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Book of Abstracts

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Collaborator

Department of Mathematics, South Asian University, New Delhi, India

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Book of Abstracts published by
Central Department of Mathematics
Tribhuvan University, Nepal

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Second International Conference on Applications of Mathematics to Nonlinear Sciences (AMNS-2019)

June 27-30, 2019, Pokhara, Nepal

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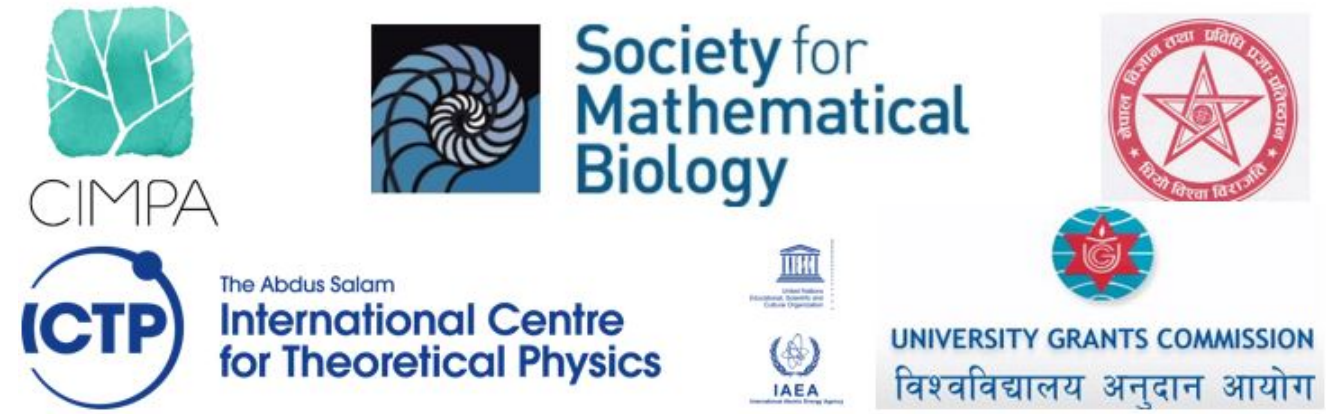

Editors
Dhruba Adhikari, Rajendra Dahal, Keshav Pokhrel

Contents

Biographies of Plenary Speakers

Jerry L. Bona is Professor of Mathematics at the University of Illinois at Chicago. He received his Ph.D. from Harvard University under supervision of Garrett Birkhoff. He worked from 1970 to 1972 at the Fluid Mechanics Research Institute University of Essex, where along with Brooke Benjamin and J. J. Mahony, he published the paper "Model Equations for Long Waves in Nonlinear Dispersive Systems", where Benjamin-Bona-Mahony (BBM) equation was first studied in detail. Professor Bona has also worked at University of Chicago, Pennsylvania State University and University of Texas at Austin. In 2012, he became a fellow of the American Mathematical Society. In 2013, he became a fellow of the Society for Industrial and Applied Mathematics.

Gianni Dal Maso is Professor of Mathematical Analysis at SISSA (International School for Advanced Studies) in Trieste, Italy. He received his Ph.D. in mathematics from Università di Pisa in 1977 and had a Post-graduate Research Fellowship in Mathematics "Perfezionamento", Scuola Normale Superiore, Pisa in 1977-1981. He has advised more than 37 SISSA Ph.D. students. The research activity of Professor Dal Maso is devoted to the Calculus of Variations, in particular to semicontinuity and relaxation problems, Gamma-convergence, and, more recently, to free discontinuity problems and applications to mechanics. He is currently serving as a member of the Scientific Council of the Centro Internazionale Matematico Estivo (CIME) and the Scientific Council of the Italian Mathematical Union (UMI). Professor Dal Maso received Stampacchia Prize in 1982, awarded by the Scuola Normale Superiore, for an article on obstacle problems; Caccioppoli Prize awarded by the Italian Mathematical Union in 1990; Medaglia dei XL per la Matematica, awarded by the Accademia Nazionale delle Scienze detta dei XL in 1996; Prize of the Minister for the Cultural Heritage for Mathematics and Mechanics, awarded by the Accademia Nazionale dei Lincei in 2003; and Prize Luigi and Wanda Amerio, awarded by the Istituto Lombardo Accademia di Scienze e Lettere in 2005. He is the author of book: An Introduction to Gamma-Convergence, Birkhäuser, Boston, 1993, and he has authered more than 170 articles in scientific journals.

Philip K. Maini received his B.A. in mathematics from Balliol College, Oxford, in 1982 and his DPhil in 1985 under the supervision of Prof J.D. Murray, FRS. In 1988 he was appointed Assistant Professor in the Mathematics Department at the University of Utah, Salt Lake City. In 1990 he returned to Oxford as a University Lecturer and in 1998 was appointed Professor of Mathematical Biology by Recognition of Distinction and Director of the WCMB. In 2005 he was appointed Statutory Professor of Mathematical Biology. He is on the editorial boards of a large number of journals, including serving as the Editor-in-Chief of the Bulletin of Mathematical Biology [2002-15]. He is a Fellow of the IMA (FIMA), a SIAM Fellow, an Inaugural SMB Fellow, a Fellow of the Royal Society of Biology (FRSB), and Miembro Correspondiente (Foreign Fellow), La Academia Mexicana de Ciencias (AMC). In 2015 he was elected Fellow of the Royal Society (FRS), and in 2017 he was elected Fellow of the Academy of Medical Sciences (FMedSci), and Foreign Fellow of the Indian National Science Academy (FNA).

His present research projects include the modelling of avascular and vascular tumours, normal and abnormal wound healing, and a number of applications of mathematical modelling in pattern formation in early development, as well as the theoretical analysis of the mathematical models that arise in all these applications. He has over 350 publications in the field and has held visiting positions at a number of universities worldwide. He was awarded a Royal Society Leverhulme Trust Senior Research Fellowship for 2001-2 and a Royal Society-Wolfson Research Merit Award (2006-11). In 2009 he was awarded the LMS Naylor Prize and Lectureship and in 2014 he was listed in "The World's Most Influential Scientific Minds 2014" (Thomson Reuters). In 2017 he was awarded the Arthur T. Winfree Prize from the Society of Mathematical Biology (SMB).

Ian W. McKeague is Professor of Biostatistics at Columbia University. His research interests include survival analysis, competing risks models for HIV/AIDS data, Markov chain Monte Carlo and Bayesian methods, empirical likelihood, statistical methods in physical oceanography, functional data analysis, inference for stochastic processes, simultaneous inference, efficient estimation for semiparametric models, missing data, counting processes, image analysis, and spatial point processes. He was on the faculty of the Department of Statistics of the Florida State University, 1980-2004. He was on sabbatical leave at the Mathematical Sciences Research Institute of the University of California at Berkeley, and then at the Laboratoire de Modélisation et Calcul of the Université Joseph Fourier, Grenoble, France, 1991-1992. He served as Chair of the FSU Statistics department, 1996-1999, and was named the Ralph A. Bradley Professor of Statistics at FSU in 2000. He has been a Professor of Biostatistics at Columbia University since 2004. He has served as an associate editor of the Annals of Statistics for seven years, the Journal of the American Statistical Association for four years, and is currently serving on the editorial boards of Statistical Inference for Stochastic Processes, and the International Journal of Biostatistics. He is a fellow of the Institute of Mathematical Statistics and a fellow of the American Statistical Association.

Chris Rasmussen is Professor of mathematics education and associate chair in the department of mathematics and statistics at San Diego State University. He received his B.A., M.A. and Ph.D. from the University of Maryland in Mechanical Engineering, Mathematics, and Mathematics Education, respectively. After receiving his undergraduate degree he served as a Peace Corp Volunteer in Sierra Leone, West Africa. He is currently an Editor-in-Chief of the International Journal of Research in Undergraduate Mathematics Education. His research investigates inquiry-oriented approaches to the learning and teaching of undergraduate mathematics, focusing on how mathematical ideas are developed through student exploration and teacher-student classroom discourse. His work in differential equations and linear algebra has led to the development of research-based curricula that begin with students' informal or intuitive ideas to progressively build more formal mathematics. He has also been at the forefront of a national study of successful calculus programs, which identified a number of programmatic features that are common among the programs identified as being more successful than peer institutions. Currently, he is co-PI on two national studies of the Precalculus to Calculus 2 sequence with the goal of better understanding current departmental practices related to these courses, the process of departmental and institutional change, and ways that professional organizations can support and help sustain such change.

Gail Wolkowicz is a professor in the Department of Mathematics and Statistics at McMaster University. She has a PhD from the University of Alberta (1984) and an MSc from McGill University (1978). She analyzes nonlinear dynamical systems with applications in mathematical biology. She is best known for her work on models in the chemostat. Potential applications include water purification, biological waste decomposition, pest control, prevention of species' extinction, control or eradication of certain diseases, and more recently anaerobic digestion to produce green energy.

She was awarded the Krieger–Nelson Prize from the Canadian Mathematical Association (CMS) in 2014. One of her papers won the 2015 biennial Lord Robert May Best Paper Prize of the Journal of Biological Dynamics. She currently serves on a number of editorial boards for peer reviewed journals and is a member of the Atlantic Association on Research (AARMS) Scientific Review Panel.

Plenary (PL)

PL1: **Jerry Bona**, University of Illinois at Chicago, USA

Title: **Applications of Model Equations for Water Waves**

Email: bona@math.uic.edu

Abstract: In this lecture, semipositone problems and some methods to solve them will be discussed. Also, recent results and open problems will be presented.

PL2: **Gianni Dal Maso**, SISSA, Trieste, Italy

Title: **A Maximal Dissipation Condition for Dynamic Fracture with an Existence Result in a Constrained Case**

Email: dalmaso@sissa.it

Abstract: We consider a model of elastodynamics with crack growth, based on an energy-dissipation balance and a maximal dissipation condition. We prove an existence result in the case of planar elasticity, where the maximal dissipation condition is satisfied among suitably regular competitor cracks. The case of kinks is also considered.

PL3: **Philip Maini**, University of Oxford, UK

Title: **Modelling Collective Cell Migration**

Email: Philip.Maini@maths.ox.ac.uk

Abstract: Collective cell migration is a phenomenon that is observed in many areas of biology, including embryonic development, tissue repair, and disease. In this talk I will review our recent work in two application areas: (i) in early development, neural crest cells migrate to various target positions where they subsequently proliferate and form structures. How this coordinated motion occurs is still unknown. Working closely with experimental biologists, we have used hybrid multi-scale cell-based models to uncover new insights into the mechanisms underlying this phenomenon; (ii) in tumour growth, cancer cells induce new blood vessels via the process of angiogenesis. We have derived a new partial differential equation model for this process, systematically upscaling from microscale to macroscale. We show that this model is different to the standard model in the literative.

PL4: **Ian McKeague**,Columbia University, New York, USA

Title: **Stein's Method and the Many Interacting Worlds Interpretation of Quantum Mechanics**

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Abstract: There have been numerous attempts by physicists to formulate quantum mechanics without requiring the use of wave functions. An interesting recent approach takes the point of view that quantum effects arise solely from the interaction of finitely many classical "worlds." The wave function is then recovered (as a secondary object) from observations of particles in these worlds, without knowing the world from which any particular observation originates. Hall, Deckert and Wiseman (2014) introduced an explicit many-interacting-worlds harmonic oscillator model to provide support for this approach. A Gaussian limit for particle positions in the ground state of this harmonic oscillator, agreeing with classical quantum theory, was conjectured by these authors.

In this talk I discuss the use of a fixed-point technique known as Stein's method to prove this result. I will also discuss extended versions of the result for excited states and multi-dimensional harmonic oscillators. References: McKeague and Levin (2016, Annals of Applied Probability), McKeague, Pekoz and Swan (2019, Bernoulli). No prior knowledge of Stein's method or quantum theory is assumed.

PL5: **Chris Rasmussen**, San Diego State University, San Diego, USA

Title: **Insights from Two National Studies of Precalculus through Calculus 2**

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Abstract: In this presentation I report on results and insights from two national studies of Precalculus through Calculus 2. The first project, Progress through Calculus, is an investigation of the factors that influence student success over the Precalculus through Calculus 2 (P2C2) sequence required of most STEM majors. As part of this project we conducted a census survey of all mathematics departments that offer a graduate degree in mathematics. From this, I report the viewpoints of departments about features shown to support students success, as well as the extent to which these features are being implemented across the country. The second project, Student Engagement in Mathematics through an Institutional Network for Active Learning, is investigating departmental change that contributes to teaching and learning environments that improve student learning in the P2C2 sequence, with a particular focus on the use of active learning strategies. Changing department culture, norms, and practices to support widespread use of active learning is notoriously difficult, and case studies of departments that have successfully made such changes are rare. I highlight the practices and policies of two, research-oriented mathematics departments that have made considerable progress on the challenge of infusing active learning into their introductory mathematics courses in sustainable and widespread ways. In particular, I highlight how departmental and institutional leadership; P2C2 structures such as course coordination; use of data; student resources such as learning or tutoring centers; and professional development have been mutually supportive to initiate, implement, and sustain active learning in P2C2 courses at these two institutions.

PL6: **Gail S. K. Wolkowicz**, McMaster University, Ontario, Canada

Title: **Predator-Prey and Host Parasitoid Dynamics: A Bifurcation Theory Approach**

Coauthor: Gunog Seo, Colgate University, USA

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Abstract:

PART I: Sensitivity of the General Rosenzweig–MacArthur Model to the Mathematical Form of the Functional Response

The Rosenzweig–MacArthur predator-prey model has been shown to be sensitive to the mathematical form used to model the predator response function even if the forms have the same basic shape: zero at zero, monotone increasing, concave down, and saturating. We revisit this model to help explain this sensitivity in the case of Holling type II: Monod, Ivlev, and hyperbolic trigonometric response functions. The local and global dynamics and the possible bifurcations with respect to variation of the carrying capacity of the prey, a measure of the enrichment of the environment are determined. An analytic expressions that determines the criticality of the Andronov-Hopf bifurcation is obtained. Models with all three forms can have a supercritical Hopf bifurcation, but only the model with hyperbolic trigonometric form can have subcritical Hopf and saddle-node of periodic orbits with multiple limit cycles, providing a counterexample to a conjecture of Kooij and Zegeling (1996) and a result in a paper by Attili and Mallak (2006). We revisit the ranking of responses according to their potential to destabilize dynamics, and show that given data, not only the choice of functional form, but the choice of the number and position of data points influences predicted dynamics.

PART II: Pest Control by Generalist Parasitoids

Magal, Cosner, Ruan, and Casas (Math. Med. Biol. 25,1-20; 2008) studied both spatial and non-spatial host-parasitoid models motivated by the need for biological control of horse-chestnut leafminers that spread through Europe. In the non-spatial model, they considered control by predation of leafminers by a generalist parasitoid population with functional response modeled using a Holling type II (Monod) form. We revisit this model providing a more detailed bifurcation analysis. Both the local stability of equilibria and global properties are considered. We provide analytical expressions for fold and Hopf bifurcations. Numerical results show multiple coexisting limit cycles, homoclinic orbits, codimension one bifurcations including: Hopf, fold, transcritical, cyclic-fold, and homoclinic bifurcations, as well as codimension two Bautin bifurcations and codimension two and three Bogdanov-Takens bifurcations.

Special Invited (SP)

SP1: **John Borkowski**, Montana State University, USA

Title: **An Overview of Several Methods for Generating Space-Filling Sets of Experimental Design Points**

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Abstract: Suppose a researcher wants to design an experiment that will either (i) allow the fitting many potential models (e.g., polynomial (linear) models or nonlinear models found in the scientific literature) or (ii) be used to explore the design space for subregions that may contain an optimum predicted response (such as a maximum or minimum). Suppose also the researcher only has enough time and money to collect N experimental combinations of the design variables. Due to the limitations of classical response surface designs in terms of design size and/or dependence on a specified model that can be fitted, a reasonable alternative is for the researcher to find a good N-point "space-filling" design. The N points should provide good coverage of the design space for combinations of the experimental variables. That is, the N points should appear throughout the design region with no points near each other spatially. This type of design will allow for the fitting of many models. The design generating procedure begins by generating a set of space-filling points in a unit hypercube. These points are then transformed back to the scale of the original design variables to generate a design the researcher will implement. Three methods that are based on simple mathematical principles are presented for generating good space-filling designs in a k-dimensional unit hypercube. These methods will be extended for application to experimental designs that involve a hyperspherical design space and for applications extended to designs of mixtures in the simplex and subspaces of the simplex.

SP2: **Narendra Dixit**, Indian Institute of Science, Bangalore, India

Title: **A Dynamical Motif Defining the Fates of Viral Infections**

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Coauthors: Subhasish Baral, Rustom Antia

Abstract: Viral infections suffer one of three fates: 1) clearance following acute infection; 2) chronic infection; 3) host mortality due to immunopathology. What defines these outcomes remains an important question in immunology. Previous studies have identified a variety of factors, such as innate immune responses, viral inoculum size, initial effector cell pool size, etc. as being responsible for these outcomes. Here, we unravel a simple dynamical motif, involving the essential interactions between antigen and effector cytotoxic T cells, that recapitulates all these outcomes. The various factors identified above modulate these outcomes, but are not central to defining them.

Using mathematical modeling and analysis based on dynamical systems theory, we systematize our understanding of the fates of viral infections. Our findings have implications for optimizing interventions.

