

# **ALL Detailed Program of Accepted Contributed Talks**

- [00002] Propagation of Lamb wave in the plate of microstretch thermoelastic diffusion materials
- [00003] Reflection of plane waves in a rotating transversely isotropic thermoelastic diffusion solid half-space from impedance boundary in a fractional-order thermo-elasticity
- [00008] Semi Analytic Solution for Coupled (n+1)-dimensional Viscous Burgers' Equation using Homotopy Perturbation Method
- [00009] Numerical Solution of Kuramoto–Sivashinsky Equation Using Orthogonal Collocation with Bessel Polynomials as Basis
- [00010] Convergence Analysis of Fourth Order Extended Fisher Kolmogorov Equation Using Quintic Hermite Splines
- [00013] Singularly perturbed problems on a graph
- [00014] Pathway Fractional Integral Operator with Composition of Generalized function  $G_{(\rho,\eta,r)}[a, z]$
- [00016] Existence and Attractivity Results for Volterra Type Nonlinear Perturbed Random Integral Equations
- [00017] Modified Operational Laws for Neutrosophic Numbers in Decision-Making Problems
- [00018] Structures and evolution of bifurcation diagrams for a one-dimensional diffusive generalized logistic problem with constant yield harvesting
- [00020] Image Functions Approximated by CNN
- [00021] Study of sonic-supersonic patch arising in axisymmetric relativistic transonic flow
- [00025] Riemann problem and limiting behaviour of a macroscopic production model
- [00026] STRESS ANALYSIS OF AN EDGE CRACK UNDER TIME-HARMONIC WAVE DISTURBANCE
- [00028] Riemann problem for the Chaplygin gas equations for several classes of non-constant initial data
- [00031] Stoneley wave in the transversely isotropic thermoelastic diffusion materials
- [00032] A geometrically preservative semi-adaptive method for the numerical solution of Kawarada equations
- [00034] Relative heat flux in nonlocal reaction-diffusion equations and thermoelectric efficiency
- [00035] Effects of toxicity and zooplankton selectivity under seasonal pattern of viruses on plankton dynamics
- [00043] Matter-chameleon coupling in reconstructed Brans-Dicke cosmology
- [00045] Nonzero-sum stochastic impulse games with an application in energy markets
- [00050] Generalized Game Theoretical Model with Multiple Types of Homogeneous Players
- [00053] How predators choose their prey to maximize their utility functions by using switching prey
- [00058] Thermocapillary dynamics of viscous droplet driven by internal thermal singularity
- [00070] SDDS-SABC based Algorithm for solving non-linear optimization problems
- [00073] Scattering behavior for one dimensional wave maps into Riemannian manifolds
- [00074] Chaos in multidimensional disordered nonlinear lattices
- [00078] A higher order numerical scheme to a nonlinear McKendrick-Von Foerster equation with singular mortality
- [00079] Multi-dimensional Optimal Systems for Chaplygin Gas Cargo-LeRoux model
- [00091] An infeasible interior-point arc-search algorithm for nonlinear constrained optimization
- [00092] The explicit formulae for the distributions of words
- [00095] Low Reynolds number hydrodynamics of a slip-stick sphere
- [00096] Multi-scale analysis of concentration distribution inside porous medium channel configuration
- [00098] Robust bring your own encryption algorithm using generalized heat equation associated with generalized Vigenère-type table over symmetric group
- [00100] Pointwise Controllability of Degenerate/Singular PDEs
- [00103] Two-dimensional Riemann problem for a new hyperbolic model for thin film flow of a perfectly soluble anti-surfactant solution
- [00104] High order approximation of Caputo-Prabhakar derivative and its application in solving time fractional Advection-Diffusion equation
- [00111] A convergent numerical method for time-fractional reaction-diffusion equation
- [00112] Vibration control on unplanned change in vehicle mass model
- [00116] Multi-Scale Modelling of three phase lag (TPL) of lung cancer during cryosurgery
- [00122] Exact expansion of functions using partial derivatives: sensitivity analysis
- [00129] Anomalous diffusion in standard maps with extensive chaotic phase spaces
- [00130] THE DYNAMICS OF THE MONKEYPOX VIRUS IN THE PRESENCE OF ENVIRONMENTAL TRANSMISSION
- [00132] Incompatibility-governed deformations: a new approach to Elastoplasticity

- [00141] Multiscale Perturbed Gradient Descent: Chaotic Regularization and Heavy-Tailed Limits
- [00144] The flux perturbed Riemann solution for isentropic Cargo-LeRoux model
- [00156] Convergence of adaptive algorithms for parametric PDEs with lognormal coefficients
- [00159] Wave interactions in drift- flux equations of two-phase flows
- [00173] Symmetries and Explicit Solutions of Fractional Nonlinear Drinfeld–Sokolov–Satsuma–Hirota System
- [00175] pFemView: An Open-Source Visualization Library for p-FEM
- [00177] Bifurcations of Limit Cycles and Multistability in Polynomial Dynamical Systems
- [00180] Relationship between musical notes and socio-political events
- [00181] Control of the Stefan problem
- [00188] Two-Phase Modelling of Plaque Growth in Early Atherosclerosis
- [00191] Two-Phase Modelling of Subcutaneous Injection of Drugs
- [00197] Mathematical analysis of a nonlinear SIS model with effect of migration
- [00200] Montgomery identity and Ostrowski type inequalities via Katugampola integral operator
- [00204] Periodicity and Symmetry on a Class of Integral Equations with Weakly Singular Kernels
- [00205] 'Period doubling' induced by optimal control in a behavioral SIR epidemic model.
- [00206] Tensor product-type methods for solving Sylvester tensor equations
- [00208] Love wave along the interface with triangular irregularity
- [00212] Optimal control for a SIR epidemic model with limited quarantine
- [00213] Advances in Derivative-free Methods and the DFO VU-algorithm
- [00218] Characterizations of diffusion matrices in homogenization of nondivergence-form elliptic equations
- [00219] Approximation methods for solving pursuit-evasion differential game
- [00224] Multi-objective multi-route STP with carbon emission and risk mitigation in Pharmaceutical Supply Chain under Pythagorean fuzzy Environment
- [00225] Multidimensional WENO-AO Reconstructions Using A Simplified Smoothness Indicator
- [00229] Mathematical modeling of spatial distribution of COVID-19 epidemic
- [00238] Numerical Schemes for Generalized Isoperimetric Constraint Fractional Variational Problem
- [00240] Phantom cosmological model with observational constraints in symmetric teleparallel gravity
- [00241] Adaptive sparse interpolation in high dimensions and applications to surrogate modeling in chemical engineering.
- [00250] Formation of delta shock waves and vacuum states in the vanishing pressure limit of the Riemann solution to the isentropic Euler system for logarithmic equation of state with the Coulomb-like friction term
- [00252] Stabilization and adaptive event-triggered tracking control for non-linear systems
- [00261] Translational motion of a slightly deformed viscous spherical droplet in Stokes flow
- [00275] A fast data-driven method for designing compressible shock dominant flows
- [00281] Simulation of the mechanical behaviour of steel-concrete-steel structures including concrete voids
- [00291] Graph Convergence and Iterative Algorithm for a System of Generalized Nonlinear Variational-like Inclusions
- [00300] Coupling macro-micro simulations in complex fluids
- [00301] On some modifications in the conjugate gradient method and its application in unconstrained optimization problems
- [00302] Manifold-Free Riemannian Optimization
- [00310] Human Activity Recognition from Inertial Motion Data
- [00314] The Orthogonal Spline Collocation Method for Parabolic Problems with Interfaces
- [00320] Sensing the electrical world: modelling to understand aerial electroreception
- [00321] Modeling of hydromagnetic unsteady flow over a upright plate using Pseudospectral method
- [00326] Estimating the lowest-order eigenvalue in Sturm-Liouville boundary value problem
- [00327] COBIT As An Information Governance Framework
- [00328] Schrödinger map and Multifractality
- [00329] A-posteriori error estimates for parabolic optimal control problems with controls acting on lower dimensional manifolds
- [00331] Mathematical modelling of fluid-particle interaction
- [00334] A generalized study of the distribution of buffer over calcium on a fractional dimension
- [00335] Fractional Relaxation-Oscillation and Fractional Biological Population Equations: Applications of the Elzaki Decomposition Method

- [00337] Extending Matrix-less Methods for Eigenvalues and Eigenvectors
- [00339] Using Numerical Modeling two phase flow Method in evaporator design
- [00344] Forced convection from an isothermal square cylinder in shear flow
- [00348] Design of control for IT2 fuzzy stochastic systems with multi disturbances
- [00362] Nonlinear biphasic mixture model: existence and uniqueness results
- [00363] Neighborhood effects, college education, and social mobility
- [00365] Advancing Computerized Tomography: Deep-Learning based Regularization in Diffuse Optical Tomography
- [00374] Recent numerical and theoretical advances in the study of matrix sequences
- [00375] Modelling Typhoid Fever Transmission: Optimal control and Cost-Effectiveness Analysis
- [00376] Adaptive Optimal Market-Making Strategies with Inventory Liquidation Costs
- [00383] A kernel-based method for Schrödinger bridges
- [00388] Numerical solution of distributed order time-fractional diffusion equations.
- [00393] Mathematical Modelling of Bilayered Cathodes for Lithium-Ion Batteries
- [00394] Numerical methods for option pricing: need and challenges
- [00395] What can be the potential risk of Mpox outbreak in the endemic country?: Non-Markovian stochastic modeling study
- [00396] A Stochastic Approach for the Computation of Large-Scale Matrix Functions
- [00397] A continuum model for the bulldozing of an immersed granular material in a confined geometry
- [00398] Approximation of Abel type nonlinear fractional integral equations by the use of orthogonal polynomials
- [00403] Exact Penalization at Stationary Points of Sparse Constrained Problem
- [00408] Reducing Complexity of a Population Balance Model for Synthesis of Composite Polymer Particles
- [00414] Asymptotically Modelling Plastic Deformation during Cold Rolling of Sheet Metal
- [00415] Finite time horizon mixed control of vibrational systems
- [00423] Understanding elastic-plastic stress distributions during cold rolling of sheet metal
- [00424] A Hydrodynamic Model for Active Polar Liquid Crystals
- [00427] Numerical Analysis of Finite dimensional approximations in Finite Temperature DFT
- [00429] Mathematical Theory to Maximize Enzymatic Activity Under Thermodynamic Constraints
- [00430] Nearest singular pencil via Riemannian optimization
- [00433] Markov Decision Processes under Model Uncertainty
- [00434] Three pieces Riemann problem for 2-D full Euler system in the Noble-Abel gas
- [00438] Network stability in co-evolved spatially-explicit model ecological communities
- [00439] Successive Approximations for Fractional BVPs with Non-local Boundary Conditions
- [00440] SIMULATION OF SHALLOW WATER EQUATIONS WITH DEPTH PERTURBATIONS AND WITH AND WITHOUT THE CORIOLIS EFFECT
- [00442] On the dynamical properties of a max-plus model identified with the Lozi map
- [00446] Beyond Empirical Risk Minimization: Minimax Risk Classifiers
- [00451] Transmission problems for composite layered elastic structures containing interfacial cracks
- [00456] Network representations of attractors for surrogates generation and change detection
- [00457] On limit cycles of discrete dynamical systems with positivity
- [00459] Tropical linear regression and mean payoff games: or, how to measure the distance to equilibria
- [00460] A Multigrid Method for Many-Electron Schrodinger Equations with ACE
- [00461] hp/Spectral Element Methods for Elliptic Boundary Layer Problems
- [00463] A kinetic model of crowd evacuation dynamics coupled with infectious disease contagion
- [00464] Predicting the role of poroelastic coatings for cell therapies via an asymptotic approach
- [00469] A Mathematical and Exploratory Data Analysis of Malaria Disease Transmission Through Blood Transfusion
- [00470] Mathematical and Exploratory Data Analysis on Blood Transfusion Transmitted Malaria
- [00476] Hierarchical Sampling Techniques and Goal-Oriented Adaptive Finite Element for Elliptic PDE with Lognormal Coefficients
- [00477] Relaxation process of Cahn–Hilliard equations with dynamic boundary conditions
- [00480] Mathematics, the Mind and Alzheimer's disease: Systematical progression on brain graphs
- [00485] Adaptive event-trigger based disturbance rejection technique for nonlinear systems
- [00487] A strongly nonlinear anisotropic parabolic-elliptic system: analysis and numerical simulation
- [00489] Curvature related properties of Finsler manifolds and applications

- [00492] Asymptotic convergence of heterogeneous first-order aggregation models: from the sphere to the unitary group
- [00494] A two-grid discontinuous Galerkin method to nonlinear time-fractional diffusion equations
- [00495] Input-state finite time stabilization of singular Markov fuzzy system.
- [00501] Efficient numerical method for simulation of plasma
- [00502] The Helmholtz-Hodge decomposition of polynomial vector fields
- [00504] Solar Influence on Earth's Seismicity and Applications in Earthquake Forecasting
- [00508] Imposing Neumann or Robin boundary conditions through a penalization method
- [00511] Metapopulation network models explain non-Poissonian statistics of intercontact times
- [00512] Rigged Hilbert Space Formulation for Many-Body Quantum Theory
- [00513] The perfectly matched layer for elastic waves in layered media
- [00514] Diffusion approximation of a Markov-modulated infinite-server queue
- [00516] Parameters Estimation For Car Following Models Using Bayesian Inference
- [00518] Unsteady Stokes flow past a sphere with mixed slip-stick boundary conditions
- [00519] Non-Newtonian fluids with discontinuous-in-time stress tensor.
- [00520] Controllability of Generalized Fractional Dynamical Systems
- [0,T]\
- [00525] Global effect of COVID-19 disease dynamics on tertiary education system in developing countries
- [00527] A fast Multiplicative Update algorithm for non-negative matrix factorization
- [00531] Calibration of hardening parameters for the absence of hysteresis test-data
- [00532] Pullback Operator Methods in Dynamical Systems: Theory and Computation
- [00535] Reinforcement Learning with Variable Exploration
- [00540] Random product homotopies for decomposing tensors
- [00541] Reinforcement Learning-based Data Collection and Energy Replenishment in SDIoT
- [00542] Approximations of quasi-linear elliptic optimal control problems under variational and virtual discretizations
- [00544] Quantification of Entangled Bipartite Systems
- [00546] Recent advances on the conjugate discrete-time algebraic Riccati equation.
- [00547] Fictitious domain methods with finite elements and penalty over spread interface
- [00549] On the penalty approach in finite difference methods
- [00551] Network suppression of the pathogen spread within the healthcare system
- [00557] Three dimensional laminar flow in a dividing channel
- [00560] Semiparametric Kernel Estimation with Bayesian Bandwidths for Multivariate Nonnegative Data
- [00561] Quantum-parallel vectorized data encodings and computations on trapped-ions and transmons QPUs
- [00565] Resonance with a Delay Differential Equation
- [00566] Numerical study of Draw resonance in Fibre spinning using multi-mode constitutive model
- [00567] Topology-aware algorithm for constructing cartograms from density-equalising map projections
- [00568] PRIMAL HYBRID METHOD FOR QUASILINEAR PARABOLIC PROBLEMS
- [00572] Model uncertainty for statistical arbitrage
- [00576] Modeling the Dispersion of Effluents Discharged into Tidally Coastal Waters
- [00577] Mixed Finite Element Method for Dirichlet Boundary Optimal Control Problem
- [00578] Secret Sharing Scheme with Perfect Concealment by Quasigroup
- [00579] Explosion times and its bounds for a system of semilinear SPDEs
- [00583] The empirical measure of invariant fields on sphere-cross-time
- [00585] Computational and Optimization Frameworks for Tissue Vascularization in Bioprinted Grafts
- [00591] Convergence rate of RBSDE by penalisation and its financial applications
- [00599] Advances on estimation of temperature and moisture of soil using sensor networks.
- [00600] A Two Timescale Evolutionary Game Theoretic Approach to Multi-Agent Learning
- [00601] Assessment of Mathematics in Higher Education over the COVID19 pandemic.
- [00610] Input-output finite time stabilization for nonlinear networked control systems
- [00611] Deformations of linear elastic bodies computed using the RBF-PU method
- [00613] Phase-field systems coupled with large deformations
- [00614] Sparse spectral methods for fractional PDEs
- [00617] Low-regularity exponential-type integrators for the Zakharov system under rough data
- [00619] Optimal Transport for Positive and Unlabeled Learning
- [00620] Development of an ion channel model-framework
- [00628] Resource Dependent Competition and Extinction

- [00629] Stability Analysis of Split Equality and Split Feasibility Problems
- [00634] Bifurcation curves for semipositone problem with Minkowski-curvature operator
- [00637] Wave Scattering from Layers of Random Particulate Materials
- [00648] Bounds for effective conductivity of multimaterial composites
- [00651] Parallel Coordinate Descent Methods for Full Configuration Interaction
- [00655] Finite-time fault-tolerant robust control design for parabolic partial differential equations
- [00659] Understanding persisting onchocerciasis hotspots in Africa using mathematical models
- [00663] Quantum Monte Carlo algorithm for solving Black-Scholes PDEs for high-dimensional option pricing in finance and its proof of overcoming the curse of dimensionality
- [00664] A New Sampling Technique for Learning with Hypergraph Neural Networks
- [00665] Estimating pressure distribution on a surface via electrical sensing skin
- [00667] Effect of tumor-associated neutrophils on tumor growth : A mathematical model
- [00668] Solution of Non-linear Problems Through Variant of Newton's Method with Applications in Engineering
- [00671] A new drone swarm model for zone occupation
- [00676] Recent Advances in 2-Lagrange Multiplier Method for Multiscale PDEs
- [00677] Mathematical Epidemiology as a decision tool
- [00678] Monitoring distributed strains on solid surfaces by electrical impedance tomography
- [00680] Computing p-Harmonic Descent Directions for Shape Optimization
- [00681] A revised Hughes model for pedestrian flow
- [00682] Cover Temporal Networks with Densest Subgraphs
- [00683] Linearized Saint-Venant Equation with Lateral Inflow in a Finite Channel
- [00684] Aggregation of Anisotropic Inclusions on Elastic Membranes
- [00688] Recovering Battery Ageing Dynamics with Invertible Neuronal Networks
- [00691] GROWTH TUMOR, PROLIFERATION AND DIFFUSION IN CELL LINES OF OSTEOSARCOMA
- [00693] Enzyme: Fast and Effective Automatic Differentiation for Academia and Industry
- [00694] Large deviation theory-based adaptive importance sampling for rare events in high dimensions
- [00697] Vicsek-Kuramoto system in collective dynamics and their macroscopic equations
- [00698] Rigidity for Sobolev inequalities and radial PDEs on Cartan-Hadamard manifolds
- [00705] A boundary integral method for slow free surface flows
- [00709] Mathematical modeling reveals P2X1 purinoceptor antagonist as a male contraceptive
- [00713] Mathematical Modeling of Lymphatic Filariasis-Buruli ulcer co-infection
- [00716] Resource Efficient Boolean Function Solver on Quantum Computer
- [00722] Scalar auxiliary variable schemes for Cahn-Hilliard systems with mass source
- [00723] Density Maximum Effect on Natural Convection in a Porous Enclosure
- [00724] Applicability to information engineering using the Sato's hyperfunction
- [00725] Role of CXCL12 in regulation of T cell invasion
- [00728] Descriptions of distribution function and hyperfunction using discretization
- [00729] q-LAPLACE TRANSFORMS FOR THE PRODUCT OF BASIC ANALOGUE FOR H-FUNCTIONS FOR TWO VARIABLES AND THE GENERAL CLASS OF q-POLYNOMIALS
- [00738] Proper Orthogonal Decomposition methods for the Navier Stokes equations
- [00741] POINTWISE ADAPTIVE QUADRATIC DG FEM FOR OBSTACLE PROBLEM
- [00743] Recent Advances on POD methods for the Navier-Stokes equations.
- [00744] On the Burgers-type equations used in soft solid acoustics
- [00745] Fluid flow and nutrient transport in hollow fibre membrane bioreactors
- [00748] New probabilistic algorithms for scientific supercomputing
- [00750] Bayesian inverse problems for some hyperbolic conservation laws
- [00751] Crack Loading and Growth Analyses with the Virtual Element Method
- [00755] A variational approach for nonlinear elasticity
- [00756] Using photogrammetry for the objective morphological study of early violins
- [00757] Effect of electrostatic forces and moments on cracked electrostrictive dielectrics
- [00762] On the dissolution of particles subject to natural convection
- [00765] V-KEMS: Tackling industrial and COVID problems via virtual study groups
- [00767] Fractal and Fractional
- [00770] Rellich eigendecomposition of paraHermitian matrices, with applications
- [00771] New class of Nested Hierarchical matrices and its applications
- [00773] Machine Learning Model for Thin Metal Sheet Counting and Thickness Measurement

- [00776] Towards a modeling class for port-Hamiltonian systems with time-delay
- [00780] Mathematical Modelling of Bidirectional Transport System
- [00784] A Lagrangian-finite difference scheme for solving viscoelastic fluid flows
- [00788] Using multi-objective evolutionary algorithms when performing preventive maintenance actions
- [00790] Machine learning methods with error analysis for optimal control problems
- [00791] FunFact: Tensor Decomposition, Your Way
- [00798] Accelerating Low-Order Matrix-Free Finite Element Methods for Geophysics on GPU Architectures
- [00803] Epilepsy MEG network TERGM analysis
- [00805] A Topological Model of Textile Structures
- [00809] Mathematical Aspects of Metaheuristics in Medical Imaging and Pattern Recognition
- [00816] Ultraspherical spectral methods for time-dependent problems
- [00817] Understanding Flood Flow Physics via Data-Informed Learning
- [00818] BENCHMARKED ASSET MANAGEMENT WITH FIXED INCOME SECURITIES
- [00820] Chemotaxis system with signal-dependent motility and the singular limit problem
- [00821] ADAPTIVE QUADRATIC DISCONTINUOUS GALERKIN FINITE ELEMENT METHOD FOR THE UNILATERAL CONTACT PROBLEM
- [00823] Weighted Trace-Penalty Minimization for Full Configuration Interaction
- [00824] Asymptotics for Some Singular Limits
- [00826] Saffman-Taylor fingers selection mechanism in non-newtonian fluids
- [00828] Role of NK cells in regulation of lung cancer progression
- [00832] Monte Carlo estimation of equity measures for apportionment problem
- [00833] Exact controllability for imperfect interface problems
- [00834] Analytical Solution for Linearized Diffusive Wave with Concentrated Lateral Inflow
- [00835] A shifted LOPBiCG method for solving nonsymmetric shifted linear systems
- [00836] Reynolds-blended weights for BDDC in applications to Navier-Stokes equations
- [00842] Iterative projection methods for solving cone-constrained eigenvalue complementarity problems
- [00844] Evidence of Multiple Effective Wavenumbers in Isotropic Random Particulate Materials
- [00846] ESR fractional model with non-zero uniform average blood velocity
- [00847] Acute Lymphoblastic Leukemia diagnosis and treatment: a mathematical analysis
- [00848] Mathematical modelling of neuroblast migration in the mouse brain
- [00849] Well-suited upwind DG scheme for a phase-field tumor model
- [00852] Energy stable and positive DG scheme for Keller-Segel equations
- [00853] Numerical Approximation of Fractional Burgers Equation with Non-singular Time-Derivatives
- [00855] Mathematical modelling of edge wave on a functionally graded thermo-poro-elastic plate
- [00856] Successive image generation though cyclic transformations using CycleGAN
- [00857] An ecological study of mathematical model on intermittent phytoplankton distribution
- [00858] An adaptive spectral method for oscillatory second-order linear ODEs with frequency-independent cost
- [00859] A mathematical model of immunotherapy: CD19 relapses in B leukemia
- [00860] Probabilistic Domain Decomposition: Challenging Amdahl's curse on partial differential equations.
- [00861] Using elastic waves to measure mechanical stress
- [00864] Stabilization of time-periodic flows
- [00865] A novel hybrid microphysical-rheological multiscale constitutive model of ferroelectrics
- [00872] Stability Estimates in Bayesian D-Optimal Experimental Design
- [00875] Deep learning based reduced ensemble Kalman inversion for microscopic parameter estimation
- [00878] Large-amplitude problem of BGK model
- [00880] Disturbance rejection based modified repetitive control design for stabilization of Takagi-Sugeno fuzzy systems
- [00883] Convergence of the Eberlein diagonalization method
- [00884] Time-Frequency Analysis of Functional Datasets
- [00885] Hybrid nanofluid of Heimenz flow over electromagnetic surface: Enhancement in thermal energy
- [00889] Multiple-Relaxation Runge Kutta Methods for Conservative Dynamical Systems
- [00892] Predicting response to pediatric leukemia with flow cytometry data
- [00894] ODE models relating irrigation to kidney bean yield
- [00899] Unlocking the Secrets of Locking

- [00901] Effect of porous layer fitted on a floating bridge in mitigating waveload
- [00902] Influence of the statistical parameters of random particulate materials on wave propagation
- [00903] Port-Hamiltonian form and stochastic Galerkin method for ordinary differential equations
- [00904] Quadrature Methods and Error Estimates for Particles in Stokes Flow
- [00909] Lipschitz stability of an inverse problem for Tumor Growth Model
- [00912] Simulation-based Bayesian optimization over categorical covariates
- [00921] Inverse Coefficient Problem - Coupling Fourth and Second Order Equations
- [00922] Matrix Factorization for Change Detection in HyperSpectral Images
- [00927] Bone marrow stem cells and exosomes control doxorubicin-induced CRCC: A mathematical model
- [00929] On the continuum limit of epidemic models on graphs
- [00930] Analysis and numerical approximation of energy-variational solutions to the Ericksen--Leslie equations
- [00931] The vaginal microbiota and its association with Chlamydia infection
- [00934] Slab LU, a sparse direct solver for heterogeneous architectures
- [00937] Asymptotic and numerical approaches to degeneracies in Stefan problems
- [00939] Learning Dynamical Systems from Invariant Measures
- [00943] Similarity solutions for cylindrical shock wave in self-gravitating non-ideal gas with axial magnetic field: Isothermal flow
- [00944] Modelling of healthcare-acquired infection spread in regional healthcare systems
- [00947] Statistical analysis of neonatal mortality predictors in Ghana
- [00954] Dynamic Modeling and Optimization of Mixed Hydrogen-Natural Gas Flow in Pipeline Networks
- [00956] Inner Structure of Attractors for a Nonlocal Chafee-Infante Problem
- [00958] Existence results and numerical approximation for a quasilinear elliptic system
- [00962] Discontinuous Galerkin method for a high order nonlocal conservation law
- [00964] The Valuation of Real Options for Risky Barrier to Entry with Hybrid Stochastic and Local Volatility and Stochastic Investment Costs
- [00968] Modelling pathogen spreading in a network of hospitals
- [00971] Quantify the classicality of quantum states
- [00972] Reducing Communication in Federated Learning with Variance Reduction Methods
- [00973] Inverse source problem for a seventh-order Korteweg-de Vries equation
- [00976] A Multi-phase Model for Silicon Carbide Production
- [00978] Real-Time Krylov Theory for Quantum Computing Algorithms
- [00979] Optimal radio channel assignment to transmitters in a network by graph labeling approach
- [00983] Effective time step analysis of numerical schemes for gradient flows
- [00985] A Routing Protocol for Enhancing the QoS in Vehicular Ad hoc Networks
- [00986] Approximation results for Gradient Descent trained Shallow Neural Networks
- [00987] Role of applied mathematics on optimum MR damper location for LQG controlled framed structure
- [00991] Applied mathematics applications in ocean engineering
- [00993] The effect of extended coupling in transport system
- [00995] Convergence of a Normal Map-Based Prox-SGD Method for Stochastic Composite Optimization
- [00996] A Decentralized Approach for Dynamic Graph Clustering
- [00997] A Normal Map-Based Perspective on Second Order Theory for Composite Problems: Second Order Conditions, Metric Regularity, and Nonsingularity
- [00998] An Optimal Consumption-Portfolio Strategy and Housing Choice Problem with a Loan-to-Value Ratio
- [00999] High-order energy stable schemes for the phase-field model by the Convex Splitting Runge-Kutta methods
- [01001] Recent developments on low-discrepancy point sets for Markov chain quasi-Monte Carlo
- [01004] An Error Estimate for an Implicit-Upwind Finite Volume Scheme for Boussinesq Model
- [01005] Nonlinear Disturbance Observer-Based Control Design for Markovian Jump Systems
- [01006] VMS-based Stabilized FE Analysis of Time-dependent Coupled Unified Stokes-Brinkman-Transport Model
- [01007] Stability & Accuracy of Free-Parameter Multistep Methods for 1st & 2nd-order IVPs
- [01008] EID estimator-based Control Design for Singular Polynomial Fuzzy Systems
- [01009] A phase transition of various retention rules from multivariate analysis for big datasets.
- [01010] Superconvergent Scheme for a System of Green Fredholm Integral Equations



- [01012] Uncertainty and disturbance estimator design for interval type-2 fuzzy systems
- [01013] Satellite Data Assimilation through Community Land Model to improve Rice Crop Dynamics
- [01014] Fault detection asynchronous filter design for Markovian jump fuzzy systems under cyber attacks
- [01015] VMSFE Analysis of Transient MHD-NS Flow
- [01016] Approximate formula for indefinite convolutions by the DE-Sinc method
- [01018] VMS Stablized FEA of M-NS Equations For Nano Thermal Fluid
- [01019] Particle Swarm Optimization Based Reliable Control Algorithm for Wireless Networks
- [01021] A mixed finite element approach to a non-isothermal flow vegetation model
- [01025] EXISTENCE OF OPTIMAL CONTROL FOR TIME VARYING STOCHASTIC DIFFERENTIAL EQUATIONS
- [01027] A Discussion on Numerical Methods to Solve Structural Engineering Problems
- [01032] Memory event-triggered finite-time fault control for neural networks system
- [01033] Convective instabilities in vertical porous media
- [01034] Machine Learning for Two-stage Robust Optimization
- [01035] Reinforcement learning-based routing strategy in IoT applications using MDC
- [01038] Study of transitional stresses in rotating disc of materials with different Poisson Ratio under varying temperature
- [01039] A model of cerebrospinal fluid flow in the cranial subarachnoid space
- [01041] Dynamical Behaviours of a Stochastic Leptospirosis Model with Saturated Incidence Rate
- [01042] Preconditioners of Reduced Dimension for Vector Field Problems
- [01044] Nonlinear SPDE models of particle systems
- [01045] Advances on intimate partner femicide applying machine learning techniques and algorithms
- [01046] Flow past a mounted wedge: The three fold structure
- [01047] Large Deviations for Two-Dimensional Stochastic Tidal Dynamics Equations driven by Levy Noise
- [01048] Analysis of a Poisson–Nernst–Planck–Fermi model for ion transport in biological channels and nanopores
- [01051] Moderate Deviations for Shell Model of Turbulence
- [01052] Large systems of linear equations in particle transport problems
- [01053] Radial Basis for Solving high-dimensional PDEs in Option Pricing
- [01056] Statistical methodology for functional meta-analysis of sex-based disparities in neurological diseases
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- [0,1] *and a leader group with a negative target opinion in*  $[-1,0]$ . A leader group agent has a constant degree to its target and mixes it with the average opinion of its group neighbors at each update. A follower has a constant degree to the average opinion of the opinion neighbors of each leader group and mixes it with the average opinion of its group neighbors at each update. In this paper, we consider a variant of the LF model, namely the mixed model, in which the degrees can vary over time, the opinions can be high dimensional, and the number of leader groups can be more than two. We investigate circumstances under which all agents achieve a consensus. In particular, a few leaders can dominate the whole population.
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- [0, a], U) *control*, where  $U$  may be a separable Hilbert space or uniformly convex Banach space. Undoubtedly, exact controllability is much more beneficial than null controllability. But, null controllability plays its role in a system where exact controllability does not hold. Differential inclusion can properly define partial differential equations involving jump discontinuous functions.
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- [02549] Copula for Markov Chain Model with Binomial Time Series Data



- [02552] The inverse elastography problem
- [02554] Domain-invariant subcell-based blending limiter for Lax-Wendroff Flux Reconstruction
- [02555] A Mean Field Game Model for Renewable Investment under Uncertainty
- [02560] A Composite Adaptive Finite Point Method for 2D Burgers' Equation
- [02566] A spherically symmetric and steady flow describing the motion of a viscous gaseous star
- [02568] A pressure-stabilized projection Lagrange--Galerkin scheme for the transient Oseen problem
- [02572] LDA Hyper-parameters Regulation for Qualitative Studies in Management
- [02573] Local convergence analysis of modified King's family for multiple roots
- [02575] Propagation of Nonlinear Waves in Non-genuinely Nonlinear Characteristic Field
- [02580] Topological-sensitivity framework for detecting perfectly-conducting buried objects in layered media
- [02581] Well-Posedness and smoothness of geometric flows with nonlinear boundary conditions
- [02583] Novel shock-capturing procedure for discontinuous Galerkin method for compressible flows
- [02584] Malmquist Productivity Index under Fuzzy Environment
- [02585] Structured Dissipative mappings with their applications in Control Systems
- [02588] Synchronization in a model system of two bubbles
- [02589] Two scale convergence method in Orlicz setting and application
- [02590] Non-Local Robust Quaternion Matrix Completion for Large-Scale Color Images and Videos Inpainting
- [02592] Pricing American barrier options with transaction costs
- [02595] Image recovery under non-Gaussian noise
- [02603] AN  $H^1$  GALERKIN MIXED FINITE ELEMENT METHOD FOR ROSENAU EQUATION
- [02604] Particle dynamics in the KP approximation
- [02606] Modeling Indonesian Government Bond Yield Curve during Covid-19 Pandemic Time
- [02608] Explorative computing for stable and consistent kinetic relaxation in lattice Boltzmann methods
- [02609] Reliable and efficient a posteriori error estimates for time-dependent wave equations
- [02610] Discrete Tensor Product BGG Sequences: Splines and Finite Elements
- [02614] Convergence of a Second-Order Scheme for Nonlocal Traffic Flow Problems
- [02615] Theory of the cell motility mechanism in the absence of adhesions
- [02619] Interplay of two finite reservoirs in bidirectional system
- [02620] Power contraction of RAS with local impedance problems for the Helmholtz equation
- [02621] Effect of magnetic field on natural convection through infinite plates with ramped velocity
- [02625] Topology-Driven Shape Programmability in Tissue Morphogenesis
- [02626] Use of Origami Maths for minimizing packing & wrapping cost
- [02635] Application of mathematics in large-scale agriculture projects
- [02638] A note on contribution of finite difference methods for fractional diffusion equations
- [02639] ON HYPERSOFT TOPOLOGY
- [02640] High-Order Finite Element Schemes for Multicomponent Flow Problems
- [02641] Reconstructing electron backscatter diffraction data using vectorized total variation flow
- [02647] Poincaré operators for BGG complexes
- [02652] A multi-parametric approach for solid transportation problem under uncertainty conditions
- [02653] Random generation of Phylogenetic networks
- [02661] Practicing Responsible Computation and Innovation in HPC: A Sociotechnical Approach
- [02664] Numerical compression of QMC rules for integration
- [02665] Modelling metal biosorption on algae-bacteria granular biofilms
- [02666] Dynamics of biofouling in microfiltration systems
- [02667] Coupled Active Contour Segmentation of Clue Cells from Immunofluorescence Microscopy
- [02670] Glacier sliding as a viscous fluid flow modulated by cavitation
- [02673] Reduced-order Modelling of Normal Elastohydrodynamic Collision of Spheres
- [02674] General Equilibrium with Unhedgeable Fundamentals and Heterogeneous Agents
- [02680] An analysis of a model of fear in disease transmission
- [02683] When to Sell an Asset? – A Distribution Builder Approach
- [02686] Double Conical degeneracy on band structures of periodic Schrödinger operators
- [02687] Semi-Markov Compartment Models
- [02688] Analytical Solutions of Delay Differential Equations
- [02689] Double Dirac Cone in Subwavelength Bandstructure
- [02692] Discovering extremal domains via shape optimization for passive tracers

- [02695] The position of the axon initial segment assembly site can be predicted from the shape of the neuron
- [02701] Pricing Multi-Asset American Options in Dynamic Programming with Sparse Grids
- [02702] A mathematical model of cell expansion for cultivated meat production
- [02907] Robust Train Trajectory Optimization
- [02961] An analysis of boundary variations in Laplace-Steklov eigenvalue problems

## **[00002] Propagation of Lamb wave in the plate of microstretch thermoelastic diffusion materials**

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @E812

**Type** : Contributed Talk

**Abstract** : The present study investigates the effect of three thermoelastic theories on the propagation of Lamb wave in a linearly isotropic microstretch diffusion plate subject to stress free thermally insulated/impermeable and isothermal/isoconcentrated boundary conditions. The secular equations of the Lamb wave are obtained for both symmetric and anti-symmetric modes of vibration. The phase velocities and attenuation coefficients are computed numerically for a particular model and these results are compared for the three theories: Coupled Thermoelasticity theory, Lord-Shulman theory and Green-Lindsay theory. The velocity curves and the attenuation coefficients are illustrated graphically. It is observed that there are three modes of velocity and attenuation for each symmetric and anti-symmetric vibration. We have noticed that the velocity of the corresponding Lamb wave increases from first to third mode of symmetric vibration in both thermally insulated/impermeable and isothermal/isoconcentrated plates. At short wavelength, the secular equation of symmetric mode of vibration reduces to that of Rayleigh surface wave for both the plates. Some special cases are also deduced from the present formulation.

