the Map-Reduce paradigm to extract subsets of features from large datasets. In order to identify the best answer rapidly, dual-threaded pincer search optimization adaptively balances exploration and exploitation. The technique can swiftly search the feature space for an ideal or nearly ideal feature subset that minimizes a specified fitness function. The suggested fitness function employed combines feature size reduction and classification accuracy. All of the pairings are generated using a double loop.Each pair is hashed, and the bucket containing the hashed results is then rounded up to 1. It should be noticed that the pair does not affect itself; rather, it only affects the single integer in the bucket. After the first pass, each bucket has a count, which is the sum of the counts for each pair that hashes into that bucket. Depending on the percentage of possible pairs of things that actually appear in a basket, another method of storing counts may be more appropriate. Counts can be stored as triples I j,c], which means that the count of a pair I j] with the I j is c. Let's say that the hash keys are positive integers. Picking h(x) = x mod B, or the remainder after dividing x by B, is a popular and straightforward hashing operation. If our population of hash keys only contains positive numbers, then that option works nicely.

Section H: Solid Mechanics, Fluid Mechanics, Astrophysics and Relativity, and related areas

Effect on propagation of acceleration waves under influence of an oblique magnetic field

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Abstract

In the present article we study the propagation of acceleration waves through a perfectly conducting inviscid gas subjected to an oblique magnetic field. The reference coordinate system for the study of transmission of acceleration waves along the characteristics path are formed by the eigen values of the quasilinear hperbolic system of equations. Transport equation is derived to examine the growth and decay behavior of an acceleration wave. Special attention is devoted to analyze the effect of magnetic field components on the formation of the shock wave in both planar and cylindrically symmetric flows. Also, it is demonstrated that a linear solution of governing system of equations in the characteristic plane shows nonlinear behaviour in the physical plane.

Effects of temperature-dependent diffusion coefficient on Gill's stability problem

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Abstract

The stability of natural convection in vertical porous slabs of significant importance due to its applications in the analysis of contaminant diffusion in the soil, the use of metal foams for the optimized design of heat exchangers, the design of packed bed reactors, the extraction of hydrocarbons, the CO_2 sequestration processes, building insulation involving an unventilated air gap and for breathing walls, among others. Gill [Gill, Journal of Fluid Mechanics, 545-547 (1969)] proved that the basic flow is unconditionally stable when the permeability of the medium is constant. Recent studies showed that the base flow becomes conditionally unstable for (a) linear, (b) quadratic, and (c) exponential permeability profiles of the slab. We ask the questions: Does a temperature-dependent diffusion coefficient enhance/suppress the instability of the base flows? To address this question, we first considered the porous slab of constant permeability and modelled the temperarure-dependent thermal diffusivity following the StokesEinstein relationship, $\mu(T)\kappa(T) =$ constant, where μ is the dynamic viscosity of the fluid and κ is the thermal diffusivity of the fluid. We carried out normal mode linear stability analysis. Through numerical solution of the resultant eigenvalue problem, we showed that the variable diffusivity acts as a stabilizing effect to the base flow. Our numerical results are supported with semi-analytic calculations. We also discussed the cases of linear and exponential permeability profiles with variable diffusion coefficients.

Heat transfer enhancement and irreversibility analysis in wavy porous domain equipped with rotating heat source and nanofluids subjected to magnetic field

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Abstract

In this investigation, computational analysis is performed for mixed convection in porous wavy-cavity with rotating heat source at its center. The fluid domain inside the cavity is heated from the centered heat source and mid-section of the bottom wall and cooled from its top wall while the wavy-walls and remaining sections of bottom wall are considered adiabatic. Modified Maxwells model and Brinkman Darcy equation are incorporated to estimate the thermal conductivity of nanofluid and porous domain. The cavity is permeated by uniform magnetic field. The governing partial differential equations are simulated using finite element method. The numerical code is validated comparing with available published works. Detailed parametric analysis is presented through streamlines, isotherm, profiles of average Nusselt number and entropy generations components, respectively. The results indicate that heat transfer rate enhances with the increase in Darcy number and decreasing porosity of the domain. Entropy generation components and Bejan number are significantly affected with the changes in permeability and porosity the cavity. Maximum heat transfer is occurred at maximum amalgamation of nanoparticles in base fluids. Moreover, heat transfer rate augments with higher rotating speed of heat source for all influential parameters whereas it reduces with higher magnetic field strength.

Scattering of water waves by two submerged horizontal porous plates over a pair of trenches

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Abstract

The problem involving the scattering of oblique water waves by two non-uniform submerged horizontal porous plates in the presence of a pair of trenches is examined. The mathematical problem is formulated based on Darcy's law for flow past a porous structure. The associated boundary value problem is solved using the eigenfunction expansion method in conjunction with matching conditions, giving rise to an over-determined system of linear equations. This system of equations is solved by method of least-squares. The numerical values of physical quantities such as reflection coefficient, transmission coefficient, dissipation coefficient and force are obtained and plotted through different graphs to visualise the effect of different system parameters. It is found that the submergence depth has a significant effect on yielding more dissipation and less force on the barriers. The study highlights that two submerged horizontal porous plates over uneven bottom topography will play a vital role in constructing an effective submerged breakwater reducing high wave impact.

Does an internal heat source enhance the migration of a Stokes droplet?