SP3: **Dave Kung**, St. Mary's College of Maryland / MAA Project NExT, USA

Title: **Mind the Gap: Bridging between educational research and college math teaching**

Email: dtkung@smcm.edu

Abstract: Decades of educational research points to ways we could structure college mathematics classrooms to help students better understand the concepts we teach. Research on how faculty run their classrooms suggests that implementation of research-based strategies has been fairly limited. Why is there such a gap between theory and practice? What barriers keep math faculty from implementing evidence-based strategies? In this session we'll dive into the research (both on teaching and on professional development), what professional development programs (including MAA Project NExT) are doing to attempt to close the gap, and what work might help accelerate the difficult process of change.

SP4: **Andrei Ludu**, Embry-Riddle Aeronautical University, USA

Title: **Evolutionary Stability of Purring Frequency in Felidae**

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Abstract: In order to understand why cats purr we performed wavelet analysis on recorded acoustic signals of purring from various felidae, including the Pantherinae, Leopardus and Felis lineages, including a large amount of data on domestic cats of different ages, genders, health states and environments. The data were embedded into an aerodynamic model of air transfer through the vocal box during purring, with geometry inspired by dissections performed on F. Catus specimens. The model predictions correlated with the field data were able to support the hypothesis that the evolutionary stability of the purring frequencies for all purring felidae is related to the acoustic innervation of the vague nerve, with releasing of stress relaxing electric pulses.

SP5: **Bal Chandra Luitel**, Kathmandu University, Nepal

Title: **Research for All: Transforming Hearts, Minds and Souls of Researchers through STEAM Education**

Coauthors: Binod Prasad Pant and Indra Mani Shrestha

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Abstract: In what ways can STEAM education research contribute to improving researchers' professional praxis? How can research in STEAM education help transform the researcher's self as a teacher/educator? In what ways can STEAM education embrace the agenda of research for all? Considering these key questions as a means for opening new vista for thinking about STEAM education research, we address the need for transformative STEAM education research by elucidating different research paradigms and approaches that we adapted in our past and present research projects (e.g. Luitel, 2009; Pant, 2015; Shrestha 2018), and significance of this research approaches in developing an inclusive vision for a culturally empowering STEAM education in Nepal. In so doing, we deconstruct the longstanding legacy of science and mathematics education research as an elite academic enterprise underpinned by Western Modern Worldview and its research paradigm of positivism being practiced under STEM education, thereby generating a much needed transformative vision for STEAM education through a multi-paradigmatic arts-based research approach in order to address problems of a culturally decontextualized STEM education faced by students,

teachers and teacher educators in transitional societies that prevents many students from being able to get social opportunities in their present and future lives.

SP6: **Shigui Ruan**, University of Miami, Florida, USA

Title: **Modeling and Analyzing the Transmission Dynamics of Visceral Leishmaniasis**

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Coauthors: Lan Zou, Jing Chen

Abstract: Leishmaniasis is a vector-borne disease that is transmitted by sandflies and caused by the protozoan Leishmania parasites. There are three main forms of the disease: Cutaneous leishmaniasis (CL; most common, causes skin sores), Mucocutaneous leishmaniasis (ML; less understood, involves the skin and mucosa) and Visceral leishmaniasis (VL, also known as kala-azar; fatal if left untreated, affects several internal organs). About 95% of CL cases occur in the Americas, the Mediterranean basin, the Middle East and Central Asia. In 2017 over 95% of new CL cases occurred in 6 countries: Afghanistan, Algeria, Brazil, Colombia, Iran, Iraq and Syrian. Over 90% of ML cases occur in Bolivia, Brazil, Ethiopia and Peru. Most VL cases occur in Brazil, East Africa and in South-East Asia. In 2017, more than 95% of new cases occurred in 10 countries: Bangladesh, Brazil, China, Ethiopia, India, Kenya, Nepal, Somalia, South Sudan and Sudan.

VL is maintained in a cycle between sandflies and animal hosts, in which domestic dogs and humans are predominant reservoir hosts. In this paper, we develop a mathematical model to study the transmission dynamics of VL. Three populations: dogs, sandflies and humans, are considered in the model. Based on recent studies, we include vertical transmission of dogs in the spread of the disease. We also investigate the impact of asymptomatic humans and dogs as secondary reservoirs of the parasites. The basic reproduction number and sensitivity analysis show that the control of dog-sandfly transmission is more important for the elimination of the disease. Vaccination of susceptible dogs, treatment of infective dogs as well as control of vertical transmission in dogs are effective prevention and control measures for VL.

SP7: **Kapil K Sharma**, South Asian University, India

Title: **Orthogonal Spline Collocation Methods for Singularly Perturbed Problems**

Coauthors: Pankaj Mishra, Amiya K Pani, Graeme Fairweather

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Abstract: The singularly perturbed problems provide a significant tool to simulate many real life phenomena. The singularly perturbed differential equation is characterized by a parameter, which is multiplied in a highest order derivative term. The solution of this class of differential equations exhibits layer behavior in narrow regions. These narrow regions are known as layer region and rest part of the domain is known as outer region. Here there is an attempt to introduce the audience with singularly perturbed problems and challenges in developing the numerical to solve the problems. Further, the development of parameter uniform numerical methods based on orthogonal spline collocation to find approximate solutions of boundary value problems for singularly perturbed differential equations are presented.

SP8: **Robert Smith?**, University of Ottawa, Canada

Title: **The Effects of Stigma on Leprosy**

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Coauthors: Stephen Mosher, Christian Costris-Vas

Abstract: The World Health Organization's leprosy-elimination campaign has significantly reduced global leprosy prevalence, but approximately 214,000 new cases of leprosy are reported each year. An ancient and neglected affliction, leprosy is also one of the most heavily stigmatised diseases of all time. We developed a mathematical model to examine the effects of stigma on sustaining disease transmission, using low and high degrees of stigma, as well as in its absence. Our results show that stigma does indeed play a central role in the long-term sustainability of leprosy. We also examined sensitivity of the outcome to all parameters and showed that the effects of stigma could increase the number of infected individuals by a factor of 80. Therefore both targeted education and shifts in cultural attitudes towards leprosy will be necessary for the eventual eradication of the disease.

SP9: **Lindi M Wahl**, Western University, Canada

Title: **Blurring the Lines between Predator and Prey: the Evolution of Temperate Viruses.**

Email: lwahl@uwo.ca

Coauthor: Amjad Khan

Abstract: When viruses infect bacteria, the virus typically produces a large number of progeny viral particles, killing the host cell in the process. Temperate viruses can kill their hosts in this way, but also have the option to integrate their genome into the host cell's genome. After this integration, the viral DNA is replicated with the host cell genome over many generations. Ultimately, this viral DNA may excise, killing the host and producing new virions, or may become domesticated, losing its ability to kill the host and contributing to the host cell genome instead. Thus, these viruses can either act as predators, or can exhibit an extreme form of cooperation, becoming an integral genetic component of their prey. We have developed a number of mathematical approaches to better understand this unique interplay between predator and prey, and will describe both long-term evolutionary outcomes and data-fitting explorations.

SP10: **Xingfu Zou**, University of Western Ontario, Canada

Title: **Modelling fear effects in predator-prey interactions**

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Coauthors: Ao Li, Xiaoying Wang, Yang Wang, Liana Zanette

Abstract: Traditional Predator-prey models focus on various types of functional responses in predation mechanism which is direct effect of predator on prey, but ignore the fear effect which is indirect. Based on some recent field experimental studies, such an indirect effect can be as significant as the direct one. In this talk, I will report some of our recent results in modifying some predator-prey models by incorporating the prey's anti-predation responses due to fear of predators. Various types of responses are considered, including reducing the productions and increasing mobilities, leading to various types of differential equations. These results not only reveal some interesting phenomena in the trade-offs between benefits and cost resulted from the anti-predation responses, they also suggest a need of re-visiting many (if not all) existing predator-prey models.

Differential Equations and Nonlinear Analysis (DE)

DE1: **Keshav Raj Achraya**, Embry-Riddle Aeronautical University, Daytona Beach, USA

Title: **Distance Properties of Titchmarsh-Weyl M Functions of Vector-Valued Discrete Schrödinger Operators**

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Abstract: In this talk, we discuss the theory of Titcchmarsh-Weyl m functions associated to the vector-valued discrete Schrödinger operators and show the connection of M functions with the spectrum of such operators. We then discuss the distance properties of these M functions defined on the half lines.

DE2: **Subas Acharya**, University of Texas at Dallas, USA

Title: **Real Options with Fixed and Variable Investment Cost**

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Coauthors: Alain Bensoussan, Alejandro Rivera, Dmitry Rachinskiy

Abstract: We revisit the classical real option problem, with additional features. The classical situation concerns choosing the right timing and right amount for an investment. We consider a stochastic optimization problem, which involves an option of one time investment and an option of closing the activities. The timing and amount of an investment and the timing of the closure are parameters to be optimized in order to maximize the expected value of the profit. We reduce the stochastic optimization problem to a deterministic variational inequality using the dynamic programming technique and discuss the properties of solutions to the variational inequality.

DE3: **Dhruba R. Adhikari**, Kennesaw State University, USA

Title: **A Topological Degree for Quasibounded Multivalued $(\widetilde{S}_+)$-Perturbations of Maximal Monotone Operators**

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Abstract: Let X be an infinite dimensional real reflexive Banach space and X^* its dual space. Let $T : X \supset D(T) \to 2^{X^*}$ be maximal monotone with $0 \in D(T)$ and $0 \in T(0)$, and let $C : X \supset D(C) \to 2^{X^*}$ be densely defined strongly quasibounded and of type $(\widetilde{S}_+)$. In this talk, a new topological degree theory for the sum $T + C$ with a degree mapping in terms of the Ma degree for multivalued compact operators will be presended. Unlike single-valued operators considered by Kartsatos and Skrypnik, the operator C here is multivalued so that the multivalued generalized pseudomonotone operators considered by Browder and Hess include such C and even $T + C$. An application of the theory to the solvability of elliptic partial differential inclusions in general divergence form will also be presented. If time permits, some extensions of the main existence results of Browder and Hess for such operators by utilizing the new degree theory will be presented.

DE4: **Anudeep Kumar Arora**, Florida International University, USA

Title: **Stable Blow-up Dynamics in the Generalized L^2-Critical Hartree Equation**

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Coauthors: Svetlana Roudenko and Kai Yang

Abstract: We study stable blow-up dynamics in the generalized Hartree equation in the L^2-critical regime. The generalized Hartree equation is a Schrödinger-type equation with a nonlocal, convolution type nonlinearity in dimension d:

$$iu_t + \Delta u + \left(|x|^{-(d-\gamma)} * |u|^p\right)|u|^{p-2}u = 0, \quad p \geq 2.$$

First, we investigate spectral properties needed to understand the blow-up dynamics of the solutions. We then show that similar to nonlinear Schrödinger equation, solutions with mass slightly above the corresponding ground state and negative energy, will blow-up with the "log-log" dynamics in the 3d generalized Hartree equation.

DE5: **Debendra P Banjade**, Coastal Carolina University, Conway, SC, USA

Email: dpbanjade@coastal.edu

Title: **Wolff's Ideal Theorem on Banach algebra $H^\infty(\mathbb{D}) \cap Q_p$**

Abstract: For $p \in (0,1)$, let Q_p space be the space of all analytic functions on the unit disk $\mathbb{D}$ such that $|f'(z)|^2(1-|z|^2)^p dA(z)$ is a p - Carleson measure. In this talk, we present that the Wolff's Ideal Theorem on $H^\infty(\mathbb{D})$ can be extended to the Banach algebra $H^\infty(\mathbb{D}) \cap Q_p$, and also to the multiplier algebra on Q_p spaces.

DE6: **Ghanshyam Bhatt**, Tennessee State University, Tennessee, USA

Title: **Frame as a Sum of Two Given Frames**

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Abstract: Frames, linearly dependent spanning set, are more stable as compared to bases under the action of a bounded linear operator. Sums of different frames under the action of a bounded linear operator is studied with the help of analysis, synthesis and frame operators. A simple construction of frames from the existing ones under the action of such operator is presented here. It is shown that a frame can be added to its alternate dual frames yielding a new frame. It is also shown that the sum of a pair of orthogonal frames is a frame. This provides an easy construction of a frame where the frame bounds can be computed easily. Moreover, for a pair of orthogonal frames, the necessary and sufficient condition is presented for their alternate dual frames to be orthogonal. This allows for easy construction of a large number of new frames.

DE7: **Hongqiu Chen**, University of Memphis, USA

Title: **Further Theory for a Higher-order Water Wave Model**

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Coauthors: Jerry Bona and Colette Guillope

Abstract: This talk is about a class of higher-order models for the uni-directional propagation of small amplitude long waves on the surface of an ideal fluid. These models are particularly interesting because certain specifications possess a helpful Hamiltonian structure. The present contribution brings forth new theory for the initial-value problem for these evolution equations.

DE8: **Lucrezia Cossetti**, Karlsruher Institut für Technologie (KIT), Karlsruhe, Germany

Title: **Unique Continuation for the ZK equation**

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Coauthors: L. Fanelli and F. Linares

Abstract: In this talk we analyze uniqueness properties of solutions to the Zakharov-Kuznetsov (ZK) equation

$$\partial_t u + \partial_x^3 u + \partial_x \partial_y^2 u + u \partial_x u = 0, \qquad (x,y) \in \mathbb{R}^2, \quad t \in [0,1].$$

Mainly motivated by the very well known PDE's counterpart of the Hardy uncertainty principle, we provide a two times unique continuation result. More precisely, we prove that if the difference $u_1 - u_2$ of two solutions u_1, u_2 of (ZK) at two different instant of time decays fast enough, then

$u_1 \equiv u_2$. As expected, it turns out that the decay rate needed to get uniqueness reflects the asymptotic behavior of the fundamental solution of the associated linear problem. Encouraged by this fact we also prove optimality of the result.

DE9: **Rajendra Dahal**, Coastal Carolina University, Conway, SC, USA

Title: **Mixed Order Monotonicity Results for Sequential Fractional Nabla Differences**

Email: rdahal@coastal.edu

Coauthors: Christopher Goodrich

Abstract: We investigate sequential nabla fractional differences of the form $\nabla_{a+1}^{\nu}\nabla_{a}^{\mu}f(t)$ in the case where $0 < \mu < 1$, $1 < \nu < 2$, and $1 < \mu + \nu < 2$, as well as differences of the form $\nabla_{a+2}^{\nu}\nabla_{a}^{\mu}f(t)$ in the case where $1 < \mu < 2$, $0 < \nu < 1$, and $1 < \mu + \nu < 2$. We demonstrate connections between the sign of these fractional sequential differences and the monotonicity of the function f.

DE10: **Menassie Ephrem**, Coastal Carolina University, Conway, SC, USA

Title: **Wavelets and Their Application to Image Noise Removal**

Email: menassie@coastal.edu

Coauthors: Maria Peters, Victor Harris

Abstract: In the past three decades wavelets have become a wonderful tool to process signals and a great source of mathematical research. Several papers have been published both in theoretical enhancement and studies of wavelets and in practical applications of them. In this talk we present the results of an ongoing research involving image processing using wavelets. We will focus on removing noise from images using Haar and Daub4 wavelets.

DE11: **Wei Feng**, University of North Carolina Wilmington, USA

Title: **Uniform Resolvent Estimates andabsence of eigenvalues for Dirac Operators with complex potentials**

Email: fengw@uncw.edu

Coauthors: Michael Freeze, Xin Lu

Abstract: We study a reaction-diffusion model for two competing biological species (u and v) with u-species under Allee effect. Under one-side Allee effect, the model demonstrates complexity on its coexistence and u-dominance steady states. The conditions for persistence, permanence and competitive exclusion of the species are obtained through analysis on asymptotic behavior of the solutions and stability of the steady states, including the attraction regions and convergent rates depending on the biological parameters. When the Allee effect constant K is large relative to other parameters, the asymptotic stability of the v-dominance state indicates the competitive exclusion of the u-species. Applying upper-lower solution method, we further prove that for a family of wave speeds with specific minimum wave speed determined by several parameters, there exist traveling wave solutions flowing from the u-dominance states to the v-dominance state. The asymptotic rates of the traveling waves at infinities are also explicitly calculated. Finally, numerical simulations are presented to illustrate the theoretical results and population dynamics.

DE12: **Jhavi Lal Ghimire**, Central Department of Mathematics, Kathmandu, Nepal

Title: **On Certain Topological Structures of Space of Entire Vector Sequences and its Generalized Forms**

Email: ghimirejl_07@gmail.com

Coauthors: Narayan Prasad Pahari

Abstract: The class of Entire Vector Sequences in a normed space and their generalized form occupy a very prominent position in the study of many research topics in Functional Analysis. The aim of our presentation is to introduce and study new classes of vector valued Orlicz Space of Entire Sequences and their successive generalizations. Beside examining the condition of pertaining the containment relations of the classes similar nature of vector valued Orlicz Space of Entire Sequences, our objective is to explore their linear space structures of the classes. In fact our work generalize and unify various scalar or vector valued sequence and function spaces including well known sequence spaces c_0, c, l_∞ and l_p, $0 < p < \infty$ which play vital role in Functional Analysis.

DE13: **Jerome Gilles**, San Diego State University, San Diego, USA

Title: **Empirical Wavelets: Theory and Applications**

Email: jgilles@sdsu.edu

Abstract: Adaptive (i.e data-driven) decomposition methods have gained a lot of success these last two decades to analyze non-stationary phenomena. If the original algorithm, the Hilbert-Huang Transform (HHT), is the most widely used method, it has a major drawback: it is purely algorithmic and lacks any mathematical theory which makes it difficult to predict. As an alternative, we proposed the Empirical Wavelets Transform (EWT) which aims at building wavelet filters based on adaptive supports in the Fourier domain. In this presentation, I will present the principles and concepts of the EWT in both 1D and 2D. I will briefly present recent theoretical advances which permit to generalize this transform. Finally some applications will be showed, in particular in texture analysis and several perspectives will be given.

