TWO-DAY CONFERENCE

ON

"MATHEMATICAL SCIENCES AND APPLICATIONS" (CMSA-2025)

(AN INTERNATIONAL CONFERENCE IN HYBRID MODE)

JANUARY 02-03, 2025

BOOK OF ABSTRACTS

Organized by

Department of Mathematical Sciences

Tezpur University,India

Two Day Conference on "Mathematical Sciences and Applications" (CMSA-2025)

(An International Conference in Hybrid Mode)

January 02–03, 2025

Book of Abstracts

Organized by

Department of Mathematical Sciences

Tezpur University

Napaam-784028, Assam, India

Website:https://www.tezu.ernet.in/

About the Conference

This conference intends to bring researchers, scientists, academicians and research scholars together to exchange and share their knowledge and experiences, new ideas, and the research outcome of all possible aspects of Mathematical Sciences and Applications. The final year PG students will also find it very useful, as some plenary talks by well-known experts are also a part of this conference. In view of NEP 2020, this conference will bring researchers from diverse areas of Mathematical Sciences to one platform, and they will be engaged in knowledge sharing about the latest trends & research methodologies. It will also promote and advance the exciting and rapidly changing fields representing all branches of Mathematics including Statistics. Participants may present their papers on topics related to Mathematical Sciences and Applications. They will get an opportunity to interact among themselves as well as with the invited Speakers and the faculty members of the Department of Mathematical Sciences, Tezpur University, which may lead to some collaborative projects in future.

About Tezpur University

Tezpur University was established by an Act of Parliament in 1994. The objectives of this Central University as envisaged in the statutes are that it shall strive to offer employment oriented and interdisciplinary courses to meet the local and regional aspirations and the development needs of the state of Assam and also offer courses and promote research in areas which are of special and direct relevance to the region and in emerging areas in Science and Technology. The university holds an 'A+' grade accreditation from NAAC and was honored with the Visitor's Best University Award by the President of India in 2016.

About the Department of Mathematical Sciences

The Department of Mathematical Sciences was started in July,1994 as one of the first three departments of Tezpur University with the objective of producing trained manpower for undertaking research and teaching in mathematics and allied branches of basic and applied sciences.It also aimed to groom trained mathematicians for problem solving in industry and other concerns. The department offers MSc and Integrated MSc in Mathematics and PhD in Mathematical Sciences. The department carries out research in areas such as Number theory (Ramanujan's Mathematics), Discrete Probability Distributions, Algebra, Topology and applications, Operator Theory and applications, Differential Equation, Graph Theory, Numerical Linear Algebra, Coding Theory, Fluid Dynamics, etc. Several projects under the sponsorship of the Department of Science and Technology(DST), Indian Space Research Organization ISRO), University Grants Commission (UGC) and Council for Scientific and Industrial Research (CSIR) have been completed by the department. Several other projects under the sponsorship of various organizations are running in the department.

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Programme Schedule

Date and time are in Indian Standard Time (IST)

Day 1: January 02, 2025 (Thursday)

Inaugural Session: 9:30 a.m. – 10:15 a.m.
Tea Break: 10:15 a.m. – 10:30 a.m.
Plenary Talk I: 10:30 a.m. – 11:45 a.m.
Contributed Talks: 12:00 noon – 1:30 p.m.
Lunch Break: 1:30 p.m. – 2:30 p.m.
Plenary Talk II: 2:30 p.m. – 3:45 p.m.
Tea Break: 3:45 p.m. – 4:00 p.m.
Contributed Talks: 4:00 p.m. – 5:30 p.m.

Day 2: January 03, 2025 (Friday)

Contributed Talks: 9:00 a.m. – 10:00 a.m.
Plenary Talk III: 10:00 a.m. – 11:15 a.m.
Tea Break: 11:15 a.m. – 11:30 a.m.
Contributed Talks: 11:30 a.m. – 1:00 p.m.
Lunch Break: 1:00 p.m. – 2:00 p.m.
Plenary Talk IV: 2:00 p.m. – 3:15 p.m.
Tea Break: 3:15 p.m. – 3:30 p.m.
Contributed Talks: 3:30 p.m. – 5:00 p.m.
Valedictory: 5:00 p.m. – 5:30 p.m.

Details of Plenary Talks

Plenary Talk I

Speaker: Prof. Rupam Barman, Department of Mathematics, Indian Institute of Technology Guwahati, India.
Title: Hypergeometric series in arithmetic geometry.
Host: Ms. Silpi Sikha Das, Department of Mathematical Sciences, Tezpur University, India.
Date: 02 January, 2025.
Time: 10.30 a.m. – 11.45 a.m.
Venue: Room No. 22

Plenary Talk II

Speaker: Prof. Peter J. Cameroon, School of Mathematics and Statistics, University of St. Andrews, UK.
Title: The ADE affair.
Host: Mr. Abhishek Sarma, Department of Mathematical Sciences, Tezpur University, India.
Date: 02 January, 2025.
Time: 2.30 p.m.–3.45 p.m.
Venue: Room No. 35 (Google Meet Link: meet.google.com/uyw-ggiv-uov)

Plenary Talk III

Speaker: Prof. Souvik Roy, Head, Indian statistical Institute North-East Centre, India.
Title: On the aggregation of choice functions.
Host: Mr. Abhishek Sarma, Department of Mathematical Sciences, Tezpur University, India.
Date: 03 January, 2025.
Time: 10.00 a.m.–11.15 a.m.
Venue: Room No. 22

Plenary Talk IV

Speaker: Prof. Rebecca Waldecker, Martin Luther University Halle-Wittenberg, Germany.
Title: The classication of finite simple groups: History and Applications.
Host: Ms. Bidushi Sharma, Department of Mathematical Sciences, Tezpur University, India.
Date: 03 January, 2025.
Time: 2.00 p.m.–3.15 p.m.
Venue: Room No. 35 (Google Meet Link: meet.google.com/yra-xopf-vvv)

Details of Contributed Talks

Day 1: Contributed Talks: Session I (12:00 noon – 1:30 p.m. IST)

Group A1 : This session will be chaired by Prof. Dhiren Kumar Basnet, Department of Mathematical Sciences, Tezpur University, India.
Host: Ms. Silpi Sikha Das, Department of Mathematical Sciences, Tezpur University, India.
Venue: Room No. 21

Speaker	Title of the talk
Dr. Parama Dutta	On certain characterizations of autocommutativity degree of finite groups
Darsana Devi	Two generalized cyclic contractions and their fixed points in b-metric spaces
Rishabh Chakraborty	Co-engel graphs of certain finite non-engel groups
Pranjal Talukdar	Some New Modular Identities for the Rogers–Ramanujan Continued Fraction
Abhishek Sarma	Arithmetic properties of 5-regular partitions into distinct parts

Group A2 : This session will be chaired by Dr. Pankaj Kumar Das, Department of Mathematical Sciences, Tezpur University, India.
Host: Ms. Bidushi Sharma, Department of Mathematical Sciences, Tezpur University, India.
Venue: Room No. 22

Speaker	Title of the talk
Sarbani Gogoi	Laplacian Matrix and Elliptic Curve Cryptography for Message Encryption
Barnam Jyoti Saharia	Multi-Algorithm Hybridization: GWO-SCA-PSO for Global Optimization
Achal Agarwal	Bounds on codes equipped with non-cyclic burst-b distance
Pritam Dahal	Estimation of distribution function of non negative data
Hosenur Rahman Prodhani	Size-biased Sujatha distribution with properties and application

Day 1: Contributed Talks: Session II (4:00 p.m. – 5:30 p.m. IST)

Group A3 : This session will be chaired by Prof. Dhiren Kumar Basnet, Department of Mathematical Sciences, Tezpur University, India.
Host: Mr. Abhishek Sarma, Department of Mathematical Sciences, Tezpur University, India.
Venue: Room No. 21

Speaker	Title of the talk
Dr. Parthajit Bhowal	Solvable conjugacy class graph of groups
Pankaj Kalita	A Brief Study on the Enhanced Power Graphs of some Groups
Firdous Ee Jannat	A survey on conjugacy class graphs of groups
Parveen	On the Minimal (Edge) Connectivity of Power Graphs of Finite Groups
Shrabani Das	On a bipartite graph defined on groups

Group A4 : This session will be chaired by Dr. Deepjyoti Goswami, Department of Mathematical Sciences, Tezpur University, India.
Host: Ms. Silpi Sikha Das, Department of Mathematical Sciences, Tezpur University, India.
Venue: Room No. 22

Speaker	Title of the talk
Dr. Karabi Rajbangshi	On Coefficient Multipliers of Dirichlet type spaces
Dr. Deepjyoti Borgohain	Generalized Cesàro operators on the spaces of Cauchy transforms
Dr. Pearl Sanchayeta Gogoi	Operator pseudo shifts as a direct sum of backward shifts, circulant operators and bilateral shifts
Dr. Dharmaraj Deka	Higher-order compact simulation of forced convection around a heated circular cylinder
Pompi Das	Mathematical Modelling of Rheology of Memang Narang (Citrus Indica) Juice through a Cylindrical Pipe by Power-law Fluid Model
Kahuwa Kuwali Barman	Impact of predator induced fear in a delayed predator prey system incorporating migration

Group B1 : This session will be chaired by Dr. Dimpal Jyoti Mahanta, Department of Mathematics, Kaziranga University, India.
Host: Ms. Payal Tak, Department of Mathematical Sciences, Tezpur University, India.
Venue: Google Meet link: http://meet.google.com/bpe-ygak-zqw

Speaker	Title of the talk
Miloudi Boudaoud	Some Applications of the Order of Entire Functions to Entire Functions that Share a Value with Two Difference Operators
Amar Ghris	Generalizations and Refinements of Numerical Radius Inequalities for Bounded Linear Operators on Hilbert Spaces
Riad Dida	Uniqueness of Meromorphic Functions with Deficient Values
Nor El-Houda Beghersa	Some characterizations of Convex functions
Mazouz Khaoula	Elliptic nonlinear problem with singular right hand side in anisotropic case

Group B2 : This session will be chaired by Dr. Sujit Talukdar, Department of Mathematics, Assam Don Bosco University, India.
Host: Ms. Darsana Devi, Department of Mathematical Sciences, Tezpur University, India.
Venue: Google Meet link: http://meet.google.com/ewt-bkqe-iyx

Speaker	Title of the talk
Billel Zaoui	An efficient interior-point algorithm for linearly constrained convex optimization
Randa Chalekh	Comparative analysis of kernel functions for primal-dual interior-point methods in convex quadratic programming
Ali Slimani	Existence and Uniqueness Solutions of Parabolic Chemotaxis model perturbed with Gaussian process
Welid Grimes	Full-Newton step feasible interior-point algorithm for a class of linear complementarity problems
Tabchouche nesrine	Primal dual interior point algorithm for sdlcp based on new type of kernel function with a new barrier term
Lachemi Nadia	Contribution to the resolution of the 0/1 bicriteria knapsack problem

Group B3 : This session will be chaired by Dr. Parama Dutta, Lakhimpur Gilrs' College, India.
Host: Ms. Puspita Paul, Department of Mathematical Sciences, Tezpur University, India.
Venue: Google Meet link: http://meet.google.com/tob-mkra-zvq

Speaker	Title of the talk
Marwa Saci	New Stability Result For a Linear Porous System With Microtemperatures Effects Only
Sami Loucif	Asymptotic behavior and numerical tests of some evolution problems with thermal effect and delay
Djellali Noura	Pseudo symmetric Riemannian manifolds
Hicham Kasri	Well-posedness and energy estimates for elastodynamic system with internal/boundary dissipation and dynamic boundary conditions
Balehouane Abdelkhalek	Existence results and exponential decay rate for coupled problem without internal damping and non ordinary conditions
Ikram Redjaimia	Numerical Study of instability onset in a Taylor-Couette System under Differential Heating

Group B4 : This session will be chaired by Dr. Arjun Singh Chetry, Department of Mathematics, Digboi College, India.
Host: Mr. Pranjal Talukdar, Department of Mathematical Sciences, Tezpur University, India.
Venue: Google Meet link: http://meet.google.com/egf-cdkv-cpi

Speaker	Title of the talk
Malki Zakarya	Fractional differential inclusions and their applications
Bouziane Aboubaker El-Sad- dik	New Existence Results for Caputo-Fractional Differential Equation With Two Integral Boundary Conditions in Banach Space
Laouar Zineb	Efficient collocation technique for fractional differential equations
Arioui Fatima Zahra	A Mild Solution to a Fractional Differential Equation Driven by a Fractional Brownian Motion
Nesrine Harrouche	Reliable Numerical Method for Solving Certain Class of non-Singular boundary Value Problems
Hassan Messaoudi	Study the asymptotic behavior of solutions for time-fractional Oldroyd-B fluid equations with generalized fractional derivatives

Group B5 : This session will be chaired by Dr. Deiborlang Nongsiang, Department of Mathematics, North-Eastern Hill University, India.
Host: Ms. Achal Agarwal, Department of Mathematical Sciences, Tezpur University, India.
Venue: Google Meet link: http://meet.google.com/cbx-ajrb-caj

Speaker	**Title of the talk**
Dr. Mojgan Afkhami	On the semi-Cayley graphs
Nasser Ghedbane	A New Public Key Cryptosystems Using Space Representations of Finte Groups
Rachid Chergui	An innovative version of the McEliece cryptosystem based on fibonacci codes
Bilel Selikh	A theoretical study of elliptic curve on a special finite ring
Zahra Barati	On the ring-index of Comaximal graphs
Walaa Nabil Fasfous	Energy and laplacian energy of non commuting graphs of finite groups

Day 2: Contributed Talks: Session III (9:00 a.m. – 10:00 a.m. IST)

Group B6 : This session will be chaired by Dr. Bijoy Krishna Debnath, Department of Applied Sciences, Tezpur University, India.
Host: Ms. Payal Tak, Department of Mathematical Sciences, Tezpur University, India.
Venue: Google Meet link: http://meet.google.com/fej-eonr-shy

Speaker	Title of the talk
Susmita Halder	Modeling the Dynamics of Pathogen Transmission from Macroalgae to Coral
Debasis Haldar	Scaling and Generalized Scaling Sets on Qp
Devanand	Spiral wave dynamics in excitable media
Dipendranath Mahato	Interpolation Problem: Conjectures & New Developments

Day 2: Contributed Talks: Session IV (11:30 p.m. – 1:00 p.m. IST)

Group A5 : This session will be chaired by Dr. Yengkhom Satyendra Singh, Department of Mathematical Sciences, Tezpur University, India.
Host: Mr. Abhishek Sarma, Department of Mathematical Sciences, Tezpur University, India.
Venue: Room No. 21

Speaker	Title of the talk
Dr. Himangshu Hazarika	Existence of special pairs of primitive normal elements over finite field
Shikhamoni Nath	Primitive normal pairs with prescribed traces over finite fields
Bidushi Sharma	Construction of permutation polynomial over finite field with the help of SCR polynomia
Dimpy Mala Dutta	A Study on Dextral Symmetric Algebras
Dr. Jayanta Bhattacharyya	Exploring Nil Clean Graphs: A Novel Perspective on Ring Structures

Group A6 : This session will be chaired by Dr. Pankaj Kumar Das, Department of Mathematical Sciences, Tezpur University, India.
Host: Ms. Silpi Sikha Das, Department of Mathematical Sciences, Tezpur University, India.
Venue: Room No. 22

