

# BOOK OF ABSTRACTS

## Fourth International Conference on Applications of Mathematics to Nonlinear Sciences (AMNS–2026)

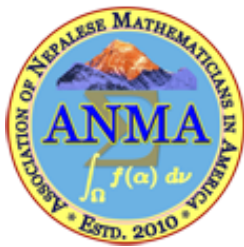


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Association of Nepalese Mathematicians in America (ANMA)

Nepal Mathematical Society (NMS)

Central Department of Mathematics, Tribhuvan University (TU)



May 28–31, 2026

Kathmandu, Nepal

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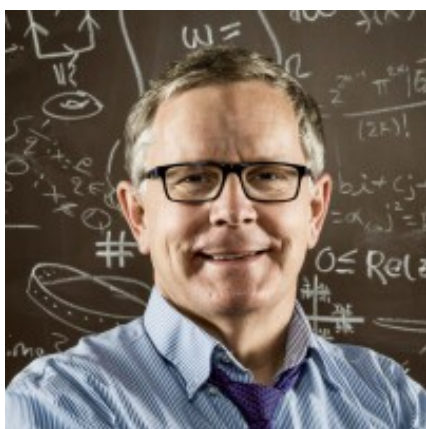
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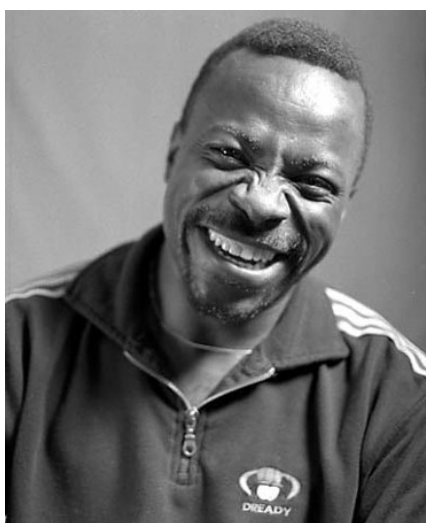
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## Biographies of Plenary Speakers



**Dr. Michael Dorff** is the past President of the Mathematical Association of America (MAA) and a professor of mathematics at Brigham Young University. He earned his Ph.D. from the University of Kentucky. He is interested in promoting mathematics to the general public, in math careers in industry, and in undergraduate research. He co-directs the MAA PIC Math program (Preparation for Industrial Careers in the Mathematical Sciences) and was the founder of CURM (Center for Undergraduate Research in Mathematics). He is a Fellow of the AMS, a CUR Fellow (Council on Undergraduate Research), and a Fulbright Scholar in Poland. He is married with 5 daughters. In any free time he has, he enjoys reading, writing, running, and traveling (he has traveled to 49 U.S. states and 48 countries).

**Dr. Zhaosheng Feng** is the Carlos and Stephanie Manrique de Lara Endowed Professor in the School of Mathematical and Statistical Sciences at the University of Texas Rio Grande Valley. His research focuses on nonlinear differential equations, dynamical systems, mathematical physics, computational methods, and population dynamics, with significant contributions to the qualitative analysis of ordinary and partial differential equations. He has published extensively in areas such as nonlinear analysis, Schrödinger equations,  $p$ -Laplacian problems, and stability theory, collaborating widely with researchers around the world. In addition to his research achievements, Professor Feng is actively involved in graduate education, editorial service, and the supervision of student research in applied and theoretical mathematics.



**Dr. Ernest Fokoué** is Professor of Statistics in the School of Mathematical Sciences at Rochester Institute of Technology (RIT) in Rochester, New York, USA, where he leads the Statistical Machine Learning and Data Science Laboratory. His intellectual journey is as rich as it is unconventional: he earned his first degrees in Mathematics and Computer Science from his native Cameroon, spent two formative years traveling with yogi monks before returning to teach at the Catholic University of Central Africa, then received a British Government scholarship to study Neural Computation at Aston University in Birmingham. He subsequently earned his Ph.D. in Statistics from the University of Glasgow under the supervision of the late Professor D. Michael Titterton — one of the world's foremost authorities on mixture models, variational Bayes, and statistical machine learning — before completing a postdoctoral fellowship at

the Statistical and Applied Mathematical Sciences Institute (SAMSI) and Duke University. He has held faculty positions at Ohio State University and Kettering University before joining RIT. Professor Fokoué’s research spans statistical learning theory, Bayesian statistics, ring-theoretic learning, computational statistics, and the philosophical foundations of scientific inference, with recent work exploring the interface of differential equations and empirical processes as a bridge between classical mathematical modeling and modern data-driven learning. He is co-author of the Springer-Verlag monograph *Principles and Theory for Data Mining and Machine Learning*, winner of the Best Young Researcher Award from the International Association of Statistical Computing, a recipient of the American Statistical Association Leadership Award, and an elected member of the International Statistical Institute. What distinguishes Professor Fokoué most deeply, however, is not his technical credentials but his philosophical convictions and his uncommon scholarly courage. He is a passionate and public opponent of mathematical and intellectual tribalism — the tendency of disciplines to guard their borders, claim sole ownership of ideas, and diminish the contributions of neighboring fields. In lecture halls, conference stages, and published essays alike, he has consistently argued that the greatest advances in human knowledge have always emerged at the intersections of disciplines, not within their fortresses. He sees the current era of Artificial Intelligence not as a conquest by computer science over statistics and mathematics, but as an invitation — perhaps the most urgent in a generation — for mathematicians, statisticians, and scientists of all traditions to work together in pursuit of systems that are not merely powerful, but rigorous, trustworthy, interpretable, and aligned with human values. He has given talks at institutions across the United States, Europe, Africa, and Australia, and his pedagogical philosophy — that learning is a joyful, communal, and deeply human act — has earned him the devotion of generations of students. Outside the academy, Professor Fokoué is an avid guitarist, a passionate soccer coach with eleven years of youth mentorship experience, a lover of languages, and a man of deep faith, who regards his scholarly vocation as a gift and a responsibility entrusted to him from above.

**Dr. Bijoy K. Ghosh** received the B.Tech. and M.Tech. degrees in Electrical and Electronics Engineering from BITS, Pilani, and the Indian Institute of Technology, Kanpur, India, and the Ph.D. degree in Applied Mathematics from the Decision and Control Group of the Division of Applied Sciences, Harvard University, Cambridge, MA, in 1977, 1979, and 1983, respectively. From 1983 to 2006, he has been a faculty member in the Department of Electrical and Systems Engineering, Washington University, St. Louis, MO, as a professor, and directed the center for BioCybernetics and Intelligent Systems. Presently he is a Dick and Martha Brooks Endowed Professor in the Department of Mathematics and Statistics at Texas Tech University, Lubbock, TX. Bijoy received the American Automatic Control Council’s Donald Eckman Award in 1988 in recognition of his outstanding contributions in the field of Automatic Control. He received the United Nations Development Program Consultancy in India under the TOKTEN program in 1993, the Japan Society for the Promotion of Science invitation fellowship for research in Japan in 1997. In the year 2000, he became a Fellow of the Institute of Electronics and Electrical Engineering for fundamental contributions to System Theory with applications to robust control, vision and multi sensor fusion. Bijoy is a member of the editorial board of *The IEEE Transactions on Computational Biology and Bioinformatics*. He has held visiting academic positions at the Yale University, USA; Università di Padova, Italy; Institut Mittag-Leffler and Royal Institute of Technology, Sweden; Tokyo Institute of



Technology and Osaka University, Japan. He is a permanent visiting professor at the Tokyo Denki University, Saitama, Japan and Technical University of Munich, Germany.



**Dr. Ji-Hyun Lee** received her Master's degree and Doctor of Public Health in 2000 and 2003, respectively, from the Department of Biostatistics at the University of North Carolina at Chapel Hill (UNC-CH). During her time as a student at UNC-CH, she worked for the Lineberger Comprehensive Cancer Center for three years as a graduate research assistant and completed an internship at the National Cancer Institute.

After graduation, she started at the Moffitt Cancer Center in Tampa, FL, as an Assistant Professor of Biostatistics and went through tenure and promotions up to the Full rank. In 2014, she moved to the University of New Mexico Comprehensive Cancer Center to lead the Biostatistics Shared Resource Group. Four years later,

she returned to Florida to become a Professor in the Department of Biostatistics and to lead the Division of Quantitative Sciences and the Shared Resource of Biostatistics and Computational Biology at the University of Florida Health Cancer Center.

As a cancer researcher, she has a long track record of successful funding and a strong dedication to improving the lives of those affected by cancer. Her research interests include clinical trial designs, longitudinal data analysis, cancer disparity, cancer prevention interventions (including smoking cessation), and AI approaches for imaging data. She has published 214 peer-reviewed papers and continue to seek effective ways to make meaningful contributions to the oncology field.

**Dr. Marcia C. Linn** is the Evelyn Lois Corey Professor of Instructional Science at the Berkeley School of Education, University of California, Berkeley. She specializes in science and technology. She is a member of the National Academy of Education and the International Academy of Education. She is a Fellow of the American Association for the Advancement of Science (AAAS), the American Psychological Association (APA), the Association for Psychological Science (APS), the American Educational Research Association (AERA), and the International Society of the Learning Sciences (ISLS). She has served as President of the International Society of the Learning Sciences (ISLS), Chair of the AAAS Education Section, and on the boards of the AAAS, the Educational Testing Service Graduate Record Examination, the McDonnell Foundation Cognitive Studies in Education Practice, and the National Science Foundation Education and Human Resources Directorate. Awards include the National Association for Research in Science Teaching Award for Lifelong Distinguished Contributions to Science Education, the American Educational Research Association Willystine Goodsell Award, and the Council of Scientific Society Presidents first award for Excellence in Educational Research.



Dr. Linn earned her Ph.D. at Stanford University where she worked with Lee Cronbach. She spent a year in Geneva working with Jean Piaget, a year in Israel as a Fulbright Professor, and a year in London at University College. She has been a fellow at the Center for Advanced Study

in Behavioral Sciences three times and a Bellagio Center Writing Resident twice. Her books include *Computers, Teachers, Peers* (2000), *Internet Environments for Science Education* (2004), *Designing Coherent Science Education* (2008), *WISE Science* (2009), and *Science Teaching and Learning: Taking Advantage of Technology to Promote Knowledge Integration* (2011) [Chinese Translation, 2015]. She chairs the Technology, Education—Connections (TEC) series for Teachers College Press.



**Dr. Ami Radunskaya** is the Lingurn H. Burkhead Professor of Mathematics at Pomona College whose research focuses on mathematical modeling of tumor growth and treatment, dynamical systems, and nonlinear power system models. She serves as president of the EDGE Foundation, a national initiative dedicated to increasing the success of women, particularly minority women, in graduate programs in the mathematical sciences. A former president of the Association for Women in Mathematics (2017–2019), she has been a strong advocate for expanding access to research, graduate education, and professional opportunities in mathematics. Professor Radunskaya is a Fellow of the American Mathematical Society and has received numerous honors for excellence in teaching, mentoring, and leadership, including awards from Pomona College and Stanford University.

skaya is a Fellow of the American Mathematical Society and has received numerous honors for excellence in teaching, mentoring, and leadership, including awards from Pomona College and Stanford University.

# ABSTRACTS

## Plenary Speakers

### 1. Michael Dorff – *Zeros of Harmonic Polynomials*

Brigham Young University, UT, USA

**Abstract:** Analytic functions can be generalized to complex-valued harmonic functions, and mathematicians have investigated how properties of analytic functions are affected when those properties are applied to complex-valued harmonic functions. In this talk, we will look at the property of the number of roots for polynomials. In the analytic case, the Fundamental Theorem of Algebra establishes that a polynomial of degree  $n$  with complex coefficients has exactly  $n$  roots in the complex numbers. That's delightful! What happens to the number of zeros when we move from an analytic polynomial of degree  $n$  to a complex-valued harmonic polynomial of degree  $n$ ? Spoiler Alert - the answer is unexpected. Come to the talk to find out more. Disclosure: Such unsolved problems make suitable research problems for students who don't need an extensive mathematical background.

### 2. Zhaosheng Feng – *Parabolic System of Aggregation Formation in Bacterial Colonies*

University of Texas Rio Grande Valley, TX, USA

**Abstract:** In this work, we introduce a nonlinear parabolic system with dispersion to describe bacterial aggregation dynamics. In contrast to the corresponding model without dispersion, the inclusion of dispersion permits the propagation of bacterial clusters, indicating that dispersion can act as a regulatory mechanism for bacterial colony behavior. An analytical expression for the traveling-wave solution is derived by explicitly accounting for the dispersion coefficient. Numerical simulations further demonstrate that an initially random bacterial concentration evolves into a periodic wave pattern, which subsequently transitions into a stationary solitary wave in the absence of dispersion.

### 3. Ernest Fokoué – *No Intelligence Without Statistics: The Mathematical Foundations and Genealogy of Artificial Intelligence*

Rochester Institute of Technology, USA

**Abstract:** This lecture presents a rigorous and impassioned reconstruction of Artificial Intelligence as the large-scale algorithmic realization of the foundational principles of mathematical statistics. At a moment when the cultural narrative surrounding AI threatens to sever it from its deepest intellectual roots, we argue — and formally prove — that there is no intelligence without statistics. We begin by establishing the Statistical Primogeniture Theorem: any learning algorithm satisfying non-trivial generalization guarantees must, of mathematical necessity, operate as a statistical estimator of a population-level risk functional. No-Free-Lunch arguments, the Representer Theorem, PAC-Bayes bounds, and the Bernstein–von Mises theorem serve as the proof's scaffolding. This result transforms the claim "no intelligence without statistics" from a philosophical assertion into a mathematical theorem. Building upon this foundation, we develop a ten-pillar genealogy tracing the evolution of machine intelligence from Fisherian maximum likelihood and Robbins–Monro stochastic approximation to the modern Transformer. A central formal result establishes that the Transformer's self-attention mechanism is provably the Nadaraya–Watson kernel regression estimator applied to learned query-key representations — a statistical pearl discovered in 1964 that waited fifty-three years to be rediscovered at the heart of the world's most powerful AI systems. We further demonstrate via PAC-Bayes analysis that the Gibbs distribution arising from Langevin-based training is simultaneously the posterior

that minimizes the generalization bound, unifying optimization and Bayesian inference into a single statistical act. Beyond demonstration, this lecture is an invitation. It argues that mathematical and statistical communities must not remain spectators in the AI revolution — not out of disciplinary pride or intellectual tribalism, but out of genuine conviction that the most important unsolved problems in AI are, at their core, mathematical problems in disguise. Singular Learning Theory requires algebraic geometry; compositional AI requires category theory; trustworthy generation requires conformal prediction; causal representation learning requires structural equation models. The statistical tree of knowledge contains many branches whose fruits have not yet been harvested. The Nadaraya–Watson kernel was one such undiscovered pearl. Others — Stein’s identity, functional data operators, optimal transport, belief propagation, reproducing kernel structures — may yet give birth to architectures that supersede the Transformer entirely. We close with a call to the mathematical and statistical communities of Nepal and beyond: the future of trustworthy, interpretable, and causally grounded Artificial Intelligence depends not on engineers alone, but on the mathematicians and statisticians who dare to dig deeper into the tree of knowledge, patient enough to find what is hiding in plain sight.

#### 4. Bijoy Ghosh – *Optimal and Nonlinear Control Problems in Binocular Eye Tracking*

Texas Tech University, TX, USA

**Abstract:** Dynamic Modeling of Human Eye movements have been of interest since the middle of nineteenth century, by physiologists like Helmholtz, Listing and Donders. It was known since then that, under normal circumstances, human eyes do not undergo torsional rotation, while they preserve the orientation of the surroundings while tracking a possibly mobile point target. These ideas were perhaps captured in the mechanical gimbals constructed for over hundreds of years but were not supported by explicit dynamic models, using geometry and mechanics, up until the last few decades of the twentieth century. Such rotation problems got renewed attention in Humanoid-Robotics and Machine-Vision where the goal is to visually track a possibly moving point target in space, requiring specific coordinated movement of eye and head. In this talk we present our own research on Binocular Eye Movement models using classical mechanics, wherein two eyes are actuated to rotate synchronously to gaze at a target. The rotations are described on space  $SO(3)$ , the special orthogonal group of degree 3, with constraints on the axis of rotation. Such constraints have been originally proposed by Donders and Listing. We propose a Tait Bryan parametrization of  $SO(3)$  and describe Donders’ constraint in these parameters. Assuming that the Eye is a perfect sphere with its mass distributed uniformly and rotating about its own center, Eye movement models are constructed using a suitably described Riemannian Metric. We present an optimal control framework for modeling binocular eye movements while tracking targets whose trajectories in space are not known in advance. We formulate a model predictive control (MPC) approach with two variants: a deterministic controller based on linear extrapolation of the target trajectory and a stochastic controller leveraging Gaussian Process regression for uncertainty-aware trajectory prediction. Numerical simulations across sinusoidal, noisy sinusoidal, and random walk trajectories demonstrate that stochastic MPC significantly improves tracking robustness in uncertain or noisy conditions.

#### 5. Ji-Hyun Lee – *Conversations with a Collaborative Statistician: The Quiet Power of Statistical Leadership*

University of Florida, FL, USA

**Abstract:** Statisticians often work behind the scenes. They ask careful questions, guide study design, and help teams turn data into evidence. Their names may not be on the front page, but their work shapes scientific discovery and medical decisions. In this interview-style seminar, I

will share a series of candid conversations that show how statistical thinking, cross-disciplinary collaboration, and inclusive leadership support better science and better patient outcomes. I will also reflect on several initiatives from my year as ASA's 2025 President to broaden community engagement, strengthen data science practice, and highlight the real impact statisticians have on research. These stories reveal the quiet power that supports modern science.

**6. Marcia Linn** – *Building Partnerships to Synergize Advances in Learning Science and Technology*

University of California, Berkeley, CA, USA

**Abstract:** Our partnership of classroom teachers, learning scientists, and computer scientists has designed and tested Open Educational Resources (OERs) that support new partnerships to investigate local environmental dilemmas. We exploit synergies between Knowledge Integration (KI) pedagogy and Artificial Intelligence (AI) adaptive guidance to amplify the impact of teachers and improve student learning. This talk reports on investigations that have strengthened the KI framework and refined AI dialogs. We invite educators around the world to use our resources to form their own partnerships.

**7. Ami Radunskaya** – *Getting Drugs to the Right Place at the Right Time: How Can Mathematics Help?*

Pomona College, Claremont, CA, USA

**Abstract:** The brain tissue is protected by the blood-brain barrier: a wall of tightly-packed cells that keep unwanted molecules from crossing from the blood vessels into the tissue. This presents challenges to delivering therapeutic drugs to locations in the brain in order to treat brain cancers or certain neuro-degenerative diseases. Bio-engineers have figured out ingenious ways to package drugs so that they can be released at just the right spot, and focused ultrasound can be used to temporarily open the blood-brain barrier at those spots. Experiments also show that ultrasound can alter the tumor microenvironment, triggering inflammatory signaling and shifting immune-cell populations. Immunotherapy has been shown to be effective for some brain tumors, however their effectiveness requires accurate timing and targeting. So there are plenty of questions to answer: how and when should we deliver ultrasound, chemotherapy and immunotherapy? Hence the need for predictive mathematical models. In this talk I will present mathematical models that describe the kinetics of drug transport and distribution through the tissue, and use these models, along with optimization tools, to answer the age-old questions in drug delivery: how much and how often?

## Special Invited Speakers

### 8. Toyohiko Aiki – *Finite Volume Method for Rigorous and Numerical Analysis of the Water Transport Model*

Japan Women's University, Tokyo, Japan

**Abstract:** We are concerned with the analysis of a water transport model in porous materials. The model is formulated as a system of nonlinear partial differential equations describing the mass conservation of water in both air and liquid phases. Since the full system presents several mathematical difficulties, our recent work focuses only on initial boundary value problems for the quasi-linear parabolic equation—known as the Richards equation—that governs the liquid phase. A distinctive feature of the problem is that the boundary condition does not satisfy the usual monotonicity property. Because of this feature, for rigorous analysis it is not easy to apply the standard fixed-point argument based on evolution equation theory and the Galerkin method. As a result, proving existence of the strong solution is difficult. For this issue we have constructed approximation solutions obtained by the finite volume method and established existence and uniqueness in the one-dimensional interval. The finite volume method (FMV) is a well-established numerical technique that approximates partial differential equations by a system of ordinary differential equations. The reduction to a system of ODEs facilitates the straightforward construction of approximate solutions while retaining the structural properties of the original PDE. Consequently, uniform a priori estimates can be established more easily, thereby allowing a rigorous analysis of the strong solvability and uniqueness. Thanks to this strong solvability, the error estimate for the approximation is developed. In this talk, we will provide some open issues that the FMV is applicable.

### 9. Till Becker – *From Text to Data: Using Large Language Models to Map Digital Skills Demand in German Public Organizations*

Hochschule Emden/Leer, Germany

**Abstract:** The digital transformation of German public organizations lags behind the private sector, with recruitment practices often misaligned with the need for digital competencies. To empirically assess this gap, a large number of job advertisements was analyzed using Large Language Models (LLMs) to transform qualitative text into structured, quantitative data based on an established framework. The findings reveal that while digital content creation and data handling are frequently demanded, competencies like communication, problem-solving, and safety are rarely mentioned. Notably, lower-level positions require more digital skills than leadership roles, highlighting a disconnect between scholarly expectations of digital government leadership and real-world hiring practices. This research demonstrates the potential of LLM-supported text mining for large-scale empirical research in various domains.

### 10. Dimplekumar Chalishajar – *Electromechanical Stability and $\mathcal{T}$ -Controllability Analysis of Hilfer Fractional Stochastic Switching Systems with Non-Instantaneous Impulses using Integral Contraction Framework*

Virginia Military Institute, USA

**Co-author(s):** Dhanalakshmi Kasinathan, Ramkumar Kasinathan, Ravikumar Kasinathan

**Abstract:** This paper investigates the existence, uniqueness, and Hyers–Ulam stability (HUS) of a class of higher-order coupled stochastic non-instantaneous impulsive Hilfer fractional switched differential equations with deviated arguments and Poisson jumps in finite-dimensional spaces. The solvability of the proposed system is established by employing the method of integral contractors (ICs), together with suitable regularity assumptions and a weakened Lipschitz condition

imposed on the nonlinear operators of the coupled stochastic system. Under these conditions, the existence and uniqueness of solutions are derived, followed by the analysis of Hyers–Ulam stability in the presence of impulsive effects and stochastic perturbations. The principal novelty of this work lies in the formulation of a new class of coupled Hilfer fractional systems that integrates mechanical and electrical dynamics within a stochastic switching framework. The proposed model simultaneously captures system behavior over non-instantaneous impulsive intervals and at switching instants, while incorporating stochastic disturbances, thereby providing a more comprehensive and realistic modeling paradigm. Moreover, the adoption of fractional integral-type initial conditions introduces a flexible and nonstandard starting configuration, which significantly broadens the scope of applicability of the proposed framework. The theoretical analysis is developed using a combination of sequencing methods, fractional calculus, Laplace transform techniques, stochastic analysis, and Mittag–Leffler functions. To illustrate the effectiveness and applicability of the theoretical results, a detailed numerical example is presented, followed by an application to electromechanical coupling and seeker stabilization. The proposed Hilfer fractional modeling approach offers a novel perspective for the analysis and control of complex hybrid stochastic systems with switching, impulses, and memory effects.

## 11. Debasis Kundu – *Bivariate Load Sharing Model*

Indian Institute of Technology Kanpur, India

**Abstract:** This work is motivated by a data set obtained from an experiment performed on diabetic retinopathy patients. The experiment was conducted to test whether there is any significance difference between two different treatments namely laser treatment and traditional treatment. The two treatments have been administered on two different eyes of the same patient. The two eyes of a patient are modeled as a two-component load-sharing system. In such systems, the failure of one component can increase the stress on the other, leading to earlier failure. In most of the existing literature, the initial lifetimes of the two components are assumed to be independent, which may not be a reasonable assumption in this context. In this paper it has been assumed that the lifetimes of the two components may be dependent. The model allows for a positive probability that both components fail simultaneously. If they do not fail simultaneously, the survivors lifetime is adjusted according to the tampered failure rate assumption, resulting in a bivariate distribution with a singular part. We have also developed the Bayesian inference of the unknown parameters under a very general set of prior assumptions when the baseline distributions are exponential, Weibull or piecewise constant hazard functions. Bayesian hypothesis testing is conducted using Bayes factors approach. Extensive simulations have been performed to show the performances of the proposed methods. The analysis of the diabetic retinopathy data set has been conducted to show the effectiveness of the Bayesian approach.

## 12. James McCoy – *Semi-discrete Linear Curvature Flow of Piecewise Linear Curves*

School of Science, RMIT University, Australia

**Abstract:** Situations where curvature flow equations are linear are exceptionally rare. One interesting such situation arises from a definition of “curvature” for piecewise linear curves. With this definition in hand, one can consider curvature flow of arbitrary even spatial order as a system of linear ordinary differential equations. I will describe settings with and without boundary including flows of both parabolic and hyperbolic type. One can also flow one curve to another via variants of such flows, potentially through specific transition states, related to a problem of Yau in the setting of smooth, closed curves. This is joint work with Jahne Meyer and Rohan St Hill.

### 13. Krishna P. Paudel – *Deforestation and Agriculture: A Modeling Approach*

Texas Tech University

**Abstract:** Using a dynamic equilibrium model and simulation exercises, this paper examines factors affecting land use decisions and derives conditions for the optimal allocation of agricultural and forest lands in an economy. The steady state resulting from this study suggests that the optimal land use decision is affected by the discount rate, land productivity, rates of return on capital and labor, and society's preferences over consumption. Unlike population pressure and other structural factors identified in previous studies, the results in this study show that the process of growth in agricultural and resource productivity is a key factor for the emergence of the inverted U-shaped relationship between income and deforestation. The theoretical analysis is supported by simulation models indicating that changes in the preference weighting value are the most sensitive factor determining the level of deforestation in an economy. Overall, under short-run, naive parameter ranges, a significant portion of land is allocated to agricultural production.

### 14. Marianna Pensky – *Davis-Kahan Theorem in the 2-to-infinity Norm and its Application to Perfect Clustering*

University of Central Florida, FL, USA

**Abstract:** Many statistical applications, such as the Principal Component Analysis, matrix completion, tensor regression and many others, rely on accurate estimation of leading eigenvectors of a matrix. The Davis-Kahan theorem is known to be instrumental for bounding above the distances between matrices  $U$  and  $\hat{U}$  of population eigenvectors and their sample versions. While those distances can be measured in various metrics, the recent developments showed advantages of evaluation of the deviation in the 2-to-infinity norm. The purpose of this talk is to provide upper bounds for the distances between  $U$  and  $\hat{U}$  in the 2-to-infinity norm for a variety of possible scenarios and competitive approaches. In addition, we discuss alternative methods for evaluation of  $\hat{U}$ . As one of possible applications, we derive sufficient conditions for perfect clustering in a generic setting, and then employ them in various applications.

## Invited/Contributed Speakers

**15. Syed Abbas** – *State Estimation and Control in the Julia Set of a Discrete Noise-induced Predator-prey Mode*

IIT Mandi, India

**Co-author(s):** Manoj Kumar

**Abstract:** The objective of this study is to examine the fractal behavior of a discrete noise-induced predator-prey model. A significant issue in nonlinear and statistical physics is comprehending the fundamental principles governing diverse phenomena in dynamical systems influenced by random noise. Comprehending the prey-predator model affected by noise is essential in ecology for predicting population dynamics and maintaining ecological sustainability. In our article, we take a discrete predator-prey model with group defense of prey and the same analysis will work for other similar types of discrete predator-prey models. The effect of dynamical noise (additive and multiplicative noise) on the fractal behavior of the discrete predator-prey model is studied with the help of Julia sets. To study the dynamics more clearly, the estimation of Julia sets of predator-prey model under the influence of dynamical or random noise is done to observe and reduce the interference of noise. At the end, the controllers are designed to study the control in the Julia set, which is an important aspect in the study of dynamical systems. Numerical simulations are conducted to demonstrate the methods and results employed in this study.