**Classification** : 74J15, 74B15, 80A17, 80A10

**Format** : Online Talk on Zoom

**Author(s)** : Sarat Singh Sanasam (Mizoram University)Sanjay Debnath (Mizoram University)

## **[00003] Reflection of plane waves in a rotating transversely isotropic thermoelastic diffusion solid half-space from impedance boundary in a fractional-order thermo-elasticity**

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @D102

**Type** : Contributed Talk

**Abstract** : The governing equations of a rotating transversely isotropic thermoelastic medium with diffusion in a fractional-order derivative thermo-elasticity are formulated. The velocity equation is obtained, which indicates the existence of four quasi plane waves. Reflection of these plane waves from a stress-free thermally insulated surface with impedance boundary is studied. The effects of anisotropy, rotation and impedance parameters on reflection coefficients are shown graphically.

**Classification** : 74-Mechanics of deformable solids

**Author(s)** : Dr. Anand Kumar Yadav (Shishu Niketan Sr. Sec School Sector 22D Chandigarh, India)

## **[00008] Semi Analytic Solution for Coupled (n+1)-dimensional Viscous Burgers' Equation using Homotopy Perturbation Method**

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @E506

**Type** : Contributed Talk

**Abstract** : Semi analytic solution for coupled (n+1)-dimensional non-linear viscous Burgers' equation has been obtained by Homotopy Perturbation Method. Potential of prescribed semi analytical technique is specifically examined for (3+1)-dimensional non-linear Burgers' equation with very small kinematic viscosity factor has not been considered yet. Numerical experiments with illustrated absolute error and 3D graphical presentation testify the reliability of the technique. All the computational

procedure has been done using MATLAB.

**Classification** : 65H20, 65N12, 65N15, 35C10

**Format** : Online Talk on Zoom

**Author(s)** : Shelly Arora (Punjabi University, Patiala)Atul Pasrija (Punjabi University, Patiala)Sukhjit Singh Dhaliwal (SLIET, Longowal)

## **[00009] Numerical Solution of Kuramoto–Sivashinsky Equation Using Orthogonal Collocation with Bessel Polynomials as Basis**

**Session Time & Room** : 2E (Aug.22, 17:40-19:20) @G402

**Type** : Contributed Talk

**Abstract** : Bessel polynomials has been proposed as a base function in orthogonal collocation to discretize fourth order Kuramoto-Sivashinsky equation. Convergence of numerical results have been analysed through  $L_2$  and  $L_\infty$  norms to discuss the effectiveness of technique. Number of test problems have been solved and comparison of results in space as well as in time direction at different number of collocation points has been presented. The numerical values are presented graphically to confirm applicability of technique.

**Classification** : 35E15, 35G20, 65M70, 33C10

**Format** : Online Talk on Zoom

**Author(s)** : Shelly Arora (Punjabi University, Patiala)Indu Bala (Punjabi University, Patiala)

## **[00010] Convergence Analysis of Fourth Order Extended Fisher Kolmogorov Equation Using Quintic Hermite Splines**

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @G502

**Type** : Contributed Talk

**Abstract** : An improvised collocation technique has been proposed to discretize multi-parameter fourth order non-linear extended Fisher Kolmogorov equation. The spatial direction has been discretized with quintic Hermite splines whereas temporal direction has been discretized with weighted finite difference scheme. The fourth order equation in space direction has been decomposed into second order using space splitting by introducing a new variable. The space splitting has been proposed to improvise the convergence of approximate solution. The proposed equation has been analyzed on uniform grid in both space and time directions. Error bounds for general order Hermite splines are established.  $\epsilon$ - uniform rate of convergence for the proposed scheme has also been discussed elaborately. The technique is illustrated by various numerical examples and error growth has been discussed by computing  $L_2$  and  $L_\infty$  norms.

**Classification** : 35K41, 35K55, 65M70, 65N35

**Format** : Online Talk on Zoom

**Author(s)** : Shelly Arora (Punjabi University, Patiala)Priyanka Bhardwaj (Punjabi University, Patiala)Saroj Kumar Sahani (South Asian University, New Delhi)

## **[00013] Singularly perturbed problems on a graph**

**Session Time & Room** : 3D (Aug.23, 15:30-17:10) @E606

**Type** : Contributed Talk

**Abstract** : In this talk, a singularly perturbed convection diffusion problems on a graph domain will be discussed. Initially, the problem is designed on a simple graph i.e k-star graph. On the common vertex, the continuity and the Kirchhoff's conditions will be discussed along with their complexity. The problem may be extended to a general graph with many vertices and edges. Some tests problems will be discussed based on upwind finite difference methods using piece-wise Shishkin meshes. Error estimates and the order of convergence are to be discussed.

**Classification** : 65Lxx, 65Mxx

**Format** : Online Talk on Zoom

**Author(s)** : Vivek Kumar Aggarwal (Delhi Technological University)

## [00014] Pathway Fractional Integral Operator with Composition of Generalized function $G_{(\rho,\eta,r)}[a, z]$

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @G305

**Type** : Contributed Talk

**Abstract** : The purpose of this paper is to consider the properties of generalized function  $G_{(\rho,\eta,r)}[a, z]$ . For this purpose we obtain certain image formulas using Pathway fractional integral operators with these properties. We also mentioned some important special cases of the main results.

**Classification** : 26A33, 33E12

**Format** : Talk at Waseda University

**Author(s)** : Harish Nagar (Chandigarh University) Seema Kabra (Sangam University)

## [00016] Existence and Attractivity Results for Volterra Type Nonlinear Perturbed Random Integral Equations

**Session Time & Room** : 1D (Aug.21, 15:30-17:10) @A208

**Type** : Contributed Talk

**Abstract** : In this talk, we prove an existence and locally attractivity result for Volterra type nonlinear perturbed random integral equations in separable Banach space under mixed generalised compactness, contraction and caratheodory conditions and also we will prove the existence of maximal and minimal solution Volterra type nonlinear random integral equations with some applications.

These types of Volterra type nonlinear perturbed random integral equations are used in various natural phenomena in which randomness occurs.

**Classification** : Existence of Solutions and their properties, Random Integral Equations, Applications in Abstract Spaces

**Format** : Online Talk on Zoom

**Author(s)** : SIDDHARTH GANESH SHETE (Swami Ramanand Teerth Marathwada University Nanded Maharashtra )

## [00017] Modified Operational Laws for Neutrosophic Numbers in Decision-Making Problems

**Session Time & Room** : 2C (Aug.22, 13:20-15:00) @G301

**Type** : Contributed Talk

**Abstract** : This presented work results from the study of the existing basic operational laws of neutrosophic numbers which had some shortcomings clearly stating that these are the special type of neutrosophic numbers and not applicable in every practical situation. To overcome this limitation the general basic operational laws of neutrosophic numbers are proposed in this paper and a numerical example from a real-life situation has been solved optimally to show the validity of the proposed neutrosophic numbers laws.

**Classification** : 03B52, 03B52, 15B15, 28E10

**Format** : Talk at Waseda University

**Author(s)** : Akanksha Singh (Chandigarh University)

## [00018] Structures and evolution of bifurcation diagrams for a one-dimensional diffusive generalized logistic problem with constant yield harvesting

**Session Time & Room** : 5B (Aug.25, 10:40-12:20) @G401

**Type** : Contributed Talk

**Abstract** : We study the diffusive generalized logistic problem with constant yield harvesting:

$$\begin{equation*}$$

$$\left\{ \right.$$

$$\begin{array}{ll}$$

$$u'^{\prime}(x)+\lambda g(u)-\mu =0, \text{ \& } -10. \text{ We prove that, for any fixed } \mu >0, \text{ on the } (\lambda, u) \text{-plane, the bifurcation diagram consists of a } \subset \text{-shaped}$$

$$\text{curve and then we study the structures and evolution of bifurcation diagrams for varying } \mu >0.$$

**Classification** : 34B18, 74G35

**Format** : Talk at Waseda University

**Author(s)** : Shin-Hwa Wang (National Tsing Hua University, TAIWAN) Kuo-Chih Hung (National Chin-Yi University of Technology, Taiwan) Yiu-Nam Suen (National Tsing Hua University, TAIWAN)

## [00020] Image Functions Approximated by CNN

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @E711

**Type** : Contributed Talk

**Abstract** : Convolutional Neural Networks (CNN) have been widely used to image understanding. However it remains an open problem to prove the approximation of image functions via CNN. In this work, it is proved that an image function can be approximated by CNN on the basis of the axiom of choice in set theory and an uncountable number of training data from the viewpoint of image decomposition.

**Classification** : Artificial neural networks and deep learning

**Format** : Talk at Waseda University

**Author(s)** : Jian-Zhou Zhang (Sichuan University)

## [00021] Study of sonic-supersonic patch arising in axisymmetric relativistic transonic flow

**Session Time & Room** : 3D (Aug.23, 15:30-17:10) @G601

**Type** : Contributed Talk

**Abstract** : In this work, we study a sonic-supersonic patch arising in 3-D axisymmetric relativistic transonic flows. The main difficulty here is the coupling of nonhomogeneous terms due to axisymmetry and the sonic degeneracy for the relativistic flow. However, using the characteristic decompositions of angle variables, we prove the existence and regularity of solutions in partial hodograph plane first and then by using an inverse transformation, we construct a smooth solution in the physical plane.

**Classification** : 35L65, 35M10, 35M33, 35Q75, 35A01

**Author(s)** : RAHUL BARTHWAL (Indian Institute of Technology Kharagpur) RAHUL BARTHWAL (Indian Institute of Technology Kharagpur) T Raja Sekhar (Indian Institute of Technology Kharagpur)

## [00025] Riemann problem and limiting behaviour of a macroscopic production model

**Session Time & Room** : 3D (Aug.23, 15:30-17:10) @G601

**Type** : Contributed Talk

**Abstract** : We are concerned with a macroscopic production model which is a hyperbolic system of conservation laws with the equation of state for a Van der Waals gas. Solution to the Riemann problem for the system for all types of initial data is constructed, which contains a vacuum state for certain initial data. Delta shock wave solution and vacuum state is observed in limiting cases.

**Classification** : 35L65, 35L67

**Format** : Talk at Waseda University

**Author(s)** : Balakrishna Chhatria (Indian Institute of Technology Kharagpur)

## [00026] STRESS ANALYSIS OF AN EDGE CRACK UNDER TIME-HARMONIC WAVE DISTURBANCE

**Session Time & Room** : 5C (Aug.25, 13:20-15:00) @E812

**Type** : Contributed Talk

**Abstract** : This article determines a stress intensity factor (SIF) at the tip of an edge crack in two considered models.

Problem-1 is an orthotropic strip of a finite thickness bonded by an orthotropic half-plane, and problem-2 is an orthotropic vertical semi-infinite strip. Edge cracks have been invaded perpendicularly by time-harmonic elastic waves. The system has been solved by using Fourier transform and Schmidt method to find the approximate analytical expression for the SIF. The variations of in plane normalized SIF for the different crack lengths and thickness were depicted graphically (2D) for different particular cases.

**Classification** : 74R99, 42A38, 74J15

**Format** : Online Talk on Zoom

**Author(s)** : Neha Trivedi (Indian Institute of Technology (BHU) Varanasi, India)Neha Trivedi (Indian Institute of Technology (BHU) Varanasi, India)

## [00028] Riemann problem for the Chaplygin gas equations for several classes of non-constant initial data

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @E506

**Type** : Contributed Talk

**Abstract** : Using the differential constraint method, a class of exact solutions is obtained for the homogeneous quasilinear hyperbolic system of partial differential equations describing Chaplygin gas equation; these solutions exhibit linearly degenerate that leads to the formation of contact discontinuities. In fact, in this paper, we solved the generalized Riemann problem through a characteristic shock(s). For several classes of non-constant and smooth initial data, the solution to the generalized Riemann problem is presented.

**Classification** : 35L67

**Format** : Talk at Waseda University

**Author(s)** : Akshay Kumar (University of Hyderabad)Radha R (University of Hyderabad)

## [00031] Stoneley wave in the transversely isotropic thermoelastic diffusion materials

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @E803

**Type** : Contributed Talk

**Abstract** : This paper investigate the secular equations of Stoneley wave propagating through bonded and unbonded interfaces between two dissimilar transversely isotropic thermoelastic diffusion half-spaces. These equations are solved numerically by modelling two distinct crustal rocks and the resultant phase velocities and attenuations are plotted graphically. This analysis explicates the position and permeability of fractures and also helps in the assessment of valuable materials under earth's crust. Some particular cases are also deduced from the present formulation.

**Classification** : Continuum Mechanics

**Format** : Talk at Waseda University

**Author(s)** : Sanjay Debnath (Mizoram University)

## [00032] A geometrically preservative semi-adaptive method for the numerical solution of Kawarada equations

**Session Time & Room** : 1E (Aug.21, 17:40-19:20) @E702

**Type** : Contributed Talk

**Abstract** : This presentation concerns the numerical stability and geometric preservations of the numerical

solution of Kawarada equation problems. The nonlinear partial differential equations exhibit strong quenching types of singularities that represent a number of key characteristics from industrial and multi-physical applications. A second order semi-adaptive implicit finite difference method will be constructed and investigated. We shall begin with a detailed mathematical analysis of the

stability without freezing singular source terms of Kawarada equations in this talk.

Preservation features of the solution vector sequences will then be

studied. Realistic orders of the convergence will be given via generalized Milne's devices. Finally, computer simulations will be carried out to demonstrate the effectiveness of the theoretical analysis and conclusions.

**Classification** : 65M06, 65M12, 65M50, 68U01, 65D18

**Format** : Talk at Waseda University

**Author(s)** : Qin Sheng (Baylor University)

## [00034] Relative heat flux in nonlocal reaction-diffusion equations and thermoelectric efficiency

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @G401

**Type** : Contributed Talk

**Abstract** : Thermoelectric generators directly convert a temperature difference into electrical energy. To study their efficiency, we consider second-order integro-differential equations describing the steady-state temperature distribution inside thermoelectric generators when the Seebeck coefficient of the thermoelectric material is temperature-independent but the electrical resistivity and thermal conductivity are temperature-dependent. In this talk, we show that the temperature solution is unique and the relative boundary Fourier heat flux can be explicitly written. Therefore, the efficiency has an explicit formula.

**Classification** : 34B15, 35A02, 35J25, 34B10, 35K59

**Format** : Talk at Waseda University

**Author(s)** : Jaywan Chung (Korea Electrotechnology Research Institute)Byungki Ryu (Korea Electrotechnology Research Institute)Hyowon Seo (Kunsan National University)

## [00035] Effects of toxicity and zooplankton selectivity under seasonal pattern of viruses on plankton dynamics

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @A601

**Type** : Contributed Talk

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

**Classification** : 92B05, 92D25, 92D30, 37A50, 34D05

**Format** : Online Talk on Zoom

**Author(s)** : Samares Pal (University of Kalyani)

## [00043] Matter-chameleon coupling in reconstructed Brans-Dicke cosmology

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @D407

**Type** : Contributed Talk

**Abstract** : In the present work, we studied the generalized Brans-Dicke (BD) model with a scalar field non-minimally coupled with the matter sector. We considered extended holographic Ricci dark energy  $\rho_{\Lambda}=3\phi(\alpha\dot{H}+\beta H^2)$  in this BD cosmology framework, derived restrictions for BD parameter  $\omega$ , and observed a stronger matter-chameleon coupling. The EoS parameter behaved like quintom. We observed an increasing potential function as matter-chameleon coupling gets stronger. Also, deceleration parameter transited from decelerated to the accelerated universe phase.

**Classification** : 83F05, 83C56

**Format** : Online Talk on Zoom

**Author(s)** : Surajit Chattopadhyay (Amity University, Kolkata)

## [00045] Nonzero-sum stochastic impulse games with an application in energy markets

**Session Time & Room** : 1C (Aug.21, 13:20-15:00) @

**Type** : Industrial Contributed Talk

**Abstract** : We study a nonzero-sum stochastic differential game with both players adopting impulse controls, on a finite time horizon.

The objective of each player is to maximize her total expected discounted profits. The resolution methodology relies

on the connection between Nash equilibrium and the corresponding system of quasi-variational inequalities (QVIs in short).

We prove, by means of the weak dynamic programming principle for the stochastic differential game, that the value function of each player is a constrained viscosity solution to the

associated QVIs system in the class of linear growth functions.



We also introduce a family of value functions converging to our value function of each player, and which is characterized as the unique constrained viscosity solutions of an approximation of our QVIs system. This convergence result is useful for numerical purpose. We apply a probabilistic numerical scheme which approximates the solution of the QVIs system to the case of the competition between two electricity retailers. We show how our model reproduces the qualitative behaviour of electricity retail competition.

**Classification** : 91B70, 93E20, 49L25, 49N70

**Author(s)** : Mohamed Mnif (ENIT, Tunisia)René Aid (University of Paris Dauphine)Lamia Ben Ajmia (ENIT, Tunisia)Mhamed Gaigi (ENIT, Tunisia)

## [00050] Generalized Game Theoretical Model with Multiple Types of Homogeneous Players

**Session Time & Room** : 3D (Aug.23, 15:30-17:10) @D514

**Type** : Industrial Contributed Talk

**Abstract** : We introduce a decision game model with finite number of types and each type has finite number of homogeneous players. We assume that each type of player has similar characteristics and will choose only between two alternative choices or decisions). The preference for each type of players is described by a discrete utility function which gathers the influence of players in the same group and the influence of players from the other groups. We will characterize all pure "united or separated" and mixed strategies that form Nash equilibria. The united strategies ensure that all players with same type will make same decision, while separated strategy includes at least one type of players who do not make same decision. We will determine the strategic thresholds for each type that identify the Nash regions in space. As a special case, we consider three types of homogeneous players and use geometry to construct three dimensional regions for Nash equilibria, where the horizontal axis reflects the preference for players of type one, the vertical axis reflects the preference for the players of type two, and the depth axis reflects the preferences for the players of type three, and we characterize all Nash equilibria regions. Finally, we apply our model in economics "tourist sector" by introducing a resort model for three types of tourists distributed among two resorts and determine the competitive Nash Equilibrium prices for given preference for the three types of tourists.

**Classification** : 91A06, 91A10, 91A35, 91A43, 91A11

**Format** : Talk at Waseda University

**Author(s)** : Abdelrahim Said Mousa (Birzeit University)

## [00053] How predators choose their prey to maximize their utility functions by using switching prey

**Session Time & Room** : 3D (Aug.23, 15:30-17:10) @D514

**Type** : Contributed Talk

**Abstract** : In this work, we model the relationship between prey and predators by studying the interactive behavior of this prey-predator model and using the change of prey. The objective is to maximize the profit function of each predator by seeking the strategy provided by each predator to maximize its profit. To do so, we maximize this utility function being constrained by balance equations between biomass and trophic, and we show that this last problem is completely equivalent to finding the Generalized Nash Equilibrium Point. To calculate it, we use the conditions of KKT and we show that it is indeed a Problem of Linear Complementarity.

**Classification** : 91A06, 91B06, 92B05, 15A03, 15A30

**Format** : Online Talk on Zoom

**Author(s)** : Asmaa IDMBAREK (LAMS, Hassan II University of Casablanca, Casablanca, Morocco)Yamna ACHIK (LAMS, Hassan II University of Casablanca, Casablanca, Morocco)Hajar NAFIA (LAMS, Hassan II University of Casablanca, Casablanca, Morocco)Imane AGMOUR (LAMS, Hassan II University of Casablanca, Casablanca, Morocco)Youssef EL FOUTAYENi (LAMS, Hassan II University of Casablanca, Casablanca, Morocco)

## [00058] Thermocapillary dynamics of viscous droplet driven by internal thermal singularity

**Session Time & Room** : 2D (Aug.22, 15:30-17:10) @E503

**Type** : Contributed Talk

**Abstract** : In a non-isothermal Poiseuille flow, we investigate the impact of an internal thermal singularity on the migration of a viscous immiscible droplet. The migration velocity strongly depends upon the type of thermal singularity and where it is located inside the droplet. In  $Re \rightarrow 0$  and  $Pe \rightarrow 0$  limits, this mathematical model provides a control mechanism for droplet migration, which may be useful in a variety of microfluidics as well as industrial applications.

**Classification** : 76T06

**Format** : Online Talk on Zoom

**Author(s)** : Arindam Basak (Indian Institute of Technology Kharagpur)Rajaram Lakkaraju (Indian Institute of Technology Kharagpur)Raja Sekhar G P (Indian Institute of Technology Kharagpur India)

## [00070] SDDS-SABC based Algorithm for solving non-linear optimization problems

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @D502

**Type** : Contributed Talk

**Abstract** : Optimizing complex non-linear constrained optimization problems is often a challenging task. This work proposes a new hybrid method called SDDS-SABC based on the Split-Detect-Discard-Shrink technique and Sophisticated ABC algorithm to optimize the said problems. The SDDS method is responsible for shrinking the full search region through a recursive breakdown and improves computational effort to focus on the subregion covering potential solutions for further decomposition. SABC plays a vital role in extracting the best solutions from the subregions whose values help detect the promising subregion. Both SDDS and SABC are sequentially repeated until the region reduces to a nominal width representing the optimization problem's global/ close to global solution(s). The Ranking and selection rules have been applied to assist optimistic decision-making with an attitude to discard the subregion covering non-promising solution (s). At the same time, the subregion with a promising solution is accepted as the current shrink region for a further split. We introduce a new initialization scheme for food sources in the SABC algorithm, which excels the existing initialization process. Develop Dual-strategy Employed bee's phase, allowing bees to split into two groups and use their respective group strategies to explore their neighbourhood while maintaining their collaborative contribution. We also introduce a new Dynamic penalty method that is free from extra parameters or factors like most existing penalty methods do to improve the optimization efficiency. To check the validity of SDDS-SABC, we have applied it to benchmark functions and engineering problems. To measure our proposed method's statistical significance against other existing heuristic optimization methods, we carried out the non-parametric Friedman and Wilcoxon rank tests.

**Classification** : 90-xx, 90-08, 90-10, optimization algorithms

**Format** : Online Talk on Zoom

**Author(s)** : Dharendra Sharma (Birla Institute of Technology Mesra, Ranchi)Darakhshan Jabeen Syeda (Birla Institute of Technology Mesra, Ranchi)

## [00073] Scattering behavior for one dimensional wave maps into Riemannian manifolds

**Session Time & Room** : 2E (Aug.22, 17:40-19:20) @F310

**Type** : Contributed Talk

**Abstract** : In this talk, we explore the scattering behavior for wave maps from Minkowski space  $\mathbb{R}^{1+1}$  into general Riemannian manifolds, provided the initial data are small. In particular, we show that the nonlinear scattering operator can be linearized as the corresponding linear scattering operator. The underlying physical intuition of this conclusion is that one-dimensional wave maps behave exactly in the same manner as their scattering fields detected by the far-away observers.

**Classification** : 35L05, 35A01, 35B40, 35P25, 35R30

**Format** : Online Talk on Zoom

**Author(s)** : Mengni Li (Southeast University)

## [00074] Chaos in multidimensional disordered nonlinear lattices

**Session Time & Room** : 5B (Aug.25, 10:40-12:20) @E802

**Type** : Contributed Talk

**Abstract** : We study the mechanisms of energy transport in multidimensional heterogeneous lattice models, studying in particular the case of the Klein-Gordon model of coupled anharmonic oscillators in one and two spatial dimensions. We perform an extensive numerical investigation of the dynamics of the considered model revealing (i) the effects of the type of the impurity (heterogeneity) parameter on the systems' transport properties and classify the transport mechanisms of the nonlinear versions of the models into various dynamical regimes. (ii) that for its nonlinear version, chaotic transport persists and (iii) chaotic hotspots meander in the region of energy concentration supporting the spreading mechanism of energy.

**Classification** : 70K55, 70H07

**Format** : Talk at Waseda University

**Author(s)** : Bob Senyange (Muni University)

## [00078] A higher order numerical scheme to a nonlinear McKendrick-Von Foerster equation with singular mortality

**Session Time & Room** : 2D (Aug.22, 15:30-17:10) @A201

**Type** : Contributed Talk

**Abstract** : In this paper, higher-order numerical schemes to the McKendrick-Von Foerster equation are presented when the death rate has singularity at the maximum age. The third, fourth-order schemes that are proposed are based on the characteristics, which are non-intersecting lines in this case, and are multi-step methods with appropriate corrections at each step. In fact, the convergence analysis of the schemes is discussed in detail. Moreover, numerical experiments are provided to validate the orders of convergence of the proposed third-order and fourth-order schemes.

**Classification** : 92D25, 65M25, 65M12

**Format** : Talk at Waseda University

**Author(s)** : Joydev Halder (School of Mathematics and Statistics, University of Hyderabad)Suman Kumar Tumuluri (School of Mathematics and Statistics, University of Hyderabad)

## [00079] Multi-dimensional Optimal Systems for Chaplygin Gas Cargo-LeRoux model

**Session Time & Room** : 2E (Aug.22, 17:40-19:20) @F310

**Type** : Contributed Talk

**Abstract** : The famous Cargo-LeRoux model for the isentropic Chaplygin gas is studied using classical Lie symmetry method. Optimal systems up to six-dimensions are constructed using the adjoint transformation and the invariants of the admitted Lie algebras. We obtain exact solutions to the Cargo-LeRoux model by using the one-dimensional optimal system and discussed the physical behavior of the solutions graphically. Finally, We discussed the evolutionary behavior of a discontinuity wave.

**Classification** : 35L40, 70G65, 76N15

**Format** : Talk at Waseda University

**Author(s)** : Manoj Kumar Pandey (BITS Pilani K K Birla Goa Campus)Pabitra Kumar Pradhan (BITS Pilani K K Birla Goa Campus)

## [00091] An infeasible interior-point arc-search algorithm for nonlinear constrained optimization

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @F312

**Type** : Contributed Talk

**Abstract** : Most algorithms based on interior-point methods are categorized as line search since they compute a search direction on a straight line. In this talk, we propose an interior-point method for nonlinear programming problems that computes the search direction along with an ellipsoidal arc. We discuss the convergence of the proposed method, and numerical experiments indicate it can solve the CUTEst benchmark problems in fewer iterations. A modified method can further reduce the computation time.

**Classification** : 49M37, 65K05, 90C30, 90C51

**Format** : Talk at Waseda University

**Author(s)** : Einosuke Iida (Tokyo Institute of Technology) Makoto Yamashita (Tokyo Institute of Technology) Yaguang Yang (US NRC)

## [00092] The explicit formulae for the distributions of words

**Session Time & Room** : 2C (Aug.22, 13:20-15:00) @G301

**Type** : Contributed Talk

**Abstract** : The distributions of the number of words play key roles in information theory, statistics, and DNA analysis. Bassino et al. 2010, Regnier et al. 1998, and Robin et al. 1999 showed generating functions of the distributions in rational forms. However, we can not expand rational functions except for simple cases and do not have explicit formulae for the distributions from them. <sup>[1]</sup><sub>sep</sub> We show the explicit formulae for the distributions of words for the Bernoulli models.

**Classification** : 05A05, 05A15, 60C05, 62E15

**Format** : Talk at Waseda University

**Author(s)** : Hayato Takahashi (Random Data Lab. Inc. )

## [00095] Low Reynolds number hydrodynamics of a slip-stick sphere

**Session Time & Room** : 2C (Aug.22, 13:20-15:00) @G304

**Type** : Contributed Talk

**Abstract** : Low Reynolds number hydrodynamics of spherical particles with non-uniform surface roughness show potential applications in microfluidic situations like swimming micro-organisms and emulsions. In this work, we study the hydrodynamics of spherical slip-stick particle models; namely, i) axisymmetric cap/strip model and ii) non-axisymmetric patch model, suspended in an unbounded arbitrary Stokes flow whose surface is partitioned into two different slip regions. We evaluate the optimum configurations for migrational and rotational motion of the slip-stick spherical particle.

**Classification** : 76D07, 35A25

**Format** : Talk at Waseda University

**Author(s)** : Shiba Biswas (Indian Institute of Technology Kharagpur, India-721302) Poornachandra Sekhar Burada (Indian Institute of Technology Kharagpur, India-721302) Raja Sekhar G P (Indian Institute of Technology Kharagpur, India-721302)

## [00096] Multi-scale analysis of concentration distribution inside porous medium channel configuration

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @D101

**Type :** Contributed Talk

**Abstract :** A multiple-scale perturbation analysis is presented for the two-dimensional concentration distribution of passive contaminant released in an incompressible viscous fluid channel filled with a porous medium. The flow is driven by the combined effect of the upper plate oscillation and the periodic pressure gradient. Homogenization technique is used to find the concentration distribution up to third order. For a fixed amplitude of oscillation and pulsation, frequency of pressure pulsation has stronger effect on the dispersion.

**Classification :** 76M50, 76R99, 76S99

**Format :** Online Talk on Zoom

**Author(s) :** Timir Karmakar (Department of Mathematics, National Institute of Technology Meghalaya, Shillong, Meghalaya 793003) Swarup Barik (2Department of Mathematics, SRM Institute of Science and Technology, Kattankulathur, Chennai 603203) Raja Sekhar G P (Indian Institute of Technology Kharagpur India)

## **[00098] Robust bring your own encryption algorithm using generalized heat equation associated with generalized Vigen\$\grave{e}\$re-type table over symmetric group**

**Session Time & Room :** 3E (Aug.23, 17:40-19:20) @E504

**Type :** Contributed Talk

**Abstract :** We develop a secure bring your own encryption algorithm that encrypts personal data. The proposed algorithm is based on a generalized heat equation associated with a generalized Vigen\$\grave{e}\$re-type table over symmetric group  $S_n$  so that existing attacks will be infeasible. Encryption keys are obtained from random key sequences tested by NIST statistical test suite. The robustness of the proposed algorithm has been found by comparing it with other competing existing algorithms.

**Classification :** 68P25, 68P30, Image encryption.

**Format :** Talk at Waseda University

**Author(s) :** Manish Kumar (BITS Pilani, Hyderabad Campus, Telangana, India)

## **[00100] Pointwise Controllability of Degenerate/Singular PDEs**

**Session Time & Room :** 5B (Aug.25, 10:40-12:20) @A207

**Type :** Contributed Talk

**Abstract :** This work deals with some controllability results of a one-dimensional degenerate and singular parabolic equation. We provide approximate and null controllability conditions based on the moment method by Fattorini and Russel.

**Classification :** 93B05, 35K65, 35K67

**Format :** Talk at Waseda University

**Author(s) :** AMINE SBAI (Hassan 1st University and Granada University)

## **[00103] Two-dimensional Riemann problem for a new hyperbolic model for thin film flow of a perfectly soluble anti-surfactant solution**

**Session Time & Room :** 3D (Aug.23, 15:30-17:10) @G601

**Type :** Contributed Talk

**Abstract :** This work is concerned with formulation of three-dimensional thin film model for an anti-surfactant solution and hence constructing unique global solution for a two-dimensional Riemann problem for the corresponding reduced hyperbolic form. We analyze the interactions of classical and non-classical waves in detail to construct the global solution of the corresponding 2-D Riemann problem. Further, we provide the expressions for strength, location and propagation speed of delta shock wave at each interaction point.

**Classification** : 35L65, 76L05, 35F55

**Format** : Talk at Waseda University

**Author(s)** : RAJA SEKHAR TUNGALA (Department of Mathematics, Indian Institute of Technology Kharagpur)

## **[00104] High order approximation of Caputo-Prabhakar derivative and its application in solving time fractional Advection-Diffusion equation**

**Session Time & Room** : 1E (Aug.21, 17:40-19:20) @E702

**Type** : Contributed Talk

**Abstract** : This work aims to devise a high-order numerical scheme to approximate the Caputo-Prabhakar derivative of order  $0 < \alpha < 1$ , using an  $r$ th degree Lagrange interpolation polynomial, where  $0 \leq r \in \mathbb{Z}^+$ . This numerical scheme can be thought of as an extension of the presented schemes for the approximation of the Caputo-Prabhakar derivative in our previous work [1]. Further, we adopt the proposed scheme to solve a time-fractional Advection-Diffusion equation with the Dirichlet boundary condition. It is shown that the method is unconditionally stable, uniquely solvable, and convergent with convergence order,  $O(\tau^{r+1-\alpha}, h^2)$ , where  $\tau$  and  $h$  are the step sizes in the temporal and spatial directions, respectively. Without loss of generality, obtained results are supported by numerical examples for  $r = 4, 5$ .

[1] Deeksha Singh, Farheen Sultana, and Rajesh K Pandey, Approximation of Caputo-Prabhakar derivative with application in solving time fractional advection-diffusion equation, International Journal for Numerical Methods in Fluids. 94(7)(2022), pp. 896-919.

**Classification** : 65M06, 65M12, Numerical approximation of fractional derivative and its application

**Format** : Talk at Waseda University

**Author(s)** : DEEKSHA SINGH (Department of Mathematical Sciences, Indian Institute of Technology, BHU, Varanasi) Rajesh K. Pandey (Department of Mathematical Sciences, Indian Institute of Technology, BHU, Varanasi)

## **[00111] A convergent numerical method for time-fractional reaction-diffusion equation**

**Session Time & Room** : 1E (Aug.21, 17:40-19:20) @E702

**Type** : Contributed Talk

**Abstract** : This paper design and analyze a robust finite difference scheme for solving a time-fractional reaction-diffusion equation with smooth and non-smooth solutions. The solution of this equation exhibits a weak singularity at the initial time  $t=0$ . So we use graded temporal mesh in order to handle the singularity. We discretize the space variable using a cubic polynomial spline difference scheme. Further, the stability and convergence for both the smooth and non-smooth solutions are analyzed separately.

**Classification** : 65M06, 65M12

**Format** : Online Talk on Zoom

**Author(s)** : Anshima Singh (Indian Institute of Technology (BHU) Varanasi)

## **[00112] Vibration control on unplanned change in vehicle mass model**

**Session Time & Room** : 3D (Aug.23, 15:30-17:10) @E504

**Type** : Contributed Talk

**Abstract** : Prolonged vibration transfer to the human body during riding affects human health. In this work, we proposed a heuristic-based chaotic artificial bee colony (ABC) optimization technique to mitigate the vibration response of running vehicle with context to the safety and comfort of passengers during a ride. We have modeled the vehicle's six degrees of freedom dynamics as a half-car with passive

suspension and passengers in a seated position. In the proposed work, two fundamental techniques are used in our analysis. Firstly, we estimate how changing the passenger mass in a vehicle affects the vibration behaviour of the entire system. This is done by simulating the dynamical model computationally and numerically over different bumpy roads. Thereby, distinguishing between the causal roles of mass, safety, and comfort, we formulate technologically constrained optimization problems and minimize the peak jerks of the vehicle and passengers. Further, implement techniques to optimize the vibration levels and design suspension parameters accordingly. The study also analyses the extreme range of vibration levels and comfort relationships for several road conditions to estimate the net effect of vehicle weight change during the ride.