Speaker	Title of the talk
Pankita Kachari	Existence of solution for impulsive fractional q_r- difference equation of implicit form with nonlocal boundary condition
Karismita Medhi	Chemically Reactive Solute Diffusion for Time-Dependent Hydromagnetic Viscoelastic Fluid Flow over a Stretching Porous Sheet with Suction/Blowing
Lovely Borah	Hyperchaotic Dynamics in a Financial System with Profit Margin and its Control: Mathematical Insights and Applications
Chetan Abhijnanam Bora	Analyzing Temporal Variations in Near Earth Asteroid Dynamics through Machine Learning and N-Body Integration
Dr. Sunayana Saikia	A method for ranking interval type-2 fuzzy numbers based on their value, ambiguity, fuzziness, and vagueness

Group A7 : This session will be chaired by Dr. Deepjyoti Goswami, Department of Mathematical Sciences, Tezpur University, India.
Host: Ms. Bidushi Sharma, Department of Mathematical Sciences, Tezpur University, India.
Venue: Room No. 35

Speaker	Title of the talk
Rituparna Chaliha	On some determinants involving residues and conjectures of Sun
Suman Mondal	Idempotents of Zn
Pappu Das	Dynamic interaction of stratifications on unsteady MHD flow across an oscillating vertical permeable plate with periodic temperature variation and exponential mass diffusion
Hirak Jyoti Sarma	A study on reliability indices of a single server N-policy queue under Bernoulli vacation subject to server breakdown

Day 2: Contributed Talks: Session V (3:30 p.m. – 5:00 p.m. IST)

Group A8 : This session will be chaired by Dr. Bipul Kumar Sarmah, Department of Mathematical Sciences, Tezpur University, India.
Host: Ms. Bidushi Sharma, Department of Mathematical Sciences, Tezpur University, India.
Venue: Room No. 21

Speaker	Title of the talk
Dr Hirakjyoti Das	Congruences Between the Coefficients of Certain Mock Theta Functions
Dr. Arjun Singh Chetry	On a finite field analogue of Lauricella hypergeomentric series $F_A^{(n)}$
Ms. Shraddha Rajkhowa	On Ramanujan's Continued Fractions of Order Twenty-Four
Ms. Sabi Biswas	Some restricted partition functions in terms of 2-adic valuation
Hemjyoti Nath	Infinite Families of Congruences for Partitions into Distinct Parts Not Congruent to 2 Modulo 4

Group A9 : This session will be chaired by Dr. Somnath Paul, Department of Applied Sciences, Tezpur University, India.
Host: Mr. Abhishek Sarma, Department of Mathematical Sciences, Tezpur University, India.
Venue: Room No. 22

Speaker	Title of the talk
Dr. Duranta Chutia	On some weak inequalities for integral operators with Oinarov's kernel
Tanmoy Barman	Weighted norm inequalities for one sided vector valued Hardy-Littlewood maximal function on one sided Morrey like spaces
Nabanita Konwar	Banach-type fixed-point theorem in bipolar p-metric spaces
Moirangthem Pradeep Singh	Fixed points of Geraghty type contraction in S_b-metric Spaces
Nirmal Kumar Singha	Improvements and generalizations of Ankeny-Rivlin type inequality for higher derivatives of a polynomial

Group B7 : This session will be chaired by Dr. Jituparna Goswami, Department of Mathematics, Gauhati University, India.
Host: Ms. Darsana Devi, Department of Mathematical Sciences, Tezpur University, India.
Venue: Google Meet link: http://meet.google.com/qaw-ktsn-ekp

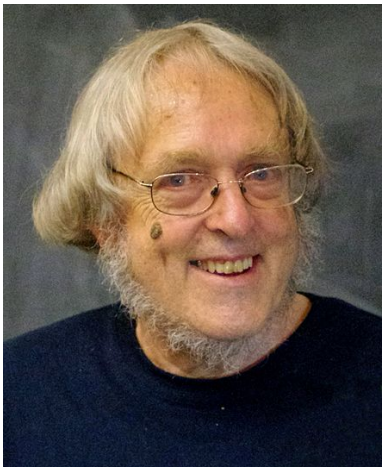
Speaker	Title of the talk
Manaa Abderrahmen	On Periodic ZIP-INGARCH Model
Sbia Manel	Modeling Triatomine Vector and Host Population Dynamics
Bengrine Fatima Zohra	Existence of positive supersolutions to nonlinear singular parabolic systems with Hardy potential
Nadjat Hamidat	Investigating the Interaction Between Hepatitis C and Diabetes: A Mathematical Approach
Hibaterrahmane Benmessaoud	Dynamic Process with Viscous Dissipation in Thermo-Viscoelasticity
Abdelaziz Bennour	On nonhomogeneous biharmonic equations with a critical Sobolev exponent and prescribed singularities

Group B8 : This session will be chaired by Dr. Jayanta Bhattacharyya, Department of Mathematics, Joya Gogoi College, India.
Host: Ms. Achal Agarwal, Department of Mathematical Sciences, Tezpur University, India.
Venue: Google Meet link: http://meet.google.com/xww-rgtq-kkd

Speaker	Title of the talk
Chouader Rima	Non-existence of limit cycle of Septic Kolmogorov system
Tikialine Belgacem	Boundary control and asymptotic stability of an axially moving
Amal Ladjeroud	Approximate Solutions of Schrodinger equation for the radial generalized Cornell plus Poschl-Teller potential
Chaili Amina	Energy Decay in Coupled Biharmonic Schrödinger Equations with Internal Fractional Damping
Abir Kicha	Lyapunov of sufficient conditions for practical semiglobal exponential stability
Abed Makreloufi	On Strong and Complete Controllability For Rectangular Descriptor Systems

About the Invited Speakers

Prof. Peter J. Cameron



Prof. Peter Jephson Cameron, an esteemed mathematician whose remarkable contributions span several decades and fields of study. Since 2013, Prof. Cameron has served as a half-time Prof. of Mathematics in the School of Mathematics and Statistics. His career includes distinguished tenures at the University of Oxford for 11 years and Queen Mary University of London for 26 years. Born on 23rd January 1947 in Toowoomba, a vibrant inland city in Southern Queensland, Australia, Prof. Cameron's academic journey began with a B.Sc. from the University of Queensland. He later earned his D.Phil. in 1971 from the University of Oxford as a Rhodes Scholar, setting the foundation for his illustrious career. Prof. Cameron's research spans algebra (groups, permutation groups, semigroups), combinatorics (enumeration, design theory and finite geometry, graph theory), and model theory (countably categorical structures). He is known for his work exploring consequences of the Classification of Finite Simple Groups for permutation group theory, for automorphism groups of countably categorical structures (he invented the term "oligomorphic" to describe these groups), and more recently applications of permutation groups in semigroup theory and in design of experiments in statistics. With an impressive output of over 300 published papers and collaboration with 200 coauthors, Prof. Cameron's influence is profound and far-reaching. Among his many accolades, he received the London Mathematical Society's Whitehead Prize in 1979 and the Senior Whitehead Prize in 2017. He is also a joint winner of the 2003 Euler Medal. In recognition of his contributions to mathematics, he was named the Forder Lecturer by the LMS and New Zealand Mathematical Society in 2008, and in 2018, he was elected a Fellow of the Royal Society of Edinburgh. Prof. Cameron's enduring passion for mathematics and his pioneering research continue to inspire the global mathematical community.

Prof. Rebecca Waldecker

Prof. Rebecca Anne Hedwig Waldecker is a distinguished mathematician specializing in group theory, particularly the study of finite groups and their structural properties. She currently serves as a Professor of Algebra at Martin Luther University Halle-Wittenberg in Germany, where she combines her passion for research with a commitment to teaching and mentorship.

Born in 1979 in Aachen, Germany, Prof. Waldecker developed an early fascination with mathematics, which she pursued at the Christian-Albrechts University of Kiel. She earned her Ph.D. in 2007 under the supervision of Prof. Helmut Bender, focusing on the subgroup structures of finite groups. Her dissertation, celebrated for its depth and innovation, paved the way for her academic career.

Following her doctoral studies, Prof. Waldecker completed a postdoctoral fellowship at University of Birmingham, where she further advanced her research in group theory. Her time at Birmingham enriched her perspective on the field and allowed her to collaborate on several significant projects in abstract algebra.

Prof. Waldecker's research is centered on finite group theory, including permutation groups and subgroup classifications, areas fundamental to algebra and computational mathematics. With over 100 publications, her work has significantly contributed to the understanding of the internal symmetries and algebraic properties of mathematical objects.

Beyond her research, Prof. Waldecker is a strong advocate for mathematics outreach and education. She is dedicated to making mathematics accessible to broader audiences and inspiring the next generation of mathematicians through workshops, lectures, and educational initiatives.

Through her scholarly work, postdoctoral achievements and educational efforts, Prof. Waldecker continues to make meaningful contributions to the mathematical community, earning her a respected position among her peers and students alike.

Prof. Rupam Barman

Prof. Rupam Barman is a professor at the Department of Mathematics, Indian Institute of Technology Guwahati, India. He did his B.Sc. from Cotton College and M.Sc. from Indian Institute of Technology Delhi. He did his Ph.D. from Indian Institute of Technology Guwahati under the supervision of Prof. Anupam Saikia. The title of his Ph.D. thesis is "Iwasawa Invariants of Elliptic Curves and p-adic Measures". Subsequently, he has held several post-doctoral positions. He received post-doctoral fellowships from ICTP, Trieste, Italy and the Mathematics Center Heidelberg (MATCH), University of Heidelberg, Germany. He was also awarded the Indo-Australian visiting fellowship by INSA to work at Newcastle University, Australia. Prior to joining Indian Institute of Technology Guwahati, he was also a faculty at the Department of Mathematical Sciences, Tezpur University from 2002 to 2013 and the Indian Institute of Technology Delhi from 2013 to 2016. He has written over 75 research papers in well reputed journals and has produced 7 Ph.D. students so far. His research area covers the following topics: Algebraic number theory, elliptic curves, Iwasawa theory, p-adic measures, exponential sums, Kloosterman sums, hypergeometric functions over finite fields, p-adic hypergeometric series, modular forms, theory of partitions, the mathematics influenced by Ramanujan and graph theory. He is also a member of the editorial boards of Journal of the Assam Academy of Mathematics and the Ramanujan Journal. In 2022, he was awarded the A. M. Mathai Research Excellence Award by the Society for Special Functions and their Applications (SSFA).

Prof. Souvik Roy

Prof. Souvik Roy is a professor at the Applied Statistics Unit of the Indian Statistical Institute, Kolkata. He is also the current Head of the Indian Statistical Institute, North-East Centre. He did his M. Stat. from Indian Statistical Institute, Delhi and his Ph.D. from University of Maastricht, Maastricht, Netherlands. Subsequently, he was a post-doctoral fellow at the University of Caen, France. He was also a lecturer at the Indian Statistical Institute, Delhi. His wide-ranging research interests include the fields of Game Theory; Matching Theory; Mechanism Design; Algebraic Graph Theory; Social Choice Theory; Probability Theory which includes diffusion processes, percolation and random matrix; Number Theory and Epistemic Game Theory. He has published around 45 research papers. In 2016, he was awarded the prestigious Prof. M. J. Manohar Rao Award for Young Researchers by the Indian Econometric Society. In 2024, he was awarded the Social Choice and Welfare Award by the Society for Social Choice and Welfare, France.

Abstracts of Plenary Talks

Plenary Talk I: Hypergeometric series in arithmetic geometry

Prof. Rupam Barman
Department of Mathematics
Indian Institute of Technology Guwahati
Guwahati - 781039, Assam, India.
rupam@iitg.ac.in

Abstract

In 1987, John Greene introduced the notion of hypergeometric functions over finite fields analogous to classical hypergeometric series (Trans. Amer. Math. Soc. 301 (1987)). Finite field hypergeometric functions were developed mainly to simplify character sum evaluations. After 10 years, Ken Ono found interesting relations between Greene's finite field hypergeometric functions and L-functions of elliptic curves (Trans. Amer. Math. Soc. 350 (1998)). In 2013, Dermot McCarthy extended the finite field hypergeometric series to the p-adic setting (Pacific J. Math. 261 (2013)). In this talk, I will introduce finite field and p-adic hypergeometric functions and show how their values are related to special values of L-functions of elliptic curves. We will also show how these functions played a significant role in proving some important conjectures of Rodriguez-Villegas and van Hamme on truncated classical hypergeometric series and special values of weight 3 and 4 newforms.

Keywords:
Finite field; Elliptic curve; L-functions; Hypergeometric series.

AMS Mathematics Subject Classification 2020:
33C20, 14H52, 11G20

Plenary Talk II: The ADE affair

Prof. Peter J. Cameron
School of Mathematics and Statistics
University of St Andrews
North Haugh St Andrews, Fife KY16 9SS, Scotland.
pjc20@st-andrews.ac.uk

Abstract

The Coxeter–Dynkin diagrams of type ADE occur all over mathematics; they are so ubiquitous that Vladimir Arnold proposed, as a modern Hilbert problem, explaining their many and varied occurrences, and Francis Buekenhout suggested that they could be used as a "calling card" for humanity on a spacecraft leaving our solar system. Areas in which they occur include finite groups generated by reflections, Lie algebras, singularity theory, spectral theory of graphs, general relativity, and cluster algebras.

I will describe some of these occurrences and their links, concentrating on the occurrences in discrete mathematics, and will tell some stories of my own interactions with them.

Keywords:
Coxeter–Dynkin graphs.

AMS Mathematics Subject Classification 2020:
05-02

Plenary Talk III: On the aggregation of choice functions

Prof. Souvik Roy
Indian Statistical Institute North-East Centre
Punioni, Solmara, Tezpur, Assam - 784501, India.
souvik.2004@gmail.com

Abstract

We consider the game theory problem of aggregating choice functions on non-rational domains satisfying the Pareto axiom and Independence of Irrelevant Alternatives (IIA). A choice function is rational if a strict preference induces it. We explore three types of non-rational domains and provide the structure of aggregation rules on these domains.

Keywords:
Game theory; Choice function; Pareto axiom.

AMS Mathematics Subject Classification 2020:
91A26

Plenary Talk IV: The classication of finite simple groups: History and Applications

Prof. Rebecca Waldecker
Institut für Mathematik
Martin-Luther-Universität Halle-Wittenberg
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Abstract

In this talk I want to discuss a theorem with you that classifies all finite simple groups. Where did this theorem come from? How can it be applied? What is its impact on modern group theory? How was it proven? What is special about this theorem and its proof in terms of our mathematical culture?

Keywords:
Finite simple groups.

AMS Mathematics Subject Classification 2020:
20D05

Abstracts of Contributed Talks

On a characterization of autocommutativity degree of finite groups

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(Joint work with Dr. Rajat Kanti Nath)

Abstract

Let G be a finite group and let $\mathrm{Aut}(G)$ be its automorphism group. The autocommuting probability of G, denoted by $\Pr(G, \mathrm{Aut}(G))$, is the probability that a randomly chosen automorphism of G fixes a randomly chosen element of G. In this paper, we characterize all finite groups G such that $\Pr(G, \mathrm{Aut}(G)) = \frac{p+q-1}{pq}$, where p, q are the smallest primes dividing $|\mathrm{Aut}(G)|$, $|G|$ respectively. We shall also show that there is no finite group G such that $\Pr(G, \mathrm{Aut}(G)) = \frac{q^2+p-1}{pq^2}$, where p, q are primes as mentioned above.

Keywords:
Automorphism group; Autocommuting probability.