DE14: **Navnit Jha**, South Asian University, New Delhi, India

Title: **A Class of Implicit Compact Formulation for Solving 3D Nonlinear Non-Stationary Advection-Diffusion Equation**

Email: navnitjha@sau.ac.in

Abstract: An implicit compact-scheme for solving 3D second-order nonlinear parabolic partial differential equations is proposed using variable grids. The new compact scheme is fourth-order accurate in space and second-order in time by employing nineteen-point single cell at each time level. We have described an operator-splitting technique to implement the alternating direction implicit method for solving the advection-diffusion equation. Thomas algorithm computes each tri-diagonal matrix that arises from alternating direction implicit steps in minimal computing time. The new variable grid high-order operator-splitting method is unconditionally stable. The inhanced accuracy is achieved at a fewer cost of computation and storage, because the spatial grid parameters tune the grids location according to the behaviour of solution values. The new algorithm successfully applied to the advection-diffusion equation, Navier-Stokes equation, and Burger's equation for the computational illustrations that corroborate the order, accuracies, and robustness of the new implicit compact scheme. The main advantage of the present work lies in achieving a fourth-order scheme on a variable spacing grid-steps, and their superiority over the corresponding uniform grid high-order compact scheme

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DE15: **Ramesh Karki**, Indiana University East, Indiana, USA

Title: **Solution to Fractional Order Semilinear Equation using Variational Method**

Coauthors: Alessandro Arsie (University of Toledo) and Young You (Indiana University East)

Email: rkarki@iue.edu

Abstract: We will discuss how we obtain a solution to a semilinear equation involving fractional power of laplacian by using a method analogous to the direct method of calculus of variations.

More precisely, we will discuss the existence of minimizer of a suitable energy-type functional whose Euler-Lagrange equation is the given semilinear pseudo-differential equation, and also discuss the regularity of such a minimizer so that it will be a solution to the semilinear equation.

DE16: **Shiv Kumar Kaushik**, Kirori Mal College, University of Delhi, India

Title: **Some Applications of Frames in Nonlinear Approximations and Quantum Information Theory**

Email: shikk2003@yahoo.co.in

Coauthors: Khole Timothy Poumai

Abstract: Using frames we define Greedy approximant and prove that frames satisfy quasi greedy and almost greedy type conditions. Some results on identity for frames have been given and conditions under which a frame is greedy has been obtained. Also, we discuss some applications of Operator Value Frames by obtaining Choi Kraus representations of quantum channels and representations of dual quantum channels by using OPV frames. Finally, we show that the orthonormal OPV frame represents projection value measure (PVM).

DE17: **Harihar Khanal**, Embry-Riddle Aeronautical University, Daytona Beach, USA

Title: **Numerical Solutions of Variable Order Differential Equations**

Email: harihar.khanal@erau.edu

Abstract: We introduce an initial value problem of the variable order differential equation

$$A\frac{d^{\alpha(t)}y}{dt^{\alpha(t)}} + B\frac{d^{\beta(t)}y}{dt^{\beta(t)}} + Cy = f\left(t, y\right),\ y(0) = y_0 \tag{1}$$

where the order of differentiation $\alpha(t) \in (1, 2)$ and $\beta(t) \in (0, 1)$ are smooth functions defined as the generalization of Riemann-Liouville fractional derivative, review some physical situations of interest in which such equations can model a complex phenomenon, and describe numerical methods to approximate the solutions to (1) based on the integral equation approach, the collocation method and the approximate integer order differential equation. The numerical methods are applied to three physical situations, namely an electric circuit, acoustic waves in a loss-fluid and for social systems with fast changing dynamics like population growth, emergency of novelty and world computer networks. The numerical results are in agreement with the expected behavior of such systems.

DE18: **Arun Kumar**, Government College Kota (Raj), India

Title: **Time Dependent Variational Approach to Modulational Instabilities in Nonlinear Partial Differential Equations**

Email: arunkr71@gmail.com

Coauthors: Coauthors: Ram Dayal Pankaj and Bhawani Singha

Abstract: The 1D Non-Linear Partial Differential (NLPD) equation is considered for study the modulational instability (MI) using a Time Dependent Variational Approach (TDVA). This approach is used to derive the nonlinear dispersion relation (NDR) for the Hirota equation. The classical modulational instability criterion is derived and it is found that there are a number of possibilities for the MI regions due to the generalized dispersion relation, which relates the frequency and wave number of the modulating perturbations. Analyzing the ensuing NLPD's, we rederived the classical modulational instability criterion.

DE19: **Sarita Kumari**, Indian Institute of Technology (ISM), Dhanbad, India

Title: **Bifurcation Analysis of Fishery Model with Optimal Harvesting Policy**

Email: saritasingh.ism@gmail.com

Coauthors: Ranjit Kumar Upadhyay, Indian Institute of Technology(ISM), Dhanbad, India

Abstract: In this paper, a plankton fish interaction model is proposed and analysed.The interference between phytoplankton and zooplankton is modeled via a Crowley-Martin functional response and the fish populations are harvested according to catch-per-unit-effort (CPUE) hypothesis. The stability analysis of temporal and spatial models has been carried out. The optimal harvesting policy is also discussed with the help of Pontryagin's Maximum Principle. Numerical results have been shown to figure out the temporal and spatial model system. To preserve phytoplankton, zooplankton, and fish is taken as an effective control instrument into the harvesting effort.

DE20: **Wenxia Li**, East China Normal University, Shanghai, China

Title: **Multiple Expansions of Real numbers with Digits Set** $\{0, 1, q\}$

Email: wxli@math.ecnu.edu.cn

Coauthors: K.Dajani, K. Jiang and D.R. Kong

Abstract: For $q > 1$ we consider expansions in base q over the alphabet $\{0, 1, q\}$. Let $\mathcal{U}_q$ be the set of x which have a unique q-expansions. For $k = 2, 3, \cdots, \aleph_0$ let $\mathcal{B}_k$ be the set of bases q for which there exists x having precisely k different q-expansions, and for $q \in \mathcal{B}_k$ let $\mathcal{U}_q^{(k)}$ be the set of all such x's which have exactly k different q-expansions. In this paper we show that

$$\mathcal{B}_{\aleph_0} = [2, \infty) \quad \text{and} \quad \mathcal{B}_k = (q_c, \infty) \quad \text{for any} \quad k \geq 2,$$

where $q_c \approx 2.32472$ is the appropriate root of $x^3 - 3x^2 + 2x - 1 = 0$. Moreover, we show that for any positive integer $k \geq 2$ and any $q \in \mathcal{B}_k$ the Hausdorff dimensions of $\mathcal{U}_q^{(k)}$ and $\mathcal{U}_q$ are the same, i.e.,

$$\dim_H \mathcal{U}_q^{(k)} = \dim_H \mathcal{U}_q \quad \text{for any} \quad k \geq 2.$$

Finally, we conclude that the set of x having a continuum of q-expansions has full Hausdorff dimension.

DE21: **Bhuwan Prasad Ojha**, Apex College, Kathmandu, Nepal

Title: **Birkhoff and Robert Orthogonality in Normed Linear Spaces Via 2-HH Norm**

Email: bhuwanp.ojha@apexcollege.edu.np

Coauthors: Prakash Muni Bajracharya

Abstract: The p-HH norms on X^2 were introduced by Kikianty and Dragomir in 2008. Besides that, E. Kikianty and S.S. Dragimor introduced HH-P orthogonality and HH-I orthogonality by using 2-HH norm and discussed main properties of these orthogonalities. In this paper, we test the concept of 2-HH norm to Birkhoff and Robert orthogonality in normed spaces and discuss some properties of these orthogonalities.

DE22: **Dinesh Panthi**, Valmeeki Campus, Nepal Sanskrit University, Nepal

Title: **Some Fixed Point Theorems for Compatible and Weakly Compatible Mappings in Dislocated Metric Space**

Email: panthid06@gmail.com

Abstract: After the establishment of Banach Contraction Principle by S. Banach in 1922, several generalizations of this theorem has been obtained by various authors in different time intervals. In

1986, S. G. Matthews introduced the concept of dislocated metric space in the context of domain theory. In 2000, P. Hitzler and A. K. Seda introduced the concept of dislocated topology, provided some variants along with dislocated metric space and established fixed-point theorems. Since then, several authors have established various fixed-point theorems in this space. In this paper, we establish some fixed-point theorems for two pairs of compatible and weakly compatible mappings satisfying Meir -Keeler type contractive conditions in dislocated metric space.

DE23: **Santosh Pathak**, University of New Mexico, USA

Title: **L^∞-estimates of the Solution of the Navier-Stokes Equations for Non-Decaying Initial Data**

Email: santosh_pathak2002@yahoo.com

Abstract: In this talk, I will consider the Cauchy problem for the incompressible Navier-Stokes equations in $\mathbf{R}^n$ for $n \geq 3$ with non-decaying initial data and derive a priori estimates of the maximum norm of all derivatives of the solution in terms of the maximum norm of the initial function.

DE24: **Bijaya Pokhrel**, Tribhuvan University, Nepal

Title: **Orthogonality on Empirical Methods**

Email: bijayapsd@gmail.com

Abstract: Empirical methods are generally known as experimental methods. These methods preserves the data nature and properties. Due to these feature, they are popular among the researcher community; who analyze the real world data like biomedical signal, seismic signal and structural health monitor etc. Adding the Gram Schmidt orthogonalization feature on empirical methods especially on ensemble empirical mode decomposition methods significantly improve the computational result of EI Centro earthquake data.

DE25: **Puskar R. Pokhrel**, RR Campus, Tribhuvan University, Nepal

Title: **Description of Stream Function-Vorticity Formulation of Bulk Mixture Model for Mass Flow**

Email: prpokharel@student.ku.edu.np

Coauthor: Bhadra Man Tuladhar

Abstract: Employing a generalized quasi two-phase bulk mixture model, a newly formed stream function-vorticity, vorticity transport equation for a rapid flow of mixture of viscous fluid and solid particles down a channel is presented in this talk. We have also developed a novel and a generalized pressure Poisson model equation in terms of stream function and mixture viscosity along with its dynamical analysis and its analytical solutions in different flow situations. The model equation is a system of non-linear partial differential equation. Various reduced forms of the generalized pressure Poisson equations are also derived. The pressure Poisson equation for shear mixture flow is also derived for a given stream function. The rate dependent viscosity term also appears in the equation. The gradient of viscosity which changes the flow behavior substantially enhances the flow. In steady flow, it can be analyzed the irrotational flow by using stream lines. These novel results are in line with observed phenomena and highlight the application potential of the new model in appropriately designing the defense structures and thus provide important information for the hazard mitigation and planning.

DE26: **Sharma Priya R**, Banaras Hindu University, Varanasi, India

Title: **Approximations of a Function by Extended Legendre Wavelets and its Applications for Solving Differential Equations**

Email: priya.naina1995@gmail.com

Coauthor: Prof. Shyam Lal

Abstract: In this paper, extended Legendre wavelet and generalized Holder's class is studied. The extended Legendre wavelets approximations of a function whose first and second derivatives belonging to generalized Holder's class have been determined. Two corollaries have been obtained by the main theorems of this paper. The solutions of linear and non-linear differential equations have been obtained by extended Legendre wavelets method.

DE27: **Svetlana Roudenko**, Florida International University, Miami, FL, USA

Title: **Soliton Stability and Blow-up in Zakharov-Kuznetsov Equation**

Email: sroudenko@fiu.edu

Coauthors: Justin Holmer, Luiz Gustavo Farah, Kai Yang

Abstract: We consider a higher dimensional extension of the generalized Korteweg-de Vries equation (gKdV), called Zakharov-Kuznetsov (ZK) equation (the gKdV is limited as a spatially one-dimensional model), and investigate asymptotic stability of solitons or existence of blow-up solutions. We positively answer the question of existence of blowup in the critical Zakharov-Kuznetsov equation and also obtain the asymptotic stability in the subcritical setting. We will discuss the main ingredients such as the Liouville-type theorem, localization of solutions, monotonicity property and consequences, localized virial and spectral properties associated to it.

DE28: **Buddhi Sapkota**, Tribhuvan University, R.R. Campus, Kathmandu, Nepal

Title: **Indoor Air Flow Distribution in a Naturally Ventilated Kitchen under Different Ventilation**

Email: buddhisapkota@gmail.com

Coauthors: K. N. Uprety, H. Khanal

Abstract: Ventilation plays a vital role in the distribution of the indoor air pollutants. We explore the air flow distribution in naturally ventilated kitchen with different ventilation conditions. Governing equations of fluid flow with appropriate boundary conditions and standard $k - \epsilon$ turbulent model are used. Simulations are made for the velocity, pressure, turbulent kinetic energy with finite volume discretization method. Comparisons of the simulated results with the experimental data shows a good agreement with each other.

DE29: **Pawan Shrestha**, Tribhuvan University, R.R. Campus, Kathmandu, Nepal

Title: **Regularity of 2D Surface Quasi Geostrophic Equations**

Email: pawanshrestha2040@gmail.com

Coauthors: Durga Jang KC, Ramjee Sharma

Abstract: In this presentation we mainly talk about the recent analytical and numerical approaches in the solution of surface quasi geostrophic equations (SQG) with different initial conditions. Also we talk about the development of finite time singularities during the solution of SQG.

DE30: **Krishna Kumar Shrestha**, Tribhuvan University, Nepal

Title: **A class of pseudo-differential operators**

Email: adhikariim35@gmail.com

Abstract: The pseudo-differential operator A_q is defined as a generalization of the classical pseudo-differential operator. In this work, a representative formula and the boundedness of the operator are investigated.

DE31: **Robert Smits**, New Mexico State University, USA

Title: **P-harmonic Measure in Slabs and Other Regions**

Email: rsmits@nmsu.edu

Coauthors: Richard DeBlassie

Abstract: The fact that p-harmonic measure is not additive can be understood from robabilistic point of view that the underlying process is not a martingale. In this talk I will present recent results on estimating p-harmonic measure in various domains and an explicit representation for a strip in the complex plane which was describe qualitatively in the pioneering work of Tom Wolff. The tools used are nonlinear pdes, martingale theory and stochastic game theory.

DE32: **Ramesh Chandra Timsina**, Tribhuvan University, Kathmandu, Nepal

Title: **A Numerical Analysis for Transport and Growth of Microbes in Unsaturated Flowing Conditions**

Email: timsinaramesh72@yahoo.com

Coauthors: Kedarnath Uprety, Harihar Khanal

Abstract: The flow of water in unsaturated porous medium follows the ordinary law of hydrodynamics, The motion being produced by gravity and pressure gradient force acting in the water. By applying the equation of continuity to the Darcy's flow law, Richards equation is obtained. In this paper the highly non-linear Richard's equation is numerically solved using finite difference scheme. However, stable numerical solution still require relatively the discretization of both the time and space domain. Also a numerical method is developed that permits to approximate the microbial growth to associate changes in hydrodynamic properties in porous medium under unsaturated flowing conditions.

DE33: **Amita Tripathi**, Banaras Hindu University, Varanasi, India

Title: **An Optimal Control Model for Cloud Seeding in Deterministic and Stochastic Environment**

Email: amita4utripathi@gmail.com

Coauthors: A. K. Misra

Abstract: To promote artificial rain in India and other such developing countries, in this paper, we have proposed and analyzed a nonlinear mathematical model for cloud seeding by taking introduction rate of aerosols proportional to the liquid water contents of available clouds. The model is analyzed using Lyapunov stability theory of differential equations. To study the effect of the optimal control strategy, the model is further modified by incorporating four control parameters to reduce the cost involved in the cloud seeding experiments. Applying optimal control theory, it is found that for minimizing the cost in place of continuous introduction of aerosols, the introduction should be for a small period of time and when the optimal outcome is achieved the introduction can be stopped. We have shown the existence and uniqueness of optimal control problem and used Pontryagins Maximum Principle to analyze the optimal control problem. Further, for a more

realistic situation, the stochastic version of the proposed model is analyzed to see the noise effects in control strategies. In this regard, the Hamilton-Jacobi-Bellman (HJB) equation for stochastic control cost function has been formed.

DE34: **Ananta Upreti**, Central Department of Mathematics, Kathmandu, Nepal

Title: **Super Time Stepping Scheme for Option**

Email: upretimath@yahoo.com

Coauthors: Kedar Nath Uprety, Harihar Khanal

Abstract: We solve the Black-Scholes equation for option pricing numerically using an explicit finite difference method. To overcome the stability restriction of the explicit scheme for parabolic partial differential equations in the time step size (CFL condition), we employ a Super Time Stepping (STS) strategy based on modified Chebyshev polynomial. The numerical results show that the STS scheme boasts large efficiency gains compared to standard explicit Euler method.

DE35: **Madhav Wagle**, South Asian University, New Delhi, India

Title: **High-Order Compact Polynomial-Spline Approximation for Parabolic-Boundary Value Problems on a Variable Mesh**

Email: mdvwg@yahoo.com

Abstract: We describe the polynomial-spline approximation for the high-order numerical solution of parabolic partial differential equations on a quasi-variable mesh. We derive the scheme for a one-dimensional quasi-linear parabolic partial differential equation to the extent that the magnitude of local truncation order remains unchanged as of the uniform mesh network. We discuss the detailed exposition of the scheme by the Fourier analysis based stability theory. Finally, we give the numerical computations that illustrate the reliability of the proposed method.

DE36: **Dongmei Xiao**, School of Mathematical Sciences, Shanghai Jiao Tong University, China

Title: **Traveling waves for a nonlocal diffusion population model**

Email: xiaodm@sjtu.edu.cn

Coauthor: Zhaoquan Xu

Abstract: In this talk, we will introduce a nonlocal diffusion population model with a general diffusion kernel and delayed nonlinearity. We will show that the existence, uniqueness of traveling waves for this model, and discuss the stability of these traveling waves.