**16. Grishma Acharya** – *Dynamics of Multi-Lakes Outburst in Reservoirs at High Mountains*

Tribhuvan University, Nepal

**Co-author(s):** Jeevan Kafle, Bekha Dangol

**Abstract:** Glacial lake outburst floods (GLOFs) pose a serious threat to high mountain regions, where the retreat of glaciers has led to the formation of numerous unstable lakes. In certain scenarios, the failure of an upstream lake can trigger a cascading sequence of outbursts in downstream reservoirs, amplifying the hazard. This study investigates the dynamics of such multi-lake outburst events using a mathematical modeling and simulation approach. The physical processes are modeled by the shallow water equations, capturing the nonlinear and transient behavior of flood propagation over complex terrains. High-resolution numerical simulations are conducted using finite volume methods and meshfree techniques to evaluate flood wave interactions, breach initiation, and timing of successive failures. The modeling framework is validated through synthetic and real-case data, emphasizing the influence of topography, inter-lake connectivity, and dam stability. The findings contribute to a deeper understanding of cascade GLOF scenarios and provide a computational foundation for risk assessment and early-warning strategies in high-altitude glacial environments.

**17. Jatin Adeshara** – *Porous Structure Based on the Kozeny–Carman Model for Hydromagnetic Squeeze Film Between Rough Circular Plates*

Vishwakarma Government Engineering College Chandkheda, Ahmedabad, India

**Co-author(s):** Riddhi Zala, Suresh Sorathiya, Gunamani Deheri, Rakesh Patel

**Abstract:** This paper investigates the performance of a hydromagnetic squeeze film bearing incorporating a Kozeny–Carman (K–C) model based porous structure with transversely rough circular plates. The lubricant and bearing surfaces are assumed to be electrically conducting and subjected to a uniform transverse magnetic field. Surface roughness is modeled as a stochastic variable with non-zero mean, accounting for variance and skewness following the

Christensen–Tonder framework. The modified Reynolds equation is stochastically averaged, and the resulting pressure distribution is obtained using appropriate boundary conditions. The load carrying capacity is then evaluated in a non-dimensional form. Numerical results are presented through graphical and tabular representations. The study reveals that transverse roughness generally deteriorates bearing performance. However, negatively skewed roughness combined with negative variance can significantly enhance load capacity, especially when supported by suitable magnetization parameters and plate conductivities. Notably, the analysis confirms that a hydromagnetic squeeze film bearing can sustain load even in the absence of lubricant flow, highlighting its potential for extending bearing life.

**18. Jatin Adeshara** – *Ferrofluid-Based Squeeze Film Between Rough Porous Annular Plates with Magnetization Dependent Boundary Conditions*

Vishwakarma Government Engineering College Chandkheda, Ahmedabad, India

**Co-author(s):** Sapankumar Shah, Suresh Sorathiya, Rakesh Patel, Gunamani Deheri

**Abstract:** This paper presents a comparative theoretical investigation of a ferrofluid-based squeeze film formed between porous annular plates exhibiting transverse and longitudinal surface roughness. The analysis incorporates magnetization-dependent boundary conditions, an aspect generally neglected in earlier investigations of ferrofluid lubrication. Surface roughness is modeled stochastically using the Christensen–Tonder framework, accounting for the standard deviation, variance, and skewness of surface asperities. The stochastically averaged Reynolds-type equations corresponding to both transverse and longitudinal roughness patterns are derived and solved to obtain closed-form expressions for pressure distribution and load carrying capacity. Numerical results are presented graphically to examine the influence of roughness parameters, porosity, radius ratio, and magnetization. The study reveals that longitudinal roughness consistently outperforms transverse roughness in terms of load support when magnetization effects are incorporated into the boundary conditions. Moreover, negatively skewed roughness significantly improves bearing performance in both cases. A notable finding is that the ferrofluid-lubricated bearing can sustain a finite load even in the absence of lubricant flow, a capability absent in conventional lubricant-based squeeze film bearings.

**19. Ami Raj Adhikari** – *Modelling and analysis of two-layer blood flow through symmetric shaped stenosis increasing over time*

Bhaktapur Multiple Campus, TU, Nepal

**Co-author(s):** Tuk Bahadur Rana, Pushpa Nidhi Gautam, Gyan Bahadur Thapa, Jeevan Kafle

**Abstract:** The deposition of fatty particles within arterial walls leads to the formation of atherosclerotic plaque, which significantly alters the hemodynamic characteristics of blood flow. This effect becomes more pronounced when the thickness of arterial stenosis increases continuously over time. Since atherosclerosis is a major contributor to cardiovascular diseases, understanding the influence of time-dependent stenosis on blood flow behavior is of considerable clinical importance. In this work, a two-layer blood flow model is considered in which the core region, consisting of erythrocyte-rich blood, is surrounded by a peripheral plasma layer with comparatively lower viscosity. A new mathematical model is developed by incorporating a non-dimensional temporal term in the geometry of the symmetric shaped stenosis and used in the Navier–Stokes equations in cylindrical coordinates system. The equation is then solved for analytical solution under certain boundary conditions. Analytical expressions for velocity distribution, volumetric flow rate, pressure drop, pressure drop ratio, wall shear stress, and shear stress ratio are obtained for both layer (peripheral and core) and evaluated using computational tools. The results indicate that as stenosis thickness increases with time, the velocity

distribution and volumetric flow rate decrease, while the pressure drop and pressure drop ratio increase significantly. It is also observed that the shear stress ratio decreases as stenosis thickness increases over time, indicating increased resistance to blood flow. Furthermore, by comparing theoretical predictions with clinically observed plaque growth rates, the approximate time required for complete arterial occlusion can be estimated. The proposed two-layer model provides a more realistic representation of blood flow in stenosed arteries and offers important insights for early diagnosis, prediction of disease progression, and timely clinical intervention in cardiovascular disorders.

**20. Bishwa Raj Adhikari** – *Multicriteria Optimization Methods for Maximum Flow Problems in Dynamic Networks*

Prithvi Narayan Campus, Pokhara, TU, Nepal

**Abstract:** Dynamic network systems often involve decision-making under multiple conflicting objectives. This paper studies a multicriteria maximum flow problem in single-source, multi-sink dynamic networks over a finite time horizon, aiming to maximize flow to each sink simultaneously. Using a time-expanded network representation and a minimum-cost circulation approach, we develop algorithms to compute the maximum and minimum attainable flow values at each sink, determining the ideal and nadir points of the objective space. These bounds can be obtained using  $2p + 1$  minimum-cost circulation computations for a network with  $p$  sinks. Furthermore, we show that feasible total flows within these bounds can be realized dynamically. Numerical examples illustrate the effectiveness of the approach and the structure of the Pareto frontier.

**21. Dhruva R. Adhikari** – *Continuity of Yosida Approximants of Maximal Monotone Operators Corresponding to General Duality Mappings*

Kennesaw State University, GA, USA

**Abstract:** Let  $X$  be a real locally uniformly convex Banach space and  $X^*$  be the dual space of  $X$ . Let  $\varphi : \mathbf{R}_+ \rightarrow \mathbf{R}_+$  be a strictly increasing and continuous function such that  $\varphi(0) = 0$ ,  $\varphi(r) \rightarrow \infty$  as  $r \rightarrow \infty$ , and let  $J_\varphi$  be the duality mapping of  $X$  corresponding to  $\varphi$ . As an application of  $J_\varphi$ , we give a concise proof of the continuity of the Yosida approximants  $A_\lambda^\varphi$  and resolvents  $J_\lambda^\varphi$  of a maximal monotone operator  $A : X \supset D(A) \rightarrow 2^{X^*}$  on  $(0, \infty) \times X$  for an arbitrary  $\varphi$  when  $X$  is reflexive and both  $X$  and  $X^*$  are locally uniformly convex. We then present an example of pseudomonotone homotopy involving  $A_\lambda^\varphi$  on which the Browder degree is invariant. We also discuss examples of positively homogeneous maximal monotone operators to which the theory developed herein is applicable.

**22. Gobinda Adhikari** – *Deferred Statistical Convergence of Bi-complex Sequences*

Tribhuvan University, Butwal Multiple Campus, Nepal

**Co-author(s):** Jhavi Lal Ghimire, Narayan Prasad Pahari

**Abstract:** In this presentation, we introduce the concept of strong deferred Cesàro summability and deferred statistical convergence of bi-complex sequences with respect to the Euclidean norm on  $\mathbb{C}_2$  and establish some inclusion relations between them. We also establish some inclusion relations between statistical convergence and deferred statistical convergence of bi-complex sequences. Finally, we show that the space of deferred statistical convergence of bi-complex sequences is a  $\mathbb{C}_2$ -submodule of  $\omega(\mathbb{C}_2)$  and also study some other properties of the space.

**23. Khagendra Adhikari** – *Mathematical Exploration of Taiwan's COVID-19 Control Success: Assessing the Control Strategy with Delay and Multi-Strain Models*

Tribhuvan University, Nepal

**Abstract:** Taiwan’s success in controlling COVID-19 stands as a model, showing how meticulous detection and timely isolation, without lockdowns, can effectively control the virus and provides a valuable lesson for the world. In this talk, I will present an exploration of Taiwan’s COVID-19 control success through two mathematical models. First, I will present a delay model that examines how the timing and proportion of case detection and isolation influence disease transmission. Our model assesses how Taiwan’s rapid response, together with a high proportion of case detection and timely isolation, kept the disease under control during the first two years of the pandemic, and how relaxing these policies influenced later waves. Second, we analyze a multi-strain model that captures the dynamics of three Omicron variants circulating after the strategic relaxation of control measures. We examine how multiple variants interacted, competed, and contributed to new waves of infection. Together, these models provide a comprehensive assessment of Taiwan’s strategic control measures through mathematical insight, from timely intervention to the management of variant-driven transmission dynamics.

**24. Baldev Adhikari** – *Hydro-Mechanical Coupling of the One-Dimensional Richards Equation and Infinite Slope Model for Soil Surface Failure Analysis*

Tribhuvan University, Nepal

**Co-author(s):** Arun Kumar Bhandari, Rameshchendra Timsina, Harihar Khanal, Kedar Nath Uprety

**Abstract:** Unsaturated flow in soils is primarily governed by gravity, capillarity, and pressure gradient forces. The hydraulic behavior of such flow can be effectively described by the continuity equation combined with Darcy’s law, forming the nonlinear Richards equation for variably saturated porous media. In this study, the simulated soil moisture dynamics obtained from Richards equation are coupled with an infinite slope stability model to analyze soil surface failure. The Richards equation is solved numerically using empirical relationships that describe the hydraulic properties of isotropic, homogeneous soils, and the resulting nonlinear system is handled through Picard iteration. Finally we present some numerical simulation results demonstrating the influence of moisture dynamics on slope stability.

**25. Hari Adhikari** – *Network Position and Pricing Power: Heterogeneous Centrality Effects Across Airline Business Models*

Embry-Riddle Aeronautical University, FL, USA

**Abstract:** This study investigates how airport network centrality influences airline pricing across different carrier business models. While existing literature mainly focuses on competition intensity, route distance, and carrier classification, this research shows that network position generates varying levels of pricing power depending on an airline’s competitive strategy. The study uses 802,506 U.S. domestic route–carrier–quarter observations from 2010 to 2025 sourced from Cirium. Fixed-effects panel regressions are estimated with route and time controls. Four network centrality measures namely: weighted degree, betweenness, PageRank, and eigenvector centrality are constructed from the air transport network and interacted with carrier tiers (Legacy, LCC, ULCC). One-quarter lagged variables help address endogeneity, and standard errors are clustered by route. Results indicate that ultra-low-cost carriers demonstrate significantly greater fare sensitivity to origin airport centrality compared with legacy carriers operating on the same routes, after controlling for market concentration (HHI), demographic factors, and hub designation. Low-cost carriers display moderate sensitivity. These findings remain consistent across all centrality measures and multiple robustness tests. Quantile regression further shows that the effect is strongest on lower-priced routes, where competitive pressure is highest. This research provides the first systematic evidence that the pricing effects of network centrality

vary across airline business models using route-level panel data with fixed effects. Prior studies typically treat centrality as uniformly advantageous or focus on industry-wide impacts. By demonstrating that network position functions as a strategic resource whose value differs by competitive orientation, this study connects network theory with industrial organization and offers policy insights regarding airport slot allocation and airline merger evaluation.

**26. Narayan Prasad Adhikari** – *A Note on Optimal Control of Dynamic Network Flows via Port–Hamiltonian Systems*

Advanced College of Engineering and Management, Kathmandu, Nepal

**Co-author(s):** Rajendra Paudyal, Phanindra Prasad Bhandari, Shree Ram Khadka

**Abstract:** Dynamic network flow problems can be seen in transportation planning, logistics, and evacuation management, where flows may behave differently over time under capacity and conservation constraints. Although classical network flow models are effective for optimization and routing, they often lack a unified system theoretical framework that simultaneously captures network structure, flow dynamics, and control actions. In this paper, we develop a Port–Hamiltonian formulation for dynamic network flows and integrate it with an optimal control framework over a finite time horizon. The network is modeled as a directed graph whose dynamics are governed by conservation laws and incidence matrix relations, leading to a structured state-space representation that preserves the underlying interconnection properties of the system. On this basis, an optimal control problem is formulated to determine efficient flow strategies subject to dynamic and structural constraints. The proposed framework gives a rigorous mathematical foundation for the analysis and control of large-scale dynamic flow networks, while also providing a physically understandable and scalable modeling approach. The results are also applicable to various applications such as evacuation planning, traffic management, and transportation systems.

**27. Ram Sharan Adhikari** – *A Modified Euler-Maruyama method and its stability analysis for a class of stochastic differential equations*

Rogers State University, Claremore , USA

**Abstract:** We propose a modified Euler-Maruyama scheme to solve a system of stochastic differential equations and discuss its rate of convergence. The proposed method has the potential to overcome the numerical instabilities often experienced when using the explicit Euler method. This work aims to determine the mean-square stability region of the weak Simpson method for linear stochastic differential equations with multiplicative noise. Specifically, the mean-square stability region of the weak Simpson scheme is identified, and step-sizes are provided where error propagation is under control in a well-defined sense. This paper proposes a novel weak Simpson method for numerical solution for a class of stochastic differential equations. We show that such a method has weak convergence of order one in general and weak convergence of order three under certain additional assumptions

**28. Iswar Mani Adhikari** – *Emergency Evacuation Planning Strategies for Symmetric and Asymmetric Networks*

Prithvi Narayan Campus, TU, Nepal

**Abstract:** Dynamic flow formulations are the fundamental mathematical tools for developing effective strategies in emergency evacuation planning problems. It can be formulated to maximize flow, minimize time, or minimize cost, as a single or multi-objective function, depending on the nature of the problem, available networks, and the scenario. But for the evacuation system, the focus is on time minimization with maximum flow so that the large number of

evacuees can be evacuated in the minimum possible time during an emergency. Their effectiveness on transit-based evacuation systems depends mainly on the network structures. Most of the networks in literature are symmetric in nature, but this is not so in real practice. Here, we consider the optimization strategies to have the minimum clearance time concerning the transit-based evacuation planning problems during emergency evacuation systems in a network with symmetric and asymmetric topologies for urban areas as an embedded network.

**29. Elisabete Alberdi** – *Comparative Analysis of Techniques for improving Short-Term Scheduling of Underground Mining Activities*

Santo Tomas University, Santiago, Chile

**Co-author(s):** Luis Álvarez, Heber Hernández, Aitor Goti

**Abstract:** The planning of preparatory and developmental activities is critical for efficient underground mining operations and ensuring continuous production. Short-term scheduling for these tasks, however, remains under-addressed in the literature. This study introduces the Cooperative Multi-start Tabu Search with Path-Relinking (CMTS-PR) method for optimizing the short-term scheduling of multiple underground headings within a single-shift timeframe. The addressed scheduling problem is formulated as a flexible job-shop scheduling problem, characterized by unrelated parallel machines and sequence-dependent setup times. The performance of CMTS-PR is evaluated against several methodologies, including a memetic algorithm, a Non-dominated Sorting Genetic Algorithm II (NSGA-II), a single-trajectory Tabu Search (TS), a Constraint Programming (CP) model, and manual scheduling by an expert planner. This evaluation is conducted using two case studies based on panel caving operations in Chile. Results indicate that while CP yields mathematically optimal solutions, it becomes computationally prohibitive. Manual scheduling ensures schedule feasibility but often leads to resource under-utilization. In contrast, CMTS-PR generates operationally viable schedules efficiently. In Case Study 1, CMTS-PR achieved outcomes equivalent to CP within 60 seconds, despite transfer time variability of 10-60 minutes. For Case Study 2, CMTS-PR demonstrated a significant improvement, increasing equivalent fronts by 120% compared to manual planning and by 2.94% relative to CP, while requiring less computational time. Overall, CMTS-PR is demonstrated to be both effective and computationally efficient. This approach represents a pioneering application of a cooperative Tabu Search framework incorporating Path-Relinking to underground short-term scheduling problems and offers a practical computational tool for daily mine operational planning.

**30. Javid Ali** – *Controllability of Generalized Hilfer Fractional Dynamical Systems*

Aligarh Muslim University, Aligarh, India

**Abstract:** In this talk, we discuss the controllability of dynamical systems with  $(k, \phi)$ -Hilfer fractional derivative with infinite delay and delay in control function. The necessary and sufficient condition obtained for the controllability requirement for linear systems, which are characterized by the Mittag-Leffler  $(M - L)$  functions, while the fixed point approach is used to arrive at adequate controllability criteria for nonlinear systems. The novel feature of this study is to inquire into the controllability notion by using  $(k, \phi)$ -Hilfer fractional derivative, the most generalized variant of the Hilfer derivative. The advantage of this type of fractional derivative is that it recovers the majority of earlier studies on fractional differential equations (FDEs). Finally, few numerical examples are provided to illustrate our main results.

**31. Mirnalini Arulrohan** – *Mathematical Modeling of Driver Sensitivity with Time-Delayed Response for Autonomous Vehicle Traffic Flow*

Asian University for Women, Bangladesh

**Co-author(s):** Md Anowar Hossain

**Abstract:** As autonomous vehicles become increasingly integrated into modern transportation systems, ensuring safe and stable traffic flow remains a significant challenge, especially under complex real-world driving conditions. Driver behavior plays a crucial role in the stability and performance of autonomous vehicle (AV) traffic systems, particularly under high-density traffic conditions. Conventional car-following models typically assume constant driver sensitivity and instantaneous response, which limits their ability to capture realistic human driving behavior. In this study, we propose a mathematically rigorous framework for time-varying driver sensitivity that incorporates reaction time  $\tau$ , acceleration sensitivity ( $\lambda_a$ ), deceleration sensitivity ( $\lambda_d$ ), headway distance ( $h_n$ ), and velocity difference ( $\Delta V_n$ ). The proposed sensitivity function  $\lambda(h_n, \Delta V_n, \tau)$  is nonlinear and bounded, enabling asymmetric responses during acceleration and deceleration events. A linear stability analysis is performed to derive critical conditions under which traffic flow remains stable, marginal, or unstable, explicitly accounting for time delays caused by driver reaction. Furthermore, a nonlinear analysis based on the modified Korteweg–de Vries (mKdV) equation reveals the formation and propagation of traffic waves under varying sensitivity parameters. Numerical simulations validate the analytical results and demonstrate that incorporating reaction-time-dependent and velocity-asymmetric sensitivity significantly enhances flow stability and suppresses unrealistic oscillations observed in conventional models. This study provides a strong applied mathematical foundation for modeling realistic driver behavior in AV traffic systems and highlights the combined influence of reaction delay, sensitivity asymmetry, and traffic density on flow dynamics.

**32. Gokarna Aryal** – *L-estimation of Location-Scale Distributions Weighted by Cubic Rank Transmuted Kumaraswamy Distribution*

Purdue University Northwest, IN, USA

**Co-author(s):** Chudamani Poudyal, Keshav Pokhrel

**Abstract:** Identifying the underlying distribution from a sample dataset is always a critical task in statistical inference. For multimodal datasets, mixture models are commonly used and typically require iterative EM algorithms for parameter estimation—an approach that can be both computationally intensive and sensitive to initialization. To address these issues, we introduce a method in modeling standalone loss distributions by integrating L-estimation with a cubic rank transmuted Kumaraswamy (CRTK) probability density with unit support - as the weight-generating function. The CRTK-weighted L-estimation framework is particularly effective for multimodal data, enabling flexible weighing schemes that capture complex distributional shapes. Through simulation studies and real-world bimodal dataset analysis, we show that CRTK-weighted models offer competitive or superior performance compared to finite mixture models in terms of flexibility, efficiency, and parsimony.

**33. Subhash Aryal** – *Association of clinical empathy with suicidal ideation among patients with chronic pain: target trial emulation*

Johns Hopkins University School of Nursing, MD, USA

**Abstract:** Background: Suicidal ideation is associated with chronic pain. Aim: To measure the association of clinical empathy with suicidal ideation among patients with chronic low back pain. Design & setting: A target trial emulation was performed using adult patients selected from a national pain research registry in the United States from May 2018 to December 2023. Method: Patients having a physician who provided primary health care for their pain were followed for 12 months. Clinical empathy was assessed using the Consultation and Relational Empathy measure. Propensity-score matching of 936 registry patients without suicidal ideation at baseline yielded 185 patients each in greater and lesser clinical empathy groups. Suicidal

ideation and helplessness were measured with the Pain Catastrophizing Scale. Results: The median (IQR) age of patients was 55 (42-64) years and 281 (75.9%) were female. Twenty-seven (14.6%) patients in the greater clinical empathy group and 45 (24.3%) patients in the lesser clinical empathy group expressed suicidal ideation (RR, 0.60; 95% CI, 0.39-0.92; P=0.02). Correspondingly, 140 (75.7%) patients in the greater clinical empathy group and 164 (88.6%) patients in the lesser clinical empathy group expressed helplessness (RR, 0.85; 95% CI, 0.78-0.94; P=0.001). Conclusion: The decreased risk of suicidal ideation in the greater clinical empathy group has potentially important implications for the delivery of primary health care for chronic pain. Research is needed to replicate these findings and determine the effects of clinical empathy on suicide attempts and completed suicides.

**34. Ramesh Prasad Awasthi** – *Students’ Mathematical Errors in School Mathematics and Its Impact on Teaching and Learning*

Amrit Science Campus, TU, Nepal

**Abstract:** Students demand effective teaching and learning methods and good achievement in exams. During the writing of mathematics, they face different types of difficulties and express these difficulties as mathematical errors. The article presents how students make errors in mathematics and how these errors affect classroom teaching-learning activities. There are different types of mathematical errors found in students’ writing and speaking. Out of those errors, conceptual errors, procedural errors, language errors and measurement errors are the major errors. The objectives of the study are to identify common mathematical errors of 100 students studying grade 10 in community and institutional schools, and to find the impact on teaching-learning after remedial teaching for minimising these errors. The individual and group discussions, as well as interactions, are done to reduce errors. Class test and cross-check of homework copy are conducted after discussion and interaction. The mathematical errors are minimized upto 90%, and students show interest in writing mathematics after discussion and interactions. Meaningful teaching, learning and regular error analysis minimise the mathematical errors, and students get a chance to express their ideas independently during class time.

**35. Suman balasubramanian** – *Resilience of Transportation Networks*

DePauw University, Greencastle, USA

**Abstract:** The resilience of transportation networks to natural and manmade influences are vital to the flow of goods and services through the network. We will discuss special cases of the importance of edges and nodes in the given network relating to the overall network resilience.

**36. Aasis Baral** – *Modeling Dengue Transmission with Infection Heterogeneity*

Mid-West University, Nepal

**Abstract:** Dengue remains a significant public health concern due to heterogeneous infection patterns, where many infected individuals show no symptoms and may unknowingly contribute to transmission. This study introduces a mathematical model that incorporates heterogeneity by distinguishing between symptomatic and asymptomatic cases to better assess transmission risks. By analyzing the model’s stability, we estimate local transmission dynamics. The simulation results illustrate how these heterogeneous groups contribute differently to outbreaks, providing important evidence to support the development of more effective and data-driven control strategies by public health authorities in Nepal.

**37. Hynek Baran** – *An infinite commuting hierarchy of nonlocal symmetries for a PDE in three variables*

Silesian univerzity in Opava, Opava, Czechia

**Abstract:** We study the modified Martínez Alonso-Shabat equation

$$u_y u_{xz} + \alpha u + x u_{ty} - (u_z + \alpha u_t) u_{xy} = 0$$

and present its recursion operator and an infinite commuting hierarchy of full-fledged nonlocal symmetries. To date, such hierarchies have been found only for very few integrable systems in more than three independent variables.

**38. Ganesh Bahadur Basnet** – *A New Class of Laplace Transforms of Generalized Hypergeometric Functions  ${}_3F_3$  With Applications*

Tribhuvan University, Nepal

**Co-author(s):** Narayan Prasad Pahari

**Abstract:** A This paper presents a new class of Laplace transforms involving the generalized hypergeometric function  ${}_3F_3$ , along with their corresponding corollaries. By employing classical integral transform techniques and known summation theorems for the series  ${}_4F_3(1)$ , previously derived by Choi and Rathie, we obtain closed-form expressions for the Laplace transforms of  ${}_3F_3$ . The results are expressed in terms of well-known gamma functions. Furthermore, several special cases are discussed as applications. The results presented in this presentation are simple and can be established with relative ease. They may be useful for further studies and applications, such as the evaluation of definite integrals and the simplification of expressions involving higher transcendental functions.

**39. Deepak Basyal** – *Beyond a Single Concept: An Analysis of Fraction Constructs in Nepali Elementary Textbooks*

Coastal Carolina University, SC, USA

**Co-author(s):** Jöran Petersson

**Abstract:** Fractions are widely recognized as both a fundamental and challenging concept in mathematics education. Although extensive research highlights their importance, teaching and learning fractions remain difficult for both teachers and students. In addition, curriculum materials often fail to adequately support the development of students' understanding of fraction concepts. Research suggests that fractions should not be treated as a single isolated concept; rather, they involve multiple constructs that require a holistic instructional approach. Therefore, it is important to examine whether instructional materials provide opportunities for students to engage with these different constructs of fractions. In this study, we analyze elementary school mathematics textbooks currently used in Nepali schools to investigate how fraction concepts are presented. We report key findings from this analysis and present insights that may be of interest to teachers, textbook authors, and other stakeholders concerned with the teaching and learning of fractions.

**40. Diptiranjan Behera** – *System of linear equations in the presence of fuzzy uncertainty: An alternative approach to the solution*

The University of the West Indies, Mona Campus, Kingston 7, Jamaica

**Abstract:** In this paper a system of algebraic equations in the presence of fuzzy uncertainty has been considered and accordingly a new alternative approach has been proposed to solve that system. In this problem we have considered all the parameters in terms of fuzzy except the coefficient matrix. The coefficient matrix is crisp in nature. In the literature, one can find a quite number of good methods for solving this type of problem, however there is a scope

for new method to investigate without the loss of generality. Accordingly, as explained here a straightforward approach based on the concept of generalized linear combination with the help of coefficient as trigonometric functions. In comparison to Behera (2023), here instead of four different coefficient parameters one can only require two parametric values to obtain the coefficients of the generalised linear combination. Using the proposed method the aim is to defuzzify the fuzzy system and solving that one can get the bounds of the fuzzy solution. Various example problems have been solved and compared with the existing results for validation. Keywords: Fuzzy system of linear equations, fuzzy number, generalised linear combination, trigonometric functions.