AMS Mathematics Subject Classification 2020:
20D60, 20P05, 20F28

Two generalized cyclic contractions and their fixed points in b-metric spaces

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Abstract

The b-metric spaces constitute a larger class than the one constituted by a metric space in which the triangular inequality generalizes non-trivially. This research focuses on the construction of a generalized cyclic type Kannan and Ćirić-Reich-Rus contraction in b-metric space with a unique fixed point via interpolation. A new approach for Cauchy sequence is adopted in both of this generalized contractions. The existance and uniqueness of fixed point in this newly introduced mappings have been studied and validated with an example. This paper also provides correction to a result of Cauchy sequence in the recent paper of Edraoui et al. [Appl. Gen. Topol. 24 (2) 2023, 247-252].

The extension of cyclical Kannan and Ćirić-Reich-Rus contraction theoretically enhances the framework of b-metric space. By exploring the different direction of contraction principle, we can obtain many results regarding the existance of fixed points in b-metric spaces.

Keywords:
Fixed point; Contraction map; b-metric space; Complete metric space; Kannan type contraction.

AMS Mathematics Subject Classification 2020:
47H10, 54H25, 54E50

Co-Engel graphs of certain finite non-Engel groups

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Abstract

Let G be a group. Associate a graph $\mathcal{E}_G$ (called the co-Engel graph of G) with G whose vertex set is G and two distinct vertices x and y are adjacent if $[x,{}_k y] \neq 1$ and $[y,{}_k x] \neq 1$ for all positive integer k. This graph, under the name "Engel graph", was introduced by Abdollahi [J. Algebra **318**, 680–691, 2007]. Let $L(G)$ be the set of all left Engel elements of G. In this paper, we realize the induced subgraph of co-Engel graphs of certain finite non-Engel groups G induced by $G \setminus L(G)$. We write $\mathcal{E}^-(G)$ to denote the subgraph of $\mathcal{E}_G$ induced by $G \setminus L(G)$. We also compute genus, various spectra, energies and Zagreb indices of $\mathcal{E}^-(G)$ for those groups. As a consequence, we determine (up to isomorphism) all finite non-Engel group G such that the clique number $\omega(\mathcal{E}^-(G))$ is at most 4 and $\mathcal{E}^-(G)$ is toroidal or projective. Further, we show that $\mathcal{E}^-(G)$ is super integral and satisfies the E-LE conjecture and the Hansen–Vukičević conjecture for the groups considered in this paper. We also look briefly at the directed Engel graph, with an arc $x \to y$ if $[y,{}_n x] = 1$ for some x. We show that, if G is a finite soluble group, this graph either is the complete directed graph (which occurs only if G is nilpotent), or has pairs of vertices joined only by single arcs.

Keywords:
Engel graph; Finite group.

AMS Mathematics Subject Classification 2010:
20D60, 05C25

Some new modular identities for the Rogers-Ramanujan continued fraction

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Abstract

We prove some new modular identities for the Rogers–Ramanujan continued fraction. For example, if $R(q)$ denotes the Rogers–Ramanujan continued fraction, then

$$R(q)R(q^4) = \frac{R(q^5)+R(q^{20})-R(q^5)R(q^{20})}{1+R(q^5)+R(q^{20})},$$
$$\frac{1}{R(q^2)R(q^3)} + R(q^2)R(q^3) = 1 + \frac{R(q)}{R(q^6)} + \frac{R(q^6)}{R(q)},$$

and

$$R(q^2) = \frac{R(q)R(q^3)}{R(q^6)} \cdot \frac{R(q)R^2(q^3)R(q^6)+2R(q^6)R(q^{12})+R(q)R(q^3)R^2(q^{12})}{R(q^3)R(q^6)+2R(q)R^2(q^3)R(q^{12})+R^2(q^{12})}.$$

In the process, we also find some new relations for the Rogers-Ramanujan functions by using dissections of theta functions and the quintuple product identity.

Keywords:
Rogers-Ramanujan functions; Rogers-Ramanujan continued fraction; Modular identities; Theta functions.

AMS Mathematics Subject Classification 2020:
11F27, 11P84, 11A55, 33D90

Arithmetic properties of 5-regular partitions into distinct parts

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Abstract

A partition is said to be ℓ-regular if none of its parts is a multiple of ℓ. Let $b'_5(n)$ denote the number of 5-regular partitions into distinct parts (equivalently, into odd parts) of n. This function has also close connections to representation theory and combinatorics. In this paper, we study arithmetic properties of $b'_5(n)$. We provide full characterization of the parity of $b'_5(2n+1)$, present several congruences modulo 4, and prove that the generating function of the sequence $(b'_5(5n+1))$ is lacunary modulo any arbitrary positive power of 5. This work has been accepted for publication in the International Journal of Number Theory.
DOI: https://www.worldscientific.com/doi/10.1142/S1793042125500332

Keywords:
ℓ-regular partition; Congruence; Modular forms.

AMS Mathematics Subject Classification 2020:
05A17, 11P81, 11P83, 11B37

Laplacian matrix and elliptic curve cryptography for message encryption

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Abstract

The key components for guaranteeing security in today's internet are efficient data encryption and decryption. It becomes crucial to convert data into an incomprehensible manner so that it is protected and only available to those who are authorised. RSA algorithm is a popular asymmetric cryptography approach that was developed in 1977 by Ron Rivest, Adi Shamir, and Leonard Adleman. They successfully encrypted all of the communications by using the prime factorisation approach. Software, communications, website data, and other types of data are frequently encrypted using RSA. The need for a higher key size is a major drawback of this strategy, though. Elliptic Curve Cryptography (ECC) is becoming more and more well-liked these days as it improves user experience while using less network and computing power, as it can offer same security comparable to RSA when using a much lower key size. Recent years have seen a large number of ECC-based experiments that additionally utilise other ideas such as number theory, matrix properties, mapping methodologies, etc. In this work, we offer a technique that uses ECC and the Laplacian matrix of graphs to safely communicate across an unsafe channel.

Keywords:
Encryption; Decryption; Elliptic curve cryptography; Laplacian matrix.

AMS Mathematics Subject Classification 2020:
Primary: 11T71. Secondary: 94A60, 05C90, 05C50

Multi-algorithm hybridization: GWO-SCA-PSO for global optimization

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Abstract

The prevailing research approach entails integrating several variations to improve the quality of solutions for global optimization challenges. This paper provides a concise account of advancements in the grey wolf optimizer during the past decade, emphasizing the several methodologies documented in the literature that highlight significant research aimed at hybridizing the algorithm for enhancement. The paper primarily introduces a novel hybrid optimization method that integrates the advantages of the Grey Wolf Optimizer (GWO), Sine Cosine Algorithm (SCA), and Particle Swarm Optimization (PSO). The proposed hybrid algorithms utilize the exploration capabilities of GWO, the sine and cosine-based search direction of SCA, and the swarm intelligence of PSO. The present work implements three types of Particle Swarm Optimization algorithms, grounded in social and cognitive components. The methods utilized to revise SCA's location are designed to improve the navigation and velocity of the alpha wolves, while PSO is employed to adjust the ranks of the beta and delta wolves. The theoretical principles of hybridization are examined, and the efficacy of the suggested algorithms is assessed using diverse statistical indicators. The efficacy of the suggested variations of GWOSCAPSO in addressing optimization challenges is assessed by its application to 23 standardized classical benchmark test issues. This research advances the creation of effective hybrid optimization methods, presenting a viable solution for many applications in science, engineering, and machine learning.

Keywords:
Optimization algorithms; Hybridization; Grey Wolf Optimizer (GWO);
Sine Cosine Algorithm (SCA); Particle Swarm Optimization(PSO).

AMS Mathematics Subject Classification 2020:
65K10, 90C26, 90C90

Bounds on codes equipped with non-cyclic burst-b distance

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Abstract

Our work deals with finding upper and lower bounds on the maximum number of codewords possible in a non-linear as well as a linear code correcting multiple-burst errors. Burst errors can be classified as cyclic bursts and non-cyclic bursts. Cyclic bursts occur towards the end of a vector and are readily less prominent than non-cyclic bursts which do not occur towards the end of a vector. Our work studies codes dealing with non-cyclic bursts. To study such codes, a distance function known as the non-cyclic burst-b ($NCB-b$) distance is used. Some inequalities comparing the maximum number of codewords possible in a non-linear code and in a linear code is found. Also, by the use of a constructive method, it is shown that for any given code length n and burst length b, there will always exist a binary linear maximum-distance separable code. Further, the Litsyn-Laihonen bound and its improved version for codes equipped with Hamming distance is extended for codes equipped with $NCB-b$ distance.

Keywords:
Multiple burst errors; Burst weight and distance; Bounds on codes.

AMS Mathematics Subject Classification 2020:
94B20, 94B35, 94B65

Estimation of distribution function of non-negative data

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Abstract

A kernel distribution function estimator based on non-negative data and using a kernel supported on $(-\infty, \infty)$ can assign positive probabilities outside the support $[0, \infty)$ of the underlying distribution. Using a kernel supported on $[0, \infty)$ in such estimators introduces higher bias. To address these issues, we propose a novel kernel-based distribution function estimator for non-negative data by truncating a traditional kernel estimator. We derive the asymptotic bias, variance and limiting distribution of the studentized estimator as the sample size increases. Comparisons of asymptotic efficiencies show that with the optimal bandwidth choice, the proposed estimator is more accurate than the empirical estimator. Additionally, we prove the strong uniform and L_2 convergence of the proposed estimator. Simulations indicate that for sample sizes $n \leq 1000$, the proposed estimator consistently outperforms both the empirical and traditional kernel estimators.

Keywords:
Non-negative data; Kernel estimation; Optimal bandwidth selection.

AMS Mathematics Subject Classification 2020:
62E20, 62G05, 62G20, 62G32

Size-biased Sujatha distribution with properties and application

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Abstract

In this paper, a size biased version of Sujatha distribution has been proposed to model flood data. Its statistical properties such as moments related measures, survival function, hazard function, reverse hazard function, mean residual life function have been studied with their graphical representation. The proposed distribution has been shown to be a member of exponential family of distributions. The sequential probability ratio test has been explained using the proposed distribution. The parameter estimation using method of moment, method of maximum likelihood, method of maximum product spacing, method of least squares, method of weighted least squares and Cramer-Von Mises estimation have been discussed. Confidence interval of the parameter is given with a graphical representation. The simulation study has been presented to know the consistency of the estimator obtained from all considered methods of estimation. The goodness of fit of the distribution has been demonstrated with a real lifetime data relating to flood and the goodness of fit shows that the proposed distribution provides better fit over the size-biased Lindley distribution, size-biased exponential distribution, Sujatha distribution, Lindley distribution and exponential distribution.

Keywords:
Sujatha distribution; Hazard function; Exponential family; Estimation of parameter; application.

AMS Mathematics Subject Classification 2020:
62E10, 62E15, 62E99

Solvable conjugacy class graph of groups

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Abstract

In this paper we introduce the graph $\Gamma_{sc}(G)$ associated with a group G, called the solvable conjugacy class graph (abbreviated as SCC-graph), whose vertices are the nontrivial conjugacy classes of G and two distinct conjugacy classes C, D are adjacent if there exist $x \in C$ and $y \in D$ such that $\langle x, y \rangle$ is solvable.

In this paper, the several key properties of the SCC-graph are investigated, including connectivity, diameter, girth, clique number, and genus. It establishes that the SCC-graph is complete if and only if the group G is solvable. The relationship between the genus of $\Gamma_{\rm sc}(G)$ and the commuting probability of finite non-solvable groups is explored, offering a bound that ties group-theoretic probabilities to graph embeddings. we discuss certain properties of the genus of $\Gamma_{\rm sc}(G)$ for the groups D_{2n}, Q_{4n}, S_n, A_n, and $PSL(2, 2d)$. In particular, we determine all positive integers n such that their solvable conjugacy class graphs are planar, toroidal, double-toroidal, or triple-toroidal. We shall also obtain a lower bound for the genus of $\Gamma_{\rm sc}(G)$ in terms of the order of the center and number of conjugacy classes for certain groups. As a consequence, we shall derive a relation between the genus of $\Gamma_{\rm sc}(G)$ and the commuting probability of certain finite non-solvable group.

Keywords:
Graph; Conjugacy class; Non-solvable group; Genus; Commuting probability.

AMS Mathematics Subject Classification 2020:
05C25, 20E45, 20F16

A brief study on the enhanced power graphs of some groups

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Abstract

The enhanced power graph $P_e(G)$ of a group G is a simple graph where the vertex set corresponds to the elements of G, and two distinct vertices are adjacent if and only if they are members of the same cyclic subgroup. This graph captures structural information about the cyclic subgroups within G, providing a combinatorial perspective on the internal organization of the group. In this work, we compute the characteristic polynomials of the adjacency matrix, Laplacian matrix, and the signless Laplacian matrix associated with the enhanced power graphs of several specific groups such as the dihedral group D_{2n}, the dicyclic group Q_{4n}, and the semidihedral group SD_{8n}. These characteristic polynomials serve as tools for understanding the spectral properties and algebraic invariants of the graphs. Furthermore, we analyze the Laplacian energy of these enhanced power graphs. Our results establish that the enhanced power graphs of these groups are L-hyperenergetic.

Keywords:
Enhanced power graphs; Spectrum; Energy; Laplacian energy; Signless Laplacian energy.

AMS Mathematics Subject Classification 2020:
05C50, 05C25, 15A18, 97K30

A survey on conjugacy class graphs of groups

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Abstract

There are several graphs defined on groups. Among them we consider graphs whose vertex set consists conjugacy classes of a group G and adjacency is defined by properties of the elements of conjugacy classes. In particular, we consider commuting/nilpotent/solvable conjugacy class graph of G where two distinct conjugacy classes a^G and b^G are adjacent if there exist some elements $x \in a^G$ and $y \in b^G$ such that $\langle x, y \rangle$ is abelian/nilpotent/solvable. After a section of introductory results and examples, we discuss all the available results on connectedness, graph realization, genus, various spectra and energies of certain induced subgraphs of these graphs. Proofs of the results are not included. However, many open problems for further investigation are stated. (This work is published in *Expositiones Mathematicae*, **42**(2):(26 pages), 2024.)

Keywords:
Commuting/Nilpotent/Solvable conjugacy class graph; Connectedness; Genus; Spectrum and Energy; Induced subgraph.

AMS Mathematics Subject Classification 2020:
20D60, 20E45, 05C25

On the minimal (edge) connectivity of power graphs of finite groups

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Abstract

In an earlier work, finite groups whose power graphs are minimally edge connected have been classified. In this article, first we obtain a necessary and sufficient condition for an arbitrary graph to be minimally edge connected. Consequently, we characterize finite groups whose enhanced power graphs and order superpower graphs, respectively, are minimally edge connected. Moreover, for a finite non-cyclic group G, we prove that G is an elementary abelian 2-group if and only if its enhanced power graph is minimally connected. Also, we show that G is a finite p-group if and only if its order superpower graph is minimally connected. Finally, we characterize all the finite nilpotent groups such that the minimum degree and the vertex connectivity of their order superpower graphs are equal.

Keywords:
Edge connectivity; Vertex connectivity; Minimum degree; Nilpotent groups.

AMS Mathematics Subject Classification 2020:
05C25

On a bipartite graph defined on groups

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Abstract

Let G be a group and $L(G)$ be the set of all subgroups of G. We introduce a bipartite graph $\mathcal{B}(G)$ on G whose vertex set is the union of two sets $G \times G$ and $L(G)$, and two vertices $(a,b) \in G \times G$ and $H \in L(G)$ are adjacent if H is generated by a and b. We establish connections between $\mathcal{B}(G)$ and the generating graph of G. We also discuss about various graph parameters such as independence number, domination number, girth, diameter, matching number, clique number, irredundance number, domatic number and minimum size of a vertex cover of $\mathcal{B}(G)$. We obtain relations between $\mathcal{B}(G)$ and certain probabilities associated to finite groups. We also obtain expressions for various topological indices of $\mathcal{B}(G)$. Finally, we realize the structures of $\mathcal{B}(G)$ for the dihedral groups of order $2p$ and $2p^2$ and dicyclic groups of order $4p$ and $4p^2$ (where p is any prime) including certain other small order groups.