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Abstract

We consider the problem of viscous droplets with internal heat sources migrating in an ambient viscous flow of different viscosity. The corresponding mathematical problem is developed as a boundary value problem involving fluid velocity, pressure, temperature, and surface concentration. Neglecting inertial effects, the Stokes equation is used to model the fluid flow and steady heat conduction is assumed for the thermal field. The surface concentration is assumed to obey the steady convection-diffusion equation on the droplet surface. Though the equations are decoupled, the interface stress balance couples the governing PDEs. We use the

double curl method to develop an analytical solution for any arbitrary ambient flow. We then consider the Poiseuille flow so that the results for migration of a viscous droplet inside a pipe can be mimicked. For the surface concentration, we develop perturbation-based solutions with respect to low surface Pèclet number and high surface Pèclet number. Our findings indicate that the type of heat source and its location inside the droplet has a significant impact on the migration velocity. A centered monopole has no effect, whereas an off-centered monopole and a dipole help the droplet to migrate faster. Even when the droplet is placed at the centerline of the flow, cross-migration can still occur. This mathematical model offers a control mechanism for droplet migration which may be helpful in a number of industrial as well as microfluidic applications.

Rigid motion of a slip-stick sphere with inhomogeneous surface roughness

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Abstract

A spherical particle with inhomogeneous surface roughness has potential applications in targeted drug delivery. The rigid motion of a spherical slip-stick particle suspended in an ambient Stokes flow has been investigated in the low Reynolds number regime. We consider that a strip/cap-shaped patch partitions the surface of the slip-stick sphere into two different slip regions. Faxén's formulae for drag and torque have been computed. In particular, the slip-stick sphere moving with some rotation in an ambient Poiseuille flow has been explored. We investigate the effect of slip lengths and strip/cap width on the slip-stick sphere's optimal migration velocity. It is observed that for that cap/strip, as mentioned earlier, whenever the ratio α of slip lengths of the cap/strip over that of the rest of the surface is less than unity, and optimal polar slip angles $\theta_1^o = \pi/4, \theta_2^o = 3\pi/4$, the migration velocity of the slip-stick sphere is maximized compared to the slip-stick sphere with uniform slip length. For $\alpha > 1$, we investigated the effect of the position of the slip-stick sphere with a cap from the centerline of the flow on migration velocity. For fixed distance from the centerline of the flow, the migration velocity is non-monotonic with θ_2 and achieves maximum for the configuration $(\theta_1, \theta_2; s_\theta) = (0, \pi/4; \pi/4)$. Moreover, due to the sudden jump in the slip lengths from the cap/strip to the rest of the surface, we observe a jump in the density of the flow field, which causes near-field deviations in streamlines. The effect of the strip/cap distribution on the far-field asymmetry in the streamlines has been discussed.

An analytical exploration for three dimensional hyperbolic heat conduction with the determination of thermoelastic attributes

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Abstract

Thermoelasticity is the study of different aspect like temperature distribution, stresses, displacement, bending, force and deflection etc. It has lots of applications in mechanical as well as other branches of engineering field. Thus, the study of heat conduction and its effect on other thermal characteristics of material is of much interest. There are different types of heat-conduction equations depending on the relations of heat flux density and temperature

gradient etc. This article depends on the study of thermoelastic performance of solids under hyperbolic heat conduction models. In which it has been discussed the thermoelastic properties of a three dimensional rectangular plate using thermal stress technique, under hyperbolic heat conduction model. An analytical approach has made to solve the governing equations. The results are discussed through graphically with the aid of mathematical software SCILAB.

Interaction of oblique water waves with a surface-piercing porous structure and an elastic plate

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Abstract

The interaction of oblique water waves with the surface-piercing porous structure of finite width in the presence of the elastic plate is investigated within the framework of linearized water wave theory. The wave past the thick porous structure is modeled using Sollitt and Cross model and the elastic plate is modeled using the thin plate theory. The corresponding boundary value problem is reduced to a set of linear algebraic equations using the eigenfunction expansion method. The system is then numerically solved and the values of important quantities like reflection, transmission, dissipation coefficients and shear force and strain on the elastic plate are obtained and plotted through different graphs. It has been found that as the surface-piercing porous structure's porosity grows, the reflection and transmission coefficients decrease and the dissipation coefficient rises.

Flow and heat transfer analysis of a special third grade fluid over a stretchable surface in a parallel free stream

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Abstract

A study is made to determine the similarity solutions for steady stagnation point flow of special third grade fluid over a permeable stretching/shrinking sheet. The Lie scaling group of transformations technique has been used for finding a new form of similarity transformations, which effectively transformed the governing momentum and energy equation into a new kind of coupled ordinary differential equations (ODEs). The transformed equations are then solved numerically using the shooting technique. It is observed that the similarity equations exhibit dual solutions in a certain range of shrinking strength. The interest lies in examining the effect of physical parameters on flow velocity, temperature distribution, skin friction

coefficient and Nusselt number. Thus, emphasis has been given to carrying out a stability analysis to determine the physically reliable solution. The stability analysis shows that the upper branch solution is stable. It is observed that the suction parameter increases the range of dual solutions and the magnitude of the critical point from where the dual solutions bifurcate; however, the non-Newtonian parameter shows the opposite behavior. The momentum, thermal and concentration boundary layer thicknesses in the upper branch solution are lower than the lower branch solution.