**41. Phanindra Prasad Bhandari** – *Center problem with fixed demands at prioritized vertices*

Khwopa Engineering College, PU, Nepal

**Co-author(s):** Shree Ram Khadka

**Abstract:** In this paper we consider 1-center problem requiring to locate a center within given region with respect to quickest fulfillment of demands/supplies at prioritized vertices. We study the problem with two quite different, with application point of views, aspects – facility location and evacuation center. The problems with first and second aspects are facility location problem and evacuation center problem, respectively. We propose polynomial time solution algorithms to both problems for uniform path length (UPL) network, a restricted class of networks.

**42. Arun Kumar Bhandari** – *Evaluating Phytoremediation Effects on Contaminant Transport in Unsaturated Soils*

Everest Engineering College, TU, Nepal

**Co-author(s):** Baldev Adhikari, Ramesh Chandra Timsina, Harihar Khanal, Kedar Nath Uprety

**Abstract:** Water flow in unsaturated soils is governed by capillary pressure gradients and described by the Richards equation, derived from the continuity equation and Darcy’s law. The equation is solved numerically using a finite difference scheme with Picard iteration to address the strong nonlinearity of soil hydraulic functions. The flow model is coupled with solute transport incorporating plant root uptake to examine phytoremediation in contaminated soils. Numerical simulations reveal phenomena such as flow instability, evaporation-driven moisture redistribution, and root-induced sink effects. Finally, we present numerical simulation results based on the Haverkamp and van Genuchten constitutive relations under identical boundary conditions and plant transpiration rates.

**43. Subash Bhandari** – *Non-Linear Dynamics and Cosmological Perturbations on Quintom Dark Energy Model with recent DESI BAO Observations*

St. Xavier’s College, Kathmandu, Nepal

**Abstract:** We present a nonlinear dynamical stability analysis of the Quintom dark energy model, which is characterized by a dark energy equation-of-state (EoS) parameter  $\omega(z)$  that crosses the phantom divide  $\omega = -1$ . This model is governed by nonlinear differential equations arising from the coupled Einstein-Boltzmann system and inherently exhibits rich nonlinear dynamics, including chaotic transitions at phantom-divide crossings. Employing autonomous equations, we derive stability conditions for  $\omega(z)$  and perform a detailed phase diagram analysis. Numerical simulations of small-scale density perturbations reveal the evolutionary trajectories and chaotic behavior during the cosmic expansion history. Further, we explore observational constraints on the model by incorporating recent cosmological observations, including Pantheon+, Dark Energy Spectroscopic Instrument (DESI) Baryon Acoustic Oscillation data, and

Planck 2018 CMB priors, and test model viability amid hints of evolving dark energy and possible phantom-divide behavior.

**44. Bishnu Prasad Bhandari** – *Analytical Study of Blood Flow in an Elliptical Stenosed Curved Artery with Relevance to CFD*

Tribhuvan University, Nepal

**Co-author(s):** Chudamani Pokharel, Kedar Chhatkuli, Jeevan Kaffle

**Abstract:** Abstract: Blood flow in stenosed arteries is strongly influenced by vessel geometry, curvature, and blood rheology, all of which play a crucial role in cardiovascular disorders. In this study, an analytical investigation is presented for steady blood flow through a curved artery with an elliptical stenosis, incorporating the combined effects of hematocrit-dependent viscosity and arterial curvature. The governing Navier–Stokes equations are formulated in cylindrical polar coordinates and solved analytically using an effective viscosity model based on Einstein’s relation. Explicit expressions are obtained for the velocity profile, volumetric flow rate, pressure drop, and wall shear stress. The results demonstrate that increases in viscosity, hematocrit, curvature, and stenosis severity significantly reduce axial velocity and volumetric flow rate, while substantially increasing pressure drop and wall shear stress within the stenosed region. Elliptical stenosis geometry is found to intensify flow resistance and shear amplification compared to non-stenosed segments, indicating enhanced hemodynamic risk. Although computational fluid dynamics is not directly employed, the analytical trends are consistent with reported CFD studies, providing a reliable theoretical benchmark for numerical validation and offering insight into stenosis-induced hemodynamic alterations relevant to clinical assessment and vascular device design.

**45. Biseswar Prashad Bhatt** – *Maximal Monotone Operators on Product Spaces*

Tribhuvan University, Nepal

**Abstract:** Let  $X$  and  $Y$  be real Banach spaces with duals  $X^*$  and  $Y^*$ , respectively. Let  $T : X \rightarrow 2^{X^*}$  and  $S : Y \rightarrow 2^{Y^*}$  maximal monotone operators. We discuss some known results on the maximality of the sum  $T + S$  in the case when  $X = Y$  and an important characterization of maximal monotone operators in general Banach spaces. As our main result, we prove that the operator  $H : X \times Y \rightarrow 2^{X^* \times Y^*}$  defined by

$$H(x, y) = \{(x^*, y^*) : x^* \in Tx, y^* \in Sy\}, \quad (x, y) \in X \times Y,$$

is maximal monotone.

**46. Ghanshyam Bhatt** – *The Method of Brackets: An Approach to Definite Integrals*

Tennessee State University, TN, USA

**Abstract:** The method of brackets is an effective tool for the evaluation of a wide class of definite integrals, particularly those arising in applied mathematics and mathematical physics. In this talk, we present the main principles of the method of brackets and illustrate its use through several representative examples.

**47. Raghubir Bhatta** – *Analysis of a Modified SIR Model Incorporating Awareness in the Transmission Dynamics of Communicable Diseases*

Aishwarya Multiple Campus, Dhangadhi, Nepal

**Abstract:** Communicable diseases remain a major public health concern with significant socio-economic impacts worldwide. This study investigates the role of awareness in controlling disease

transmission using a modified SIR (Susceptible–Infectious–Recovered) model. In particular, yoga awareness is incorporated as a preventive intervention influencing individual behavior and health practices. The classical SIR model is extended by introducing an awareness-dependent transmission rate, denoted by  $\beta_1$ , which is assumed to be lower than the baseline transmission rate  $\beta$ . The resulting system of ordinary differential equations is analyzed using standard mathematical techniques. The reproduction number associated with awareness,  $R_a$ , is derived via the next-generation matrix method. Sensitivity analysis reveals that  $R_a$  decreases with increasing awareness coverage and higher recovery rates, indicating a reduction in disease spread and infectious duration. Stability analysis shows that the disease-free equilibrium is locally and globally asymptotically stable when  $R_a < 1$ , whereas an endemic equilibrium exists when  $R_a > 1$ . Numerical simulations support the analytical results and demonstrate that increased awareness significantly reduces both susceptibility and transmission. The findings highlight the importance of awareness-based interventions, such as yoga-informed lifestyle practices, in mitigating the dynamics of communicable diseases.

**48. Hari Prasad Bhattarai** – *Mathematical Modeling of Tuberculosis: Exploring Paths to Achieve the SDG Elimination Plan in Nepal*

Himalaya College of Engineering, Nepal

**Abstract:** Tuberculosis (TB) remains a significant public health challenge in Nepal despite ongoing control efforts and high treatment success rates. However, many TB cases remain undiagnosed, slowing progress toward the targets of the WHO End TB Strategy and the Sustainable Development Goals (SDGs). We develop a mathematical model to analyze the transmission dynamics of TB and to assess the intervention strategies required to achieve TB reduction targets in Nepal by 2030 and 2035, and to become “TB-free” by 2050. The model is parameterized using available national epidemiological data and evaluates the impact of improved diagnostic coverage and community-based case detection. Our study explores the effectiveness of different intervention strategies and shows that strengthening early diagnosis and expanding community-led treatment can substantially reduce TB transmission and accelerate progress toward these targets.

**49. Pushpa Bhattarai** – *Organizational citizenship behavior (ocb): a study of faculty member of faculty of constituent and affiliated colleges of koshi province, Nepal*

Purbanchal University, Nepal

**Abstract:** This study investigates organizational citizenship behavior (OCB) among faculty members of constituent and affiliated colleges of Koshi Province, Nepal. The study is based on the facts of unequal governance, resource support, and institutional conditions in Nepalese higher education. For data collection purposes, a quantitative survey methodology was applied, and information was gathered from a total number of 394 faculty members teaching management courses in 38 colleges in Koshi Province (8 constituent and 30 affiliated). For designing the questionnaire used in the study, procedures of translation, pilot testing, and psychometric evaluation were applied; the result was an instrument that proved itself reliable and valid. According to descriptive findings, faculty OCB is moderate, which implies that voluntary behaviors, including collegial support, help in college affairs, and conscientious compliance with organizational rules, are current but not yet deeply embedded. Correlation and multiple regression analyses indicate that all the variables of organizational commitment, job satisfaction, organizational justice, perceived organizational support, and organizational motive are significantly positively related with OCB. The combination of these variables explain 66.4% of the variance in OCB, with organization commitment coming out as the most significant predictor. The study also identifies that faculty in constituent college’s record much higher OCB and a

better organizational environment than in affiliated colleges, but not by gender. The findings support social exchange, attitudinal, and motivational approaches on citizenship behavior and emphasize the significance of fairness, support, satisfaction, commitment, and internal motivation in faculty contribution beyond the formal role. The study offers practical implications to university leaders and policymakers who have to improve institutional performance and create more supportive, participatory, and academically productive higher education contexts in Nepal.

#### **50. Gauri Bhujū** – *Analysis of Fuzzy SEIR–SEI Dengue Transmission Dynamics*

Bhaktapur Multiple Campus, TU

**Co-author(s):** Ganga Ram Phajoo, Dil Bahadur Gurung

**Abstract:** Dengue is a mosquito-borne infectious disease that remains a major public health problem in tropical and subtropical regions. In the present work, a fuzzy SEIR–SEI model is developed to describe the transmission dynamics of dengue between human and mosquito populations under parameter uncertainty. The transmission rate and recovery rate are modeled as triangular fuzzy numbers, and the  $\alpha$ –cut method is used to transform the fuzzy system into interval-valued differential equations. Using the next-generation matrix approach, a fuzzy basic reproduction number  $R_0(\alpha)$  is derived to measure the transmission potential of the disease under uncertainty. The stability of the disease-free equilibrium is characterized in terms of this fuzzy threshold parameter. Numerical simulations are performed to evaluate  $R_0(\alpha)$  across different  $\alpha$ –levels. The results demonstrate that incorporating fuzzy parameters provides a more realistic representation of uncertainty in dengue transmission dynamics.

#### **51. Madhav Kumar Bhusal** – *Exploring Individual and Community-Level Determinants of Under-five Mortality in Nepal Using Multilevel Modeling*

Central Department of Statistics, Tribhuvan University, Nepal

**Co-author(s):** Shankar Prasad Khanal

**Abstract:** Background: Under-five mortality (U5M) remains a major global public health concern. Mortality rates vary across settings due to differences in socioeconomic disparities, community environments, access to healthcare services, and other allied factors. Although Nepal has made notable progress in reducing child mortality over the past decades, the recent decline has slowed, posing challenges to achieving the Sustainable Development Goals (SDGs) target for U5M reduction by 2030.

Methods: This study examined individual and community-level determinants of U5M in Nepal. A population-based cross-sectional design was used to analyze nationally representative data from the 2022 Nepal Demographic and Health Survey (NDHS). The analysis included a weighted sample of 5,193 children under five years. Multilevel logistic regression models were applied to identify the factors of U5M (alive or died) at the individual level (level 1), nested within 74 districts at level 2.

Results: During the 5 years preceding the survey, 153 of 5,193 children died before reaching the age of five. Children younger than five born to mothers with total children ever born (CEB)  $\geq 3$  (AOR: 3.45, 95% CI: 1.52 – 7.83) as compared to those whose mothers had total CEB  $< 3$ , the short preceding birth interval (PBI)  $< 24$  months (AOR: 2.45, 95% CI: 1.18 – 5.07) in contrast to  $\geq 24$ , and place of delivery at home (AOR: 3.14, 95% CI: 1.51 – 6.53) as compared to those born at health facility had increased odds of dying before the age five. Whereas children from households having  $> 2$  children aged  $\leq 5$  (AOR: 0.19, 95% CI: 0.044 – 0.87) in contrast to those having  $\leq 2$ , and those residing in the communities where  $\leq 48\%$  mothers had access to media (AOR: 0.36, 95% CI: 0.14 – 0.89) relative to those born in the communities with  $> 48\%$  had lower odds of U5M.

Conclusions: The total CEB, the number of children aged  $\leq 5$  in the household, the PBI, and the place of delivery were identified as key individual-level determinants of U5M. At the community level, the proportion of mothers with access to mass media was also associated with U5M. Strengthening public health interventions that promote adequate birth spacing, institutional deliveries, family planning awareness, and wider access to mass media for maternal and newborn health education is essential to reduce U5M in Nepal.

**52. Milan Bimali** – *Left-Censored Longitudinal PFAS Data in a Randomized Controlled Trial: Comparing Imputation and Censored Regression Methods*

University of Arkansas for Medical Sciences, AR, USA

**Co-author(s):** Todd Everson, Kevin Pearson, Andrew Morris, Brittany Burgener, Elisabet Borsheim, Lauren Havens, Aline Andres

**Abstract:** Per- and polyfluoroalkyl substances (PFAS) are environmental contaminants of significant public health concern due to their ubiquity and effects on human health. PFAS data can include measurements below the limit of detection (LOD) and are therefore left-censored. Several approaches are used to analyze left-censored data. These methods include single imputation using scaled LOD, complete case analysis (CCA), multiple imputation using chained equations (MICE), and censored regression. Comparative evaluations of these methods in the context of longitudinal data remain limited, specifically in assessing differences in the strength of evidence they provide under varying modeling assumptions. We compared these methods using four PFAS analytes with  $\geq 50\%$  detectable values from a randomized controlled trial of pregnant participants with obesity and sedentary behaviors who were randomized to a physical activity intervention or standard of care, to assess the effect of physical activity on PFAS measures during pregnancy. Statistical analyses included scaled LOD imputation, CCA, longitudinal MICE, and a multilevel Tobit model. The effect sizes were consistent across methods. Among the four PFAS, baseline-adjusted perfluoropentanoic acid (PFPeA) showed suggestive evidence of reduction in the intervention group. Intervention effects (ratios of means) and 95% confidence intervals (CI) were 0.80 (0.62–1.04, p-value = 0.08), 0.78 (0.64–0.95, p-value = 0.01), 0.79 (0.61–1.02, p-value = 0.07), and 0.72 (0.49–1.06, p-value = 0.10) across the four methods, respectively. Findings must be interpreted cautiously due to differences in modeling assumptions.

**53. Pawan Kumar BK** – *Predator-Prey Dynamics in Economic and Financial Systems*

Tribhuvan University, Nepal

**Co-author(s):** Pitambar Acharya, Deepak Bastola, Deepak Dulal

**Abstract:** This paper develops a rigorous, self-contained mathematical framework for applying predator–prey dynamical systems to economic and financial phenomena. Beginning with a complete analysis of the classical Lotka–Volterra equations, including positive invariance, a conserved Hamiltonian, and center stability via a strict Lyapunov function—we systematically derive and analyze three classes of socioeconomic models. First, the Goodwin growth-cycle model is established as an exact algebraic isomorphism with the Lotka–Volterra system, yielding a closed-orbit characterization of endogenous business cycles. Second, a two-species debt–capital predator–prey model is derived from microeconomic first principles: we prove, via an explicit Lyapunov function, that the condition  $rD > rC$  (net interest rate exceeding capital return) constitutes a necessary and sufficient criterion for Minskyan financial instability, providing the first rigorous stability-theoretic proof of Minsky’s Financial Instability Hypothesis within a predator–prey framework. Third, a three-species extension incorporating financial super-predators (highly leveraged speculative intermediaries) is introduced and analyzed; the existence of a unique interior equilibrium is established, and a Hopf bifurcation leading to

period-doubling and eventual chaos is characterized via Routh–Hurwitz conditions. As a further original contribution, we formulate a stochastic agent-based generalization of the buyer–seller model with herding and prove a law-of-large-numbers convergence theorem: as the number of agents  $N \rightarrow \infty$ , the stochastic system converges in probability, uniformly on compact time intervals, to the deterministic Lotka–Volterra ODE. Equilibrium analysis, local and global stability theorems, phase-portrait numerics, and policy implications are presented throughout.

**54. Tek Bahadur Budhathoki** – *Dynamic Analysis of Mixture Mass Flow in Nepalese Super grains*

Thapathali Campus, TU, Nepal

**Co-author(s):** Puskar Raj Pokhrel

**Abstract:** Abstract: Geophysical mass flows, such as landslides, debris flows, and rock avalanches, represent significant natural hazards. This study explores the mechanics of mass flows through the lens of mathematical modeling, employing partial differential equations to describe their behavior. Specifically, we introduce a model for mixture mass flows, providing experimental results that reveal the dynamics of these flows and the morphology of their deposition in the run-out zone. Our experimental setup utilizes a mixture of Nepalese super grains- Hog plum seeds (Champati) and Horse gram (Gahat). Despite their material properties, the mixture demonstrates unique mechanical behavior. Through a detailed analysis of these flows, we elucidate key dynamic properties and offer insights into their behavior. This research contributes to the broader understanding of geophysical mass flows, with implications for hazard assessment and mitigation strategies.

**55. Ganga Ram D C** – *Modeling the Transmission Dynamics of Lumpy Skin Disease in a Metapopulation*

Tribhuvan University, Nepal

**Co-author(s):** JIvandar Jnawali, Kedar Nath Uprety, Naveen K. Vaidya

**Abstract:** Lumpy skin disease (LSD), caused by the lumpy skin disease virus, is a highly host-specific and transboundary emerging disease of cattle and Asian water buffalo that causes substantial economic losses and is primarily transmitted mechanically by arthropod vectors. The disease is endemic in most African countries and has since 2012 spread rapidly through the Middle East, South-East Europe, West and Central Asia, with multiple outbreaks reported across Asia since 2019 and recent incursions into South-East Asia, yet critical gaps remain in understanding how spatial heterogeneity and transmission mechanisms shape disease dynamics in connected landscapes. To address this, we develop a multi-patch metapopulation model for LSD transmission in Karnali Province, Nepal, integrating within-patch SIR-type dynamics for cattle coupled with vector dynamics and between-patch cattle movement. The model incorporates both vector-mediated and direct contact transmission pathways, with patch-specific cattle populations, transmission rates, mortality rates, and initial infection values, while mobility parameters between ten districts were derived from correlation coefficients of new infection patterns. Global PRCC sensitivity analysis reveals that vector-mediated transmission rates are substantially more influential than direct contact rates in driving LSD dynamics, highlighting the dominant role of vector-borne spread. Furthermore, cattle mobility emerges as a highly sensitive parameter in shaping spatial disease distribution. These findings demonstrate that effective LSD control requires an integrated approach combining insecticide application, isolation of infected animals, and strategic vaccination, with intervention strategies tailored to local transmission intensity and mobility patterns.

**56. Harsh Bahadur Chand** – *Undergraduate Mathematics Education Students' Performance*

Far Western University, Nepal

**Abstract:** In the proof oriented courses like real analysis and abstract algebra, large portion of the curriculum can be found to be devoted to the proof comprehension and proof construction. However, only few studies were carried out regarding the proof comprehension in undergraduate mathematics education students. In this regard, this study was carried out to explore status of local and holistic aspects of proof comprehension in real analysis among undergraduate mathematics education students in Western Nepal. For this research, qualitative research design was used under an interpretive paradigm. Proof comprehension test and interview protocols were used as data collection tools. Sixteen students enrolled in undergraduate mathematics education program who have completed two semester real analysis course of two of the universities situated in the Western Nepal were selected as the participants of the study. I conducted the proof comprehension tests of all the participants followed by interviews of purposively selected six students. I coded the data and generated themes. I found that the participants showed weak performance in both local and holistic aspects of proof comprehension. Comparatively, holistic aspects were seemed problematic than the local aspects. The results of this study might be useful for the undergraduate students, university teachers, and researchers.

**57. Kedar Nath Chhatkuli** – *A mathematical modelling of two-layered blood flow through artery with bell-shaped stenosis*

Tribhuvan University, Nepal

**Co-author(s):** Bishnu Prasad Bhandari, Chudamani Pokharel, Jeevan Kafle

**Abstract:** This study examines how bell-shaped stenosis affects the two-layered blood flow in arteries, which is important to know about cardiovascular health. We use the Navier-Stokes equation in cylindrical polar coordinates to derive analytical solutions for key two-layered hemodynamic parameters such as wall shear stress, velocity, pressure, and pressure drop ratio. The dynamics of pressure drop and shear stress ratios inside the bell-shaped stenotic area are investigated using numerical integration in core layer as well as peripheral layer. This paper examines and analyses a variety of flow parameters while taking blood into account as a Newtonian fluid. Given that bell-shaped stenosis increases the likelihood of developing diseases including ischaemic heart disease and stroke, this study provides important new information about how two-layered blood flow behaves in this state. By improving the ability to manage and treat cardiovascular disorders, the findings aid in the development of sophisticated analytical tools and treatment approaches in cardiology and bio-fluid mechanics.

**58. Maya Chhetri** – *Regularity and explicit  $L^\infty$  estimates for a class of elliptic systems*

The University of North Carolina Greensboro, NC, USA

**Abstract:** We establish an explicit  $L^\infty(\Omega)$  a priori estimate for weak solutions to subcritical elliptic problems with nonlinearity on the boundary, in terms of the powers of their  $H^1(\Omega)$  norms. To prove our result, we combine Moser type estimates together with elliptic regularity and Gagliardo–Nirenberg interpolation inequality.

**59. Mabel Cuesta** – *Multiplicity Results for Nonlinear Elliptic Problems with Indefinite Weights*

Université du Littoral Côte d’Opale, Calais, France

**Abstract:** Nonlinear elliptic equations arise naturally when studying stationary solutions of reaction–diffusion equations, such as the heat equation, as well as Schrödinger or Navier–Stokes

equations, all of which involve the diffusion operator  $-\Delta u$ . Among these partial differential equations, an important class consists of problems involving a nonlinear term  $f(u)$ . There is a vast literature concerning the existence of solutions when the growth of  $f$  does not exceed a critical power depending on the dimension  $N$  of the spatial domain where the problem is posed. In this talk, we consider the following nonlinear elliptic problem involving a slightly subcritical nonlinearity and a sign-changing weight  $m \in C^1(\Omega)$ :

$$\begin{cases} -\Delta u = \lambda u + m(x)f(u), & \text{in } \Omega, \\ u > 0 & \text{in } \Omega, \\ u = 0 & \text{on } \partial\Omega, \end{cases}$$

where  $\Omega$  is a smooth bounded domain of  $\mathbb{R}^N$ , with  $N \geq 2$ . A model nonlinearity we have in mind is

$$f(s) = \frac{s^{\frac{N+2}{N-2}}}{\ln(e+s)^\alpha}, \quad \alpha > 0.$$

Nonlinearities of this type fall outside the standard framework of subcritical elliptic problems. We will revisit the classical bifurcation result of Crandall–Rabinowitz [1] and the quasilinear version of Drabek. These results will allow us to prove the existence of a bifurcating branch of positive solutions containing a turning point, which leads to multiplicity results. This talk is based on joint work with Prof. Rosa Pardo.

**60. Keshab Dahal** – *Deep Learning-Based Prediction of Nepal Stock Exchange Movements from Financial News Headlines*

State University of New York Cortland, Cortland, USA

**Abstract:** Predicting the direction of stock market movements is a challenging task due to its fuzzy, chaotic, volatile, nonlinear, and complex nature. However, with advancements in artificial intelligence, abundant data availability, and improved computational capabilities, creating robust models capable of accurately predicting stock market movement is now feasible. This study aims to develop a predictive model using news headlines to forecast the direction of stock market movements. It conducts a comparative analysis of four supervised classification deep learning models—long short-term memory (LSTM), gated recurrent unit (GRU), bidirectional long short-term memory (BiLSTM), and bidirectional gated recurrent unit (BiGRU)—to predict the next day’s movement direction of the close price of the Nepal Stock Exchange (NEPSE) index. Sentiment scores from the news headlines are computed using the Valence Aware Dictionary for Sentiment Reasoning (VADER) and TextBlob sentiment analyzer. The models’ performance is evaluated based on sensitivity, specificity, accuracy, and the area under the receiver operating characteristic (ROC) curve (AUC). Experimental results indicate that all four models perform similarly when using sentiment scores from either VADER or TextBlob. Additionally, GRU and BiGRU models show consistent performance across both sentiment analyzers. However, LSTM and BiLSTM perform slightly better with TextBlob sentiment scores compared to those from VADER. These findings are further validated through statistical tests.

**61. Rajendra Dahal** – *Determining Drug Dosage Using Calculus*

Coastal Carolina University, SC, USA

**Co-author(s):** Keith Bullard

**Abstract:** For most drugs, there is a concentration below which the drug is ineffective and a concentration above which the drug is dangerous. Addressing the question of the appropriate dosage and frequency of administration is crucial in pharmacology. In this presentation, we will study how the dosage and dosing intervals can be modified to ensure a safe, yet efficient, level of the drug in the bloodstream.

## 62. Bekha R. Dangol – *Some Analytical Solutions to Mixture Mass Flows*

Tribhuvan University, Patan Multiple Campus, Nepal

**Co-author(s):** Shiva P. Pudasaini

**Abstract:** Mathematical models and their analytical solutions are commonly employed methods to better understand the mechanics of mass flows. These flows involve mixtures of soil particles and viscous fluid, whose motion is governed by phase interactions, relative motion, and viscous effects. Here, some novel analytical solutions to the general two-phase mixture model (Pudasaini, 2012) are derived, expressing the physical and mechanical parameters in terms of the state variables. The solutions fully describe solid, fluid, and mixture velocities under gravity, Coulomb friction, interfacial and viscous drag. Explicit solutions for solid and fluid velocities are obtained using two approaches: Coupling with velocity drift and coupling with solid velocity. Analysis of the phase velocities with physically realistic parameters highlights the roles of Coulomb friction, interfacial drag, and viscous drag. Without these resistive forces, motion is driven only by gravity and velocity increases monotonically without bound, which is physically unrealistic. When all resistive forces act together, their combined effect produces a stronger decelerating force than any individual or other combined mechanisms. As a result, velocity increases only during the incipient motion before quickly approaching a terminal velocity. For comparative analysis of the solid and fluid velocities in the mixture flows, the system of differential equations is also solved numerically under different initial conditions, as analytical solutions of the fully coupled nonlinear system are generally not feasible. Accurate phase-velocity estimation is important for landslide hazard assessment, protective structure design, and mitigation planning.

## 63. Maximilian Dauner – *Learning the Invisible: Neural Wind Field Prediction for Realistic Urban Flight Simulation*

Munich University of Applied Sciences HM, Munich Center for Digital Sciences and AI, Germany

**Co-author(s):** Michael Kurz, Gudrun Socher, Alexander Knoll

**Abstract:** Urban flight operations are strongly affected by complex wind phenomena such as gusts, shear, vortices, and building-induced turbulence, which are difficult to perceive, predict, and reproduce in conventional simulators. This talk presents the integration of a Factorized Fourier Neural Operator into a high-fidelity H145 Level D full-flight simulator to generate realistic three-dimensional urban wind fields in real time. The predicted wind fields are coupled directly to the simulator, sampled at the helicopter position, and used to create dynamic wind and turbulence effects during pilot-in-the-loop scenarios. In addition, hazardous flow regions are identified and visualized as adaptive keep-out geofences to support situational awareness during urban approach and landing. Initial pilot evaluations show that the system can reproduce realistic wind effects around buildings and offers promising training value for rotorcraft operations and future urban air mobility.

## 64. Mitra Devkota – *School quality capitalization in suburban housing markets: evidence from Alpharetta, Georgia*

University of North Georgia, GA, USA

**Co-author(s):** Humnath Panta, Arun Narayanasamy

**Abstract:** This study investigates the effects of structural features and High School Assignments on residential property prices. We use hedonic regressions for single-family homes in Alpharetta, Georgia, to estimate how public high school zoning impacts prices. After controlling for lot size, interior area, age, and other structural features, homes zoned to Alpharetta,

Cambridge, Innovation Academy, and Milton sell for about 17 to 21 percent more than similar homes zoned to Centennial. The estimates remain strong even after log transformations and tests for multicollinearity. Structural characteristics have expected effects, showing that school quality and accessibility are both considered in suburban housing values.