DE37: **Kai Yang**, Florida International University, USA

Title: **Stable blow-up dynamics in the critical and supercritical NLS and Hartree equations**

Email: yangk@fiu.edu

Coauthors: Svetlana Roudenko and Yanxiang Zhao

Abstract: We study stable blow-up dynamics in the nonlinear Schrödinger (NLS) equation and generalized Hartree equation with radial symmetry in the L2-critical and supercritical regimes. The NLS equation is with pure power nonlinearity $iu_t + \Delta u + |u|^{2\sigma}u = 0$, and the Hartree equation is a Schrödinger-type equation with a non-local, convolution-type nonlinearity in dimension d: $iu_t + \Delta u + \left(|x|^{-(d-2)} * |u|^p\right)|u|^{p-2}u = 0$, $p \geq 2$. First, we consider the L2-critical case for the NLS equation in dimensions $4 \leq d \leq 12$ and for the Hartree in dimensions $d = 3, 4, 5, 6, 7$. We show that a generic blow-up in both equations exhibits not only the rate $\|\nabla u\|_{L^2} \sim (T-t)^{-\frac{1}{2}}$

, but also the "log-log" correction, thus, behaving similarly to the stable collapse in the lower dimensional NLS (such as the 2d cubic NLS). In this setting we also study blow-up profiles and show that generic blow-up solutions converge to the rescaled Q, the ground state solution of the elliptic equations, which is well-known in the NLS case: $-\Delta Q+Q-Q^{2\sigma+1}=0$, and for the Hartree it is $-\Delta Q+Q-\left(|x|^{-(d-2)}*Q^{p}\right)Q^{p-1}=0$. Next, we examine the L2-supercritical cases for both equations. For the self-similar blow-up solutions we study the profile equations and discuss the existence and local uniqueness theory of the solutions. We then show that our numerical simulations indicate that the solutions Q to such profile equations exhibit a multi-bump structure, and thus, in a sense, not unique. Direct numerical simulations of the NLS and generalized Hartree equations by the dynamic rescaling method indicate that only one of those multi-bump profile solutions serves as the stable blow-up profile. We also investigate the rate of the blow-up and obtain the square root blow-up rate without any corrections. Our findings indicate that the nonlinearity type in the Schrodinger-type equations is not essential for the stable collapse formation.

Mathematical Biology (MB)

MB1: **Vijay Pal Bajiya**, Central University of Rajasthan, Ajmer, Rajasthan, India

Title: **A Mathematical Model for Cholera Transmission with Measures of Effective Control Strategy**

Email: bajiya123@gmail.com

Coauthor: Dr. Jai Prakash Tripathi

Abstract: In this work, a deterministic mathematical model is proposed for the transmission of Cholera disease considering media coverage and awareness program, vaccination, water sanitation and drug treatment as control strategies. Mainly, our aim to give a better understanding of the effects of control measures coupled with the transmission dynamics of Cholera and this will help in several ways to gain practical and efficient preventive strategies for the control of the Cholera epidemic. The dynamical behavior of the model and the epidemiological threshold R0 are explored. The existence and stability of equilibria are analyzed in the term of R0. Further, we analyzed the proposed model by obtaining the basic reproduction number R0 with single and various combination of control strategies and compared with each other to determine the most effective combination of control strategies to the eradication of Cholera disease. Sensitivity analysis of the basic reproduction number R0 with respect to parameters is discussed. Finally, we have given numerical simulation to support the analytical results.

MB2: **Gauri Bhuju**, Kathmandu University, Dhulikhel, Nepal

Title: **Fuzzy Dynamical System of SEIR-SEI Dengue Epidemic Model**

Email: bhujug@gmail.com

Coauthors: Ganga Ram Phaijoo and Dil Bahadur Gurung

Abstract: Dengue is mosquito-borne infectious disease. It has been an important public health problem particularly in the tropical and subtropical regions in the world. It is necessary to understand their transmission dynamics to propose the control strategies. In the present work, fuzzy approach is used to study transmission dynamics of the epidemic disease using SEIR-SEI compartmental model. Transmission rate and recovery rate of the disease are considered as fuzzy members. Also, the fuzzy basic reproduction number for group of infected individuals with different virus loads is calculated. Simulations are made to illustrate the mathematical results graphically.

MB3: **Cameron Browne**, University of Louisiana at Lafayette, USA

Title: **Predator-Prey Dynamics of HIV/SIV and Immune Response: an Evolutionary Perspective**

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Abstract: The dynamics of virus and immune response within a host can be viewed as a complex and evolving ecological system. For example, during HIV infection, an array of CD8+ T-cell immune response populations effectively target different HIV epitopes (viral proteins), however the virus can rapidly evolve resistance at distinct epitopes. In recent work, we analyzed a general model for the prey-predator network of multiple virus and immune response populations in HIV. Also, in another study, we investigated the cross-correlation between several immune cell populations and viral effective population sizes (Ne) sampled from experiments of the simian immunodeficiency virus (SIV)-infected macaque model of HIV infection. In particular, overall viral Ne was found to oscillate in concert with changing immune cell population levels. Connecting the theoretical modeling with this data, we observe that simulations of extended versions of the virus-immune network model mimic the large-scale oscillations in Ne. The results suggest that HIV diversity within the host is governed by a dynamic and complex predator-prey relationship, wherein differing phases of infection are the result of adaptation and gene flow in response to differing arms of the global immune response.

MB4: **Sarita Bugalia**, Central University of Rajasthan, India

Title: **Analysis of an Amensalism Model of Two Species with Beddington–DeAngelis Functional Response and Allee Effect on First Species and Harvesting in Second Species Affected by Disease**

Coauthors: Jai Prakash Tripathi

Email: saritabugalia44@gmail.com

Abstract: In this work, we proposed a two species model with disease and harvesting in second species. The interaction between species is amensalism type with Beddington–DeAngelis functional response. The second species classified into susceptible and infected population. The disease is not transmitted between first and second species. We show the local stability of all equilibria are under certain conditions. We analyzed the effect of harvesting in susceptible and infected species. Further, we incorporate the Allee effect into the first species and deliver a complete qualitative and bifurcation analysis of the system with Allee effect. In numerical simulation we see the behaviour of the system with and without Allee effect.

MB5: **Stanca Ciupe**, Virginia Tech University, Virginia, USA

Title: **Early Events Following Hepatitis B Virus Infection**

Email: stanca@vt.edu

Coauthors: Jonathan Forde, Naveen K. Vaidya

Abstract: Experimental studies in non-human primates inoculated with hepatitis B virus have shown that virus dose influences the kinetics of virus spread and the disease outcome. In particular, high and low doses lead to the infection of the entire liver, while intermediate doses lead to less than one percent liver infection. To determine the relationship between virus dynamics, percentage of liver infection, and immune priming we developed an in-host mathematical model that considers the effects of cellular immune responses in controlling the disease. We fitted the model to data and predicted correlations between dose size, the timing of the immune response, the potency of immune effects, and disease outcome. Such results can guide our understanding of the virus-host dynamics that control the virus or permit a transition to chronic disease.

MB6: **Tanuja Das**, IIT Patna, Patna, Bihar, India

Title: **Effect of Information and Saturated Treatment on a SEIR Infection Model**

Email: tanujamanidas@gmail.com

Coauthors: Prashant K Srivastava, Anuj Kumar

Abstract: In our work, we study a susceptible-exposed-infective-recovered (SEIR) model with a nonlinear incidence function and saturated treatment function. This incidence function accounts for the sensitivity of susceptible individuals towards the infective density in population due to the impact of media coverage. We analyse the model for stability. We obtained the basic reproduction number $\mathcal{R}_0$ for the model. It is shown that when $\mathcal{R}_0 < 1$, the disease dies out and the disease free equilibrium is globally stable. When $\mathcal{R}_0 > 1$, the disease free equilibrium becomes unstable and there is possibility of existence of three endemic equilibrium points. Stability of endemic equilibrium is performed analytically when it is unique and it is shown globally asymptotically stable conditionally. Numerically we have shown the existence and stability properties in case of multiple endemic equilibrium. Also, numerical simulations are used to explore and analyse our analogical findings. We observe that saturation in treatment and information plays important role in the dynamics of disease spread.

MB7: **Jonathan Forde**, Hobart and William Smith Colleges, New York, USA

Title: **Models of Chronic Hepatitis B Infection**

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Abstract: Chronic hepatitis B infection is a major public health burden, leading to more than 750,000 deaths per year as result of cirrhosis and hepatocellular carcinoma. Understanding the interplay between viral factors and the host immune reaction is essential for designing interventions. We develop a mathematical model of chronic HBV infection and the immune response, incorporating long-term effects such as immune exhaustion. While immune reactivation is a desired outcome that can reduce the risk of cancer development, it can also lead to heightened liver damage. We use our model to explore this tradeoff.

MB8: **Avinita Gautam**, Banaras Hindu University, Varanasi, India

Title: **Effect of External Applied Current on Neural Signals and Bifurcation Analysis**

Email: avinitagautam@gmail.com

Coauthor: Anupam Priyadarshi

Abstract: In daily life, it can be observed how the signal passes from body parts to the brain and vice-versa. These activities are carried out with the function of neurons. In this manuscript, the dynamics of neuron has been studied by applying external currents on the Hodgkin-Huxley model. Neuron generates action potential when a continuous and sufficiently large current is applied in a continuous manner. With constant external current Hodgkin-Huxley model shows stable and periodic behavior but when varying sinusoidal stimulus is applied to the system then it behaves differently. Periodic behavior of neuron shows the repetitive firing of action potentials while stable equilibrium shows quiescent state. External pulse plays an important role in the dynamics of neuron since the state of neurons shifts from one attractor (limit cycle) to another one (equilibrium point). Bifurcation analysis gives us a clear picture to understand the behavior of neurons and their dynamics.

MB9: **David Gerberry**, Xavier University, Cincinnati, Ohio, USA

Title: **Feasible and Ethical Rollout of Intervention Resources for Infectious Disease using Mathematical Optimization**

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Coauthor: Sally Blower

Abstract: In this talk, we consider a new approach for designing rollout strategies for infectious disease interventions. We will discuss situations in which this approach would be more flexible, more detailed and more consistent with how policy decisions are made than a standard optimal control framework. We will also show how feasibility and ethical constraints can be incorporated into such allocations. As an application, we consider the initial rollout of Treatment as Prevention (TasP) resources for HIV in South Africa that occurred within the last decade. While somewhat completed now, going back to TasP's initial rollout allows us to demonstrate important characteristics of this approach.

MB10: **Hayriye Gulbudak**, University of Louisiana at Lafayette, Lafayette, USA

Title: **Heterogeneous Viral Strategies Promote Coexistence in Virus-Microbe Systems**

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Coauthor: Joshua S. Weitzlogy

Abstract: Viral infections of microbial cells often culminate in lysis and the release of new virus particles. However, viruses of microbes can also initiate chronic infections, in which new viruses particles are released via budding and without cell lysis. In chronic infections, viral genomes may also be passed on from mother to daughter cells during division. The consequences of chronic infections for the population dynamics of viruses and microbes remains under-explored. In this paper we present a model of chronic infections as well as a model of interactions between lytic and chronic viruses competing for the same microbial population. In the chronic only model, we identify conditions underlying complex bifurcations such as saddle-node, backward and Hopf bifurcations, leading to parameter regions with multiple attractors and/or oscillatory behavior. We then utilize invasion analysis to examine the coupled nonlinear system of microbes, lytic viruses, and chronic viruses. In so doing we found unexpected results, including a regime in which the chronic virus requires the lytic virus for survival, invasion, and persistence. In this regime, lytic viruses decrease total cell densities, so that a subpopulation of chronically infected cells experience decreased niche competition. As such, even when chronically infected cells have a growth disadvantage, lytic viruses can, paradoxically, enable the proliferation of both chronically infected cells and chronic viruses. We discuss the implications of our results for understanding the ecology and long-term evolution of heterogeneous viral strategies.

MB11: **Rabindra Kumar Gupta**, Butwal Multiple Campus, Nepal

Title: **Mathematical Models of Spread and Control of Epidemic Through a Susceptible Population**

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Abstract: Millions of people in many countries throughout the world have been suffering over countries through the prevalence of infectious diseases.This article focuses on Mathematical modeling of spread and control of epidemic through a susceptible population. Some simple epidemic models like SI model, SIS model, SIR, SEIR models have significant role in clarifying the concepts regarding development and control of many diseases, especially in the area of bacterial diseases are discussed in the article. The population model is simple deterministic model and the assumptions are: (i) The disease is transmitted by contact between the infected individual and susceptible individual. (ii) There is no latent (incubation) period for the disease hence; the disease is transmitted instantaneously on contact. (iii) All susceptible individuals are equally susceptible and all infected individual are equally infected. (iv) The population under consideration is fixed in size that is no birth and migration occur and all deaths are taken into account. (v) The article reflects on the model formulation the solution of model and interpretation. The models in the article can be used to predict the speed and size of an outbreak.

MB12: **Jane Heffernan**, York University, Toronto, Canada

Title: **Models of Waning Immunity and Childhood Diseases**

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Abstract: Many childhood diseases are vaccine preventable. However, there continue to be many cases of such vaccine preventable diseases every year, even in countries with high vaccination coverage. It has been indicated that waning immunity may be the culprit in such situations. Mathematical models of waning immunity based on the SIRS, SIRVS, or SIRWS frameworks have indeed shown that this could be case. We continue in this venue, by adding new components to models of waning immunity that allow for further study of this topic, including immune status dependent susceptibility and transmissibility. In this talk I will review our models (and their connection to the underlying biology) and I will provide two case studies of waning immunity and vaccination using models with and without age structure. The basic reproduction and control reproduction numbers will be derived. Strategies for pathogen elimination will be discussed.

MB13: **Paul J. Hurtado**, University of Nevada, Reno, USA

Title: **A General 'Linear Chain Trick' for building ODE models with more flexible dwell time distributions**

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Coauthor: Adam S. Kirosingh

Abstract: ODE models have been criticized for their inability to incorporate non-exponential dwell time distributions (e.g. for infectious period). The Linear Chain Trick (LCT; aka the Gamma Chain Trick) is a technique for constructing mean field ODE models with dwell times that are Erlang distributed (i.e., gamma distributed with integer shape parameter), however we lack general theory to facilitate the easy application of this technique, especially for complex models, where ODEs must instead be derived from integral equations or continuous time stochastic models. This shortcoming has forced modelers to either construct ODE models using heuristics with oversimplified dwell time assumptions, or use time consuming derivations from first principles, or to instead use non-ODE models (like integro-differential equations or delay differential equations) which can be cumbersome to derive and analyze.

I will present results that generalize the LCT, and make it easier to construct mean field ODEs that better incorporate appropriate dwell time assumptions, including some conditional dwell time assumptions. Specifically, I will 1) present novel extensions of the LCT to various scenarios found in applications; 2) provide formulations of the LCT and its extensions that bypass the need to derive ODEs from integral or stochastic model equations; and 3) I'll introduce a novel Generalized Linear Chain Trick (GLCT) framework that extends the LCT to a much broader family of distributions, including the flexible phase-type distributions. These results also help clarify connections between individual-level stochastic model assumptions and the structure of corresponding mean field ODE models.

MB14: **Hem Raj Joshi**, Xavier University, Cincinnati, Ohio, USA

Title: **Overview of Optimal Control and Its Applications to Biology**

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Coauthors: Suzanne Lenhart, Mike Neubert, Guillermo Herrera, Sanjukta Hota and Folashade Agusto

Abstract: We will explain optimal Control in detail, apply it in fishery model and SIR type model. In fishery model, we present a mathematical model for the growth, movement, and harvesting

of a renewable resource, and characterize the spatiotemporal distribution of harvest effort which maximizes the present value of harvest (yield) over a finite time horizon. We derive the optimality system for this model and show that the yield-maximizing solution often includes one or more no-take reserves that change in size over time. We explore how the results change with varying parameter values. The results inform ongoing debate about the use of reserves, and are increasingly relevant as technology enables enforcement of spatially structured harvest constraints. We present numerical solutions to the optimality system for some bioeconomically interesting scenarios. In SIR model, we educate public to manage a disease outbreak when effective treatments or vaccines are not readily available or out of reach due to economic situation. We study stability analysis and use optimal control theory to achieve the goal of minimizing the infected population. We also run numerical simulations.

MB15: **Kabita Luitel**, Bhaktapur Multiple Campus, Bhaktapur, Nepal

Title: **Numerical Study of Heat Transfer in Human Body with Protective Layer**

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Coauthors: Dil Bahadur Gurung, Harihar Khanal and Kedar Nath Uprety

Abstract: The thermal balance is affected by body metabolism, clothing transport properties, and ambient conditions. Clothing plays an important role in effectively protecting the human body by controlling heat transfer from both, body to environment and environment to the body. So the present study aims to evaluate the heat transfer from the human skin surface to clothes, then clothes to the environment. The skin of the clothed human body is divided into four layers (namely: Subcutaneous, Dermis, Epidermis and protective layers). Various physical and physiological parameters across the layers of skin along with clothing area factors and clothing insulation in the protective layer have been incorporated in the model. The reformulated form of one-dimensional Pennes' bio-heat equation with appropriate boundary condition is solved by using a Finite Difference Technique. The numerical results are illustrated by using CAS software to clear that the protective layer maintains a suitable temperature at the skin surface regardless of the surrounding temperature.