Keywords:
Graphs on groups; Bipartite graph; Dihedral group; Dicyclic group.

AMS Mathematics Subject Classification 2020:
20D60, 05C25

On coefficient multipliers of Dirichlet type spaces

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Abstract

Let $H(\mathbb{D})$ be the class of all functions analytic in the open unit disk $\mathbb{D}$ of the complex plane. Let $0 < r < 1$ and $f \in H(\mathbb{D})$. For $0 < p < \infty$, the integral means of f are defined by

$$M_p(r, f) = \left(\frac{1}{2\pi}\int_0^{2\pi} |f(re^{i\theta})|^p \, d\theta\right)^{1/p}$$

and

$$M_\infty(r, f) = \sup_{[0,2\pi]} |f(re^{i\theta})|.$$

$M_p(r, f)$ is an increasing function of r.
For $0 < p \leq \infty$, the Hardy space H^p consists of those $f \in H(\mathbb{D})$ for which

$$\|f\|_{H^p} = \sup_{0<r<1} M_p(r, f) < \infty.$$

For $0 < p < \infty$ and $-\infty < \alpha < \infty$, the generalized weighted Bergman space A^p_α consists of those $f \in H(\mathbb{D})$ for which

$$\|f\|^p_{A^p_\alpha} = \int_{\mathbb{D}} |f^{(k)}(z)|^p \left(1 - |z|^2\right)^{kp+\alpha} dA(z) < \infty,$$

where $dA(z) = \frac{dxdy}{\pi}$ is the normalized area measure on $\mathbb{D}$ and k is a nonnegative integer such that $kp + \alpha > -1$.
For $\alpha > -1$, the weighted Dirichlet space D^p_α consists of those $f \in H(\mathbb{D})$ for which

$$\|f\|^p_{D^p_\alpha} = (\alpha + 1) \int_{\mathbb{D}} |f'(z)|^p (1 - |z|^2)^\alpha \, dA(z) < \infty.$$

Let X and Y be two spaces of analytic functions on the unit disc $\mathbb{D}$. Let $f \in X$ with $f(z) = \sum_{n=0}^{\infty} a_n z^n$. Suppose that $\{\lambda_n\}_{n=0}^{\infty}$ is a sequence such that

$\sum_{n=0}^{\infty} \lambda_n a_n z^n \in Y$. Then we can define an operator $T_\lambda : X \to Y$ as

$$(T_\lambda f)(z) = \sum_{n=0}^{\infty} \lambda_n a_n z^n.$$

The sequence $\{\lambda_n\}_{n=0}^{\infty}$ is said to be a coefficient multiplier from X into Y. The set of multipliers from X to Y is denoted by (X, Y). In this article we characterize the coefficient multipliers from Dirichlet type spaces to Hardy spaces and weighted Berman spaces for certain ranges of parameters using the Gaussian Hypergeometric Function ${}_2F_1(a, b; c; z)$.

Keywords:
Hypergeometric functions; Coefficient multipliers; Dirichlet spaces; Bergman spaces; Hardy spaces.

AMS Mathematics Subject Classification 2020:
33C05, 44A35, 42A45, 30H20, 30H10

Generalized Cesàro operators on the spaces of Cauchy transforms

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Abstract

Let D be the unit disk in the complex plane, $H(D)$ be the class of analytic functions on D. Let $M(T)$ be the space of all finite complex valued Borel measures on the unit circle $T = [0, 2\pi]$ and $M(T)$ equipped with the total variation norm $\|\mu\|$ is a Banach space. A function $f \in H(D)$ belongs to the space of Cauchy transforms K if there exists $\mu \in M(T)$ such that

$$f(z) = \int_0^{2\pi} \frac{1}{1 - e^{i\theta} z} d\mu(\theta), \qquad z \in D.$$

The space K is a Banach space under the norm

$$\|f\|_K = \inf\{\|\mu\| : \mu \in M(T)\}.$$

For $\alpha > 0$ let K_α be the space of all $f \in H(D)$ that can be represented as

$$f(z) = \int_0^{2\pi} \frac{1}{(1 - e^{i\theta} z)^\alpha} d\mu(\theta), \qquad z \in D,$$

for some $\mu \in M(T)$. The spaces K_α are Banach spaces under the norm

$$\|f\|_{K_\alpha} = \inf\{\|\mu\| : \mu \in M(T)\}.$$

The generalized Cesàro operators denoted by $\mathcal{P}^{b,c}$ are defined as

$$\mathcal{P}^{b,c} f(z) = \sum_{n=0}^{\infty} \left(\frac{1}{A_n^{b+1;c}} \sum_{k=0}^{n} b_{n-k} a_k \right) z^n,$$

where

$$A_k^{b;c} = \frac{(b,k)}{(c,k)},$$

and b_k is given by $b_0 = 1$, and for $k \geq 1$,

$$\frac{1+b-c}{c} A_{k-1}^{b+1;c+1} = \frac{1+b-c}{b} A_k^{b;c}.$$

In this paper we study the two parameter family of generalized Cesàro operators $\mathcal{P}^{b,c}$ on the space of Cauchy transform K.

Keywords:
Gaussian hypergeometric function; Boundedness; Spaces of Cauchy transform.

AMS Mathematics Subject Classification 2020:
33C05, 30E20, 46E15, 47B38

Operator pseudo shifts as a direct sum of backward shifts, circulant operators and bilateral shifts

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Abstract

We consider an operator weighted pseudo shift T_φ defined on the space $l^2_+(K)$, induced by an injective map φ on the set of non negative integers N_0. The operator weights involved here are a sequence of bounded linear operators on a Hilbert space K and are positive invertible. The operators are defined in such a way that they have a diagonal matrix representation with respect to the standard basis e_i of K. We then show that T_φ defined in this manner can be identified with a direct sum of copies of unilateral (backward) operator weighted shifts, circulant operators and bilateral operator weighted shifts.

Keywords:
Pseudo shift operator; Hilbert space; Orthonormal basis; Invertible weights.

AMS Mathematics Subject Classification 2020:
(Primary) 47B37, 47A15

Higher-order compact simulation of forced convection around a heated circular cylinder

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Abstract

A temporally third order accurate and spatially second order accurate Padé based finite difference compact scheme has been formulated to simulate the forced convection around a heated circular cylinder. The discretization can handle nonuniformity in polar coordinates without any domain transformation. The scheme developed here combines the advantages of body-fitted mesh with grid clustering, thereby making it efficient to capture flow gradients on polar grids. The scheme is validated by capturing the transient Gaussian pulse governed by the convection-diffusion equation. The computations for forced convection around a circular cylinder have been carried out for Re values ranging from 10 to 300. Robustness of the study has been portrayed by the efficient capture of von Kárḿan vortex street for periodic flow. Novelty of the work is to employ a transformation free compact scheme which can handle nonuniformity in both radial as well as tangential direction to study both flow and heat transfer around a circular cylinder. The results obtained in this study are analyzed and compared with the well-established numerical and experimental data wherever available in the literature. The newly developed scheme is found to generate accurate solutions in each case.

Keywords:
HOC scheme; Finite difference; Nonuniform grid; Boussinesq equations; Von Kármán vortex street.

AMS Mathematics Subject Classification 2020:
76M20

Mathematical modelling of rheology of Memang Narang (Citrus Indica) juice through a cylindrical pipe by power-law fluid model

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Abstract

This study focuses on the flow behaviour of Memang Narang (Citrus Indica) juice through a cylindrical pipe, with a particular emphasis on its rheological properties. Experimental data on the juice's flow parameters are collected using rheometer ARES-G2 at various temperatures and fitted to the Power-law fluid model. The fluid guided governing equations in cylindrical coordinate system are obtained considering appropriate flow assumptions. The expression of velocity, volumetric rate of flow, average velocity, maximum velocity and friction factor are obtained analytically. The velocity profile for different values of consistency coefficient and flow index are plotted with the help of MATLAB programming code to study the flow pattern. The influence of rheological flow parameters on the velocity, volumetric flow rate, average velocity and friction factor are analyzed from graphs. The study examines how rheological parameters influence the flow characteristics, providing insights for designing and evaluating juice transportation systems.

Keywords:
Rheology; Memang Narang Juice; Power-law fluid; Consistency coefficient; Flow index.

AMS Mathematics Subject Classification 2020:
76A99, 76D99, 76Z99

Impact of predator induced fear in a delayed predator prey system incorporating migration

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(Joint work with Hemanta Kumar Sarmah)

Abstract

The examination of how behavioral patterns affect the ecological dynamics that precede infection in prey species is a crucial component of epidemiological and ecological research. This forces us to think about the dynamics of the predator-prey scenario in which the prey is infected. The entire population is separated into three groups: susceptible prey, infected prey, and predator. Predator-dependent functional response is used to describe the predation rate. Predation fear in susceptible prey, along with migration in both species, are incorporated. Since disease transmission is not instantaneous, a delay term is also included in the system for a susceptible prey population to be infected. The positivity and boundedness of the solutions of the non-delay model are assured. To study the dynamics of the non-delay model, we have analyzed the local as well as global stability. Additionally, the occurrence of Hopf bifurcation in the non-delay model is explored. The local stability conditions for the delayed model are discussed after linearization. Using the delay term as the bifurcation parameter, the Hopf bifurcation is investigated. Finally, the numerical simulations for validating our theoretical findings are performed.

Keywords:
Eco-epidemiology; Fear effect; Migration; Stability; Delay; Hopf bifurcation.

AMS Mathematics Subject Classification 2020:
34K18, 37M10, 37N25

Some applications of the order of entire functions to entire functions that share a value with two difference operators

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Abstract

In this work, we explore some applications of the order of entire functions to entire functions that share a value with two difference operators. In this case, we find that f can be written in a special form. Here, we say that two entire functions $f(z)$ and $g(z)$ share a value CM if $f(z)-a$ and $g(z)-a$ have the same zeros with same multiplicities.

Keywords:
Uniqueness; Entire functions; Difference operators.

AMS Mathematics Subject Classification 2020:
30D35, 39A45

Generalizations and refinements of numerical radius inequalities for bounded linear operators on Hilbert spaces

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Abstract

Mathematical inequalities play a pivotal role in advancing both pure and applied mathematics, providing powerful tools for estimating solutions to practical problems in engineering and scientific disciplines. Among these, numerical radius inequalities have garnered considerable attention in functional analysis due to their critical applications in operator theory and numerical analysis. In this paper, we present generalizations and refinements of lower bounds for the numerical radius of bounded linear operators on complex Hilbert spaces, significantly improving upon existing results. Utilizing these refined bounds, we further derive novel upper bounds for the numerical radius of operator commutators. These findings enrich the theoretical framework of operator inequalities and offer sharper analytical tools for studying the behavior of operators in Hilbert spaces.

Keywords:
Numerical radius; Operator norm; Inequalities; Cartesian decomposition.

AMS Mathematics Subject Classification 2020:
47A12, 47A30

Uniqueness of meromorphic functions with deficient values

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Abstract

In this work, we prove a uniqueness theorem concerning meromorphic functions that share a value counting multiplicities (CM) with their derivatives. Using Nevanlinna theory, we establish sufficient conditions under which the meromorphic function is uniquely determined by its relationship with its derivative. Our approach relies on the deficient values of the function.

Keywords:
Meromorphic functions; Uniqueness; Deficiency.

AMS Mathematics Subject Classification 2020:
30D35

Some characterizations of convex functions

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Abstract

In the following work, we will establish another characterization for convex functions under special conditions. Also, we will provide some results about the h-convexity of these functions where we suppose that our intervals are closed.

Keywords:
Convex function; h-Convex function; Smooth function.

AMS Mathematics Subject Classification 2020:
26A51, 52A41, 26E25

Elliptic nonlinear problem with singular right-hand side in anisotropic case.

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Abstract

We investigate the existence results of anisotropic elliptic equations with a singular lower order term exhibiting natural growth with respect to the gradient. The model problem we consider is

$$\begin{cases} -\sum_{i=1}^{d}\left[|u_{x_i}|^{p_i-2}u_{x_i}\right]_{x_i} = \sum_{i=1}^{d}\dfrac{|u_{x_i}|^{p_i-1}}{u^{\theta}} + f & \text{in } \Omega, \\ u = 0 & \text{on } \partial\Omega, \end{cases} \tag{1}$$

where $0<\theta<1$, $\Omega \subset R^N (N \geq 2)$, is a bounded domain, $2 \leq p_1 \leq p_2 \leq \ldots \leq p_d$. Our main study is about the existence and regularity results of this problem, where f is a positive function (i.e., $f(x) \geq 0$ and not zero almost everywhere) belonging to $L^m(\Omega)$ $(m \geq 1)$, $0 \leq \theta < 1$, and r, p_i satisfies the following conditions for all $i = 1, \ldots, N$:

$$2 \leq p_1 \leq p_2 \leq ... \leq p_{N-1} \leq p_N \quad \text{and} \quad 2 \leq \overline{p} < N, \tag{2}$$

where $\overline{p}$ is the harmonic mean of p_i.

The anisotropic Sobolev spaces $W^{1,\overrightarrow{p}}(\Omega)$ and $W_0^{1,\overrightarrow{p}}(\Omega)$ offer the suitable functional setting for tackling Problem 01.

Let Ω be an open bounded domain in R^N, where $N \geq 2$, and let the vector $\overrightarrow{p} = (p_1, p_2, \ldots, p_N)$. The anisotropic Sobolev spaces are defined as follows

$$W^{1,\overrightarrow{p}}(\Omega) = \left\{ w \in W^{1,1}(\Omega) : \; w_{x_i} \in L^{p_i}(\Omega), \; \forall i = 1, \ldots, d \right\},$$

and $W_0^{1,\overrightarrow{p}}(\Omega)$ can also be defined as the closure of $\mathcal{C}_0^\infty(\Omega)$ in $W^{1,\overrightarrow{p}}(\Omega)$

$$W_0^{1,\overrightarrow{p}}(\Omega) = \left\{ w \in W_0^{1,1}(\Omega) : \ w_{x_i} \in L^{p_i}(\Omega), \ \forall i = 1, \ldots, d \right\},$$

with respect to the norm

$$\|w\|_{1,\overrightarrow{p}} = \sum_{i=1}^{d} \|w_{x_i}\|_{L^{p_i}(\Omega)}.$$

Keywords:
Anisotropic elliptic problem; Singular gradient lower order term; L^m data; Harnack inequality; Comparison principle.
AMS Mathematics Subject Classification 2020:
35J60, 35J70, 35B45, 35D30, 35B65

An efficient interior-point algorithm for linearly constrained convex optimization

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(Joint work with Djamel Benterki)

Abstract

We introduce a new primal-dual interior-point algorithm for linearly constrained convex optimization (LCCO) with a full-Newton step. The proposed method is based on a new reformulation of the nonlinear equation of the system that defines the central path. We demonstrate that the presented method efficiently solves the LCCO problems in polynomial time. Notably, the short-step algorithm achieves the best-known iteration bound. Moreover, some numerical experiments are presented to support our theoretical results.

Keywords:
Convex programming; Interior-point methods; Primal-dual algorithm; Descent direction.