**Classification** : 68-XX, 68Txx, 68T20, 37Nxx, 37N40

**Format** : Online Talk on Zoom

**Author(s)** : Darakhshan Jabeen Syeda (Birla Institute of Technology Mesra, Ranchi)

## **[00116] Multi-Scale Modelling of three phase lag (TPL) of lung cancer during cryosurgery**

**Session Time & Room** : 4D (Aug.24, 15:30-17:10) @E504

**Type** : Contributed Talk

**Abstract** : On the basis of the study of cryosurgery with mathematical modelling we discuss about the study related to non-Fourier bio-heat transfer available numerically with various boundary conditions for frozen and non frozen region. By the CAD/ANSYS study a specific region is developed for the tumor detected area. We'll elaborate three phase lag (TPL) bio-heat transfer model to analysis of the temperature distribution in living tissue. By this work of mathematical modelling of cryosurgery in lung cancer to elaborate the knowledge of TPL bio-heat model by using numerical methods.

**Classification** : 92-XX, 92Bxx, 92B05

**Format** : Online Talk on Zoom

**Author(s)** : Sarita Singh (Doon University Dehradun Uttarakhand India Doon University Dehradun Uttarakhand )

## **[00122] Exact expansion of functions using partial derivatives: sensitivity analysis**

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @F403

**Type** : Contributed Talk

**Abstract** : Expansions of functions such as Taylor' series, ANOVA and anchored decompositions are widely used for approximating and analyzing complex mathematical models. We propose a novel and exact expansion of functions using their cross-partial derivatives, the distribution functions and densities of the input variables. In uncertainty quantification and multivariate sensitivity analysis, such expansion allows for developing a dimension-free computation of sensitivity indices for dynamic models, and for proposing new lower and upper bounds of total indices.

**Classification** : 49Q12, 46G10, 46G99

**Format** : Online Talk on Zoom

**Author(s)** : Matieyendou LAMBONI (université de Guyane)

## **[00129] Anomalous diffusion in standard maps with extensive chaotic phase spaces**

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @E505

**Type** : Contributed Talk

**Abstract** : In this work, we investigate the long-term diffusion transport and chaos properties of single and coupled standard maps (SMs). We analyze parameters that are known to produce anomalous diffusion in the phase spaces of maps, with the presence of so-called accelerator modes. We study how different ensembles affect the behavior, asymptotic diffusion rates, and time scales required for these maps. We also explore the global diffusion properties and chaotic dynamics of various coupled SM

configurations.

**Classification** : 65Pxx

**Format** : Talk at Waseda University

**Author(s)** : Henok Tenaw Moges (University of Cape Town)Henok Tenaw Moges (University of Cape Town)Charalampos Skokos (University of Cape Town)

## **[00130] THE DYNAMICS OF THE MONKEYPOX VIRUS IN THE PRESENCE OF ENVIRONMENTAL TRANSMISSION**

**Session Time & Room** : 5C (Aug.25, 13:20-15:00) @G401

**Type** : Contributed Talk

**Abstract** : A deterministic model for the environmental transmission dynamics of monkeypox with the presence of quarantine and vaccination is presented. The analysis of the model presented three important equilibrium states namely; monkeypox-free equilibrium (MPXV-FE), infected rodent-free endemic equilibrium (IRF-EE) and coexistence equilibrium (CO-EE). The local and global stability of the equilibrium states is established in terms of the basic reproduction number,  $\mathcal{R}_0$ . For global stability, the Comparison theory is used for MPXV-FE while the Volterra-Lyapunov matrix theory is used for both IRF-EE and CO-EE. Sensitivity analysis is performed using the Latin Hypercube sampling method with the results showing that environmental transmission parameters are the main driver of infection in the dynamics of monkeypox infection. This is further supported by numerical simulations to show the impact of environmental transmission on monkeypox infection and also the validity of the theoretical analysis presented. Based on the results, it is recommended that health practitioners and policy-makers should constitute control strategies that will focus on reducing environmental transmission and shedding of the virus in the environment while increasing the environmental decay rate of the monkeypox virus. This will complement the quarantine and vaccination strategies in place.

34C60, 92B05, 34D23, 34D20

**Classification** : 34CXX, 34DXX

**Format** : Online Talk on Zoom

**Author(s)** : Chinwendu Emilian MADUBUEZE (Federal university of Agriculture Makurdi Nigeria )

## **[00132] Incompatibility-governed deformations: a new approach to Elastoplasticity**

**Session Time & Room** : 5B (Aug.25, 10:40-12:20) @G502

**Type** : Contributed Talk

**Abstract** : We present theoretical as well as numerical results concerning a novel approach to model elasto-plastic phenomena in deformable solids based on a decomposition of the total deformation tensor into a compatible (i.e., a symmetric gradient) and an incompatible part at each point of the domain. The incompatible part aims to model the part of the deformation due to dislocation movement that eventually is responsible for the creation of plastic regions. This is a joint work with Samuel Amstutz (Ecole Polytechnique de Palaiseau, France).

**Classification** : 35J48, 49S05, 74C05, 74G99, 80A17

**Format** : Talk at Waseda University

**Author(s)** : Nicolas Van Goethem (Universidade de Lisboa )

## **[00141] Multiscale Perturbed Gradient Descent: Chaotic Regularization and Heavy-Tailed Limits**

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @E711



**Type :** Contributed Talk

**Abstract :** Recent studies have shown that gradient descent (GD) can achieve improved generalization when its dynamics exhibits a chaotic behavior. However, to obtain the desired effect, the step-size should be chosen sufficiently large, a task which is problem dependent and can be difficult in practice. In this talk, we introduce multiscale perturbed GD (MPGD), a novel optimization framework where the GD recursion is augmented with chaotic perturbations that evolve via an independent dynamical system. We analyze MPGD from three different angles: (i) By building up on recent advances in rough paths theory, we show that, under appropriate assumptions, as the step-size decreases, the MPGD recursion converges weakly to a stochastic differential equation (SDE) driven by a heavy-tailed Lévy-stable process. (ii) By making connections to recently developed generalization bounds for heavy-tailed processes, we derive a generalization bound for the limiting SDE and relate the worst-case generalization error over the trajectories of the process to the parameters of MPGD. (iii) We analyze the implicit regularization effect brought by the dynamical regularization and show that, in the weak perturbation regime, MPGD introduces terms that penalize the Hessian of the loss function. Empirical results are provided to demonstrate the advantages of MPGD.

**Classification :** 68T07, Machine learning, optimization, stochastic differential equations

**Format :** Talk at Waseda University

**Author(s) :** Soon Hoe Lim (Nordita, KTH Royal Institute of Technology and Stockholm University)

## **[00144] The flux perturbed Riemann solution for isentropic Cargo-LeRoux model**

**Session Time & Room :** 2E (Aug.22, 17:40-19:20) @G502

**Type :** Contributed Talk

**Abstract :** In this research, we study the pressureless Cargo-LeRoux model of conservation laws, which is modeled from the one-dimensional constant gravity Euler equations. Introducing flux perturbation of a van der Waals isentropic gas equation of state, the exact solution of Riemann problem is derived and establish the existence and uniqueness of the Riemann solution globally. Finally, the influence of van der Waals excluded volume on the physical quantities is illustrated graphically using MATLAB software.

**Classification :** 35D30, 35L65, 76L05, 76N10, 76N15

**Format :** Talk at Waseda University

**Author(s) :** Sahadeb Kuila (DEPARTMENT OF MATHEMATICS, SRM Institute of Science and Technology, Kattankulathur, Tamil Nadu 603203) Sumita Jana (DEPARTMENT OF MATHEMATICS, SRM Institute of Science and Technology, Kattankulathur, Tamil Nadu 603203)

## **[00156] Convergence of adaptive algorithms for parametric PDEs with lognormal coefficients**

**Session Time & Room :** 5D (Aug.25, 15:30-17:10) @E504

**Type :** Contributed Talk

**Abstract :** Numerical methods for random parametric PDEs can greatly benefit from adaptive refinement schemes, in particular when functional approximations are computed as in stochastic Galerkin methods with residual based error estimation. In this talk we derive an adaptive refinement algorithm for an elliptic parametric PDE with unbounded lognormal diffusion coefficient steered by a reliable error estimator for both the spacial mesh and the stochastic space. Moreover, we will prove the convergence of the derived adaptive algorithm.

**Classification :** 65N12, 65N50, 65F10, 65F55, 65D40

**Author(s) :** Nando Hegemann (Physikalisch-Technische Bundesanstalt) Nando Farchmin (Physikalisch-Technische Bundesanstalt)

## [00159] Wave interactions in drift- flux equations of two-phase flows

**Session Time & Room** : 2E (Aug.22, 17:40-19:20) @F310

**Type** : Contributed Talk

**Abstract** : In this talk, we consider the interactions of arbitrary shocks for a  $3 \times 3$  system of conservation laws governing drift-flux equations of two-phase flows with isothermal and isentropic equation of states. Here, we use the properties of Riemann solution and interaction of weak shocks for this study. Consequently, we reduce the system of equations by taking the projection of shocks in the phase plane to investigate the interactions of arbitrary shocks.

**Classification** : 35L40, 35L45, 35L65, 35L67, Hyperbolic system of conservation laws

**Format** : Talk at Waseda University

**Author(s)** : Minhajul Minhajul (Department of Mathematics, Birla Institute of Technology and Science Pilani, K K Birla Goa Campus, India) Rakib Mondal (Department of Mathematics, Birla Institute of Technology and Science Pilani, K K Birla Goa Campus, India)

## [00173] Symmetries and Explicit Solutions of Fractional Nonlinear Drinfeld–Sokolov–Satsuma–Hirota System

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @G305

**Type** : Contributed Talk

**Abstract** : In this work, a space-time fractional nonlinear Drinfeld–Sokolov–Satsuma–Hirota system is considered. The symmetry approach and power series expansion technique are applied to derive the explicit solutions of the system. The coupled DSSH system was seen as a special form example of Lax pairs and a special case of the four-reduced Kadomtsev–Petviashvili hierarchy in literature. The main motivation for present work is the global behaviour and various applications of fractional DSSH in applied science. The results obtained in the paper can be useful in calculating in conservation laws of the system.

**Classification** : 26A33, 76M60, Fractional Derivatives, Symmetry Analysis

**Format** : Online Talk on Zoom

**Author(s)** : Komal Singla (Chandigarh University)

## [00175] pFemView: An Open-Source Visualization Library for p-FEM

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @E711

**Type** : Contributed Talk

**Abstract** : We present a new approach to visualize p-hierarchical basis finite element (p-FEM) solutions on the scientific visualization application ParaView. Since ParaView uses a linear/quadratic interpolation at specific geometric nodes, a refined visualization mesh needs to be constructed efficiently. This is accomplished via the key steps “p-hierarchical to nodal projection” and “higher-order to lower-order projection”, which have been implemented in an open-source C++ library “pFemView”. Furthermore, examples are presented to illustrate the effectiveness of this library.

**Classification** : 65N30, 65Y15, 68-04

**Format** : Talk at Waseda University

**Author(s)** : Janitha Gunatilake (University of Peradeniya)

## [00177] Bifurcations of Limit Cycles and Multistability in Polynomial Dynamical Systems

**Session Time & Room** : 5C (Aug.25, 13:20-15:00) @G401

**Type** : Contributed Talk

**Abstract** : We study global limit cycle bifurcations and multistability in 2D polynomial dynamical systems, namely, in: the general Liénard polynomial system, the Euler-Lagrange-Liénard mechanical system, Leslie-Gower ecological or biomedical systems, and a reduced quartic Topp system which models the dynamics of diabetes. We study also 3D polynomial dynamical systems and, in particular, complete the strange attractor bifurcation scenarios in Lorenz type systems connecting globally the homoclinic, period-doubling, Andronov-Shilnikov, and period-halving bifurcations of limit cycles.

**Classification** : 34C05, 34C07, 34C23, 37G10, 37G15

**Format** : Talk at Waseda University

**Author(s)** : Valery A. Gaiko (United Institute of Informatics Problems, National Academy of Sciences of Belarus)

## [00180] Relationship between musical notes and socio-political events

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @E811

**Type** : Contributed Talk

**Abstract** : Historians and scientists long suspected that sounds and music impact different cultures. However, empirical data to support such claim is sparse. Previous research using Supervised Machine Learning algorithms, i.e. ANFIS (Adaptive Neuro-Fuzzy Inference System) has successfully categorised musical genre classification and predicted the outcome of the United Kingdom's election results using popular music released in that period by feeding sound wave features to the ANFIS algorithm. This study reports similar research for the Moroccan elections using two different supervised machine learning algorithms namely, k-NN and SVM.

**Classification** : 68T09, 91C99

**Format** : Talk at Waseda University

**Author(s)** : Choi-Hong Lai (University of Greenwich)Nakunam Kokulan (University of Greenwich)Yahya Chahine (University of Greenwich)

## [00181] Control of the Stefan problem

**Session Time & Room** : 5B (Aug.25, 10:40-12:20) @A207

**Type** : Contributed Talk

**Abstract** : The Stefan problem is the quintessential macroscopic model of phase transitions in liquid-solid systems. We consider the one-phase Stefan problem with surface tension, set in two-dimensional strip-like geometry. We discuss the local null controllability of the system in any positive time, by means of control supported within an arbitrary open and non-empty subset.

**Classification** : 93B05, 35R35, 35Q35, 93C20, Stefan problem, free boundary problem, controllability

**Author(s)** : Debayan Maity (TIFR Centre for Applicable Mathematics)

## [00188] Two-Phase Modelling of Plaque Growth in Early Atherosclerosis

**Session Time & Room** : 3D (Aug.23, 15:30-17:10) @D514

**Type** : Contributed Talk

**Abstract** : We discuss the early stage of atherosclerotic plaque formation within arteries. The production of foam cells characterizes such plaque. Foam cells generate from the differentiated form of monocytes (called macrophages) owing to oxidized low-density lipoprotein (ox-LDL) cholesterol intake. Initially, plaque radius grows exponentially and later on, it stabilizes with time. Such behaviour is due

to the death of foam cells owing to the toxicity of excess ox-LDL intake, although ox-LDL enhances foam cell proliferation.

**Classification** : 92C35, 92-10, 76M20, 35B20, 92B05

**Format** : Talk at Waseda University

**Author(s)** : Abdush Salam Pramanik (Department of Mathematics, University of North Bengal) Bibaswan Dey (Department of Mathematics, University of North Bengal)

## [00191] Two-Phase Modelling of Subcutaneous Injection of Drugs

**Session Time & Room** : 3D (Aug.23, 15:30-17:10) @A511

**Type** : Contributed Talk

**Abstract** : Various drugs and vaccines are administered through the subcutaneous pathway. The adipose cells within the subcutaneous layer impart structural anisotropy. We address the mechanical response of the adipose tissue in terms of the computed stress fields to understand the pain a patient realizes. Tissue anisotropy instigates the interstitial fluid to generate one or more eddies. Eddies help a low viscous injected drug homogenize when the skin pinching height is high at the injection apply area.

**Classification** : 92C35, 92B05, 92C50, 35B20, 92-10, Mathematical Modeling of Problems on Biological Phenomena

**Format** : Online Talk on Zoom

**Author(s)** : Bibaswan Dey (Department of Mathematics, University of North Bengal) Abdush Salam Pramanik (Department of Mathematics, University of North Bengal) Timir Karmakar (Department of Mathematics, National Institute of Technology Meghalaya, India) Kalyan Saha (Department of Mathematics, University of North Bengal)

## [00197] Mathematical analysis of a nonlinear SIS model with effect of migration

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @G501

**Type** : Contributed Talk

**Abstract** : We consider a nonlinear SIS epidemic model with nonlocal disease transmission rate and diffusion in space which is a system of parabolic equations. The existence and uniqueness of steady state are studied using compact and nonsupporting operators, and strongly continuous semigroup theory, respectively. Due to the nonlinearity in the disease transmission rate, proof of the uniqueness of a steady state requires a completely different approach. The linearization around the nontrivial steady state of the model requires the study of a perturbed operator. Spectral analysis is used to study the local stability and the global stability of the steady state.

**Classification** : 35B35, 35Q92, 47H10, 92D25

**Format** : Talk at Waseda University

**Author(s)** : Soumak Nag (University of Hyderabad) Suman Kumar Tumuluri (University of Hyderabad)

## [00200] Montgomery identity and Ostrowski type inequalities via Katugampola integral operator

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @G305

**Type** : Contributed Talk

**Abstract** : In this talk, we will discuss the extended version of Montgomery identity using Katugampola integral operators. Also we will establish Ostrowski type integral inequalities and fractional integral inequality for product of two functions.

**Classification** : 26A33, 26D07, 26D10

**Format** : Online Talk on Zoom

**Author(s)** : Henok Desalegn Desta (Addis Ababa university) Deepak B. Pachpatte (Dr. Babasaheb Ambedkar Marathwada University, India) Tadesse Abdi (Addis Ababa University) Jebessa B. Mijena (Georgia College & State University)

## [00204] Periodicity and Symmetry on a Class of Integral Equations with Weakly Singular Kernels

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @G709

**Type** : Contributed Talk

**Abstract** : In this study, we introduce the periodic and symmetric properties of the states in a class of weakly singular integral equations. Motivation of this paper is based on the main results of previous paper: bounded forces produce bounded states in the infinite field. We furthermore observed that in finite times, steady states show. For each periodicity, two kinds of initial conditions apply: one is same as the original one, the other is the steady state from previous period. For symmetry, we apply same magnitudes of forces but opposite directions.

**Classification** : 37Mxx, 31Axx, 33Exx

**Format** : Talk at Waseda University

**Author(s)** : Shihchung Chiang (Chung Hua University)

## [00205] 'Period doubling' induced by optimal control in a behavioral SIR epidemic model.

**Session Time & Room** : 2E (Aug.22, 17:40-19:20) @A201

**Type** : Contributed Talk

**Abstract** : We consider a behavioral SIR epidemic model to describe the action of the public health system aimed at

enhancing the social distancing during an epidemic outbreak. An optimal control problem is proposed where the control acts in a specific way on the contact rate. We show that the optimal control of social distancing is able to generate a period doubling-like phenomenon. Namely, the 'period' of the prevalence is double the 'period' of the control, and an alternation of small and large peaks of disease prevalence can be observed.

**Classification** : 92D30, 34C60, 93C15

**Format** : Online Talk on Zoom

**Author(s)** : Sileshi Sintayehu Sharbayta (Addis Ababa University) Bruno Buonomo (University of Naples Federico II) Alberto d'Onofrio (University of Trieste) Tadesse Abdi (Addis Ababa University)

## [00206] Tensor product-type methods for solving Sylvester tensor equations

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @G304

**Type** : Contributed Talk

**Abstract** : The tensor biconjugate gradient (TBiCG) method has recently been proposed for solving Sylvester tensor equations. TBiCG is based on BiCG that may exhibit irregular convergence behavior. To overcome the limitations of BiCG, product-type methods have been proposed. In this study, we propose tensor product-type methods to solve Sylvester tensor equations. Furthermore, we consider the preconditioned versions using the NKP preconditioner. Numerical experiments illustrate that the proposed methods are competitive with some existing methods.

**Classification** : 15A69, 65F10

**Format** : Talk at Waseda University

**Author(s)** : Jing Niu (Nagoya University) Tomohiro Sogabe (Nagoya University) Lei Du (Dalian University of Technology) Tomoya Kemmochi (Nagoya University) Shao-Liang Zhang (Nagoya University)

## [00208] Love wave along the interface with triangular irregularity

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @E812

**Type** : Contributed Talk

**Abstract** : Propagation of the love wave is studied along the irregular interface between the porous layer and the elastic half-space. The porous layer is assumed to be saturated by two immiscible fluids. The irregularity at the interface is considered in the form of a triangular pit embedded in the half-space. The elastic half-space is considered to be initially stressed under the effect of gravity. A complex transcendental and implicit relation between the frequency and the phase speed of the Love wave is derived in the form of a dispersion relation. A numerical study is conducted to observe the effect of material parameters and irregularity on the behavior of the Love wave. A significant impact of the triangular pit, porosity, and frequency is observed on the phase speed of the propagating Love wave and depicted graphically.

**Classification** : 74J15

**Format** : Talk at Waseda University

**Author(s)** : Ashish Arora (I. K. Gujral Punjab Technical University)

## [00212] Optimal control for a SIR epidemic model with limited quarantine

**Session Time & Room** : 5B (Aug.25, 10:40-12:20) @A201

**Type** : Contributed Talk

**Abstract** : Social distance and total lock-downs are interventions that have been used to mitigate the spread of the COVID-19 virus. However, these measures could be harmful to societies in terms of social and economic costs. Using optimal control tools and numerical computations we investigate the optimal strategies that minimize the impact of an epidemic, by studying the conditions for an optimal control of a Susceptible-Infected-Recovered model.

**Classification** : 92D30, 34H05, 49N90

**Format** : Online Talk on Zoom

**Author(s)** : Rocio Celeste Balderrama (Departamento de Matematica-Universidad de Buenos Aires)Javier Peressutti (Universidad de Mar del Plata)Juan Pablo Pinasco (Universidad de Buenos Aires-IMAS-CONICET)Constanza Sanchez de la Vega (Universidad de Buenos Aires-IMAS-CONICET)Federico Vazquez (Universidad de Buenos Aires-IC-CONICET)

## [00213] Advances in Derivative-free Methods and the DFO VU-algorithm

**Session Time & Room** : 4D (Aug.24, 15:30-17:10) @D408

**Type** : Contributed Talk

**Abstract** : The VU-algorithm is a method of minimizing convex, nonsmooth functions by splitting the space into two subspaces: the V-space, on which the objective function's nonsmooth behavior is captured, and the orthogonal U-space, on which the function behaves smoothly. The algorithm's convergence is accelerated, as it takes a (slow) proximal point step in the V-space, then a (fast) quasi-Newton step in the U-space, since gradients and Hessians exist there. New convergence rates and subroutines are presented.

**Classification** : 90C25, 49J52

**Format** : Talk at Waseda University

**Author(s)** : Chayne Planiden (University of Wollongong)

## [00218] Characterizations of diffusion matrices in homogenization of nondivergence-form elliptic equations

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @G501

**Type** : Contributed Talk

**Abstract** : We provide characterizations of diffusion matrices  $A$  for which the sequence of solutions  $(u^\varepsilon)_{\varepsilon > 0}$  to  $-A(x/\varepsilon):D^2 u^\varepsilon = f$  in  $\Omega$ ,  $u^\varepsilon = g$  on  $\partial\Omega$ , converges to the solution of the homogenized problem with  $L^\infty$ -rate  $\mathcal{O}(\varepsilon^2)$  for all sufficiently regular  $f, g$ . Whereas such diffusion matrices can be characterized via the third-order homogenized tensor, we provide more explicit characterizations and prove an open conjecture posed by Guo and Tran.

**Classification** : 35B27, 35B40, 35J25

**Format** : Talk at Waseda University

**Author(s)** : Xiaoqin Guo (University of Cincinnati) Timo Sprekeler (National University of Singapore) Hung Vinh Tran (University of Wisconsin Madison)

## [00219] Approximation methods for solving pursuit-evasion differential game

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @G402

**Type** : Contributed Talk

**Abstract** : In this study we present an appropriate singular, zero-sum, linear-quadratic differential game. One of the main features of this game is that the weight matrix of the minimizer's control cost in the cost functional is singular. Due to this singularity, the game cannot be solved either by applying the Isaacs MinMax principle, or the Bellman–Isaacs equation approach. As an application, we introduced an pursuit-evasion differential game with an appropriate regularized cost functional and developed an appropriate dual representation. Developing the variational derivatives of this regularized cost functional, we apply several approximation methods and show how the numerical results coincide with the dual representation.

**Classification** : 34H05, 49J15, 91A23, 90C90, 49N15

**Format** : Talk at Waseda University

**Author(s)** : Oleg Kelis (Technion) Oleg Kelis (The Technion—Israel Institute of Technology)

## [00224] Multi-objective multi-route STP with carbon emission and risk mitigation in Pharmaceutical Supply Chain under Pythagorean fuzzy Environment

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @D505

**Type** : Industrial Contributed Talk

**Abstract** : This research proposes multi-objective multi-route fixed-charge solid transportation problem with carbon emission and risk mitigation in Pharmaceutical Supply Chain (PSC) under trapezoidal Pythagorean fuzzy environment. A novel ranking index is proposed to convert the suggested Pythagorean fuzzy model into its deterministic version. This study develops new computational procedure to minimize the chosen factors in PSC. Thereafter the model is solved by intuitionistic fuzzy and hybrid programming. Finally, an example is included to show the effectiveness of the model.

**Classification** : 90B06, 90B50, 90C29, 90C70

**Format** : Talk at Waseda University

**Author(s)** : Dr. Sankar Kumar Roy (Dept. of Applied Mathematics, Vidyasagar University, Midnapur-721102, West Bengal, India)

## [00225] Multidimensional WENO-AO Reconstructions Using A Simplified Smoothness Indicator

**Session Time & Room** : 4C (Aug.24, 13:20-15:00) @E704

**Type** : Contributed Talk

**Abstract** : Finite volume, weighted essentially non-oscillatory (WENO) schemes using the simple smoothness indicator  $\sigma_j = 1/(L-1) \sum_{m \neq j} (u_j - u_m)^2$ , are presented, where  $L$  is the number of mesh elements in the stencil,  $u_j$  is the local function average over  $j$ th element, and index  $m$  gives the target element. We develop a modification of WENO-Z weighting that gives a reliable and accurate reconstruction of adaptive order. Convergence results are proved. Numerical experimental results are also provided.

**Classification** : 65D15, 65M08, 65M12, 76M12

**Format** : Online Talk on Zoom

**Author(s)** : Chiehshen Huang (National Sun Yat-sen University) Todd Arbogast (University of Texas; Austin) Chenyu Tian (University of Texas; Austin)

## [00229] Mathematical modeling of spatial distribution of COVID-19 epidemic

**Session Time & Room** : 4C (Aug.24, 13:20-15:00) @E507

**Type** : Contributed Talk

**Abstract** : This study provides a mathematical study of the Susceptible, Exposed, Infected, Recovered, and Vaccinated population model of the COVID-19 pandemic by the bias of reaction-diffusion equations. We showed the spatial distribution of the model compartments when the basic reproduction rate  $R_0 < 1$  and  $R_0 > 1$ . We demonstrate the model's effectiveness by performing numerical simulations and then investigated the impact of vaccination and the significance of spatial distribution parameters in the spread of COVID-19 epidemic.

**Classification** : 60J70, 62H12, 00A71

**Format** : Talk at Waseda University

**Author(s)** : Kayode Oshinubi (Northern Arizona University) Jacques Demongeot (University of Grenoble Alpes) Brice Kammegne (University of Dschang)

## [00238] Numerical Schemes for Generalized Isoperimetric Constraint Fractional Variational Problem

**Session Time & Room** : 2E (Aug.22, 17:40-19:20) @F401

**Type** : Contributed Talk

**Abstract** : This paper discusses three numerical schemes for Generalized Isoperimetric Constraint Fractional Variational Problems (GICFVPs) defined using generalized fractional derivatives. Three Numerical schemes, i.e. linear, quadratic, and quadratic-linear schemes, are used to get numerical solutions of a GICFVP. The convergence rate of the linear and quadratic schemes for  $\alpha \in (0,1)$  are  $2-\alpha$  and  $3-\alpha$ . It is observed that the presented schemes perform well, and when the step size  $h$  is decreased, the desired solution is attained.

**Classification** : 49R99, 65K10, 65L60, 65L70

**Format** : Online Talk on Zoom

**Author(s)** : DIVYANSH PANDEY (IIT (BHU), Varanasi) Rajesh Kumar Pandey (IIT (BHU), Varanasi)



## [00240] Phantom cosmological model with observational constraints in symmetric teleparallel gravity

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @D407

**Type** : Contributed Talk

**Abstract** : The cosmological model of the Universe has been presented in symmetric teleparallel gravity and the parameters are constrained from the cosmological datasets. The nonmetricity function considered here contains higher power of the nonmetricity. With some algebraic manipulation the Hubble parameter has been obtained in redshift. The cosmological and geometrical parameters are obtained and constrained using the recent Hubble and Pantheon + SHOES datasets. The model shows early deceleration and late time acceleration.

**Classification** : 83C15, 83D05, 83C10, Modified Gravity, Cosmological Model.

**Author(s)** : Bivudutta Mishra (BITS-Pilani, Hyderabad Campus)

## [00241] Adaptive sparse interpolation in high dimensions and applications to surrogate modeling in chemical engineering.

**Session Time & Room** : 4C (Aug.24, 13:20-15:00) @E507

**Type** : Contributed Talk

**Abstract** : We present theoretical and practical aspects on the development of accurate surrogate models from first-principles, multiscale, PDE models for industrial chemico-physical processes. We will present many applications in Phosphate industry done in collaboration with OCP-Group in Morocco.

The surrogate models are based on sparse multivariate polynomial interpolation. The goal is to reduce the computational time while preserving its physical properties such as monotonicity and positivity.

**Classification** : 65D40, 65D05

**Format** : Talk at Waseda University

**Author(s)** : Saad Benjelloun (Makhbar Mathematical Sciences Research institute)saad benjelloun (Makhbar institute)Abdellah Chkifa (UM6P)

## [00250] Formation of delta shock waves and vacuum states in the vanishing pressure limit of the Riemann solution to the isentropic Euler system for logarithmic equation of state with the Coulomb-like friction term

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @E505

**Type** : Contributed Talk

**Abstract** : We investigate the limiting behavior of the Riemann solution to the isentropic Euler equations for logarithmic

equation of state with the Coulomb-like friction term. The formation of vacuum state and delta shock waves are

identified and analyzed when the pressure vanishes. Unlike the homogeneous case, the Riemann solution is no

longer self-similar. We prove that the Riemann solution of the isentropic Euler equations for logarithmic equation of state with friction term converges to the Riemann solution of the zero-pressure gas dynamics system with a

body force when the pressure vanishes.

**Classification** : 35L65, 35L67, 35L45

**Format** : Talk at Waseda University

**Author(s)** : Anupam Sen (Post Doctoral Fellow at Centre for Applicable Mathematics, Tata Institute of Fundamental Research)

## [00252] Stabilization and adaptive event-triggered tracking control for non-linear systems

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @G402

**Type** : Contributed Talk

**Abstract** : An adaptive event-triggered-based output tracking problem for non-linear network control systems with malicious attacks is discussed in this work. An adaptive event-triggered mechanism is developed to reduce the number of triggering and communication burdens. Feedback control is constructed to force the output trajectories to track reference input with disturbance and malicious attacks. Tracking objective transformed into input-output finite time stabilization. Sufficient conditions are developed based on Lyapunov–Krasovskii functional and advanced integral inequalities.

**Classification** : 34H05, 93D25, Systems and control theory

**Format** : Online Talk on Zoom

**Author(s)** : Vijayakumar Muthusamy (Anna University )

## [00261] Translational motion of a slightly deformed viscous spherical droplet in Stokes flow

**Session Time & Room** : 4D (Aug.24, 15:30-17:10) @D401

**Type** : Contributed Talk

**Abstract** : The problem of steady translational motion of a slightly deformed spherical droplet immersed in an immiscible viscous fluid is studied analytically under the consideration of vanishing Reynolds number. The flow fields in both the regions i.e. in the interior of droplet and exterior of droplet are governed by steady Stokes equations that are solved asymptotically using a method of perturbed expansions undersuitable boundary conditions. The deformation from spherical shape is characterized by a small parameter called deformation parameter, therefore, we have solved the problem up to the second order of the deformation parameter by neglecting the higher orders. The effect of deformation parameter is observed by means of force expression. The explicit expressions for the hydrodynamic drag force exerted on the droplet surface are obtained for the special cases of prolate and oblate spheroids. Our results are in good agreement with the existing results in literature for deformed solid sphere up to first and second order.

**Classification** : 76D07, 76T06, Transport Phenomena, Motion of bubbles and drops

**Format** : Talk at Waseda University

**Author(s)** : Jai Prakash (Mahindra University, Hyderabad)Huan J. Keh (National Taiwan University, Taipei)

## [00275] A fast data-driven method for designing compressible shock dominant flows

**Session Time & Room** : 2E (Aug.22, 17:40-19:20) @F310

**Type** : Contributed Talk

**Abstract** : We will present a new class of high-order numerical algorithms for computational fluid dynamics. Called "GP-MOOD," the new finite volume method is based on the Gaussian Processes modeling that generalizes the Gaussian probability distribution. Solutions at shocks and discontinuities are handled by the improved Multidimensional Optimal Order Detection (MOOD) strategy, which controls numerical stability and accuracy in an "a posteriori" shock-capturing formalism. We also introduce a new data-driven "a priori" MOOD method.

**Classification** : 35L25, 76N15, 85-08, 65M08

**Format** : Online Talk on Zoom

**Author(s)** : Dongwook Lee (University of California Santa Cruz)

## [00281] Simulation of the mechanical behaviour of steel-concrete-steel structures including concrete voids

**Session Time & Room** : 1E (Aug.21, 17:40-19:20) @F401

**Type** : Contributed Talk

**Abstract** : Numerical tools, including finite element simulations, are considered to investigate the effect of initial voids inside concrete on the mechanical behavior of steel-concrete composite structures in compression. A refined numerical strategy is first defined, including a particular care on the relations between each structural component. Due to high computational cost, progressive numerical simplifications are then discussed to conclude in the most acceptable simplified hypothesis. A parametric study is finally launched and perspectives are discussed.

**Classification** : 74-10, 74S05, 74R05, simulation, damage models, structural behaviour

**Format** : Talk at Waseda University

**Author(s)** : Ludovic JASON (Université Paris-Saclay, CEA, Service d'Études Mécaniques et Thermiques)

## [00291] Graph Convergence and Iterative Algorithm for a System of Generalized Nonlinear Variational-like Inclusions

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @F311

**Type** : Contributed Talk

**Abstract** : We focus on the investigation of the problem of finding a common point lying in the solutions set of a system of generalized nonlinear variational-like inclusions and the fixed points set of a total asymptotically nonexpansive mapping. A new iterative algorithm is suggested by employing the concepts of  $P$ - $\eta$ -proximal-point mapping and graph convergence. Convergence of a sequence of above is established. We Prove the strong convergence and stability of the sequence generated by our algorithm.

**Classification** : 47H20, Operator theory

**Format** : Talk at Waseda University

**Author(s)** : Suliman S Al-Homidan (King Fahd University of Petroleum and Minerals)

## [00300] Coupling macro-micro simulations in complex fluids

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @A601

**Type** : Contributed Talk

**Abstract** : Some of the most remarkable properties and functions served by some complex fluids originate from the interplay between external fields and microstructural dynamics. From a computational point of view this generates a set of challenges related to the need of coupling dynamics at different length and times scales, sometimes spanning several orders of magnitude. Micro-macro simulations have gained a lot of recognition within the field because these methods allow capturing full dynamics at the macroscale without losing resolution at the microscale. In this talk, we will review our efforts to couple existing macroscopic solvers for the Navier-Stokes equations with microstructural dynamics described by Langevin-type equations. In particular, we will discuss dumbbells models - under viscometric and capillary thinning flows fields- and parallel computing using GPUs.