Transient response of collinear Griffith cracks in a functionally graded strip bonded between dissimilar elastic strips under shear impact loading

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Abstract

This article analyses the interaction between a central and two symmetrically placed collinear Griffth cracks subject to transient response under anti-plane shear impact loading. The cracks are situated in a strip constituted by functionally graded material (FGM) bonded between two dissimilar elastic strips of equal thickness. The material properties of FGM are assumed to vary exponentially as a function of thickness. Applying integral transforms, the boundary value problem reduces to a system of singular integral equations in the Laplace transformed domain. These equations are solved numerically using the Lobatto-Chebyshev collocation quadrature approach. The inverse Laplace transform is used to find the approximate expressions of dynamic stress intensity factors (DSIFs). The striking feature of the article is the study of phenomenal changes of shielding and amplification through dynamic stress magnification factor (DSMFs) at the tips of the cracks under the sudden impact loading applied at the upper material surface. The effects of impact load applied at different surfaces, positions of cracks' axis and the thickness of the strips of the composite material on the possibilities of cracks' arrest are depicted graphically for different particular cases.

Semi-analytical solutions of the time-fractional multi-dimensional KdV using RPSM

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Abstract

In this paper, the approximate analytic solution of any arbitrary order time-fractional Kortewegde Vries (KdV) equations is solved using the semi-analytical, named residual power series method (RPSM). The RPSM is a recent technique based on the generalized Taylor series, which extended to handle proposed KdV equations. The primary step is to obtain fractional power series (FPS) solutions by RSPM. In the final step, it is shown that RPSM is a very efficient, plain, and powerful method for obtaining the solution of any arbitrary order time-fractional linear and nonlinear KdV equations in the form of FPS by illustrative examples.

Scattering by the edges of a pair of semi-elastic floating plates over a flexible sea-bed

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Abstract

This paper analyzes the reflection and transmission phenomena of scattering of surface water-waves by the edges of a pair of thin semi-elastic plates, floating in an ocean involving its flexible bed in presence of small undulation. The approximate analytical solution of the resulting boundary value problem is studied by utilizing the Wiener-Hopf technique with a conjunction of perturbation analysis. By Wiener-Hopf technique, our aim is to find a two-part Wiener-Hopf functional relation which is to be estimated. In this functional relation we consider two unknowns which are analytic in a particular region. Finally, an analytical formulae are obtained for the first order reflection and transmission coefficients in terms of the small parameter involving in bottom undulation.

Thermocapillary migration of a compound drop in a viscous fluid

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Abstract

The problem of thermocapillary migration of a compound drop has been studied under the consideration of vanishing Reynolds number. The compound drop can be viewed as dispersed phase where a spherical droplet of one fluid is surrounded by a fluid envelope of another immiscible fluid that is placed in a continuous phase which is of different viscosity. The thermal and hydrodynamic problems have been discussed. The hydrodynamic problem is coupled with the thermal problem via the boundary condition for hydroynamic problem where the thermocapillary effect is reflected. The hydrodynamic problem of motion of a compound drop placed in an aribitray viscous flow field is studied, whereas the thermal problem is studied subjected to uniform temperature field. In order to take in to account the thermocapillary effect, it is further assumed that surface tension decreases linearly with temperature. The analytical expressions for velocity and temperature distribution of a compound drop have been obtained. The hydrodynamic forces acting on the coumpound drop are obtained in terms of Faxen's law. Various cases cases involving uniform flow-uniform temperature, shear flow, heat source, uniform flow-shear flow have been discussed. The migration velocity of compound drop has been obtained in case of uniform flow field. It is observed that drag is not influenced by the shear flow and is having a contribution only from thermal component in uniform- shear flow variation.

On uniqueness and reciprocity theorem under Moore-Gibson-Thompson thermoelasticity theory

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Abstract

The main concern of the present paper is based on Moore-Gibson-Thompson thermoelasticity theory in which a relaxation parameter is included in the Green-Naghdi III model for an isotropic and homogeneous medium. The uniqueness theorem and reciprocity theory stated by Enric Betti are derived in this context.

Lie symmetry analysis in the linear hydrodynamic instability of a three-dimensional plane shear flow

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Abstract

The study presents a symmetry classification of the linearised Navier-Stokes equations for a three-dimensional unbounded incompressible arbitrary plane shear flow. There is a huge applications of this type of flows in industrial processes and biomedical sciences. In the case of a two-dimensional shear flow with linear profile, Nold and Oberlack [Phys. Fluids 25, 104101 (2013)]showed the existence of three different kind of linear instability modes using the framework of Lie symmetry analysis. Those perturbation modes are normal mode, kelvin mode and a new type mode that was not reported before for the similar flow configuration. We have extended their analysis for a three-dimensional arbitrary plane shear flow with linear as well as non-linear profiles. The current investigation presents a full symmetry classification for the instability modes of the linearised three-dimensional Navier-Stokes equations, governing the flow dynamics. The analysis is done for both viscous and inviscid flows by taking the linear, exponential, fractional shear flow profiles. In the derivation process, we first find out the set of infinitesimal generators for the generalized system using Lie symmetry analysis and then, some additional symmetries for each sub cases. Further, the governing system of partial differential equations are converted into a system of differential equation by using the symmetries and invariant condition. The most popular three-dimensional Orr-Sommerfield equation is obtained by taking the general symmetry. Moreover, for each of the sub cases, we have derived the exact solutions of the system and the bahavious of the solutions are explored for different parameter range.