MB16: **Bhawna Malik**, Shiv Nadar University, UP, India

Title: **Antibiotic Drug-Resistance as a Complex System Driven by Socio-Economic Growth and Antibiotic Misuse**

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Coauthor: Samit Bhattacharya

Abstract: Overwhelming antibiotic use poses a serious challenge today to the public-health policy makers worldwide. Many empirical studies pointed out this ever-increasing antibiotic consumption as a primary driver of community-acquired antibiotic drug-resistance, especially in middle and lower income countries. The association is well documented across spatial and temporal gradients in many countries, and WHO has endorsed a Global Action Plan to optimize antibiotic consumption. However, there is rarely any study that emphasizes mechanism of the association, which is important for combating the drug-resistance. Formulating a mathematical model of emergence and transmission of drug-resistance, we in this paper, present how amalgamating three components: socio-economic growth, population ecology of infectious disease, and antibiotic misuse can instinctively incite proliferation of resistance in the society. The combined impact of economy, infections, and self-medication signifies a positive feedback on each component, presenting it as self-reinforcing cycle in developing community-acquired drug-resistance in the population. Analysis of the model shows that the socio-economic status of population may be the single major driver that fuels irrational use of antibiotics, exhibiting a negative relationship with antibiotic resistance. Our model illustrates that a proper and timely government aid can slow down the process of development and reduce the burden of drug-resistance in community.

MB17: **Anushaya Mohapatra**, Bits-Pilani K-K Birla Goa Campus, Goa, India

Title: **The Evolutionary Stability of Partial Migration under Different Forms of Competition**

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Coauthors: Patrick De Leenheer, Haley Ohms, David Lytle

Abstract: Partial migration is a unique form of phenotypic diversity wherein migrant and non-migrant individuals coexist together in a population. Recent research has shown that the partial migration can be an evolutionarily stable strategy (ESS) and convergent stable strategy (CSS) if migrants and non-migrants experience density-dependent competition among individuals of the same type during reproduction. However, not all partially migratory species experience this particular form of competition during reproduction. In this talk we discuss how various degrees of competition between migrants and non-migrants influence whether or not partial migration is an ESS and CSS. We find that the degree of competition influences the evolutionary outcome of partial migration, and provide sharp thresholds relating these degrees of competition to the carrying capacities of both phenotypes.

MB18: **Buddhi Pantha** Abraham Baldwin Agricultural College, USA

Title: **Modeling Transmission Dynamics of Rabies in Nepal**

Email: bpantha@abac.edu

Coauthors: Sunil Giri, Hem Joshi, Naveen Vaidya

Abstract: Rabies is a neglected tropical disease caused by Rhabdovirus and often transmitted to humans and animals through the bites of infected animals. Even though vaccines against rabies are available, rabies still remains a burden killing significant number of humans as well as domestic and wild animals in many parts of the world, including Nepal. In this study, we develop a mathematical model to describe transmission dynamics of rabies in Nepal. In particular, an indirect interspecies transmission from jackals to humans through dogs, which is relevant to the context of Nepal, is one of the novel features of our model. Using our model with some parameters estimated from human rabies data, we calculated the basic reproduction number (R_0) for Nepal, and performed sensitivity analysis to identify that the dog-related parameters are primary contributors to R_0. We find that even though intraspecies basic reproduction numbers of both dogs (R_0^D) and jackals (R_0^J) are less than 1, the rabies epidemic may still occur ($R_0 > 1$) due to interspecies transmission. Our results show that, along with dogs, jackals also play important roles in the persistence of rabies in Nepal, and that only the currently practiced pre-exposure vaccines to dogs and post-exposure vaccines to the exposed humans are not sufficient to eradicate rabies. In addition, our model suggests that control strategies, such as dog sterilization and dog culling, may help reduce the prevalence and outbreak significantly but the jackal vaccination may not be as effective as other preventive strategies. These results may be useful to design effective prevention and control strategies for mitigating the rabies burden in Nepal.

MB19: **Libin Rong**, University of Florida, Florida, USA

Title: **Multi-stage models in HIV infection and treatment**

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Abstract: Highly active antiretroviral therapy has successfully controlled HIV replication in many patients. The treatment effectiveness may depend on the intracellular stages of the viral replication cycle inhibited by drugs. In this talk, I will present a few multi-stage models developed to study HIV dynamics under treatment. I will show that different drug classes have different influence on HIV decay dynamics. I will also discuss the clinical implications of these modeling results.

MB20: **Gergely Röst**, University of Szeged, Hungary

Title: **Global Dynamics of a New Delay Logistic Equation Arisen in Cell Biology**

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Coauthors: Ruth Baker, Péter Boldog

Abstract: The delayed logistic equation (also known as Hutchinson's equation or Wright's equation) was originally introduced to explain oscillatory phenomena in ecological dynamics. While it motivated the development of a large number of mathematical tools in the study of nonlinear delay differential equations, it also received criticism from modellers because of the lack of a mechanistic biological derivation and interpretation. Here we propose a new delayed logistic equation, which has clear biological underpinning coming from cell population modelling. This nonlinear differential equation includes terms with discrete and distributed delays. The global dynamics is completely described, and it is proven that all feasible nontrivial solutions converge to the positive equilibrium. The main tools of the proof rely on persistence theory, comparison principles and an L2-perturbation technique. Using local invariant manifolds, a unique heteroclinic orbit is constructed that connects the unstable zero and the stable positive equilibrium, and we show that these three complete orbits constitute the global attractor of the system. Despite global attractivity, the dynamics is not trivial as we can observe long-lasting transient oscillatory patterns of various shapes. We also discuss the biological implications of these findings and their relations to other logistic type models of growth with delays.

MB21: **Saroj Kumar Sahani**, South Asian University, India

Title: **Effects of Environmental Fluctuations on the Survival of Species**

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Abstract: We propose a delayed model for the effects of environmental fluctuation on the species survival. Here, the environmental fluctuation means the pollutant which enter the environment in the species lives get altered by any means. We assumed that the species grows with logistic rate. It is very well understood that the uncontrolled pollutant have very adverse effects on the species and sometime it may lead to the extinction of the species. We assume that the pollutants affects the living species with a delayed response once it enter into the environment. We have simulated the system for its long term dynamical properties and establish the existence of non-trivial equilibrium point which will ascertain the survival of species in the polluted environment.

MB22: **Elissa J. Schwartz**, Washington State University, Washington, USA

Title: **Dynamics of lentiviral infection in vivo in the absence of adaptive immune responses**

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Coauthors: Naveen K. Vaidya, Karin S. Dorman, Susan Carpenter, Robert H. Mealey

Abstract: Understanding the dynamics of acute viral infection is crucial for developing strategies to prevent and control infection. In this study, lentiviral dynamics in a host without adaptive immunity were examined in order to determine kinetic parameters of infection and quantify the effect of neutralizing antibodies in preventing infection, using mathematical modeling of data from equine infectious anemia virus (EIAV) infection of horses with severe combined immunodeficiency (SCID). Estimated parameters were used to calculate the basic reproductive number and virus doubling time and found that the rate that antibodies neutralized virus was 18 times greater than the virus clearance rate. These results establish EIAV replication kinetics in SCID horses and the minimal efficacy of antibodies that blocked infection. Furthermore, they indicate that EIAV is at most mildly cytopathic. This study advances our understanding of EIAV infection and may have important implications for the control of other viral infections, including HIV.

MB23: **Sharad Silwal**, Jefferson College of Health Sciences, Virginia, USA

Title: **R Methods for Ecological and Clinical Data**

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Coauthors: Chet Bhatta, Richard Carliss

Abstract: R, an open-source statistical computing language, has become increasingly popular in academia. In this talk, I will provide a short review of how R can be used in analyzing data in biological sciences. Examples include ecological data of bee foraging and clinical trial data of a pain medication.

MB24: **Adnan Sljoka**, RIKEN, University of Toronto, Canada

Title: **Lifting the curtain: probing biological secrets at molecular level with rigidity theory and algorithms**

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Abstract: Proteins are a constituent element of all living organism and play crucial roles in immunity, metabolism, and they serve as catalysts for virtually all biochemical reactions in living organism. Moreover, proteins such as enzymes, ion channels and receptors are the most common biological targets in drug therapeutics. To deeply understand how proteins function one must examine their internal flexibility and dynamics and how various components move within their folded structure. One critical way proteins regulate their dynamics and ultimately function is through a phenomena known as 'allostery' which has been coined as 'second secret of life'. Allostery is a universal phenomena which involves regulation and/or signal transduction induced by a perturbation at one site on the protein which is a topographically distinct site from an active site. Allostery is often synonymous with "signaling" as it involves transmission of signals across protein structure. In spite of its importance, the molecular mechanisms that give rise to allostery are still poorly understood. Advancements in the field of biophysics and mathematical rigidity theory have opened up a number of exciting opportunities for very fast computational predictions of protein flexibility and their dynamics and allostery. In this talk we will review some of recent developments in this highly interdisciplinary area of research. We have recently developed rigidity-transmission allostery (RTA) algorithm, an extremely fast computational method based on mathematical algorithms in rigidity theory. RTA algorithm provides a mechanical interpretation of allosteric signaling and is designed to predict if mechanical perturbation of rigidity (mimicking ligand binding) at one site of the protein can transmit and propagate across a protein structure and in turn cause a transmission and change in conformational degrees of freedom at a second distant site, resulting in allosteric transmission. We will illustrate our method, identification of novel allosteric sites and a detailed mapping of allosteric pathways, which are in agreement with NMR data studies on various class of proteins: GPCRs [Nature Communication 2018], enzyme fluorocatate dehalogenase [Science 2017, J. Am. Chem. Soc. (2019)], and others. RTA method is computational very efficient (takes minutes of computational time on standard PC) and can scan many unknown sites for allosteric communication, identifying potential new allosteric sites and it can be used to engineer allosteric control of protein function. We will also highlight other recent results where our rigidity-based algorithms provide key new insights into the biophysical mechanisms that underlie affinity maturation of antibody proteins [Frontiers in Immunology, 2018], a process which is fundamental to understanding B-cell immunity and we will introduce our novel work on validation of NMR structures.

MB25: **Amber Smith**, University of Tennessee Health Science Center, USA

Title: **Modeling Disease Progression During Influenza**

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Coauthors: Margaret A. Myers, Amanda P. Smith, Lindey C. Lane, David J. Moquin, J. Robert Michael, Peter Vogel, Stacie Woolard

Abstract: Influenza A viruses cause a significant amount of morbidity and mortality. Understanding how the infection is controlled by host immune responses and how different factors influence severity are critical to combat the infection. During infection, virus increases exponentially, peaks, then declines until resolution. The viral decline is often biphasic, which we previously determined is a consequence of density-dependent infected cell clearance. The second, rapid clearance phase corresponds with the infiltration of CD8 T cells, but how the rate changes with infected cell density and CD8 density is unclear. Further, neither of these kinetics directly correlate to disease severity. Thus, we investigated these relations by infecting mice with influenza A/PR8, simultaneously measuring virus and CD8s, and developing/calibrating a kinetic model. The model predicts that virus resolution is sensitive to T cell expansion, that there is a critical CD8 magnitude below which the infection is significantly prolonged, and that the efficiency of CD8-mediated clearance is dependent on infected cell density. To further examine this finding and validate the model, we quantified infected cells kinetics using histomorphometry. These data showed that the area of lung infected reflects the predicted infected cell dynamics, and that the infection resolution dynamics parallel the relative CD8 magnitude. Our analysis further revealed a nonlinear relation between disease severity and the percent damaged lung. Establishing these critical connections that map the kinetics of virus, infected cells, T cells, lung pathology, and disease severity aids our ability to predict the course of infection, disease progression, and potential complications.

MB26: **Anup Tuladhar**, Kathmandu University, Dhulikhel, Nepal

Title: **Mathematical Model for HIV Epidemic in Far Western Nepal due to Seasonal Male Labor Migration to India**

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Coauthors: Naveen K. Vaidya, D. B. Gurung

Abstract: Due to high unemployment rate in Nepal and open boarder provision between Nepal and India, it is quite common for male population from Far Western Nepal to work as labor migrants in India's big cities such as New Delhi and Mumbai. While they are far from home, their regular visit to brothel and unsafe sexual practices (where HIV prevalence is extremely high) leads them to acquire HIV viruses, which they can easily transmit to their wife and other women upon their return to home in Nepal. So, we develop a mathematical model to study the effect of such seasonal labor male migration on the HIV prevalence of population in Far Western Nepal. In particular, we consider parameters such as migrants HIV prevalence, the rate of condom use and the rate of inflow population from India for this study. Analysis of our model reveal that the HIV prevalence is more sensitive to HIV prevalence among migrants in India. An increase in migrants' HIV prevalence from 2.2% to 10% will increase the HIV prevalence in Far Western Nepal from 0.39% to 1.5%, respectively. Our study highlights the importance of strategies focused on seasonal labor migrants group to control HIV epidemics in Far Western Nepal.

MB27: **Hui Wu**, Clark Atlanta University, Department of Mathematical Sciences, USA

Title: **Kuramoto Model with Time Delayed Positive and Negative Couplings**

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Abstract: In many physical, biological and man-made oscillatory systems, the coupling not only involve attractive (positive) coupling but also involve repulsive (negative) coupling.Transitions to synchronization depend on several factors, including interaction time-delays, which are often unavoidable and significant in spatially distributed systems of oscillators like the interactions among brain neurons due to finite speeds of signal propagation. In this talk, I will discuss our findings on (i) The exact boundaries for stable incoherent and coherent states for identical oscillators, and (ii) The effects of time-delayed coupling in synchronization of oscillators with distributed frequencies.

Probability and Statistics (ST)

ST1: **Gokarna R. Aryal**, Purdue University Northwest, Indiana, USA

Title: **McDonald-G-Poisson Family of Distributions**

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Abstract: In this talk, we present a new family of distributions called the McDonald-G-Poisson (McGP) family. The McGP family is constructed by using the genesis of the zero-truncated Poisson distribution and the McDonald distribution. We provide motivation for the construction of such family and discuss some other families which have emerged as a special case of McGP family. We provide some mathematical and statistical properties of McGP family. Parameter estimation and simulation procedures are also discussed. Usefulness of McGP family is illustrated by modeling real-life data from different areas of applications.

ST2: **Ram C. Kafle**, Sam Houston State University, Houston, Texas, USA

Title: **A Population-Based Study on the Effect of Smoking on Age-adjusted Lung Cancer Incidence using Bayesian Approach**

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Coauthor: Melinda M. Holt

Abstract: Cancer is a major public health problem around the globe. Lung cancer is a particular concern as it is the leading cause of cancer-related deaths in the population. The Center for Disease Control and Prevention reports that 80 to 90 percent of lung cancer deaths are associated with cigarette smoking. Smokers are 15 to 30 times more likely to get lung cancer or die from lung cancer compared to non-smokers. The aim of this study is to develop the quantitative relationship between the smoking rate and incidence of lung cancer in the population. We apply log linear Bayesian joinpoint regression model to jointly study the effect of smoking on the incidence of lung cancer. The developed model estimates the age-adjusted lung cancer incidence rates with the adjustment of smoking rates and other applicable covariates in the model. The quantitative relationship between smoking and incidence is estimated by the unobserved time lag between the smoking and the incidence process in population.

ST3: **Netra Khanal**, University of Tampa, Florida, USA

Title: **What is contributing to Carbon Dioxide Emission? Differential Equation Model using Functional Data Analysis Approach**

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Abstract: Solid, liquid, and gaseous fuels are considered to be major contributors to the emission of carbon dioxide in the atmosphere- the one that causes Global Warming. In this study, we develop a differential equation to model carbon dioxide emission while considering the impact of major contributors as an input function. The input function is estimated using a differential operator as data a smoother and penalized least square criteria is implemented to select a model using functional data analysis techniques. The proposed model is applied to the historical data of carbon dioxide emission and its most significant constituents in the continental United States from 1882 to 2014. The data is obtained from the Carbon Dioxide Information Analysis Center (CDIAC), the primary climate change data and information analysis center of the United States Department of Energy. The proposed model is expected to be useful to understand the dynamics of major attributing variables and their impacts on the rate of change of carbon dioxide emission.

ST4: **Keshav Pokhrel**, University of Michigan-Dearborn, Michigan, USA

Title: **Cybersecurity: A Predictive Analytical Model for Software Vulnerability Discovery Process**

Email: kpokhrel@umich.edu

Coauthors: Netra Khanal, Nawaraj Pokhrel and Chris P. Tsokos

Abstract: A software vulnerability is defined as a flaw that exists in computer resources or control that can be exploited by one or more threats. Vulnerabilities are discovered throughout the entire life cycle of the software. In this paper, we examine existing vulnerability models on the subject area and propose a new time-based differential equation model. Our proposed model is based on the assumption that vulnerability saturation is a local phenomenon, that possesses an increasing cyclic behavior within the software vulnerability life cycle. Daily vulnerability data is extracted from the National Vulnerability Database (NVD) to obtain a cumulative quarterly vulnerability data set for three Operating Systems: Mac OS X, Windows 7, and Linux Kernel. When we apply the the proposed model to this data, it is discovered that our model performs significantly better than existing models, in terms of fitting and prediction capabilities.

Physical Sciences (PS)

PS1: **N Jalatheeswari**, Kanchi Mamunivar Centre for Post Graduates study, Lawspet, India

Title: **Lubrication of Rollers with Pressure and Temperature effects on Consistency of the Power Law Lubricants**

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Coauthor: Dr. Dhaneshwar Prasad

Abstract: Thick fluid film lubrication of cylinders is here presented including the effects of non-Newtonian power law lubricants with normal squeezing motion & cavitations. The two dimensional consistency change of the power law lubricant is considered to be pressure and temperature dependent. The results for pressure and temperature are computed including loads, traction for various values of the consistency index n and normal velocity q. These results are metaphor with the previous one. Most of them are found to be in good agreement with the previous findings.