**Classification** : 92B05, 76A05, 76A10, 76D05, 97M60

**Format** : Talk at Waseda University

**Author(s)** : Paula A Vasquez (University of South Carolina)Michael Cromer (RIT)

## [00301] On some modifications in the conjugate gradient method and its application in unconstrained optimization problems

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @D502

**Type** : Contributed Talk

**Abstract** : Conjugate gradient (CG) methods are preferably used to solve large-scale unconstrained optimization

problems due to strong local and global convergence properties and low memory requirements. To enhance its convergence, we introduce an improved hybrid form of the conjugate gradient method in this

work. We propose a new form of CG parameter ( $\beta_k$ ), combining the Fletcher Reeves (FR) and three-term

search directions. Our proposed search directions formula satisfies the sufficient descent condition independent of any line search and are bounded. For the global convergence, some proper assumptions on the

objective function and its gradient have been taken into account, which fulfills the strong Wolfe-Powell line search conditions. Finally, numerical experiments have been carried out on some standard benchmark test functions and compared with other CG methods from the literature to check the validity of

the proposed algorithm. Numerical results guarantee the efficiency and robustness of our proposed CG method.

**Classification** : 90-XX, 90C26, 90C30, 90bxx, 90-08

**Format** : Online Talk on Zoom

**Author(s)** : Sweta Kumari (Birla Institute of Technology Mesra, Ranchi) Darakhshan Jabeen Syeda (Birla Institute of Technology Mesra, Ranchi)

## [00302] Manifold-Free Riemannian Optimization

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @E605

**Type** : Contributed Talk

**Abstract** : Optimization problems constrained to a smooth manifold can be solved via the framework of Riemannian optimization. To that end, a geometrical description of the constraining manifold, e.g., tangent spaces, retractions, and cost function gradients, is required. In this talk, we present a novel approach that allows performing approximate Riemannian optimization based on a manifold learning technique, in cases where only a noiseless sample set of the cost function and the manifold's intrinsic dimension are available.

**Classification** : 65K05, 53Z50, 65D15

**Format** : Talk at Waseda University

**Author(s)** : Boris Shustin (Tel-Aviv University) Haim Avron (Tel-Aviv University) Barak Sober (The Hebrew University of Jerusalem)

## [00310] Human Activity Recognition from Inertial Motion Data

**Session Time & Room** : 2E (Aug.22, 17:40-19:20) @E803

**Type** : Contributed Talk

**Abstract** : Human activity recognition (HAR) using inertial motion streaming has gained a lot of momentum in

recent years. This has been driven by smart environments and the ubiquity of inertial-motion sensors in modern

commodity devices. HAR applications span all aspects of human life such as healthcare, sports, manufacturing, etc. In this talk we give a brief description of the state-of-the-art work in HAR including

action recognition, biometrics analysis (gender, age,...), sensor's location determination, gait analysis, etc.

**Classification** : 68T01, 68T05, 92C47

**Format** : Talk at Waseda University

**Author(s)** : Walid Gomaa (Egypt Japan University of Science and Technology)

## **[00314] The Orthogonal Spline Collocation Method for Parabolic Problems with Interfaces**

**Session Time & Room** : 1E (Aug.21, 17:40-19:20) @E702

**Type** : Contributed Talk

**Abstract** : The parabolic problems with interfaces are solved using a method in which orthogonal spline collocation (OSC) is employed for the spatial discretization and the Crank–Nicolson method for the time-stepping. The derivation of the method is described in detail for the case in which cubic monomial basis functions are used in the development of the OSC discretization. The results of extensive numerical experiments involving examples from the literature are presented.

**Classification** : 65M06, 65M22, 65M55, 65M70, 35K05

**Format** : Talk at Waseda University

**Author(s)** : Danumjaya Palla (BITS-Pilani KK Birla Goa Campus)Santosh Kumar Bhal (Centurion University of Technology and Management)Graeme Fairweather (Mathematical Reviews, American Mathematical Society)

## **[00320] Sensing the electrical world: modelling to understand aerial electroreception**

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @D514

**Type** : Contributed Talk

**Abstract** : Bees and spiders (and other arthropods) can sense naturally occurring electrical fields. This recent discovery expands our view of how such organisms explore their environments, revealing previously unknown sensory capabilities.

This talk consists of three topics: 1) the physical and biological feasibility of this sense, 2) how interactions between sensory hairs alter their sensitivity to different stimuli, and 3) the new sensory possibilities (e.g., object identification) and biological implications of this sense (e.g., decision-making).

**Classification** : 92C10, 92C05, 74F10, 92C42

**Format** : Talk at Waseda University

**Author(s)** : Ryan Palmer (University of Bristol)Daniel Robert (University of Bristol)Isaac Chenchiah (University of Bristol)

## **[00321] Modeling of hydromagnetic unsteady flow over a upright plate using Pseudospectral method**

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @D404

**Type** : Contributed Talk

**Abstract** : This study looks at the effects of a crosswise magnetic field along with thermal radiation proceeding the unsteady two-dimensional magneto hydrodynamic viscous flow, electrically insulating, and Newtonian fluid across an upright plate next to a Darcian rule. For governing equations, Pseudospectral Method is used. In this inquiry, the governing non-linear, coupled partial differential equations are decoded using Pseudospectral scheme that is reliable, effective, and has undergone substantial validation. The technique's precision and efficacy are proven.

**Classification** : 80Axx, 80Mxx, 80M22

**Format** : Online Talk on Zoom

**Author(s)** : Anju Saini (Graphic Era (Deemed to be University) Dehradun)

## [00326] Estimating the lowest-order eigenvalue in Sturm-Liouville boundary value problem

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @G401

**Type** : Contributed Talk

**Abstract** : We investigate a special case of the Sturm–Liouville boundary value problem (BVP) and examine the BVP in the

Schrödinger form. By considering a reciprocal quadratic form of the corresponding invariant function, we estimate the

lowest-order eigenvalue without solving the eigenvalue problem but by utilizing the localized landscape and effective

potential functions. Some combinations of parameter values yield poor spectrum estimates. Other combinations are

satisfactorily although the values tend to overestimate results from numerical computations.

**Classification** : 34B05, 34B24, 34L15

**Format** : Talk at Waseda University

**Author(s)** : Natanael Karjanto (Sungkyunkwan University)

## [00327] COBIT As An Information Governance Framework

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @D402

**Type** : Contributed Talk

**Abstract** : This contributed talk aimed to present the information governance frameworks , In order to answer to the problem of the study, first we will present the information governance definition and importance, the information governance frameworks, then we'll show the COBIT as one of the important frameworks, its benefits and its principles, finally the study concluded that COBIT is a framework that ensure an optimum information technology.

**Classification** : 93Dxx, 93Axx, 93-00

**Format** : Online Talk on Zoom

**Author(s)** : Amina Feddaoui (Chadli Bendjedid university el tarf)

## [00328] Schrödinger map and Multifractality

**Session Time & Room** : 1E (Aug.21, 17:40-19:20) @E702

**Type** : Contributed Talk

**Abstract** : In this talk, we will explore the richness of the Schrödinger map equation by discussing some recent results on its evolution in both hyperbolic and Euclidean geometrical settings. In the latter case, the equivalent form of the equation describes the motion of a vortex filament, e.g., smoke rings, tornadoes, etc. With numerical, theoretical techniques, we will show that when the filament curve initially has corners, its evolution and the trajectory of its corners exhibit multifractality.

**Classification** : 65M06, 28A80, 11L05, 65M20, 35Q55, Mathematical physics, Numerical methods, Schrödinger-type equations, Hyperbolic space

**Format** : Talk at Waseda University

**Author(s)** : Sandeep Kumar (CUNEF University)Luis Vega (Basque Center for Applied Mathematics)Francisco de la Hoz (The University of the Basque Country)

## [00329] A-posteriori error estimates for parabolic optimal control problems with controls acting on lower dimensional manifolds

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @F312

**Type :** Contributed Talk

**Abstract :** In this talk, we shall present a-posteriori error estimates for the fully discrete finite element approximation to the optimal control problem governed by parabolic partial differential equations where the control is acting on lower dimensional manifolds. We use piecewise linear and continuous finite elements for the approximations of state and adjoint variables whereas piecewise constant functions are employed to approximate the control variable. Moreover, the time derivative is approximated by using the backward Euler scheme. We derive a-posteriori error estimates for the various dimensions of the manifold. Numerical results reveal the effectiveness of the error estimators.

**Classification :** 49J20, 49K20, 65N15, 65N30

**Format :** Talk at Waseda University

**Author(s) :** Rajen Kumar Sinha (Indian Institute of Technology Guwahati) Ram Manohar (Indian Institute of Technology Kanpur)

## **[00331] Mathematical modelling of fluid-particle interaction**

**Session Time & Room :** 3D (Aug.23, 15:30-17:10) @E820

**Type :** Contributed Talk

**Abstract :** Fluid-particle interactions are fundamental to many problems in industry and biology, for example aircraft icing, where ice adheres to aircraft, and the movement of drugs/thrombi in blood. Mathematical modelling and asymptotic methods can be used to reduce such problems to simple ODEs and PDEs which can be solved to reveal an intriguing variety of particle motions. Current work includes an ice particle submerged in water, and a particle in lubrication flow with application to blood.

**Classification :** 76B10, 76D08, 76D09, 76M45

**Author(s) :** Ellen Mary Jolley (UCL)

## **[00334] A generalized study of the distribution of buffer over calcium on a fractional dimension**

**Session Time & Room :** 3E (Aug.23, 17:40-19:20) @G305

**Type :** Contributed Talk

**Abstract :** Here, we focus on cellular calcium fluctuations with different buffers, including calcium-binding buffers, using the Hilfer fractional advection-diffusion equation for cellular calcium. By combining with intracellular free calcium ions, buffers reduce the cytosolic calcium concentration. Models are developed for association, dissociation, diffusion, and buffer concentration. In comparison to the conventional calcium model, the modified Hilfer calcium model offers a richer physical explanation. Numerical simulations are also carried out in MATLAB.

**Classification :** 26A33, 35Q92, 44A10, 92C99

**Format :** Online Talk on Zoom

**Author(s) :** Sanjay Bhattar (Malaviya National Institute of Technology Jaipur) Kamlesh Jangid (Central University of Rajasthan, Ajmer) Shyamsunder - (Malaviya National Institute of Technology Jaipur) Sunil Dutt Purohit (Rajasthan Technical University, Kota) Dumitru Baleanu (Cankaya University, Ankara) Daya Lal Suthar (Wollo University)

## **[00335] Fractional Relaxation-Oscillation and Fractional Biological Population Equations: Applications of the Elzaki Decomposition Method**

**Session Time & Room :** 3C (Aug.23, 13:20-15:00) @F311

**Type :** Contributed Talk

**Abstract :** In various suitable habitat scenarios, the Elzaki decomposition method is used to handle the fractional order relaxation and damped oscillation equation along with the time-fractional spatial diffusion biological population model. According to the graphs for the found solutions, fractional relaxation is a super-slow phenomenon due to its protracted descent, and fractional damped oscillation is an intermediate process that explains damped oscillation dynamic systems generated by some

attenuated oscillations. The biological population model of time-fractional spatial diffusion portrays a rapid increase in population density in an ecosystem migrating from an unfavourable zone to a good habitat.

**Classification** : 26A33, 33E12, 35A22, 34C26, 60J70

**Format** : Online Talk on Zoom

**Author(s)** : Daya Lal Suthar (Wollo University)

## **[00337] Extending Matrix-less Methods for Eigenvalues and Eigenvectors**

**Session Time & Room** : 4D (Aug.24, 15:30-17:10) @E508

**Type** : Contributed Talk

**Abstract** : Toeplitz and Toeplitz-like matrices arise in many fields; of special interest are the discretisations of differential equations. Matrix-less methods exploit the fact that we can view these Toeplitz(-like) matrices as part of a sequence of matrices and that the eigenvalues in the sequence behave as samplings of a function, called the symbol. We will discuss recent developments to handle the case of variable coefficient matrices, the approximation of eigenvectors, and Toeplitz(-like) matrices with non-monotone symbols.

**Classification** : 65F15, 15B05, 15A18

**Format** : Talk at Waseda University

**Author(s)** : David Meadon (Uppsala University)

## **[00339] Using Numerical Modeling two phase flow Method in evaporator design**

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @D403

**Type** : Industrial Contributed Talk

**Abstract** : Evaporator is a critical component in integration of simple cycle gas turbine into combined cycle power plant. Evaporator should be designed in accurate way depend on thermal parameters (gas & water). The method developed for design evaporator of Baiji gas power plant in Iraq. The method based on modeling two phase flow by combination of three governing equations of energy conservation, Mass conservation and momentum conservation equation with numerical simulation using finite difference method.

**Classification** : 80-xx, 80-10

**Format** : Talk at Waseda University

**Author(s)** : Maher Saab Salamah (Ministry of Electricity / Iraq)

## **[00344] Forced convection from an isothermal square cylinder in shear flow**

**Session Time & Room** : 2C (Aug.22, 13:20-15:00) @D401

**Type** : Contributed Talk

**Abstract** : Forced convection from an uniformly heated square cylinder placed in linear shear flow of constant properties fluid is numerically investigated at Reynolds number,  $Re=100$ , shear rate,  $K=0.0-0.2$  and Prandtl number,  $Pr=0.5$ . The two-dimensional mathematical equations of flow motion and energy are solved using a higher order compact (HOC) finite difference scheme on Cartesian grids. The effect of  $K$  is investigated on flow and thermal fields in terms of isotherm patterns, Nusselt number distributions etc. The resulting vortex shedding phenomena behind the cylinder is detected and thermal field is determined.

**Classification** : 76D05

**Format** : Online Talk on Zoom

**Author(s)** : Atendra Kumar (National Institute of Technology Srinagar, India)



## [00348] Design of control for IT2 fuzzy stochastic systems with multi disturbances

**Session Time & Room** : 2E (Aug.22, 17:40-19:20) @D515

**Type** : Contributed Talk

**Abstract** : Anti disturbance control design problem is proposed for a class of interval type-2 fuzzy stochastic systems subject to uncertainty and multiple disturbances. A fuzzy exogenous system considers a new fuzzy disturbance observer to precisely evoke the properties of interval type 2 fuzzy stochastic models with multiple disturbances. In order to ensure the stochastic stability of the closed-loop fuzzy system, a new sufficient condition is constructed using the method of linear matrix inequalities by integrating the  $\text{Ito}$  operator and choosing the appropriate Lyapunov-Krasovskii functional candidate dissipativity performance index. Finally, the provided theory is demonstrated with the example.

**Classification** : 93Bxx, 93Exx, 93Dxx

**Format** : Online Talk on Zoom

**Author(s)** : Aarthi Subramanian (Research Scholar, Anna University Regional Campus Coimbatore) Marshal Anthoni S (Anna University Regional Campus Coimbatore)

## [00362] Nonlinear biphasic mixture model: existence and uniqueness results

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @D402

**Type** : Contributed Talk

**Abstract** : The purpose of this study is to develop a multiphase mathematical model based on interstitial hydrodynamics and tissue deformation mechanics within an in vitro solid tumor. We use classical mixture theory to derive the balance equations for mass and momentum. The study makes a significant contribution by treating hydraulic resistivity as anisotropic and heterogeneous, which leads to strongly coupled and nonlinear PDEs. We further establish existence and uniqueness result in a weak sense.

**Classification** : 76Txx, 76Zxx, 35Q74, 35D30, Analysis of nonlinear partial differential equations

**Format** : Talk at Waseda University

**Author(s)** : Meraj Alam (Mahindra University, Hyderabad) Adrian Muntean (University of Karlstad) Raja Sekhar G P (Indian Institute of Technology Kharagpur India)

## [00363] Neighborhood effects, college education, and social mobility

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @G402

**Type** : Contributed Talk

**Abstract** : This study models the impact of environmental factors on upward social mobility, where the educational environment is measured by the proportion of college-educated individuals, and social mobility is measured by a change in the proportion of people in different income classes. The dynamics of the educational environment are modeled using a modified version of the invasion/extinction ecological model of Richard Levins. The educational environment influences the educational choices of poor people, becoming effective only after a threshold point is reached. The rate of growth in influence is modeled using a monotonically increasing saturation function, which includes a delay parameter referred to as handling time, that measures the speed of influence. Our simulations indicate that poor people choose to become educated at a rate that primarily depends on the density of the local environment.

**Classification** : 34-11, 37N40, 92B05

**Author(s)** : Cesar Montalvo (University of Virginia)

## [00365] Advancing Computerized Tomography: Deep-Learning based Regularization in Diffuse Optical Tomography

**Session Time & Room** : 2D (Aug.22, 15:30-17:10) @E709

**Type** : Contributed Talk

**Abstract** : X-rays Computed Tomography is a main pillar of medical imaging which at present is experiencing a strong innovation phase. While new tomographic systems try to minimize X-rays exposure, non-trivial challenges exist, mainly increased noise levels and the need for dealing with low and high contrast regions. In this talk we will refer about our research on new algorithms able to efficiently deal with this trade-off, with specific reference to Diffuse Optical Tomography.

**Classification** : 65Z05, 65N20, 65N80, 68T07

**Format** : Talk at Waseda University

**Author(s)** : Paola Causin (University of Milano )Andrea Aspri (University of Milano )

## [00374] Recent numerical and theoretical advances in the study of matrix sequences

**Session Time & Room** : 2E (Aug.22, 17:40-19:20) @G305

**Type** : Contributed Talk

**Abstract** : We present recent developments in the study of the spectral behaviour of structured matrix sequences. For example, all PDE discretizations, such as FEM, FDM, and DGM, generate these types of sequences. We will mainly discuss matrix-less methods for non-Hermitian sequences, where the generating symbol does not describe the eigenvalue distribution; we can now numerically approximate, with high accuracy, the spectral symbol describing the eigenvalue distribution. Standard double precision eigenvalue solvers typically fail for these matrices.

**Classification** : 15Axx, 35Pxx, 65Fxx

**Format** : Talk at Waseda University

**Author(s)** : Sven-Erik Ekström (Uppsala University)

## [00375] Modelling Typhoid Fever Transmission: Optimal control and Cost-Effectiveness Analysis

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @A601

**Type** : Industrial Contributed Talk

**Abstract** : Typhoid fever has been a public health challenge globally, most especially in the developing countries where sanitation and personal hygiene are not taken serious coupled with non-availability of safe-drinking water. In this paper, a deterministic mathematical model of direct and indirect mode of transmission of Typhoid fever dynamics is formulated to investigate the influence of limited clinical efficacy of antibiotics administer to patients suffering from the disease with optimal control and cost-effectiveness analysis.

Typhoid fever has been a public health challenge globally, most especially in the developing countries where sanitation and personal hygiene are not taken serious coupled with non-availability of safe-drinking water. In this paper, a deterministic mathematical model of direct and indirect mode of transmission of Typhoid fever dynamics is formulated to investigate the influence of clinical efficacy of antibiotics administer to patients suffering from the disease. The basic reproduction number is analytically computed, and existence and local stability condition of disease-free equilibrium is investigated. Subsequently, the global sensitivity analysis of the model parameters is computed. The optimal control and cost-effectiveness analysis were also computed. Our results suggest that hygiene practice and awareness campaign, and disinfection or sterilization or bacteria decay control is the most cost-effective in eliminating the disease from the population and from preventing the susceptible individuals from contracting the bacteria disease.

**Classification** : 92BXX, 92-XX, 92-10, 91-XX, 91-10, Mathematical modeling of infectious disease(Biomathematics)

**Author(s)** : kazeem Austin TIJANI (Federal University of Agriculture(J. S Tarka university), Makurdi)Chinwendu Emilian MADUBUEZE (Federal university of Agriculture Makurdi Nigeria )Iortyer Reuben GWERYINA (Federal university of Agriculture(J.S. Tarka University), Makurdi))

## **[00376] Adaptive Optimal Market-Making Strategies with Inventory Liquidation Costs**

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @A510

**Type** : Contributed Talk

**Abstract** : An optimal market-making strategy for a high-frequency market maker under a discrete-time Limit Order Book model is presented. Interestingly, the optimal market-making strategy adapts to the past arrivals of market orders, making it adapted to previous market information. Admissibility and optimality of the optimal strategy are also proved. Finally, we test our assumptions empirically and compare the optimal strategy to one used under a non-adaptive framework where only the “average” past information is considered.

**Classification** : 91G15, 93E20, 91B70, 91G30, 49J55

**Format** : Talk at Waseda University

**Author(s)** : Jonathan Allan Chávez Casillas (University of Rhode Island)José Enrique Figueroa López (Washington University in St. Louis)Chuyi Yu (Washington University in St. Louis)Yi Zhang (University of Illinois Urbana-Champaign)

## **[00383] A kernel-based method for Schrödinger bridges**

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @D514

**Type** : Contributed Talk

**Abstract** : We propose a kernel-based machine learning method for numerical solutions of Schrödinger's bridge problems. In this method, the terminal time distribution constraint is described by a kernel-based metric on the space of probability measures.

**Classification** : 93E20

**Format** : Talk at Waseda University

**Author(s)** : Yumiharu Nakano (Tokyo Institute of Technology)

## **[00388] Numerical solution of distributed order time-fractional diffusion equations.**

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @G601

**Type** : Contributed Talk

**Abstract** : In this work, we solved distributed order time-fractional diffusion equation with the help of a wavelet approximation scheme and the Gauss quadrature rule. First, we construct wavelet-based operational matrices of distributed order fractional derivatives and integer order derivatives. After the construction of the operational matrix apply the tau method and convert the original mathematical problem into a system of linear algebraic equations and solve the equations for finding the approximate solutions. For method validation, we have provided some test examples, convergence analysis, and error estimation, and verify with the existing scheme with one of the existing schemes.

**Classification** : 35J99, 65N35, 65N99

**Format** : Online Talk on Zoom

**Author(s)** : Yashveer Kumar (Indian Institute of Technology(BHU), Varanasi, India.)Vineet Kumar Singh (Department of Mathematical Sciences, Indian Institute of Technology (Banaras Hindu University), Varanasi, India.)

## [00393] Mathematical Modelling of Bilayered Cathodes for Lithium-Ion Batteries

**Session Time & Room** : 2D (Aug.22, 15:30-17:10) @E709

**Type** : Contributed Talk

**Abstract** : Bilayered cathodes are promising candidates to improve lithium-ion battery performance by optimising the electrode design. In this work, lithium iron phosphate and nickel manganese cobalt chemistries are connected in two discrete layers within a cathode, which improves the C-rate performance above 2C compared to uniform cells. To inform the design process we create mathematical model to accommodate multilayers. The model is solved numerically, validated against data and explains how each layer acts.

**Classification** : 35Qxx, 37Nxx

**Format** : Talk at Waseda University

**Author(s)** : Eloise Tredenick (University of Oxford)

## [00394] Numerical methods for option pricing: need and challenges

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @E504

**Type** : Contributed Talk

**Abstract** : The stability analysis of numerical methods is often challenging. In this talk, compact schemes are considered for the variable coefficient PDEs arising in option pricing. A sufficient condition for stability of the schemes has been derived using novel difference equation based approach. The condition number of amplification matrix is also analyzed, and an estimate for the same is derived. An example is provided using MATLAB to support the assumption taken to assure stability.

**Classification** : 65N12, 65N06, 65N15

**Format** : Talk at Waseda University

**Author(s)** : KULDIP SINGH PATEL (Indian Institute of Technology Patna)

## [00395] What can be the potential risk of Mpox outbreak in the endemic country?: Non-Markovian stochastic modeling study

**Session Time & Room** : 5B (Aug.25, 10:40-12:20) @A201

**Type** : Contributed Talk

**Abstract** : In 2022, the Mpox outbreak shocked the world, with a completely different pattern and scale compared to past incidences in non-endemic countries, more than 80,000 cases have been confirmed. In this talk, we present how we analyzed the risk of local spread using a non-Markovian stochastic model. Multiple factors, which are suspected to affect the early stage of the outbreak significantly, the contact tracing, self-report-related behavior of the primary case, and secondary infectees were examined.

**Classification** : 92D30, 60H30, 62M09

**Format** : Talk at Waseda University

**Author(s)** : Youngsuk Ko (Department of mathematics, Konkuk university)Victoria May Mendoza (Institute of Mathematics, University of the Philippines Diliman)Renier Mendoza (Institute of Mathematics, University of the Philippines Diliman)Yubin Seo (Hallym University College of Medicine)Jacob Lee (Hallym University College of Medicine)Eunok Jung (Department of mathematics, Konkuk University)

## [00396] A Stochastic Approach for the Computation of Large-Scale Matrix Functions

**Session Time & Room** : 5B (Aug.25, 10:40-12:20) @E505

**Type** : Contributed Talk

**Abstract** : Although many scientific problems can be described in term of functions over matrices, their high computational cost and the lack of parallel and scalable numerical tools propel scientists to seek alternative solutions. In this talk, we will introduce a Monte Carlo method that is capable of computing matrix functions for large-scale datasets and in particular present how it can be used to solve time-fractional differential equations.

**Classification** : 65C05, 35R11, 33E12, 60Gxx, 60K50

**Format** : Talk at Waseda University

**Author(s)** : Nicolas Guidotti (INESC-ID, Instituto Superior Técnico, Lisboa)

## [00397] A continuum model for the bulldozing of an immersed granular material in a confined geometry

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @E803

**Type** : Contributed Talk

**Abstract** : We present a reduced-order continuum model for the bulldozing of an immersed, sedimented granular material by a rigid piston in a fluid filled gap between two parallel plates. In our model, the granular pile and the overlying fluid layer evolves as coupled thin-films. We solve our model numerically for a variety of different scenarios to develop insight into the interactions between wall friction, internal viscous-like stresses, and fluid flow both above and through the pile.

**Classification** : 74-10, 76-10

**Format** : Talk at Waseda University

**Author(s)** : Liam Morrow (University of Oxford)Chris MacMinn (University of Oxford)

## [00398] Approximation of Abel type nonlinear fractional integral equations by the use of orthogonal polynomials

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @G601

**Type** : Contributed Talk

**Abstract** : The nonlinear fractional integral equations of the type Abel are presented in this study with general framework for determining the approximate solution. As basis functions, this method makes use of Lagrangian interpolating polynomials (LIPs) and shifting Legendre polynomials (SLPs). The original problem is converted into a system of algebraic nonlinear equations using operational matrices of SLPs and LIPs, which are first developed. We investigated at the provided techniques' stability and convergence under several significant conditions.

**Classification** : 35J99, 65N35, 65N99

**Author(s)** : Aman Singh (Department of Mathematical Sciences, Indian Institute of Technology (Banaras Hindu University))Vineet Kumar Singh (Department of Mathematical Sciences, Indian Institute of Technology (Banaras Hindu University))

## [00403] Exact Penalization at Stationary Points of Sparse Constrained Problem

**Session Time & Room** : 1E (Aug.21, 17:40-19:20) @F309

**Type** : Contributed Talk

**Abstract** : Nonconvex sparse optimization problems with the trimmed l1 norm or truncated nuclear norm, which is a penalty function of cardinality or rank constraint, have been actively studied. A unified framework that includes all the existing trimmed l1-penalized problems is introduced. We show

that under mild conditions, any d-stationary point of the penalized problem satisfies the corresponding constraint. Our result is superior to almost all existing results, especially from the viewpoint of practice.

**Classification** : 90C06, 90C26, 90C30, 90C46, 90C90

**Author(s)** : Shotaro Yagishita (Chuo University)Jun-ya Gotoh (Chuo University)

## [00408] Reducing Complexity of a Population Balance Model for Synthesis of Composite Polymer Particles

**Session Time & Room** : 1D (Aug.21, 15:30-17:10) @F311

**Type** : Contributed Talk

**Abstract** : An accurate prediction of the formation of polymer particles is vital for synthesis of high quality materials, but still not feasible due to its complexity. We present a Population Balance Equations model as a tool targeting the task. Aimed to enhance model performance, we derive a quantitative criterion for locating regions of “slow” aggregation among particles. Within such a regime, the aggregation terms can be neglected and computational efficiency improves by several orders of magnitude.

**Classification** : 45Kxx, 70-10, 92Exx

**Format** : Talk at Waseda University

**Author(s)** : Simone Rusconi (CUNEF Universidad)Christina Schenk (IMDEA Materials Institute)Arghir Zarnescu (Basque Center for Applied Mathematics)Elena Akhmatkaya (Basque Center for Applied Mathematics)

## [00414] Asymptotically Modelling Plastic Deformation during Cold Rolling of Sheet Metal

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @D102

**Type** : Contributed Talk

**Abstract** : Cold rolling is a metal forming process where strip of metal passes between two rollers and comes out

thinner. We present a multiple-scale asymptotic model of cold rolling. Assuming rigid perfectly-plastic material and large rolls, we explain how to rederive and go beyond existing theories. Results agree well with

FE simulations, and suggest the origin of residual stress in the resulting strip. This modelling approach has

potential applications in many metal forming processes.

**Classification** : 74C05, 74M10, 41A60, 35C20, 35Q74

**Author(s)** : Mozhddeh Erfanian (School of Mathematics, University of Warwick)Ed Brambley (School of Mathematics, University of Warwick)Francis Flanagan (Department of Mathematics and Statistics, University of Limerick)Doireann O'Kiely (Department of Mathematics and Statistics, University of Limerick)

## [00415] Finite time horizon mixed control of vibrational systems

**Session Time & Room** : 2E (Aug.22, 17:40-19:20) @D515

**Type** : Contributed Talk

**Abstract** : We consider a vibrational system control problem over a finite time horizon. The performance measure of the system is taken to be  $p$ -mixed  $H_2$  norm which generalizes the standard  $H_2$  norm. Our novel procedure efficiently takes into account the structure of the vibrational system. An objective function is represented in terms of integrals which are solved using adaptive quadrature rules. We illustrate our approach by numerical examples concerning an  $n$ -mass oscillator with one damper.

**Classification** : 93C05, 93C15, 74D99, 70Q05

**Format** : Talk at Waseda University

**Author(s)** : Zoran Tomljanovic (University of Osijek, Department of Mathematics)Ivica Nakic

(Department of Mathematics, University of Zagreb)Marinela Pilj Vidakovic (University of Osijek,  
Department of Mathematics)

## **[00423] Understanding elastic-plastic stress distributions during cold rolling of sheet metal**

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @D102

**Type** : Contributed Talk

**Abstract** : In cold rolling, a metal sheet is passed between two rotating rollers which reduce the thickness of the sheet. In this talk, we present our new elastic-plastic mathematical model for describing the stress distribution during cold rolling, which is an extension of some existing asymptotic models, where elastic effects are neglected. At leading order, our model returns the popular slab-type analysis, but at higher orders, through-thickness variations can be predicted accurately.

**Classification** : 74C05, 74M10, 41A60, 35C20, 35Q74

**Format** : Talk at Waseda University

**Author(s)** : Francis Flanagan (Department of Mathematics and Statistics, University of Limerick)Doireann O'Kiely (Department of Mathematics and Statistics, University of Limerick)Alison O'Connor (School of Engineering, Bernal Institute, University of Limerick)Mozhdeh Erfanian (School of Mathematics, University of Warwick)Ed Brambley (School of Mathematics, University of Warwick)

## **[00424] A Hydrodynamic Model for Active Polar Liquid Crystals**

**Session Time & Room** : 5B (Aug.25, 10:40-12:20) @D101

**Type** : Contributed Talk

**Abstract** : We present a hydrodynamic model of active polar liquid crystals. We consider sheared active polar liquid crystals, and study dynamics of the polar order and shear rheology of the system. We show that shear may increase or decrease the polarization magnitudes. We derive the apparent viscosity formula showing a regime of negative apparent viscosity and a superfluid behavior for pushers. Our results echo previous results from numerical simulations and experiments.

**Classification** : 76A15, 76A05

**Format** : Talk at Waseda University

**Author(s)** : Zhenlu Cui (Fayetteville State University)

## **[00427] Numerical Analysis of Finite dimensional approximations in Finite Temperature DFT**

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @G709

**Type** : Contributed Talk

**Abstract** : We study the numerical approximation of the ground state solution in finite temperature density functional theory. We formulate the problem with respect to the density matrix, and justify the convergence of the numerical approximations of the ground state. Finally, we give a quasi-optimal a priori error estimate with some mild assumptions. We also present some numerical experiments to support the theory.

**Classification** : 35Q55, 65N15, 65N25, 65N30

**Format** : Talk at Waseda University

**Author(s)** : Ge Xu (Beijing Normal University)

## [00429] Mathematical Theory to Maximize Enzymatic Activity Under Thermodynamic Constraints

**Session Time & Room** : 1C (Aug.21, 13:20-15:00) @D515

**Type** : Contributed Talk

**Abstract** : Understanding the relationship between enzymatic activity is critical not only for bioengineering, but also for rationalizing enzyme optimization in nature. Here, we applied the Arrhenius and Bronsted-Evans-Polanyi equations to the Michaelis-Menten model of enzyme catalysis, and show that enzymatic activity is maximized when the binding affinity between the enzyme and the substrate ( $K_m$ ) is equal to the substrate concentration.

**Classification** : 92C45

**Format** : Talk at Waseda University

**Author(s)** : Hideshi Ooka (RIKEN)Yoko Chiba (RIKEN)Ryuhei Nakamura (RIKEN)

## [00430] Nearest singular pencil via Riemannian optimization

**Session Time & Room** : 1E (Aug.21, 17:40-19:20) @G304

**Type** : Contributed Talk

**Abstract** : The problem of finding the nearest complex (real) singular pencil can be cast as a minimization problem over the manifold  $U(n) \times U(n)$  via the generalized Schur form. This novel perspective yields a competitive numerical method by pairing it with an algorithm capable of doing optimization on a Riemannian manifold.

**Classification** : 15A22

**Format** : Talk at Waseda University

**Author(s)** : Lauri Nyman (Aalto University)

## [00433] Markov Decision Processes under Model Uncertainty

**Session Time & Room** : 4C (Aug.24, 13:20-15:00) @A207

**Type** : Contributed Talk

**Abstract** : We introduce a general framework for Markov decision problems under model uncertainty in a discrete-time infinite horizon setting.

By providing a dynamic programming principle we obtain a local-to-global paradigm, namely solving a local, i.e., a one time-step robust optimization problem leads to an optimizer of the global (i.e. infinite time-steps) robust stochastic optimal control problem, as well as to a corresponding worst-case measure.

Moreover, we apply this framework to portfolio optimization involving data of the S&P 500. We present two different types of ambiguity sets; one is fully data-driven given by a Wasserstein-ball around the empirical measure, the second one is described by a parametric set of multivariate normal distributions, where the corresponding uncertainty sets of the parameters are estimated from the data.

It turns out that in scenarios where the market is volatile or bearish, the optimal portfolio strategies from the corresponding robust optimization problem outperforms the ones without model uncertainty, showcasing the importance of taking model uncertainty into account.

**Classification** : 90C40, 91G10, Robust Finance

**Format** : Talk at Waseda University

**Author(s)** : Julian Sester (National University of Singapore)Ariel Neufeld (Nanyang Technological University)Mario Šikić (University of Zurich)



## [00434] Three pieces Riemann problem for 2-D full Euler system in the Noble-Abel gas

**Session Time & Room** : 4D (Aug.24, 15:30-17:10) @G602

**Type** : Contributed Talk

**Abstract** : We present Riemann problem governed by 2-D full Euler system in the Noble-Abel gas. Riemann data, consisting three constants, are distributed in three distinct regions with an assumption that two adjoining regions can be connected by only one planar elementary wave. We present criteria for existence of different configurations of elementary waves for isentropic, as well as full, Euler system. We also discuss the effect of the Noble-Abel gas and the angle of regions on elementary waves and corresponding stream curves.

Note: The present article has been published on 17 May 2022 in the journal "Mathematical Methods in the Applied Sciences"/ Volume 45, Issue 16 with DOI:10.1002/mma.8377.

**Classification** : 35L65, 35L67, 35Q30, 35Q31, 35Q35, Hyperbolic Conservation Laws, Shocks and Singularities for Hyperbolic equations, Navier-Stokes equations, Euler equations, PDEs in connection with fluid mechanics.