Linear stability analysis of double diffusive convective motion in a reactive inclined porous medium layer saturated by non-Newtonian fluid

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Abstract

Using linear stability analysis, it is investigated how chemical reaction affects a double-diffusive convective motion in an inclined reactive porus medium layer saturated by a non-Newtonian viscoelastic fluid (Kuvshiniski type) saturated a porous layer. As the momentum equation, the Darcy model is used, which includes the boussinesq estimation and the Kuvshiniski type viscoelastic impact of viscoelastic fluid. By using the linear stability theory in terms of a critical thermal Rayleigh-Darcy number, it is possible to calculate the circumstances under which stationary and oscillatory convective movements might occur. It was discovered that oscillatory convection can only occur when a solute's Rayleigh-Darcy number is negative and depends on the relevant physical parameter. The range of the solute Rayleigh-Darcy number in which the oscillatory convection of the privileged increases with a rise in the value of the Kuvshiniski parameter and the heat capacity ratio, but it decreases with a rise in the value of a chemical reactive parameter and the Levis number. Angle of inclination also has effect on the onset of convection. Additionally, raising the Kuvshiniski parameter and the heat capacity ratio results in a reduction in convective heat and mass transfer, yet doing so also increases both the thermal Rayleigh-Darcy number and the solute Rayleigh-Darcy number.

Latest Developments in the Mathematical Modeling and Simulation of Nanofluid Flow

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IMS Subject Classification: H

Abstract

Exploiting nanofluids in thermal systems is growing day by day. Nanofluids having ultra-fine solid particles promise new working fluids for application in energy devices. Many studies have been conducted on thermophysical properties as well as heat and fluid flow characteristics of nanofluids in various systems to discover their advantages compared to conventional working fluids. The main aim of this study is to present the latest developments and progress in the mathematical modeling of nanofluids flow. For this purpose, a comprehensive study of different nanofluid computational fluid dynamics (CFD) approaches is carried out. Again the assessment of the thermal performance of a system through numerical simulations is much affordable compared to experimental studies with high expenses of material and equipment. This study provides detailed information about the commonly used formulations as well as techniques for computational fluid dynamics (CFD) modeling and simulation of nanofluids.

Modelling nanoparticle electrification in the stagnation point flow of nanofluid towards a linear stretching sheet

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Abstract

The present study explores the modelling of nanoparticle electrification in the stagnation point flow of silver water nanofluid towards a linear stretching sheet using Buongiornos two component non-homogeneous nanofluid model. The governing equations are reduced to ordinary differential equations using similarity transformation and solved numerically by using bvp4c function of MATLAB package. The impact of electrification in presence of viscous dissipation on normalized velocity, temperature and nanoparticle concentration, skin friction coefficient, rate of heat transfer and rate of mass transfer are depicted and analyzed through graphs and tables. It is envisaged that the higher electrification parameter reduces the normalized base fluid temperature and enhances the normalized velocity as well as rate of heat transfer of nanofluid. Hence it is concluded that the nanoparticle electrification is an important and possible mechanism for the enhancement of thermal conductivity of base fluid.

Aerodynamic flow simulation over a 2D AHMED body in dusty fluid medium

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Abstract

Aerodynamic flow simulation over a 2D Ahmed body in dusty fluid medium have been studied. The impact of suspended dust particles present in air on the drag coefficient and the aerodynamic flow field past a 25o slanted 2D Ahmed body have been investigated utilizing the Realizable $k-\epsilon$ turbulence scheme of ANSYS Fluent $v19$. The simulation results of drag coefficients in dusty fluid medium are compared with that of existing experimental results and single-phase turbulence simulation results pertaining to clear air. The pressure, velocity and turbulent Kinetic Energy contours have been depicted through figures for the volume fraction of dust particles $\phi = 0.1$ in dusty fluid medium and have been compared with that clear fluid medium for $\phi = 0.0$. In the presence of suspended dust particles in the air, the total drag coefficient is attenuated. It is concluded that Aerodynamic flow simulation in dusty fluid medium could be a better simulation technique as compared to single-phase simulations in clear fluid medium.

Section I: Mathematical Modelling, Bio-Mathematics, Operations Research, etc.

Parameter estimation in population balance models using uncertainty and sensitivity analysis

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Abstract

The accurate estimation of sensitive parameters in a mathematical model predicting the outcome of a real experiment is of great importance in studying a complex physical phenomenon. We present a systematic methodology based on the uncertainty and sensitivity analyses framework for precise estimation of model parameters. The nonintrusive polynomial chaos expansion and the Sobol-based sensitivity indices are used to quantify the uncertainties in the model prediction due to parameter uncertainties, and the Monte Carlo method is used for the validation of uncertainty quantification results. A population balance model for an unseeded batch cooling crystallization of L-asparagine monohydrate is selected to demonstrate the methodology. The results clearly demonstrate the effectiveness of the proposed strategy in improving the predictive ability of the population balance model. For models involving many uncertain parameters, the proposed strategy can be adopted to rank parameters by decreasing importance and then achieve precise estimation of the more significant parameters using a suitable optimization algorithm and experimental data set.