**65. Rasmit Devkota** – *Numerical optimization of error control scheduling in quantum algorithms*

Georgia Institute of Technology, GA, USA

**Co-author(s):** Nolan Heffner, Younos Hashem, Noah Song, Benjamin Hagan

**Abstract:** Quantum computation poses a potential solution for solving problems in mathematics and the natural sciences at a scale potentially larger than is currently possible by means of classical computation. However, such algorithms tend to be very large and error-sensitive, requiring the use of quantum error mitigation, detection, and correction (QEMDAC) techniques which are performed during computation to minimize error. QEMDAC techniques themselves are also expensive and not fully robust in their current form, prompting studies into how these techniques should be scheduled in a computation to minimize overhead while maximizing the suppression of errors. The existing literature approaches the problem from a simplified perspective which does not take into account all of the relevant hardware noise parameters and lacks real-world applicability. In this work, we perform a more comprehensive study of the numerical optimization of QEMDAC timing by considering a more extensive set of hardware parameters, as well as interaction effects between different steps of the computation. By benchmarking our approaches against many-body simulation problems in high-energy and condensed matter physics, we show that such optimization results in higher-fidelity computation for useful quantum algorithms.

**66. Prem Kumari Dhakal** – *Effect of Virtual Learning Environment on Mathematics Achievement*

Mid-West University, Nepal

**Abstract:** The purpose of this study entitled ‘Effect of Virtual learning Environment on Mathematics Achievement’ was to assess the effect of virtual learning environment on mathematics achievement. This is quasi-experimental study and the data were collected through mathematics achievement test items that were constructed on the basis of specification grid of grade nine prescribed by curriculum development center, Nepal. The test items were finalized after piloting and finding difficulty and discrimination index. This study site was Birendranagar Municipality, Surkhet. Sixty six students of grade nine from two institutional schools were the participants. The intervention and comparison groups were made similar on the basis of the achievement scores on mathematics in basic level examination, score of first ability test and the score of pre-test. The intervention package was of 8 weeks with 24 teaching hours of the unit ‘Mensuration’ of grade nine. SPSS-20 was used to analyze the quantitative data statistically. The finding of this study indicated that virtual mode of learning is effective than face to face learning approach. Significant difference between the achievement score of intervention and comparison groups revealed that mathematics can be taught effectively in secondary level using different tools and software through virtual mode.

**67. Ram Chandra Dhungana** – *Budget-Constrained Facility and Flow Optimization in Evacuation Network*

Kathmandu University, Nepal

**Abstract:** Designing evacuation strategies entails resolving decision problems with multiple, of-

ten competing objectives. This study develops an integrated optimization framework grounded in multi-objective network flow theory to address such complexity. The proposed model simultaneously determines optimal facility locations and flow optimizations, aiming to achieve both efficient and equitable evacuation outcomes. To further enhance network performance, a cost-sensitive contraflow mechanism is incorporated, which selectively reverses underutilized arcs while accounting for associated switching and traffic management costs. By embedding these practical considerations, the framework enables systematic evaluation of trade-offs among operational feasibility, cost efficiency, and evacuation effectiveness in disaster management contexts.

**68. Sukanya Dutta** – *Analytical Structures and Exact Solutions of Integrable Nonlinear Evolution Equation*

**Co-author(s):** Nonlinear mathematical models, governed by partial differential equations, describe a range of real-world phenomena, including wave propagation, fluid dynamics, plasma physics, biological systems, and optical fibres. Over the decades, the nonlinear evolution equations have been used to explain the dynamic behaviour of the above phenomena. The integrability of these equations is a fundamental property that reflects the algebraic and geometric structures of the system. Numerous analytical methods have been developed to test integrability and to construct exact solutions for integrable models. Exact solutions are crucial for understanding nonlinear wave phenomena, which include solitons, kinks, lumps, breathers, and even more exotic structures like Wronskian, Grammian, and Pfaffian solutions, as well as positons, negatons, and complexitons. Among the available techniques, the Hirota bilinear method provides a powerful, systematic framework for transforming nonlinear equations into a bilinear form. Once this bilinear representation is established, various determinants and Pfaffian-based approaches, such as Wronskian, Grammian, and Pfaffian methods, Pfaffianization, can be employed to generate a wide range of exact solutions. Moreover, Bilinear Bäcklund transformations have evolved as an important tool within the Hirota bilinear method, allowing new solutions to be derived from known ones and, in some cases, revealing connections between different integrable equations. In this work, we highlight how these analytical techniques enhance the physical understanding of nonlinear phenomena in various scientific fields for a nonlinear evolution equation model.

**Abstract:**

**69. Bullock Emma** – *Studying Wicked Problems: A Visualization Process to Guide Mixed Methods Data Collection and Analysis Through a Complexity Lens*

Sam Houston State University, TX, USA

**Abstract:** Background: In this presentation, I explore mixed methods data collection possibilities and advance practical guidance for researchers studying wicked problems to address Bronfenbrenner’s (1979) concern for ecological and developmental validity. Wicked problems, characterized by complex and nested systems that demonstrate emergent properties, are inherently difficult to study. Researchers would benefit from practical guidance that move beyond reductionist design approaches that often result in oversimplified data collection plans (Bullock and Poth, 2024; 2025; Poth and Bullock, 2023). Design and Methods: To begin addressing issues of data oversimplification, I use a mathematics education example to illustrate a visualization process consisting of three strategies (Situating, Illustrating, and Capturing Influences) carried out in an interrelated, nonlinear, and iterative manner. Using the wicked problem of closing secondary mathematics achievement gaps in urban settings, I discuss situating the nested levels of influence in the wicked problem, illustrating the challenges with developing ecologically and developmentally valid data collection plans, and capturing influences that better represent diverse perspectives. Conclusions and Implications: I discuss the essential role of the result-

ing series of images for representing researchers' emerging understandings of complex system structures and stakeholder influences, highlighting the diverse perspectives necessary for mixed methods wicked problem data collection plans, and informing the selection of instruments that can yield more ecologically and developmentally valid findings.

Bronfenbrenner, U. (1979). *The ecology of human development: Experiments by nature and design*. Harvard University Press.

Bullock, E. P., and Poth, C. (2024). A visualization process to guide data collection plans when studying wicked problems: The example of closing secondary mathematics achievement gaps in urban settings. *International Journal of Complexity in Education*. 5:1, 7-40

Bullock, E. P., & Poth, C. N. (2025). Virtual Special Issue on "Complexity in Mixed Methods Research". *Journal of Mixed Methods Research*, 19(3), 230-236.

Poth, C., & Bullock, E. P. (2023). Mixed methods research design practices to address complexity in education. In T. Robert, R. Fazal, E. Kadriye, & S. Graham (Eds.), *International Encyclopedia of Education* (Vol. 12, pp. 615–625). Elsevier.

#### **70. Francesca Faraci** – *Singular Problems With Mixed Dirichlet-nonlinear Boundary Conditions on Annular Type Domains*

University of Catania, Italy

**Co-author(s):** Maya Chhetri

**Abstract:** We consider a class of singular elliptic problems in an annular-type domain, subject to zero Dirichlet condition on the interior boundary and a nonlinear boundary condition on the exterior boundary. We establish the existence of positive solutions for both mildly and strongly singular cases when the boundary nonlinearity exhibits sublinear growth at infinity. To this end, we first prove existence results for a more general class of problems with mixed Dirichlet–nonlinear boundary conditions, using the sub- and supersolution method.

#### **71. Di Gao** – *The Analysis of Gene Expression Using Statistical Learning Approaches*

Sam Houston State University, TX, USA

**Co-author(s):** Xiyuan Liu, Gang Shen

**Abstract:** The classification problem of gene expression level, specifically gene expression analysis, is a major research area in biostatistics. There are several classical methods to solve the classification problem. For example, hypothesis testing with the Benjamini-Hochberg method, Logistic regression, Hidden Markov Chain (HMM) model, and Support Vector Machine (SVM). These classical methods can be applied and perform well with some strict assumptions. One of such is the observations in the data should be independent. However, in gene analysis, these assumptions are violated. The Conditional Random Field (CRF) was introduced to solve the problem. This presentation will discuss some classical methods and the CRF model. Finally, the Least Absolute Selection and Shrinkage Operator (LASSO) penalty, a dimensional reduction method, is introduced to improve the CRF model.

#### **72. Shanta Gautam** – *Assessing the Components of Human Development Index (HDI) and Their Influence on Life Satisfaction: Evidence from Bagmati Province, Nepal*

CDRD, Tribhuvan University, Nepal

**Abstract:** This study is based on 568 survey responses based on structured questionnaire and collected information are from Bagmati Province using a three-stage stratified random sampling method. Data were gathered through intensive interviews in 17 municipalities across 8 districts representing Mountain, Hill, and Terai regions. The results show that there are significant differences in life satisfaction among three regions, as confirmed by Analysis of Variance ( $F =$

68.23,  $p < 0.05$ ). This means that the variation in life satisfaction is mainly due to real differences between groups rather than chance. Correlation analysis further shows that several factors are positively related (0.7) to life satisfaction level. The factors like social governance index has the strongest relationship, and followed by income, technology adaptation, and education index, all of which are statistically significant. This indicates that better governance, stronger social and cultural conditions, higher income, improved access to technology, and education all contribute to higher life satisfaction. Among these, governance and social conditions appear to have the greatest influence. In contrast, health does not show a significant relationship with life satisfaction in this study. This does not mean health is unimportant; rather, it suggests that most respondents were generally healthy, resulting in little variation in health status. Because of this, health acts as a background condition and does not strongly influence differences in reported life satisfaction. The relatively small sample size for correlation analysis may also limit the detection of its effect. Overall, the study concludes that life satisfaction is mainly influenced by social governance, income, and technology, while health remains a basic but less visible factor in this context.

**73. Ramesh Gautam** – *Modeling the Persistence of Japanese Encephalitis in Nepal: The Impact of Porcine Amplification and Waning Immunity*

Ratna Rajyalaxmi Campus, Tribhuvan University, Nepal

**Co-author(s):** Khagendra Adhikari, Anjana Pokharel

**Abstract:** This study develops a deterministic compartmental model to investigate the transmission dynamics of Japanese Encephalitis (JE) in Nepal, a nation where the disease remains endemic despite robust human immunization programs. Uniquely, our model integrates a One Health framework, incorporating both human and pig vaccination strategies alongside the dynamics of asymptomatic and symptomatic infections. Qualitative analysis reveals the presence of a backward bifurcation, a critical finding driven by the synergistic effects of waning vaccine-induced immunity in humans and silent viral amplification in porcine hosts. By validating the model with longitudinal secondary JE case data from Nepal, we demonstrate that the threshold policy of achieving a vaccination reproduction number slightly below unity is insufficient for eradication due to the coexistence of stable endemic and disease-free equilibria. Numerical simulations further confirm that the ecological reservoir in pigs creates a high-pressure transmission environment that human vaccination alone cannot overcome. Our findings suggest that to transition from JE control to elimination, Nepal must adopt a comprehensive strategy integrating life-course boosters for humans and a systematic vaccination program for domestic pig populations.

**74. Pushpa Nidhi Gautam** – *Mathematical modelling of blood flow through a curved artery with stenosis increasing over time*

Padma Kanya Multiple Campus, TU, Nepal

**Co-author(s):** Tuk Bahadur Rana, Jeevan Kafle

**Abstract:** The formation of stenosis in the lumen obstructs blood flow, causing disorders in the cardiovascular system. Since the curvature affects the flow parameters, which favors the deposition, the stenotic thickness increases gradually. Due to this, the lumen decreases, and flow becomes complicated. The effect of increasing stenosis in the curved part of the artery is investigated in this work using the Navier-Stokes equation in cylindrical polar form, considering blood as a Newtonian fluid. A new model is developed by incorporating curvature and a temporal term to address the combined effect. The equation, with appropriate boundary conditions, is solved to obtain analytical solutions for velocity, volumetric flow rate, pressure drop, and shear stress, with all results analyzed geometrically. The quantitative effect of in-

creasing stenosis on flow parameters in a curved artery is visualized, aiding researchers in the related field. The proposed model provides important insights for early diagnosis, prediction of disease progression, and timely clinical intervention in cardiovascular disorders, as well as valuable guidance for biomedical applications such as angioplasty planning and the design of cardiovascular medical devices.

**75. Ryad Ghanam** – *The origin of Lie symmetry methods for differential equations and the rise of abstract Lie algebras*

Virginia Commonwealth University in Qatar

**Abstract:** In this talk we shall focus on the origins of Lie theory and discuss several examples of differential equations to which the Lie symmetry method is applicable. Thereafter we shall trace the development of the theory of abstract Lie algebras and its importance in theoretical physics. We will also consider a special system of differential equations on Lie groups; called the geodesic equations of the canonical connection.

**76. Kailash Ghimire** – *Student Vulnerability Risk Index: Early Identification and Early Intervention in Gateway Mathematics Courses*

Georgia Southwestern State University, GA, USA

**Co-author(s):** Manoj Thapa

**Abstract:** Gateway mathematics courses often experience high rates of D, F, and withdrawal (DFW) outcomes, partly because gaps in prerequisite knowledge are not identified early. This paper describes an early identification and targeted support approach implemented in gateway mathematics courses, in which a short Week 1 diagnostic assessment was used to identify deficiencies in prerequisite skills. In addition, we explore the development of a Student Vulnerability Risk Index using logistic regression to help guide instructional interventions and targeted academic support.

**77. K P Ghimire** – *The effects of social media on senior secondary students' performance in mathematics*

NIST/NSS, Nepal

**Abstract:** This study investigates the effects of social media and technology use on the mathematics achievement of senior secondary students. In today's digital age, students regularly use smartphones, the internet, and social media platforms for both learning mathematics and entertainment. While technology can provide helpful learning resources, it may also create distractions that influence students' academic performance. The study was conducted among 270 Grade 12 science students studying mathematics, including both boys and girls, in 2025 AD from higher secondary schools situated in Kathmandu. The purpose was to understand how students' use of social media and digital technology relates to their learning performance in mathematics. Technology offers many learning benefits. Students can use educational apps, and digital learning materials to better understand mathematical concepts. These tools can make learning more interesting. However, excessive use of social media, online games, and messaging can reduce study time, affect concentration which may negatively influence academic performance. The findings suggest that technology itself is not entirely positive or negative. Its impact depends largely on how students use it and how well they manage their time. The study recommends that teachers, parents, and students promote responsible use of technology to improve learning outcomes in mathematics.

**78. Sabindra Giri** – *Mathematical Model for Malaria Transmisssion with Phase Wise Vacci-*

Himalaya College of Engineering, Nepal

**Abstract:** Malaria remains a major public health challenge, particularly for children under five years of age. Although the vaccine represents an important milestone, the effectiveness of different vaccination schedules and doses remains to be uncovered. In this study, we develop a malaria transmission model to explore the efficacy of phase-wise vaccination. Furthermore, we perform model analysis and simulation to assess the impact of the vaccination program on malaria transmission.

**79. Hari Gnawali** – *A Fractional Order SIR Model for Epidemic Dynamics*

Tribhuvan University, Nepal

**Abstract:** Classical integer order SIR models often fail to capture the memory effect and hereditary properties inherent in biological epidemic process. Therefore there is a need for a more accurate model to represent such dynamics. Traditional SIR models do not adequately represent non-local interactions and time-dependent behavioral changes in susceptible, infectious, and recovered populations. A fractional SIR model is presented by incorporating a fractional derivative in the Caputo sense. The model accounts for memory and non-local effects. The existence, uniqueness, stability, and equilibrium points of the fractional system are analyzed, along with numerical simulations. Numerical simulations demonstrate that fractional order parameters provide greater flexibility in fitting real-world outbreak data and capture the slow onset and long-tailed decay observed in many infectious diseases. The results highlight the advantage of fractional modeling over classical approaches for understanding and predicting complex epidemic dynamics.

**80. Santosh Gnawali** – *Massively Parallel Methods for Homological Constructions*

Janko Boehm, Lakshmi Ramesh, Wolfram Decker

**Co-author(s):** Free resolutions and related homological invariants are fundamental objects in commutative algebra and algebraic geometry, yet their computation is expensive. Computations over rational numbers face intermediate coefficient growth. Modular methods have proven effective in tackling this bottleneck. This talk presents two interrelated contributions from the author’s doctoral work, all implemented within the massively parallel Singular/GPI-Space framework. Building on Schreyer’s refined algorithm, we structure syzygy and free resolution computations as a tree traversal, and introduce parallelism via a Petri net formulation executed in the Singular/GPI-Space framework. All transitions are implemented in the Singular kernel for optimal performance. The implementation scales well and outperforms the built-in commands of Singular, with a pronounced advantage whenever coefficient arithmetic is expensive. A natural setting where coefficient arithmetic is particularly costly is birational geometry, where computations over  $\mathbb{Q}$  suffer from intermediate expression swell. This observation motivates our second result. A key challenge in birational geometry is the classification of algebraic varieties up to birational equivalence. Building on the parametrization algorithm implemented in `paraplanecurves.lib` (Böhm, Decker, Laplagne, Seelisch) and the massively parallel modular framework of Basson, Böhm, Marais, Rahn, and Rakotoarisoa, we develop a modular extension to compute parametrizations of rational normal curves and plane (singular) rational curves, as well as to lift specified differentials in a free resolution. Working modulo several primes and reconstructing via the Chinese Remainder Theorem avoids coefficient explosion and integrates naturally with the GPI-Space workflow. The parametrization of rational curves relies on freeresolutions as a core computational primitive, and a natural generalization is to seek resolutions in a richer algebraic setting — namely, over the exterior algebra — where they encode global geometric information via sheaf cohomology. Pursuing this direction, in joint work with J.

Böhm, W. Decker, and L. Ramesh, we develop a massively parallel algorithm for computing free resolutions over the exterior algebra  $E = \bigwedge V$ , where  $V$  is an  $n$ -dimensional vector space. The sequential foundation is due to Ramesh, which adapts the refined Schreyer algorithm to the non-commutative setting of  $E$  using relative Gröbner bases and implements it in the Singular library `sresext.lib`. We parallelize Ramesh’s algorithm using a Petri net formulation in the Singular/GPI-Space framework, extending the massively parallel approach for polynomial rings to the exterior algebra. Via the Eisenbud–Flöystad–Schreyer correspondence, this yields an efficient parallel method for computing the cohomology numbers  $h^i(\mathbb{P}^n, \widetilde{M}(d))$  of coherent sheaves over projective space.

**Abstract:**

**81. Shiva Prakash Gupta** – *Optimization of Multi-Commodity Flows under Arc Multipliers and Non-Symmetric Transit Times*

Tri-Chandra College, TU, Nepal

**Abstract:** Multi-commodity flow problem deals with routing several distinct goods from specific supply points to the corresponding demand points on an underlying network - not violating the capacity constraints. During transmission of commodities from one place to another, there may be chances of loss due to death, leakage or damage, or evaporation. To address this issue, each arc of the network contains a new attribute known as a loss factor, and the network is known as a generalized multi-commodity network. Motivated by the uneven road condition of transportation network topology, we incorporate a contraflow approach with orientation-dependent transit times on arcs and introduce the generalized multi-commodity contraflow problem with orientation-dependent transit times. In general, the generalized dynamic contraflow problem is NP-hard. For a lossy network with symmetric transit time on anti-parallel arcs, the problem is solved within pseudo-polynomial time. We present an extension of the analytical solution approach of single-commodity generalized dynamic contraflow problem to the case of multi-commodity with orientation-dependent transit times on arcs - both in discrete and continuous-time settings and provide algorithms which solve it within the same time complexity.

**82. Karel Hasik** – *Global stability of Wright-type equations with negative Schwarzian*

Silesian University in Opava, Czech Republic

**Abstract:** Simplicity of the 37/24-global stability criterion announced by E.M. Wright in 1955 and rigorously proved by B. Bánhelyi et al in 2014 for the delayed logistic equation raised the question of its possible extension for other population models. In our study, we answer this question by extending the 37/24- stability condition for the Wright-type equations with decreasing smooth nonlinearity  $f$  which has a negative Schwarzian and satisfies the standard negative feedback and boundedness assumptions. The proof contains the construction and careful analysis of qualitative properties of certain bounding relations. To validate our conclusions, these relations are evaluated at finite sets of points; for this purpose, we systematically use interval analysis.

**83. Harsh Jain** – *A Surrogate Modeling Framework for Data Informed and Uncertainty Aware Agent Based Modeling in Biology*

University of Minnesota Duluth, MN, USA

**Abstract:** Agent based models (ABMs) are a powerful way to represent complex biological systems when population level outcomes emerge from heterogeneous individuals interacting with each other and their local microenvironment. To support reliable quantitative prediction and mechanistic insight, ABMs must be connected to real data through calibration, and their pre-

dictions must be stress tested with uncertainty quantification and global sensitivity analysis. However, the inherent stochastic nature of ABMs, together with the extensive computational demands involved in simulating large agent populations, make these steps computationally infeasible for many realistic models. In this talk, we introduce two complementary methods that exploit explicitly formulated surrogate models to make these analyses practical: SMoRe ParS for efficiently calibrating ABMs to real-world data, and SMoRe GloS for enabling scalable global sensitivity analysis. We demonstrate our framework using examples from tumor biology including in vitro cell growth assays and 3D vascular tumor growth. Across these examples, analyses that would otherwise take days or weeks of computation become tractable while preserving calibrated behavior and sensitivity conclusions. Our method thus provides a robust and scalable strategy for leveraging multidimensional data to inform multiscale ABMs and explore the uncertainty in their parameters.

**84. Molhu Prasad Jaiswal** – *Bicomplex  $n$ -Normed Sequence Spaces in the Framework of  $l_p$  Spaces*

Narayan Prasad Pahari, Chet Raj Bhatta

**Co-author(s):** In this paper, we introduce a new class of sequence spaces  $m(\phi, \|\cdot\|_n)$  defined via an  $n$ -norm over bicomplex numbers, addressing a gap in the study of  $n$ -normed structures in the bicomplex setting. The algebraic and topological properties of the space are examined, including solidness, monotonicity, and symmetricity. It is shown that the space is solid and symmetric but not convergence-free. Additionally, inclusion relations with classical bicomplex sequence spaces  $\ell$  and  $\ell_\infty$  are established. The results provide a foundation for further developments in hypercomplex sequence space theory.

**Abstract:**

Keywords: bicomplex numbers,  $n$ -norm, sequence space, solidness, symmetricity, convergence-free property.

**85. Swikar Jaiswal** – *Budget Constrained Flow Improvement in Multi-Facility Induced Quickest Transshipment*

Kathmandu University, Nepal

**Co-author(s):** Ram Chandra Dhungana

**Abstract:** Natural or human-induced disasters place populations at risk and require the movement of evacuees from affected zones to shelters with limited capacity. Effective management of such movement requires in-route monitoring and control, which reduces the effective capacity of roads. While utilizing inbound roads for outbound flow can reduce evacuation time, it must be planned effectively for traffic management within limited resources. To address such an issue, a multi-objective optimization problem should be developed, combining NP-hard problems: facility placement, quickest transshipment, and budget-constrained contraflow. For a tractable solution, this is modeled as a multi-facility induced quickest transshipment with cost-aware contraflow on a fixed graph. Facility placement is represented by assigning  $q$  facilities to arcs, where the largest assigned facility determines the capacity reduction. Contraflow is incorporated through arc reversals with associated costs under a total budget constraint. A polynomial-time algorithm is developed via a reduction to a minimum cost flow problem on a fixed graph. For the  $q$ -FlowLoc problem, a heuristic procedure is implemented to obtain feasible placements. Based on these approaches, a polynomial time procedure is developed that returns an acceptable solution to the integrated problem.

**86. Jay Jha** – *Mathematical Modelling and Dynamic Analysis of Mixture Mass Flow with Viscosity and Pressure Effects*

Tribhuvan University, Nepal

**Abstract:** Debris flows are complex natural phenomena of geophysical hazards characterized by the rapid movement of saturated granular material. Understanding the dynamics of such flows is important for describing the transport behaviour of granular-fluid mixtures that arise in various natural environments. Employing the generalized mixture mass flow model developed by Pokhrel and Pudasaini (2018) which captures the distinct dynamics of the solid and fluid phases, as well as their interactions and also investigates the influence of viscosity and pressure on flow dynamics. This study presents a robust description framework for a two-phase mixture mass flow model designed to simulate debris flow dynamics over complex topography. We describe and analyse the mixture viscosity as well as mixture pressure, also to solve the depth-averaged conservation equations for mass and momentum. These equations are expressed as a system of nonlinear partial differential equations involving key parameters such as mixture density, solid volume fraction, gravitational forces, and interaction terms between the phases. Furthermore, the model shows improved predictive capability regarding runout distance and flow depth compared to equivalent single-phase approximations. These findings suggest that the proposed mathematical framework is a viable tool for hazard assessment and the design of mitigation structures in debris-flow-prone regions.

### 87. Anilchandra Jha – *Cakravāla Method for Integral Solutions of Vargaprakṛti*

Nepal Sanskrit University, Nepal

**Abstract:** The Hindu term for the indeterminate quadratic equation is varga-prakṛti. The most fundamental equation of this class is  $Nx^2 + 1 = y^2$ , where  $N$  is a non-square integer, which occupies a significant place in the history of number theory. The Hindu mathematician Bhāskarācārya developed a remarkably elegant and systematic approach to finding integral solutions to such equations, called Cakravāla or the Cyclic Method. This study adopts an analytical approach by examining classical Sanskrit texts alongside contemporary mathematical interpretations to reconstruct the algorithmic structure of the method. It focuses on the cyclic iteration process, the selection of appropriate intermediate values, and the convergence mechanism of the method. The findings indicate that the Cakravāla method provides an efficient and finite approach for determining minimal integer solutions. Additionally, it demonstrates rapid convergence and an implicit connection to continued fraction techniques that were later formalized in Europe for solving Pell's equation. The discussion emphasizes the originality and sophistication of this cyclic algorithm and highlights its role as a forerunner to modern methods, as well as its significant place in the global evolution of number theory.

### 88. Govind Jnawali – *Why Does Poverty Persist in a Sacred Tourism Destination? A PLS-SEM Analysis of Household Dependency Burden and Social Exclusion in Lumbini, Nepal*

Tribhuvan University, Nepal

**Co-author(s):** Rabindra Kayastha

**Abstract:** While tourism is widely promoted as a solution to poverty, residents in major tourist destinations remain economically marginalized. The study examines the paradox of serious poverty in areas with many tourists and focuses on how internal social characteristics and external economic forces interact, using Household Dependency Burden as a moderating variable to analyse how domestic constraints worsen poverty through employment insecurity, social exclusion, and migration pressure. This study was conducted in Lumbini Sanskritik Municipality, Rupandehi, using a sample of 450 households and applying the PLS-SEM method. The measurement model was confirmed by Cronbach's alpha ( $> 0.91$ ) and Average Variance Extracted ( $> 0.71$ ), which showed excellent reliability and convergent validity. The result shows that Human Capital Constraints ( $\beta = 0.395$ ,  $p < 0.001$ ) and Social Exclusion ( $\beta =$

0.312,  $p < 0.001$ ) are the leading factors causing poverty. Employment insecurity ( $\beta = 0.327$ ,  $p < 0.001$ ) and labor migration pressure ( $\beta = 0.312$ ,  $p < 0.001$ ) also significantly deteriorate one's economic condition. On the other hand, Tourism Inclusiveness has a substantial negative impact on poverty ( $\beta = -0.293$ ,  $p < 0.001$ ). The structural model explains 68.1% ( $R^2 = 0.681$ ) of the variation in poverty status. Moreover, the household dependency burden that plays a vital moderating role ( $p < 0.001$ ) also indicates that internal factors keep families in the poverty cycle. Therefore, tourism by itself cannot eradicate poverty; the government must take measures that emphasize the distribution of benefits and development of human resources at the local level.