AMS Mathematics Subject Classification 2020:
90C20, 90C51

Comparative analysis of kernel functions for primal-dual interior-point methods in convex quadratic programming

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Abstract

In this study, we introduce various parameterized kernel functions with a logarithmic barrier term. Then, using some simple analytic tools, we provide a primal-dual interior-point method (IPM) for the convex quadratic programming problem employing these kernel functions. We determine the complexity bound for large-update algorithms. By varying the parameter values, we may achieve the best known iteration bounds for large-update algorithms, which are $O\left(\sqrt{n}\log n\log\frac{n}{\epsilon}\right)$. Our technique yields numerical data that demonstrate the performance of the suggested kernel functions.

Keywords:
Kernel function; Convex quadratic programming; Interior-point method; Primal-dual method; Large-update method.

AMS Mathematics Subject Classification 2020:
90C20, 90C51, 49M15

Existence and uniqueness solutions of parabolic chemotaxis model perturbed with Gaussian process

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Abstract

In this present article, we consider stochastic chemotaxis KellerSegel model impact by gaussian process. First, we study the local existence in time of nonlinear stochastic Keller-Segel model with zero Dirichlet boundary conditions and then we add conditions to prove that the local solution is a global solution, for this we use analysis techniques lemmas and semigroup theory.

Keywords:
Stochastic Keller-Segel model; Space-time white noise; Chemotaxis; Gaussian process.

AMS Mathematics Subject Classification 2020:
92C17, 35K58, 82C22

Full-Newton step feasible interior-point algorithm for a class of linear complementarity problems

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Abstract

In this paper, a full-Newton step feasible interior-point algorithm is proposed for solving $P_*(\kappa)$-linear complementarity problems. We prove that the full-Newton step to the central path is local quadratically convergent and the proposed algorithm has polynomial iteration complexity, namely, $O\left((1+4\kappa)\sqrt{n}log\frac{n}{\epsilon}\right)$, which matches the currently best known iteration bound for $P_*(\kappa)$-linear complementarity problems. Some preliminary numerical results are provided to demonstrate the computational performance of the proposed algorithm. The paper generalizes the results from monotone LCP to $P_*(\kappa)$-LCPs. However, the analysis of the proposed algorithm is more complicated than in the monotone LCP case.

Keywords:
Interior-point algorithms ; $P_*(\kappa)$-linear complementarity problems; Full-Newton step ; Polynomial complexity.

AMS Mathematics Subject Classification 2020:
90C33, 90C51

Primal-dual interior-point algorithm for SDLCP based on a kernel function with a new barrier term

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Abstract

In our work, a large-update primal-dual interior-point algorithm for monotone semidefinite linear complementarity problems is proposed. The complexity analysis of this algorithm is based on a parametric kernel function . By means of this parametric kernel function, the currently best known iteration bounds for large- update methods is established. Some computational results have been provided.

Keywords:
Semidefinite linear complementarity; Kernel function; Interior-point methods.

AMS Mathematics Subject Classification 2020:
90C22, 90C25, 90C51

Contribution to the resolution of the 0/1 bicriteria knapsack problem

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Abstract

The knapsack problem is a well-known combinatorial optimization problem with a wide range of real-world applications. In this work, we specifically focus on the 0/1 knapsack problem with two distinct criteria, referred to as $BOKP$. To solve this problem, we propose an innovative approach aimed at computing all efficient solutions. The $BOKP$ is first formulated as a directed acyclic network, thus providing a structured framework for analysis. Finding efficient solutions in this context involves identifying efficient paths that connect a designated starting node to an ending node in the network. To achieve this, we use some node selection and removal conditions combined with intelligent comparisons between different paths within the graph.

Keywords:
Optimization; Two criteria knapsack problem; Efficient solutions; Network; Efficient path.

AMS Mathematics Subject Classification 2020:
90C05, 90C27, 90C35.

New stability result for a linear porous system with microtemperatures effects only

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Abstract

In this paper, we study a porous-elastic system with dissipation only due to microtemperatures effects. We introduce a new stability number and prove that the unique dissipation due to the microtemperatures is strong enough to drive the system to the equilibrium state in an exponential manner. This result is new and improves previous results in the literature. In recent years a great effort has been developed to obtain exponential stability of solutions in classical thermoelasticity and numerous stability results have been established. Our aim in this work is to investigate a linear porous system, prove the well posedness and establish an exponential result in the energy norm depending on the following parameters by using the multiplier method.

Keywords:
Energy method; Exponential decay; Lyapunov functional; Porous system, Microtemperatures effects.

AMS Mathematics Subject Classification 2020:
435B7, 35L55, 74D05, 93D15

Asymptotic behavior and numerical tests of some evolution problems with thermal effect and delay

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Abstract

In the presentation, we focus on a one-dimensional initial-boundary value problem of a thermoelastic piezoelectric beam in the presence of magnetic effects with distributed delay. The well-posedness of the system is initially demonstrated by applying semigroup theory. Also, based on the construction of a Lyapunov functional, which is equivalent to the energy functional of the problem through multiplier techniques, we show that a unique dissipation through frictional damping is strong enough to ensure exponential stabilization of the system. Next, the results are compared to those of quasi-static approaches or the electrostatic. Our results are related to the distributed delay weights. Finally, we give some numerical tests to illustrate the theoretical result.

Keywords:
Magnetic effect; Thermal effect; Distributed delay term; Semigroup theory; Well-posedness; Exponential stability.

AMS Mathematics Subject Classification 2020:
35Q60, 35B35, 35B40

Pseudo symmetric Riemannian manifolds

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Abstract

A model geometry of Thurston the 4-dimension (G, X) is a connected and simply connected manifold X with a Lie group G acting transitively on X by compact stabilizers, such that G maximal and there exists a manifold Y of finite volume modeled by (G, X). R. O. Filipkiewicz has classified the 4-dimensional Thurston geometries that symmetric and non-symmetric spaces. S. Maier has studied the conformal flatness of Thurston geometries. A Riemannian manifold (M, g) is said to be locally symmetric if the Riemann curvature tensor R is parallel $\bigtriangledown R = 0$. A Riemannian manifold (M, g) is semi-symmetric if $R(X, Y).R = 0$. A Riemannian manifold (M, g) is said to be pseudo symmetric, in the sense of Deszcz, if there exists a function L_R such that $R(X, Y).R = L_R((X \wedge Y).R)$. Let (Nil^4, g) be 4-dimensional non symmetric Thurston geometry, where

$$g = {\theta_1}^2 + {\theta_2}^2 + {\theta_3}^2 + {\theta_4}^2$$

We prove that (Nil^4, g) is not pseudo-symmetric, neither Ricci pseudo-symmetric nor Weyl pseudo-symmetric

Keywords:
Pseudo-symmetric; Ricci pseudo-symmetric; Weyl pseudo-Symmetric; Lie group (Nil^4, g).

AMS Mathematics Subject Classification 2020:
31C12

Well-posedness and energy estimates for elastodynamic system with internal/boundary dissipation and dynamic boundary conditions

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Abstract

In this work, we deal with the elastodynamic system with localized/boundary damping and dynamic Wentzell boundary conditions. We first use the standard semigroup theory to prove the well-posedness result of the system, and the asymptotic behaviour is obtained by making use of the multiplier technique combined with integral inequalities and some geometrical assumptions imposed on Ω.

Keywords:
Elastodynamic system; Wentzell conditions; Uniform stabilization; Internal and boundary damping.

AMS Mathematics Subject Classification 2020:
35Q60, 93D15, 93C20

Existence results and exponential decay rate for coupled problem without internal damping and non ordinary boundary conditions

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Abstract

In this paper, we investigate the existence, uniqueness, and uniform stabilization of a thermoelastic system governed by dynamic Wentzell boundary conditions. We establish well-posedness by employing semigroup theory and demonstrate that the energy of the system decays uniformly over time. The analysis utilizes a novel multiplier technique to derive energy estimates, considering only feedback mechanisms at the boundary. Our results extend previous findings in the context of mixed boundary conditions and contribute to the understanding of stabilization phenomena in thermoelastic systems.

Keywords:
Thermoelastic system; Wentzell boundary condition; Semigroup theory.

AMS Mathematics Subject Classification 2020:
28C10

Numerical study of forced and mixed convection in a Taylor-Couette system under differential heating

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Abstract

This study presents a numerical investigation of the onset of instabilities in a Taylor-Couette system subjected to radial differential heating. The fluid confined in the annular region is considered Newtonian and incompressible, with thermo-dependent physical properties. The primary objective is to enhance the understanding of instability mechanisms by identifying the critical Reynolds numbers for two configurations: horizontal ($\alpha = 0°$) and vertical ($\alpha = 90°$). This aims to optimize the positioning of industrial heat systems involving rotational flows. A second-order spatiotemporal discretization is employed, and the finite volume method is used to solve the conservation equations for mass, momentum, and energy, along with their boundary conditions. The model incorporates buoyancy effects through the Boussinesq approximation, allowing the evaluation of differential heating's impact on the formation of convective cells and flow regimes. The results reveal that the inclination angle α has no effect on the velocity field during forced convection. However, buoyancy forces influence both the velocity and temperature fields. From a thermal perspective, the horizontal configuration is preferable, as it ensures greater dynamic and thermal stability.

Keywords:
Instability; Finite volume method; Taylor vortex flow; Differential heating; Mixed convection.

AMS Mathematics Subject Classification 2020:
20E45, 94A60

Fractional differential inclusions and their applications

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Abstract

We investigate the presence of Cauto-Hadamart derivative solutions to a non-local fractional integral (nfi) issue involving the Langevin model fractional differential inclusion (fdi) requirements. We discuss valued right-hand sides that are both convex and non-convex.

Keywords:
Random fractional differential equation; Hadamard fractional differential equation; Fixed point; Vector metric space.

AMS Mathematics Subject Classification 2020:
34A08, 47B80, 34F05

New existence results for Caputo-fractional differential equation with two integral boundary conditions in Banach space

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Abstract

We introduce an existence result for a Caputo fractional boundary value problem with two integral boundary conditions in Banach space by applying Mönch's fixed point theorem and the technique of measure of noncompactness. In this study, we analyze a sufficient conditions for the existence of solutions for the following boundary-value problem for a Caputo-fractional differential equa- tions with integral boundary conditions.

$$C_{D^\alpha}x(t) + f(t, x(t)) = 0 t \in J = [0, 1], \alpha > 3 \quad (1)$$

$$x^{(j)}(0) = 0, j \in 0, 1, \ldots, n-1 \setminus j_1, j_2, n = [\alpha] + 1 \quad (2)$$

$$a_k x^{(qk)}(1) = I^{pk}x(1), (a_k, p_k) \in R \times N, 0 < a_k, 1 < p_k, k = 1, 2. \quad (3)$$

Where C_{D^α} is the Caputo fractional derivative of order $\alpha, f : J \times E \to E$ is a given function, E is a Banach space.

Keywords:
Banach space; Boundary value problem; Caputo-fractional derivative; Measure of non- compactness; MöNch's fixed point theorem.

AMS Mathematics Subject Classification 2020:
34A08

Efficient collocation technique for fractional differential equations

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Abstract

Addressing real-world problems through applied mathematics often involves solving equations that model complex phenomena. In recent years, fractional differential equations have gained significant attention across various disciplines. Due to the inherent complexity of such equations in practical applications, numerical methods have become indispensable for their analysis. This study focuses on the numerical solution of fractional differential equations, where the fractional derivative is defined in the Caputo sense. The proposed methodology employs the collocation method, utilizing generalized Lucas polynomials as basis functions to construct the approximate solution. By doing so, the original problem is reformulated into a more manageable algebraic system, enabling efficient computation. To validate this approach, we present several examples and compare the performance of generalized Lucas polynomials with other polynomial families related to the Lucas series. The results underline the method's effectiveness and demonstrate the advantages of using generalized Lucas polynomials for numerical approximation in the context of fractional differential equations.

Keywords:
Fractional differential equations; Caputo fractional derivative; Generalized Lucas polynomials; Collocation method.

AMS Mathematics Subject Classification 2020:
26A33, 34A08, 65N35

A mild solution to a fractional differential equation driven by a fractional Brownian motion

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Abstract

The main goal of this work is to prove the existence of mild solution for fractional stochastic impulsive differential inclusions driven by fractional Brownian motion in a separable Hilbert space of the form

$$\begin{cases} {}^{c}D_t^{\alpha} y(t) \in Ay(t) + F(t, y_t) + G(t)\frac{dB_Q^H(t)}{dt}, t \in [0,b], t \neq t_k, k = 1, \ldots, m \\ y(t_k^+) - y(t_k^-) = I_k(y(t_k^-)), \quad k = 1, 2, \ldots, m. \\ y(t) = \varphi(t), \quad t \in [-r, 0], \end{cases}$$

where ${}^{C}D_t^{\alpha}$ denotes the Caputo derivative of order $\alpha \in (\frac{1}{2}, 1)$, $A : D(A) \subset \mathcal{H} \to \mathcal{H}$ is the infinitesimal generator of a strongly continuous semigroup of a bounded linear operators $\{S(t)\}_{t\geq 0}$ on a separable Hilbert space $\mathcal{H}$. B_Q^H with $H \in (\frac{1}{2}, 1)$ is a fBm with respect to a complete probability space $(\Omega, \mathcal{F}, \mathcal{F}_t, P)$ defined on a separable Hilbert space $\mathcal{K}$. $y(t_k^+)$ and $y(t_k^-)$ exist and denote the left and the right limits of $y(t)$ at $t = t_k$, respectively, with $y(t_k^-) = y(t_k)$. $F : J \times \mathcal{B} \to \mathcal{P}(\mathcal{H})$, $G : J \to L_Q^0(\mathcal{K}, \mathcal{H})$, $I_k \in C(\mathcal{H}; \mathcal{H})$ are the impulsive functions and $y_t \in \mathcal{B}$ where $y_t(\theta) = y(t + \theta)$, $t \in [0, b], \theta \in (-\infty, 0]$. Here $\mathcal{B}$ is the space of all functions mapping from $(-\infty, 0]$ to $\mathcal{H}$ and $L_Q^0(\mathcal{K}, \mathcal{H})$ denotes the space of all Q Hilbert-Schmidt operators from $\mathcal{K}$ into $\mathcal{H}$. Our tools are based on fractional calculus, where a solution to the Caputo fractional derivative equations is defined, and on stochastic analysis techniques applied to the stochastic term. By using the fixed-point theorem for condensing multi-valued maps, with the Kuratowski measure of non-compactness, the existence result is obtained.

Keywords:
Fractional calculus; Semigroup; Impulsive stochastic differential inclusions; Fixed point theorem.

AMS Mathematics Subject Classification 2020:
26A33, 34K50, 60H20

Reliable numerical method for solving certain class of non-singular boundary value problems

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Abstract

In this study, an efficient analytical tool is developed to investigate the approximate solution of fuzzy fractional differential equations based on the Caputo Fabrizio fuzzy fractional derivative. The proposed technique depends on the reproducing kernel Hilbert space method. The methodology relies on constructing a fractional crisp system in convergent form under strongly generalized differentiability. Parametric characterizing of solutions is obtained by switching the Caputo Fabrizio fuzzy fractional differential equation into equivalent crisp system of Caputo Fabrizio fractional differential equations. This adaptive can be used as an alternative technique in solving many uncertain problems arising in different fields of engineering, chemistry, and biology. The effectiveness and validity of the method are illustrated by checking a numerical example.

Keywords:
Fuzzy fractional BVPs; Reproducing kernel Hilbert space; Caputo–Fabrizio derivative; Numerical solvability; Error analysis.