A scheme for constrained multi-objective optimization problems based on trust-region technique

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Abstract

This work develops a scheme based on trust-region technique to solve multi-objective optimization problems with inequality type constraints. The proposed algorithm works iteratively by solving a sub-problem, which uses quadratic approximation of all the objective functions as well as constraint functions along with a trust region constraint. At every iteration, the acceptance of the step is decided with the help of a merit function and the relation between the actual reduction and predicted reduction. An adaptive BFGS update formula is introduced. The global convergence is proved under the Mangasarian-Fromovitz constraint qualification. Furthermore, it is shown that the proposed algorithm displays a superlinear rate of convergence under some mild assumptions. Numerical results are provided to show the efficiency of the algorithm.

Effects of urban developments and greenhouse gases on human population: a nonlinear modelling study

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Abstract

Greenhouse gas emission has been rising in response to urban developments due to rise in population. In this work, a nonlinear mathematical model is proposed to study the effect of an increase in population on urban developments and its effect on greenhouse gases emission. In the modeling process, it is assumed that the concentration of greenhouse gases increases in the atmosphere not only naturally but also through urban developments. The proposed model is mathematically analyzed using stability theory of differential equations for determining the long term behaviour of the system. The qualitative properties of equilibrium solutions, extending from their existences to stabilities are obtained. The system is also investigated for transcritical and Hopf bifurcations to demonstrate the impact of parametric variations on dynamical behaviour. It is concluded that greenhouse gases, augmented through urban developments, result into destabilization of the whole system.

Disease dynamics of an epidemiological model in presence of demographic stochasticity

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Abstract

In this presentation, we use the continuous-time Markov chain model to develop and analyze stochastic epidemic models corresponding to deterministic model. By using the disease extinction process, we compare both deterministic and stochastic models. We observe that the numerically approximated probability of disease extinction agrees well with the calculated probability using multitype branching process approximation. We conduct a sensitivity analysis for the stochastic model also to examine how the system parameters affect the probability of disease extinction. We have also derived the equation for the expected time required to reach disease-free equilibrium for stochastic models. Finally, the effect of the parameters on the expected time is represented graphically.

Local stability and chaotic analysis of discrete time population model with and without

Allee effect

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Abstract

In this paper, we have investigated the region of local stability of discrete time population model with and without Allee effect. It is observed that Allee effect decreases the region of the local stability about an equilibrium point of the population model in two periodic cycle. In two periodic cycle, the region of local asymptotic stability about an equilibrium point decreases more rapidly with comparision to the period of one cycle. Beyond the stability region Chaos is established in period of three cycle. Results are generalised for period of n-cycle.

A hybrid SDDS-SABC algorithm for constrained optimization problems

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Abstract

We propose a new hybrid algorithm called SDDS-SABC for solving constrained optimization problems. The SDDS method is responsible for splitting, detecting and shrinking the full search region into subregions through recursive breakdown and improves computational effort to focus on the subregion covering potential solutions for further decomposition. Sophisticated Artificial Bee Colony Algorithm (SABC) has been applied to subregions to find the best solutions in the subregions whose values help detect the promising subregion. Alternative application of SDDS and SABC improved computational effort to reach the global/ close to global solution(s). The ranking and selection rules have been applied to assist optimistic decision-making in selecting the subregion covering promising solution(s). We also introduce a new initialization scheme for food sources in the SABC algorithm, develop a new strategy for employed bees phase and a new Dynamic penalty method to improve the convergence of the algorithm towards optimism. We check the validity of SDDS-SABC on benchmark functions and engineering design problems and measure its statistical significance against other existing heuristic optimization methods using non-parametric Friedman and Wilcoxon rank tests.

Improved hybrid conjugate gradient method for unconstrained optimization problems

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Abstract

This work proposes an improved hybrid conjugate gradient (CG) method for solving nonlinear unconstrained optimization problems. We have introduced a new form of β_k taking a combination of Fletcher Reeves (FR) and three-term search directions to compute the gradient parameter. The search directions are evaluated by our proposed formula, satisfy the sufficient descent condition independent of any line search and are bounded. The global convergence of the proposed algorithm is done under the strong Wolfe-Powell line search conditions through the utility of some proper assumptions on the objective function and its gradient. At last, Numerical experiments have been carried out on some standard benchmark test functions to show the efficiency of the proposed algorithm and further compared with other recently proposed CG methods.

The best replacement strategy for a failing system with longer repair time frames

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Abstract

The most effective technique for maintaining and replacing a usable and repairable system that is deteriorating and exposed to unpredictably occurring shocks is examined in this study. We may express the system's long-term average cost per unit time explicitly by modeling the failure mechanism by a generalized delta shock process and the repair time by a geometric process. This is carried out as part of a replacement plan of the threshold kind. To determine the optimal replacement policy N* and lower the average cost rate, we offer an average cost function. We further demonstrate the uniqueness of the optimal policy N* with the aid of additional numerical examples. Numerous systems in the actual world can use the model developed in this study.

Stability analysis through interval arithmetic approach of SIQR-QS-QI model when parameters exists in interval form

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Abstract

In this paper, we have constructed a compartmental model where all parameters are in closed interval form and analysed its stability when quarantine population are allowed to mix with infectious and susceptible populations. Here the local and global dynamics of the population model are investigated through interval arithmetic approach. Result shows that the disease free equilibrium point and endemic equilibrium point are locally asymptotically stable. Further Lyapunov functions are constructed for both the equilibrium points. It is also established that both the equilibrium points are globally asymptotically stable.