**Format** : Talk at Waseda University

**Author(s)** : Harsita Srivastava (Dr. B. R. Ambedkar National Institute of Technology Jalandhar, Punjab)M. Zafar (Dr. B. R. Ambedkar National Institute of Technology Jalandhar, Punjab)

## [00438] Network stability in co-evolved spatially-explicit model ecological communities

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @A511

**Type** : Contributed Talk

**Abstract** : The self-assembly of ecological communities on complex spatial networks from an initial species can be mathematically modelled by a combination of ecological and evolutionary processes. We investigate how the topology of the spatial network influences the structure of the co-evolved populations, and hence the stability of the resulting meta-community of species against perturbations including invasion, extinction, patch removal, and alterations to the spatial environment. In response, different nature reserve configurations can simulate biodiversity conservation strategies.

**Classification** : 92-10, 37N25

**Format** : Online Talk on Zoom

**Author(s)** : Gavin Michael Abernethy (University of Stirling)

## [00439] Successive Approximations for Fractional BVPs with Non-local Boundary Conditions

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @G306

**Type** : Contributed Talk

**Abstract** : In joint work with Dr. Kateryna Marynets, we adapt a numerical-analytic technique for constructing approximations to a system of nonlinear fractional differential equations with integral boundary conditions. The boundary conditions are parametrized, and the parameter values, which govern the solution's behavior, are calculated numerically. The convergence of the method is improved using a dichotomy-type approach, and its applicability is extended to a wider class of problems. Our results are confirmed by a model example.

**Classification** : 34A08, 34B10, 37M99, Fractional boundary value problems

**Format** : Talk at Waseda University

**Author(s)** : Dona Pantova (TU Delft)Kateryna Marynets (TU Delft)

## [00440] SIMULATION OF SHALLOW WATER EQUATIONS WITH DEPTH PERTURBATIONS AND WITH AND WITHOUT THE CORIOLIS EFFECT

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @D502

**Type** : Contributed Talk

**Abstract** : Shallow water equations are a system of partial differential equations that describe the superficial layer of a fluid with hydrostatic equilibrium derived from the Navier-Stokes equations which are used to describe fluid movements based on characteristics such as density, etc. We perform simulations of the evolution of water surface with various bottom variations, with and without the Coriolis effect using finite differences to analyze and understand how these variations affect the fluid dynamics.

**Classification** : 76-02, 76-05, 76-10, 68R99

**Format** : Talk at Waseda University

**Author(s)** : Daniel Francisco Sanabria Bernal (Universidad Militar Nueva Granada)  
Maria Isabel Romero Rodriguez (Universidad Militar Nueva Granada)

## [00442] On the dynamical properties of a max-plus model identified with the Lozi map

**Session Time & Room** : 2E (Aug.22, 17:40-19:20) @G709

**Type** : Contributed Talk

**Abstract** : We focus on a max-plus discretized model that is identified with the Lozi map in this talk. The max-plus model can be derived from the generalized Sel'kov model composed of non-linear differential equations via tropical discretization and ultradiscretization. Based on the Poincare mapping method and the estimation of Lyapunov exponents, the dynamical properties of the max-plus model and its transformation from the generalized Sel'kov model are discussed.

**Classification** : 37M20, 37M15, 65P40, 68Q80, 37J70

**Format** : Talk at Waseda University

**Author(s)** : Shousuke Ohmori (Waseda University) Yoshihiro Yamazaki (Waseda University)

## [00446] Beyond Empirical Risk Minimization: Minimax Risk Classifiers

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @E711

**Type** : Contributed Talk

**Abstract** : The empirical risk minimization (ERM) approach for supervised learning has been the workhorse of machine learning. However, ERM methods strongly rely on the specific training samples available and cannot easily address scenarios affected by distribution shifts and corrupted samples. This talk presents a learning framework based on the generalized maximum entropy principle that leads to minimax risk classifiers (MRCs). MRC learning is based on expectation estimates and does not strongly rely on specific training samples.

**Classification** : 68Q32, 68T05, 68T37, 68T01, Machine Learning, Supervised Classification

**Format** : Talk at Waseda University

**Author(s)** : Santiago Mazuelas (Basque Center for Applied Mathematics (BCAM))

## [00451] Transmission problems for composite layered elastic structures containing interfacial cracks

**Session Time & Room** : 5C (Aug.25, 13:20-15:00) @G302

**Type** : Contributed Talk

**Abstract** : We investigate mixed transmission problems of the generalized thermo-electro-magneto elasticity theory for complex elastic multi-layered structures containing interfacial cracks. We apply the potential method and the theory of pseudodifferential equations and analyze smoothness properties and asymptotic behaviour of solutions near the edges of cracks and near the curves where different type boundary conditions collide. We describe the stress singularity exponents explicitly.

**Classification** : 74A15, 74H35, 74F05, 74F15

**Format** : Talk at Waseda University

**Author(s)** : David Natroshvili (Georgian Technical University)

## [00456] Network representations of attractors for surrogates generation and change detection

**Session Time & Room** : 2E (Aug.22, 17:40-19:20) @G709

**Type** : Contributed Talk

**Abstract** : Attractors arising from delay embedded time-series can characterise system dynamics. However, extracting useful representations is challenging for systems with high-dimensional or complex structure. We propose a data-driven method to represent attractors as networks, where dynamics are encoded as node transition probabilities. The usefulness of this representation is demonstrated in two tasks: (1) surrogate data generation; and (2) change point detection. These methods are applied to chaotic time-series, and experimental ECG data for heart attack detection.

**Classification** : 37M10, 37M22, 94C12

**Format** : Talk at Waseda University

**Author(s)** : Eugene Tan (The University of Western Australia)Shannon Dee Algar (The University of Western Australia)Debora Correa (The University of Western Australia)Thomas Stemler (The University of Western Australia)Michael Small (The University of Western Australia)

## [00457] On limit cycles of discrete dynamical systems with positivity

**Session Time & Room** : 2E (Aug.22, 17:40-19:20) @G709

**Type** : Contributed Talk

**Abstract** : We focus on limit cycles of discretized Sel'kov model derived from continuous Sel'kov model via tropical discretization. The discretized model possesses a parameter for time step. We numerically found, by varying the parameter, that density profile of phase in the limit cycles transits between continuous and ultradiscrete, and that the ultradiscrete state corresponds to a max-plus dynamical system. In this talk, we discuss these findings from the viewpoint of nonlinear dynamical systems.

**Classification** : 37M20, 37M15, 65P40, 68Q80, 37J70, ultradiscretization, max-plus dynamical system, bifurcation

**Format** : Talk at Waseda University

**Author(s)** : Yoshihiro Yamazaki (Waseda University)Shousuke Ohmori (Waseda University)

## [00459] Tropical linear regression and mean payoff games: or, how to measure the distance to equilibria

**Session Time & Room** : 2E (Aug.22, 17:40-19:20) @G304

**Type** : Contributed Talk

**Abstract** : We study a tropical linear regression problem consisting in finding a best approximation of a set of points by a tropical hyperplane. We establish a strong duality theorem, showing that the value of this problem coincides with the maximal radius of a Hilbert's ball included in a tropical polyhedron. We show that this problem is polynomial-time equivalent to mean payoff games. We illustrate our results by solving an inverse problem from auction theory.

**Classification** : 14T90, 91A25, 91B26

**Format** : Talk at Waseda University

**Author(s)** : Omar Saadi (College of Computing, Mohammed VI Polytechnic University)Marianne Akian (INRIA and CMAP, École polytechnique)Stéphane Gaubert (INRIA and CMAP, École polytechnique)Yang Qi (INRIA and CMAP, École polytechnique)

## [00460] A Multigrid Method for Many-Electron Schrodinger Equations with ACE

**Session Time & Room** : 3D (Aug.23, 15:30-17:10) @E606

**Type** : Contributed Talk

**Abstract** : We parameterize the many-electron wave functions by atomic cluster expansion (ACE) approach and calculate ground-state energies and electron densities of some molecule systems within the variational Monte Carlo framework. Compared with the neural-network-based representations, the novelty of our method lies in (i) a convenient and accurate linear polynomial expansion; (ii) a hierarchical structure that applies naturally to a multigrid variation; and (iii) possibly revealing the correlation of the system by increasing the body-order.

**Classification** : 35Q40, 65N25, 65N35, 81Q05

**Format** : Talk at Waseda University

**Author(s)** : Dexuan Zhou (Beijing Normal University)

## [00461] hp/Spectral Element Methods for Elliptic Boundary Layer Problems

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @E709

**Type** : Contributed Talk

**Abstract** : Elliptic boundary layer problems arise in many applications including fluid dynamics, gas dynamics, plate and shell problems in structural mechanics, modeling of semiconductor devices and many more.

We propose a least-squares hp-spectral element method for 1D elliptic boundary layer problems. The regularity estimates are stated and the main stability theorem is obtained using non-conforming spectral element functions. For the hp-version we use a 3 element mesh which allows us to resolve the boundary layers completely by placing very thin needle like elements near the boundary layer and a coarse mesh away from the layer. Numerical scheme and error estimates are obtained which are robust i.e. independent of the boundary layer parameter and decay exponentially in terms of the degree of the approximating polynomials. Numerical results confirm convergence results with various combinations of the boundary layer thickness, degrees of the approximating polynomials, and layers in the mesh.

**Classification** : 65N35, 65N20, 65N50

**Author(s)** : Akhlaq Husain (Jamia Millia Islamia New Delhi)Akhlaq Husain (BML Munjal University Gurgaon)

## [00463] A kinetic model of crowd evacuation dynamics coupled with infectious disease contagion

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @A511

**Type** : Contributed Talk

**Abstract** : We propose a kinetic theory model coupling crowd evacuation and disease spreading. Movement of individuals is modeled by a description of interactions among individuals. Interactions among healthy and infectious individuals may generate disease spreading if exposure time is long enough. Immunization of the population and awareness to contagion is also considered. The model is qualitatively studied and different scenarios related to gathering formation within indoor venues under the spread of an infectious disease are explored.

**Classification** : 92-10, 92C60, 92D30

**Format** : Talk at Waseda University

**Author(s)** : Juan Pablo Agnelli (CIEM CONICET & FaMAF Universidad Nacional de Córdoba) Bruno Buffa (FaMAF Universidad Nacional de Córdoba) Damian Alejandro Knopoff (CONICET, Argentina & Intelligent Biodata SL, Spain) German Torres (IMIT CONICET & FaCENA UNNE)

## [00464] Predicting the role of poroelastic coatings for cell therapies via an asymptotic approach

**Session Time & Room** : 1C (Aug.21, 13:20-15:00) @D515

**Type** : Contributed Talk

**Abstract** : Cell therapies are a promising alternative for treating liver disease. Encapsulation modulates the mechanical cues inflicted on a cell, which can increase engraftment at the injury site. We model an individual, hydrogel-coated stem cell translating axially along a fluid-filled channel due to a Stokes flow, obtaining semi-analytic solutions in the limit of a stiff coating. We conduct a parametric study to predict the role of coatings and discuss implications for biological cells.

**Classification** : 92C37, Poroelasticity, Fluid-structure interaction, asymptotics

**Format** : Talk at Waseda University

**Author(s)** : Simon Mark Finney (University of Oxford) Sarah Louise Waters (University of Oxford) Andreas Muench (University of Oxford) Matthew Gregory Hennessy (University of Bristol)

## [00469] A Mathematical and Exploratory Data Analysis of Malaria Disease Transmission Through Blood Transfusion

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @A511

**Type** : Contributed Talk

**Abstract** : Malaria is a mosquito-borne disease spread by an infected vector (infected female Anopheles mosquito) or through transfusion of plasmodium-infected blood to susceptible individuals. The disease burden has resulted in high global mortality, particularly among children under the age of five. Many intervention responses have been implemented to control malaria disease transmission, including blood screening, Long-Lasting Insecticide Bed Nets (LLIN), treatment with an anti-malaria drug, spraying chemicals/pesticides on mosquito breeding sites, and indoor residual spray, among others. As a result, a SIR (Susceptible - Infected - Recovered) model is developed to study the impact of various malaria control and mitigation strategies. The associated basic reproduction number and stability theory is used to investigate the stability analysis of the model equilibrium points. The global stability of the malaria-free equilibrium is investigated by constructing an appropriate Lyapunov function. By determining the direction of bifurcation, the implicit function theorem is used to investigate the stability of the model endemic equilibrium. Using R and MATLAB, the model is fitted to malaria data from Benue State, Nigeria. Estimates of parameters were made. An optimal control model is then developed and analyzed using Pontryagin's Maximum Principle. The malaria-free equilibrium point is locally and globally stable if the basic reproduction number  $(R_0)$  and the blood transfusion reproduction number  $(R_{\alpha})$  are both less or equal to unity. The study of the sensitive parameters of the model revealed that the transmission rate of malaria from mosquito-to-human

$\beta_{mh}$ , transmission rate from humans-to-mosquito  $\beta_{hm}$ , blood transfusion reproduction number  $R_{\alpha}$  and recruitment rate of mosquitoes  $b_m$  are all sensitive parameters capable of increasing the basic reproduction number  $R_0$  thereby increasing the risk in spreading malaria disease. The result of the optimal control shows that five possible controls are effective in reducing the transmission of malaria. The study recommended the combination of five controls, followed by the combination of four and three controls is effective in mitigating malaria transmission. The result of the optimal simulation also revealed that for communities or areas where resources are scarce, the combination of Long Lasting Insecticide Treated Bednets  $u_2$ , Treatment  $u_3$ , and Indoor insecticide spray  $u_5$  is recommended. Numerical simulations are performed to validate the model's analytical results.

**Classification** : 93-xx, 93-10, Mathematical modeling or simulation for problems pertaining to systems and control theory

**Author(s)** : Michael Olaniyi Adeniyi (Lagos State University of Science and Technology)Raphael Oluwaseun Aderele (Lagos State University of Science and Technology )Olajumoke Y Oludoun (Department of Mathematics, Bowen University, Iwo, Nigeria)Matthew Iwada Ekum (Lagos State University of Science and Technology)Segun Isaac Oke (Department of Mathematics, Ohio University, Athens, OH 45701-2979, USA)

## [00470] Mathematical and Exploratory Data Analysis on Blood Transfusion Transmitted Malaria

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @A511

**Type** : Contributed Talk

**Abstract** : Malaria is a disease spread by an infected mosquito or through transfusion of plasmodium-infected blood to susceptible individuals. Many interventions have been implemented to control malaria transmission, including blood screening, Long-Lasting Insecticide Bed Nets (LLIN), treatment with an anti-malaria drug, spraying chemicals/pesticides on mosquito breeding sites, and indoor residual spray, among others. As a result, a deterministic model is developed to study the impact of various malaria control and mitigation strategies against malaria transmission.

**Classification** : 93-xx, 93-10, Mathematical modeling or simulation for problems pertaining to systems and control theory

**Author(s)** : Michael Olaniyi Adeniyi (Lagos State University of Science and Technology)Raphael Oluwaseun Aderele (Lagos State University of Science and Technology )Olajumoke Y Oludoun (Department of Mathematics, Bowen University, Iwo, Nigeria)Matthew Iwada Ekum (Lagos State University of Science and Technology)Segun Isaac Oke (Department of Mathematics, Ohio University, Athens, OH 45701-2979, USA)

## [00476] Hierarchical Sampling Techniques and Goal-Oriented Adaptive Finite Element for Elliptic PDE with Lognormal Coefficients

**Session Time & Room** : 5B (Aug.25, 10:40-12:20) @E505

**Type** : Contributed Talk

**Abstract** : We propose our Adaptive Multilevel Monte Carlo (AMLMC) method to solve an elliptic partial differential equation with lognormal random input data where the PDE model has geometry-induced singularities.

This work combines (MLMC) and the dual-weighted-residual goal-oriented adaptive finite element. Specifically, for a given input coefficient realization and an accuracy level, the (AMLMC) constructs its approximate sample as the ones using the first mesh in the sequence of pre-generated, non-uniform meshes satisfying the sample-dependent bias constraint.

**Classification** : 65C05, 65N50, 65N22, 35R60

**Format** : Talk at Waseda University

**Author(s)** : Joakim Beck (King Abdullah University of Science and Technology)Yang Liu (King

Abdullah University of Science and Technology)Erik von Schwerin (King Abdullah University of Science and Technology)Raul Tempone (King Abdullah University of Science and Technology)

## **[00477] Relaxation process of Cahn–Hilliard equations with dynamic boundary conditions**

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @E702

**Type** : Contributed Talk

**Abstract** : This talk is concerned with a numerical analysis of the initial value problem for the Cahn–Hilliard equation with dynamic boundary conditions in one-dimensional space, using a structure preserving scheme based on the discrete variational derivative method. We discuss the relationship between the parameter related to the time evolution on the boundary and the time it takes for the numerical solution to approach a stationary solution.

**Classification** : 65M22, 82C26, 65M06

**Format** : Talk at Waseda University

**Author(s)** : Keiichiro Kagawa (RIES, Hokkaido University)Yoshihiro Yamazaki (Waseda University)

## **[00480] Mathematics, the Mind and Alzheimer's disease: Systematical progression on brain graphs**

**Session Time & Room** : 3D (Aug.23, 15:30-17:10) @A601

**Type** : Contributed Talk

**Abstract** : Neurodegenerative diseases, Alzheimer's disease (AD) in particular, present a clear challenge to modern medicine due to brain delicate in vivo environment and limited insight from the human whole nervous system. Mathematical network models of dementia, such as AD, offer a path forward that can be deployed using the multitude of anatomical brain-graph data from real human patients. The dynamical processes of the model support front-like propagation on networks, where an initial localized perturbation grows and systematically invades all nodes in the network. The main question is to understand its overall dynamics. For instance, if a process starts at a seed location, how long will it take to appear at other locations, and then develop through a full-scale invasion, leading to dementia for the brain? The arrival-time problem, that consists in determining the time it takes for a quantity of interest to reach a certain level at each node, greatly depends on the coupling dynamics between nodes. In this talk, I address a question to extract estimates for the dynamics motivated by the study of toxic protein propagation in neurodegenerative diseases: if a single node is seeded at a small concentration, when will other nodes reach the same initial concentration? My research demonstrates that different estimates can give their important insights to understand the dynamics and, in particular, analytical methods to estimate and compute the arrival times are extremely powerful and can capture essential features in AD.

**Classification** : 92B05, General biology and biomathematics

**Format** : Talk at Waseda University

**Author(s)** : Prama Setia Putra (Mathematical Institute, University of Oxford)Prama Setia Putra (Mathematical Institute, University of Oxford)Alain Goriely (Mathematical Institute, University of Oxford)

## **[00485] Adaptive event-trigger based disturbance rejection technique for nonlinear systems**

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @D515

**Type** : Contributed Talk

**Abstract** : In this work, the stabilization and disturbance rejection problem for a nonlinear system is discussed. In order to reduce the communication burden, adaptive event-triggered based control is proposed. Further, an improved equivalent-input disturbance estimate technique is incorporated to suppress the effects of external

disturbances. A set of essential conditions are developed by applying Lyapunov stability theory to ensure the system is stable. Numerical examples with engineering significance are demonstrated to emphasize the effectiveness.

**Classification** : 93CXX, 37MXX, 37N35, 34H05, 34H15

**Format** : Online Talk on Zoom

**Author(s)** : Asha Safana Mohamed (Anna University) Marshal Anthoni S (Anna University)

## **[00487] A strongly nonlinear anisotropic parabolic-elliptic system: analysis and numerical simulation**

**Session Time & Room** : 2E (Aug.22, 17:40-19:20) @G502

**Type** : Contributed Talk

**Abstract** : We study the existence of a capacity solution to a nonlinear coupled parabolic-elliptic system.

This system is a generalization of the so-called thermistor problem which models a temperature dependent electrical resistor.

In this analysis we have considered the case where  $\Delta$  is an operator of the Leray-Lions class defined in an anisotropic Sobolev space.

We also show some numerical simulations of this problem and we discuss the obtained results.

**Classification** : 35K55, 35J70, 46E35

**Format** : Talk at Waseda University

**Author(s)** : Francisco Ortegon Gallego (Universidad de Cádiz) Manar Lahrache (Moulay Ismail University) Mohamed Rhoudaf (Moulay Ismail University) Hajar Talbi (Moulay Ismail University)

## **[00489] Curvature related properties of Finsler manifolds and applications**

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @F402

**Type** : Contributed Talk

**Abstract** : Finsler manifolds are important generalizations of Euclidean and Riemannian ones with applications in different domains of mathematics, physics and engineering. In the present talk we are going to present some recent results concerning Finsler connections, curvature and relation with statistical models in the real world. We suggest possible development of information geometry on Finsler manifolds that would allow a wide range of applications.

**Classification** : 53C60

**Format** : Talk at Waseda University

**Author(s)** : Sorin Sabau (Tokai University)

## **[00492] Asymptotic convergence of heterogeneous first-order aggregation models: from the sphere to the unitary group**

**Session Time & Room** : 5C (Aug.25, 13:20-15:00) @G401

**Type** : Contributed Talk

**Abstract** : We provide the detailed asymptotic behavior for first-order aggregation models of heterogeneous oscillators. Due to the dissimilarity of natural frequencies, one could expect that all relative distances converge to definite positive value and furthermore that each oscillator converges to a possibly different stationary point. In order to establish the desired results, we introduce a novel method, called dimension reduction method that can be applied to a specific situation when the degree of freedom of the natural frequency is one. In this way, we would say that although a small perturbation is allowed, convergence toward an equilibrium of the gradient flow is still guaranteed. Several first-order aggregation models are provided as concrete examples by using the dimension reduction method to study the structure of the equilibrium, and numerical simulations are conducted to support theoretical results.



**Classification** : 34C15, 34D06, 34C40

**Format** : Talk at Waseda University

**Author(s)** : Dohyun Kim (Sungkyunkwan University)Dohyun Kim (Sungshin Women's University)

## **[00494] A two-grid discontinuous Galerkin method to nonlinear time-fractional diffusion equations**

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @E605

**Type** : Contributed Talk

**Abstract** : A two-grid algorithm for discontinuous Galerkin method is proposed for nonlinear time-fractional diffusion initial-boundary-value problems. The numerical scheme consists of DG method for the spatial derivatives and L1-scheme for time stepping. Error estimate for the proposed scheme is obtained. The numerical experiments are presented to prove the efficiency of our algorithm.

**Classification** : 65M60, 65M15

**Author(s)** : SANDIP MAJI (Indian Institute of Technology Guwahati)Natesan Srinivasan (Indian Institute of Technology Guwahati)

## **[00495] Input-state finite time stabilization of singular Markov fuzzy system.**

**Session Time & Room** : 1C (Aug.21, 13:20-15:00) @G501

**Type** : Contributed Talk

**Abstract** : This work aims to examine the problem of Input-state finite-time stabilization of singular Markov T-S fuzzy systems with input time delay and disturbance. The sampled-data control for a singular Markov T-S fuzzy system with the quantized state has been designed. Using Lyapunov stability theory and linear matrix inequalities we guarantee that the singular fuzzy system is Input state Finite time stable. Finally, a numerical example is used to show the effectiveness of the proposed method.

**Classification** : 93CXX, 37MXX, 37N35, 34H05, 34H15

**Format** : Online Talk on Zoom

**Author(s)** : Keerthana N (Anna University )

## **[00501] Efficient numerical method for simulation of plasma**

**Session Time & Room** : 1E (Aug.21, 17:40-19:20) @G401

**Type** : Contributed Talk

**Abstract** : Understanding the dynamics of plasma is crucial in many concurrent applications. Those include astrophysics, space discovery, and designing fusion reactors. Numerical methods are a great tool for this purpose. In this talk, an efficient numerical method based on Galerkin approximations is presented. The method has high accuracy, capability of capturing shocks and turbulence, and consistency with thermodynamics. We show several interesting numerical simulations to demonstrate those properties.

**Classification** : 34A45

**Format** : Talk at Waseda University

**Author(s)** : Tuan Anh Dao (Uppsala University)

## **[00502] The Helmholtz-Hodge decomposition of polynomial vector fields**

**Session Time & Room** : 4C (Aug.24, 13:20-15:00) @G502

**Type** : Contributed Talk

**Abstract** : The Helmholtz-Hodge decomposition is a fundamental tool in the study of vector fields and has many applications. In this talk, we will focus on the case of polynomial vector fields. First, we will introduce results on the general properties and methods for finding a decomposition. As an application,

we will explain the relationship between the Helmholtz-Hodge decomposition and the construction of Lyapunov functions.

**Classification** : 37B25, 31B99

**Format** : Talk at Waseda University

**Author(s)** : Tomoharu Suda (RIKEN)Tomoharu Suda (Keio University)

## **[00504] Solar Influence on Earth's Seismicity and Applications in Earthquake Forecasting**

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @G710

**Type** : Contributed Talk

**Abstract** : The scientific community is yet to find an effective method to forecast and avoid earthquake hazards, due to the problem complexity. After decades of debate, the Sun has again been recently brought forth as a potential precursor to earthquakes. This study aims to investigate the existence of such relationship from a dynamical systems perspective. Having confirmed the existence, we also show that Sun data can be included in forecasting models to improve forecasting accuracy.

**Classification** : 37N05, 86A15, 60G55, 37Hxx

**Format** : Talk at Waseda University

**Author(s)** : Matheus Henrique Junqueira Saldanha (University of Tsukuba)Matheus Henrique Junqueira Saldanha (University of Tsukuba)Yoshito Hirata (Faculty of Engineering, Information and Systems, University of Tsukuba)

## **[00508] Imposing Neumann or Robin boundary conditions through a penalization method**

**Session Time & Room** : 5C (Aug.25, 13:20-15:00) @E705

**Type** : Contributed Talk

**Abstract** : We will present an n-dimensional extension of a penalization method previously suggested for Neumann or Robin boundary conditions. The existence and uniqueness are obtained using Droniou's approach for non-coercive linear elliptic problems, and we develop a boundary layer approach to establish the convergence of the penalization method. We present two-dimensional numerical examples using adequate schemes suitable for advection dominated problems, and outline the application of this method to population dynamics subject to climate change.

**Classification** : 65N85, 65M85, 65N06, 65M06, 92D25

**Format** : Talk at Waseda University

**Author(s)** : Bouchra Bensiali (École Centrale Casablanca)Jacques Liandrat (École Centrale Marseille, I2M)

## **[00511] Metapopulation network models explain non-Poissonian statistics of intercontact times**

**Session Time & Room** : 5C (Aug.25, 13:20-15:00) @G302

**Type** : Contributed Talk

**Abstract** : Intercontact times in empirical data obtained from humans and animals typically obey heavy-tailed distributions as opposed to exponential distributions that would correspond to Poisson processes. We show that this phenomenon is a mathematical property of a most basic metapopulation network model used in epidemiology and ecology modeling, in which individuals move from a patch to another according to the simple or other types of random walks. Our results hold true for any network structure.

**Classification** : 05C82, 60K20

**Format** : Talk at Waseda University

**Author(s)** : Elohim Fonseca dos Reis (State University of New York at Buffalo)Naoki Masuda (State University of New York at Buffalo)

## [00512] Rigged Hilbert Space Formulation for Many-Body Quantum Theory

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @F311

**Type** : Contributed Talk

**Abstract** : The rigged Hilbert space that associates the distribution functions with the Hilbert space is the fundamental one of quantum mechanics to define the bra-ket vectors. Their construction has been attempted mainly for single-particle systems. We are trying to extend the rigged Hilbert space formulation to various realistic quantum systems. In this presentation, we present the result of extending this formulation to quantum many-body systems.

**Classification** : 47A70, 81Q10, 81V70

**Format** : Talk at Waseda University

**Author(s)** : Junichi Takahashi (Waseda University)Shousuke Ohmori (Waseda University)

## [00513] The perfectly matched layer for elastic waves in layered media

**Session Time & Room** : 2C (Aug.22, 13:20-15:00) @E702

**Type** : Contributed Talk

**Abstract** : The perfectly matched layer (PML) is widely used to truncate domains in large-scale simulation of wave propagation in open boundaries. PML absorbs outgoing waves without reflection and significantly improves computational efficiency. However, it is very challenging to prove stability of PML models. In this talk, I present our recent contribution on the stability analysis of PML models for the elastic wave equation in layered media modeling seismic wave propagation in the Earth layers.

**Classification** : 65M06, 65M12, 86-08

**Format** : Talk at Waseda University

**Author(s)** : Siyang Wang (Umeå University)

## [00514] Diffusion approximation of a Markov-modulated infinite-server queue

**Session Time & Room** : 2C (Aug.22, 13:20-15:00) @E501

**Type** : Contributed Talk

**Abstract** : In a queue, overdispersion nature of arrivals and stochastic nature of service times can be captured by incorporating modulation into the queue dynamics. We discuss stochastic approximations for an infinite-server queue, where the stochastic arrival and service rates are determined by a Markovian environment. The incorporation of modulation leads to an Ornstein-Uhlenbeck process as its diffusion approximation with the variance parameter capturing the stochastic variations of both modulating and modulated processes.

**Classification** : 60K25, 60K37

**Format** : Talk at Waseda University

**Author(s)** : Selvaraju Natarajan (Indian Institute of Technology Guwahati, India)Ankita Sen (Indian Institute of Technology Guwahati, India)

## [00516] Parameters Estimation For Car Following Models Using Bayesian Inference

**Session Time & Room** : 2D (Aug.22, 15:30-17:10) @E503

**Type** : Contributed Talk

**Abstract** : Car following (CF) models play an important role in traffic simulation software. Estimating their parameters is necessary to enhance predictive performance and is traditionally accomplished through optimisation. In this research, we adopted Bayesian inference which is advantageous for



**[0,T]\**

$$x(0) = x_0$$

$\end{eqnarray}$

where  $0 < \alpha < 1, \rho > 0, \rho \neq 1$  and  $x \in \mathbb{R}^n$  is the state vector,  $u \in \mathbb{R}^m$  is the control vector,  $x_0 \in \mathbb{R}^n$

and  $A$  is an  $n \times n$  matrix and  $B$  is an  $n \times m$  matrix.

Here the generalized fractional derivative is taken as

$\begin{eqnarray}$

$${}^C D^{\alpha, \rho}_{0^+} x(t) = \frac{\rho^{\alpha}}{\Gamma(1-\alpha)} \int_0^t \frac{1}{(t^{\rho} - s^{\rho})^{\alpha}} x'(s) ds$$

$$\int_0^t \frac{1}{(t^{\rho} - s^{\rho})^{\alpha}} x'(s) ds$$

$\end{eqnarray}$

Further sufficient conditions are obtained for the following nonlinear fractional system

$\begin{eqnarray}$

$${}^C D^{\alpha, \rho}_{0^+} x(t) = Ax(t) + Bu(t) + f(t, x(t)),$$

$$x(0) = x_0$$

$\end{eqnarray}$

where the function  $f: J \times \mathbb{R}^n \rightarrow \mathbb{R}^n$  is continuous.

The results for linear systems are obtained by using the Mittag-Leffler function and the Grammian matrix. Controllability of

nonlinear fractional system is established by means of Schauder's fixed point theorem. Examples are provided to illustrate the results.

**Classification** : 93B05, 34A08, Controllability, Fractional Dynamical Systems

**Format** : Talk at Waseda University

**Author(s)** : Balachandran Krishnan (Department of Mathematics, Bharathiar University, Coimbatore-641046)

## **[00525] Global effect of COVID-19 disease dynamics on tertiary education system in developing countries**

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @G710

**Type** : Contributed Talk

**Abstract** : A mathematical model that describes the effect of COVID-19 dynamics on the student population of higher learning institutions was studied. Qualitative analyses were done on the model, and numerical simulations were used to evaluate the effects of personal protective, quarantine, treatment, and management measures to mitigate the community spread of COVID-19. Finally, a cost-effectiveness analysis was used to ascertain the most-effective and least expensive strategy required for preventing and controlling the spread of the pandemic.

**Classification** : 37N25, 37N35, 37N40, 37D10, 34C40

**Format** : Online Talk on Zoom

**Author(s)** : John Olajide Akanni (Koladaisi University Ibadan, Oyo State, Nigeria) Afeeze Abidemi (Federal University of Technology, Akure, Ondo State, Nigeria) Oluwole Daniel Makinde (Faculty of Military Science, Stellenbosch University, South Africa)

## **[00527] A fast Multiplicative Update algorithm for non-negative matrix factorization**

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @E605

**Type** : Contributed Talk

**Abstract** : This work proposes an efficient algorithm called fastMU (Multiplicative Updates) to deal with a Non-Negative Matrix Factorization problem, based on majorization minimization principle. We derive theoretical convergence results and show the effectiveness of our method through comparison with state-of-the-art methods on both synthetic and realistic data. Practical results show that fastMU is often several orders of magnitude faster than the regular MU proposed by Lee and Sung, and can even

be competitive with state-of-the-art methods.

**Classification** : 65Kxx, 90Cxx

**Format** : Talk at Waseda University

**Author(s)** : Mai-Quyen PHAM (IMT Atlantique)Jeremy Cohen (CREATIS, CNRS)Thierry Chonavel (IMT Atlantique)

## **[00531] Calibration of hardening parameters for the absence of hysteresis test-data**

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @D102

**Type** : Contributed Talk

**Abstract** : A mathematical model is developed to estimate combined nonlinear isotropic-kinematic hardening parameters of ductile materials using Ramberg-Osgood constants for monotonic and cyclic stress-strain curves. This compact model can be performed even if the hysteresis curves test results are unavailable for the specimens subjected to high amplitude cyclic loading. The model is applied for AW6082 and HX220-BD, Finite Element simulation results are compared with test results, and very good agreements are obtained.

**Classification** : 74C15, 74-10

**Format** : Talk at Waseda University

**Author(s)** : Eray Arslan (TU Wien)Milan Zigo (MAGNA STEYR Fahrzeugtechnik GmbH & Co KG)

## **[00532] Pullback Operator Methods in Dynamical Systems: Theory and Computation**

**Session Time & Room** : 4C (Aug.24, 13:20-15:00) @G502

**Type** : Contributed Talk

**Abstract** : Koopman operator methods along with the associated numerical algorithms have provided a powerful methodology for the data-driven study of nonlinear dynamical systems. In this talk, we will give a brief outline of how the Koopman group of operators can be generalized beyond function spaces to the space of sections of various vector bundles over the state space. We describe their relationship with the standard Koopman operator on functions as well as describe the new spectral invariants produced by these generalized operators. We then demonstrate how the recently developed spectral exterior calculus framework can be utilized to compute the spectral properties of the generator of the induced operator on sections of the cotangent bundle. We conclude with some applications of the algorithm to some well-known dynamical systems.

**Classification** : 37C30

**Format** : Online Talk on Zoom

**Author(s)** : Allan M. Avila (AIMdyn Inc.)

## **[00535] Reinforcement Learning with Variable Exploration**

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @E711

**Type** : Contributed Talk

**Abstract** : Reinforcement learning is a powerful machine learning technique, but unreliable when multiple agents learn simultaneously. Our work applies Q learning to the Iterated Prisoner's Dilemma, an ideal setting to study AI cooperation. We investigate how different frameworks for variable exploration rates effect performance by escaping local optima. One result finds shorter learning periods produce more cooperation, potentially indicating incentive alignment. This furthers previous studies by carefully considering the ways exploration rate might vary over time.

**Classification** : 68T05, 91A26, 37N40, 91A05

**Format** : Talk at Waseda University

**Author(s)** : Brian Mintz (Dartmouth College)Feng Fu (Dartmouth College)

## [00540] Random product homotopies for decomposing tensors

**Session Time & Room** : 2E (Aug.22, 17:40-19:20) @G304

**Type** : Contributed Talk

**Abstract** : The rank one decomposition of the tensor is considered. The upper bound of rank is derived under which computing the decomposition is equivalent to solving a structured polynomial system that is determined by the full rank factorization of the matricization of the tensor. Under the generic uniqueness conditions, the solutions of the system are isolated and can be efficiently achieved by random product homotopies.