AMS Mathematics Subject Classification 2020:
47B32, 26A33, 34A08

Study the asymptotic behavior of solutions for time-fractional Oldroyd-B fluid equations with generalized fractional derivatives

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Abstract

The past thirty years or so have seen a significant increase in popularity and importance for the field of fractional calculus. The origins of fractional calculus can be traced back to a question posed by the Marquis de L'Hopital to Gottfried Wilhelm Leibniz in 1695 [A.A. Kilbas, H.M. Srivastava, J.J. Trujillo. *Theory and applications of fractional differential equations*. Elsevier, 2006]. In the present work, we improve and generalize the results in [V. V. Tri. Existence of an initial value problem for time-fractional Oldroyd-B fluid equation using Banach fixed point theorem. *Adv. Theory Nonlinear Anal. Appl*, **5** (4): 523–530, 2021]. In other words, we consider the following problem

$$\begin{cases} \left(1+a\partial_g^{\alpha}\right)u_t(x,t)=\mu\left(1+b\partial_g^{\beta}\right)\Delta u(x,t)+F\left(x,t,u(x,t)\right), \\ x\in\mathcal{D},\ d<t\leq T, \\ u(x,t)=0,\ \ (x,t)\in\partial\mathcal{D}\times(d,T), \\ u(x,d)=u_d(x),\ I_g^{1-\alpha}u_t(x,d)=0,\ x\in\mathcal{D}, \end{cases} \tag{3}$$

where $T>0$ be a fixed time, $0<\alpha<\beta<1$, $a,b,d\geq 0$ and $\mu>0$ be given constant parameters. The key contribution in this work is that we study the existence and uniqueness of solutions for time-fractional Oldroyd-B fluid equations with generalized fractional derivatives. We distinguish two cases. Firstly, for the linear case, we get regularity results under some hypotheses of the source function and the initial data. Secondly, for the nonlinear case, we use the Banach fixed point theorem to obtain the existence and uniqueness of solutions.

Keywords:
Time-fractional Oldroyd-B Fluid Equations; Regularity; Banach fixed point theorem.

AMS Mathematics Subject Classification 2020:
35R11, 35B65, 26A33

On the semi-Cayley graphs

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Abstract

Let G be a group with the identity element e and S be a non-empty subset of G such that $S^{-1} = S$ and $e \notin S$. The Cayley graph of G with respect to S, denoted by $\mathrm{Cay}(G, S)$, is the graph whose vertices are the elements of G and two distinct vertices g and h are adjacent if and only if $gh^{-1} \in S$. There are several generalizations of Cayley graphs. One of them is the semi-Cayley graph. Let S_1, S_2 and S_3 be three subsets of G such that $S_1^{-1} = S_1$ and $S_2^{-1} = S_2$ and $e \notin S_1 \cup S_2$. The Semi-Cayley graph over G with respect to S_1, S_2 and S_3, denoted by $\mathrm{BC}(G, S_1, S_2, S_3)$, is defined as an undirected graph with vertex set $G \times \{0, 1\}$ and two distinct vertices (h, i) and (g, j) are adjacent if and only if one of the following holds: (1) $i = j = 0$ and $gh^{-1} \in S_1$, (2) $i = j = 1$ and $gh^{-1} \in S_2$, (3) $i = 0, j = 1$ and $gh^{-1} \in S_3$. Let R be a commutative ring with non-zero identity and R^+ and $Z^*(R)$ be the additive group and the set of all non-zero zero-divisors of R, respectively. In this paper, we study some basic properties of the semi-Cayley graph $\mathrm{BC}(R^+, Z^*(R), Z^*(R), \{0\})$.

Keywords:
Cayley graph; Semi-Cayley graph; Group; Commutative ring; Zero-divisor.

AMS Mathematics Subject Classification 2020:
05C25, 05C10

New Public Key Cryptosystem Using the Isomorphism Problem on Matrix Representations of Önite Groups

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Abstract

This paper presents an innovative public key cryptosystem built upon the isomorphism problem on matrix representations of finite groups. We describe the theoretical foundation of this cryptosystem, provide detailed example, and analyze its security based on the computational hardness of the isomorphic representations problem.

Keywords:
Public Key Cryptography; Group Theory; Space Representations; Cryptanalysis.

AMS Mathematics Subject Classification 2020:
11T71

An innovative version of the McEliece cryptosystem based on Fibonacci codes

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Abstract

McEliece invented the first encryption system based on the algebraic theory of codes. In these cryptosystems, the public key is the generating matrix of a linear code. Efforts have been made to reduce the size of this key using various methods. At present, various strategies have been suggested by adjusting the structure of the Goppa code such as Reed Muller codes, LDPC codes, convolutional codes etc. Our proposed scheme is based on Fibonacci codes. Our system has the advantage of being resistant to attacks based on hollow matrices. It also reduces the size of the keys.

Keywords:
McEliece cryptosystem; Fibonacci number; Algorithm; Complexity.

AMS Mathematics Subject Classification 2020:
05A10, 05A17, 11B39, 14G50

A theoretical study of elliptic curve on a special finite ring

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Abstract

Let F_3^d be a finite field of order 3^d with $d \in N^*$. In this paper, we study the elliptic curve over the finite ring $F_3^d[\epsilon] := F_3^d[X]/(X^4 - X^3)$, where $\epsilon^4 = \epsilon^3$ of characteristic 3 given by the homogeneous Weierstrass equation of the form: $Y^2Z = X^3 + aX^2Z + bZ^3$, where $a, b \in F_3^d[\epsilon]$. Such that we study the arithmetic operations of this ring and define the elliptic curve over it. Next, we show that $E_{\pi 0(a),\pi 0(b)}(F_3^d)$ and $E_{\pi 1(a),\pi 1(b)}(F_3^d)$ are two elliptic curves over the finite field F_3^d, such that $\pi 0$ is a canonical projection and $\pi 1$ is a sum projection of coordinate of element in $F_3^d[\epsilon]$, and we conclude by given a classification of elements in elliptic curve over the finite ring $F_3^d[\epsilon]$.

Keywords:
Elliptic curve; Finite ring; Finite field; Weierstrass equation.

AMS Mathematics Subject Classification 2020:
11H52, 11T55, 14D99, 14G99

On the ring-index of comaximal graphs

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Abstract

Let G be a graph with n vertices and m edges. The free rank of G, denoted by $frank(G)$, is the number of primitive cycles of G. Also, the number $rank(G) = m-n+r$, where r is the number of connected components of G, is called the cycle rank of G. These two numbers satisfy the inequality $rank(G)$ is less or equal to $frank(G)$. Furthermore, it was shown that the family of ring graphs are the family of graphs where the equality occurs.
Given a graph G, we denote the kth iterated line graph of G by $L^k(G)$. In particular $L^0(G) = G$ and $L^1(G) = L(G)$ is the line graph of G. The ring index of a graph G, denoted by $\zeta(G)$, was defined as the smallest k such that $L^k(G)$ is not a ring graph. If $L^k(G)$ is ring graph for all k, we define $\zeta(G) = \infty$.
The Comaximal graph of a commutative ring R, denoted by $\Gamma(R)$, is a simple graph with all elements of R as its vertices and two distinct vertices a and b are adjacent if and only if $aR+bR = R$. In this paper, we study the ring index of the Comaximal graphs and give a full characterization of these graphs with respect to their ring indices.

Keywords:
Comaximal graph; Ring graph; Ring index; Commutative ring; Iterated line graph.

AMS Mathematics Subject Classification 2020:
05C10, 05C76, 13M05

Inequalities involving energy and Laplacian energy of non-commuting graphs of finite groups

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Abstract

Let G be a finite non-abelian group with center $Z(G)$. The commuting graph of G, denoted by $\Gamma_c(G)$, is a simple undirected graph whose vertex set is $G \setminus Z(G)$, and two distinct vertices a, b are adjacent if and only if $ab = ba$. The complement of this graph is known as non-commuting graph or NC-graph of G and it is denoted by $\Gamma_{nc}(G)$. The study of commuting graphs of finite groups was introduced by Brauer and Fowler in the year 1955. However, the study of non-commuting graphs of finite groups was originated from the work of Erdoos and Neumann in the year 1976. In this paper, we compute spectrum and energy of $\Gamma_{nc}(G)$ for certain classes of finite groups. As a consequence of our results we construct infinite families of integral complete r-partite graphs. We compare energy and Laplacian energy (denoted by $E(\Gamma_{nc}(G))$ and $LE(\Gamma_{nc}(G))$ respectively) of $\Gamma_{nc}(G)$.

Keywords:
Non-commuting graph; Spectrum; Energy; Finite group.

AMS Mathematics Subject Classification 2020:
05C50, 15A18, 05C25

Modeling the dynamics of pathogen transmission from macroalgae to coral

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Abstract

Coral reefs are among the most diverse marine ecosystems but they facing significant threats due to climate change, habitat destruction (competition with macroalgae), and disease outbreaks. This study presents a mathematical model to analyze the transmission dynamics of pathogens associated with macroalgae that impact coral populations. The model integrates process such as macroalgal growth, pathogen release, pathogen decay, and coral infection dynamics to examine the cascading effects on reef eco-system. Through detailed analysis, the study reveals that pathogens released by macroalgae can drive significant coral decline, creating opportunities for macroalgae to dominate reef spaces.The colonization rate of macroalgae on algal turf is detrimental to the coral reef ecosystem affected by the coral disease. The system becomes macroalgae-dominated when the macroalgal immigration on algal turfs becomes high. A coral dominated stable state exists when both the macroalge-mediated FLP growth and disease transmission rate are at low. Even with high levels of macroalgal toxicity affecting corals, a higher grazing rate by herbivores can help maintain a stable coral-dominated state.

Keywords:
Coral; Macroalgae; Turf-algae ; Free-living pathogen; Black band disease.

AMS Mathematics Subject Classification 2020:
92B05, 92D25, 92D40

Scaling and generalized scaling sets on $\mathbb{Q}_p$

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Abstract

I will present MRA theory along with wavelet theory through corresponding sets in $L^2(\mathbb{Q}_p)$. Generalized scaling sets are important in wavelet theory as they determine (multi)wavelet sets. Although, the theory of scaling sets and generalized scaling sets on $\mathbb{R}$ and local fields of positive characteristics are already developed to some extent, but it is yet to be studied on local fields of zero characteristic like $\mathbb{Q}_p$. I will present some necessary conditions for scaling sets with counting formulae for the elements in scaling sets, and characterization of generalized scaling sets with examples.

Keywords:
p-adic number; Scaling set; Multiwavelet set; Generalized scaling set.

AMS Mathematics Subject Classification 2020:
42C40, 43A70, 11F85

Spiral wave dynamics in excitable media

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Abstract

Reaction-diffusion systems support a wealth of complex self-organized patterns, among which one of the well-known patterns is the spiral wave pattern found in excitable media such as heart tissue, chemical reactions, ecological networks, and the brain. The functional role of such patterns in biological systems makes it imperative to better understand the conditions under which they can spontaneously emerge. For example, these patterns have been implicated in the genesis of life-threatening arrhythmias in the heart, while in the brain, they have been thought to provide a spatial framework for cortical oscillations. In the case of cardiac arrhythmias, the evolution of the spiral wave is particularly significant in the heart, where the transition from a stable (periodic) to a meandering (nonperiodic) or drifting tip, and then to a spiral wave breakup, is very similar to the transition from stable to polymorphic electrical arrhythmias and then to fibrillation and sudden cardiac death. The movement of a spiral wave can be studied by tracing the location of the spiral wave tip. Thus, in the present talk, I will briefly discuss the transition of a spiral wave from periodic to non-periodic rotation by studying the motion of a spiral wave tip. Moreover, a brief numerical description of a numerical method to determine the spiral tip location will be discussed.

Keywords:
Excitable media; Spiral waves; Reaction-diffusion model.

AMS Mathematics Subject Classification 2020:
91-10

Interpolation problem: conjectures & new developments

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Abstract

Classical Interpolation problem of estimating new data from a set of known data is well understood under one variable situation. There are modified numerical methods of estimation, even for multiple (but small) variables. In higher dimensional spaces (namely, Projective Space) the main problem is of finding the lowest possible degree of the hyper-surface passing through a given set of points with prescribed multiplicity. To tackle such problems there are some famous conjectures: Chudnovsky's Conjecture (provides the lower bound for the degree of the lowest possible hyper-surface that passes through the given set of points at least once), Demailly's Conjecture (similar to the Chudnovsky's Conjecture, but it captures the multiplicities also), and etc. I will be discussing those conjectures and some recent developments in this area, also some connected well-famous problems associated to interpolation problem.

Keywords:
Demailly's conjecture; Waldschmidt constant; Symbolic powers; Containment problem.

AMS Mathematics Subject Classification 2020:
14N20, 13F20, 14C20

Existence of special pairs of primitive normal elements over finite field

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Abstract

Let $\mathbb{F}_{q^m}$ be the extension of the field $\mathbb{F}_q$ of degree m, where q is power of prime p, i.e., $q = p^k$, where k is a positive integer. We established sufficient condition for the existence of a primitive normal element $\alpha \in \mathbb{F}_{q^m}$ over $\mathbb{F}_q$ such that $\alpha^2+\alpha+1$ is also primitive normal element of $\mathbb{F}_{q^m}$ over $\mathbb{F}_q$. We prove that for the finite field $\mathbb{F}_{q^m}$, for $m \geq 35$ the results hold for $p \geq 11$ and $k \geq 11$.

Keywords:
Finite fields; Primitive elements; Normal elements; Character sums.

AMS Mathematics Subject Classification 2020:
11T30, 11T24

Primitive normal pairs with prescribed traces over finite fields

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Abstract

Let q be a positive integral power of some prime p and $\mathbb{F}_{q^m}$ be a finite field with q^m elements for some $m \in \mathbb{N}$. Here, we establish a sufficient condition for the existence of primitive normal pairs of the type $(\epsilon, f(\epsilon))$ in $\mathbb{F}_{q^m}$ over $\mathbb{F}_q$ with two prescribed traces, $Tr_{\mathbb{F}_{q^m}/\mathbb{F}_q}(\epsilon) = a$ and $Tr_{\mathbb{F}_{q^m}/\mathbb{F}_q}(f(\epsilon)) = b$, where $f(x) \in \mathbb{F}_{q^m}(x)$ is a rational function with some restrictions and $a, b \in \mathbb{F}_q$. Furthermore, for $q = 5^k$, $m \geq 9$ and rational functions with degree sum 4, we explicitly find at most 12 fields in which the desired pair may not exist.

Keywords:
Finite fields; Primitive elements; Additive and multiplicative characters; Normal elements; Trace.

AMS Mathematics Subject Classification 2020:
12E20, 11T23

Construction of permutation polynomials over finite fields with the help of SCR polynomials

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Abstract

In this paper, we take a deeper look at the self conjugate reciprocal (SCR) polynomials, which play a crucial role in constructing new classes of permutation polynomials of simpler forms over $\mathbb{F}_{q^2}$. Our study focuses on the conditions required for certain classes of degree 2 and degree 3 SCR polynomials to have no root in μ_{q+1}, the set of $(q+1)-th$ roots of unity. This investigation aids in identifying polynomials that permute $\mathbb{F}_{q^2}$. Additionally, we examine higher-degree SCR polynomials that can be reduced to degree 2 SCR polynomials over fields of both odd and even order. Furthermore, we explore SCR polynomials of the form $ax^{q+1}+bx^q+bx+a^q$, considering the cases where $a \in \mathbb{F}_q$ and $a \in \mathbb{F}_{q^2} \setminus \mathbb{F}_{q^2}$.