Model prediction for time-to-event data in the presence of competing risks

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Abstract

Survival studies are commonly analyzed using survival-time prediction models in many sectors, including but not limited to manufacturing, finance, economics, healthcare and others fields. The most common methods for analyzing survival data with competing risks are Cumulative Incidence Function (CIF), Cause Specific Hazard (CSH) and Fine and Gray method. In recent times, Decision Tree and Random Forest Analysis are Machine Learning Methods used for Classification and Predictions. In order to join hands between time-to-event data (with presence of competing risks and censoring) and advanced machine learning methods with embedded variable selection, modifications are being made to the latter. In this article, statistical and machine learning methods in survival analysis with the presence of competing risks are studied. Random survival forest model is compared to the cause-specific and sub-distribution hazard models for the real time data. The evaluation of the prediction error is expressed by an Integrated Brier Score (IBS), and the measure of predictive ability is calculated as the concordance index (Cindex) applied for different survival models. Measure of Discrimination using Area under receiver operating characteristic curve (AUC) and Measure of Calibration using calibration plots for each model were obtained and compared. From the suggestions obtained from the data and model, the best model for this data is applied and interpreted the results.

Numerical simulation on 2D phase change TPL bioheat model using RBF meshfree method

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Abstract

The estimation of the temperature inside the biological bodies or skin tissue has been on trend for as best as possible treatments to destroy the abnormal tissue. Cryosurgery (or cryotherapy) is a type of surgery in which the abnormal tissue is destroyed by generating extremely low temperature in the targeted tumor tissue using probes. A successful treatment requires a high cooling efficiency of cryoprobe for destroying target tumor tissues.

In the present time, the radial basis function (RBF) has done a great job to solve a partial differential equations. Due to its simplicity and effectiveness, it is most preferable tools to solve PDE's. Also it is not more complicated for the problems with many space dimensions as well as comlex geometry.

This paper is concerned with the numerical study of two-dimensional phase change problem in biological tissues during cryosurgery. To investigate the freezing interface position and temperature distribution in the skin tissue, we take into account the three phase lag (TPL) bioheat model. We apply the effective heat capacity formulation to solve the nonlinear governing equation. The Gaussian radial basis function and Crank-Nicolson (C-N) finite difference approximation are applied for spatial and time derivative, respectively. Using the present algorithm, we study the impact of phase lag (τ_v) on phase change interface position and thermal distribution. The obtained results may be beneficial in the field of oncology.

Comparison of nonparametric survival models with bootstrapping technique

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Abstract

Survival analysis is a subsection of statistics in which the goal is to analyse and model data with the outcome being the time until an event of interest occurs; Time till a machine breaks, the amount of time before a patient with an illness passes away, and other measures are analysed in many studies using duration analysis in economics and reliability analysis in engineering. We take into account the right random censorship model, where the life time distribution function is the main quantity of interest. A nonparametric maximum likelihood estimator, which Kaplan and Meier (KM) developed, is a logical generalisation of the empirical distribution in the situation of data. In this study, the author compared the survival probabilities obtained from nonparametric methods Kaplan-Meier and Nelson-Aalen for Two Real Time data. Obtained Survival estimates from Nelson-Aalen is greater than Product Limit Estimation. When applied Bootstrapping Techniques for the above both methods same inference made. Quantiles and 95% Confidence limits for the Nonparametric method of Estimation and with Bootstrapping methods were compared. Both Techniques provided similar results.

An inventory model for both ameliorating and deteriorating items with power demand pattern in crisp & fuzzy environments

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Abstract

In this paper, we devise an inventory model for the retailer's problems for the items with constant deterioration rate as well as of weibull ameliorating pattern having power demand under shortages. We have first considered the model in the crisp environment having the deterministic parameters, such as, holding cost, rate of deterioration, and amelioration cost. Subsequently, to deal with the real world situations, we have modeled this problem in the fuzzy environment having impreciseness in the above-mentioned parameters. In particular, we have considered the impreciseness in holding cost, deterioration rate, and amelioration cost as triangular fuzzy numbers, and used Graded Mean Integration Representation (GMIR) Method for defuzzification. We have proposed a general approach to obtained the optimal strategy for the proposed inventory problem in both the environments. Finally, several numerical examples are illustrated to justify the findings. Lastly, managerial insights are proposed after carefully investigating the sensitivity behavior of various associated key parameters.

Modeling time-to-event data using Cox regression model

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Abstract

Survival analysis is a study about time to event data analysis. Survival data consist of a response variable that measures the duration of time to specific event. Nonparametric, Semiparametric and Parametric methods are used for analysing survival data in many fields. Cox Proportional Hazard model is a semi-parametric model that leaves its baseline hazard function unspecified. Furthermore, the cox regression models extend the survival analysis method to assess simultaneously the effect of several risk factors on survival time. The author applied Nonparametric and Semiparametric method for Cancer and Eye Retinopathy data collected from EYDOX Eye Hospital private Limited, Chennai and observed their Survival Probabilities. Using Cox PH techniques, different models are analysed and finally obtained the model which contains only significant covariates and the effect of covariates related to event of interest observed.

A two-phase model of early atherosclerotic plaque growth

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Abstract

Atherosclerosis, a chronic cardiovascular disease in which fatty plaque builds inside our artery wall, can be modelled as an inflammatory disease. It begins with the penetration of low-density lipoprotein (LDL) into the intima and subsequently gets oxidized. The consequent immune response causes the recruitment of monocytes from the blood-stream, which are subsequently differentiated into macrophages and consume oxidized LDL (ox-LDL) to become lipid-laden foam cells. Consequently, early plaque is formed, which is characterized by foam cells and macrophages. For an atherosclerotic person, plaque growth is almost asymptomatic before it appears on the clinical site.