PS2: **Real Jung KC**, Oklahoma State University, Oklahoma, USA

Title: **Investigation of a Low Profile Vortex Generator via Experimental Methods**

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Abstract: Conformal Vortex Generators (CVGs) present a novel mean of flow control in a commercial aircraft. CVGs are relatively new and much of their properties are still unknown. This research presents the study of CVGs via wake surveys in a wind tunnel. For this study, multiple CVG configurations were applied separately to an LA203A wing model. The tests were conducted at Reynolds number of 300,000 and the angle of attack of the wing was varied from 0 to 10 degrees. The CVGs were able to generate strong coherent structures that persisted into the wake region five chord lengths downstream of the wing. Making the CVG sizes smaller weakened the coherent structures. The further upstream the step of the CVGs were located, the higher the coefficient of drag was at high angles of attack. CVG outperforms a backward facing step but not a clean wing.

PS3: **Andrei Ludu**, Embry-Riddle Aeronautical University, Dept. Mathematics and Wave Lab, USA

Title: **Time Dependent Dynamical Systems with Accelerated Change**

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Abstract: We introduce a new predictive model that can be applied in physical, biological or social systems manifesting accelerated change, essential singularity in the Ulam-Neumann sense, and span several scaling orders during their evolution. Examples can be explosive population growth, memory modeling machine learning, technological singularity, and the adjacent possible. The model is based on the concept of time-dependent order of differentiation equations introduced in 2016 and involves Riemann-Liouville and Caputo fractional calculus and nonlinear integral equations. An example of application of the model to the Navier-Stokes existence and smoothness problem is presented. We will discuss difficulties in defining an appropriate initial manifold, and an interesting connection between the corresponding time-dependent fractional De Rham cohomology of such equations and fractal dimensions homology with a re-interpretation of the Stokes theorem as the definition of boundary.

PS4: **Prabhash Pokhrel**, Trichandra Multiple Campus, Kathmandu, Nepal

Title: **Time Dilation in Different Planets In Accordance To Theory Of Relativity**

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Coauthor: Puskar Raj Pokhrel

Abstract: Time is not constant all around the universe. Time may be an illusion as Einstein said but it is definitely not persistent. According to Newtonian physics, Time is taken as constant reference all over the universe but Velocity and Distances are the variables, whereas according to Einstein, Time, Velocity and Distance all are variables and depend on each other simultaneously. This is mainly due to difference in gravitational pull in different planets and stars, and also due to many small physical factors.

PS5: **Dhaneshwar Prasad**, KMCPGS, Lawspet, Puducherry, India

Title: **Thick Fluid Film Lubrication of Rollers with Two Dimensional Power Law Consistency Variation**

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Coauthors: N. Jalatheeswari, Venkata Subrahmanyam Sajja

Abstract: Hydrodynamic fluid film lubrication of rollers by power law lubricants is studied including normal squeezing motion. Effects of the pressure and the temperature on the lubricant consistency variation (two dimensional) are taken into consideration. Results are calculated for pressure and temperature including loads, traction for various values of the consistency index n and the normal squeezing velocity parameter q. The obtained results are compared and found that they are in good agreement with the previous findings.

PS6: **Venkata Subrahmanyam Sajja**, Koneru Lakshmaiah Education Foundation, Guntur, India

Title: **Hydrodynamic Lubrication of Asymmetric Rollers by Power-Law and Bingham Plastic Fluids**

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Coauthors: Sudam Sekhar Panda, Dhaneshwar Prasad

Abstract: Hydrodynamic lubrication characteristics of asymmetric rollers by power-law fluid and Bingham plastic fluid are studies in this work. A comparative study is made with these non-Newtonian lubricants assuming the consistency of the power-law fluid and the viscosity of the

Bingham plastic fluid varies with hydrodynamic pressure. The important governing equations like continuity and momentum are solved analytically under usual boundary conditions and the obtained a numerical solution using MATLAB. Significant changes in pressure, load, and traction are observed. The velocity profiles with power-law fluid and Bingham plastic fluid are also presented. The results are in good agreement with the previous findings.

Algebra and Topology (AT)

AT1: **Pawan Kumar B.K.**, Kathmandu, Nepal

Title: **Convergence of the Ratio of Perimeter of a Regular Polygon to the Length of its Longest Diagonal as the Number of Sides of Polygon Approaches to ∞**

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Abstract: Regular polygons are planar geometric structures and that are used to a great extent in mathematics, engineering and physics. The purpose of the paper is to introduce Bishwakarma Ratio Formulae through proper mathematical explanations. Bishwakarma Ratio Formulae calculate the ratios of perimeters of regular polygons to their corresponding longest diagonals. For all size of a regular polygon the ratio is always constant and converges to the value of πas the number of sides of the polygon approaches to ∞. These ratios are called Bishwakarma Ratios as they have been obtained via Bishwakarma Ratio Formulae. In short form Bishwakarma Ratios are denoted by BK ratios. Validation of ratios is done by actually calculating the ratio for each polygon by using corresponding formula and geometrical reasoning. A computational calculation of the ratio has also been presented up to 30 and 50 significant figures to validate the convergence.

AT2: **Chadwick Gugg**, Georgia Southwestern State University, USA

The Mathematics of Srinivasa Ramanujan – Ramanujan's 40 Identities for the Rogers-Ramanujan Functions

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Abstract: During his life, Indian mathematician Srinivasa Ramanujan recorded nearly 3900 results and made substantial contributions to number theory, mathematical analysis, infinite series, and continued fractions. Two important functions he worked with are the Rogers-Ramanujan functions and, closely associated with them, the Rogers-Ramanujan continued fraction. We discuss some of the elegant identities recorded by Ramanujan in his notebooks for these functions. I discuss certain related identities with powers of the Rogers-Ramanujan functions that I have worked on, and connections to the theory of partitions.

AT3: **Toshihisa Kubo**, Ryukoku University, Kyoto, Japan

Title: **Kable's Heisenberg Ultrahyperbolic Operator and Hypergeometric Polynomials**

Email: toskubo@econ.ryukoku.ac.jp

Coauthor: Bent Ørsted

Abstract: Roughly speaking, representation theory is a field of mathematics that studies "symmetry" of a vector space. Such symmetry arises in many different areas of mathematics. For instance, Kobayashi–Ørsted showed that the space of solutions to the ultrahyperbolic operator $\mathcal{D}_{p,q}$ on Euclidean space $\mathbb{R}^{p,q}$ has an exceptional symmetry of the orthogonal group $O(p,q)$ (called the minimal representation). Recently, Kable introducued a one-parameter family $\mathcal{D}_{\mathrm{H}^n}(s)$ of differential operators on Heisenberg space H^n with complex parameter s. He called such operators

Heisenberg ultrahyperbolic operators. In this talk we consider the Heisenberg ultrahyperbolic operator $\mathcal{D}_{\mathrm{H}^3} \equiv \mathcal{D}_{\mathrm{H}^3}(0)$ with $s = 0$ on three-dimensional Heisenberg space H^3 and describe the symmetry of the solution space to $\mathcal{D}_{\mathrm{H}^3}$ in terms of hypergeometric polynomials. This is based on a joint work with Bent Ørsted.

AT4: **Bishnu Hari Subedi**, Tribhuvan University, Kathmandu, Nepal

Title: **A Study of Holomorphic Semigroups**

Email: subedi.abs@gmail.com

Coauthor: Ajaya Singh

Abstract: In this presentation, we investigate some characteristic features of holomorphic semigroups. In particular, we investigate nice examples of holomorphic semigroups whose every left or right ideal includes minimal ideal. These examples will be compact topological holomorphic semigroups and examples of compact topological holomorphic semigroups are the spaces of ultrafilters of semigroups.

AT5: **Naomi Tanabe**, Bowdoin College, Maine, USA

Title: **Identifying a modular form**

Email: ntanabe@bowdoin.edu

Coauthor: Alia Hamieh

Abstract: A Hilbert modular form is a complex analytic function of several variables, which can also be viewed as a function on GL_2 over the adelic ring. It encompasses rich arithmetic properties, and has been an important object to study in the areas of number theory. For example, an intriguing problem is to identify a unique modular form by analyzing their properties as well as that of their associated L-functions. In this talk, I will survey some of their properties, and then study the extent to which certain values of automorphic L-functions determine underlying modular forms.

AT6: **Timothy Trujillo**, Sam Houston State University, Houston, Texas, USA

Condorcet's Paradox and Ultrafilters

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Abstract: Two of the most iconic results of voting theory are Condorcet's paradox and Arrow's impossibility theorem. The purpose of this talk is to place these results in the context of Ramsey theory - the study of collections of sets that are partition regular. We give a short proof of Arrow's theorem which uses Condorcet's paradox. Along the way the notion of an ultrafilter plays a prominent role.

Mathematical Education (ME)

ME1 **Gokarna Aryal**, Purdue University Northwest, USA

Title: **Developing Statistics Modules for Dynamic Processes to Enhance Effective Learning by Integrating Visualization**

Email: aryalg@pnw.edu

Coauthors: Lash Mapa, Magesh Chandramouli

Abstract: This presentation demonstrates a learning activity of probability and statistics using computer graphics environment. The activity involves data collection from a manufacturing process through visualization. In particular, it involves analysis of conveyor belt arrangements using computer vision to identify colored items and then dissect the arrangements in the form of static matrix. The implementation includes usage of Vision APIs (Application Programming Interface) from Google and OpenCV to capture and analyze the arrangement. Subsequent to data collection, the methodical analysis is carried to facilitate teaching the concepts of randomization, construction of control charts, and process capability analysis among others.

ME2 **Irina Aryal**, The Celebration Co-Ed School, Kathmandu, Nepal

Title: **An Initiation to Improve the Mathematics Learning for Slow Learners**

Email: irina_aryal@yahoo.com

Coauthor: Sagar Dahal

Abstract: Mathematics is seen by many as hard, boring or both. But evidence suggests that a love of mathematics is no barrier to fun and humor, although a poor understanding of mathematics can have unpleasant consequences. And it can be very hard to learn mathematics for the slow learning students. My paper focuses on special techniques, which may boost the caliber of slow learners in mathematics so that students can focus and be curious to learn mathematics and remove "mathematics as terror" from their mind. The methodologies used in this paper are: in-depth interview, lived experiences, narrative inquiry.

ME3 **Pradip R. Aryal**, New Mexico State University, USA

Title: **Quality Matters: For Your Teaching**

Email: pradip@nmsu.edu

Abstract: In this presentation, I will talk about how "Quality Matters" helps you teach online classes effectively, and its positive impact on face-to-face classes as well. In addition, I will demonstrate an example of a successfully QM-reviewed course.

ME4 **Deepak Basyal**, University of Wisconsin-Milwaukee, USA

Title: **What Statistical Content Children Learn in Nepal: An Analysis of Five Textbook Series Currently in Use in Nepali Schools**

Email: basyal@uwm.edu

Coauthor: Dustin L. Jones

Abstract: To make decisions in today's world, people need to appropriately understand, analyze, and interpret information and data. Recognizing that the study of statistics can prepare students to make informed decisions, governments and professional organizations have made recommendations and guidelines regarding statistics. In Nepal, the Curriculum Development Center established guidelines for the topics to be studied in several subjects, including mathematics classes, with statistics addressed in grades 4-10. We report on an analysis of five Nepali textbook series that were written to meet these guidelines. We examined all of the tasks in each statistics chapter, and classified them according to the phases of the statistical problem solving process (formulate questions, collect data, analyze data, interpret results) that were addressed. We found that nearly every task required students to analyze data; the other phases were rarely addressed.

ME5 **Magesh Chandramouli**, Purdue University Northwest, Indiana, USA

Title: **VR-based Instructional Visualization for Mathematics, STEM, & Computational Thinking**

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Abstract: Interactive VR (Virtual Reality)-based tools can be quite effective in stimulating interest and reducing cognitive load. Designing the instructional modules in a fun-based interactive desktop VR setting can motivate students to explore new ways to interact with the materials presented. Some of the major underlying concepts of computer science and computational thinking involve abstraction, expressions, remixing, and iteration. Computational thinking skills are becoming increasingly important in both academia and industry. While this signifies numerous opportunities for students, it also inherently involves the challenge of preparing students suitably for these opportunities. To this end, to facilitate interactive and fun-filled learning, this research employs a learner-centric, user-friendly Virtual Environment (VE) to teach mathematics and computational thinking concepts. The impact of this research extends beyond engineering and technology education as this framework can serve as a tool to strengthen STEM education and enhance general computational thinking literacy.

ME6 **Niroj Dahal**, Nepal Open University, Patan, Nepal Title: **STEAM Education: An Eye Opening for 21st Century Education**

Email: niroj@nou.edu.np

Coauthors: Bal Chandra Luitel, Binod Prasad Pant

Abstract: National curriculum of Nepal prepared by CDC has faced several reasonable criticisms for not reviewing it as per the requirement, not being able to maintain the contextual and practical aspirations and topographies. In this paper, I explored my voyage of working with in-service teachers in school-level as they have developed, refined, and implemented problem-based STEAM or STEAM challenges for investigations in their classrooms with a focus on mathematics. My work with teachers as researcher has yielded several problem-based STEAM or STEAM challenge investigations that accurately and meaningfully integrate content areas to solve real-world problems in mathematics by using participatory action research. My paper provides readers with concrete examples of teacher training sessions and their inputs that have successfully and meaningfully integrated innovative models and curricula designed to guide the process of developing transformative education and sustainable goals. I conclude, this research paper by embark on developing and implementing innovative and integrated pedagogy for STEAM education for promoting transformative teaching and learning for contributing new knowledge for change and sustainable education. I have explored some tips and helpful resources for readers wishing to engage in the implementation of high-quality STEAM Education required for the 21st century.

ME7 **Sagar Dahal**, The Celebration Co-Ed School and Kathmandu University, Nepal

Title: **Student-Teacher Ratio on Academic Achievement of Students in Mathematics in Private Schools: A Narrative Inquiry**

Email: sagardahalphy@gmail.com

Coauthor: Irina Aryal

Abstract: Student–teacher ratio or student–faculty ratio is the number of students who attend a school or university divided by the number of teachers in the institution. For example, a student–teacher ratio of 10:1 indicates that there are 10 students for every one teacher. The research problem of this paper examined the gap of policy provision practices in the context of Nepal with academic performances in mathematics and real classroom practices in Private schools in Mathematics classroom. In this paper, school head teachers were the participants. The research question was 'How do head teachers narrate their lived experiences of student and teacher ratio with teacher's perceptions and student's perceptions in the mathematics classroom for academic

performance?' The purpose of the paper was to provide information about the school student and teacher ratio inside the classroom of private schools in Kathmandu district with the present conditions and challenges faced by school leaders in the institutions regarding the ratio of student and teacher. The head teachers stories were collected which were in narrative form, thus qualitative approach with narrative inquiry as research paradigm was used in this paper. Vygotsky theory of learning was used for the narratives of head teachers. According to the UNESCO data for Nepal from 1970 to 2017, the average value for Nepal during that period was 34.24 students per teacher with a minimum of 19.21 students per teacher in 1972 and a maximum of 47.64 students per teacher in 1981.The higher the student-teacher ratio, the harder it is for students to learn and get attention of teachers. Rautahat has the highest student teacher ratio in Nepal followed by Sarlahi and Mahottari. The result and findings of this paper had also focus on less score in mathematics having higher ratio as the teacher could not provide time individually, less participatory of students for the interactions and group discussions. The conclusion of the paper was equal ratio of students and teacher in the classroom could yield best result and quality of an organization could be achieved in the educational institutes. Thus, on-going this paper, the findings also suggested that year of experience and qualification had some impact on academic performance of mathematics. Based on these findings recommendations were made for MOES (Ministry of Educations), donors and other education stakeholders could use for policy work and in the design of the School Sector Reform.

ME8 **Gaya Jayakody**, Faculty of Technology, University of Sri Jayewardenepura, Sri Lanka

Title: **"Swtiching" between Realizations in the Discourse of Continuous Functions**

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Abstract: The topic of continuous functions is identified as a challenging one for undergraduate students, in the mathematics education literature. Extending prior research on students' mental representations of continuous functions, this study focuses on how students communicate about continuous functions and the process of discourse along with its patterns and mechanisms. The study uses a commognitive approach to analyze certain aspects of students' discourse on continuous functions. In particular, I focus on two definitions for continuous functions (and for continuity at a point) from the literature, which in some cases lead to inconsistent conclusions with respect to continuity of a given function. I have identified a number of realizations of continuous functions (different ways in which students communicate about a continuous function) and this paper, specifically reports on two types of switchings between realizations that emerged in the study.

ME9 **Bishnu Khanal**, Tribhuvan University, Mahendra Ratna Campus, Kathmandu, Nepal

Title: **Classroom Practices for the Promotion of Students' Learning Strategies in Mathematics**

Email: bkhanal1974@gmail.com

Abstract: This paper highlights the classroom practices as learning strategy promotes activities in learning mathematics. The study was conducted through a purposive sampling procedure with 12 grade IX students and 2 mathematics teachers of two schools of Kathmandu district, Nepal. The author has employed interpretive qualitative method to observe classes and interview the key informants. The result shows that secondary school mathematics teachers in Nepalese schools used traditional teacher-centered approach for teaching mathematics without encouraging students to participate in the classroom activities. This mismatches between the classroom activities and students' nature resulted into the inattentive, poor performances in the tests, and discouragement in promoting effective learning strategies. Teachers need to use various teaching strategies and to help students in their learning difficulties, to develop their learning strategies, and to use these strategies effectively and efficiently.