**Classification** : 13P15, 15A69, 15A72

**Format** : Talk at Waseda University

**Author(s)** : Tsung-Lin Lee (National Sun Yat-sen University)

## [00541] Reinforcement Learning-based Data Collection and Energy Replenishment in SDIoT

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @E711

**Type** : Contributed Talk

**Abstract** : In software-defined internet of things (SDIoT) with wireless rechargeable sensor networks, a novel reinforcement learning-based method is proposed for collecting data and scheduling mobile sinks to recharge the sensor nodes. The suggested technique extends the network lifetime while ensuring the QoS of the SDIoT. Finally, the results show that the suggested approach significantly increases the energy efficiency and also increases the network's lifetime.

**Classification** : 68T05, 68T40, 68T20, 68Q06, Internet of Things; Machine learning; Reinforcement learning

**Format** : Talk at Waseda University

**Author(s)** : Vishnuvarthan Rajagopal (Research scholar, Department of Electronics and Communication Engineering, Anna University Regional Campus, Coimbatore.)Bhanumathi V (Assistant Professor, Department of Electronics and Communication Engineering, Anna University Regional Campus, Coimbatore.)

## [00542] Approximations of quasi-linear elliptic optimal control problems under variational and virtual discretizations

**Session Time & Room** : 1C (Aug.21, 13:20-15:00) @F310

**Type** : Contributed Talk

**Abstract** : This talk will discuss virtual and variational discretizations for the numerical approximation of optimal control problems governed by the quasi-linear elliptic equation with distributed control. A conforming virtual element method is employed for the discretization of state and co-state equations that appeared in the model problem. The numerical approximation of the control variable is based on two different discretizations: variational and virtual. In the variational approach, the discrete space associated with the control is not discretized explicitly, whereas, for the virtual discretizations, the discrete spaces are taken as virtual element spaces that include linear polynomials and non-polynomials functions over the polygonal mesh, and a discretize-then-optimize approach is used for the computation of control. With the help of certain projection operators, optimal a priori error estimates are established for the control, state, and co-state variables in suitable norms. Numerical experiments are presented under general polygonal meshes to illustrate the performance of the proposed scheme and verify the theoretical convergence rate.

**Classification** : 49M29, 49M41, 65K15, 90C46

**Format** : Talk at Waseda University

**Author(s)** : Anil Kumar (BITS Pilani KK Birla Goa Campus, Goa (India))Jai Tushar (BITS Pilani KK Birla Goa Campus, Goa (India))Sarvesh Kumar (Indian Institute of Space Science and Technology, Thiruvananthapuram)

## [00544] Quantification of Entangled Bipartite Systems

**Session Time & Room** : 2D (Aug.22, 15:30-17:10) @E505

**Type** : Contributed Talk

**Abstract** : Gauging the distance between a mixed state and its nearest separable state is important but challenging in the quantum mechanical system. We, in this talk, propose a dynamical system approach to tackle low-rank approximation of entangled bipartite systems, which has several advantages, including 1) A gradient dynamics in the complex space can be described in a fairly concise way; 2) The global convergence from any starting point to a local solution is guaranteed; 3) The requirement that the combination coefficients of pure states must be a probability distribution can be ensured; 4) The rank can be dynamically adjusted. The theory, algorithms, and some numerical experiments will be presented in this talk.

**Classification** : 65F10, 15A24, 65H10, 15A72, 58D19

**Author(s)** : Matthew M. Lin (National Cheng Kung University) Moody T. Chu (North Carolina State University)

## [00546] Recent advances on the conjugate discrete-time algebraic Riccati equation.

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @G304

**Type** : Contributed Talk

**Abstract** : In this talk, we consider a class of conjugate discrete-time Riccati equations, arising originally from the linear quadratic regulation problem for discrete-time antilinear systems. A constructive proof is given for the existence of the maximal solution. Furthermore, an accelerated fixed-point iteration based on the semigroup property is developed for computing the maximal solution and the convergences is at least  $R$ -superlinear. An example is given to demonstrate the correctness of our main theorem.

**Classification** : 15A24, 65H05, 93A99

**Format** : Talk at Waseda University

**Author(s)** : Chun-Yueh Chiang (Center for General Education, National Formosa University) Hung-Yuan Fan (National Taiwan Normal University)

## [00547] Fictitious domain methods with finite elements and penalty over spread interface

**Session Time & Room** : 5C (Aug.25, 13:20-15:00) @E705

**Type** : Contributed Talk

**Abstract** : We present a spread interface approach in fictitious domain methods to decipher the elliptic PDEs depicted over curved complex domains. In this approach, we employ the  $L^2$  penalty for a small tubular neighborhood  $\Omega_{\delta}$  near  $\partial\Omega$  in  $\mathbb{R}^n \setminus \Omega$  in place of the substantial penalty for the whole fictitious part  $\mathbb{R}^n \setminus \Omega$ . We achieve strong convergence results concerning the penalty parameter  $\epsilon$  in addition to the a priori estimates and stability analysis. We implement the linear finite elements and acquire the expected error estimates. The comprehensive numerical investigations support the mathematical findings, which also anticipate optimal convergence regardless of the convexity and shape of the domain.

**Keywords**: Fictitious domain methods, Elliptic problems, Curved domain, Error estimates, Uniform mesh.

**References**:

1. S. Kale, and D. Pradhan, An augmented interface approach in fictitious domain methods, Comput. Math. with Appl., Vol. 125, pp. 238-247, (2022).



2. B. Maury, Numerical Analysis of a finite element/volume penalty method, SIAM J. Numer. Anal., Vol. 47(2), (2009), pp. 1126-1148.
3. N. Saito and G. Zhou, Analysis of the fictitious domain method with an  $L^2$ -penalty for elliptic problems, Numer. Funct. Anal. Optim., Vol. 36, (2015), pp. 501-527.
4. S. Zhang, Analysis of finite element domain embedding methods for curved domains using uniform grids, SIAM J. Numer. Anal., Vol. 46(6), (2008), pp. 2843-2866.

**Classification** : 65N85, 65N15, Numerical solutions to partial differential equations

**Format** : Online Talk on Zoom

**Author(s)** : Swapnil Kale (Defence Institute of Advanced Technology, Pune)Debasish Pradhan (Defence Institute of Advanced Technology, Pune)

## [00549] On the penalty approach in finite difference methods

**Session Time & Room** : 5C (Aug.25, 13:20-15:00) @E705

**Type** : Contributed Talk

**Abstract** : We introduce a finite difference method with the  $H^1$  and  $L^2$  penalties to solve the elliptic PDEs over curved complicated domains. The sharp convergence of the penalized solution to the original one is provided. The accuracy in both strategies is almost analogous, provided the penalty parameter  $\epsilon$  is  $O(h^2)$  in the  $H^1$  penalty approach and  $O(h^4)$  in the  $L^2$  penalty approach. The iterative methods developed for the proposed idea are highly efficient and furnish the theoretical outcomes.

**Keywords**: Finite difference method, Elliptic PDEs, Penalty, Curved domain, Cartesian mesh.

**References**:

1. S. Kale, and D. Pradhan, Error estimates of fictitious domain method with an  $H^1$  penalty approach for elliptic problems, Comp. Appl. Math., Vol. 41, (2022), pp. 1-21.
- 2.B. Maury, Numerical Analysis of a finite element/volume penalty method, SIAM J. Numer. Anal., Vol. 47(2), pp. 1126-1148, (2009).
- 3.N. Saito and G. Zhou, Analysis of the fictitious domain method with an  $L^2$ -penalty for elliptic problems, Numer. Funct. Anal. Optim. Vol. 36, (2015), pp. 501-527.
- 4.H. Suito, and H. Kawarada, Numerical simulation of spilled oil by fictitious domain method, Japan J. Indust. Appl. Math., Vol. 21, (2004), pp. 219-236.

**Classification** : 65N85, 65N15

**Format** : Talk at Waseda University

**Author(s)** : DEBASISH PRADHAN (Defence Institute of Advanced Technology, Pune - 411025, India)Swapnil Kale (Defence Institute of Advanced Technology, Pune)

## [00551] Network suppression of the pathogen spread within the healthcare system

**Session Time & Room** : 1E (Aug.21, 17:40-19:20) @G401

**Type** : Contributed Talk

**Abstract** : We consider an impulsive-differential-equation system, based on SIS model, to describe the spread of pathogens in healthcare systems accounting for patient mobility. We propose sufficient conditions guaranteeing network suppression of infection and an algorithm to indicate hospitals prone to high bacteria prevalence and ultimately to ensure the stability of a disease-free state. As an illustration, we present a model of hospital-acquired multidrug-resistant bacteria transmission based on hospital admission records provided by a German insurance company.

**Classification** : 34A37, 65P40, 92D30

**Format** : Talk at Waseda University

**Author(s)** : Monika Joanna Piotrowska (Institute of Applied Mathematics and Mechanics, University of Warsaw)Aleksandra Puchalska (Institute of Applied Mathematics and Mechanics, University of

Warsaw)Konrad Sakowski (Institute of Applied Mathematics and Mechanics, University of Warsaw and Institute of High Pressure Physics, Polish Academy of Sciences)

## [00557] Three dimensional laminar flow in a dividing channel

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @D505

**Type** : Contributed Talk

**Abstract** : This talk will describe a mathematical-modelling study concerned with fluid flow within a channel using asymptotic methods to study fluid behaviour on long axial length scales. Although many 3D problems can be solved through direct numerical simulations, it is generally useful to verify them with concrete analytical theory, which this study aims to do. Motivations for this research relate to providing insights into branching flows for cardiovascular vessels, industrial problems and Hele-Shaw cells.

**Classification** : 76-10, 76d10, 76D27

**Format** : Talk at Waseda University

**Author(s)** : Thuy Duong Dang (University College London)Frank Smith (University College London)Christian Klettner (University College London)

## [00560] Semiparametric Kernel Estimation with Bayesian Bandwidths for Multivariate Nonnegative Data

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @E501

**Type** : Contributed Talk

**Abstract** : We introduce a flexible semiparametric kernel method for smoothing distributions on nonnegative supports. This multivariate estimator is guided by a given parametric part, here an uncorrelated exponential distribution estimated by maximum likelihood, and a nonparametric part which is a weight function to be smoothed through multiple gamma kernels. Also, a diagnostic model discusses the choice between the parametric, semiparametric and nonparametric approaches. Finally, practical multivariate semicontinuous datasets illustrate the usefulness of the method.

**Classification** : 62Gxx, 62Hxx

**Format** : Talk at Waseda University

**Author(s)** : Sobom Matthieu Somé (Université Thomas SANKARA)Célestin C. Kokonendji (Université Bourgogne Franche-Comté)

## [00561] Quantum-parallel vectorized data encodings and computations on trapped-ions and transmons QPUs

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @E711

**Type** : Contributed Talk

**Abstract** : We introduce new quantum data representations derived from uniformly controlled rotation gates.

QCrank encodes a sequence of real-valued data as rotations of the data qubits allowing for high storage density. QBart directly embeds a binary representation in the computational basis and requires a lower number of quantum measurements. We demonstrate quantum algorithms for DNA pattern matching, Hamming weight calculation, complex value conjugation, and O(400) bits image retrieving executed on Quantium, IBMQ, and IonQ QPUs.

**Classification** : 68Q12, 81P68, 81P45, 81P16, Quantum encoding and computation on NISQ QPUs

**Format** : Talk at Waseda University

**Author(s)** : Jan Balewski (National Energy Research Scientific Computing Center, Lawrence Berkeley National Laboratory)Mercy G. Amankwah (Case Western Reserve University, Cleveland)Roel Van Beeumen (Applied Mathematics and Computational Research Division, Lawrence Berkeley National Laboratory)E. Wes Bethel (Computer Science Department, San Francisco State University)Talita Perciano (Scientific Data Division, Lawrence Berkeley National Laboratory)Daan

**[00565] Resonance with a Delay Differential Equation****Session Time & Room** : 5D (Aug.25, 15:30-17:10) @G401**Type** : Contributed Talk

**Abstract** : We propose here a delay differential equation with a linear time coefficient that produces transient resonant behavior. The oscillatory transient dynamics appear and disappear as the delay is increased between zero to asymptotically large delay. Also, for an appropriately tuned value of the delay, the height of the power spectrum goes through the maximum. This resonant behavior contrasts itself against the general behaviors observed with the constant coefficient delay differential equations.

**Classification** : 34K23, 93C43**Format** : Talk at Waseda University**Author(s)** : Kenta Ohira (Nagoya University)Toru Ohira (Graduate School of Mathematics, Nagoya University)**[00566] Numerical study of Draw resonance in Fibre spinning using multi-mode constitutive model****Session Time & Room** : 4E (Aug.24, 17:40-19:20) @G401**Type** : Contributed Talk

**Abstract** : We study the instability called Draw resonance that occurs in the industrial process of manufacture of thin polymer fibres, called fibre spinning using a multi-mode viscoelastic constitutive equation. We do a linear stability analysis of the equations by carrying out numerical simulations for a varying number of modes in the constitutive equation. We compare our results with those got by using single-mode viscoelastic models and discuss our findings.

**Classification** : 34B09, 34B60, 65N25, Polymer flows in industrial processes**Format** : Talk at Waseda University**Author(s)** : Renu Dhadwal (Center for Mathematical Modelling, FLAME University )**[00567] Topology-aware algorithm for constructing cartograms from density-equalising map projections****Session Time & Room** : 2E (Aug.22, 17:40-19:20) @F401**Type** : Contributed Talk

**Abstract** : Cartograms are maps in which the areas of enumeration units  $\text{e.g. administrative divisions}$  are proportional to quantitative data  $\text{e.g. population}$ . Generating cartograms with density-equalising map projections guarantees that geographic neighbours remain neighbours in the cartograms if all boundaries are infinitely dense sequences of points. However, computers represent boundaries with only finitely many points, often causing invalid topologies in the cartogram. This talk shows how line densification and topology-aware simplification solve this problem.

**Classification** : 51M30, 53-08, 68-04**Format** : Talk at Waseda University**Author(s)** : Michael T Gastner (Yale-NUS College)Nguyen Phong Le (Yale-NUS College)Nihal Z Miaji (Yale-NUS College)Adi Singhanian (Yale-NUS College)

## [00568] PRIMAL HYBRID METHOD FOR QUASILINEAR PARABOLIC PROBLEMS

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @E605

**Type** : Contributed Talk

**Abstract** : A second-order quasi-linear parabolic initial-boundary value problem is approximated by using primal hybrid finite element method and Lagrange multipliers. Semidiscrete and backward Euler based fully discrete schemes are discussed and optimal order error estimates are established by applying modified elliptic projection. Optimal order error estimates in maximum norm are also derived. Earlier results on maximum-norm superconvergence of the gradient in piecewise linear finite-element approximations of elliptic and parabolic problems are now carried over to quasilinear case using primal hybrid method. Finally, the results on numerical experiments confirm our theoretical findings.

**Classification** : 65M60

**Format** : Talk at Waseda University

**Author(s)** : Ajit Patel (The LNM Institute of Information Technology) Ravina Shokeen (The LNM Institute of Information Technology) Amiya Kumar Pani (Birla Institute of Technology & Science, Pilani)

## [00572] Model uncertainty for statistical arbitrage

**Session Time & Room** : 2E (Aug.22, 17:40-19:20) @F412

**Type** : Contributed Talk

**Abstract** : We consider an optimal stopping problem that addresses \textit{model uncertainty}, which affects the model assumptions, e.g., the parameters embedded in the probability distribution.

The result presented in this talk shows the explicit form of the boundary indicating the optimal stopping time, assuming the portfolio value as an Ornstein-Uhlenbeck process.

Applying our method might make statistical arbitrage more robust because the trading code for statistical arbitrage often depends on incorrect estimation.

**Classification** : 60G40, 60G10, 91G80

**Format** : Talk at Waseda University

**Author(s)** : Daisuke Yoshikawa (Kansai University)

## [00576] Modeling the Dispersion of Effluents Discharged into Tidally Coastal Waters

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @D402

**Type** : Contributed Talk

**Abstract** : Mixing and dispersion of effluents discharged under the spring neap tidal oscillations are studied analytically on a flat seabed and a uniformly sloping bed. The solutions of two-dimensional advection-diffusion equations are presented graphically to visualize and analyze the spreading of effluent plumes in coastal waters, following discharges from a single sea outfall, multiple outfalls, and multiport diffusers, to showcase the model applications of marine outfall systems for disposal from industrial plants in the far field.

**Classification** : 76Rxx, 35Q35, 76-10

**Format** : Talk at Waseda University

**Author(s)** : Anton Purnama (Sultan Qaboos University) Ahmed Al-Kasbi (University of Technology and Applied Sciences)

## [00577] Mixed Finite Element Method for Dirichlet Boundary Optimal Control Problem

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @E711

**Type** : Contributed Talk

**Abstract** : The optimal control problems (OCPs) subjected to partial differential equations (PDEs) have numerous applications in fluid dynamics, image processing, mathematical finance etc. The objective of OCPs is to find the optimal control which minimizes or maximizes the given cost functional with certain constraints being satisfied. There are mainly two types of OCPs available in literature namely, Distributed Control Problems where the control acts on the system through an external force and Boundary Control Problems where the control acts on the system through a Dirichlet or Neumann or Robin boundary conditions. Dirichlet boundary control problems are difficult to handle due to variational difficulty.

In many applications, it is important to obtain accurate approximation of the scalar variable and its gradient simultaneously. A common way to achieve this goal is to use mixed finite element methods. The main aim of my talk is to analyze the mixed finite element method for the second order Dirichlet boundary control problem in which the control is penalized in the energy space. Mixed finite element methods have the property that they maintain the discrete conservation law at the element level. For the variational formulation, the state equation is converted to the mixed system using the mixed variational scheme for second order elliptic equations and then the continuous optimality system is derived. In order to discretize the continuous optimality system, the lowest order Raviart-Thomas space is used to numerically approximate the state and co-state variables whereas the continuous piece-wise linear finite element space is used for the discretization of control. Based on this formulation, the optimal order a priori error estimates for the control in the energy norm and  $L_2$ -norm is derived. The reliability and the efficiency of proposed a posteriori error estimator is also discussed using the Helmholtz decomposition. Finally, several numerical experiments are presented to confirm the theoretical findings.

**Classification** : 65N30, 65N15, 65N12, 65K10

**Format** : Talk at Waseda University

**Author(s)** : Divay Garg (Indian Institute of Technology Delhi) Kamana Porwal (Indian Institute of Technology Delhi)

## [00578] Secret Sharing Scheme with Perfect Concealment by Quasigroup

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @A502

**Type** : Contributed Talk

**Abstract** : A secret sharing scheme was introduced by Shamir in 1979. A quasigroup is equivalent to a Latin square. The concept of perfect concealment is also called perfect security. The word ‘security’ describes a property of a phenomena, and the word ‘concealment’ describes an action which makes a phenomenon. In this talk, we force an action rather than a property, and we give new construction of secret sharing scheme with perfect concealment by quasigroup.

**Classification** : 94A62, 05B15, 20N05, 60B99

**Format** : Talk at Waseda University

**Author(s)** : Tomoko Adachi (Shizuoka Institute of Science and Technology) Izumi Takeuti (National Institute of Advanced Industrial Science and Technology)

## [00579] Explosion times and its bounds for a system of semilinear SPDEs

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @G702

**Type** : Contributed Talk

**Abstract** : In this paper, we obtain lower and upper bounds for the blow-up times to a system of semilinear stochastic partial differential equations. Under suitable assumptions, the bounds of the explosion times are obtained by using explicit solutions of an associated system of random PDEs and a formula due to Yor. We provide an estimate for the probability of the finite-time blow-up and the impact of the noise on the solution is investigated.

**Classification** : 35R60, 60H15, 74H35

**Format** : Talk at Waseda University

**Author(s)** : Karthikeyan Shanmugasundaram (Periyar University)

## [00583] The empirical measure of invariant fields on sphere-cross-time

**Session Time & Room** : 2E (Aug.22, 17:40-19:20) @F412

**Type** : Contributed Talk

**Abstract** : In this talk we investigate geometric properties of random fields on the two-dimensional sphere evolving over time, that are widely used in several scientific areas to model and analyze data (e.g. in Climate Science related to Earth surface temperature). In particular we study the behavior for large time of their excursion area at any threshold, establishing both asymptotic variances and limit theorems. We will show that phase transitions can occur for specific levels and memory.

**Classification** : 60G60, 33C55, 60D05, 60F05, 62M15

**Format** : Talk at Waseda University

**Author(s)** : Domenico Marinucci (University of Roma "Tor Vergata")Maurizia Rossi (University of Milano-Bicocca)Anna Vidotto (University of Napoli "Federico II")

## [00585] Computational and Optimization Frameworks for Tissue Vascularization in Bioprinted Grafts

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @F311

**Type** : Contributed Talk

**Abstract** : Template channels within tissue-engineered skin grafts can provide a promising tool for faster microvasculature formation and transport of nutrients to cells outside channels. Developing viable grafts requires the optimal design to support cell viability by controlled channel geometry and biomaterial properties. We discuss the recent advances in creating a robust computational framework to simulate physical and biological phenomena in graft samples. The first computational results will speak for future applications to models using laboratory data.

**Classification** : 49-06, 92-10, 76Z05, 92-08, 92C75

**Format** : Talk at Waseda University

**Author(s)** : Chris Bashur (Florida Institute of Technology)Beste Caner (Florida Institute of Technology)Vladislav Bukshtynov (Florida Institute of Technology)

## [00591] Convergence rate of RBSDE by penalisation and its financial applications

**Session Time & Room** : 4C (Aug.24, 13:20-15:00) @E704

**Type :** Contributed Talk

**Abstract :** In this paper, we study the convergence of numerical solution of Reflected Backward Stochastic Equations (RBSDEs) by the penalisation approach and we apply this on the pricing problem of American option. Usually the obstacle-related problem is studied by Snell Envelope and penalisation is used on proving existence. Here we fill the gap between penalisation and numerical solution. As result, we proved successfully the convergence rate for both continuous and discrete penalised solution.

**Classification :** 60Hxx, 65Cxx, 60H35, 65C30, 60G40

**Format :** Talk at Waseda University

**Author(s) :** Wanqing WANG (Ecole Polytechnique)Emmanuel Gobet (Ecole Polytechnique)Mingyu Xu (Fudan University)

## **[00599] Advances on estimation of temperature and moisture of soil using sensor networks.**

**Session Time & Room :** 3C (Aug.23, 13:20-15:00) @G709

**Type :** Industrial Contributed Talk

**Abstract :** Given a sensor network set up on an agricultural field, we review methods based on PDE, regression and Principal Component Analysis algorithms to estimate the temperature and moisture of soil.

With PCA it is possible to identify those sensors or groups of sensors which are influential at the time of measuring the temperature or moisture at a given point of the field.

Validation results are provided based on real data from agricultural fields.

**Classification :** 35Q79, PDE, regression, PCA

**Format :** Talk at Waseda University

**Author(s) :** Carlos Fresneda-Portillo (Universidad Loyola Andalucía (Spain))Carmelina Ierardi (Universidad Loyola Andalucía )José Ramón Salvador-Ortiz (Universidad Loyola Andalucía)Javier Pérez (Universidad Loyola Andalucía )Diego Luis Orihuela (Universidad Loyola Andalucía )

## **[00600] A Two Timescale Evolutionary Game Theoretic Approach to Multi-Agent Learning**

**Session Time & Room :** 3D (Aug.23, 15:30-17:10) @D514

**Type :** Contributed Talk

**Abstract :** We propose a two timescale evolutionary game theoretic approach to solving multiagent reinforcement learning problems. This new approach enables us to avoid the computationally expensive step of solving exact equilibrium in each iteration. It provably converges to epsilon-Nash equilibria without imposing the global optima or saddle point conditions, two restrictive assumptions that are typically needed in the literature. The numerical experiments show the computationally efficiency of the algorithm.

**Classification :** 91A15, 91A22, 68T05, 37N40, Reinforcement learning; Multi-agent system

**Format :** Talk at Waseda University

**Author(s) :** Nan Chen (The Chinese University of Hong Kong)Chengli Ren (The Chinese University of Hong Kong)

## **[00601] Assessment of Mathematics in Higher Education over the COVID19 pandemic.**

**Session Time & Room :** 3E (Aug.23, 17:40-19:20) @D514

**Type :** Industrial Contributed Talk

**Abstract :** A comparative analysis of various assessment methods on Higher Education Mathematics is provided. A discussion on the reliability of these methods is provided with particular emphasis on distance/online (uncontrolled) assessment methods and face to face (controlled) assessment methods.

We analyse the data collected from an assessment strategy based on a set of tests before and throughout the COVID pandemic. Results show that online assessment is less reliable for those students with lower academic performance.

**Classification** : 97D60, Assessment of Mathematics in Higher Education

**Format** : Talk at Waseda University

**Author(s)** : Carlos Fresneda-Portillo (Universidad Loyola Andalucía (Spain))James Maunder (Oxford Brookes University)

## **[00610] Input-output finite time stabilization for nonlinear networked control systems**

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @G802

**Type** : Contributed Talk

**Abstract** : In this talk, we discuss the problem of input-output finite time stabilization for nonlinear networked control systems with network induced delay. The nonlinear system can be linearized by fuzzy model with weighted membership functions. Memory event-triggering mechanism incorporated to reduce frequent packets transmission. The sufficient stabilization conditions are developed in the form of linear matrix inequalities with aid of Lyapunov stability theory. Finally, numerical example is provided to demonstrate the viability of the suggested approach.

**Classification** : 37N35, 34A34, 93D15, 93D25, 93C42

**Format** : Talk at Waseda University

**Author(s)** : Marshal Anthoni Selvaraj (Anna University Regional Campus Coimbatore)

## **[00611] Deformations of linear elastic bodies computed using the RBF-PU method**

**Session Time & Room** : 4C (Aug.24, 13:20-15:00) @E711

**Type** : Contributed Talk

**Abstract** : In this talk we will present numerical solutions to boundary value problems of linear elasticity, computed using the Radial Basis Function Partition of Unity (RBF-PU) method in the least squares formulation. Specifically, we will show deformations of 3D geometries, including a thin plank under bending and a reconstructed human diaphragm under ventilation conditions. Convergence studies and a comparison of the RBF-PU method to the standard Galerkin Finite Element method (GFEM) will be presented.

**Classification** : 65N35, 74S25, 74B05

**Format** : Talk at Waseda University

**Author(s)** : Andreas Michael (Uppsala University)

## **[00613] Phase-field systems coupled with large deformations**

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @E812

**Type** : Contributed Talk

**Abstract** : Multiphase dynamical systems coupled with finite strain are used for the mathematical description of many phenomena in soft matter physics and biology, such as swelling and wetting processes of gels. We derive a thermodynamically consistent framework to couple phase fields and mechanics in a gradient flow structure allowing for various dissipation mechanisms. Combining modeling tools, rigorous analytical considerations, and the construction of numerical implementations allows us to understand practical and technical details from different perspectives.

**Classification** : 74Fxx

**Format** : Talk at Waseda University

**Author(s)** : Leonie Schmeller (Weierstrass Institute)Barbara Wagner (Weierstrass Institute)Dirk Peschka (Weierstrass Institute)



## [00614] Sparse spectral methods for fractional PDEs

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @G701

**Type** : Contributed Talk

**Abstract** : Fractional partial differential equations model nonlocal processes such as wave absorption in the brain, long-range geophysical effects, and Lévy flights. We introduce a spectral method for the fractional Laplacian in one dimension that induces sparse linear systems. We only deal with the coefficients of the expansion and thus time-stepping is fast. We consider a number of examples including the fractional heat and fractional wave propagation equations.

**Classification** : 35R11, 65N35, 65M70, 65R10, Numerical Analysis, Nonlocal PDEs

**Format** : Talk at Waseda University

**Author(s)** : Ioannis P. A. Papadopoulos (Imperial College London)

## [00617] Low-regularity exponential-type integrators for the Zakharov system under rough data

**Session Time & Room** : 5C (Aug.25, 13:20-15:00) @E703

**Type** : Contributed Talk

**Abstract** : Two low-regularity exponential-type integrators (LREIs) are proposed and analyzed for the Zakharov system (ZS), including a first-order integrator and a second-order one. To my knowledge, it is the first time to propose such LREIs that achieve the first- and second-order accuracy by requiring one or two additional derivatives for the solutions of ZS, respectively. Numerical comparison with other methods demonstrates the superiority of the newly proposed LREIs for rough data.

**Classification** : 65M70, 65M12, 65M15, 65T50

**Format** : Talk at Waseda University

**Author(s)** : Hang Li (Tsinghua University ) Chunmei Su (Tsinghua University)

## [00619] Optimal Transport for Positive and Unlabeled Learning

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @F403

**Type** : Contributed Talk

**Abstract** : Positive and unlabeled learning (PUL) aims to train a binary classifier based on labeled positive samples and unlabeled Samples, which is challenging due to the unavailability of negative training samples. This talk will introduce a novel optimal transport model with a regularized marginal distribution for PUL. By using the Frank-Wolfe algorithm, the proposed model can be solved properly. Extensive experiments showed that the proposed model is effective and can be used in meteorological applications.

**Classification** : 49Q22, 68T01

**Format** : Talk at Waseda University

**Author(s)** : Jie ZHANG (University of Hong Kong) Yuguang YAN (Guangdong University of Technology) Michael Ng (University of Hong Kong)

## [00620] Development of an ion channel model-framework

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @A511

**Type** : Contributed Talk

**Abstract** : Ion channels in cell membranes are of ultimate importance in physiology. They control a large fraction of biological processes and are mainly investigated by current-voltage experiments. To support the interpretation of measured results, we develop a model-framework based on non-equilibrium thermodynamics that accounts for various important aspects, e.g., finite-volume effects and the surface charges of the channel. Julia-based numerical simulations are performed to compute current-voltage relations, with varying ion concentrations, applied voltages, and channel properties.

**Classification** : 92-10, 92C40, 92-08

**Format** : Talk at Waseda University

**Author(s)** : Christine Keller (Weierstrass Institute for Applied Analysis and Stochastics (WIAS))Juergen Fuhrmann (Weierstrass Institute for Applied Analysis and Stochastics (WIAS))Manuel Landstorfer (Weierstrass Institute for Applied Analysis and Stochastics (WIAS))Barbara Wagner (Weierstrass Institute for Applied Analysis and Stochastics (WIAS))

## [00628] Resource Dependent Competition and Extinction

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @G710

**Type** : Contributed Talk

**Abstract** : The classical theory of competitive exclusion does not consider the type of interaction between species. We create a new competition model in which the maximum population of a species is dependent on the availability of resources, or food supply, and competition is in the form of competition for these resources. We find this model always leads to stable coexistence and we investigate ways to bring about extinction.

**Classification** : 37N25, 92D25, 92-10

**Format** : Talk at Waseda University

**Author(s)** : Robert Garvey (University of Limerick)Andrew Fowler (University of Limerick)

## [00629] Stability Analysis of Split Equality and Split Feasibility Problems

**Session Time & Room** : 2E (Aug.22, 17:40-19:20) @F401

**Type** : Contributed Talk

**Abstract** : In this talk, the stability of solutions to parametric split equality and split feasibility problems is addressed for the first time. Characterizations for the Lipschitz-likeness of solution maps are obtained by exploiting special structures of the problems and by using an advanced result of B.S. Mordukhovich on parametric generalized equations. Examples are presented to illustrate how the obtained results work in practice and to show that extra mild assumptions made cannot be omitted.

**Classification** : 49J53, 49K40, 65K10, 90C25, 90C31

**Format** : Talk at Waseda University

**Author(s)** : Huong Thi Vu (Institute of Mathematics, Vietnam Academy of Science and Technology)Yen Dong Nguyen (Institute of Mathematics, Vietnam Academy of Science and Technology)

## [00634] Bifurcation curves for semipositone problem with Minkowski-curvature operator

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @G502

**Type** : Contributed Talk

**Abstract** : We study the shape of bifurcation curve of positive solutions for the semipositone Minkowski-curvature problem  $-\left( u^{\prime} / \sqrt{1 - \{u^{\prime}\}^2} \right)^{\prime} = \lambda f(u)$ ,  $u \in (-L, L)$ , and  $u(-L) = u(L) = 0$ , where  $\lambda, L > 0$  and  $\beta(u) < 0$  for  $u > 0$ . We prove that if  $f$  is either convex or concave, then the bifurcation curve is C-shaped.

**Classification** : 34B15, 34B18, 34C23, 74G35

**Format** : Talk at Waseda University

**Author(s)** : Shao-Yuan Huang (National Taipei University of Education)

## [00637] Wave Scattering from Layers of Random Particulate Materials

**Session Time & Room** : 5C (Aug.25, 13:20-15:00) @E817

**Type** : Contributed Talk

**Abstract** : To characterise any material with sound waves, the wave will propagate through several layers before reaching the material. If that material is a random particulate material, then to date there is no simple model to deal with the layers. In this talk we show how extending the quasi-crystalline approximation (a technique from statistical physics) to layers leads to clear and simple models which separate the influence of the microstructure from the material geometry.

**Classification** : 74J20, 82D30, 45B05

**Format** : Talk at Waseda University

**Author(s)** : Paulo Sergio Piva (The University of Sheffield)Kevish Napal (The University of Sheffield)Artur Gower (The University of Sheffield)

## [00648] Bounds for effective conductivity of multimaterial composites

**Session Time & Room** : 2C (Aug.22, 13:20-15:00) @F312

**Type** : Contributed Talk

**Abstract** : The paper discusses the exact bounds for the effective properties of multimaterial composites. We refine Hashin-Shtrikman bounds in the region where the last ones are loose. We show that fields in optimal structures vary in restricted domains, modify the Translation method, and obtain new exact bounds and optimal structures. Different volume fractions of components correspond to topologically different types of optimal structures.

**Classification** : 49K20

**Format** : Talk at Waseda University

**Author(s)** : Andrej Cherkaev (University of Utah)

## [00651] Parallel Coordinate Descent Methods for Full Configuration Interaction

**Session Time & Room** : 2D (Aug.22, 15:30-17:10) @E709

**Type** : Contributed Talk

**Abstract** : Solving the time-independent Schrödinger equation gives us full access to the chemical properties of molecules. Among all the ab-initio methods, full configuration interaction (FCI) provides the numerically exact solution under a predefined basis set. However, the FCI problem scales factorially with respect to the number of bases and electrons and suffers from the curse of dimensionality. The FCI problem could be reformulated as an unconstrained minimization problem. This work proposes a novel algorithm to address the minimization problem. The algorithm introduces an extra search dimension to enable the exact linesearch for the multi-coordinate descent method, which could be fully parallelized. Hence, the proposed algorithm benefits from both exact linesearch and parallelization. Numerically, we demonstrate the parallel efficiency of the algorithm. The algorithm achieves better energy and parallelism on systems with approximately a hundred electrons than other existing methods.

**Classification** : 65Z05, 68Q12

**Format** : Talk at Waseda University

**Author(s)** : Yuejia Zhang (Fudan University)Yingzhou Li (Fudan University)

## [00655] Finite-time fault-tolerant robust control design for parabolic partial differential equations

**Session Time & Room** : 2D (Aug.22, 15:30-17:10) @A201

**Type** : Contributed Talk

**Abstract** : In this paper, a finite-time fault-tolerant robust control design for parabolic partial differential equations in the presence of uncertainties, actuator faults and external disturbances is discussed. The main aim is to design a non-fragile fault-tolerant control to ensure the robust stabilization of the considered PDEs. By employing Lyapunov method, a novel set of conditions is obtained to ensure the required result. Finally, simulations are provided to demonstrate the effectiveness of the developed control design.

**Classification** : 93D15, 93D05, 93D40, Robust Control Theory

**Author(s)** : Sakthivel Rathinasamy (Bharathiar University)

## [00659] Understanding persisting onchocerciasis hotspots in Africa using mathematical models

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @D514

**Type** : Contributed Talk

**Abstract** : Onchocerciasis/river blindness is a vector-borne neglected tropical disease with persistent transmission hotspots despite the repeated distribution of ivermectin in endemic communities in Africa. One of the hypotheses for the persistence of transmission is due to the movement of parasites via infected humans and/or vectors between neighbouring communities. I have explored how vector movement affects transmission using spatially-structured mathematical models informed by genetic and environmental data, which might aid in making public-health decisions to eliminate onchocerciasis.