In this study, we introduce a multiphase model that explores the growth of the plaque region at the early stage. Appropriate boundary conditions with the assumption of the plaque moving boundary are included to formulate the problem mathematically. This study emphasises the role of cytokines (MCP-1) and ox-LDL in monocyte recruitment and foam cell production, respectively. The present model includes a toxicity level representing the threshold at which foam cells start to die due to excessive consumption of ox-LDL. Numerical simulations are performed with the help of a semi-analytical method (perturbation technique) to study the plaque's growth dynamics. Results suggest that initially, plaque width grows exponentially, but later on, it stabilises with time due to the toxicity of ox-LDL. The present study also includes some parameters that represent the flux of ox-LDL and cytokines through the endothelium. The higher flux of ox-LDL leads to plaque growth decay, although increased cytokines flux results in plaque growth increasing.

Queuing theory: a case study in analyzing the vaccination service in Ranchi city

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Abstract

Many research and development teams throughout the world are working on COVID-19 vaccines, but getting the vaccinations to different cities in the India has become a recurring issue. The purpose of this study is to identify the influences on vaccination rates. This study focuses on the Ranchi City vaccination queuing system, which was observed within the parameters of arrival time, queue waiting time, and vaccine service time during Covid-19. Direct time study was used by the researchers to collect their data. Data from each procedure was gathered using a watch and timer. All the data for the three research factors are manually entered for a period of one hour. Monitoring has the slowest average time in the system as a result may be enterpreted the data following the M/M/1 queuing model. It takes the longest in terms of the Average Waiting Time and slowest in terms of the Average Service Time. Different odd steps have the highest percentage for the probability of no users in the system, and even steps have the highest percentage of the probability of a busy server.

An integrated stage-structured prawn and broiler harvesting model

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Abstract

In the present work, an integrated stage-structured harvesting model of prawn and broiler has been considered. The species are classified based on two stages of maturing, the juvenile and the mature. The species' natural growth rate are remained to be same with different evolving levels. Through the cultivation process, prawns of non-marketable quality with rich protein have been considered as a good source of nutrients for the broiler and similarly, poultry litter, excreta of broilers, and dead broilers are being used as a nutrient for prawns. Recognizing the prawns and broilers as reciprocal predators of each other, an integrated. dynamical system has been formulated. The boundedness of the dynamical system, conditions for local stability, and global stability using an appropriate Lyapunov function has been derived. Using numerical analysis stability of the model has been discussed, and it has been investigated that the stability of broiler biomass (both juvenile and mature) is occurring faster than prawn biomass (both juvenile and mature).

Analysis of the wave force on the vertical cylinder surrounded by multiple porous layers

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Abstract

In this work, we analyze the effect of multiple porous layers around the vertical circular cylinder on the wave forces acting on the rigid structure. Using the eigenfunction expansion method in cylindrical coordinates we have derived the expressions for velocity potentials in the respective domains and finally calculated the wave force on the rigid structure by integrating the pressure term acting on the structure. Consideration of the multiple porous layers with different porosities gives rise to a very basic question to answer and that is what will be the arrangements of the porous layers to reduce the wave impact. Hence, for numerical study we considered three different arrangements of the porous layers: (i) porosity increases monotonically from the innermost layer to the outermost layer; (ii) porosity decreases monotonically from the innermost layer to the outermost layer; (iii) equal porosity in all the layers. For these

three different arrangements of the porous layers, we have also analysed the effects of the other crucial parameters on the wave force such as the number of porous layers, the thickness of porous layers, inertia, and friction factor for each layer. The key finding of the analysis is that, for long waves, the wave force acting on the rigid structure can be minimized by increasing the number of porous layers with decreasing porosity from the innermost layer to the outermost layer. This work is also verified with an existing work in the literature which shows excellent agreement.

A study of prediction performances using ARIMA and soft computing ANN models for Indian coal mines of black carbon concentration data

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Abstract

Fresh air is imminent for life and to thrive on this planet. However, this vital component of life is ill-effected by fast-paced industrialization, urbanization, automobiles, factories and coal-based thermal power generation as over the years these have jeopardized the air quality index. Due to hazardous impact of black carbon on the environment as well as human health, researchers have turned their attention towards its study. The comparative analysis of artificial neural network and econometric models used to predict the time series of monthly observations of black carbon emissions from three major coal mines located at Bokaro, Jharia and Raniganj in India. These coal mines have large emissions of particulate matter ( ) that contribute significantly to pollution levels. A multilayer perceptron feedforward artificial neural network is used to predict the black carbon concentration data from these three coal mines. The neural network is trained using a Bayesian regularization backpropagation algorithm. The efficiency of neural network models is evaluated by mean absolute deviation (MAD), root mean square (RMSE), and coefficient of determination ( ) values. The results obtained are then compared with the well-known and widely used autoregressive integrated moving average (ARIMA) model. The results of the study reveal the effective performance of artificial neural networks over the ARIMA model in forecasting black carbon concentration data. It has also been found that the performance of an ARIMA model is dependent upon the length of the forecasting horizon. However, no such evidence is found for ANN model in forecasting black carbon concentration data.