**89. Hem Raj Joshi** – *COVID-19 Epidemics Modeling in Nepal*

Xavier University, OH, USA

**Abstract:** We study COVID-19 transmission in Nepal using an SIR-type model that incorporates interprovincial and cross-border mobility. We estimate the reproduction number for each province and present the results as heat maps. To capture transmission dynamics, the model includes daily interprovincial movement, seasonal migrant labor, and cross-border travel with India, particularly during periods of changing travel restrictions in 2020. A connectivity matrix is constructed using highway networks, passenger movement data, and border entry points. We perform identifiability analysis to ensure reliable parameter estimation and compute the basic reproduction number  $R_0$  under mobility scenarios involving one and two provinces. Sensitivity analysis is conducted to assess the impact of key parameters on model outcomes. Numerical simulations illustrate the effects of mobility and intervention scenarios on disease spread.

**90. Sakrit Kafle** – *Separating Energy Accounting from Task Productivity in Energy-Aware Evaluation of Language Models*

Vellore Institute of Technology, India

**Abstract:** The rapid growth of large language model (LLM) inference has raised significant concerns regarding energy consumption and sustainability. Existing efficiency metrics frequently entangle physical energy usage with task-specific notions of intelligence, obscuring wasted computation and limiting interpretability and comparability. This paper argues for a strict separation between energy accounting and productivity evaluation. We formalize Tokens-per-Joule (TPJ) as a task-agnostic base metric that measures total system output per unit energy, independent of correctness or task success. Task-level productivity is evaluated externally and analyzed jointly with TPJ through a vector representation. This separation exposes inefficiencies directly, avoids implicit value judgments, and supports transparent, reproducible, and standards-aligned energy-aware evaluation.

**91. Hana Kakiuchi** – *On behavior of the free boundary to two-phase Stefan problems for the bread baking process*

Japan Women's University, Japan

**Co-author(s):** Toyohiko Aiki

**Abstract:** We consider a free boundary problem for a system of two parabolic equations on the one-dimensional space interval. The problem has been proposed as a mathematical model for a baking bread process in a hot oven. In the model they assume that the region consists of crumb, crust, and the evaporation front. For the model, we add a free boundary condition obtained from the energy conservation law. The unknown functions of our problem are the position of the evaporation front, the temperature field, and the water content. For solving this problem we observed two difficulties that the growth rate of the free boundary contains

the water content and the boundary condition for the water content depends on the unknown temperature. For these issues, we can establish existence of a solution locally in time and its uniqueness under high regularity assumptions on the initial data. Moreover, based on analysis for stationary solutions, we present the behavior result on the free boundary in this talk. The key of the proof is that a comparison principal for the solutions holds, even if the latent heat coefficient depends on time and lacks differentiability with respect to the time variable.

**92. Ankesh Karn** – *Analytical Approaches to Solving Fuzzy Matrix Games*

Tribhuvan University, Nepal

**Co-author(s):** Ashok Sah

**Abstract:** Matrix Games form a fundamental component of game theory used to model decision-making scenarios involving two or more rational players. Traditional matrix games assume precise payoffs, which may not be realistic in uncertain or imprecise environments. To address this limitation, the concept of fuzzification has been introduced, allowing payoffs to be expressed as fuzzy numbers rather than crisp values. This paper reviews and develops methods for solving fuzzy matrix games by using various approaches such as  $\alpha$ -cut (alpha cut) method, ranking functions and defuzzification techniques. Comparative analysis and illustrative examples are provided to demonstrate the efficiency and applicability of these methods.

**93. Raman Karn** – *Orbital Dynamics of Artificial Satellites: Non-Resonant Solutions to Governing Equations and Their Stability Analysis*

Tribhuvan University, Nepal

**Abstract:** The motion of artificial satellites around Earth is described by differential equations that take into account various forces such as Earth's gravity, atmospheric drag, solar radiation pressure, and the planet's shape. Among the different types of orbital behavior, non-resonant solutions are particularly significant. In these cases, the natural frequencies of a satellite's motion do not create simple ratios with external forces. This prevents resonance effects that could greatly amplify orbital disturbances. This study looks at non-resonant solutions of satellite motion using Hamiltonian mechanics and perturbation techniques. The governing equations are written using canonical orbital elements, while disturbing forces are expressed with Fourier series expansions. By using the averaging method, we remove short-term oscillations and focus on long-term changes that affect orbital evolution. Orbital stability is examined using Lyapunov direct method and linear stability analysis. We derive stability conditions based on the semi-major axis, eccentricity, and inclination of the orbit. Numerical simulations back up the analytical results, indicating that non-resonant orbits usually show quasi-periodic motion and can stay stable under small disturbances within certain parameter ranges. These findings are helpful for satellite mission planning, especially for long missions that need predictable paths and minimal orbital adjustments. The framework also points out the boundaries between stable and unstable conditions, providing practical advice for steering clear of sensitive orbital configurations.

**94. Ruchi Kawatra** – *Applications of AI and ML to Nonlinear Sciences*

SRM University, Delhi-NCR, Sonapat, India

**Abstract:** Nonlinear sciences encompass the study of complex behaviors such as chaos, bifurcations, and sensitivity to initial conditions, which pose significant challenges for conventional modeling and analytical techniques. Artificial Intelligence (AI) and Machine Learning (ML) approaches for modeling, prediction, and control of nonlinear dynamical systems contribute to real-time analysis. Advanced ML techniques, including deep neural networks (DNNs), long

short-term memory (LSTM) networks, support vector machines (SVMs), and physics-informed neural networks (PINNs), are employed to approximate nonlinear relationships and extract hidden patterns from high-dimensional data. Applications such as chaotic time-series forecasting, fluid dynamics, climate systems, and biological networks are bringing transformation in real world. Despite notable advancements, challenges related to model generalization, interpretability, and computational cost remain. The emerging techniques, including explainable AI (XAI) and hybrid physics-guided learning models, helps to improve robustness and scalability in real-world nonlinear applications. Despite their advantages, challenges such as interpretability, data dependency, and computational cost remain significant. Nevertheless, the integration of AI and ML with nonlinear science holds immense potential for advancing research and solving complex real-world problems across interdisciplinary domains. Future developments are expected to enhance model transparency, efficiency, and applicability, further bridging the gap between theory and practical implementation

**95. Arnav Khadka** – *Secure electronic voting system that achieves ballot secrecy, verifiability, integrity, and robustness without reliance on a trusted central authority*

Kathmandu University, Nepal

**Co-author(s):** Saraswati Acharya

**Abstract:** This paper presents the design and implementation of a secure electronic voting system that combines ElGamal encryption, Pedersen commitments, disjunctive Chaum-Pedersen zero-knowledge proof, Shamir  $(t, n)$  secret sharing to achieve ballot secrecy, verifiability, integrity, and robustness without reliance on a trusted central authority. The system is developed as an academic demonstration in Python with a Tkinter graphical interface, providing a concrete and inspectable realisation of the cryptographic protocols used in real-world verifiable election systems such as Helios and Belenios. The implementation demonstrates that all four cryptographic components are structurally necessary and non-interchangeable in this architecture: ElGamal provides the homomorphic tally, Pedersen commitments anchor the validity proof, the Chaum-Pedersen zero-knowledge proof binds the two representations and enforces binary vote values, and Shamir sharing removes the single point of failure in decryption. Using these components a secure and verifiable e-voting system has been implemented.

**96. Netra Khanal** – *Risk-Disciplined AI for Portfolio Optimization*

University of Tampa, FL, USA

**Co-author(s):** Jayanta Pokharel, Binod Rimal

**Abstract:** This study presents a risk-disciplined AI framework for portfolio optimization that integrates machine-learning forecasts with the Capital Asset Pricing Model (CAPM). Using the S&P 500 universe, the approach selects robust assets via clustering and fundamental screening, then blends Prophet, Random Forest, and XGBoost predictions with a CAPM adjustment to stabilize risk. Results show that machine learning alone yields unstable exposures and weak long-run performance, whereas CAPM-aligned AI delivers consistent expected returns and stronger risk-adjusted outcomes. The framework provides a transparent and reliable method for AI-driven portfolio construction under disciplined risk control.

**97. Nilam Kharel** – *Modeling the Impacts of Climate Change on Dengue Transmission Dynamics in Koshi Province, Nepal*

Mechi Multiple Campus, TU, Nepal

**Co-author(s):** Yagya Pant, Anjana Pokharel, Ramesh Gautam, Naveen Vaidya, Khagendra Adhikari

**Abstract:** Dengue fever is becoming an increasingly serious public health issue in Nepal, particularly in Koshi Province, where cases have risen sharply in recent years. Climate change is predicted to worsen this trend by affecting mosquito populations and the spread of the disease. Here, we developed a mathematical model to analyze the impact of climate change on Dengue transmission in Koshi Province. By studying data on disease patterns together with climatic factors, it improves the accuracy of predictions about Dengue transmission. The model is based on SEIR-SEI compartmental framework, incorporating combined effects of climatic factors such as temperature, rainfall and humidity to assess their influence on disease dynamics. The model is shown to be biologically valid and the formula for basic reproduction number is derived. The key parameters of the model are estimated for addressing the Dengue transmission dynamics of the province. The findings provide good insights on Dengue pattern in Koshi Province and are expected to help in developing and applying more effective control strategies against Dengue in time. It also guides policy makers and authorities to reduce the risk of future outbreaks in Nepal.

**98. Eduard-Wilhelm Kirr** – *Large Coherent Structures in Wave Equations via Computer Assisted Proofs*

University of Illinois, Urbana-Champaign, IL, USA

**Abstract:** While coherent structures play an essential role in the analysis and applications of wave equations it has been impossible (until now) to find all the nonlinear ones. This talk will focus on the Nonlinear Schrödinger Equations where coherent structures have the form  $\exp(iEt)f(x)$  where the frequency  $E$  is nonnegative and the profile  $f$  is in the  $H^1(\mathbb{R}^n)$  Sobolev space. We show that all coherent structures organize themselves into smooth surfaces accumulating to  $E = \infty$ . In this limit they split into peaks and an algebraic equilibrium equation between peak-potential and peak-peak interaction emerges. The equation determines not only the  $E = \infty$  limiting points but also the surfaces of coherent structures approaching them. For small number of peaks or for peaks in a collinear configuration the solution to the limiting equation and the corresponding coherent structures can be obtained by hand. However, for large number of non-collinear peaks we employ computer assisted proofs.

**99. Bikash Koirala** – *Institutional practices for academic Outcome: A study in non-accredited Colleges in Koshi Province*

Purbanchal University, Nepal

**Abstract:** This paper examines how institutional practices shape student academic outcomes in non-accredited Master's programs in Koshi Province, Nepal. The study is grounded in the concern that many postgraduate programs operate without formal accreditation, while empirical evidence on how institutional quality influences student outcomes in such settings remains limited. The study focuses on four institutional-practice dimensions: Instructional Quality, Student Support and Administrative Services, Learning Resources and ICT Environment, and Engagement and Campus Climate. It investigates how these dimensions relate to student academic outcomes in an understudied higher education context. A quantitative, cross-sectional survey design was employed. Data were collected from 381 students enrolled in selected non-accredited Master's colleges in Koshi Province, yielding an 84.7% usable response rate. The data were analyzed using descriptive statistics, exploratory factor analysis, correlation, multiple regression, one-way ANOVA, and independent-samples t-tests in SPSS. Exploratory factor analysis refined the outcome structure into two retained dimensions: Perceived Employability and Career Readiness (PECR) and Academic Success and Institutional Commitment (ASIC). The findings show that all four institutional-practice dimensions significantly and positively predicted overall Academic Outcome, with the model explaining 79.0% of the variance. Instructional

Quality emerged as the strongest overall predictor ( $\beta = .352, p < .001$ ), followed by Learning Resources and ICT Environment ( $\beta = .324, p < .001$ ), Engagement and Campus Climate ( $\beta = .304, p < .001$ ), and Student Support and Administrative Services ( $\beta = .221, p < .001$ ). For PEQR, Instructional Quality was the strongest predictor ( $\beta = .427, p < .001$ ), whereas for ASIC, Learning Resources and ICT Environment was dominant ( $\beta = .520, p < .001$ ). Academic outcomes also differed significantly by college type, with private colleges performing better than constituent and community colleges, while gender differences were not statistically significant.

**100. Kota Kumazaki** – *A strong solution to a two-scale problem with a free boundary*

Kyoto University of Education, Japan

**Abstract:** We study a two-scale parabolic problem for water-induced swelling, coupling macroscopic moisture diffusion with microscopic free-boundary pore dynamics. We prove the existence and uniqueness of strong solutions and discuss their global behavior.

**101. Laxman Bahadur Kunwar** – *Dynamics of Alcoholism with Media Campaigns and Two Time Delay*

Tribhuvan University, Nepal

**Abstract:** In this paper, a non-linear mathematical model with two time delays is proposed to analyze the effect of awareness campaigns through different media on the spread of alcoholism in society. In the modeling process, it is assumed that alcoholism (heavy drinking habit) spreads through direct contact between susceptible and heavy alcohol consuming individual. Furthermore, the growth rate of awareness programs affecting the population is assumed to be proportional to the number of individuals in the heavy drinking population. It is assumed that due to the effect of awareness programs, susceptible individuals form a separate class named aware class. The conversion of susceptible to heavy drinker is not instantaneous and so first time delay ( $\tau_1$ ) has been implemented in the model. Second time delay ( $\tau_2$ ) has been incorporated for the impact of awareness campaigns on the susceptible population. Positive and boundedness of solutions are analytically studied. The model is analyzed by using stability theories of differential equation. Mathematical analysis of the model has been carried out by determining two equilibria: one alcohol-free equilibrium, and second alcohol-present equilibrium. Sensitivity analysis has been carried out by calculating normalized sensitivity indices for parameters involved in the basic reproduction number. The alcohol-free equilibrium is stable for any delay when the value of basic reproduction number is less than unity. Moreover, theoretical results reveal that if the basic reproduction number is greater than one, the alcohol-present equilibrium may lost its stability and bifurcated periodic solution occurs when time delay is taken as the bifurcation parameter. The model analysis revealed that the spread of alcoholism in the community can be controlled by awareness programs, but it persists in the community as an endemic. The numerical simulations are carried out to confirm consistency with theoretical results. The outcomes of the numerical simulations show the significance of awareness campaigns and the delay in controlling the spread of alcoholism in society.

**102. Basanta Raj Lamichhane** – *Exploring Epistemic Injustice in Assessment of Learning in Mathematics: An Auto/Ethnographic Inquiry*

Saptagandaki Multiple Campus, Nepal

**Abstract:** Assessment of learning instigates the notion of standardized tests, which are backed by the Western-Eurocentric thought and neoliberal politico-economic policy—privatization, marketization, and individualization through endorsements of competition and efficiency at the expense of a collaborative and empathetical learning culture that restrain the learners as passive recipients of ratifying mathematical knowledge perpetuating an epistemic injustice. Against

this backdrop, this research explores how the assessment of learning perpetuates epistemic injustice. I deployed auto/ethnographic research to generate field texts and postcolonial theory to interpret and make meaning from the field texts through layered writing. I have captured three themes—ignorance of the epistemic agency of learners, the winner-taken-all approach, and devaluing alternative assessment systems that perpetuate epistemic injustice in mathematics education. An implication is that the issue of epistemic injustice needs to be urgently addressed to bring a paradigm shift in mathematics education.

**103. Manoj Lamichhane** – *Enhancing Student Engagement and Learning Through iRAT and tRAT in Team-Based Inquiry Learning (TBIL)*

Florida Polytechnic University, FL, USA

**Abstract:** Team-Based Inquiry Learning (TBIL) has been incorporating in my teaching since 2022 as a way to encourage active participation, strengthen student accountability, and promote collaboration in the classroom. Two central elements of this approach are the Individual Readiness Assurance Test (iRAT) and the Team Readiness Assurance Test (tRAT). The iRAT gives students an opportunity to demonstrate their preparation before class and reflect on their own understanding of the assigned material. This is followed by the tRAT, where students work together in teams to discuss the same concepts, compare their reasoning, and receive immediate feedback. In this talk, I will share my experience using iRAT and tRAT within the TBIL framework and reflect on how these activities influence student preparation, engagement, and teamwork. I will also discuss how structured peer discussion and immediate feedback help students take greater responsibility for their learning while contributing to a more interactive and collaborative classroom environment.

**104. Guillaume Leduc** – *Dominance Patterns in Ranking Investment Opportunities Across Risk-Aversion Levels: A Reward–VaR Framework*

American University of Sharjah

**Abstract:** We introduce a novel methodology for ranking and comparing financial indices across varying levels of risk aversion. The approach is based on the construction of a Reward–VaR curve, which generalizes classical mean–variance and Sharpe-type performance measures by linking expected return to Value-at-Risk thresholds. By analyzing the entire curve rather than a single summary statistic, the method allows for a comprehensive dominance analysis across confidence levels. We establish theoretical properties of the Reward–VaR framework, including its consistency with standard risk-adjusted performance measures under normality and its structural dominance patterns under higher-order modified VaR. To assess the statistical reliability of the observed dominance patterns, we employ a bootstrap procedure that approximates the sampling distributions of both the Reward–VaR curve and the difference between the corresponding Reward–VaR curves of competing indices across a range of risk thresholds. This allows us to construct confidence intervals and to determine statistically significant dominance and equivalence regions. The methodology is applied to a set of major equity indices to illustrate how performance rankings vary with the degree of risk aversion. The results demonstrate that index dominance is not uniform across risk thresholds and may exhibit phase transitions as confidence levels change. The framework provides a flexible and statistically grounded tool for comparative performance analysis under heterogeneous risk preferences.

**105. Kabita Luitel** – *Bioheat-CEM43 with Drug Metabolism: Thermal Dose Modeling of Hyperthermia Treatment of Cancer*

Bhaktapur Multiple Campus, Tribhuvan University, Nepal

**Abstract:** This research presents a computational framework that bridges the gap between

Pennes' bioheat transfer and pharmacological kinetics. By synthesizing the Cumulative Equivalent Minutes (CEM43) thermal dose metric with a dynamic drug metabolism model, we aim to quantify the therapeutic enhancement triggered by heat-induced chemical sensitization in oncology. We developed a numerical simulation representing a vascularized solid tumor. The thermal environment is governed by a bioheat equation that accounts for vascular perfusion and metabolic heat generation. Crucially, the drug's metabolic rate and absorption efficacy are modeled as temperature-dependent functions, allowing for the simulation of synergistic "thermal-chemo" interactions. The findings indicate that localized hyperthermia (maintained between 40°C and 45°C) acts as a catalyst for drug accumulation within the tumor mass. The CEM43 calculations provide a reliable threshold for preventing unintended thermal damage to healthy margins, while the metabolic model identifies the optimal timing for drug administration relative to peak heating. Coupling thermal dosimetry with metabolic drug tracking provides a more comprehensive predictive tool for personalized cancer treatment. This integrated approach allows for the optimization of "thermal dose" protocols to maximize drug efficacy while minimizing systemic side effects.

**106. Aashiq Mahato** – *Resolution Generalization Limits of Neural Operators for Nonlinear Partial Differential Equations*

Rajarshi Janak University, Nepal

**Co-author(s):** Suresh Kumar Sahani

**Abstract:** Neural operators have revolutionized the solution of nonlinear partial differential equations (PDEs) by learning mappings between infinite-dimensional function spaces. Despite widespread claims of resolution invariance, their ability to generalize across different discretization scales remains poorly understood. This work presents a systematic evaluation of the resolution-dependent performance of Fourier Neural Operators (FNOs) on two prototypical nonlinear PDEs: Burgers' equation and the nonlinear heat equation. By decomposing the prediction error into discretization and learning components, we identify precise conditions under which high-resolution predictions degrade significantly, especially in the presence of sharp gradients or high-frequency modes. These findings reveal fundamental limitations of current neural operator architectures and offer practical guidelines for designing resolution-aware models. Our results provide a novel bridge between rigorous approximation theory and modern scientific machine learning for complex nonlinear systems.

**107. Shivam Kumar Mishra** – *Long-term behavior of a stochastic predator-prey epidemic model with Allee effect and disease in prey*

Indian Institute of Technology Mandi, India

**Co-author(s):** Syed Abbas

**Abstract:** We consider a stochastic eco-epidemiological predator-prey model that includes an Allee effect in the prey population. The model describes the interaction between disease transmission in prey, predator-prey dynamics, and environmental stochasticity. Conditions ensuring extinction and persistence of the populations are established using stochastic Lyapunov techniques. Furthermore, numerical simulations are performed to illustrate the influence of the Allee threshold and environmental fluctuations on the long-term behaviour of the system.

**108. Shahid Mohammad** – *Lambda Exponential Family of Distributions With Properties and Applications*

University of Wisconsin Oshkosh, WI, USA

**Co-author(s):** Kahadawala Cooray

**Abstract:** This research introduces a new family of probability distributions called the lambda exponential (LE) family. These distributions are constructed by multiplying an exponential density function with a continuous cumulative distribution function. A key motivation is obtaining closed-form solutions for the moment-generating function. Various mathematical properties of the LE family are investigated. As a specific case, the inverse Gaussian (IG) cumulative distribution function is used to derive the lambda exponential inverse Gaussian (LE-IG) distribution and study its characteristics. Performance of maximum likelihood estimation is assessed through simulations using the quantile function. To demonstrate flexibility and applicability, the LE family is fitted to two real datasets and compared to other distributions via likelihood methods.

**109. Vivek Natarajan** – *Motion planning for infinite-dimensional systems using flatness and semi-discretization*

Indian Institute of Technology Bombay, India

**Co-author(s):** Soham Chatterjee, Aman Batra

**Abstract:** In this talk, I will discuss our results on the motion planning problem for 1D linear boundary controlled PDEs. The objective in the motion planning problem is to design a control input which can transfer the PDE from a given initial state to a desired final state over a prescribed time interval. We address this problem by combining the flatness technique with PDE semi-discretization. In this approach, we first discretize the spatial derivative in the PDE using the finite-difference scheme to obtain an  $n^{\text{th}}$ -order linear ODE (in time) approximation for the PDE. We prove that the solution to the  $n^{\text{th}}$ -order ODE converges to the solution of the PDE as  $n$  tends to infinity, in the desired norm, under appropriate assumptions. Then using the flatness technique we construct an input signal that transfers the  $n^{\text{th}}$ -order ODE between states obtained by discretizing the given initial and final states, over the prescribed time interval. We prove that, as the discretization step size converges to zero (i.e. as  $n$  tends to infinity), the input signal constructed for the  $n^{\text{th}}$ -order ODE converges to a limiting input signal which can execute the desired transfer for the PDE. The above approach works provided the initial and final states have certain smoothness. We have used this approach to address certain motion planning problems for 1D parabolic PDEs, which resulted in a new proof of their null controllability, and Euler-Bernoulli beam PDE.

**110. Jayadev Nath** – *Boundedness of Bilinear Variable 1-Haar Multipliers in Unweighted Lebesgue Spaces*

Tribhuvan University, Nepal

**Co-author(s):** Ishwari Kunwar, Chet Raj Bhatta

**Abstract:** We study the boundedness of bilinear variable 1-Haar multipliers on unweighted Lebesgue spaces. These dyadic bilinear operators depend on a spatial weight  $w$  and a multi-index  $\vec{\alpha} \in \{(0, 1), (1, 0), (0, 0)\}$ , and may be viewed as dyadic models for multilinear pseudo-differential operators. Our goal is to understand when these operators map

$$L^{p_1}(\mathbb{R}) \times L^{p_2}(\mathbb{R}) \quad \text{into} \quad L^r(\mathbb{R}), \quad \frac{1}{r} = \frac{1}{p_1} + \frac{1}{p_2}.$$

For the paraproduct-type components  $\vec{\alpha} \in \{(0, 1), (1, 0)\}$ , we obtain a complete characterization in the Banach range  $r > 1$ : boundedness holds if and only if the spatial weight  $w$  belongs to the dyadic reverse Hölder class  $RH_r^d$ . In the quasi-Banach range  $0 < r \leq 1$ , we show that the problem is naturally connected to a weighted dyadic square-function estimate. In particular, in

a model case, this approach identifies the local coefficient condition

$$\sup_{I \in \mathcal{D}} \frac{\langle w^r \rangle_I}{\langle w \rangle_I^2} < \infty.$$

We also analyze the diagonal component  $\vec{\alpha} = (0, 0)$ , where the absence of cancellation in  $h_I^2$  leads to substantially different behavior. Testing on localized functions yields two natural necessary conditions: a local reverse Hölder condition and a global fractional tail condition over dyadic ancestors. Finally, we establish a pointwise factorization of the diagonal term into a product of two weight-adapted dyadic square functions. This factorization reveals the structure of the diagonal contribution and provides a framework for further study of its boundedness.

**111. Hari Nandan Nath** – *A Genetic Algorithm for the Multi-Facility Network Flow Location Problem*

Tribhuvan University, Bhaktapur Multiple Campus, Nepal

**Abstract:** The Network Flow Location Problem (NFLP) seeks to optimally locate multiple facilities on the edges of a network to maximize the flow subject to capacity constraints. While the problem is practically relevant in evacuation planning and logistics, it has been proved that no polynomial-time finite  $\alpha$ -approximation algorithm exists for the multi-facility NFLP unless  $P = NP$ . Consequently, exact methods are intractable for large instances, and existing greedy heuristics, while fast, often explore a limited region of the solution space. In this work, we propose a Genetic Algorithm (GA) tailored for the NFLP. We use a permutation-based encoding and introduce repair mechanisms to ensure that facility assignments remain feasible throughout the evolutionary process. To enhance solution quality, we seed the initial population with solutions obtained from existing greedy heuristics, guaranteeing that the proposed scheme performs at least as well as these traditional approaches. Extensive numerical experiments are carried out to validate the performance of the algorithm and demonstrate its ability to find high-quality solutions beyond the reach of current heuristics.

**112. Kedar Nepal** – *The Evolving Role of Mathematics Textbooks in the Age of Generative AI*

Mercer University, GA, USA

**Co-author(s):** Krishna Pokharel

**Abstract:** With the advent of generative artificial intelligence (GenAI), the use of GenAI in higher education and K–12 settings has been growing. Like any new technological tool, GenAI has brought both challenges and opportunities to the teaching and learning of mathematics. Traditionally, mathematics textbooks have been used as primary instructional tools for teachers and as a primary source of knowledge for students (e.g., Lepik et al., 2015). They serve as a baseline of knowledge that all students should learn and are often closely aligned with the curriculum. However, textbook content is static and mostly adopts a one-size-fits-all approach, which may not address the varying needs of a diverse group of students. Drawing on research on the role of GenAI in mathematics education, we will present how GenAI has the potential to transform the teaching and learning of mathematics and discuss its implications for the continued relevance of physical textbooks. We will also discuss how teachers can integrate GenAI to supplement textbooks and support differentiated instruction to better meet the needs of individual students. Particular attention will be given to the potential challenges and opportunities of supplementing textbooks with GenAI in the context of Nepal.

**113. Surendra Nepal** – *Random walk algorithm for a moving boundary problem describing the diffusing penetration into rubbers*

Department of Mathematics and Physics, Linnaeus University, Sweden

**Co-author(s):** Magnus Ogren, Yosief Wondmagegne, Adrian Muntean

**Abstract:** For certain materials science scenarios arising in rubber technology, one-dimensional moving boundary problems (MBPs) with kinetic boundary conditions are capable of unveiling the large-time behavior of the diffusants penetration front, giving a direct estimate on the service life of the material. In this paper, we propose a random walk algorithm able to lead to good numerical approximations of both the concentration profile and the location of the sharp front. Essentially, the proposed scheme decouples the target evolution system in two steps: (i) the ordinary differential equation corresponding to the evaluation of the speed of the moving boundary is solved via an explicit Euler method, and (ii) the associated diffusion problem is solved by a random walk method. To verify the correctness of our random walk algorithm we compare the resulting approximations to results based on a finite element approach with a controlled convergence rate. Our numerical experiments recover well penetration depth measurements of an experimental setup targeting dense rubbers.