Keywords:
Permutation polynomial; Trinomial; Quadrinomial; Self Conjugate Reciprocal(SCR) polynomial.

Mathematics Subject Classification 2020:
11T06, 11T55

A study on Dextral symmetric algebras

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Abstract

Extending the notion of symmetric rings to possibly non-associative algebras, we introduce dextral symmetric algebras. We derive a complete classification of dextral symmetric Leavitt path algebras as well as right Leibniz algebras up to dimension 4. We also define a weaker notion of nilpotency in Leibniz algebras and obtain its equivalence with solvability in a subclass of finite dimensional dextral symmetric right Leibniz algebra.

Keywords:
Dextral symmetric; Symmetric rings; Leibniz algebra; Solvable Leibniz algebra; Leavitt path algebra.

AMS Mathematics Subject Classification 2020:
17A32, 16S88, 17A01

Exploring nil clean graphs: A novel perspective on ring structures

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Abstract

Rings, as fundamental algebraic structures, have been extensively studied through various lenses. One such approach is the examination of their elements' decomposition into idempotent and nilpotent components, leading to the concept of nil clean elements. In this talk, we introduce the nil clean graph of a ring, where vertices represent ring elements, and two vertices are connected if their sum is nil clean. We studied the properties of nil clean graphs, exploring their connectivity, diameter, and adjacency conditions. Specifically, we discuss key theorems that characterize these graphs for commutative and local rings, highlighting their significance in understanding the underlying algebraic structure. Through examples and visualizations, such as the nil clean graph, we provide insights into the interplay between graph theory and ring theory.

Keywords:
Nil clean rings; Nil clean rings graph.

AMS Mathematics Subject Classification 2020:
05C75, 16N40, 16U99

Existence of solution for impulsive fractional q_r-difference equation of implicit form with nonlocal boundary condition

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(Joint work with Dr. Jayanta Borah and Prof. Bipan Hazarika)

Abstract

This study examines the conditions needed for the existence of solutions to an impulsive fractional q_r-difference equation with the implicit form. The fractional derivative we analyze in the problem is of the Caputo type, which involves a q-shifting operator of the form ${}_a\phi_q(u) = qu + (1-q)a$. Here, nonlocal conditions are the boundary conditions we take into account. Regarding the existence of solutions for the given problem, the result is obtained by means of Krasnoselskii's fixed point theorem. In addition, circumstances required for the Ulam-Hyers and Generalized Ulam-Hyers stability of the impulsive problem are explored. Finally, we provide an example to demonstrate our findings.

Keywords:
Quantum calculus; Implicit; Impulsive fractional q_r-difference equation; Non-local boundary condition; Ulam-Hyers stability.

AMS Mathematics Subject Classification 2020:
39A13, 26A33, 34A37, 34A09, 34B10

Chemically reactive solute diffusion for time-dependent hydromagnetic viscoelastic fluid flow over a stretching porous sheet with suction/blowing

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(Joint work with Prof. (Dr.) Kamal Debnath)

Abstract

This study examines time-dependent hydromagnetic viscoelastic fluid flow with the diffusion of chemically reactive species undergoing a first-order chemical reaction over a stretching porous sheet, incorporating suction or blowing effects and a power-law variation in wall concentration. Viscoelastic fluids are a type of non-Newtonian fluid that exhibit both viscous and elastic characteristics. Walters Liquid (Model B) is used for viscoelastic behaviour. By applying a similarity transformation, the governing partial differential equations are reduced to nonlinear self-similar ordinary differential equations. These equations are then solved using the finite difference method-based solver 'bvp4c'. The results show that increasing the viscoelastic, unsteadiness, and magnetic parameters leads to an enhancement in fluid velocity. Conversely, fluid concentration decreases with higher viscoelastic and magnetic parameters, while the unsteadiness parameter increases the concentration. A rise in the magnetic parameter results in a reduction in velocity and an increase in concentration. As the strength of suction increases, both the momentum and concentration boundary layer thicknesses shrink, whereas blowing has the opposite effect. Additionally, mass transfer from the sheet decreases with higher Schmidt number, reaction rate parameter, and power-law exponent.

Keywords:
Time-dependent flow; Viscoelastic fluid; Stretching sheet; Chemical reaction.

AMS Mathematics Subject Classification 2020:
76A10, 76D99

Hyperchaotic dynamics in a financial system with profit margin and its control: mathematical insights and applications

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Abstract

In this study, we introduce a new factor namely profit margin in a chaotic financial system. This introduction leads the system to a hyperchaotic one. The motivation of doing so is to enhance the practical applicability and realism of financial dynamical system. The modification introduced increases the system's dimensionality, leading it to hyperchaotic one characterized by multiple positive Lyapunov exponents, which reflect the system's heightened sensitivity and complexity. To address the challenges posed by hyperchaos, we investigate effective control strategies, specifically speed feedback control and linear feedback control, to stabilize the system. Numerical simulations are employed to validate the existence of hyperchaotic behavior and to demonstrate the efficacy of the proposed control mechanisms. This work highlights both mathematical theory and real-world applications, providing insights into the dynamic behavior of financial systems. The results have significant implications for financial stability analysis, risk management, and the design of robust financial policies in complex economic environments.

Keywords:
Financial system; Profit margin; Lyapunov exponents; Chaos control; Numerical simulation.

AMS Mathematics Subject Classification 2020:
37D45, 37N40, 37N45, 91B55, 93D15

Analyzing temporal variations in Near Earth Asteroid dynamics through machine learning and N-body integration

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(Joint work with Badam Singh Kushvah, Gunda Chandra Mouli and Saleem Yousuf)

Abstract

Asteroids pose a significant risk to Earth, emphasizing the need for early detection and possible deflection strategies. This study utilizes machine learning (ML) to classify asteroids into Near-Earth Asteroids (Atens, Amors, Apollos, and Apoheles) and Non-Near-Earth Asteroids, further assessing their hazard potential. Seven ML models were trained on a dataset of 4,687 asteroids, achieving high predictive accuracy. Regularization techniques were applied to mitigate overfitting, and model performance was validated using an extensive unseen dataset. Additionally, a 1-million-year N-body integration was conducted using the Mercury integrator to examine the long-term evolution of asteroid orbital properties. The best-performing ML model was subsequently employed to classify asteroids based on orbital and hazard characteristics. The analysis revealed temporal trends, including transitions of initially hazardous asteroids to non-hazardous states and asteroid ejection patterns over time. Graphical representations illustrate these findings, offering valuable insights into asteroid dynamics. The results underscore the potential of ML-driven classification in planetary defense and long-term asteroid monitoring, contributing to future research and protection strategies.

Keywords:
Software: Data Analysis – Celestial Mechanics – Minor Planets, Asteroids: General – Methods: Numerical – Astronomical Data Bases: Miscellaneous

AMS Mathematics Subject Classification 2020:

A method for ranking interval type-2 fuzzy numbers based on their value, ambiguity, fuzziness, and vagueness

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Abstract

Uncertainty appears in real-world problems rather often. Some parameters, such fuzzy numbers, can be considered to avoid this ambiguity. Therefore, the ability to rank fuzzy numbers is essential for clarifying unclear circumstances in real life. An interval type-2 fuzzy number ranking system based on value, ambiguity, fuzziness, and vagueness has been established in this work. The proposed ranking approach is found to have a high discrimination and to rank fuzzy numbers that other current and well-established methods are unable to discern. In contrast to existing methods, there are also some numerical instances that demonstrate significant discrimination power. Also, it appears that the recommended approach performs better in every situation. Further, a real-life application has been done in this study.

Keywords:
Trapezoidal fuzzy numbers (TrFNs); Ranking trapezoidal fuzzy numbers; Value; Ambiguity; Fuzziness; Vagueness.

AMS Mathematics Subject Classification 2020:
62C99, 90B50, 91B06.

On some determinants involving residues and conjectures of Sun

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Abstract

We conclude some properties for the determinant

$$S_{m,k}(d,p) = |(\alpha_i + d\alpha_j)^m|_{1\le i,j\le \frac{p-1}{k}},$$

where p is an odd prime, $d,k,m \in \mathbb{Z}$ and α_i are distinct k-th power residues modulo p. We further investigate the Legendre symbols

$$\left(\frac{\sqrt{S_{1+\frac{p-1}{k},k}(-1,p)}}{p}\right) \text{ and } \left(\frac{\sqrt{S_{3+\frac{p-1}{k},k}(-1,p)}}{p}\right)$$

that concludes some conjectures of Sun as particular cases. Moreover, we investigate the number of primes p such that $p \mid S_{m+\frac{p-1}{k},k}(-1,p)$, and confirm another conjecture of Sun.

Keywords:
Residues; Legendre symbol; Determinants.

AMS Mathematics Subject Classification 2020:
11A07, 11A15, 11C20, 15A15, 15B36, 11R11

Idempotents of $\mathbb{Z}_n$

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Abstract

We know that if there are k distinct prime factors of $n \in \mathbb{N}$, then the ring $\mathbb{Z}_n$ of integers modulo n has exactly 2^k idempotent elements. In this article, we try to describe all the idempotents of $\mathbb{Z}_n$ for any given $n \in \mathbb{N}$.

Keywords:
Ring of integers modulo n; Idempotent element.

AMS Mathematics Subject Classification 2020:
12E20, 11T23

Dynamic interaction of stratifications on unsteady MHD flow across an oscillating vertical permeable plate with periodic temperature variation and exponential mass diffusion

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Abstract

The present study investigates the impacts of both mass and thermal stratification on unsteady magnetohydrodynamic flow past a plate swinging vertically on its own axis while entangled in a porous medium with periodic temperature variation and exponential mass diffusion. The technique of Laplace transform for the unitary Prandtl and Schmidt numbers is employed to obtain the closed form solution for the non-dimensional system of partial differential equations that govern the system for velocity, temperature, and concentration fields. For various physical factors, such as stratification parameters, phase angle, thermal Grashof number, Darcy number, mass Grashof number, and time on velocity, temperature, concentration, skin-friction, plate heat flux, and mass flux, numerical computations have been performed and illustrated in graphs. It has been observed that the steady state is attained more swiftly when stratification is applied to the flow. The desire to enhance the knowledge of fluid flow in many technological as well as environmental circumstances, where such conditions are widely used could be the driving force behind this research. Significant results from the thermal and mass stratification are contrasted with the environment where stratification is absent. Understanding flow mechanisms in both naturally occurring and artificially created environments can be enriched by this innovative method.

Keywords:
MHD flow; Oscillating plate; Unsteady flow; Stratification; Porous medium.

AMS Mathematics Subject Classification 2020:
35Q35, 76D05, 76D50, 76S05, 76W05, 80A20

A study on reliability indices of a single server N-policy queue under Bernoulli vacation subject to server breakdown

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Abstract

This research studies a bulk arrival single-server queueing system that provides two heterogeneous services with an optional re-service, operating under Bernoulli vacation schedule and N-policy while accounting for random breakdowns of the service station. The system reliability function is analyzed using the Laplace-Stieltjes transform, which is applied via the supplementary variable technique. Additionally, the server's mean time to first failure is derived as a key performance measure. An extensive numerical analysis is conducted to demonstrate the proposed model's practicality and relevance, highlighting its potential applications in real-world scenarios.

Keywords:
Bernoulli vacation schedule; Breakdown; Mean time to first failure; N-policy; Reliability function.

AMS Mathematics Subject Classification 2020:
60K25, 90B22, 60K20

Congruences between the coefficients of certain mock theta functions

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Abstract

In this article, we prove several congruences modulo 3, 4, 5, 8, 9, 12, 24, 27, 81, 243, and 729 enjoyed by the coefficients of certain mock theta functions. As an example, for the second order mock theta functions

$$\mu_2(q) := \sum_{n=0}^{\infty} \frac{(-1)^n q^{n^2} \left(q;q^2\right)_n}{\left(-q^2;q^2\right)_n^2} = \sum_{n=0}^{\infty} P_{\mu_2}(n) q^n,$$
$$B_2(q) := \sum_{n=0}^{\infty} \frac{q^{n(n+1)} \left(-q^2;q^2\right)_n}{\left(q;q^2\right)_{n+1}^2} = \sum_{n=0}^{\infty} \frac{q^n \left(-q;q^2\right)_n}{\left(q;q^2\right)_{n+1}} = \sum_{n=0}^{\infty} P_{B_2}(n) q^n,$$

we have

$$P_{\mu_2}(27n+26) \equiv 25 P_{B_2}(108n+103) \pmod{27}$$

for all $n \geq 0$.

Keywords:
Mock theta function; Congruence; q-series; Modular form.

AMS Mathematics Subject Classification 2020:
11P83, 05A17, 05A15

On a finite field analogue of Lauricella hypergeomentric series $F_A^{(n)}$

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Abstract

We develop a finite field analogue for one of the Lauricella series, $F_A^{(n)}$. Extending results of Greene, a finite field analogue for the multinomial coefficient is developed in order to express the Lauricella series in terms of binomial coefficients. We have further deduced certain transformation and reduction formulas for the Lauricella series $F_A^{(n)}$. Finally, we have obtained a number of generating functions for the Lauricella series $F_A^{(n)}$.

Keywords:
Hypergeometric series; Supercongruences; Gamma function.

AMS Mathematics Subject Classification 2020:
11A07, 11D88, 33B15, 33C20

On Ramanujan's continued fractions of order twenty-four

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Abstract

We derive two continued fractions $U(q)$ and $V(q)$ of order twenty-four from a general continued fraction identity of Ramanujan. Some theta-function and modular identities for $U(q)$ and $V(q)$ are established to prove general theorems for the explicit evaluations of $U(\pm q)$ and $V(\pm q)$. From the theta-function identities of $U(q)$ and $V(q)$, some colour partition identities are derived as application to partition theory of integer. Further, we study matching coefficient and vanishing coefficient results for the two continued fractions.

Keywords:
Continued fractions; Ramanujan's theta-function; Explicit value; Colour partition of integer; Matching coefficient; Vanishing coefficient.

AMS Mathematics Subject Classification 2020:
33B70, 11F27, 11A55, 11P84

Some restricted partition functions in terms of 2-adic valuation

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(Joint work with Prof. Nipen Saikia)

Abstract

The 2-adic valuation of an integer n which is the exponent of the highest power of 2 that divides n. In the paper, we give representations of certain restricted partition functions in terms of 2-adic valuation.

Keywords:
2-adic valuation; Restricted partition functions.

AMS Mathematics Subject Classification 2020:
11P82, 11P84, 05A10

Infinite families of congruences for partitions into distinct parts not congruent to 2 modulo 4

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Abstract

Let $\mathcal{D}_{-2,4}(n)$ denote the number of partitions of n into distinct parts not congruent to 2 (mod 4). In this article, we derive several infinite families of congruences for $\mathcal{D}_{-2,4}(n)$ modulo 2 and modulo 8, using generating function manipulations and the theory of Hecke eigenforms. We also prove that the series $\sum_{n=0}^{\infty}\mathcal{D}_{-2,4}(n)(9n+1)qn$ is lacunary modulo 2.

Keywords:
Integer partitions; Ramanujan-type congruences; Modular forms; Hecke eigenforms.

AMS Mathematics Subject Classification 2020:
05A17, 11P83, 11F11, 11F20

On some weak inequalities for integral operators with Oinarov's kernel

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Abstract

Let us consider the integral operator, $\mathcal{I}$ for a non-negative measurable function f on the real line as

$$\mathcal{I}f(t) = h(t)\int_0^t K(t,\tau)f(\tau)w(\tau)d\tau,$$

where h, w are two positive measurable functions on $\mathbb{R}$ and the kernel K, defined on $\{(t,\tau) : 0 \leq \tau \leq t\}$ satisfies Oinarov's condition. In this short talk, we address some weak and extra weak type weighted inequalities for the integral operator in Orlicz space setting.