A mathematical model on increasing atmospheric carbon dioxide concentation, and global

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Abstract

In this paper, a non-linear mathematical model is considered and analysed to investigate the effects of human population growth and urbanization on forest resources, atmospheric carbon dioxide concentrations and global warming. It is assumed that both forest resources

and human population grows logistically. Also, it is assumed that the atmospheric concentration of carbon dioxide is rising as a result of deforestation, burning of fossil fuels and other factors that contribute to global warming. The model is presented as a nonlinear dynamical system that takes into account various variables and equations. The resulting model is both quantitative and qualitatively evaluated using numerical simulation and differential equation stability theory.

Effect of non-local interactions in a spatiotemporal preypredator model with hunting cooperation

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Abstract

In this work we mainly focus on a spatiotemporal prey-predator system with hunting cooperation in predator where the prey population is subjected to nonlocal interactions. Cooperative hunting is a less addressed topic but ecological data and some recent works show that the cooperative hunting is quite frequent in nature. Also inclusion of cooperative hunting in model gives rise to very complicated dynamics. In fact, spatiotemporal models, where the local interactions are considered, with hunting cooperation can produce several non-turing patterns such as target, spirals and spatio temporal chaos[1]. Here, we consider a prepredator model with hunting cooperation where the prey population interacts non-locally. Both turing and spatial-Hopf bifurcations are studied in detail. All possible local and nonlocal patterns are produced and numerically validated. We have given special emphasis on the effect of non-local parameter on the resulting patterns.

References

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Poster Presentations

Euler's Pioneering Equation

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Abstract

In 1748, after Roger Cotes geometrical argument which missed the multivariable nature of the complex logarithm, was published, Leonhard Euler derived the famous Eulers formula

$$e^{ix} = cosx + isinx \tag{5}$$

comparing the Taylor series expansion of the exponential and trigonometric expression. Eulers identity

$$e^{i^{\pi}} - 1 = 0 \tag{6}$$

is just a special case of Eulers formula which is obtained by setting x=π. This identity is considered to be the most beautiful equation of mathematics. It is the only equation that links together the five most fundamental and significant constants of mathematics with the three basic operations. But the real beauty and intrigue of this identity is that it raises a number to an imaginary power and it ends up making perfect sense. This result can be verified using the concept of power series.

This poster gives a representation of how Eulers formula relates complex exponential functions to the complex plane and this results in the observation that the exponential function and sinusoids are the two sides of the same coin if the usage of complex numbers is known.
As some scientists have claimed, we live in Eulers world.
This poster also throws light on how this equation interacts with the actual world. Eulers formula underlies the use of simple arithmetic to account for the behavior of electric circuits using Alternating current. It also describes the mathematical structure of the complex wave equation produced in De-Broglies wave-particle duality hypothesis. this poster will also demonstrate Euler's formula as the true basis of Einstein's relativity theory.

A fuzzy multiobjective optimization approach to tourist carrying capacity problem

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IMS Subject Classification: G

Abstract

Tourism is a significant industry in the world economy. Tourism now accounts for 10.4 % of global GDP and 7% of total world exports. The industry is worth more than US USD 1.1 trillion.It also generates opportunities for employment in service sector of the economy associated with tourism. Simultaneously, tourist destinations will face the negative impacts of the increasing pressure of overcapacity. The tourist capacity should focus more on how many tourists are required and can be absorbed in a destination than how many tourists want to or can be persuaded to come to an area. This paper recommends an intuitionistic fuzzy linear multi-objective approach for the determination of tourist-carrying capacity. We consider two objective functions namely maximizing total outlays and minimizing waste disposal, subject to constraints like hotel bed availability, daily lunches, parking places, etc. The objectives can be conflicts in nature. This uncertainty is best represented by intuitionistic fuzzy sets, a more advanced form of fuzzy sets having a greater number of degrees of freedom. The performance of the approach is tested through an example available in previously published work (Carrillo 2006). The application of this decision-making problem could help make productive plans for economic and social development and reduce the negative aspect like overcrowding or the environmental impact of tourism.

A new approach for Logistic regression

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Abstract

This paper proposes modeling approach where the s- shaped growth is observed and applying the growth curves in logistic regression model. Of them the Richards family curves constitute the most useful in modeling the growth they present an opportunity for better mapping of data points when the points are clustered around the point of inflexion or when the density of points are more on either the top or bottom of the point of inflexion and also at the points which are closer to the upper and the lower asymptote. It presents an idea where the replacement of the standard sigmoid with the s shaped curves to better model and classify the data. We also Analyse the consequences of this approach and study the if this leads to under or overfitting of data.

Machine Learning Algorithms and Modalities in Enhancing Healthcare Decisions

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IMS Subject Classification: G

Abstract

Management information system (MIS), decision support system (DSS), and executive support system (EES) are the inevitable constituents of the intelligent systems which are being integrated with the infrastructural and technological development of the organizations to address non-routine decisions. The intelligent systems are incorporated with methodologies that support providing solutions to unpredicted decisions by employing mathematical and statistical tools and incorporating software programs embedded with cutting-edge algorithms. We investigate the applicability of several algorithms in the healthcare domain and propose mechanisms of development of machine learning techniques in the area of artificial intelligence. Artificial intelligence (AI) encompasses integer linear programming (ILP) and machine learning (ML) that further motivates us to dig up the algorithms and learning techniques to find the best solution in the field of predictive analytics for the supervised learning environments in correlating blood glucose concentration and hematocrit volume.

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