**Classification** : 92-08, 92-10, 92D30, 92D25, 92D40

**Format** : Talk at Waseda University

**Author(s)** : Himel Shrestha (La Trobe University)Himal Shrestha (La Trobe University)Shannon Hedtke (La Trobe University)Karen McCulloch (La Trobe University)Warwick Grant (La Trobe University)Rebecca Chisholm (La Trobe University)

## [00663] Quantum Monte Carlo algorithm for solving Black-Scholes PDEs for high-dimensional option pricing in finance and its proof of overcoming the curse of dimensionality

**Session Time & Room** : 1E (Aug.21, 17:40-19:20) @E704

**Type** : Contributed Talk

**Abstract** : In this talk, we first provide a brief introduction to quantum computing from a mathematical perspective. No prior knowledge of quantum computing is necessary.

We then introduce a quantum Monte Carlo algorithm to solve high-dimensional Black-Scholes PDEs with correlation for high-dimensional option pricing. The payoff function of the option is of general form

and is only required to be continuous and piece-wise affine (CPWA), which covers most of the relevant payoff

functions used in finance. We provide a rigorous error analysis and complexity analysis of our algorithm.

In particular, we prove that the computational complexity of our algorithm is bounded polynomially in the

space dimension  $d$  of the PDE and the reciprocal of the prescribed accuracy  $\epsilon$  and so demonstrate that our

quantum Monte Carlo algorithm does not suffer from the curse of dimensionality.

This talk is based on a joint work with Yongming Li.

**Classification** : 65M75, 91G20, Deep Learning method for nonlinear PDEs

**Format** : Talk at Waseda University

**Author(s)** : Ariel Neufeld (NTU Singapore)Philipp Schmocker (NTU Singapore)Sizhou Wu (NTU Singapore)

## **[00664] A New Sampling Technique for Learning with Hypergraph Neural Networks**

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @E811

**Type** : Contributed Talk

**Abstract** : Hypergraphs can represent higher-order relations among objects. Traditional hypergraph neural networks produce high computational cost and timing. We propose a new sampling technique for learning with hypergraph neural networks. The core idea is to design a layer-wise sampling scheme for nodes and hyperedges to approximate original hypergraph convolution. Notably, the proposed sampling technique allows us to handle large-scale hypergraph learning. Experiment results demonstrate that our proposed model keeps a good balance between time and accuracy.

**Classification** : 68T07, 05C65, 62D05, 68T09, large-scale hypergraph learning, hypergraph neural networks, hypergraph sampling, variance reduction, importance sampling

**Format** : Talk at Waseda University

**Author(s)** : Fengcheng Lu (The University of Hong Kong)Michael Kwok-Po Ng (The University of Hong Kong)

## **[00665] Estimating pressure distribution on a surface via electrical sensing skin**

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @E820

**Type** : Contributed Talk

**Abstract** : Sensing skins allow for monitoring of a surface by electrically imaging a conductive layer on an object. One example is fracture detection of concrete elements by imaging a conductive paint layer. In this talk, we present a way to estimate pressure distribution on a surface by using sensing skin -based techniques.

**Classification** : 78-05, 78-10, 65Nxx, Electrical Impedance Tomography

**Author(s)** : Petri Kuusela (University of Eastern Finland)Moe Pour-Ghaz (North Carolina State University)Aku Seppänen (University of Eastern Finland)

## **[00667] Effect of tumor-associated neutrophils on tumor growth : A mathematical model**

**Session Time & Room** : 5C (Aug.25, 13:20-15:00) @D515

**Type** : Contributed Talk

**Abstract** : Tumor-associated neutrophils (TANs) have been under discussion for their dual role on tumor microenvironment, but they are emerging as important agents in tumor invasion. In this study, we divided TANs into two different phenotypes: N1 TANs, the anti-tumor neutrophils and N2 TANs, the tumorigenic neutrophils. We developed a mathematical model to investigate the dynamics of tumor growth between different TANs and responses to various stimuli, and finally to build simulations for brain tumor treatment.

**Classification** : 92C99, 35Q92, 37N25, Mathematical oncology

**Format** : Talk at Waseda University

**Author(s)** : Haneol Cho (Konkuk university)Yangjin Kim (Konkuk university)Junho Lee (Konkuk university)

## [00668] Solution of Non-linear Problems Through Variant of Newton's Method with Applications in Engineering

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @E506

**Type** : Contributed Talk

**Abstract** : Various non-linear problems that formulated from sciences and engineering like Combustion problems, Chemistry of rainwater, Heat problems, etc. are difficult to solve with analytical methods. So, the approximate solution of such non-linear problems is obtained through iterative methods. Hence, we will discuss variant of Newton's method and its validity in terms of a convergence order, minimum computation cost, time, and efficiency over existing techniques.

**Classification** : 65H10, 41A58, 65Y20, Numerical Analysis

**Format** : Talk at Waseda University

**Author(s)** : Sonia Bhalla (Chandigarh University)

## [00671] A new drone swarm model for zone occupation

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @G709

**Type** : Contributed Talk

**Abstract** : We focus on fluid modeling for decentralized fleets of autonomous drones with Newtonian models. The corresponding system of hyperbolic conservation laws is obtained through mean field limit and moments closure assumption. The objective is to reduce the complexity for swarm tasks simulations such as zone occupation. Taking advantage of the macroscopic representation of the density, we introduce a new model for this task accounting for the drones inertia, which has been neglected so far.

**Classification** : 35Q70, 35B40, 35B45

**Format** : Talk at Waseda University

**Author(s)** : Axel Maupoux (ONERA / Institut Mathématique de Toulouse)Guillaume Dufour (ONERA)

## [00676] Recent Advances in 2-Lagrange Multiplier Method for Multiscale PDEs

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @E709

**Type** : Contributed Talk

**Abstract** : The heterogeneous 2LM method, introduced in Loisel et al., SIAM J. Sci. Comput., 37, 2015, is a domain decomposition method where the coarse space is built using eigenvectors associated with subdomain eigenproblems. In this talk, we provide a new a-priori estimate for the norm of the coarse problem to guarantee further that the method is robust w.r.t the changes in the contrast of the diffusion coefficient. Numerical results are provided to support the theoretical findings.

**Classification** : 65N55, 65F10, 65N30, 65N22

**Format** : Talk at Waseda University

**Author(s)** : Hieu Nguyen (Fulbright University Vietnam)Sébastien Loisel (Heriot-Watt University)

## [00677] Mathematical Epidemiology as a decision tool

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @A511

**Type** : Industrial Contributed Talk

**Abstract** : Mathematics is a powerful tool for tackling real world problems; concretely, we are interested in monitoring epidemics. Some members of the MOMAT Research Group -Complutense University of Madrid- have worked in collaboration with veterinary groups, healthcare companies and public entities of the Spanish healthcare system. In this talk, we present some mathematical models developed by this research group for both animal -e.g., Classical Swine Fever, Bluetongue- and human -e.g., COVID-19, Ebola- infectious diseases.

**Classification** : 92-10, 92Dxx, Mathematical Epidemiology

**Format** : Talk at Waseda University

**Author(s)** : Alicja B. Kubik (Universidad Complutense de Madrid) Benjamin Ivorra (Universidad Complutense de Madrid) Angel M. Ramos (Universidad Complutense de Madrid) María Vela-Pérez (Universidad Complutense de Madrid) Miriam R. Ferrández (Instituto de Matemática Interdisciplinar)

## [00678] Monitoring distributed strains on solid surfaces by electrical impedance tomography

**Session Time & Room** : 1E (Aug.21, 17:40-19:20) @D405

**Type** : Contributed Talk

**Abstract** : Measuring strains induced by loads on structural elements is a key component of structural health monitoring  $\text{SHM}$ . Current methods are mostly based on localized measurements and offer limited information on distributed strain. We present results on distributed strain monitoring based on electrical impedance tomography  $\text{EIT}$  imaging of a painted, elastic surface coating. The method can extract information on the surface strain field by solving the EIT inverse problem based on measured data.

**Classification** : 78A46, 78A55, 74Bxx

**Format** : Talk at Waseda University

**Author(s)** : Mikko Räsänen (University of Eastern Finland) Aku Seppänen (University of Eastern Finland) Moe Pour-Ghaz (North Carolina State University) Jari Kaipio (University of Eastern Finland)

## [00680] Computing $p$ -Harmonic Descent Directions for Shape Optimization

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @F403

**Type** : Contributed Talk

**Abstract** : Recent development in shape optimization suggests enhanced results by using a  $p$ -harmonic approach to determine descent directions. Therefore, we present the extension of an algorithm to solve the occurring vector-valued  $p$ -Laplace problem subject to a boundary force without requiring an iteration over the order  $p$  and thus compute higher-order solutions efficiently. Results are verified by numerical experiments in a fluid dynamic setting.

**Classification** : 49Q10, 49M41

**Format** : Talk at Waseda University

**Author(s)** : Henrik Wyszka (University of Hamburg) Martin Siebenborn (University of Hamburg) Winnifried Wollner (University of Hamburg)

## [00681] A revised Hughes model for pedestrian flow

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @G710

**Type** : Contributed Talk

**Abstract** : In this talk, we analyse the modified Hughes model for pedestrian dynamics, in which individuals seek to minimize their travel time. We present the existence and uniqueness of the solution and illustrate the behavior of the model with various numerical results. This is joint work with Prof Nader Masmoudi

**Classification** : 35Q91, 35Q70, 35F21

**Format** : Talk at Waseda University

**Author(s)** : Mohamed Ghattassi (NYUAD)

## [00682] Cover Temporal Networks with Densest Subgraphs

**Session Time & Room** : 2E (Aug.22, 17:40-19:20) @G304

**Type** : Contributed Talk

**Abstract** : Temporal networks have been introduced to represent the dynamics of a complex system. In this contribution we consider a problem that asks for a collection of dense temporal subgraphs that covers a given temporal graph. The problem has application in the identification of communities of a complex system, for example of a social network.

We present a result on the computational complexity of the problem and a polynomial-time approximation algorithm.

**Classification** : 05C85, 05C90, 68R10, 68R05, 68Q25

**Format** : Talk at Waseda University

**Author(s)** : Riccardo Dondi (Università degli Studi di Bergamo)

## [00683] Linearized Saint-Venant Equation with Lateral Inflow in a Finite Channel

**Session Time & Room** : 2E (Aug.22, 17:40-19:20) @F412

**Type** : Contributed Talk

**Abstract** : We present a solution for linearized Saint-Venant equations with uniformly distributed lateral inflow for a finite rectangular channel. The discharge is presented as the convolution of the distributed lateral inflow and lateral channel response function. We study the behavior of lateral channel response function for different parameters. To find discharge at any location of a channel for a given channel width, the choice of reference discharge and slope of the channel play a significant role.

**Classification** : 35Q35, 44A10

**Author(s)** : Swaroop Nandan Bora (Indian Institute of Technology Guwahati) Shiva Kandpal (Indian Institute of Technology Guwahati)

## [00684] Aggregation of Anisotropic Inclusions on Elastic Membranes

**Session Time & Room** : 2E (Aug.22, 17:40-19:20) @D405

**Type** : Contributed Talk

**Abstract** : Elastic interactions mediated by biological membranes are an important class of sorting mechanisms used to organise proteins in living systems and with applications for biotechnology. Proteins that bind to the membrane and generate this curvature are often anisotropic and this broken symmetry yields new phenomena in their interactions. In this talk, I will discuss the many-body structures that can emerge from these elastic, quadrupole-like interactions and explore the consequences of these aggregates.

**Classification** : 74L15, 92C10, 92C37, 74G10

**Format** : Talk at Waseda University

**Author(s)** : Matthew William Cotton (University of Oxford) Jon Chapman (University of Oxford) Alain Goriely (University of Oxford)

## [00688] Recovering Battery Ageing Dynamics with Invertible Neuronal Networks

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @G709

**Type** : Contributed Talk

**Abstract** : Modern Lithium-Ion-Batteries (LIBs) suffer from degradation. This leads to a dependency of the voltage-capacity-curve on the charge-discharge-cycle. However, there are different processes inducing this degradation, each with a different influence on the aforementioned curve. Given such a



curve, we recover the ageing dynamic of each effect and identify how much it contributes to the overall degradation using Invertible Neuronal Networks.

**Classification** : 35Q79, 62F15, 35B27, 65M60

**Format** : Talk at Waseda University

**Author(s)** : Alireza Selahi (Weierstraß Institute for Applied Analysis and Stochastics)Manuel Landstorfer (Weierstraß Institute for Applied Analysis and Stochastics)

## **[00691] GROWTH TUMOR, PROLIFERATION AND DIFFUSION IN CELL LINES OF OSTEOSARCOMA**

**Session Time & Room** : 4D (Aug.24, 15:30-17:10) @D401

**Type** : Contributed Talk

**Abstract** : Osteosarcoma is a bone cancer. According to medical studies, it has a high genetic complexity, with different mechanisms of appearance and evolution. Our goal is to describe how is the diffusive behavior of cell lines at early times, that is, times close to the instant of inoculation and when the volumes are still small compared to the largest experimental volume reached by the cell lines studied.

**Classification** : 92-XX, 92Bxx, 92B05, Biomathematics

**Format** : Online Talk on Zoom

**Author(s)** : Maria Isabel Romero Rodriguez (Universidad Militar Nueva Granada)María Isabel Romero Rodríguez (Universidad Militar Nueva Granada)Eduard Leonardo Sierra Ballén (Universidad Militar Nueva Granada )Juan Camilo Vargas Pino (Universidad Militar Nueva Granada)

## **[00693] Enzyme: Fast and Effective Automatic Differentiation for Academia and Industry**

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @E605

**Type** : Industrial Contributed Talk

**Abstract** : Automatic differentiation (AD) is key to training neural networks, Bayesian inference, and scientific computing. Applying these techniques requires rewriting code in a machine learning framework or manually providing derivatives. We present Enzyme, an AD extension for the industry-standard LLVM/MLIR compiler. Enzyme differentiates programs in any LLVM-based language. Unlike traditional tools, Enzyme performs AD on optimized code, resulting in a 4.2x speedup on the CPU and orders of magnitude speedup on the GPU.

**Classification** : 65Kxx, 65Yxx, 68Vxx

**Format** : Talk at Waseda University

**Author(s)** : William Steven Moses (MIT)Valentin Churavy (MIT)Ludger Paehler (TUM)Oleksandr Zinenko (Google)

## **[00694] Large deviation theory-based adaptive importance sampling for rare events in high dimensions**

**Session Time & Room** : 5B (Aug.25, 10:40-12:20) @E505

**Type** : Contributed Talk

**Abstract** : I will discuss our proposed method for estimating rare event probabilities for expensive-to-evaluate numerical models in high dimensions. The approach combines ideas from large deviation theory and adaptive importance sampling. Large deviation theory is used to find a good initial biasing distribution and to identify a low-dimensional subspace that is most informative of the rare event probability. We compare the method with a state-of-the-art cross-entropy-based importance sampling scheme.

**Classification** : 65C05, 60F10, 62L12, 65F15, 65K10

**Format** : Talk at Waseda University

**Author(s)** : Shanyin Tong (Columbia University)Georg Stadler (New York University)

## **[00697] Vicsek-Kuramoto system in collective dynamics and their macroscopic equations**

**Session Time & Room** : 3D (Aug.23, 15:30-17:10) @A601

**Type** : Contributed Talk

**Abstract** : In this project we investigate a 'Vicsek-style' model, where noisy self-propelled particles align orientation and angular velocity through interaction with their neighbours. This work has been inspired by the model introduced by Chen, C. et al. Nature (2017) to describe the behaviour of dense colony of bacteria, which self-organize into robust collective oscillatory motion. The main focus is to investigate how individual-level behaviours influence the emergence of macroscopic patterns.

**Classification** : 92B05, 82C31

**Format** : Talk at Waseda University

**Author(s)** : Carmela Moschella (University of Vienna )

## **[00698] Rigidity for Sobolev inequalities and radial PDEs on Cartan-Hadamard manifolds**

**Session Time & Room** : 2E (Aug.22, 17:40-19:20) @G402

**Type** : Contributed Talk

**Abstract** : We aim at classifying all the Cartan-Hadamard manifolds supporting an optimal function for the  $p$ -Sobolev inequality. We prove that, under the validity of the Cartan-Hadamard conjecture, which is known to be true in dimension  $n \leq 4$ , the only such manifold is  $\mathbb{R}^n$ , up to isometries. We also investigate radial solutions to the related  $p$ -Laplace Lane-Emden equation, obtaining rigidity of finite-energy solutions regardless of optimality. Furthermore, we study the asymptotic behavior of infinite-energy solutions.

**Classification** : 35B53, 35J92, 58J05, 58J70, 46E35

**Format** : Talk at Waseda University

**Author(s)** : Matteo Muratori (Politecnico di Milano)Nicola Soave (Politecnico di Milano)

## **[00705] A boundary integral method for slow free surface flows**

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @D101

**Type** : Contributed Talk

**Abstract** : In this talk we will present a boundary integral method suitable for the solution of creeping flow boundary value problems where the boundary presents singularities in the stresses. We use the method to solve the problem of the planar extrusion of a Newtonian fluid at zero Reynolds number and, in particular, to determine the shape of the free surface in the immediate neighbourhood of the separation point for a range of capillary numbers.

**Classification** : 76M15, 76D05, 76D07, Free-surface fluid flows, singularities

**Format** : Talk at Waseda University

**Author(s)** : Loïc Gobet (University of Montreal)Robert Gwyn Owens (University of Montreal)

## **[00709] Mathematical modeling reveals P2X1 purinoceptor antagonist as a male contraceptive**

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @D514

**Type** : Contributed Talk

**Abstract** : Condoms and vasectomies are the only male contraceptive options with disruption of foreplay and reversibility issues. The vas deferens smooth muscle (VDSM) contracts for sperm transportation. The pharmacological inhibition of VDSM contraction might explore promising new

contraceptives. We established a mathematical model of VDSM cell using ordinary differential equations for an insilico electrophysiological investigation. The findings from our mathematical model reveal that the P2X1-purinoceptors antagonist 2-phenyl-5,6,7,8- tetrahydroquinoxaline might be considered as a new male contraceptive.

**Classification** : 92-08, 92-10, 92-05

**Format** : Online Talk on Zoom

**Author(s)** : CHITARANJAN MAHAPATRA (Paris-Saclay Institute of Neuroscience - CNRS)Ashish Kumar Pradhan (Indian Institute of Sciences Bangalore)

## **[00713] Mathematical Modeling of Lymphatic Filariasis-Buruli ulcer co-infection**

**Session Time & Room** : 3D (Aug.23, 15:30-17:10) @A601

**Type** : Industrial Contributed Talk

**Abstract** : A mathematical model for Lymphatic Filariasis -Buruli ulcer co-infection is explored to provide a theoretical analysis of the disease's dynamics. The disease free equilibrium is proved to be locally asymptotically stable; the model was found to be showing transcritical and backward bifurcation, time dependent controls are incorporated to obtain necessary conditions for optimal control of the diseases. Numerical simulation results suggest best strategy in controlling the diseases is using all the controls at the same time.

**Classification** : 92B05, 37G10

**Author(s)** : Helen Olaronke Edogbanya (Federal University Lokoja, Kogi State)Helen Olaronke Edogbanya (Federal University Lokoja)Zamurat Ayobami Adegboye (Institute of Mathematical and Physical Sciences, IMSP-UAC, Dangbo)

## **[00716] Resource Efficient Boolean Function Solver on Quantum Computer**

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @E711

**Type** : Contributed Talk

**Abstract** : Grover's algorithm is the best-known quantum search algorithm for problems when classical ones cannot outperform brute-force search. We propose several novel techniques to improve efficiency in solving boolean equations under Grover's algorithm framework. A W-cycle circuit construction strategy and a greedy compression technique are proposed for the oracle to reduce quantum resource usage. A randomized Grover's algorithm further reduces the circuit depth. Numerical results on boolean quadratic equations demonstrate the advantage of the proposed techniques.

**Classification** : 68Q12, 81P68

**Format** : Talk at Waseda University

**Author(s)** : Xiang Li (Fudan University)Hanxiang Shen (Fudan University)Yingzhou Li (Fudan University)Weiguo Gao (Fudan University)

## **[00722] Scalar auxiliary variable schemes for Cahn-Hilliard systems with mass source**

**Session Time & Room** : 5C (Aug.25, 13:20-15:00) @G502

**Type** : Contributed Talk

**Abstract** : The scalar auxiliary variable approach presents a novel way to discretize a large class of dissipative systems. We consider a general Cahn-Hilliard system with mass source that may not admit a known dissipative structure, and so the stability of discrete solutions is not immediate. With a bounded mass source, we show stability and convergence of time discrete solutions for a first-order scheme, and apply our ideas to systems in tumour growth, image inpainting and segmentation.

**Classification** : 35K35, 35K55, 65M12, 65Z05

**Format** : Talk at Waseda University

**Author(s)** : Andrew Lam (Hong Kong Baptist University)Ru Wang (Hong Kong Baptist University)

## **[00723] Density Maximum Effect on Natural Convection in a Porous Enclosure**

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @D403

**Type** : Contributed Talk

**Abstract** : The maximum density effect on natural convection in an enclosure filled with porous medium is numerically examined. One of the vertical walls is either fully or partially heated and various thermal boundary walls are considered for the cooling location. The nonlinear partial differential equations are solved by finite volume method together with power-law-scheme using SIMPLE algorithm. The qualitative results are expressed in the graphical form. The motivation for the study is the cooling of equipment.

**Classification** : 80-XX, 80Axx, 80Mxx, 65Yxx, 76R10, 80 Classical thermodynamics, heat transfer

**Format** : Talk at Waseda University

**Author(s)** : NITHYADEVI NAGARAJAN (Bharathiar University)

## **[00724] Applicability to information engineering using the Sato's hyperfunction**

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @F311

**Type** : Contributed Talk

**Abstract** : Wavelet transform and discrete image processing are one of the important subjects in the field of information engineering. However, although the use of the generalised function in Fourier transform is possible, it is difficult to apply to wavelet transform by using the generalised function. On the other hand, the delta function is mainly used in discrete image analysis.

In this study, we have considered their applicability using the Sato's hyperfunction.

**Classification** : 46F15, 32A45, 65T60, 65D18, 46T30

**Format** : Talk at Waseda University

**Author(s)** : HIROSHI MURAYAMA HIROSHI MURAYAMA (Graduate School of Science and Engineering, SOKA University)Yoshio ISHII (Faculty of Science and Engineering, SOKA University)

## **[00725] Role of CXCL12 in regulation of T cell invasion**

**Session Time & Room** : 3D (Aug.23, 15:30-17:10) @A601

**Type** : Contributed Talk

**Abstract** : In this study, we investigate the mutual interactions between the CD8+ T cells and the CXCL12 that prevent T cell invasion by developing mathematical models that involve taxis-reaction-diffusion. We apply the mathematical model to a Boyden invasion assay used in the experiments to demonstrate that the over-expressed CXCL12 can prevent T cell infiltration into tumor. Moreover, we consider tumor-immune dynamics by a hybrid approach and investigate the fundamental mechanism of cytokine shield.

**Classification** : 92B05, 92C17, 92C45, 92C50

**Format** : Talk at Waseda University

**Author(s)** : Junho Lee (Konkuk University)Yangjin Kim (Konkuk University)Chaeyoung Lee (Korea University)

## [00728] Descriptions of distribution function and hyperfunction using discretization

**Session Time & Room** : 1E (Aug.21, 17:40-19:20) @G401

**Type** : Contributed Talk

**Abstract** : Nonlinear systems with singular solutions, such as vortices and vortex sequences, can be mathematically described using the distribution function ( $\delta$  function). However, it is difficult to numerically analyze the singular solution.

In this study, we have considered approaches to discretize the distribution function and discussed the usefulness of introducing it into numerical analysis. Furthermore, we have carried out some examples of applications to discrete distribution functions and Sato's hyperfunction.

**Classification** : 32A45, 46F15, 46F30, 46T30, 65E05

**Format** : Talk at Waseda University

**Author(s)** : Yuya Taki (Graduate School of Science and Engineering, SOKA University)Yoshio Ishii (Faculty of Science and Engineering, SOKA University)

## [00729] $q$ -LAPLACE TRANSFORMS FOR THE PRODUCT OF BASIC ANALOGUE FOR H-FUNCTIONS FOR TWO VARIABLES AND THE GENERAL CLASS OF $q$ -POLYNOMIALS

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @G402

**Type** : Contributed Talk

**Abstract** : The  $q$ -Laplace transforms for the product of basic analogue of H-function of two variables and the general class of  $q$ -polynomials has been evaluated in the present paper. Few cases of the main outcomes including the applications involving the basic analogues of Fox's H-functions as well as general class of  $q$ -polynomial are also evaluated.

**Classification** : 33D60, 44A10, 44A20

**Format** : Talk at Waseda University

**Author(s)** : Vijay Kumar Vyas (Sur University College,Oman)Ali A. AL-JARRAH (Sur University College,Oman)

## [00738] Proper Orthogonal Decomposition methods for the Navier Stokes equations

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @E508

**Type** : Contributed Talk

**Abstract** : In this talk we study numerical approximations to the incompressible Navier-Stokes equations by

means of proper orthogonal decomposition (POD) methods. Several questions are considered: the influence of including snapshots that approach the velocity time derivative and the influence of considering different discretizations for the nonlinear term in the full order model and the reduced order model. Error bounds with constants independent of the Reynolds numbers are obtained in the numerical analysis.

**Classification** : 65M12, 65M15, 65M60

**Format** : Talk at Waseda University

**Author(s)** : Julia Novo (Universidad Autónoma de Madrid)

## [00741] POINTWISE ADAPTIVE QUADRATIC DG FEM FOR OBSTACLE PROBLEM

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @E711

**Type** : Contributed Talk

**Abstract** : The obstacle problem, often considered as a prototype for a class of free boundary problems. The elliptic obstacle problem is a nonlinear model that describes the vertical movement of a object restricted to lie above a barrier  $\text{\textit{obstacle}}$  while subjected to a vertical force. In this talk, we perform a posteriori error analysis in the supremum norm for the quadratic Discontinuous Galerkin  $\text{\textit{DG}}$  method for the elliptic obstacle problem. Compare with the energy norm estimates, supremum norm estimates gives the pointwise control on the error. We have carried out the analysis on two different discrete sets, one set having integral constraints and other one with the nodal constraints at the quadrature points, and discuss the pointwise reliability and efficiency of the proposed a posteriori error estimator. In the analysis, we employ a linear averaging function to transfer DG finite element space to standard conforming finite element space and exploit the sharp bounds on the Green's function of the Poisson's problem. Moreover, the upper and the lower barrier functions corresponding to continuous solution  $u$  are constructed by modifying the conforming part of the discrete solution  $u_h$  appropriately. Finally, the numerical results for adaptive FEM are presented in order to exhibit the reliability and the efficiency of the proposed error estimator.

**Classification** : 65N30, 65N15

**Format** : Talk at Waseda University

**Author(s)** : Ritesh Ritesh (Indian Institute of Technology, Delhi) Rohit Khandelwal (Indian Institute of Technology, Delhi) Kamana Porwal (Indian Institute of Technology, Delhi)

## [00743] Recent Advances on POD methods for the Navier-Stokes equations.

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @E508

**Type** : Contributed Talk

**Abstract** : We present some recent advances on proper orthogonal decomposition (POD) methods for the Navier-Stokes equations. Among them, recovering the pressure in a robust manner when the snapshots are discretely divergence-free. We analyze the different sources of error and how they affect the pressure recovery. We also study how to adapt the POD method for varying values of the Reynolds number.

**Classification** : 65M12, 65M15, 65M60

**Format** : Talk at Waseda University

**Author(s)** : Bosco García-Archilla (Universidad de Sevilla)

## [00744] On the Burgers-type equations used in soft solid acoustics

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @E804

**Type** : Contributed Talk

**Abstract** : A strain-rate model of soft viscoelastic solid is presented. The constitutive law accounts for finite strain, incompressibility, material frame-indifference, nonlinear elasticity, and viscous dissipation. Shear waves are governed by a nonlinear viscous wave equation, of which a one-way Burgers-type approximate equation is derived. Analysis of the travelling wave solutions shows that the two equations produce distinct solutions, unless amplitudes are infinitesimal. In the inviscid case, links with simple wave theory are established.

**Classification** : 74D10, 74J30, 74H10

**Format** : Talk at Waseda University

**Author(s)** : Harold Berjamine (School of Mathematical and Statistical Sciences, University of Galway, University Road, Galway, Republic of Ireland)

## [00745] Fluid flow and nutrient transport in hollow fibre membrane bioreactors

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @A511

**Type** : Contributed Talk

**Abstract** : We present an axisymmetric model of fluid flow through a hollow fibre membrane bioreactor for applications in tissue engineering. We derive a reduced model by exploiting the small aspect ratio of bioreactor radius to length. Coupled to a system of reduced-order advection-reaction-diffusion equations for nutrient transport, we reveal how nutrient delivery to cells depends on membrane permeability. We then determine how spatial variations in scaffold permeability can be established to tune nutrient delivery to cells.

**Classification** : 92-10, 92C35, 76Z05, 92C50, 76D08, Tissue Engineering

**Format** : Online Talk on Zoom

**Author(s)** : George Booth (University of Oxford)Mohit Dalwadi (University College London)Cathy Ye (University of Oxford)Pierre-Alexis MOUTHUY (University of Oxford)Sarah Waters (University of Oxford)

## [00748] New probabilistic algorithms for scientific supercomputing

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @E705

**Type** : Contributed Talk

**Abstract** : Sustained strong scalability is hard to sustain beyond 10K processors due to the communication and synchronisation involved in domain decomposition for PDEs. Seeking to overcome them, Spigler and Acebrón introduced probabilistic domain decomposition, which inserts stochastic calculus in the formulation---however with slow error convergence. I will present a hybrid idea, SpAc, which retains most of the scope for embarrassing parallelism, while being orders of magnitude faster. Proof of concept supercomputing simulations will be discussed.

**Classification** : 65Nxx

**Format** : Talk at Waseda University

**Author(s)** : Francisco Bernal (Carlos III University of Madrid)

## [00750] Bayesian inverse problems for some hyperbolic conservation laws

**Session Time & Room** : 4D (Aug.24, 15:30-17:10) @G602

**Type** : Contributed Talk

**Abstract** : We study some inverse problems for hyperbolic conservation laws. Given observations of the entropy solution, we consider the problem of identifying the initial field or the flux function. Due to shockwaves, direct observations of the entropy solution are not "regulated" enough to fit in the Bayesian framework in Stuart (2010). To get round this, we propose a new approach by studying the trajectories for hyperbolic conservation laws and exploring their existence, uniqueness and stability.

**Classification** : 35L65, 35R30, 62F15, Partial Differential Equations, Inverse Problems

**Format** : Talk at Waseda University

**Author(s)** : Duc-Lam Duong (LUT University)Duc-Lam Duong (LUT University)Masoumeh Dashti (University of Sussex)

## [00751] Crack Loading and Growth Analyses with the Virtual Element Method

**Session Time & Room** : 5C (Aug.25, 13:20-15:00) @E812

**Type :** Contributed Talk

**Abstract :** The virtual element method is a modern discretization scheme for solving boundary value problems on polytopal meshes, sparing the explicit knowledge of element shape functions. In the context of numerical fracture mechanics, crack tip loading analyses and in particular crack growth simulations benefit from its ability of handling arbitrary complex meshes straightforwardly. This work aims to discuss challenges and opportunities of implementing concepts of fracture mechanics in the context of the virtual element method.

**Classification :** 74R10, 74S05, 74A45, Numerical Fracture Mechanics

**Format :** Talk at Waseda University

**Author(s) :** Kevin Schmitz (University of Kassel) Andreas Ricoeur (University of Kassel)

## [00755] A variational approach for nonlinear elasticity

**Session Time & Room :** 3E (Aug.23, 17:40-19:20) @E820

**Type :** Contributed Talk

**Abstract :** This research concerns the Weighted Energy-Dissipation approach for nonlinear elasticity. We introduce a family of  $\epsilon$ -dependent functionals defined over entire trajectories and we prove that they admit minimisers which are solutions of the corresponding Euler-Lagrange problem. Considering the limit  $\epsilon \rightarrow 0$  we prove that those minimisers converge to the solutions of a specific nonlinear elasticity equation. Eventually, linearized elastic energies are proven to be the  $\Gamma$ -limits of the rescaled nonlinear energies.

**Classification :** 74B20, 47J30, 47J35, 58E30, 74B15

**Format :** Online Talk on Zoom

**Author(s) :** Riccardo Voso (University of Vienna)

## [00756] Using photogrammetry for the objective morphological study of early violins

**Session Time & Room :** 4C (Aug.24, 13:20-15:00) @G301

**Type :** Contributed Talk

**Abstract :** Some early violins were reduced during their history to fit imposed morphological standards. We propose an objective photogrammetric approach to differentiate between a reduced and an unreduced instrument by examining 3D meshes, previously validated with a sub-millimetre accuracy through a comparison with CT scans. We show how quantitative and qualitative features can be automatically extracted from the meshes with geometrical, statistical and machine learning tools, allowing to successfully highlight differences between reduced and unreduced instruments.

**Classification :** 00A65, 51-XX, 68UXX, Photogrammetry, Violin reduction, Geometric analysis, CT scans, Error assessment, Point cloud registration

**Format :** Talk at Waseda University

**Author(s) :** Philémon Beghin (UCLouvain) François Glineur (UCLouvain) Anne-Emmanuelle Ceulemans (UCLouvain)

## [00757] Effect of electrostatic forces and moments on cracked electrostrictive dielectrics

**Session Time & Room :** 1E (Aug.21, 17:40-19:20) @G304

**Type :** Contributed Talk

**Abstract :** Going beyond the scope of solely mechanical considerations, fracture mechanics of smart dielectrics is additionally concerned with the implications of electric fields on crack tip loading. In this work, the oftentimes neglected electric body and surface forces as well as body couples stemming from the Maxwell stress tensor are studied in the context of a crack in an infinite electrostrictive dielectric by exploiting holomorphic potentials and Cauchy's integral formulae within the framework of complex analysis.

**Classification :** 30E20, 30E25, 74A35, 74R10, 78A30



**Format** : Talk at Waseda University

**Author(s)** : Lennart Behlen (University of Kassel)Daniel Wallenta (University of Kassel)Andreas Ricoeur (University of Kassel)

## **[00762] On the dissolution of particles subject to natural convection**

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @D502

**Type** : Contributed Talk

**Abstract** : The dissolution of a solid spherical particle is a canonical problem that finds many areas of application, including the pharmaceutical industry. In this work, we provide a generalized theory that tackles the role of natural convection in the surrounding dissolving medium. We investigate its effects on hydrodynamics and how it interacts with the diffusion during dissolution to deform the particle geometry whilst altering the release profile of pharmaceutical ingredients, a key aspect in drug delivery.

**Classification** : 76-10, 76R10, 76R50

**Format** : Talk at Waseda University

**Author(s)** : Milton Assunção (University of Limerick)Michael Vynnycky (University of Limerick)Kevin Moroney (University of Limerick)

## **[00765] V-KEMS: Tackling industrial and COVID problems via virtual study groups**

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @D501

**Type** : Industrial Contributed Talk

**Abstract** : During the pandemic a group of UK mathematicians formed the Virtual Forum for Knowledge Exchange in the Mathematical Sciences (V-KEMS). This ran many online virtual study groups (VSGs), using mathematics to tackle urgent societal challenges. These varied from keeping shops, workplaces, and universities safe, to advising the transport, healthcare, and leisure industries. VSGs were so effective that they informed government policy. My talk will describe how VSGs work, and plans for their future development.