**114. Surendra Raj Nepal** – *Forecasting Models for Predicting the Ecological Footprint of Nepal*

Tribhuvan University, Nepal

**Co-author(s):** Prof. Srijan Lal Shrestha (Ph.D.)

**Abstract:** Background: Nepal has been suffering from an ecological deficit since 1989. It is important to assess the future condition of Nepal’s ecological footprint; however, such studies are rare. Objective: The objective of this study is to explore a relatively better model for forecasting the Ecological Footprint of Nepal. Method: Data on Nepal’s ecological footprint and biocapacity from 1989 to 2022 have been collected from the Global Footprint Network. At first, the stationarity of data was checked through the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) unit root test. Then, the order of Moving Average and Autoregressive in the ARIMA (Autoregressive Integrated Moving Average) model was chosen using the Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF). The ARCH (Autoregressive Conditional Heteroskedasticity) test was used to examine the volatility in the ecological footprint. In addition to ARIMA, Simple Exponential Smoothing, and Holt’s Linear methods were examined to find a superior forecasting model. The models were evaluated based on Root Mean Square Error (RMSE), Mean Absolute Error (MAE), and Mean Absolute Percentage Error (MAPE). Result: ACF and PACF suggested the ARIMA (0,1,0). The ARCH test was found to be insignificant. RMSE, MAE, and MAPE of Holt’s Linear method are less than those of other models. Conclusion: There is no evidence of volatility in the Ecological Footprint of Nepal. Holt’s Linear method is a better forecasting model for estimating the Ecological Footprint of Nepal.

**115. Raktim Neupane** – *Koopman-von Neumann Operator Analysis of Nonlinear Dynamics in Chaotic Duffing Oscillator*

St. Xavier’s College, Nepal

**Abstract:** Nonlinear dynamical systems exhibiting chaotic behavior puts significant analytical challenges in phase space due to their intrinsic non-linearity. The Koopman–von Neumann (KvN) framework provides an operator theoretic formulation in which nonlinear flows are lifted to linear evolution on Hilbert spaces of observables. In this work, the Duffing oscillator is analyzed within the KvN formulation. We present a comprehensive computational study of the harmonically driven Duffing oscillator

$$\ddot{x} + \delta\dot{x} + \alpha x + \beta x^3 = \xi \cos(\omega t),$$

with parameters  $(\alpha, \beta, \delta, \xi, \omega) = (-1.0, 1.0, 0.3, 0.5, 1.2)$  chosen to place the system firmly in the chaotic regime ( $\lambda_1 \approx 0.10$ ), through the dual lens of classical nonlinear dynamics and Koopman–von Neumann (KvN) mechanics. In the KvN formulation, classical trajectories are replaced by a wavefunction  $\psi(x, t) \in L^2(\Gamma)$  whose evolution is governed by an exact linear Schrödinger like equation

$$i\hbar\partial_t|\psi\rangle = L_{\text{KvN}}|\psi\rangle,$$

where  $L_{\text{KvN}}$  is the Hermitian Liouvillian operator acting on phase-space functions. We compute the full time evolution of the phase space probability density  $\rho = |\psi|^2$ , compute the Koopman eigenvalue spectrum and leading eigenfunctions via Extended Dynamic Mode Decomposition (EDMD) on a radial basis function dictionary, compute the Gibbs entropy  $S = -\int \rho \ln \rho d^2x$ , and compare classical and KvN power spectra. The Koopman spectrum shows a countably discrete set of physical modes lying inside the unit circle of the complex plane, whose imaginary parts directly predict the dominant spectral peaks in the classical power spectral density. The leading Koopman eigenfunctions capture the slow linear and quadratic  $x$ -marginal structure of the attractor, while higher modes encode the fine scale fractal geometry. Our results demonstrate that the KvN operator theoretic framework provides a rigorous, globally linear description of chaotic dynamics and shows way to reduced order modeling of strange attractors.

**116. Surya Niraula** – *The Effects of Vegetarian Diets on Blood Pressure: A Systematic Review and Meta-Analysis of Randomized Clinical Trials (RCTs)*

Texas Tech University, TX, USA

**Abstract:** Background: Hypertension is a global health issue. Many Randomized Clinical Trials (RCTs) report that a vegetarian diet plays a significant role in decreasing blood pressure, while others report insignificant effect, which is a worldwide concern. Objective: To evaluate the impact of vegetarian diets on systolic blood pressure (SBP) and diastolic blood pressure (DBP) in adults. Methods: A systematic review was conducted by screening all related articles on PubMed, Scopus, and Web of Science for eligibility based RCTs and following the PRISMA reporting guidelines. Twenty eligible RCTs comparing the impact of vegetarian diets with control diets on adult blood pressure were included in a meta-analysis. Random-effects models were used to pool data, and subgroup analysis was performed based on intervention duration and participants' health status. Results: A pooled analysis of 21 effect sizes from 20 trials, indicated that vegetarian diets were not significantly associated with a decrease in SBP (WMD:  $-1.08$  mmHg; 95% CI:  $-2.58$  to  $0.41$ ) or in DBP (WMD:  $-0.35$  mmHg; 95% CI:  $-1.47$  to  $0.77$ ). There was moderate heterogeneity ( $I^2 = 63.9\%$  for SBP;  $71.9\%$  for DBP). Subgroup analysis based on trial duration or type 2 diabetes status did not alter the results. Conclusions: Overall, there is not sufficient evidence to support the claim that vegetarian diets lead to a statistically significant decrease in SBP and DBP in adults. To elucidate the role of vegetarian diets in blood pressure management, more carefully planned, well-designed, long-term RCTs with robust adherence monitoring are required.

**117. Chandan Pal** – *Approximation Algorithms for Risk-Sensitive First Exit Time Control with Varying Discount Factors on a General State Space*

Indian Institute of Technology Guwahati, India

**Co-author(s):** Amit Ghosh, Arghyadip Roy

**Abstract:** This talk studies a risk-sensitive first-exit-time stochastic control problem for discrete-time systems defined on a general state space with state-dependent discount factors. Under suitable assumptions and for bounded cost functions, we establish the existence, uniqueness, and Bellman characterization of the optimal value function over the class of randomized history-dependent policies. To compute the optimal solution, we develop a Policy Iteration Algorithm

(PIA) and prove its convergence on a general state space using a stochastic representation of the value function. In addition, a value-iteration-based approximation scheme is proposed for practical computation. The theoretical results are supported by a numerical example motivated by a real-life application and implemented through MATLAB simulations.

**118. Ashish Pandey** – *Spectral Stability of Arbitrary Amplitude Periodic Traveling Waves: A Fredholm Determinant Approach*

IIT Delhi, New Delhi

**Co-author(s):** Aarushi Kansal

**Abstract:** The spectral stability of arbitrary amplitude periodic traveling waves in nonlocal dispersive equations (such as the Whitham, KdV, and BBM equations) is classically studied via Floquet-Bloch theory, often leading to large-scale numerical eigenvalue problems. In this paper, we recast the linearized Floquet spectral problem as an abstract infinite-dimensional operator equation  $\lambda v = \mathcal{K}(\mathcal{D} + \mathcal{A})v$  on  $\ell^2(Z)$ . By exploiting the rapid decay of the wave's Fourier spectrum, we construct a well-defined Fredholm determinant  $\Delta(\lambda, \mu)$ . Using the Plemelj-Smithies trace formula, we derive explicit algebraic criteria for the onset of modulational instability and establish rigorous asymptotic bounds on the maximum instability growth rate strictly in terms of the Sobolev norms of the base wave. These results provide an explicit generalized Lighthill criterion valid beyond the weakly nonlinear regime.

**119. Khyam Paneru** – *Study on the Impact of Self-Care and Stressors on Mental Health among College Students during the COVID-19 Pandemic*

The University of Tampa, FL, USA

**Co-author(s):** Neely Mahapatra, Jamie Smiertelny

**Abstract:** This study examined the impact of stressors on the mental health of college students enrolled in a professional social work program during the COVID-19 pandemic and the extent to which self-care practices mitigated these effects. Data were collected from undergraduate and graduate students ( $n = 133$ ) through an online survey. Multiple linear regression analysis was employed to assess the direct relationships among stressors, mental health, and self-care during the pandemic, with age, gender, and living arrangement included as control variables. The findings highlight the critical role of self-care in reducing the adverse impact of stressors on students' mental health during this period.

**120. Giri Raj Paneru** – *Capacity Enhancement in Convex Cost Flow Networks with Total Cost Minimization*

Trichandra Multiple Campus, TU, Nepal

**Co-author(s):** Hari Nandan Nath, Tanka Nath Dhamala

**Abstract:** In a convex cost flow problem, the capacities of arcs are restricted by given values, while the costs are convex functions of flows. In such problems, flow is sent through arcs to ensure feasibility while minimizing the total cost to satisfy the given supplies/demand in the nodes. In this paper, we aim to find the minimum cost flow by enhancing the capacities of necessary arcs. Our motivation comes from the fact that some arcs either act as bottlenecks due to limited capacity but may have relatively low costs; increasing the capacities of such arcs can enhance the feasibility or further reduce the overall cost. We consider arc cost as convex cost functions and allow capacity enhancements on arcs with an associated improvement cost. The improvement cost is not assumed to be constant; instead, it varies across different levels of capacity enhancement as a convex function of the capacity enhancement as a convex function

of the capacity enhanced. The objective of this paper is to determine which arcs should be improved and to what extent, along with their associated costs, to minimize the total cost. Proving that the total cost function is convex, we present a polynomial-time algorithm and provide a detailed analysis of its time complexity.

**121. Badri Prasad Pangani** – *Flow Dynamics with Uncertainty in Arc Costs*

Prithvi Narayan Campus, TU, Nepal

**Abstract:** In this paper, we first present contributions to discrete dynamic deterministic network flow models, along with those based on uncertainty theory. We consider a discrete dynamic cost optimization flow model in the classical version, and we then transform it into a model with uncertainty in arc costs and certainty in storage costs at the intermediate vertices. Using the benefits of robust optimization and duality techniques, the model is again transformed into different forms. The convexity of the objective function and the network flow behavior of the uncertainty model support us in designing an algorithm for the cost optimization. Finally, an illustrative example is presented to analyze and verify the problem in particular.

**122. Tek Raj Pant** – *Integrating GBM, Jump-Diffusion, and COGARCH: A Unified Theoretical Analysis of Chaotic Financial Systems*

Kathmandu University, Nepal

**Co-author(s):** Samir Shrestha

**Abstract:** This research integrates jump-diffusion price dynamics with COGARCH stochastic volatility to capture the complex and dynamic behavior of financial markets. The study establishes rigorous mathematical foundations for the coupled system, and theoretical basis for its well-posedness, existence of stationary distributions, and positivity of volatility under specified conditions. Using the Lyapunov exponent analysis, we can show that the system exhibits chaotic behavior or not under the given condition. These theoretical work have significant implications for financial risk management, option pricing, and trading strategies, highlighting the limitations of traditional Gaussian based approaches in chaotic, multi fractal markets. The research provides theoretical insights into market dynamics for enhanced financial modeling and risk assessment.

**123. Yagya Raj Pant** – *A Mathematical Model for Dengue Incorporating the Seasonal Variation in Temperature and Rainfall*

Siddhanath Science Campus, TU, Nepal

**Co-author(s):** Nilam Kharel

**Abstract:** Abstract: Dengue dynamics are driven by environmental temperature because its vectors – *Aedes aegypti* and *Aedes albopictus* – are poikilothermic. Temperature regulates biting rate, oviposition, development, and survival, while rainfall creates breeding sites that support aquatic stages. In Nepal, seasonal temperature and rainfall variations cause mosquito populations to fluctuate, leading to corresponding peaks in dengue incidence. We develop a climate-sensitive mathematical model for the regions like Nepal that integrates these seasonal effects on mosquito life traits, perform its mathematical analysis and calibrate the model with epidemiological data from Nepal. Mathematical analysis and numerical simulations reveal that increasing mosquito mortality and reducing environmental carrying capacity (thereby limiting aquatic mosquitoes) are effective interventions to control dengue outbreaks.

**124. Humnath Panta** – *Insider CEOs and Credit Ratings*

Cal Poly Humboldt, Arcata, USA

**Co-author(s):** Arun Narayanasamy, Binam Ghimire, Ayush Panta

**Abstract:** This study examines the effect of the CEO's previous position (inside or outside the firm) on credit ratings using a large sample of US firms from 1992 to 2017. The main finding reveals that firms employing insider CEOs receive higher credit ratings. Our estimated ratings improvement of 0.334 implies a reduction of roughly 10-17 basis points in borrowing costs. This finding remains robust after controlling for firm-level and CEO-level fixed effects, addressing endogeneity issues, alternative estimation techniques, and attempts to mitigate omitted variable biases. Our findings reveal the importance of internal CEO hire in a firm's credit rating. This study contributes to the literature by providing new evidence concerning the effects of CEO succession origin on corporate credit ratings.

**125. Mahesh Parajuli** – *Efficient Pneumonia Detection in Chest Radiographs Using a Compact Domain-Adapted ResNet Architecture*

Kathmandu University, Nepal

**Co-author(s):** Subindra Karki, Khim Bahadur Khattri

**Abstract:** The accessibility, speed, and cost-effectiveness of the chest radiography makes it one of the most widely used diagnostic imaging techniques for detecting pulmonary diseases. The subtle pathological patterns, low image contrast, overlapping anatomical structures, and variability across patients are factors that make the accurate interpretation of chest X-rays for disease detection including pneumonia, challenging. This study was done to address these challenges by introducing a domain-adapted and less complex CNN-ResNet framework, which better interprets the x-rays for pneumonia classification in chest radiographs. The proposed model, which is inspired by the ResNet18, incorporates architectural changes adapted for grayscale medical imaging and significantly reduces model complexity without degrading the accuracy. These modifications decrease two third of the parameters as compared to standard ResNet18 which has approximately 11 million parameters and also mitigate overfitting on limited medical datasets. The ResNet framework preserves gradient flow and alleviates the degradation problem by incorporating skip connections and batch normalization. Training and validation was done on pneumonia dataset publicly available on Kaggle and final testing was done on an independent test set collected from Dhulikhel Hospital to assess real-world generalizability and to make final decision unbiased. The architecture yielded 93.4 percent accuracy and 0.96 ROC-AUC on the test data. The results achieved in this study were comparable to models that relied on transfer learning, although pre-trained weights were not used during training. This suggests that domain-adapted, lightweight deep learning models are a feasible and efficient option for aiding computer-assisted diagnosis of lung diseases in resource-limited clinical settings.

**126. Purushottam Parajuli** – *On Some Generalized Difference Sequence Spaces Over Bi-complex Scalars*

Prithvi Narayan Campus, TU, Nepal

**Co-author(s):** Narayan Pahari

**Abstract:** In this article, we have introduced the notion of difference sequence spaces within the framework of bi-complex numbers. Further, we have established their algebraic, topological and geometric properties including some inclusion relations.

**127. Rosa Pardo** – *Uniform a priori bounds for Slightly Subcritical Elliptic Problems*

Universidad Complutense de Madrid, Madrid, Spain

**Co-author(s):** Mabel Cuesta

**Abstract:** We obtain a uniform  $L^\infty(\Omega)$  a priori bound, for any positive weak solutions to elliptic problem with a smooth nonlinearity  $f$  slightly subcritical, slightly superlinear, and regularly varying. We isolate a structural condition, that precludes concentration near the Sobolev threshold and yields a priori bounds for the critical case with  $q = 2^* - 1$ . To achieve our result, we first obtain a uniform estimate of a specific  $L^1(\Omega)$  weighted norm. This, combined with moving planes method and elliptic regularity theory, provides a uniform  $L^\infty$  bound in a neighborhood of the boundary of  $\Omega$ . Next, by using Pohozaev's identity, we obtain a uniform estimate of one weighted norm of the solutions. Joining now elliptic regularity theory, and Morrey's Theorem, we estimate from below the radius of a ball where a solution exceeds half of its  $L^\infty(\Omega)$ -norm. Finally, going back to the previous uniform weighted norm estimate, we conclude our result. We include a collection of examples satisfying our hypothesis. This is a joint work with Mabel Cuesta, see [1]. [1] M. Cuesta, and R. Pardo. Uniform a priori bounds for Slightly Subcritical Elliptic Problems. *Mediterr. J. Math.*, 22:211, 2025. <https://doi.org/10.1007/s00009-025-02979-z>.

**128. Shankar Pariyar** – *An Analytical Framework for Modeling Urban Pollutant Dispersion With Fractional Transport Dynamics*

Tribhuvan University, Nepal

**Co-author(s):** Jeevan Kafle

**Abstract:** Conventional advection–diffusion models often struggle to represent pollutant dispersion in complex urban settings such as Kathmandu, Nepal, because they cannot adequately capture memory effects and anomalous diffusion generated by turbulent airflow over intricate terrain. To address this limitation, we develop a two-dimensional time-fractional advection–diffusion equation using the Caputo fractional derivative to embed temporal memory and non-classical diffusion behavior into the transport formulation. The model incorporates a fractional-order parameter that controls subdiffusive behavior and memory effects, thereby extending the classical diffusion framework. To support this formulation, Analytical solutions are derived via eigenfunction expansions involving sine functions and Mittag–Leffler terms under Dirichlet boundary conditions. For practical implementation and verification, numerical solutions are obtained using the forward-time central-space method combined with the standard fractional approximation for the fractional derivative. Simulations demonstrate that smaller values of the fractional order lead to stronger pollutant retention, whereas the classical-order case recovers the uniform spreading behavior characteristic of classical diffusion. These findings show how the fractional order mediates the transition between anomalous and classical regimes and illustrate the distinct dispersion patterns generated by fractional-order dynamics. Overall, the framework provides a flexible methodological basis for investigating pollutant transport under anomalous diffusion conditions and offers a path toward future coupling with realistic wind fields and topographic data. The present study does not undertake the representation of the full atmospheric and terrain complexity of Kathmandu but sets up a basic framework that can be extended with meteorological inputs to study dispersion processes in complex urban basins.

**129. Rakesh Manilal H. Patel** – *A Unified Complexity Framework for Nonlinear Sciences: Mathematical Foundations and Socio-Medical Applications*

Government Science College, Gujarat, India

**Co-author(s):** Dhinesha Ruwanthi Perera, Pankajkumar B. Solanki, Anand K. Acharya, Haresh D. Chaudhari, Prof. Bhavin S. Shah, Naynesh A. Gadhavi

**Abstract:** Nonlinearity constitutes the structural and functional foundation of real-world com-

plex systems spanning medical sciences, socio-managerial environments, economic governance, and technological infrastructures. This paper develops a Unified Complexity Framework (UCF) that integrates nonlinear dynamical systems theory, multiscale modeling, stochastic processes, network science, and decision analytics into a coherent mathematical architecture applicable across disciplinary boundaries. Unlike reductionist linear paradigms, the proposed framework captures emergent behavior, feedback loops, bifurcations, chaotic transitions, and adaptive self-organization observed in real-life systems. In medical sciences, nonlinear modeling explains disease progression, epidemic dynamics, neural synchronization, tumor growth kinetics, pharmacokinetic–pharmacodynamic interactions, and digital health intervention responses. Socio-managerial systems—including organizational behavior, financial markets, supply-chain resilience, policy decision-making, and socio-economic inequalities—are interpreted as adaptive nonlinear networks characterized by threshold effects, path dependence, and systemic risk propagation. The framework further incorporates optimization under uncertainty, multi-objective decision theory, evolutionary game dynamics, and agent-based simulations to analyze real-life managerial dilemmas such as healthcare resource allocation, crisis governance, sustainability transitions, and technological innovation diffusion. Mathematically, the framework formalizes system evolution as:

$$\dot{x} = f(x, \lambda, t) + \eta(t),$$

where  $x \in \mathbb{R}^n$  represents multilevel state variables,  $\lambda$  denotes adaptive control parameters, and  $\eta(t)$  captures stochastic perturbations reflecting environmental uncertainty. Stability analysis, Lyapunov functions, entropy measures, and complexity indices are employed to characterize system robustness and resilience. The Unified Complexity Framework therefore establishes a transdisciplinary mathematical foundation connecting nonlinear sciences with medical diagnostics, public health modeling, socio-economic governance, and managerial strategy. By bridging theoretical rigor with applied analytics, the study advances complexity-informed policy design and evidence-based decision systems for real-life global challenges.

**130. Rakesh Manilal H. Patel** – *Applications of Mathematics to Nonlinear Sciences in View of Socio-Managerial Aspects: A Unified Complexity Framework*

Government Science College, Gujarat, India

**Co-author(s):** Naynesh A. Gadhavi, Dhinesha Ruwanthi Perera

**Abstract:** Nonlinear sciences provide a rigorous mathematical foundation for understanding complex socio-managerial systems characterized by feedback loops, adaptation, uncertainty, and emergent behavior. Classical linear models fail to capture structural instability, tipping points, strategic interdependence, and path dependence inherent in economic, organizational, and policy environments. This paper develops a unified nonlinear mathematical framework integrating dynamical systems theory, bifurcation analysis, chaos theory, evolutionary game dynamics, network theory, and stochastic processes to model socio-managerial phenomena. Applications include economic cycles, organizational change, innovation diffusion, supply chain instability, risk contagion, and strategic decision systems. The study demonstrates how nonlinear mathematics enhances predictive robustness, resilience modeling, and multi-objective managerial optimization. The proposed framework establishes mathematics as a central analytical engine for modern socio-managerial science.

**131. Rakesh Manilal H. Patel** – *A Unified Framework across Medical, Mathematical and Managerial Systems*

Government Science College, Gujarat, India

**Co-author(s):** Dhinesha Ruwanthi Perera

**Abstract:** Nonlinearity constitutes the structural foundation of contemporary scientific inquiry into complex adaptive systems. Across biomedical regulation, epidemiological spread, organizational behavior, and macroeconomic competition, real-world systems exhibit feedback amplification, threshold effects, bifurcations, hysteresis, multi-stability, stochastic perturbations, and emergent collective behavior that fundamentally exceed the explanatory power of linear approximation. Traditional reductionist frameworks, while analytically convenient, often fail to capture phase transitions, systemic tipping points, resilience breakdown, and nonlinear adaptation under uncertainty. This study develops an integrative nonlinear modeling architecture that unifies mathematical theory with applications in medical and managerial sciences. Drawing upon dynamical systems theory, nonlinear ordinary and partial differential equations, stochastic processes, chaos theory, nonlinear optimization, and complex network analysis, the paper conceptualizes nonlinearity not merely as a mathematical property but as a cross-domain epistemological structure. The proposed framework embeds biomedical state variables (e.g., disease progression markers, immune response parameters), economic indicators (e.g., productivity, market dynamics, resource allocation), and behavioral–organizational variables (e.g., compliance, strategic adaptation, leadership response) within a single adaptive dynamical system. The architecture integrates deterministic and stochastic components to model uncertainty, incorporates bifurcation analysis to detect regime shifts, and employs nonlinear optimization for decision-sensitive intervention design. By synthesizing medical modeling, managerial analytics, and complexity science within a unified nonlinear formalism, the study advances a prescriptive mathematical paradigm capable of informing therapeutic strategy, institutional governance, and policy formulation. The paper argues that nonlinear mathematics functions simultaneously as an analytical lens, predictive instrument, and structural decision engine. Rather than serving as a descriptive overlay, nonlinearity emerges as the underlying generative logic of adaptive systems, providing a rigorous foundation for interdisciplinary modeling in environments characterized by uncertainty, interdependence, and dynamic instability.

**132. Resham Prasad Paudel** – *On a New Methodological Approach to the Derivation of Sherman’s Five Infinite Series*

Tribhuvan University, Nepal

**Co-author(s):** Narayan Prasad Pahari

**Abstract:** The main objective of this presentation is to develop a systematic link between generalized hypergeometric function and the series containing reciprocals of central binomial coefficients. we concentrate on the evaluation of five particular series originally investigated by Sherman. These derivations are based on Gauss’s second summation theorem and its contiguous relations. This is achieved by converting the series into a hypergeometric function with the argument and substituting the established values of the corresponding hypergeometric functions available in the literature, the series can be evaluated in a closed and explicit form.

**133. Santosh Paudel** – *Marker Cell Methods for extended Quasi-Two-Phase Mass Flows Model*

Kathmandu University, Nepal

**Co-author(s):** Narayan Sapkota, Shyamshwar Baral, Khim Bahadur Khattri

**Abstract:** Avalanches, lahars, and debris flows are examples of mass flows that behave as complex solid–fluid mixtures. Accurate modeling of the interface between the moving mass and the surrounding environment is crucial for predicting flow dynamics and hazard extent. In this study, a higher-order numerical method based on Lagrangian–Eulerian techniques is developed to solve extended quasi-two-phase mass flow model. The Marker-and-Cell (MAC) approach provides a robust framework for obtaining numerical solutions by tracking phase boundaries while

simultaneously resolving conservation equations on a fixed Eulerian grid. Accurate representation of pressure and velocity fields, together with appropriate consideration of the Froude number, enables MAC simulations to effectively capture a wide range of free-surface flow regimes, from slow, gravity-dominated flows to high-speed, inertia-dominated flows exhibiting hydraulic jumps and wave phenomena. Furthermore, the MAC method demonstrates strong capability in simulating landplaning and handling complex geometries. Finally, this study evaluates the strengths and limitations of marker-based approaches and identifies best practices and future research directions for enhancing hazard assessment.

**134. Rajendra Paudyal** – *A Note On Lexicographic Network Flow Problem*

Advanced College of Engineering and Management, Nepal

**Co-author(s):** Narayan Prasad Adhikari, Phanindra Prasad Bhandari, Shree Ram Khadka

**Abstract:** Network flow theory is a widely researched area in mathematical optimization. Its main goal is to move units of flow efficiently from a source to a destination within a network. One important variant is the lexicographic flow problem, where nodes with capacity limits are assigned priorities, and flow conservation may not hold at intermediate nodes. This paper discusses the lexicographic flow model, presents various solution approaches for its different forms, and highlights their significance in practical, real-world applications.

**135. Dhinesha Ruwanthi Perera** – *Nonlinear Modeling of Structural Social Transformation*

General Sir John Kotelawala Defence University, Sri Lanka

**Co-author(s):** Rakesh Manilal H. Patel

**Abstract:** This paper develops a managerial–mathematical framework for analyzing structural social transformation in systems characterized by institutional inequality. Drawing conceptual inspiration from structural analyses of exclusion such as those articulated by B. R. Ambedkar, the study constructs a formal dynamic model integrating institutional reform (law), political mobilization (collective agency), economic restructuring, and normative change. Using nonlinear dynamical systems, game theory, and systems management analytics, the model demonstrates how structural inequality persists as a stable equilibrium unless multidimensional intervention shifts system parameters beyond critical thresholds. The paper further introduces managerial policy simulations showing how coordinated strategies outperform isolated reforms. The findings contribute to complexity-based governance theory, strategic public management, and socio-mathematical policy design.

**136. Katarína Petrlová** – *Application of mathematical methods in crisis management*

Silesian University in Opava, Opava, Czechia

**Abstract:** In general, can be said that a method is a way to achieve a certain, predetermined goal through conscious and planned activity. It can also be stated that it is appropriate to use different methods to solve various problems in crisis management. The author of the contribution is an assistant professor at the Institute of Mathematics in Opava, Silesian University in Opava, Czech republic. In her scientific and research activities, she deals with methods, techniques and systematic approaches used in solving crisis situations and emergencies. Mathematical modeling, probability theory, statistical methods and graph theory are scientific disciplines that intervene in solving practical decision-making, organizational, technical and economic tasks. Therefore, they can be used in all areas where it is necessary to analyze and coordinate the implementation of operations within a specific system in crisis management. The aim of the contribution is to familiarize with the mathematical methods used at the Institute of Mathematics in Opava in the area of crisis management.