Keywords:
Weights; Weighted inequalities; Integral operator; Oinarov's kernel.

AMS Mathematics Subject Classification 2020:
42B25, 46E30.

Weighted norm inequalities for one sided vector valued Hardy-Littlewood maximal function on one sided Morrey like spaces

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(Joint work with Prof. Rajib Haloi and Dr. Jayanta Bora)

Abstract

In this presentation, we study the boundedness of one-sided Hardy-Littlewood maximal operator in vector-valued setting on one-sided weighted like Morrey space. We establish Fefferman-Stein's weighted lemma for one-sided Hardy-Littlewood maximal operator considering the one-sided weighted Morrey like space even though the Fefferman-Stein's weighted lemma is not true generally in Morrey space.

Keywords:
One-sided maximal function; One-sided weighted like Morrey space; Weighted norm inequality; Vector-valued inequality.

AMS Mathematics Subject Classification 2020:
42B25, 42B35, 46E30

Banach-type fixed-point theorem in bipolar p-metric spaces

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Abstract

In this current work we present the concept of Banach-type fixed point theorem in bipolar p-metric spaces. We also present the idea of F-contraction in bipolar p-metric spaces. Further we discuss some new results in this area.

Keywords:
p-metric space; Bipolar p-metric space; F-contraction; Banach type fixed point theorem.

AMS Mathematics Subject Classification 2020:
47H10

Fixed points of Geraghty type contraction in S_b-metric spaces

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(Joint work with Yumnam Rohen Singh and Sunil Panday)

Abstract

In this study, the authors verify fixed-point results for Geraghty contractions with a restricted co-domain of the auxiliary function in the context of generalized metric structure, namely the S_b-metric space. This new idea of defining Geraghty contraction for self-operators generalizes a large number of previously published, closely related works on the presence and uniqueness of a fixed point in S_b-metric space. Also, the outcomes are achieved by removing the continuity constraint of self-operators.

Keywords:
S_b-metric space; Fixed point; Geraghty-type contraction.

AMS Mathematics Subject Classification 2020:
58C30

Improvements and generalizations of Ankeny-Rivlin type inequality for higher derivatives of a polynomial

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Abstract

In this paper, we explore the concept of the s^{th} derivative (where $0 \leq s < n$) for a polynomial $p(z)$ of degree n, based on a result from Govil et al. [Illinois J. Math., 23 (1979), 319–329]. Using this result, we derive improved generalizations of the well-known theorem by Ankeny and Rivlin [Pacific J. Math., 5 (1955), 849–852]. Additionally, these advancements lead to refinements of a previous result by Jain [Turk. J. Math., 31 (2007), 89–94]. We compare these new results with Jain's work through a concrete numerical example and analyze them graphically to demonstrate their sharpness.

Keywords:
Polynomial; Maximum modulus; s^{th} derivative; Gauss-Lucas theorem.

AMS Mathematics Subject Classification 2020:
30A10, 30C10, 30C15

On periodic ZIP-INGARCH model

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Abstract

This paper introduces the zero-inflated Poisson integer-valued generalized autoregressive conditional heteroskedastic (ZIP-INARCH) model with periodic coefficients to tackle two key challenges: the zero-inflated nature of count time series and the presence of periodic features in the autocorrelation function. The study thoroughly examines the probabilistic and statistical properties of this model class, including conditions for the existence of higher-order moments and their explicit formulas in terms of model parameters. Notably, the conditions for periodic stationarity of the first and second moments are established, and closed-form expressions are derived based on these conditions. The paper also explores the periodic autocovariance structure and presents a closed-form expression for the periodic autocorrelation function. For parameter estimation, the Conditional Maximum Likelihood (CML) method is employed using the Expectation Maximization (EM) algorithm, and its effectiveness is evaluated through a simulation study. The practical utility of the proposed model is demonstrated by analyzing the daily number of COVID-19 deaths in Finland. The results highlight the model's capability to capture the zero-inflated and periodic features in count time series, providing a robust tool for analyzing similar datasets with periodic characteristics.

Keywords:
Higher order moments; EM algorithm; COVID-19 deaths in Finland.

AMS Mathematics Subject Classification 2020:
62F12, 62M10

Modeling triatomine vector and host population dynamics

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Abstract

Chagas disease, a vector-borne illness caused by *Trypanosoma cruzi*, remains a significant public health challenge in many regions of the world. Recent studies have observed developmental delays in certain triatomine vectors . In this work, we introduce these delays into our mathematical model to better understand their impact on the spread of Chagas disease. This approach aims to shed light on how these biological mechanisms influence transmission dynamics, potentially guiding improved control strategies.

Keywords:
Chagas disease; Diapause; Delay differential equation; Population dynamics; Triatomines.

AMS Mathematics Subject Classification 2020:
92D25

Existence of positive supersolutions to nonlinear singular systems with Hardy potential

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Abstract

We present the existence and non-existence results of systems with singular Hardy potential. We will consider three main cases:

1. the case where we choose f and g as potential functions, using suitable process argument, we show the existence of a critical curves in $H(p,q)$ such that the system (S) has a solution according to the sign of H.

2. the cases where we choose f and g as gradient functions or mixed functions. Here the situation is more complicated and we need to use a suitable weighted Sobolev inequality in order to get the critical curves of existence.

Keywords:
Hardy potential; Singular system; Positive supersolutions.

AMS Mathematics Subject Classification 2020:
35E99, 35A21

Investigating the interaction between hepatitis C and diabetes: A mathematical approach

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Abstract

Hepatitis C virus (HCV) infection has been linked to an increased risk of developing insulin resistance and type 2 diabetes mellitus in many studies. Moreover, mathematical models have been instrumental in understanding various aspects of the HCV epidemic, including the importance of new treatment strategies. In this study, we develop a mathematical model to evaluate the interaction between HCV and diabetes, aiming to provide insights into the comorbidity of these conditions. Our goal is to provide targeted prevention and treatment strategies for individuals who are at high risk of developing diabetes as a result of HCV infection by examining the dynamics of HCV infection and its interaction with diabetes. This approach bridges the gap between clinical management and public health planning, fostering better disease control and resource allocation.

Keywords:
Hepatitis C(HCV); Diabetes; Mathematical modeling; Comorbidity; Disease dynamics; Epidemiology.

AMS Mathematics Subject Classification 2020:
92C60

Dynamic process with viscous dissipation in thermo-viscoelasticity

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Abstract

We examine a mathematical model that describes the dynamic evolution of a linear thermo-viscoelastic body, incorporating the effects of internal forces that produce a nonlinear viscous dissipation function. We derive a variational formulation for the system, which includes both a motion equation and an energy equation. We also establish the existence of weak solutions within a suitable function space. This work focuses on a mathematical model for the dynamic behavior of thermo-viscoelastic materials, accounting for viscous dissipation and boundary conditions. The model is represented by a hyperbolic-parabolic partial differential system with irregular data L^1.

Keywords:
Viscous dissipation; Thermo-viscoelasticity.

AMS Mathematics Subject Classification 2020:
35M10, 74D05, 74F05

On nonhomogeneous biharmonic equations with a critical Sobolev exponent and prescribed singularities

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(Joint work with Messirdi Sofiane and Matallah Atika)

Abstract

We will discuss in this forum the existence of multiple solutions for a biharmonic problem involving multi-polar Rellich type potentials and Sobolev critical nonlinearity following:

$$(\mathcal{P})\begin{cases}\Delta^2 u - \sum\limits_{i=1}^{k}\dfrac{\mu_i}{|x-b_i|^4}u = |u|^{2^*-2}u + \sum\limits_{i=1}^{k}\dfrac{\lambda_i}{|x-b_i|^{4-\alpha_i}}u + f(x), & x\in\Omega,\\ u = \dfrac{\partial u}{\partial n} = 0, & x\in\partial\Omega,\end{cases}$$

where Ω is a bounded domain in $\mathbb{R}^N$ $(N \geq 5)$, containing b_i, $\Delta^2 = \Delta\Delta$ and ∂n denotes the outward unit normal on the boundary $\partial\Omega$, μ_i and λ_i are positive parameters, $0 < \alpha_i < 4$ and f is a given bounded measurable function. Here $2^* = \frac{2N}{N-4}$ is the Sobolev critical exponent. The presence of the singular weights and the critical exponent of Sobolev impose a critical growth of the nonlinearity which causes a loss of compactness of the problem, consequently one cannot apply the classical variational methods directly which makes the study less obvious and more difficult. We consider in our research the space $H_0^2(\Omega)$ with the norm

$$\|u\| = \left(\int_\Omega (|\Delta u|^2 - \sum_{i=1}^{k}\frac{\mu_i}{|x-b_i|^4}u^2)dx\right)^{\frac{1}{2}},$$

with $\sum\limits_{i=1}^{k}\mu_i < \overline{\mu}$.

For $i \in \{1, ..., k\}$, our problem is related to the eigenvalue problem and has a first eigenvalue λ_i^1 given by

$$\lambda_i^1 = \inf_{u \in H \setminus \{0\}} \frac{\int_\Omega (|\Delta u|^2 - \sum_{j=1}^{k} \frac{\mu_j}{|x-b_j|^4} u^2) dx}{\int_\Omega \frac{u^2}{|x-b_i|^{4-\alpha_i}} dx}.$$

Let

$$\lambda^1 = \min_{1 \leq i \leq k} \lambda_i^1.$$

In what follows, we state the main results for which we consider the following hypothesis.

$$(\mathcal{H}) \qquad 0 < \inf\{C_N (Q(u))^{\frac{N+4}{8}} - \int_\Omega f u dx : \ u \in H, \int_\Omega |u|^{2^*} dx = 1\}$$

where $C_N = \frac{8}{N-4} (\frac{N-4}{N+4})^{\frac{N+4}{8}}$, and $Q(u) = \|u\|^2 - \sum_{i=1}^{k} \lambda_i \int_\Omega \frac{u^2}{|x-b_i|^{4-\alpha_i}} dx$.
By using the variational methods and the Nehari manifold decomposition. The problem $(\mathcal{P})$ has $2k$ distinct solutions.

Keywords:
Multi-singular potentials; Critical Sobolev exponent; Biharmonic; Rellich inequality; Variational method.

AMS Mathematics Subject Classification 2020:
31B30, 35B33, 34J60

Non-existence of limit cycle of Septic Kolmogorov system

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Abstract

In this work, we study a class of Septic Kolomgorov systems of the form :

$$\left\{ \begin{array}{l} x' = (x+p)\,P_6(x,y) \\ y' = (y+q)\,Q_6(x,y) \end{array} \right\} \tag{4}$$

$$\begin{aligned} P_6(x,y) &= \left(\begin{array}{c} x(q+y)\left(ax^4+ay^4+2bxy^3+2bx^3y\right) \\ +cx(x+p)(q+y)^2+\left(x^2+y^2\right)\left(-4qy^3+x^4-3y^4\right) \end{array} \right) \\ Q_6(x,y) &= \left(\begin{array}{c} y(p+x)\left(ax^4+ay^4+2bxy^3+2bx^3y\right) \\ +cy(q+y)(x+p)^2+\left(x^2+y^2\right)\left(4px^3-y^4+3x^4\right) \end{array} \right) \end{aligned}$$

and p, q, a, b, c are real numbers. We show that our system exhibiting an explicit expression of first integral. Moreover, according to certain conditions on the parameters the system admits a non algebraic limit cycle which can be explicitly given. We give an example to illustrate this proved result.

Keywords:
Kolmogorov systems; First integral; Limit cycle.

AMS Mathematics Subject Classification 2020:
34A05, 34C05, 34C07, 34C25

Boundary control and asymptotic stability of an axially moving

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Abstract

Axially moving continuous materials can be found in various engineering areas such as continuous material manufacturing lines and transport processes. Especially, the dynamics analysis and control for axially moving continuous materials which have received a growing attention due to the entrance of new applications in exible robotic manipulators and exible space structures, we are interested in studying the stabilization of an axially moving, like threads, belts, wires, cables, magnetic tapes and chains. The work is concerned with an axially moving string subject to unbounded boundary disturbance. The Lyapunov method is employed to show the effectiveness of the boundary control for ensuring the vibration reduction. The obtained results improve certain previous results.

Keywords:
General decay; Multiplier technique; Moving structure; High-gain adaptive stabilization.

AMS Mathematics Subject Classification 2020:
34H05

Approximate solutions of Schrödinger equation for the radial generalized Cornell plus Pöschl-Teller potential

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(Joint work with Badredine Boudjedaa)

Abstract

Approximate eigensolutions of Schrödinger equation are found, for the radial generalized Cornell plus Pöschl-Teller potential, in the framework of quasi-exactly solvable problems. It is shown that by using an appropriate approximation scheme, the radial equation can be put in the biconfluent Heun's equation form, where the approximate eigensolutions and the corresponding energy eigenvalues are obtained in closed form.

Keywords:
Schrödinger equation; Approximate eigensolutions; Radial generalized Cornell potential; Pöschl-Teller potential; Biconfluent Heun's equation.

AMS Mathematics Subject Classification 2020:
81Q05, 34B30

Energy decay in coupled Biharmonic Schrödinger equations with internal fractional damping

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Abstract

This study investigates stabilization techniques for coupled Biharmonic Schrödinger equations with internal fractional damping. First, we establish the well-posedness of our system and demonstrate the existence and uniqueness of the solution using the semi group theory for linear operators. Then, we demonstrate the strong stability of our system. Finally, by employing multiplier techniques combined with frequency domain methods, we establish a polynomial decay rate for the solutions. These findings enhance our understanding of the dynamics of coupled Biharmonic Schrödinger equations under fractional dissipation and highlight the effectiveness of our proposed methodology.

Keywords:
Biharmonic Schrödinger equations; C0 semigroup; Strong stability; General decay.

AMS Mathematics Subject Classification 2020:
35B40, 35Q41

Lyapunov sufficient conditions for practical semiglobal exponential stability

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Abstract

In this work, we deduce Lyapunov sufficient conditions for the practical uniform exponential stability of nonlinear perturbed systems under different conditions for the perturbed term. In addition, we present a converse Lyapunov theorem for the notion of semiglobal uniform exponential stability for parametrized nonlinear time-varying systems. We establish the possibility of application of a perturbed parametrized system, with the help of the Lyapunov theory, to the investigation of the robustness properties that may provide practical semiglobal uniform exponential stability with respect to perturbations.

Keywords:
Lyaponov theory; Parametrized systems; Practical semi-global uniform exponential stability.

AMS Mathematics Subject Classification 2020:
34D05, 34D10, 34D20, 93D09

On strong and complete controllability for rectangular descriptor systems

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Abstract

In this work, we study different concepts related to the controllability of irregular descriptor systems. Contrary to the theory of controllability of ordinary systems, there are various concepts of controllability for singular systems: C-controllability, R-controllability, I-controllability, and controllability at infinity. These concepts are described and defined using an equivalent form for linear descriptor systems. We show that complete and strong controllability for a descriptor system is equivalent to the controllability for some suitably designed normal systems under natural assumptions. The normal systems are obtained by a numerically stable algorithm that is solely based on the singular value decomposition of system matrices. To illustrate the presented theory, we give some real-life problems in electrical networks and mechanical systems.

Keywords:
Controllability; Rectangular descriptor systems; Equivalent form.

AMS Mathematics Subject Classification 2020:
34A09, 93B05

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"The beauty of mathematics only shows itself
to more patient followers."
Maryam Mirzakhani

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