ME10 **Basanta Raj Lamichhane**, Saptagandaki Multiple Campus, Chitwan, Nepal

Title: **Philosophical Underpinning of School Mathematics Curriculum of Nepal: A Critical Perspective**

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Abstract: This paper describes the major philosophical perspectives, orientations, and intentions that work as hidden forces, which have governed and shaped an overall framework of mathematics curriculum. Un/knowingly, most of the curriculum experts, mathematics educators, and researchers are not willing to discuss such forces because they held the views of mathematics as the pure science largely uncontaminated from the worldviews, anthropogenic attributes; emotions, feelings, attitudes, perceptions, and describe it as value-free, cultural-free and political-free discipline. In this regard, I reviewed school mathematics curriculum practices of Nepal since 1951 for uncovering such hidden forces through the critical lens. I explored that most of the curriculum documents focus on imparting the literal meaning or understanding, which produce isolated thinking; supports to emerge the materialistic ethos in practitioners. It largely ignores conceptual, relational and cultural understanding of mathematics knowledge and impedes the development of creative, imaginative and critical thinking in learners. Finally, I envisage the alternative vision of curriculum that helps to flourish the grounds of transformative mathematics education for the sustainable development of the nation by preparing conscious citizens, which can contribute a deep-democratic practice for the better future of the world. Keywords: Mathematics curriculum; Critical perspective; Transformative mathematics education; Relational and cultural understanding.

ME11 **Sarala Luitel**, Department of Mathematics Education, Kirtipur, Kathmandu

Title: **Rethinking Classroom Assessment: A Critical issue of higher Education**

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Abstract: Traditionally, classroom assessment was considered a mechanism for providing an index of learning on the basis of students' knowledge of the material, made judgments about students' achievement based on the testing, and then moved on to the next unit of work. More recently, however, this approach to assessment has been challenged and cognitive science has provided new insights into the nature of learning, and the traditional role of assessment in motivating student learning.

In this context, this study focused on critical analysis of situation of classroom assessment and dimensions of rethinking to make it more worthy and contextual. This research is based on interpretivist paradigm focusing on phenomenological study. Phenomena were analyzed on the basis of the class observations of mathematics education of master degree at Tribhuwan University, Kirtipur. Participant observation and informal dialogue were the main tools to generate the required information. Thematic approach was used to analyze the gathered data. It was found that the classroom assessment was focused on 'Assessment of learning rather assessment for learning'. Classroom assessment would be more worthy if teachers apply alternative ways of assessment for learning and assessment as learning rather than existing practice as assessment of learning is the main conclusion to strengthen worthiness. This study will be significant for all teachers, evaluators and policy makers working on the sector of assessment and evaluation.

ME12 **Kedar Nepal**, Mercer University, Georgia, USA

How Do Students in College Mathematics Courses Justify Their Self-assessment Behaviors?

Coauthors: Ram Chandra Kafle, Ramjee Sharma

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Abstract: Research shows that accurate self-assessment (calibration accuracy) is linked to better or efficient study habits (Horgan, 1990), and also to higher academic achievement (Butler & Winne,

1995). Using Moore and Healy's (2008) framework, we designed a study and collected data on students' self-assessment behavior from various college mathematics courses. We asked students to write their expected scores in quizzes and selected problems in exams after they completed them. We also asked to justify their expected scores. Audio-recorded interviews were conducted with a purposeful sample of students. The students were asked to explain their perceived reasons for their self-assessment behaviors. We found that top performers generally underestimated their performance; bottom performers overestimated, and those in-between were (almost) accurate predictors. Results showed that the calibration behavior of students is generally a function of their performance, which changes as they perform differently on different assignments. Using qualitative analysis, we were able to categorize student behavior into five categories: knowing about knowing (KK), not knowing about knowing (NKK), knowing about not knowing (KNK), knowing something is not known but not sure what (KBNKW), and not knowing about not knowing (NKNK). Results showed that students in the KK, KNK, and KBNKW categories are more accurate predictors of their performance than those in NKNK and NKK. And those in NKNK were the least accurately calibrated among all the categories.

ME13 **Binod Prasad Pant**, Kathmandu University School of Education, Nepal

Title: **Roles of "Arts" in STEAM Education**

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Coauthors: Bal Chandra Luitel

Abstract: STEM (Science, Technology, Engineering and Mathematics) disciplines have been conventionally considered as dry subjects for many years. The teaching and learning processes in these disciplines have been guided by the notion of memorization of facts, and understanding of the predetermined algorithmic steps. As a result, students seem demotivated in learning STEM related subjects. The number of students has been decreasing day-by-day in these disciplines around the globe. On the other side, the human resources produced from such conventional STEM disciplines turned to be job seekers rather than entrepreneurs with sufficient critical and creative sensibilities, with their roles and responsibilities to make significant contributions towards the society. In this context, the roles of Arts in STEM related disciplines could be one of the major departures for making creative, critical and ethical human resources for sustainable development of the community and beyond. This paper, a theoretical perspective of ongoing PhD research of the first author, argues the needs of STEAM (STEM + Arts) education that provides enough space for developing integrated curriculum and productive pedagogy with enough space for transversal skills in the school education. We argue the need of arts-based methods (painting, building models, storytelling, design thinking, etc.) in teaching and learning mathematics and science help teachers and students to be critical, creative and imaginative for solving real-world problems.

ME14 **Tara Paudel**, Tribhuvan University, Mahendra Ratna Campus, Tahachal, Kathmandu, Nepal

Title: **Identity Shaping of Female Mathematics Teachers at University Education**

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Abstract: This study elaborates the scenario of identity shaping of female mathematics teachers at university education. Female mathematics students are fewer in number as compared to their male counterparts at universities. In the context of Nepal, females have been struggling to shape their identities in the field of mathematics. In this scenario, this paper focuses on how they are struggling to shape their identities during their learning journey in university level. The applied theoretical framework is Vygotsky's Self in Cultural Historical Activity Theory which played a crucial role in this research about identity shaping. Narrative Inquiry was adopted as a research methodology to generate information from three participants about their mathematics learning experiences gained during their university education. The result revealed that during this phase every female student faced challenges and took steps towards their careers which turn out to be a milestone for their

identity construction. This research encourages, motivates, inspires and empowers every female mathematics students who wishes to shape their identities in mathematics field.

ME15 **Krishna P. Pokharel**, Young Harris College, Georgia, USA

Title: **Why Do Wrong Logics Look Right to Students?**

Email: kppokharel@yhc.edu

Coauthors: Kedar Nepal, Debendra Banjade, Manoj Lamichhane, Deepak Basyal

Abstract: Many students who take calculus sequence and other college mathematics courses often come underprepared (Rodgers, Blunt & Tribe, 2014; Poladian & Nicholas, 2013). Our experience shows that students frequently make and repeat errors pertaining to prerequisite concepts and skills, mostly precalculus. Such errors are common in nature among students across institutions. We conducted a study in an attempt to understand the thought processes of those students who make such errors. Based on our past observation of student errors, we carefully designed two true or false quizzes, each for precalculus and calculus I. We gave these quizzes to students in five universities: two private and three public. Instead of asking students to justify their choices, we asked them to explain why the answer was not true if their choice was false, and vice-versa. Based on student justifications, we classified their responses into three categories: right choice right reason (RR), right choice unsatisfactory reason (RU), and wrong choice wrong reason (WW). Preliminary results showed that 48.63% of justifications fell into the category RR, 12.78% into RU, and 38.59% into WW. In this presentation, we will discuss the problems that were selected for the quizzes and representative student justifications. We will also discuss how those justifications can offer insight into their thought processes.

ME16 **Milos Savic**, University of Oklahoma, USA

Title:**University Instructors' Pedagogical Changes as a Result of Focusing on Mathematical Creativity**

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Coauthor: Gail Tang, University of La Verne

Abstract: Research on mathematical creativity has focused on students primarily, whether it be using rubrics on students' creative products or processes (e.g., Leikin, 2009; Savic et al., 2017), the dynamic of fostering creativity in classrooms for students (e.g., Levenson, 2011; Cilli-Turner et al., accepted) or as a factor in shifting students' identities (e.g., Omar et al., 2018). However, little has been researched on what a focus on mathematical creativity can do to instructors' pedagogy and their shifts in teaching philosophy. Since instructors' teaching beliefs are a strong force in what happens in the class (Muijs & Reynolds, 2002), we focus on two calculus instructors who participated in a semester-long study concentrating on fostering mathematical creativity in their classroom. Through professional-development sessions, paragraph entries, and interviews, we attempt to chronicle the changes or shifts that both instructors conveyed as a result of focusing on mathematical creativity. In particular, there seemed to be minor shifts in choice of tasks on exams and belief in students to answer open-ended tasks that may be related to shifts in teaching. The results could provide insight for practitioners or professional development specialists who wish to make pedagogical changes in the mathematics classroom.

ME17 **Indra Mani Shrestha**, Kathmandu University School of Education, Kathmandu, Nepal

Title: **A Marriage Between Cognition and Affection: A Transformative Pedagogical Approach in Mathematics Education**

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Coauthor: Bal Chandra Luitel

Abstract: Being a transformative pedagogical practitioner, how can a marriage as dialectical relationship be established between cognition and affection through a transformative pedagogical approach on achieving the goal of meaningful learning of mathematics? Subscribing to this issue based on MPhil research done by the first author under the supervision of second author, we discuss about the dialectical role between cognition and affection, in which cognitive domain gives rise to linearity and affective domain gives rise to nonlinearity in teaching and learning of mathematics, so as to develop students' cognitive and affective domains for the purpose of engaging them in committed actions that contribute to meaningful learning. Therefore, this paper explores how we can establish a marriage as dialectical relationship between cognition and affection using both eastern and western wisdom traditions, which can be a powerful aspect of transformative pedagogy that gives rise to non/linearity in teaching and learning of mathematics, using writing as narrative inquiry within an arts-based auto/ethnography as research methodology.

ME18 **Mohan Thapa**, University of Wisconsin-Milwaukee, USA

Title:**Creative Reasoning Opportunities in Secondary School Mathematics Textbooks in Nepal**

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Coauthor: Deepak Basyal

Abstract: To investigate the extent of mathematical problems in mathematics textbooks for higher secondary schools in Nepal, we analyzed four textbooks currently in use. A mathematical task is a mathematical problem if creative reasoning is needed to solve it (Brehmer, Ryve & Steenbrugge, 2015). We used theoretical framework by Lithner (2006) to analyze creative and imitative mathematical reasoning. Our study shows that the textbooks rarely provide opportunities for students to be creative and mostly focus on procedural skills. Further examination of mathematical problems using the framework by Brehmer, Ryve & Steenbrugge (2015) was carried out to determine their placement (beginning, middle, end), difficulty level (easy, moderate, hard) and context (personal, occupational, mathematical). We observed that the majority of mathematical problems with a greater level of difficulty are given toward the end of the chapters and presented in purely mathematical context. Implications and recommendations will be discussed.

Numerical Analysis, Scientific Computation, and Optimization (NA)

NA1 **Iswar Mani Adhikari**, Tribhuvan University, Central Department of Mathematics, Nepal

Title: **Minimum Clearance Time with Earliest Arrival Pattern for Transit-based Evacuation**

Email: adhikariim35@gmail.com

Coauthor: Tanka Nath Dhamala

Abstract: Evacuation scheduling, traffic route guidance, destination optimization and the optimal route choice are some of the approaches to accelerate the evacuation process on transit-based evacuation system. Their effectiveness depends upon the evacuee arrival patterns at the pick-up locations and the assignment of the resources at the network. With an eagle eye view on the arrival patterns of the evacuees at different pick-ups, we concentrate on the earliest arrival flows including the networks permitting for the earliest arrival transshipments. This work focuses on the determination of the evacuees at the pick-up locations on zero transit times from a source, and their assignment to transit vehicles by treating such pick-ups be the sources for the subsequent process. We propose an integrated approach in the transit-based network to optimize the evacuation planning problems.

NA2 **Ram Sharan Adhikari**, Rogers State University, Oklahoma, USA

Title: **An Extended Euler-Maruyama Method For a Class of Stochastic Differential Equations and Numerical Stability Results**

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Abstract: In this work, we introduce a new class of weak numerical schemes (we call it Extended Euler-Maruyama scheme) for solving systems of Itô stochastic differential equations (SDEs). Weak order of convergence one is established under the suitable conditions. We also discuss about the numerical performance of our method with some examples. The proposed weak Extended Euler-Maruyama scheme has the potential to overcome some of the numerical instabilities that are often experienced when using explicit Euler method. A mean-square stability region of the proposed method is identified.

NA3 **Phanindra Prasad Bhandari**, Tribhuvan University, Nepal

Title: **Earliest Arrival Flows on UPL-TTSP Network with Non-Conservation Flow Constraint**

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Coauthor: Shree Ram Khadka

Abstract: The earliest arrival flow evacuation planning problem seeks a flow plan on the existing road network shifting as many people as possible from disastrous zone, the source, to the safe zone, the sink, as to the earliest within given time horizon. The limitation of the problem with the flow conservation constraint at the intermediate nodes is that no more evacuee can be sent out from the source if the evacuee cannot reach the sink even though there may be relatively safe places despite of the sink. In this paper, we consider the problem with non- conservation flow constraint at the intermediate nodes so that the evacuees can also be sent to relatively safe nodes in between the source and the sink during evacuation. We propose an efficient algorithm for the problem considered in a uniform path length two terminal series parallel (UPL-TTSP) network with prioritized intermediate nodes of sufficient capacities. Keywords: Evacuation Planning Problem, Earliest Arrival Flow, UPL-TTSP Network.

NA4 **Jose E Castillo**, Computational Science Research Center, San Diego State University, USA

Title: **Mimetic Finite Difference Methods**

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Abstract: Mimetic discretizations or compatible discretizations have been a recurrent search in the history of numerical methods for solving partial differential equations with variable degree of success. There are many researches currently active in this area pursuing different approaches to achieve this goal and many algorithms have been developed along these lines. Loosely speaking, "mimetic" or "compatible" algebraic methods have discrete structures that mimic vector calculus identities and theorems. Specific approaches to discretization have achieved this compatibility following different paths, and with diverse degree of generality in relation to the problems solved and the order of accuracy obtainable. Here, we present theoretical aspects a mimetic method based on the extended Gauss Divergence Theorem as well as examples using this methods to solve partial differential equations using the Mimetic Library Toolkit (MTK).

NA5 **Prem Bahadur Chand**, National Academy of Science and Technology, Dhangadhi, Nepal

Title: **Optimal Fourth Order Methods for Solving Non-linear Equations Having Multiple Roots and Their Dynamics**

Email: premchand13@gmail.com

Coauthor: Pankaj Jain, Kriti Sethi

Abstract: In this work, we present an optimal fourth order method for finding multiple roots of nonlinear equations with known multiplicity. The method is based on the third order method given by Weerakoon and Fernando for simple roots. The dynamics of these methods around multiple roots is studied using basin of attraction in complex plane. Some numerical results are presented to support the theoretical results

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NA6 **Ram Chandra Dhungana**, Tribhuvan University, Kathmandu, Nepal

Title: **Contraflow Problems with Fixed Switching Costs**

Email: dhungana.ramchandra@gmail.com

Coauthor: Tanka Nath Dhamala

Abstract: Natural and human-created disasters have drawn the attention of people to protect the life and their surroundings. In such situations, network flow improvement strategies play significant role to evacuate maximum number of evacuees within the limited time horizon. We should tolerate a number of costs to increase the capacities of edges. This is a bi-criteria optimization problem where the cost is constrained and the flow is maximized under that constraint. It is not an easy task to develop a universally accepted solution strategy for handling these issues by utilizing limited resources. The main goal of this research is to evacuate maximum number of evacuees in limited time by using minimum budget. Different flow improvement strategies: integral, rational and either all or not all types of capacities increment with fixed switching costs will be discussed. We also conjecture some results for contraflow model with fixed arcs switching costs that improve flow by using minimum budget.

NA7 **Suyog Garg**, IIITDM Kancheepuram, Chennai, India

Titel: **Evidence of Waldmeier Effect in Sun-like Stars**

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Abstract: One of the most intriguing features of the Solar Magnetic Cycle is that the stronger cycles rise faster than the weaker ones. This is known as the Waldmeier Effect (WE) which has been realized for about 50 years now. This fundamental feature of the Solar Cycle has many implications, for instance in the prediction of the upcoming cycle strength. However, Sun isn't the only star in the Universe which has a magnetic cycle. This paper presents the evidence of existence of the Waldmeier Effect in Sun-like stars. WE can manifest in two ways, a positive correlation between the rise rate of magnetic cycles and their peak magnetic strength (termed WE2) and a negative correlation between the rise time of the magnetic cycles and the corresponding peaks (WE1). This research focuses on WE2. We first started by selecting 13 stars from the Bohm-Vitense 2007 list, which showed good cycles, and then fitted appropriate curves to the data. The Ca II HK S-Index was used as a proxy for the magnetic field strength. The Pearson correlation coefficients between rise rate and peak are obtained as, 0.83 for Quasi-Planck fitting and 0.67 for Skewed-Gaussian fitting. The last ten cycles of the Sun were also analysed for comparison.

NA8 **Narendra Narayan Jha**, P. N. Campus, Pokhara, Nepal

Title: **Study and Analysis of Steady Flow between Two Parallel Plates and Laminar Flow Between two Parallel Walls**

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Abstract: In this paper the steady flow between two parallel plates and laminar flow between two parallel walls has been studied. This paper also includes how the Navier stoke's equation is compulsory for steady flow and oil flow between two parallel plates, one of which is at rest and other moves with certain velocity. The case study for plane Couette flow, plane Poiseuille flow and

generalized plane couette flow has been discussed with different plate condition when (i) Lower plate is stationary while the upper is moving with uniform velocity U, parallel to x-axis in case of couette flow. (ii) When both the walls are at rest in the case of plane poiseuille flow (iii) In generalized plane couette flow case $\frac{dp}{dx}$ = constant, the lower plate is at rest while the upper is in motion with velocity U.