**137. Krishna Pokharel** – *An Isospectral Flow on Complex Hessenberg Matrices and Its Applications*

University of North Georgia, GA, USA

**Abstract:** In this talk, we present an isospectral flow in the space of matrices, which deforms any given complex upper Hessenberg matrix with a simple spectrum to a normal upper Hessenberg matrix. We prove that if the spectrum of the initial condition is contained in a line inside the complex plane, then its omega-limit set is a tridiagonal normal matrix possessing a special symmetry among the off-diagonal elements. Moreover, we show that this flow is also the solution of an infinite time horizon optimal control problem and prove that it can be used to construct even dimensional real skew-symmetric tridiagonal matrices with a given simple spectrum and given sign pattern for the co-diagonal elements. Furthermore, we provide simulation results highlighting the transient behavior of subdiagonal elements under the flow.

**138. Gunakhar Pokharel** – *Study on Tinau Flood at Butwal: An Optimization Evacuation Perspective*

Kathmandu Model Secondary School, Nepal

**Co-author(s):** Phanindra Prasad Bhandari, Shree Ram Khadka

**Abstract:** The Tinau flood, caused by the Tinau River during monsoon, is a major disaster in Butwal, Nepal, threatening lives and properties. The flood threatens lives and properties along the riverbank. Evacuation planning is crucial to save lives and minimize the loss of property. Extensive literature explores various mathematical models for evacuation planning. Network flow models are also applied to various real-world situations, including evacuation planning. In this study, we study lexicographically maximum contraflow (Lex-Max Contraflow) problem and implement it to real data set for Tinau flood evacuation to propose optimum evacuation route plan along with optimum distribution of evacuees among shelters based on their suitable prioritization.

**139. Chudamani Pokharel** – *Two-Layer Blood Flow with Effective Viscosity in Arteries with Bell-Shaped Multiple Stenoses*

Bhaktapur Multiple Campus, TU, Nepal

**Co-author(s):** Jeevan Kafle, Bishnu Prasad Bhandari, Kedar Nath Chhatkuli

**Abstract:** This study investigates two-layer blood flow in arteries with bell-shaped multiple stenoses. Blood is modeled as a core region of red blood cells surrounded by a peripheral plasma layer to account for variations in viscosity and hematocrit under physiological conditions. The governing momentum equations are analyzed to evaluate the effects of viscosity, hematocrit, and stenosis severity on velocity distribution, volumetric flow rate, pressure drop, and wall shear stress. The results indicate that increasing viscosity and hematocrit significantly reduce flow velocity and transport within the artery. Moderately stenosed arteries show greater sensitivity to rheological parameters, while severe stenoses act as strong flow-restricting regions. The analysis also reveals that pressure drop and wall shear stress increase markedly with stenosis severity, highlighting important hemodynamic changes relevant to cardiovascular studies.

**140. Sabin Pokharel** – *A Three-Dimensional Extension of the Matrix Encryption Walk: Construction and Analysis*

Priti Tamang, Ishan Acharya, Harish Chandra Bhandari

**Co-author(s):** The Matrix Encryption Walk (MEW) is a lightweight stream cipher that drives a structured walk over a two-dimensional key matrix, using plaintext bytes to determine direc-

tion and step length. While the scheme is well-suited for resource-constrained environments, extension to higher dimensions has not been developed. This work proposes a three-dimensional generalization of MEW. The key matrix is replaced by a cubic key tensor, and each plaintext byte is partitioned across three coordinate axes to govern movement through the extended lattice. We formalize the encoding scheme, describe the bit-partitioning design across three axes, and characterize the walk dynamics and cycle structure relative to the original two-dimensional construction. We discuss implications for cryptographic strength and identify open problems in key transport over walk-based structures.

**Abstract:**

**141. Sujan Pokharel** – *Adaptive Fractional Kolmogorov–Arnold Networks for Time-Fractional Diffusion Equations*

Kathmandu University, Nepal

**Co-author(s):** Samir Shrestha

**Abstract:** We propose Adaptive Fractional Kolmogorov–Arnold Networks (AFKAN), a physics-informed neural framework for solving time-fractional diffusion equations. Fractional partial differential equations are widely used to model anomalous diffusion and memory-dependent processes in viscoelastic materials, porous media, biological systems, and finance. However, their numerical treatment is challenging due to the non-local structure of fractional derivatives, solution singularities near the initial time, and high computational cost. AFKAN incorporates the Kolmogorov–Arnold representation theorem into a physics-informed architecture, expressing multivariate solutions as sums of adaptive univariate functions. Fractional operators are embedded directly into the loss formulation, preserving the non-local nature of the Caputo time derivative without requiring temporal discretization. The proposed framework is designed to accurately capture the characteristic initial-time singular behavior of time-fractional diffusion solutions. By combining adaptive function representation with physics-based constraints, AFKAN improves stability, accuracy, and convergence compared to standard physics-informed neural networks (PINNs). The method provides an efficient and interpretable scientific machine learning approach for solving forward and inverse fractional diffusion problems and can be extended to more general fractional PDE models.

**142. Keshav Pokhrel** – *Bayesian generalized weibull regression with applications to survival data*

University of Michigan-Dearborn, MI, USA

**Abstract:** We propose a Bayesian generalized Weibull regression method and develop Accelerated time-to-failure models using Bayesian methods. The parameter estimation procedure is carried out using the Hamiltonian Monte Carlo algorithm with No-U-Turn Sampler and compares the results of generalized Weibull regression with exponentiated Weibull regression, Weibull regression, and log-normal distribution across simulated and clinical data sets. In addition to monotone and bathtub hazard shapes, the additional shape parameter in the generalized Weibull distribution provides flexibility to model a broader class of monotone hazard rates.

**143. Puskar R. Pokhrel** – *Multiscale Modelling and Dynamics of Mixture Mass Flows*

Tribhuvan University, Nepal

**Abstract:** Landslides and debris flows are natural mass movements that erode and transport material downslope. These flows can be effectively described using partial differential equations. To understand their dynamics and geometry, Pokhrel et al. (2018) developed a two-dimensional mixture mass flow model. To incorporate multiscale analysis, the two-dimensional model is inte-

grated using the depth-averaging concept based on the Leibnitz rule. The idea of the multiscale approach is to numerically couple the two-dimensional and one-dimensional models at their interfaces, forming a coupled model through interface-based numerical decomposition. The flow of solid-fluid mixtures down a channel is represented by a system of three highly non-linear partial differential equations in conservative form, describing the mass and momentum balances, with the inclusion of drift factors. These coefficients capture the underlying physics of the system, reflecting the complex interactions between solid and fluid phases, physical parameters, mechanics, and flow dynamics. Novel mechanical and dynamical concepts, including normal and shear viscosities, and phase velocities, are incorporated to enhance predictive accuracy and better describe mixture mass flow dynamics. Numerical simulations demonstrate the model's capability to reproduce key phenomena such as phase separation, flow front propagation, and deposition patterns, providing critical insights into flow mechanics and hazard assessment. This coupled multiscale framework offers a robust numerical tool for understanding and predicting mixture mass flows in natural and engineered channels, with applications in disaster risk management, engineering design, and mitigation strategies for environments prone to debris flows, landslides, and other multiphase geophysical flows.

**144. Gyan Prasad Paudel** – *A Study of Sequence Spaces Defined by Statistical Convergence of Fuzzy Numbers*

Mid-West University, Surkhet, Nepal

**Abstract:** Sequence spaces are fundamental mathematical structures that play a significant role in functional analysis, topology, and sequence theory. These spaces consist of sequences of elements, typically real or complex numbers, equipped with specific topological or algebraic properties. This work investigates sequence spaces defined through the statistical convergence of fuzzy numbers, with particular emphasis on the development and analysis of new sequence spaces extending the classical framework within fuzzy set theory. By employing a difference operator, we further introduce the sequence spaces  $F_cI(S)$  and  $F_cI(S)_0$  of fuzzy numbers determined via  $I$ -statistical convergence. The study examines the fundamental algebraic and topological properties of these spaces and provides a detailed analysis of their structural characteristics. In addition, important properties such as symmetry, solidity, and convergence-free behavior are investigated, and several significant inclusion relations are established. This research contributes to the theory of  $I$ -statistical convergence in sequence spaces of fuzzy numbers by extending classical concepts and offering potential applications in fuzzy set theory and other areas involving uncertainty.

**145. Chudamani Poudyal** – *Flexible Non-likelihood Statistical Learning for Financial Claim Severity Models*

University of Central Florida, FL, USA

**Co-author(s):** Gokarna R Aryal, Keshav P. Pokhrel

**Abstract:** Learning financial claim severity models requires estimation methods that remain reliable under heavy tails, outliers, and multimodal structures. Maximum likelihood approaches often face instability in such settings, motivating the use of non-likelihood alternatives. Within the framework of general  $L$ -statistics, we present a flexible class of statistical learning algorithms that introduce observation-specific weights. This approach enables user-driven weighting schemes that adjust smoothly across the data range, capturing both heavy-tailed and multimodal features. The resulting estimators, available in closed form for many probability distributions, possess established asymptotic properties and avoid the computational burden of EM-based mixture fitting for multimodal data. Simulation studies and real-world claim data analyses show that the framework supports a clear flexibility vs efficiency tradeoff, giving prac-

tioners tools to align estimation with data characteristics and modeling objectives. The proposed method can further assist insurers in setting risk capital levels, particularly in meeting solvency capital requirements under regulations such as Solvency II. Future directions, such as implementing the proposed learning techniques to generalized linear models, will be discussed.

**146. Basanti Sharma Poudyal** – *Artinian Gorenstein Rings over Macaulay’s Inverse System*

Tarrant County College Northeast Campus, TX, USA

**Abstract:** In this talk, we consider Artinian rings  $(A, \mathfrak{m}, k)$ , which are rings that satisfy the descending chain condition on ideals. We say that  $(a, b)$  is an exact pair of zero divisors in  $A$  if there exists a pair of elements  $a, b$  in  $\mathfrak{m}$  such that  $\text{ann}_A(a) = (b)$  and  $\text{ann}_A(b) = (a)$ . It is known that a generic Artinian Gorenstein ring of socle degree 3 contains at least one pair of exact zero divisors. We investigate the existence of totally reflexive modules in the absence of exact pairs of zero divisors. Since the existence of totally reflexive modules is guaranteed in Artinian Gorenstein rings, we consider Artinian non-Gorenstein rings. We use Macaulay’s Inverse System to construct these rings. As a result, we obtain a class of rings having non-free totally reflexive modules in the absence of exact pair of zero divisors.

**147. Eeshwar Poudel** – *An Optimal Data-Assimilative Approach to Air Quality Analytics for Policy and Emergency Planning*

Tri-Chandra Multiple Campus, Tribhuvan University

**Co-author(s):** Jeevan Kafle, Shree Ram Khadka, Shankar Pariyar

**Abstract:** Air pollution continues to be a significant environmental and public health challenge, especially in urban and industrial areas, highlighting the importance of accurate dispersion modelling and efficient emission mitigation strategies. In this work, a unified framework is developed for a two-dimensional advection–diffusion equation that accounts for both molecular diffusion and turbulent mixing processes. A closed-form analytical solution obtained through eigenfunction expansion serves as a reliable benchmark, while an efficient Alternating Direction Implicit (ADI) method is used for numerical computation. To enhance the reliability of concentration predictions, noisy synthetic observations are incorporated through a Kalman Filter, which refines the state estimates and reduces model uncertainty. Using these filtered states, an optimal control problem is formulated to determine emission policies that simultaneously minimize pollutant concentrations and associated control costs. By integrating Pontryagin’s Maximum Principle with Kalman filter–based state estimation, the proposed framework establishes a closed-loop, real-time control strategy driven by data-informed state estimates rather than solely relying on deterministic model outputs. The methodology is illustrated through a case study inspired by air-quality conditions in Nepal, demonstrating its applicability in data-scarce settings and its potential usefulness for emission management and emergency response planning.

**148. Surya Prakash** – *A Novel Alpha-Powered Generated Family of Lifetime Distributions: Properties, Estimation, and Applications*

Banaras Hindu University, India

**Co-author(s):** Arun Kaushik

**Abstract:** In this paper, a new lifetime distribution is introduced through a novel transformation of an arbitrary baseline cumulative distribution function. The proposed model incorporates two additional shape parameters that substantially enhance flexibility in modeling skewness, tail behavior, and a wide variety of hazard plot contradicting these statements. Explicit expressions are derived for several important statistical and reliability characteristics of the distribution,

such as the probability density function, survival function, hazard rate, moments, moment generating function, quantile function, order statistics, entropy measures, Lorenz and Bonferoni curves, mean residual life, and stress–strength reliability. Identifiability and stochastic ordering properties are also established. Parameter estimation is addressed using multiple classical and modern approaches, including maximum likelihood, maximum product spacing, least squares, weighted least squares, Cramér–von Mises, Anderson–Darling, and Bayesian estimation via Markov Chain Monte Carlo methods. The finite-sample performance of the estimators is examined through an extensive simulation study. The practical usefulness of the proposed distribution is demonstrated using a real fatigue-life data set, where it is shown to outperform several well-known competing lifetime models in terms of information criteria and goodness-of-fit measures. These results indicate that the proposed distribution provides a flexible and analytically tractable alternative for modeling lifetime and reliability data.

**149. Gopal Prasad Acharya** – *The Comparative Analysis of the Efficacy of the Cauchy’s Momentum Equation and Navier Stokes(N-S) Equation in Fluid Dynamics*

New Horizon College, Nepal

**Abstract:** Firmly rooted with the Newton’s Second law of motion, the Cauchy momentum equation and the Navier Stokes(N-S) equation endure the critical distinction in the formulation, structure and the level of generalities. Fundamentally, Cauchy’s equation is the equation of motion for any continuum body that describes the conservation of momentum and flow pattern regardless of specific material behavior whereas N-S equations is the special form of Cauchy’s equation designed for only the Newtonian fluids. Over the Cauchy’s equation, the N-S equation typically enriched with the constitutive equation that relates the stress to the rate of strain and turns it out as solvable variable. The analysis of their distinct features and significance of the models are discussed.

**150. Tuk Bahadur Rana** – *Hemodynamic Analysis of Two-Layered Blood Flow Through Overlapping Stenosed Artery*

Padma Kanya Multiple Campus, TU, Nepal

**Co-author(s):** Jeevan Kafle, Ami Raj Adhikari, Pushpa Nidhi Gautam, Gyan Bahadur Thapa

**Abstract:** Stenosis, the abnormal narrowing of arteries caused by atheroma formation, significantly alters blood flow dynamics and may lead to severe cardiovascular complications. Over time, a single stenosis can develop into overlapping stenoses, producing greater arterial obstruction and increasing clinical risk. In this study, blood flow through an artery with overlapping stenosis is investigated using the Navier–Stokes equations formulated in cylindrical coordinates. A two-layer mathematical model is developed, consisting of a peripheral plasma layer and a central core region representing concentrated blood cells. Analytical expressions for important hemodynamic parameters, including velocity distribution, volumetric flow rate, pressure drop, wall shear stress, and flow resistance, are derived. The results obtained from the two-layer model are also compared with those of a corresponding single-layer model in order to assess the influence of the layered structure and viscosity variation on the flow characteristics. The effects of overlapping stenosis and variations in core and peripheral viscosities are examined and compared with the corresponding non-overlapping stenosis case. The results indicate that overlapping stenosis significantly modifies flow characteristics in both layers, resulting in distinct hemodynamic behavior. The proposed model may provide useful insights for biomedical applications such as angioplasty planning and the design of blood-contacting medical devices.

**151. Pratik Ray** – *Modeling Information Leakage in Encryption Algorithms Using Entropy Analysis*

Kathmandu University, Nepal

**Co-author(s):** Shubheeksha Shrestha, Anurag Kafle, Saraswati Acharya

**Abstract:** Encryption algorithms are commonly evaluated for computational security, the statistical randomness of ciphertext distributions remains less studied. This paper quantifies information leakage in RSA using Shannon entropy, defining leakage as  $L = 8 - H(X)$ , where  $H(X)$  is the entropy of the ciphertext byte distribution. We generate a dataset of 360 encrypted messages across varying key sizes (1024, 2048, 3072 bits), plaintext lengths (64, 128, 256, 512 bytes), and plaintext types (repetitive, natural, and random). RSA with OAEP padding achieves near-optimal entropy ( $\approx 99.97\%$  of the theoretical maximum), demonstrating minimal leakage across all configurations. A nonlinear regression model,

$$L = a + \frac{b}{K} + ce^{-dN} + eT + f\frac{T}{K},$$

relating leakage to key size ( $K$ ), message length ( $N$ ), and plaintext type ( $T$ ), achieves  $R^2 = 0.7271$  and  $\text{RMSE} = 0.1715$ . Results show that larger keys and longer messages marginally reduce leakage, while plaintext type has negligible impact. This paper presents a mathematical framework for parameter selection in cryptography

**152. Dipendra Regmi** – *Global Regularity of the 2D Magneto-Micropolar Equations with Partial Dissipation*

University of North Georgia-Gainesville Campus, GA, USA

**Abstract:** We study the global existence and regularity of classical solutions to the two-dimensional incompressible magneto-micropolar equations with partial dissipation. These equations describe the motion of electrically conducting micropolar fluids in the presence of a magnetic field. When only partial dissipation is present, the global regularity problem can be quite difficult. We identify three special cases of partial dissipation and prove the global regularity of classical solutions in each case. As important consequences, our results also imply the global existence of classical solutions for several related systems, including the two-dimensional Navier–Stokes, magnetohydrodynamic, and micropolar equations with certain types of partial dissipation.

**153. Ramchandra Rimal** – *Uncertainty Quantification in Large Language Models for Complex Quantitative Reasoning*

Middle Tennessee State University, TN, USA

**Abstract:** Large Language Models (LLMs) show great promise in complex reasoning. However, their deployment in high-stakes financial and actuarial fields is limited by the risk of unpredictable errors, often called "hallucinations." Actuarial problems require strict precision and multi-step logic, meaning a single reasoning error can compound exponentially. This study introduces a rigorous mathematical framework to measure, debias, and bound the trustworthiness of LLMs in these demanding environments. We model the step-by-step reasoning of LLMs as a probabilistic process. By applying deterministic and probabilistic bounds alongside nonparametric Monte Carlo estimators, we establish confidence intervals around the model's logical trajectory. We then evaluate this framework across three core dimensions. First, we assess the baseline capability of LLMs to achieve passing-level accuracy across a comprehensive spectrum of professional actuarial exams. Second, we move beyond standard final-answer grading by constructing an automated, probabilistically sound system to verify the correctness of intermediate reasoning steps. Finally, we examine the robustness of this evaluation framework. We demonstrate how a bounded "LLM-as-a-judge" architecture can effectively mitigate known AI evaluation biases, such as position, verbosity, and self-enhancement biases, to ensure reliable

and objective assessments. Ultimately, this research provides the statistical guarantees necessary to transition LLMs from heuristic text generators into mathematically verifiable engines for complex quantitative reasoning.

**154. Narayan Sapkota** – *A Hybrid Godunov-PINN Framework for the Savage-Hutter Granular Avalanche Model*

Kathmandu University, Nepal

**Co-author(s):** Shyamshwar Baral, Santosh Paudel, Khim Bahadur Khattri

**Abstract:** The Savage–Hutter (SH) model describe the motion of a finite cohesionless granular mass down a rough inclined plane and serve as the governing model for rockfalls, debris flows, and snow avalanches. Despite their physical importance, their numerical solution remains challenging due to three compounding difficulties: the non-conservative hyperbolic structure of the system, the discontinuous switching of the Coulomb basal friction term between active and passive earth pressure states, and the presence of moving vacuum fronts at the leading and trailing margins of the granular mass. Existing numerical methods either misrepresent the asymptotic profile or fail to correctly capture the reposing state, motivating the development of a more robust and unified computational framework. Meanwhile, data-free physics-informed neural networks (PINNs), trained without any labelled data, emerged as a completely independent method for solving PDEs, required only to satisfy the differential equations, initial conditions, and boundary conditions simultaneously, yet their application to geophysical granular flows with non-smooth friction laws and free boundaries remain entirely unexplored. This paper presents the unified hybrid computational framework combining a high-resolution Godunov-type finite volume scheme and a PINN for both forward and inverse problem of SH model.

**155. Stephen M Scariano** – *Nonstandard Control Charting for Tenure of U.S. Supreme Court Justices*

Sam Houston State University, TX, USA

**Co-author(s):** Richard Kelley

**Abstract:** The length of tenure of U. S. Supreme Court Justices has been claimed to be increasing in recent years. This study casts doubt on this claim by examining the length of service of all these justices except those who have not yet finished their national service. Some interesting results are seen using Exponentially Moving Average, Cumulative Sum and Standard Control Charting methodologies.

**156. Stephen M Scariano** – *The Coefficient of Dependence*

Sam Houston State University, TX, USA

**Abstract:** The Coefficient of Dependence is introduced as an avenue for aiding student understanding of dependent, statistical events. The essential features of this coefficient are studied using different models and explored with multiple examples. Conditional probabilities are ultimately understood to be simple transformations of marginal probabilities via the Coefficient of Dependence, which is an idea well within the grasp of all undergraduate students.

**157. Adisak Seesanea** – *Lane–Emden type problems with several sublinear terms involving measures*

Sirindhorn International Institute of Technology, Thammasat University, Pathum Thani, Thailand

**Abstract:** This talk is concerned with positive bounded solutions to a Lane–Emden type

problems on domains with sublinear terms and measure data. I will present existence, uniqueness, and sharp bilateral pointwise estimates for solutions, and also discuss a related result for positive continuous solutions. I will further mention how the method extends to sublinear problems involving the fractional Laplacian  $(-\Delta)^\alpha$  in  $\mathbb{R}^n$ . This is joint work with Kentaro Hirata (Hiroshima) and Toe Toe Shwe (SIIT).

**158. Ramsha Shafqat** – *Fractional-Order Modeling of Paliperidone Inhibition in RAGE–HMGB1 Signaling Using Deep Neural Networks*

Thammasat University, Rangsit Campus, Thailand

**Abstract:** The HMGB1–RAGE signaling axis is a key driver of cancer progression, linking inflammatory stress to enhanced survival, proliferation, and therapy resistance. Classical models struggle to capture the long-memory and multiscale behavior of this pathway and become computationally expensive in fractional settings. In this work, we propose a hybrid computational framework that combines a Caputo fractional-order model with a deep neural network surrogate to quantify the inhibitory effects of Paliperidone on HMGB1–RAGE signaling. Non-integer-order kinetics describe hereditary effects in receptor regulation, ligand–drug competition, downstream signaling, and apoptosis. High-fidelity trajectories from the fractional system are used to train a hyperbolic tangent neural network, achieving mean squared errors below  $10^{-7}$ . The surrogate enables efficient exploration of dose–response behavior and fractional orders without repeated numerical integration. Simulations show that Paliperidone suppresses RAGE activation, weakens HMGB1-mediated survival signals, and enhances apoptosis, while fractional orders  $\alpha < 1$  induce persistent memory effects consistent with experimental observations.

**159. Ramsha Shafqat** – *Modified ABC Fractional Modeling of Polio Transmission with Vaccination and Deep Neural Networks*

Thammasat University, Rangsit, Thailand

**Abstract:** This study presents a deterministic epidemiological model to analyze the transmission dynamics of poliomyelitis while incorporating vaccination and hospitalization effects. The total population is divided into six compartments: susceptible, vaccinated, infected, hospitalized, paralyzed, and deceased individuals. To capture memory effects in the disease progression, the model is formulated using a fractional-order framework based on the modified Atangana–Baleanu–Caputo operator. The qualitative properties of the model are investigated using fixed-point theory to establish the existence and uniqueness of solutions. An approximate analytical solution of the system is obtained through the Laplace Adomian Decomposition Method, and the stability of the iterative scheme is verified using Picard stability analysis. Furthermore, the basic reproduction number is derived via the next-generation matrix approach, and the disease-free and endemic equilibria are analyzed together with their stability properties. A sensitivity analysis of  $R_0$  is also conducted to assess the influence of key epidemiological parameters. To validate the theoretical results, numerical simulations are performed for various fractional orders and transmission parameters. In addition, a Deep Neural Network framework is employed to approximate the behavior of the model, where the dataset is divided into training, validation, and testing sets. The obtained results confirm that the proposed fractional model combined with deep learning techniques provides an effective framework for understanding polio transmission dynamics and evaluating the role of vaccination strategies.

**160. Laxmi Sharma** – *Pathways to Cultural and Economic Capital in Nepal: Evidence from Sanskrit-Mathematics Nexus*

Nepal Sanskrit University, Nepal

**Co-author(s):** Lekhnath Sharma, Bishnu Khanal, Dinesh Panthi

**Abstract:** Many parents have clear expectations that their children will be more cultured, kind, and socialized, in addition to achieving better academic performance. A child’s skills, qualifications, and capabilities are fundamental requirements for a better future and for raising their living standard. Ultimately, these expectations and requirements are closely intertwined with the acquisition of cultural and economic capital of students. Sanskrit stream educational institutions in Nepal are central where this dynamic unfolds. These institutions provide opportunities for students to learn religious and cultural knowledge while simultaneously receiving a formal education aligned with national curriculum standards. However, research on how these institutions create hidden gender and caste-based disparities in access to sociocultural and economic capital remains unexplored. This study explores early engagement of students in income generating and ritualistic practices and analyses structural disparities through qualitative data from interviews, focus group discussions, and observational insights. Findings reveal that Hindu Brahmin boys are benefited from economic and sociocultural involvement in rituals whereas girls and non-Brahmin boys are symbolically included in cultural values but practically excluded from economic opportunities. Such exclusion limits social mobility, empowerment, and educational equity. The study advocates integrating context-specific mathematics and life skills rooted in indigenous knowledge systems such as Chatussasthi Vidya to bridge gaps. Policy interventions should harmonize traditional values with contemporary frameworks of gender and caste justice, empowering all students to engage effectively in both economic and cultural spheres.

**161. Shrijak Shrestha** – *Diffusion-Based Generation of Nepali Handwritten Characters for Low-Resource Script Modeling*

Kathmandu University, Nepal

**Co-author(s):** Khim Bahadur Khattri

**Abstract:** Handwritten text generation has become an important task in document analysis, data augmentation, and handwriting recognition systems. While diffusion-based generative models have demonstrated significant success in synthesizing handwriting for major scripts such as Latin and Chinese, the application of these techniques to low-resource writing systems, including Nepali written in Devanagari, has received comparatively little attention. This paper proposes a diffusion-based framework for generating synthetic Nepali handwritten characters to support handwriting recognition and digital document processing. The proposed method trains a conditional denoising diffusion probabilistic model on a dataset of Nepali handwritten characters collected from scanned documents and curated handwriting datasets. The model learns the distribution of character shapes and stylistic variations by progressively adding and removing Gaussian noise during training and sampling. Style conditioning is incorporated using latent embeddings to capture variations in individual writing styles. The generated characters are evaluated using structural similarity metrics and downstream handwriting recognition performance when used as synthetic data augmentation. The experiments show that the diffusion model can generate visually realistic Nepali handwritten characters with diverse writing styles while preserving the structural integrity of individual glyphs. Incorporating the generated samples as additional training data leads to improved recognition accuracy in Nepali handwriting recognition models. These findings suggest that diffusion-based approaches offer a practical solution for low-resource script synthesis and can support broader efforts in document digitization and preservation for Nepali and other Indic languages.

**162. Sharmila Shrestha** – *Application of the Finite Element Method to Analyze Breast Tissue Temperature*

Khwopa College, Nepal

**Abstract:** The Finite Element Method (FEM) is a well-established numerical approach for solving differential equations subject to defined boundary conditions and is extensively utilized across scientific and engineering domains. In the context of biomedical studies, temperature represents a fundamental variable for interpreting physiological processes and is typically described using such equations. This work examines the application of FEM in analyzing temperature distribution within human female breast tissue. Owing to the breast's complex geometry and multilayered composition with varying thermal properties, FEM offers an efficient solution by discretizing the domain into triangular elements, thereby facilitating accurate and dependable simulation of thermal behavior.

**163. Ishwar Kumar Shrestha** – *Determinants Associated with Time to First Birth Among Women in Nepal: A Generalized Gamma Survival Analysis*

Central Department of Statistics, Tribhuvan University, Nepal

**Co-author(s):** Shankar Prasad Khanal

**Abstract:** Background: In Nepal, women often experience their first childbirth at an early age, although the timing varies across socio-demographic, economic, and cultural contexts. The timing of the first birth influence women's reproductive behavior, fertility patterns, and maternal-child health outcomes. This study aims to examine significant determinants associated with time to first birth (TFB) among women in Nepal. Methods: Using data from the Nepal Demographic and Health Survey - 2022, this study applied a generalized gamma (GG) survival model to analyze time to first birth (TFB) among women in Nepal, where TFB was the response variable. Time ratios (TR) were reported as effect size, and statistical significance was declared at  $p$ -value  $\leq 0.05$  with 95% confidence interval. The GG model provided a balance between goodness-of-fit and model parsimony. Results: Ten significant determinants of TFB were identified, where early TFB was associated among women marrying before the age of 18 (TR:0.83; 95%CI:0.82-0.83) compared those marrying later. Factors, such as no education: women (TR:0.89; 95%CI:0.87-0.90) and husbands (TR:0.98; 95%CI:0.96-0.99); Dalit women (TR:0.98; 95%CI:0.97-0.99); and women in Karnali (TR:0.98; 95%CI:0.97-0.98) associated with early TFB. Likewise, early menarche (TR:0.98; 95%CI:0.97-0.98) and a larger spousal age gap (TR:0.98; 95

Conclusion: In Nepal, over half of first births occur during adolescence, with nearly a quarter before age 18 – a barrier for education and personal development. Preventing adolescent motherhood and its associated maternal-child health consequences requires targeted action addressing early marriage, larger spousal age gaps, and limited access to educational - particularly for high-risk subgroups.

**164. Anand Singh** – *Turing Pattern Formation in a Seasonally Forced Predator-Prey Model with Fear Effects and Prey Refuge*

Masoom Bhargava, Balram Dubey

**Co-author(s):** Seasonal variations critically influence species movement and migration, with profound implications for ecological stability, as evidenced by numerous natural phenomena. In this work, we modify the traditional Lotka-Volterra model by incorporating three key mechanisms: predator-induced fear effects on prey reproduction and mortality, prey refuge dynamics, and periodic environmental fluctuations. For the autonomous system, we conduct a comprehensive stability analysis and uncover rich dynamics, including key bifurcations such as saddle-node, Hopf, and codimension-two bifurcations, specifically Bogdanov-Takens and cusp bifurcations, as well as global homoclinic bifurcations. Building upon the temporal case, we explore the non-autonomous dynamics by including seasonal changes in the fear and refuge parameters,

where we establish criteria for permanence and the existence of globally attractive periodic solutions, highlighting how seasonal forcing can lead to ecological collapse by crossing extinction thresholds. We further analyze a reaction-diffusion system under both autonomous and non-autonomous frameworks to investigate the spatial distribution of species. For non-autonomous cases with time-varying cross-diffusion and periodic reaction rates, we derive Turing instability conditions using comparison principles, expressed through inequalities involving time-varying parameters and their derivatives. The autonomous case recovers classical Turing conditions, validating our generalized approach. Numerical simulations quantify how fear intensity and refuge availability modulate pattern formation, while seasonality induces complex dynamics such as periodic oscillations, chaotic regimes, and bursting behaviors. This study highlights the profound impact of seasonal variations on ecological stability and pattern formation, offering valuable tools for understanding non-autonomous systems in ecological modeling.

**Abstract:**

**165. Eric Stachura** – *The Drude-Born-Fedorov system on anisotropic fractal porous media*

Kennesaw State University, GA, USA

**Co-author(s):** Ioannis Stratis

**Abstract:** In this talk, I will discuss a mathematical framework for wave propagation in anisotropic fractal porous media. These materials are fractal structures that could have different dimensions in each direction and appear, for instance, in the modeling of composite structures with fractal type microstructures. I will discuss the vector framework to study electromagnetic wave propagation and apply it to the special case of the Drude-Born-Fedorov system—a particular model of an electromagnetically bi-anisotropic medium which incorporates chirality. This is joint work with I. G. Stratis (National and Kapodistrian University of Athens).

**166. Shantiram Subedi** – *A Review on Multivariate Statistical Modeling for the Analysis of NEPSE Stock Data*

Kathmandu University, Nepal

**Co-author(s):** Rabindra Kayastha

**Abstract:** Introduction: The stock market serves as a key indicator of economic growth; however, its behavior is inherently complex due to nonlinear dynamics influenced by economic, political, and psychological factors, as well as the fuzzy and volatile nature of financial data. With increasing market complexity, there is a growing need for advanced forecasting models capable of delivering higher predictive accuracy to support well-informed decision-making. Objectives: This article aims to systematically review the existing literature on multivariate models used for stock market forecasting, and to identify dominant variables, evaluation methods, and research gaps. Methods: This study investigates the application of multivariate statistical modeling techniques to analyze Nepal Stock Exchange (NEPSE) data. The review synthesizes findings from 22 empirical studies and employs a range of statistical and econometric frameworks, including time series analysis, dynamic linear models, Principal Component Analysis (PCA), factor analysis, and multivariate regression. It further compares traditional econometric models (ARIMA, VAR, VECM) with machine-learning approaches (SVM, Random Forest, LSTM). Results: The comparative analysis indicates that Vector Error Correction Models (VECM) consistently outperform VAR and ARIMA models in capturing long-run stock index dynamics. For short-term forecasting of stationary data, VAR models demonstrate superior performance. In highly volatile and nonlinear market conditions, machine-learning models—particularly LSTM networks—achieve the highest forecasting accuracy. Conclusion: Evidence from 22 empirical studies shows that forecasting performance depends strongly on data characteristics and time

horizon. VECM consistently provides superior long-run forecasts under cointegration, while VAR performs better for short-run stationary series. For highly volatile and nonlinear markets, LSTM models achieve the largest accuracy gains, reducing forecast errors. Implications: The study offers insights into the relative effectiveness of different forecasting models and highlights the need for multivariate modeling of the NEPSE index to give much richer and realistic picture. Thus, the stakeholders can appropriately analyze and amalgamated the model's outcomes.

**167. RANI SULVIANURI** – *The Momentum Conservative Scheme for Simulating Wave Generated by Landslide in U-Shaped Bays*

**Co-author(s):** SRI REDJEKI PUDJAPRASETYA

**Abstract:** Research on waves generated by landslides has been widely conducted, covering cases of landslides occurring over flat sea beds and along sloping coastlines, and employing analytical, numerical, and experimental methods. In this study, we investigate landslide-induced waves in long and narrow bays where the governing dynamics can be described by Saint-Venant type equations. We revisit and modify a numerical scheme we previously developed in order to account for landslide motion. The capability of the scheme to reproduce waves generated by landslides in U-shaped bays is validated through comparisons with available analytical solutions. The numerical simulations are further used to examine wave shoaling processes within the U-bay and to explore resonance phenomena, both of which show a good agreement with theoretical predictions. Additionally, nonlinear behaviors captured by the numerical model are analyzed. Finally, the model is applied to a realistic case study to estimate the potential wave runup in Palu Bay.

**168. S Sundar** – *A meshless shock-capturing method for solving the shallow water equations*  
Indian Institute of Technology, Madras, India

**Abstract:** This study proposes a numerical method, namely, a shock-capturing meshless geometric conservation weighted least square (GC-WLS) method for solving the shallow water equations using the HLL (Harten–Lax–van Leer) Riemann solver for simulating 1D and 2D open-channel flows on a highly variable topography even in presence of shocks and discontinuity. The HLL Riemann solver in the proposed meshless method is used to compute convective flux. The spatial derivatives in the shallow water equations and the reconstruction of conservative variables to calculate flux terms at midpoints are computed using GC-WLS method. The proposed meshless method is tested for various numerically challenging problems, including analytical, laboratory experiments, and real-life flood scenarios. The proposed meshless model is found to be accurate, robust and suitable for simulating real-world open-channel flow dynamics. The performance of the meshless method is also compared with the mesh-based method. In summary, the study recommends the utilization of the developed meshless method in conjunction with the HLL Riemann solver for accurately capturing open-channel flow, especially when shocks and discontinuities are observed.

**169. Bal B Tamang** – *A Unified Local–Global Computational Framework for Generalized Pell-Type Equations with Large Parameters*

Mahendra Ratna Multiple Campus, Nepal

**Co-author(s):** Ajaya Singh

**Abstract:** We investigate generalized Pell-type equations of the form

$$x^2 - Dy^2 = N,$$

where  $D \geq 23$  is a fixed nonsquare integer and  $N$  is a large positive odd integer. In this large-parameter regime, classical exact methods become computationally impractical. We propose a unified local–global computational framework for analyzing both solvability and unsolvability. This framework integrates local congruence criteria and  $p$ -adic solvability analysis with efficient modular sieving procedures and explicit bounds derived from Diophantine approximation. Local criteria yield immediate certificates of global impossibility, while modular sieving significantly restricts the admissible solution space. Moreover, Liouville inequalities furnish effective upper bounds on the variables, thereby reducing the problem to the verification of finitely many explicitly identified cases. The resulting methodology provides a scalable and computationally efficient approach to the systematic investigation of generalized Pell-type equations with large parameters.

**170. Dhana Kumari Thapa** – *Perceived Barriers to Women’s Pursuit of Mathematics in Higher Education in Nepal: Perspectives of Teachers and Students*

Padmakanya Multiple Campus, Nepal

**Abstract:** The share of women’s participation in mathematics studies in higher education in Nepal remains low. The research paper aims to explore personal, social, and cultural barriers that prevent women from studying mathematics at higher educational institutions. The paper is based on a study that was conducted in Kathmandu using an interpretivist paradigm and qualitative research methods. Data were collected from twelve participants, including four university mathematics teachers and eight female students enrolled in university-level mathematics programs using in-depth interview. Data were analyzed employing a thematic approach, which identified seven themes, each described as a perceived barrier. These barriers include the perception of mathematics as a difficult and abstract subject; lack of sufficient self-efficacy; the impact of marriage and family responsibilities; a lack of visible female role models; insufficient support from teachers and academic institutions; persistent gender stereotypes portraying mathematics as a male domain; and overarching social and cultural norms that prioritize women’s domestic roles. The findings indicate that these interconnected factors create significant barriers, preventing women from pursuing advanced studies in mathematics and continuing their career development in the field. Mitigating these barriers requires a comprehensive intervention strategy to create a supportive environment at home, in society, and in academic institutions for promoting women in mathematics at the university level.

**171. Ritu Basnet Thapa** – *Optimizing Production System Using Queueing Model and Defect Classification*

Tribhuvan University, Nepal

**Co-author(s):** Sushil Ghimire, Ram Prasad Ghimire

**Abstract:** This paper develops a queueing system for a production line of prefabricated structures like poultry houses, goat shelters, and related agricultural buildings. In prefabricated structures, defective products may appear, which increases the cost of production. Products undergo quality inspection and are classified into three categories defect-free, minor defects, or major defects each with distinct arrival and service rates. Defect-free items proceed to sale, while defective items enter respective repair states. Using probability generating functions, explicit formulas are derived for expected number of products waiting in the queue and in the system, expected waiting time of a product in the queue and in the system. A cost optimization determines optimal repair service rates. The model is validated via MATLAB simulations.

**172. Bhikhari Tharu** – *Estimating Missing Breast Cancer Mortality Rates for the Females in the USA*

Spelman Collage, GA, USA

**Abstract:** Breast cancer is the most diagnosed cancer and the second most common cause of morbidity and mortality among women in the United States. Despite the substantial progress in reducing breast cancer mortality in the US over the past decades, disparities are still exit, especially among Black women. Continued surveillance and the study of breast cancer are essential to monitor progress, evaluate policies, and inform cancer control strategies. However, a complete and clean data set is sometimes unavailable for analysis despite every effort, posing challenges in the study and negatively affecting decision making in the related areas. The breast cancer mortality rates for the US females by race are obtained from 1990 to 2023 from National Cancer Institute (NCI). In this study, we implement functional data analysis approach to estimate the missing values. The method can estimate the values even when one or few observations are available with high degrees of confidence and the estimates are statistically significant at 0.05 level. The model estimates a continuous decline in the breast cancer mortality rates for Asian Pacific Islander women, while the rates remain stable for black and American Indian/Alaska Native women.

**173. M. Thenmozhi** – *AI and ML Applications in Predicting Financial Data*

Indian Institute of Technology Madras, India

**Abstract:** The recent advances in application of AI and ML techniques in financial markets have augmented the decision making and use of market information by regulators, traders, analysts and investors. Support Vector machine models outperform ANN, Random Forest Regression and ARIMA in financial forecasting. Hybrid Support vector machines based models outperform Hybrid Artificial neural network based models in forecasting stock returns and is robust for different input variables (Technical indicators, auto-regressive lags and global stock market cues), rolling sample, during crisis period and different economic cycles, and evaluated on a range of trading strategies using multiple objectives. Hybrid SVM-GA simulated trading Model using global cues are suitable for algorithmic trading. We strongly recommend use of customised hybrid models for (algorithmic) trading (including emerging market price transmission in the model), to generate better returns in day trading.. Deep learning and Explainable AI models augment the explainability of the predictions using machine learning models.

**174. Archana Timsina** – *Modeling the effectiveness of potential Clostridioides difficile vaccines in a healthcare metapopulation*

Hampton University, VA, USA

**Abstract:** Clostridioides difficile (C. difficile) is a leading cause of infectious diarrhea and a major cause of healthcare-associated infections. Vaccines based on toxin-related antigens have been tested in clinical trials. Vaccines based on other antigens with the potential to prevent colonization or reduce infectiousness are in earlier phases of development. To assess the impact of such vaccines on the transmission of cdiff in healthcare settings, we developed a deterministic model of disease flow in a metapopulation of community, hospital, and skilled nursing facilities. We analyzed the potential effect of vaccination on the prevalence of the disease in the heterogeneous population by measuring its efficacy on susceptibility, colonization, infectiousness, and clinical disease with the group of vaccinated individuals. We determined the values of the parameters using clinical and observation data, and calibrated the model parameters to match the observed prevalence. We also analyzed the most sensitive parameters for the cumulative asymptomatic and symptomatic cases of C. difficile in the metapopulation, as well as the prevalence of colonized and diseased individuals in the community, skilled nursing facility, and hospital in the absence of vaccine efficacy. Similarly, we compared the simulated

solution curves of the cumulative cases of asymptomatic and symptomatic individuals as well as the prevalence of the colonized and diseased individuals, not only highlighting the relative infectiousness in central but also in different percentages of vaccine efficacy, including one-year and 15-year time intervals. Our results demonstrate that incrementing the various vaccine efficacy effects reduces the cumulative cases of  $cdiff$  and the prevalence of the colonized and diseased individuals in the metapopulation over time, with the dominant effect coming from lowering the transmission rate into the colonized state .

**175. Ramesh Timsina** – *Traveling-Front Solutions of the Richards Equation with Nonlinear Soil Hydraulic Properties*

Harihar Khanal, Andrei Ludu

**Co-author(s):** The Richards equation is a fundamental model for water transport in unsaturated soils. This study examines traveling-front solutions under nonlinear soil hydraulic properties. Using a traveling-wave transformation, the governing partial differential equation is reduced to an ordinary differential equation, enabling phase-plane analysis of solution behavior. We establish conditions for the existence of monotone traveling fronts connecting distinct equilibrium states and analyze their propagation characteristics. The results provide insight into the formation and movement of wetting fronts in porous media. Numerical illustrations support the analytical findings. These results enhance the theoretical understanding of nonlinear flow in unsaturated media and have potential applications in hydrology and environmental modeling. **Keywords:** Richards equation, traveling wave solution, unsaturated porous media, phase-plane analysis, nonlinear partial differential equation.

**Abstract:**

**176. Pitamber Tiwari** – *Hermite-Hadamard Integral Inequalities for  $m$ -Harmonically Convex Functions*

Department of Mathematics, Bhairahawa Multiple Campus, Tribhuvan University

**Co-author(s):** Chet Raj Bhatta, Central Department of Mathematics, Tribhuvan University

**Abstract:** One of the major natures of the geometric function theory is to measure the notion of the convexity or concavity of the function which ultimately helps to pure and applied disciplines. The growth of numerous pure and applied disciplines is fundamentally influenced by convexity theory. Convexity and inequalities are interlinked that play a basic character in many branches of mathematical sciences. The Hermite-Hadamard Integral Inequality is among the best-known inequalities for convex functions. This double inequality provides an upper and a lower bounds of the integral mean of a convex function. The Hermite-Hadamard inequality plays a significant role in the development of all fields of mathematics with applications in integral inequalities, approximation theory, optimization theory, information theory, and numerical analysis. The recent trend in classical convexity is to extend to various forms of convexity. Enhancing the result already obtained is always thought as the interest of research. In this paper, we have generalized harmonically convex function to  $m$ -harmonically convex function and applied them to develop some Hermite-Hadamard type integral inequalities whose first order derivatives are  $m$ -harmonically convex function. Apart from this, we have further generalized harmonically  $P$ -function to  $m$ -harmonically  $P$ -function and applied them to extend Hermite-Hadamard type integral inequalities **Keywords:**convexity; harmonic convexity; Hermite-Hadamard inequality.

**177. Sudarshan Tiwari** – *Meshfree Semi-Lagrangian (SL) vs Arbitrary Lagrangian-Eulerian (ALE) methods for the BGK equation with moving boundaries*

RPTU Kaiserslautern-Landau, Germany

**Abstract:** We present two meshfree methods for solving the BGK model of the Boltzmann equation for rarefied gases. Widely used approaches for solving the Boltzmann equation are stochastic methods, such as the DSMC method. DSMC is well suited for stationary problems as well as high-speed flows. However, our focus is on low-speed flows and flows induced by the motion of rigid bodies. In these cases, DSMC is not optimal, as it typically requires multiple independent runs to obtain accurate results, which can be computationally expensive. Therefore, we investigate alternative approaches to overcome these limitations. The first method we consider is a semi-Lagrangian (SL) scheme, in which we employ a meshfree interpolation technique based on the Moving Least Squares method for function reconstruction. The second method is an Arbitrary Lagrangian–Eulerian (ALE) approach. Both methods are designed to incorporate a moving rigid body immersed in a rarefied gas. In the SL framework, this is achieved using an immersed boundary technique, whereas in the ALE approach such a technique is not required. Finally, we compare simulation results obtained from both methods.

**178. Chet N. Tiwari** – *Generalized Brachistochrone with Curvature, Friction and Viscous Drag*

Kathmandu Institute of Complex Flows, Nepal

**Co-author(s):** Parameshwari Kattel, Shiva P. Pudasaini

**Abstract:** We develop a generalized dynamical model for the brachistochrone problem within a variational framework. The motion of a particle is analyzed under the combined influence of gravity, Coulomb friction, and viscous drag. The inclusion of velocity-dependent drag introduces intrinsic nonlinearities that prevent reduction to solvable form. The governing equation is obtained as a second-order nonlinear differential equation describing the optimal descent curve, which further reduces to Riccati equation for small value of drag coefficient. The model recovers the classical brachistochrone for vanishing dissipative forces, thereby ensuring the consistency of the generalized model. Furthermore, the formulation is extended to incorporate non-zero initial velocity, revealing its influence on the initial slope and trajectory geometry. It is shown that increasing dissipative effects leads to a systematic flattening of the optimal path. These results highlight the importance of multi-mechanism dissipation in variational problems and provide a framework for analyzing particle motion in resistive media, with potential applications in engineering and geophysics.

**179. Tripti Tripathi** – *Bayesian quantile regression for right censored survival data from exponentiated exponential distribution*

Banaras Hindu University, India

**Abstract:** This study presents a Bayesian analysis of the quantile regression model for right-censored data from the exponentiated exponential distribution. In the case of quantile regression, Bayesian analysis always leads to analytically intractable posteriors. To address this challenge, a gradient-based Metropolis-Hastings algorithm is used utility on Barker proposal. We perform Bayesian model selection for various combinations of covariates using the Bayesian Information Criterion, the Deviance Information Criterion, and the logarithm pseudo-marginal likelihood. Numerical illustrations are provided for simulated and real datasets. For a real study, endometrial cancer survival data is considered.

**180. Anup Tuladhar** – *Modeling within-host co-infection dynamics of SARS-CoV-2 infection underlying HIV infection*

Tribhuvan University, Nepal

**Co-author(s):** Jivandhar Jnawali, Kedar Nath Uprety, Naveen K. Vaidya

**Abstract:** The global spread of SARS-CoV-2 has raised significant concerns regarding its interaction with chronic viral infections, particularly Human Immunodeficiency Virus (HIV). In this study, we develop a novel within-host mathematical model to investigate the co-infection dynamics of SARS CoV-2 and HIV, capturing the bidirectional interaction in which HIV depletes the naive CD4+ T cells pool required for effective SARS-CoV-2 clearance, while SARS-CoV-2 infection accelerates T cell activation and turnover. Numerical simulations demonstrate that in co-infected individuals, SARS-CoV-2 viral loads reach higher peaks and persist for a significantly longer duration compared to mono-infection scenarios, mechanistically driven by the HIV-induced impairment of the adaptive immune response. These findings underscore the synergistic burden of co-infection and suggest that maintaining CD4+ T cell homeostasis through effective antiretroviral therapy (ART) is crucial for mitigating severe SARS-CoV-2 outcomes in people living with HIV.

**181. Jyoti Upadhyaya – *Multivariate Statistics of Infectious Disease - Examples from COVID-19 pandemic of Nepal***

Kathmandu University, Nepal

**Abstract:** *Background and Objectives:* COVID-19 pandemic decimated millions of people. The need to model and project the spread of this disease was urgently felt. This paper demonstrates the use of various statistical techniques in understanding and predicting COVID-19. During this time, variables such as daily tests, daily infections, daily deaths and daily discharge have exhibited different patterns. Here, the path traced by these variables are analyzed using various multivariate statistical techniques. *Methods:* Ministry of Health and Population, Government of Nepal COVID-19 data is used here. The data used here is from 26 February 2020 to 25 January 2023. The use of statistical techniques such as Vector Autoregression (VAR), Granger Causality, Quantiles, Quantile Regression, Structural Equation modelling, Principal Components Analysis, Non-Linear Regression and ARIMA models is displayed. *Results:* Deaths and disease are directly visible to the eye. But several latent variables were also associated with the spread of COVID-19. Degradation of mental health, negative impact of lockdown, underreporting of number of daily infected and daily deaths are the names of a few. Here these latent variables are measured. *Conclusions:* It was found that changing the type of control from complete to partial to absence of lockdown, had a detrimental effect on the spread of the pandemic. The underreporting in total daily infections and deaths in Kathmandu Valley in the period between 1 Feb to 1 June 2021 was predicted to be 55990 and 2750 respectively. The results obtained here help in better management of any pandemic including the COVID-19 pandemic.

**182. Ananta Upreti – *Modeling Dengue Transmission Dynamics in Kathmandu Valley, Nepal: Impact of Improper Waste Management***

Tri-Chandra Multiple Campus, TU, Nepal

**Co-author(s):** Jivandhar Jnawali, Kedar Nath Uprety, Naveen Kumar Vaidya

**Abstract:** Dengue fever, a mosquito-borne disease, poses a global threat to nearly half of the world's population, with an estimated 100-400 million infections annually. Accumulated waste in communities creates favorable breeding conditions for mosquitoes, posing significant challenges for controlling dengue transmission. In this study, we developed a novel mathematical model to assess the impact of garbage accumulation on dengue transmission dynamics. We parameterized and validated the developed model using the data from Kathmandu Valley, where inefficient garbage removal has exacerbated dengue transmission. Through our model analysis, we established a threshold condition for the stability of the dengue-free equilibrium. Using our model, we analyzed the impact of three different garbage removal programs: (1) constant

removal, (2) impulsive removal, and (3) central removal. Our model predicts that the impulsive garbage removal is the most effective among the three strategies considered. Our findings underscore the importance of reducing waste accumulation as a vital strategy for dengue control, providing policymakers with a framework for implementing targeted waste-management initiatives.

**183. Petr Vojcak** – *On full-fledged recursion operators for symmetries of linearly degenerate Lax-integrable equations*

Silesian University in Opava, Opava

**Abstract:** Full-fledged nonlocal symmetries provide a natural framework for describing the complete symmetry structure of integrable equations beyond the local and weakly nonlocal setting. We propose a method for constructing recursion operators for such symmetries – to the best of our knowledge, the first explicit construction of this kind – and apply it to linearly degenerate Lax-integrable equations. The resulting recursion operators can be interpreted as infinite-dimensional matrices of differential functions acting on generating vector functions of nonlocal symmetries via matrix multiplication. We further investigate the algebraic properties of these operators and discuss their role in the construction of  $\mathbb{Z}$ -graded Lie algebras of full-fledged nonlocal symmetries.

**184. Shantanu Kumar Yadav** – *A Beta Exponential Power Function Distribution: Properties and Applications*

Banaras Hindu University, India

**Co-author(s):** Arun Kaushik

**Abstract:** In this paper, we introduce a new two-parameter distribution, called the Beta Exponential Power Function (BEPF) distribution, obtained from a parametric transformation of a baseline cumulative distribution function. The proposed model arises by taking the power function distribution as the baseline, leading to the distribution function , where and . The additional shape parameter enhances the flexibility of the model in capturing diverse data behaviors. Several structural properties of the BEPF distribution are derived, including the density function, hazard rate function, moments, quantile function, order statistics, entropy, and stochastic ordering. The estimation of the model parameters is discussed using classical methods, and a simulation study is conducted to examine the performance of the estimators. The usefulness of the proposed model is illustrated through applications to real datasets. Model performance is evaluated using standard information criteria such as AIC, AICc, BIC, and log-likelihood. The results indicate that the BEPF distribution provides improved flexibility and competitive fitting performance compared to existing models.

**185. Muhammad Zulqurnain** – *A Stochastic Physics-Informed Neural Network Framework for Fractional-Order Modeling of Non-Newtonian Blood Rheology*

Abdus Salam School of Mathematical Sciences, Government College University Lahore

**Co-author(s):** Azhar Ali Zafar

**Abstract:** This study investigates blood rheology modeled as a non-Newtonian nanofluid flow governed by fractional-order partial differential equations, incorporating thermal effects and shape-dependent nanoparticles. The base model describes blood as an Oldroyd-B fluid to capture viscoelastic behavior, while the Atangana-Baleanu-Caputo (ABC) fractional framework accounts for memory and hereditary effects inherent in biological flows. The influence of gold (Au), copper (Cu), and aluminum oxide ( $Al_2O_3$ ) nanoparticles—considering spherical, cylindrical, and platelet geometries—is analyzed regarding heat transfer and flow dynamics. To

extend classical analytical approaches, we propose a hybrid computational framework integrating Physics-Informed Neural Networks (PINNs) to solve the resulting nonlinear fractional PDE system. This data-driven methodology enables efficient approximation of complex solutions without relying solely on traditional integral transform techniques. Furthermore, a stochastic modeling component is introduced to account for parametric uncertainties in physiological and thermophysical properties, providing a realistic description of biological variability. This approach bridges fractional calculus, machine learning, and stochastic analysis to enhance the predictive capability of biofluid models. Results indicate that integrating PINNs improves computational flexibility, while stochastic extensions capture uncertainty effects in velocity and temperature profiles. Comparative analysis shows that platelet-shaped gold nanoparticles offer superior heat transfer enhancement (54.2%), highlighting their potential in biomedical applications such as cryosurgery and targeted drug delivery. This framework offers a robust approach for analyzing nonlinear transport phenomena in complex physiological environments.

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