NA9 **Jivandhar Jnawali**, Ratna Rajyalaxmi Campus, Kathmandu, Nepal

Title: **Iterative Methods for Solving Nonlinear Equations**

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Abstract: The main aim of this presentation is to introduce a new family of Newton type methods as a generalization of McDougall and and Wotherspoon method. This family of methods contains several methods having the same order of convergence as Newton's method, the Newton method, and McDougall and Wotherspoon method. Also, we propose a hybrid method for solving nonlinear equations with faster convergence obtained by amalgamation of mid point Newton's method, and McDougall and Wotherspoon method. Finally, we give some numerical examples to demonstrate the performance of newly introduced methods.

NA10 **Jeevan Kafle**, Kathmandu University, Dhulikhel, Nepal

Title: **Numerical Investigation of the Interaction between Two-Phase Landslide and Submarine Obstacle, and Induced Tsunami**

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Coauthor: Bhadra Man Tuladhar

Abstract: Tsunamis generated by landslides may be classified as subaerial, partially submerged or submarine landslide generated tsunamis depending on the initial position of the landslide relative to the water depth. Also, these water bodies may contain or can be installed with different solid objects (obstacles), which substantially alter the mass flow dynamics and reduce the devastating effects of submarine landslide and tsunami. Existing approaches cannot take into account other important aspects of interfacial momentum transfer in mixture flows such as interfacial drag, buoyancy, mobility of the fluid at the particle surface, and virtual mass force, that play important role in more accurate prediction of mixture flow dynamics by dynamic interactions between the landslide mass and the water. So as to include these important physics of two-phase mass flows and especially to include dynamic interactions between the landslide mass and the water, we apply a general two-phase mass flow model (Pudasaini, 2012) and non-oscillatory schemes to present three-dimensional, high-resolution novel simulation results for a two-phase landslide impacting a fluid reservoir containing obstacles of different sizes, dimensions and numbers, installed at different positions in bathymetric surface. The effects of the obstacles in the water body, and the resulting intensity of tsunami and its propagation have been analyzed in detail. As the tsunami enters the shallow regions, the propagation speed decreases and the amplitude grows drastically. Placing obstacles in the flow path controls the flow dynamics by reducing the destructive wave impact, run up and the resulting damages. The increased height of the obstacle reduces the overtopping but the holding of mass and/or the deflection of mass increases. Changing the position of obstacles brings a substantial change in the flow dynamics, mainly in holding of mass, its deflection, re-direction and the resulting tsunami intensity and run ups. The increased number of obstacles magnifies this effect and the moving mass decreases both in amount and speed. These simulation results may help us to appropriately choose the size, position and number of obstacles in different bathymetric surface to mitigate the mountain and coastal hazards and the integrity of hydroelectric power plant due to landslide and tsunami impacts.

NA11 **Parameshwari Kattel**, Kathmandu University, Dhulikhel, Nepal

Title: **Some Aspects of Flow-Obstacle-Interactions**

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Coauthors: Khim Khattri, Bhadra Man Tuladhar

Abstract: Viscous fluid and solid constituents in different geophysical mass flows possess different mechanics and rheologies. We use two-phase mass flow model (Pudasaini, 2012) and present numerical experiments to study different aspects of flow-obstacle-interactions, such as flow obstruction, redirection and phase separation.

NA12 **Shree Ram Khadka**, Central Department of Mathematics, Kirtipur, Kathmandu, Nepal

Title: **Evacuation Over a Network with Non-Conservation Vertices**

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Coauthors: Phanindra Prasad Bhandari and Stefan Ruzika

Abstract: There are several efficient algorithms for the maximum flow evacuation planning problem, which asks for a flow which sends a maximum number of evacuees (flow units) along from the disastrous zone, the source, to the safe zone, the sink, over a given time horizon. The limitation of the problem with the flow conservation constraint at the intermediate vertices is that no more evacuee can be sent out from the source if the evacuee cannot reach the sink even though there may be relatively safe places despite of the sink. In this presentation, we consider the problem over a network that consists of vertices into which one may send evacuees in an priority order despite of the sink. We propose polynomial algorithm over a network with no transit time and a pseudo polynomial algorithm over a network with transit time. Moreover, we present a counter example which assures that temporally repeated flow is not possible over a general network.

NA13 **Tanmay Kundu**, PDPM Indian Institute of Information Technology, Jabalpur, India

Title:**Airline Crew Scheduling: An Optimization Approach**

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Abstract: Airline crew scheduling is one of the most sophisticated problems encountered when dealing with airline operations. Crew scheduling problem is the problem of assigning crew members to the flights so that the total cost is minimized while regulating and legal restrictions are satisfied. Now a days the airline industries seek more growth and are increasing their fleet sizes to obtain greater market shares. As a result the complexity and size of the airline crew scheduling problem, which is one of the major planning problem in the industry, is also increased. Several mathematical models and algorithms are used to solve these problems. This paper presents a survey of different approaches studied by a number of researchers in the past few years to optimize the allocation of crew to flights for reducing costs and their proposed solutions from the literature. Hence, perspective studies will be proposed and discussed with the aim of developing better solutions for crew scheduling problems in future.

NA14 **Xiaoyan Liu**, University of La Verne, California, USA

Title: **A Weighted Rational Interpolation Spline Surfaces and Local Constraint Control**

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Coauthors: Liu Zhi , Xiao Kai , Chen Xiaoyan , Jiang Ping , Xie Jin

Abstract: This paper presents new weighted rational spline interpolation surfaces based on the values and partial derivatives of functions being interpolated, and discusses some properties of

them. The local constraint control of surfaces is parsed. Method: On the one hand, rational cubic interpolation spline is constructed on the x-direction, and then a bivariate rational interpolation spline surface is constructed from the y-direction. On the other hand, another bivariate rational interpolation spline surface is obtained in the reverse order. Finally, a new weighted rational interpolation spline surface is generated by weighting two different interpolation surfaces. Result: This paper discusses some properties of the interpolating function, such as the bases of the interpolation, the bounded property, the properties of integral weighted coefficients, and the error between the interpolating function and the function being interpolated. By selecting suitable parameters and weight coefficient, the local constraint control in the interpolating region can be obtained without changing the interpolating data. Conclusion: Experimental results illustrate that the new weighted rational interpolation spline surfaces possesses good constraint control properties.

NA15 **Manish Kumar Mishra**, Indian Institute of Technology (Indian School of Mines), Dhanbad, India

Title: **Algorithms of Minimal Number of Sensors Placement for Leak Detection in Pipe Network Using PSA**

Email: manish0546@gmail.com

Coauthor: Dr Kailash Jha

Abstract: In the proposed work algorithms have been developed to minimise the placement of number of sensors to detect leaks in the looped pipe network using pressure sensitivity analysis (PSA). The algorithm of sensor placement uses the pressure sensitivity matrix which is the differences between the pressures calculated without leak and with leak at nodes by EPANET simulation. Leakages are simulated as a constant demand that is assumed at junction. Binarised matrix is obtained by normalized pressure sensitivity matrix using threshold. The algorithm starts with the assumption that every node has a sensor. The minimum number of sensor is obtained using binarised matrix in such a way that every leak present in the network should be detected and isolated. The implementation of present algorithms shows the placement of sensors are minimised up to 15-20 % of total number sensor placed at nodes. The problem identifies the best location of minimum number sensors in the pipe network.

NA16 **Ananda Prasad Panta**, Nepal Sanskrit University, Nepal

Title: **Optimization and Sensitivity Analysis of Multi-Server Finite Capacity Queueing System**

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Abstract: This paper deals with optimization of multi-server queueing system with the provision of working breakdowns and multiple vacations of servers. Customers arrive in the system in Poisson process and are served exponentially in the basis of first-come-first-served (FCFS) service discipline. Sensitivity analysis of time spent in waiting in queue and sojourn time of the system has also been made. The optimal number of servers for various parameters has been obtained.

NA17 **Ganesh Sapkota**, Kathmandu University, Nepal

Title: **Transient solution of an M/M/c vacation queuing model with a waiting server and impatient customers**

Email: sapkotaganesh05@gmail.com

Coauthor: Ram Prasad Ghimire

Abstract: In this study, we consider an M/M/c queueing model subject to multiple exponential vacations wherein arrivals follow a Poisson fashion and the 'c' servers provide service according to an

exponential distribution. Service has been provided with multiple vacations and there are impatient customers with fixed rate ξ waiting in queue which is exponentially distributed. Objective of this paper is to find probability distribution function explicitly and formulae for number of customers waiting in queue, mean number of customers in the system, waiting time in queue and the time spent in the system using matrix geometric method. Some of the numerical illustrations from the application point of view are also presented.

NA18 **Manoj Thapa**, Georgia Southwestern State University, Georgia, USA

Title: **A Computational Study of the Origin of Turbulence at Lage-Stage of Transitional Flow**

Email: manoj.thapa@gsw.edu

Coauthor: Chaoqun Liu

Abstract: The transition process from laminar to turbulent flow in boundary layers is a basic scientific problem in modern fluid mechanics and has been the subject of study for over a century due to its great importance in various engineering applications. Our current understanding is far from complete. Direct Numerical Simulation (DNS) are widely used to study the turbulence due that fact that turbulence is characterized by extremely wide range of length scales. In this talk, we will highlight some of our numerical simulation results on the origin turbulence in late flow transition.

NA19 **Kedar Nath Uprety**, Tribhuvan University, Nepal

Title: **Unsteady Solution of the Flow in Heated Tube Networks**

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Abstract: Natural circulation steam generator consisting of a network of heated pipes is considered and the unsteady state behavior of the flow is studied. The model is focused on a geometry consisting of three pipes connecting a drum at the top and a collector at the bottom. The flow in the pipes is modeled by the one dimensional Euler equations with source terms describing the impact of heating, gravity, and friction. The equations describing the drum and the collector provide necessary boundary conditions for the pipe flow. The equation of state is represented by a surface in pressure, density, and temperature space depending upon the complex properties of water. This model is analyzed with three phases: the liquid, the wet steam and the steam phase.

NA20 **Bharat Raj Wagle**, Pokhara University School of Business, Pokhara, Nepal

Title: **Identification of Bottleneck Problems in a Hospital with the Help of Queueing Simulations**

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Abstract: Bottleneck problem in queueing theory is more important for queueing networks system modeling which helps us to identify the notions of interactivity of the systems which helps us to enhance the performance of the systems. Our model can model a finite number of patient can join in the queue in different nodes and performance of the server in these nodes in perticular time. The approach suggested is through Monte-Carlo simulation models supported by suitable technology. Under the research work I claim to address research problems like as to study queueing system of hospital where finite number of patient joined in the systems, service of the server and try to find some performance measure such as system through put time spent in the system, server utilization, queue length, average service time, to investigate the mathematical models for queueing network in different framework. In this paper, we will discuss the role that simulation can play in a hospital to create real world learning experiences for stakeholders. All these results will have been confined to the evaluation and analysis of the performance measures investigation.

Posters

Numerical Solution of a Parabolic Partial Differential Equation (Heat Equation) by Finite Difference Method

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Abstract: Many physical problems in the real world such as heat equation, wave equation, Poisson equation and Laplace equation are modeled by partial differential equations (PDEs). A PDE of the form $u_t = \alpha u_{xx}; \quad \alpha > 0$, where u is a function of two independent variables, x and t, is called one dimensional heat equation. Heat equation, an example of a parabolic PDE have exact solution in regular shape domain. But, in general, if the domain has irregular shape, computing exact solution is difficult. Due to this, we use appropriate numerical methods to compute the solution of the modeled PDEs. Among these, Finite Difference Method (FDM) computes the solutions of PDEs by discretizing the domain into finite number of regions. The solutions are computed at the grid points of the domain. Here, we first derive $1D$ heat equation and find the exact solution using separation of variable method. Then, numerical solution of $1D$ heat equation by using Forward Time Central Space Scheme (FTCSS) obtained with the given conditions and study the behavior of the solution for different values of t. We also check consistency and stability of FTCSS. We also compare exact and numerical solutions which perfectly match. We also discuss the application of Heat Equation.

Visualization, Formulation and Intuitive Explanation of Numerical Methods for solving Ordinary Differential Equations

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Abstract: Connecting mathematics with 'real life' is often challenging. Many physical problems in the real world are basically modelled by ordinary differential equations (ODEs). So here, we take a real life situation and translate it into an ODE with an initial value. As real life problems are usually non-linear, numerical methods are generally needed to approximate their solution. We will frame the necessary numerical methods like, explicit (forward) and implicit (backward) Euler method, classical second-order Runga-Kutta method (Heun's method or Improved Euler method), which are popular iteration methods for approximating solutions of ODEs. Moreover, an intuitive explanation of these methods will also be presented by comparing them, and also with the exact solutions with necessary visualizations. Finally, we analyze the error and accuracy of these methods with the help of suitable computer algebra system.

Comparison of Numerical and Exact Solutions of Laplace Equation

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Abstract: Partial differential equations (PDEs) find their applications not only in natural science and engineering, but also in many social sciences. Among the classes of PDEs, Laplace equation is elliptic and can be used to model a wide range of phenomena including steady state ground water flow and temperature distribution over a region. We employ finite difference method (FDM) that converts a linear (or non-linear) PDEs into a system of linear (or non-linear) equations, to solve Laplace equation. We also compare numerical solution of Laplace equation with exact solution. We also discuss its application.

Integration of ICT for Meaningful Mathematics Learning

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Abstract: n recent days, mathematics is considered as a difficult subject in school level. We have observed that the students don't like mathematics. There could be various reasons behind this situation. One of which is traditional lecture-based method used by school teachers. This is an era of science and technology. The growth of technology has made a remarkable influence in the field of education in general and teaching and learning mathematics in particular. The purpose of this paper is to explore the models of integrating ICT in teaching and learning mathematics for meaningful and conceptual understanding. ICT is beneficial for teachers to permute various pedagogical skills, communication and problem solving skills. It helps to visualize the mathematical concepts by creating a rich environment for discussion. The conceptual clarity of mathematical concepts becomes richer when the integration of ICT as tools and process is made as an inseparable part of pedagogical process. In the content of Nepal, government of Nepal has also put emphasis on the integration of ICT as a pedagogical approach. So, the finding of this paper helps the school level mathematics teachers and students regarding the integration of ICT in teaching and learning Mathematics.

A Predator-Prey Model

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Abstract: Malthus population growth model, also called exponential growth model, was developed as the time-dependent population growth of single species. The single species models are of relevance to laboratory studies in particular. But in the real world,the model can reflect telescoping of effects which influence the population dynamics. The approach due to Malthus in 1798, is fairly unrealistic for a long run of course. The exponential growth model, presented by Malthus, is adjusted by Verhulst (1838, 1845) and proposed that a self limiting process should operate when a population becomes too large. He introduced the concept of carrying capacity of the environment, which is usually determined by the available sustaining resources. In this article, we consider a system involving two-species system and describe the model presented by Lotka and Volterra, called Predator-Prey Model or Lotka-Volterra systems. In more modern theories, there will be multiple species each with their own interactions but we will limit ourselves this to simpler but highly instructive classical system. We shall cover various standard tools for analyzing such systems. We shall discuss dynamic solutions, equilibrium solutions and phase curves that best illustrate the phenomena. Also we shall raise the nation stability and reachability of the equilibrium solutions.

Dynamic Analysis of Prey-Predator Model with Harvesting

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Abstract: A mathematical model of a Prey-Predator model was developed by Alfred Lotka (1880-1949), and Vito Volterra (1860-1940) in the 1920's, and is characterized by fluctuation in the population size of both prey and predator, with the peak of the prey' s fluctuation dragging slightly behind the peak of the predator's fluctuation. The model makes several simplifying assumptions: (i) the prey population will grow at natural way when the predator is absent; (ii) the predator population will die in the absence of the prey population; (iii) predator can consume infinite quantities of prey; and (iv) there is no environmental complexity. In this paper, we present a system of ordinary differential equations of prey- predator model which describe the dynamics of two species in a simple ecosystem. We present the qualitative analysis of the model. We further analyze the non-linear system of ordinary differential equation by solving numerically.

Survival Analysis of Young Leukemia Patients

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Abstract: With cancer as a leading cause of death in the United States, the study of its related data is imperative due to the potential patient benefits. We examine the Surveillance, Epidemiology, and End Results program (SEER) research data of reported cancer diagnoses from 1973-2014 for the incidence of leukemia in young (0-19 years) patients in the United States. The aim is to identify variables, such as prior cancers and treatment, with a unique impact on survival time and five-year survival probabilities using visualizations and different machine learning techniques. This goal culminated in building multiple models to predict the patient's hazard probability. The two most insightful models constructed were both neural networks. One network used discrete survival time as a covariate to predict one conditional hazard per patient. The prediction rate is nearly 95% for testing datasets. The other network built hazards for discrete time intervals without survival time as a covariate and predicted with lower accuracy, but captured variable effects from initial testing better.

Mitigating Rabies Epidemics in Nepal: Modeling and Optimal Control Theory Perspective

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Abstract: Despite significant progress in the development of control strategies such as vaccines, rabies still remains a huge issue in Nepal, partly because of limited resources available to implement existing strategies. In this poster, we present a novel mathematical model that can describe a unique feature of rabies transmission in Nepal, where indirect interspecies transmission from jackals to humans through dogs also plays an important role on the persistence of rabies. Using our model, we formulate an optimal control problem, which is subsequently solved using control theory. Through the optimal control approach developed here we identify ideal control strategies for mitigating rabies epidemics in Nepal.

Thank You

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Paper submitted will be peer-reviewed and published in the following journal as a special issue for conference articles.

Theme of the special issue: **Mathematical Biology and Applied Evolutionary Equations**
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AMNS-2019 conference partially supported by

Nepal Tourism Board