**Classification** : 90-10, 35Mxx, 34Fxx

**Format** : Talk at Waseda University

**Author(s)** : Chris Budd (University of Bath)

## **[00767] Fractal and Fractional**

**Session Time & Room** : 2E (Aug.22, 17:40-19:20) @G305

**Type** : Contributed Talk

**Abstract** : Several physical and natural phenomena are characterized on one hand by the presence of different temporal and spatial scales, on the other by the presence of contacts among different components through rough interfaces like domains with non-smooth boundaries and fractal layers.

The principal aim of the talk is to propose mathematical models to investigate these phenomena as well as their numerical approximation.

Our attention will be focused on fractional Cauchy problems on the random Koch domains with different boundary conditions.

Random Koch domains are domains whose boundary are constructed by mixtures of Koch curves with random scales. These domains are obtained as limit of domains with Lipschitz boundary whereas for the limit object, the fractal given by the random Koch domain, the boundary has Hausdorff dimension between 1 and 2. We point out that Random Koch domains provide a suitable setting to model phenomena - taking place across irregular and wild structures in which boundaries are "large" while bulk is "small"- in which the surface effects are enhanced like, for example, pulmonary system, root infiltration, tree foliage, etc..

**Classification** : 28A80, 35R11, 26A33, 35J25, 65K15

**Format** : Talk at Waseda University

**Author(s)** : Raffaella Capitanelli (Sapienza University of Roma)

## [00770] Rellich eigendecomposition of paraHermitian matrices, with applications

**Session Time & Room** : 1E (Aug.21, 17:40-19:20) @G304

**Type** : Contributed Talk

**Abstract** : Let  $H(z)$  be paraHermitian, that is, analytic and Hermitian on the unit circle  $\mathbb{S}^1$ . We prove that  $H(z) = U(z)D(z)U(z)^*P$  where, for all  $z \in \mathbb{S}^1$ ,  $U(z)$  is unitary,  $U(z)^*P = U(z)^*$ , and  $D(z)$  is real diagonal; moreover,  $U(z)$ ,  $D(z)$  are analytic in  $|z| = 1 + \frac{1}{N}$  for some positive integer  $N$ , and  $U(z)^*P$  is the paraHermitian conjugate of  $U(z)$ . We discuss the implications on the svd of an  $\mathbb{S}^1$ -analytic matrix and the sign characteristics of unimodular eigenvalues of  $*$ -palindromic matrix polynomials.

**Classification** : 15A23, 15A18, 15A54, 15B57

**Format** : Talk at Waseda University

**Author(s)** : Vanni Noferini (Aalto University) Giovanni Barbarino (Aalto University)

## [00771] New class of Nested Hierarchical matrices and its applications

**Session Time & Room** : 5B (Aug.25, 10:40-12:20) @E603

**Type** : Contributed Talk

**Abstract** : I'll discuss a new class of nested Hierarchical matrices in 2D (HODLR2D<sup>2</sup>). This is based on weak admissibility criteria and the compressions are done using NCA. Using this Hierarchical framework, one can perform matrix-vector product that scales almost linearly; hence, large dense linear systems arising out of  $N$  body problems can be solved using iterative solvers with almost linear complexity. Also, I'll discuss its performance over other Hierarchical matrices and applications in solving integral equation and radial basis interpolation.

**Classification** : 65F55, 65R20, 65R10, Numerical Linear Algebra

**Format** : Talk at Waseda University

**Author(s)** : Ritesh Khan (Indian Institute of Technology Madras) Sivaram Ambikasaran (Indian Institute of Technology Madras)

## [00773] Machine Learning Model for Thin Metal Sheet Counting and Thickness Measurement

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @E811

**Type** : Contributed Talk

**Abstract** : In this talk we are to discuss about counting stacked metal foils in real time. For the purpose a non-contact method based on broadband X-ray absorption spectra was employed to scan the experimental samples and artificial neural network was built to count and measure thickness of the stacked foil. Further, the attained results are compared with polynomial fitting model and linear regression in order to verify the difference in prediction accuracy of the three models.

**Classification** : 68T07, 78M32, 82C32, 62J05, 65D10

**Format** : Talk at Waseda University

**Author(s)** : Elayaperumal Ayyasamy (Anna University, Chennai)

## [00776] Towards a modeling class for port-Hamiltonian systems with time-delay

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @G401

**Type** : Contributed Talk

**Abstract** : The framework of port-Hamiltonian (pH) systems is a broadly applicable modeling paradigm. In this talk, we extend the scope of pH systems to time-delay systems. Our definition of a delay pH system is motivated by investigating the Kalman-Yakubovich-Popov inequality on the corresponding infinite-dimensional operator equation. Moreover, we show that delay pH systems are passive and closed under interconnection. We describe an explicit way to construct a Lyapunov-Krasovskii functional and discuss implications for delayed feedback.

**Classification** : 34K06, 37J06, 93C05, 34A09

**Format** : Talk at Waseda University

**Author(s)** : Dorothea Hinsen (TU Berlin)Tobias Breiten (TU Berlin)Benjamin Unger (University of Stuttgart)

## [00780] Mathematical Modelling of Bidirectional Transport System

**Session Time & Room** : 1E (Aug.21, 17:40-19:20) @D405

**Type** : Contributed Talk

**Abstract** : One of the major issues in real life is evolving vehicular traffic. Recently the totally asymmetric simple exclusion process (TASEP) has been utilized to investigate transport systems. We present a novel generalized two-lane TASEP model with bidirectional movement under a new kind of symmetric coupling between lanes to gain insight into the evolutionary traffic dynamics. We employ the mean-field theory to solve the system theoretically and validate theoretical outcomes through extensively performed Monte Carlo Simulations.

**Classification** : 82DXX, 82-10, 82M20, 82M60, 82M31, Non-equilibrium Statistical Mechanics, Mathematical Modelling and Simulation, Partial Differential Equations, Stochastic Processes

**Format** : Talk at Waseda University

**Author(s)** : Atul Kumar Verma (NIT Trichy, India)

## [00784] A Lagrangian-finite difference scheme for solving viscoelastic fluid flows

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @D401

**Type** : Contributed Talk

**Abstract** : In this work, we will present a new numerical scheme that combines the Generalized Lie Derivative in a Lagrangian framework with the finite difference method. The viscoelastic models with the upper-convected time derivative term are rewritten in order to improve the stability of the method. Moreover, the proposed scheme can also be applied to study the High Weissenberg Number Problems.

**Classification** : 76M20, 76A10, 65M50

**Format** : Talk at Waseda University

**Author(s)** : jose Alberto Cuminato (University of São Paulo)Cassio Machiavelli Oishi (São Paulo State University)Debora de Oliveira Medeiros (University of São Paulo)

## [00788] Using multi-objective evolutionary algorithms when performing preventive maintenance actions

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @E820

**Type** : Industrial Contributed Talk

**Abstract** : Maintenance has always been a key activity in the manufacturing industry, because of its economic consequences. Nowadays, its importance is increasing thanks to the Industry 4.0'' or thefourth industrial revolution'', which promotes automation through computer systems in

manufacturing and aims to achieve intelligent or smart factory. There are more and more complex systems to maintain, and to keep all these devices in proper conditions maintenance management must gain efficiency and effectiveness. Within maintenance, Condition-Based Maintenance (CBM) programs can provide significant advantages, but it can be said that often these programs are complex to manage and understand, so several researches propose as simple as possible approaches that can be understood by users and modified by experts. With these context conditions, this paper focuses on CBM optimization in an industrial environment, with the objective of determining the optimal values of preventive intervention limits for equipment under corrective and preventive maintenance cost criteria. It develops a cost-benefit mathematical model that considers the evolution in quality and production speed, along with condition based, corrective and preventive maintenance. The cost-benefit optimization is performed using a Multi-Objective Evolutionary Algorithm. Both the model and the optimization approach are applied to an industrial case.

**Classification** : 68W50, 68T20, 90C59

**Format** : Talk at Waseda University

**Author(s)** : Eilsabete Alberdi (University of the Basque Country UPV/EHU) Aitor Goti (University of Deusto) Aitor Oyarbide-Zubillaga (University of Deusto) Pablo Garcia-Bringas (University of Deusto) Ana Sánchez (Polytechnic University of Valencia)

## [00790] Machine learning methods with error analysis for optimal control problems

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @F312

**Type** : Contributed Talk

**Abstract** : We consider optimal control with partial differential equations (PDE) and present a numerical method based on machine learning including control error analysis. Physics-Informed Neural Networks (PINN) are used with the cost and penalty terms for the PDE as loss function. The model size is iteratively increased until the a posteriori estimated control error satisfies a given accuracy. The method is illustrated with numerical examples for 1D heat transfer and 3D turbine activation.

**Classification** : 49M41, 49M25, 68T05, 65G20

**Format** : Talk at Waseda University

**Author(s)** : Georg Vossen (Kreleld University of Applied Sciences) Semih Sirin (Kreleld University of Applied Sciences) Nicolai Friedlich (Kreleld University of Applied Sciences)

## [00791] FunFact: Tensor Decomposition, Your Way

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @G305

**Type** : Contributed Talk

**Abstract** : FunFact simplifies the design of matrix and tensor factorization algorithms. It features a powerful programming interface that augments the NumPy API with Einstein notations for writing concise tensor expressions. Given an arbitrary forward calculation scheme, the package will solve the inverse problem using stochastic gradient descent, automatic differentiation, and multi-replica vectorization. It is GPU- and parallelization-ready thanks to modern numerical linear algebra backends such as JAX/TensorFlow and PyTorch. We demonstrate a variety of use cases.

**Classification** : 15-04, 65F55

**Format** : Talk at Waseda University

**Author(s)** : Daan Camps (Lawrence Berkeley National Laboratory) Yu-Hang Tang (NVIDIA)

## [00798] Accelerating Low-Order Matrix-Free Finite Element Methods for Geophysics on GPU Architectures

**Session Time & Room** : 5B (Aug.25, 10:40-12:20) @E703

**Type** : Contributed Talk

**Abstract** : Low-order matrix-free FEMs offer an alternative approach that avoids the need to construct a global stiffness matrix. In this study, we compare the performance of low-order matrix-free FEMs with a sparse-matrix approach on GPU architectures for geophysics applications. Our results show that low-order matrix-free FEMs can significantly accelerate the solution of large linear systems on GPU architectures.

**Classification** : 65M60, 86-08, 65F50

**Format** : Talk at Waseda University

**Author(s)** : Yohann Dudouit (Lawrence Livermore National Lab)Randy Settgaest (Lawrence Livermore National Lab)Nicola Castelletto (Lawrence Livermore National Lab)

## [00803] Epilepsy MEG network TERGM analysis

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @G701

**Type** : Contributed Talk

**Abstract** : The brain has a complex structure where different neurons are connected. To study brain activity and disorders, it is important to analyze the functional connectivity of the brain through network analysis. Because of high temporal and spatial resolution, MEG (magnetoencephalography) can provide useful information for brain network analysis. We analyzed functional connectivity using static/temporal network statistics, MCCA (multiset canonical correlation analysis), and TERGM (temporal exponential random graph model) with epilepsy MEG data.

**Classification** : 62H22, 62P10

**Format** : Talk at Waseda University

**Author(s)** : Haeji Lee (Duksung women's university)Jaehee Kim (Duksung women's university)

## [00805] A Topological Model of Textile Structures

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @E504

**Type** : Contributed Talk

**Abstract** : Textiles are complex entangled structures made of threads embedded in a thickened plane. From nano to macro scale and high functionality to pure esthetic, they have been studied and fabricated for thousands of years in disciplines as diverse as materials science and art. Currently an active research topic in mathematics, we will present a topological model that aims to define, construct and classify specific textile structures from a knot theory viewpoint and highlight some applications.

**Classification** : 57K10, 57K12

**Format** : Talk at Waseda University

**Author(s)** : Sonia Mahmoudi (Drexel University)

## [00809] Mathematical Aspects of Metaheuristics in Medical Imaging and Pattern Recognition

**Session Time & Room** : 2D (Aug.22, 15:30-17:10) @A201

**Type** : Contributed Talk

**Abstract** : Medical imaging and pattern recognition have very important applications in the health and other industrial sectors. In this talk, we will be focusing on the mathematical model that deals with high-order graph matching using a metaheuristic technique. This model has been tested real-life images including identifying white blood cells in human blood. The models work on the idea of artificial intelligence and have a high level of efficiency with good results. The role of AI is in terms of

AI-based metaheuristics which are used as search and optimization techniques to address aforementioned problems.

**Classification** : 68W50, 68U10, 68T42, 68T10, 68T05, Evolutionary Algorithms, Agent Based Systems, Graph Matching

**Format** : Talk at Waseda University

**Author(s)** : Anupam Yadav (Dr BR Ambedkar National Institute of Technology Jalandhar)

## **[00816] Ultraspherical spectral methods for time-dependent problems**

**Session Time & Room** : 1E (Aug.21, 17:40-19:20) @E704

**Type** : Contributed Talk

**Abstract** : Spectral methods solve elliptic partial differential equations (PDEs) numerically. Their main advantage is spectral convergence, i.e., error decays exponentially when the solution is analytic. We present numerical schemes for solving some time-dependent linear PDEs utilizing the ultraspherical spectral method in space and time, thus portraying overall spectral convergence. Moreover, they lead to sparse and well-conditioned linear systems. We compare their performance with existing spectral schemes and explore their parallelization in time.

**Classification** : 65M70, 65L05, 35K20, 35L20, 41A10

**Format** : Talk at Waseda University

**Author(s)** : Avleen Kaur (University of Saskatchewan)S, H. Lui (University of Manitoba)

## **[00817] Understanding Flood Flow Physics via Data-Informed Learning**

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @E811

**Type** : Contributed Talk

**Abstract** : Modeling the dynamics of fast-moving floods has historically been an intractable problem due to the inherent complexity and multi-scale physics of the underlying processes involved. Recent advancements in physics-constrained machine learning indicate that neural networks can be used to effectively model phenomena for which physical laws are poorly understood. By combining real data and first principles, we show that we can enhance knowledge about the underlying physics of flood phenomena via the learned constitutive laws.

**Classification** : 68T07, 76T99, 86-10

**Format** : Talk at Waseda University

**Author(s)** : Jonathan Thompson (University of Colorado Colorado Springs)Radu Cascaval (University of Colorado Colorado Springs)

## **[00818] BENCHMARKED ASSET MANAGEMENT WITH FIXED INCOME SECURITIES**

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @A510

**Type** : Contributed Talk

**Abstract** : We discuss a continuous-time portfolio optimization problem to beat a stochastic benchmark. In addition to plain equities, the proposed model is suitable to include fixed-income securities. In the proposed economy, the dynamics of assets and economic factors are described by non-linear stochastic differential equations, which make the model vast to account for various interest rate models. We prove the existence and uniqueness of optimal investment strategies for finite and infinite planning horizons.

**Classification** : 91G10, 91G30, 91G15, 60G65, 35Q93

**Format** : Talk at Waseda University

**Author(s)** : Mayank Goel (Birla Institute of Technology and Science Pilani)Ravi Shankar (Birla Institute of Technology and Science Pilani)

## **[00820] Chemotaxis system with signal-dependent motility and the singular limit problem**

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @G502

**Type** : Contributed Talk

**Abstract** : We study the reaction-diffusion model that consists of equations that govern the evolution of bio-cells in a chemotactic environment. In our modeling framework, we assume that if the chemical concentration is low, then the cells move actively, whereas if the chemical concentration is high, they become less active. As we take a limit of conversion process, we formally obtain the singular limit problem of Fokker-Planck type diffusion. The aim of this study is to prove the global well-posedness of the singular limit problem and its convergence rigorously.

**Classification** : 35K51, 35K57, 92C17

**Format** : Talk at Waseda University

**Author(s)** : Changwook Yoon (Chungnam National University)Yong-Jung Kim (KAIST)

## **[00821] ADAPTIVE QUADRATIC DISCONTINUOUS GALERKIN FINITE ELEMENT METHOD FOR THE UNILATERAL CONTACT PROBLEM**

**Session Time & Room** : 4C (Aug.24, 13:20-15:00) @E711

**Type** : Contributed Talk

**Abstract** : The proposed title of my talk will be ADAPTIVE QUADRATIC DISCONTINUOUS GALERKIN FINITE ELEMENT METHOD FOR THE UNILATERAL CONTACT PROBLEM . In the talk, I will be discussing about employing discontinuous Galerkin methods (DG) for the finite element approximation of frictionless unilateral contact problem using quadratic finite elements over simplicial triangulation. We shall analyze a posteriori error estimates in the DG norm wherein, the reliability and efficiency of the proposed a posteriori error estimators will be addressed. Further we will show that numerical results substantiate the theoretical findings,

**Classification** : 65N30, 65N15

**Format** : Talk at Waseda University

**Author(s)** : Tanvi Tanvi (Research Scholar)Kamana Porwal (IIT DELHI)

## **[00823] Weighted Trace-Penalty Minimization for Full Configuration Interaction**

**Session Time & Room** : 4D (Aug.24, 15:30-17:10) @E508

**Type** : Contributed Talk

**Abstract** : A novel unconstrained optimization model named weighted trace-penalty minimization (WTPM) is proposed to address the extreme eigenvalue problem arising from the Full Configuration Interaction (FCI) method. The coordinate descent method is adapted to WTPM and results in WTPM-CD method. With the sparse features of both FCI matrices and the global minimizers in mind, the reduction of computational and storage costs shows the efficiency of the algorithm.

**Classification** : 65F15, Electron Structure Calculation

**Format** : Talk at Waseda University

**Author(s)** : Weiguo Gao (Fudan University)Yingzhou Li (Fudan University)Hanxiang Shen (Fudan University)

## [00824] Asymptotics for Some Singular Limits

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @G501

**Type** : Contributed Talk

**Abstract** : The asymptotic behavior of solutions as a small parameter tends to zero is determined for a variety of singular-limit PDEs. In some cases even existence for a time independent of the small parameter was not known previously. New examples for which uniform existence does not hold are also presented.

Some of the results are joint work with Samuel Nordmann.

**Classification** : 35B25, 35B40

**Format** : Online Talk on Zoom

**Author(s)** : Steve Schochet (Tel Aviv University)

## [00826] Saffman-Taylor fingers selection mechanism in non-newtonian fluids

**Session Time & Room** : 5C (Aug.25, 13:20-15:00) @D101

**Type** : Contributed Talk

**Abstract** : We present an analytical approach, based on the Wentzel-Kramers-Brillouin technique, to predict the finger width of a simple fluid driving a non-Newtonian, power-law fluid. We find that in the limit of small surface tension,  $(\nu)$ , the relation between the dimensionless  $(\nu)$ , viscosity and finger width,  $(\Lambda)$ , has the form:  $(\Lambda \sim \frac{1}{2} - \mathrm{O}(\nu^{-1/2}))$  for shear thinning case, and  $(\Lambda \sim \frac{1}{2} + \mathrm{O}(\nu^{2/(4-n)}))$  for shear thickening case. A detailed comparison is provided.

**Classification** : 76E17

**Format** : Talk at Waseda University

**Author(s)** : Diksha Bansal (IIIT Delhi)

## [00828] Role of NK cells in regulation of lung cancer progression

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @A601

**Type** : Contributed Talk

**Abstract** : Tumor-associated neutrophils (TANs) and STAT signaling can stimulate or inhibit tumor growth. We developed and analyzed a mathematical model to address the issues of phenotypic transition and nonlinear regulation of NK cells, thus tumor dynamics, in response to various biochemical stimuli. Several optimal tumor prevention strategies including NK cells and Ionizing radiation have been developed to slow tumor growth. Therefore, We suggested how the optimal combination of anticancer treatments.

**Classification** : 92B05, 92-04, 92-10, Mathematical Biology

**Format** : Talk at Waseda University

**Author(s)** : Donggu Lee (Konkuk University)

## [00832] Monte Carlo estimation of equity measures for apportionment problem

**Session Time & Room** : 5B (Aug.25, 10:40-12:20) @E505

**Type** : Contributed Talk

**Abstract** : A Markov chain Monte Carlo method is devised for the computation of several equity measures for the apportionment problem of assembly seats to electoral districts. Seat bias and Gini mean difference is of our primary interest in computing. Generating a random walk in the high-dimensional simplex is the key to our algorithm. It is helpful to estimate the mean and several quantiles of the target statistics.

**Classification** : 65C05, 91G60, 60J22



**Format** : Talk at Waseda University

**Author(s)** : Hozumi Morohosi (National Graduate Institute for Policy Studies)

## [00833] Exact controllability for imperfect interface problems

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @G601

**Type** : Contributed Talk

**Abstract** : We study the exact internal and boundary controllability for a second order linear evolution problem defined in a two-component domain. We prescribe a homogeneous Dirichlet condition on the exterior boundary and a jump of the displacement proportional to the conormal derivatives on the interface. This last condition is the mathematical interpretation of an imperfect interface. The results are achieved via a constructive method known as Hilbert Uniqueness Method, HUM for short, introduced by J. -L. Lions. Unlike classical cases, we find lower bounds for the control times depending not only on the geometry of the domain and on the coefficient matrix of our problems but also on the coefficient of proportionality of the jump with respect to the conormal derivatives.

References

- [1] S. Monsurro, A. K. Nandakumaran, C. Perugia, Exact Internal Controllability for a Problem with Imperfect Interface, Appl. Math. Optim. (2022), 1-33.
- [2] S. Monsurro, A. K. Nandakumaran, C. Perugia, A Note on the Exact Boundary Controllability for an Imperfect Transmission Problem, Ric. Mat. 40 (2021), 1-18.

**Classification** : 35LXX, 35QXX

**Format** : Talk at Waseda University

**Author(s)** : Sara Monsurro (University of Salerno)

## [00834] Analytical Solution for Linearized Diffusive Wave with Concentrated Lateral Inflow

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @G802

**Type** : Contributed Talk

**Abstract** : We present a solution for flow depth and discharge at different locations of a finite prismatic channel for linearized diffusive wave approximation with concentrated lateral inflow subjected to water discharge as the upstream boundary and flow depth as the downstream boundary. Laplace transform is used to find the analytical solution. We present some results to show the effect of Peclet number and the point of confluence on discharge and flow depth.

**Classification** : 44A10, 35Q35, 86A05, Hydraulics, River Mechanics

**Format** : Online Talk on Zoom

**Author(s)** : Shiva Kandpal (Indian Institute of Technology Guwahati)Swaroop Nandan Bora (Indian Institute of Technology Guwahati)

## [00835] A shifted LOPBiCG method for solving nonsymmetric shifted linear systems

**Session Time & Room** : 5B (Aug.25, 10:40-12:20) @E603

**Type** : Contributed Talk

**Abstract** : Premature convergence of the seed system can lead to shifted systems being unsolved when applying shifted Krylov subspace methods to solve shifted linear systems. To avoid this, a seed-switching technique may be a method of choice; however, the conventional product-type methods cannot use this technique since it requires the collinear residuals between the seed and shifted systems. We propose a variant of the shifted BiCGStab method so that the technique can be applied.

**Classification** : 65Fxx

**Format** : Talk at Waseda University

**Author(s)** : Ren-Jie Zhao (Nagoya University)Tomohiro Sogabe (Nagoya University)Tomoya Kemmochi (Nagoya University)Shao-Liang Zhang (Nagoya University)

## [00836] Reynolds-blended weights for BDDC in applications to Navier-Stokes equations

**Session Time & Room** : 4D (Aug.24, 15:30-17:10) @E504

**Type** : Contributed Talk

**Abstract** : We solve incompressible Navier-Stokes equations by the finite element method with one step of the Balancing Domain Decomposition by Constraints (BDDC) method. This method requires a scaling operator at the interface between subdomains. We introduce a new interface scaling tailored to Navier-Stokes equations. The weights in this averaging consider a local Reynolds number. This Reynolds-blended scaling is compared with several existing approaches on 3D lid-driven cavity and backward-facing step problems.

**Classification** : 65Y05

**Format** : Talk at Waseda University

**Author(s)** : Martin Hanek (Czech Technical University in Prague, Institute of Mathematics of the Czech Academy of Sciences)

## [00842] Iterative projection methods for solving cone-constrained eigenvalue complementarity problems

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @E605

**Type** : Contributed Talk

**Abstract** : Cone-constrained eigenvalue complementarity problems are associated with unstable modes and vibrations of dynamic systems in engineering. In this talk, iterative projection methods are proposed to quickly search the corresponding K-eigenvalues and K-eigenvectors. Particularly, it is also designed to find specific solutions of the considered problem. Convergence analysis is studied in detail and the sufficient conditions are given. Numerical results are shown to confirm the advantages of our algorithms.

**Classification** : 65K15, 15A42

**Format** : Talk at Waseda University

**Author(s)** : Nan Li (Nagoya University)Tomohiro Sogabe (Nagoya University)Jun-Feng Yin (Tongji University)Tomoya Kemmochi (Nagoya University)Shao-Liang Zhang (Nagoya University)

## [00844] Evidence of Multiple Effective Wavenumbers in Isotropic Random Particulate Materials

**Session Time & Room** : 5C (Aug.25, 13:20-15:00) @E817

**Type** : Contributed Talk

**Abstract** : In random particulate materials, it is generally assumed that if we average over all particle configurations, the averaged wave field satisfies the wave equation with a unique effective wavenumber  $k^*$ . As the medium is homogeneous and isotropic - because the particles have no specific orientation or direction - it is reasonable to assume the presence of one effective wavenumber. However, recent work theoretically predicted the existence of at least two (complex) effective wavenumbers for one fixed frequency. A phenomenon normally observed only in anisotropic media. Our goal is to find clear evidence of these wavenumbers using the Monte-Carlo approach and show how they influence the total field.

**Classification** : 74J20, 74A40, 78A48, 82D30, 82M31, wave scattering, multiple scattering, random media, ensemble averaging, Monte Carlo methods

**Format** : Talk at Waseda University

**Author(s)** : Aristeidis Karnezis (The University of Sheffield)Artur Lewis Gower (The University of Sheffield)

## [00846] ESR fractional model with non-zero uniform average blood velocity

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @G305

**Type** : Contributed Talk

**Abstract** : This article discusses a new solution to the time-fractional ESR model, taking into account the non-zero average blood velocity. We not only obtain an analytic solution to the generalized model of Sharma et al. and da Sousa et al., but also we present some new results which establish that the developed fractional order model is better-suited one by using which predicting the ESR rate can take place more accurately.

**Classification** : 26A06, 26A33, 33E12, 35R11

**Format** : Online Talk on Zoom

**Author(s)** : Abhijit Shit (Indian Institute of Technology Guwahati)Swaroop Nandan Bora (Indian Institute of Technology Guwahati)

## [00847] Acute Lymphoblastic Leukemia diagnosis and treatment: a mathematical analysis

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @G306

**Type** : Contributed Talk

**Abstract** : Despite the recent medical advances, treatments are unsuccessful in 15-20% of cases in Acute Lymphoblastic Leukemia ( ALL ) patients. The main aim of our study is to analyse data from bone marrow samples and to use artificial intelligence to improve current techniques of diagnosis in ALL protocols. Using machine learning techniques, our results predict bone marrow behavior and allow us to classify patients depending on their relapse risk.

**Classification** : 34A12, 92-10

**Format** : Online Talk on Zoom

**Author(s)** : Ana Niño-López (Department of Mathematics, Universidad de Cádiz)Salvador Chulián (University of Cádiz)Álvaro Martínez-Rubio (Department of Mathematics, Universidad de Cádiz)María Rosa (Department of Mathematics, Universidad de Cádiz)

## [00848] Mathematical modelling of neuroblast migration in the mouse brain

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @G710

**Type** : Contributed Talk

**Abstract** : This talk is devoted to the mathematical modeling of migration of neuroblasts, precursor cells of neurons, with PDE. The pathway is determined mainly by attraction forces and the heterogeneous mobility of neuroblasts in different regions of the brain. In numerical simulations, the application of novel discontinuous Galerkin methods allows to maintain the properties of the continuous model. We present some successful computer tests including parameter adjust to fit real data from rodent brains.

**Classification** : 35Q92, 92-10, 65M60

**Format** : Online Talk on Zoom

**Author(s)** : Noelia Ortega-Román (Universidad de Cádiz)J. Rafael Rodríguez-Galván (Universidad de Cádiz)Daniel Acosta-Soba (Universidad de Cádiz)Francisco Guillén-González (Universidad de Sevilla)

## [00849] Well-suited upwind DG scheme for a phase-field tumor model

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @G710

**Type** : Contributed Talk

**Abstract** : This talk is focused on the numerical analysis of a modified diffuse-interface tumor model with degenerate mobility. In particular, we develop a discontinuous Galerkin upwind scheme that conserves the mass, preserves the discrete maximum principle and satisfies an energy law both for the Cahn-Hilliard equation and for the phase-field tumor model. Moreover, we present several numerical experiments that enhance the qualitative behavior of the model and which are in accordance with the theoretical results.

**Classification** : 35Q92, 65M60, 92-10

**Format** : Online Talk on Zoom

**Author(s)** : Daniel Acosta-Soba (Universidad de Cádiz)Francisco Guillén-González (Universidad de Sevilla)J. Rafael Rodríguez-Galván (Universidad de Cádiz)

## [00852] Energy stable and positive DG scheme for Keller-Segel equations

**Session Time & Room** : 5B (Aug.25, 10:40-12:20) @E703

**Type** : Contributed Talk

**Abstract** : This work is focused on discretization of the Keller-Segel equations for chemotaxis, a challenging problem due to its convective nature. Specifically, we introduce a new upwind, mass-conservative, positive and energy-dissipative discontinuous Galerkin which is based on the gradient-flow structure of the equations. Also we present some numerical tests in accordance with the aforementioned properties of the discretization, showing a good behaviour in the case of chemotactic collapse, where very steep gradients appear

**Classification** : 65M60, 35Q92, 92-10

**Format** : Online Talk on Zoom

**Author(s)** : J. Rafael Rodríguez-Galván (Universidad de Cádiz)Francisco Guillén-González (Universidad de Sevilla)Daniel Acosta-Soba (Universidad de Cádiz)

## [00853] Numerical Approximation of Fractional Burgers Equation with Non-singular Time-Derivatives

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @E504

**Type** : Contributed Talk

**Abstract** : Fractional Burgers equation (FBE) is a partial differential equation being non-linear in space. This work presents a numerical method to solve a time-FBE with second order of convergence. The fractional time-derivative is taken as non-singular derivative whose kernel contains the Mittag-Leffler function. The discretization of derivatives is done by using finite difference method and Newton iteration method. Developed numerical scheme is stable and convergent in  $L^\infty$  norm. Examples have been illustrated to validate the theory.

**Classification** : 26A33, 65R10, 35R11

**Format** : Online Talk on Zoom

**Author(s)** : Swati Yadav (NTNU Trondheim)Swati Yadav (NTNU Trondheim)Rajesh Kumar Pandey (IIT BHU, Varanasi)

## [00855] Mathematical modelling of edge wave on a functionally graded thermo-poro-elastic plate

**Session Time & Room** : 5C (Aug.25, 13:20-15:00) @E817

**Type** : Contributed Talk

**Abstract** : An analysis of flexural edge waves propagating in a thermally affected poroelastic plate supported by a Pasternak foundation is presented. The Kirchhoff plate theory and Moore-Gibson-Thomson (MGT) thermos elasticity theory are applied to study the displacement field of the plate and temperature distribution on edge wave, respectively. There are seven different porosity models considered to compare the edge wave behavior in different porous structures. The grid dispersion is optimized by applying the FDM to the wave equation. The effects of porosity, temperature, elastic foundation, cutoff-frequency, and wave frequency are investigated numerically.

**Classification** : 74J20, 35L05, 35L53, 86-10, 74S20

**Author(s)** : Santanu Manna (Department of Mathematics, Indian Institute of Technology Indore, Simrol, Khandwa road, Indore-453552, M.P., India)Rahul Som (Department of Mathematics, Indian Institute of Technology Indore, Simrol, Khandwa road, Indore-453552, M.P., India)Tanisha Kumari (Department of Mathematics, Indian Institute of Technology Indore, Simrol, Khandwa road, Indore-453552, M.P., India)

## [00856] Successive image generation though cyclic transformations using CycleGAN

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @E811

**Type** : Contributed Talk

**Abstract** : CycleGAN is a deep generative adversarial networks that performs image to image style translation by learning relationship between two image domains.

By using CycleGAN, here we developed a model performing cyclical transformation that generates a series of similar images. This system can be regarded as a dynamical system; it can continuously sample various images along the trajectory of the dynamical system. The chaotic behavior of this deep model was studied.

**Classification** : 68T07, 37N99

**Format** : Talk at Waseda University

**Author(s)** : Takaya Tanaka (Graduate School of Engineering, Fukuoka Institute of Technology)Takaya Tanaka (Graduate School of Engineering, Fukuoka Institute of Technology)Yutaka Yamaguti (Faculty of Information Engineering, Fukuoka Institute of Technology)

## [00857] An ecological study of mathematical model on intermittent phytoplankton distribution

**Session Time & Room** : 1C (Aug.21, 13:20-15:00) @D514

**Type** : Contributed Talk

**Abstract** : A microscale ecological study is done using the closure approach to understand the impact of productivity controlled by geographical and seasonal variations on the intermittency of phytoplankton. Parameters are estimated from the nature of productivity and spread of phytoplankton density during field observation done at four different locations of Tokyo Bay. The model validation shows that our results are in good agreement with the field observation and succeeded in explaining the intermittent phytoplankton distribution.

**Classification** : 92-10, 92D40, Mathematical Biology

**Format** : Talk at Waseda University

**Author(s)** : Sandip Banerjee (Indian Institute of Technology Roorkee)Arpita Mondal (Indian Institute of Technology Roorkee)

## [00858] An adaptive spectral method for oscillatory second-order linear ODEs with frequency-independent cost

**Session Time & Room** : 3D (Aug.23, 15:30-17:10) @E606

**Type** : Contributed Talk

**Abstract** : I will introduce an efficient method for solving 2nd order, linear ODEs whose solution may vary between highly oscillatory and slowly changing over the solution interval. Within a marching scheme, the solution is generated either via a nonoscillatory phase function (computed by defect correction), or spectral collocation, whichever is more efficient for the current timestep. With numerical experiments I will show that our algorithm outperforms other state-of-the-art oscillatory solvers and has a frequency-independent runtime.

**Classification** : 65Lxx, 34E05, 65L60, 34-04, 65Gxx

**Format** : Talk at Waseda University

**Author(s)** : Fruzsina Julia Agocs (Center for Computational Mathematics, Flatiron Institute)Alex Harvey Barnett (Center for Computational Mathematics, Flatiron Institute)

## [00859] A mathematical model of immunotherapy: CD19 relapses in B leukemia

**Session Time & Room** : 3D (Aug.23, 15:30-17:10) @A511

**Type** : Contributed Talk

**Abstract** : B-cell Acute Lymphoblastic Leukemia (B-ALL) is the most common type of pediatric leukaemia. For relapsing patients, a treatment possibility is chimeric antigenic receptor (CAR)-T cells, which recognize target cells with the antigen CD19, expressed in B-ALL. We show a mathematical model based on partial differential equations and focus on how CAR-T cell therapy can lead to positive or negative CD19 relapses. The analysis presented represents real-life scenarios, where optimal treatment can be studied.

**Classification** : 92-10, 37N25, 35Q92

**Format** : Online Talk on Zoom

**Author(s)** : Salvador Chulián (Department of Mathematics, University of Cádiz)Álvaro Martínez-Rubio (Department of Mathematics, University of Cádiz)Ana Niño-López (Department of Mathematics, Universidad de Cádiz)María Rosa (Department of Mathematics,)

## [00860] Probabilistic Domain Decomposition: Challenging Amdahl's curse on partial differential equations.

**Session Time & Room** : 5C (Aug.25, 13:20-15:00) @E705

**Type** : Contributed Talk

**Abstract** : Probabilistic Domain Decomposition allows solving elliptic BVPs with remarkable scalability by taking advantage of probabilistic representations of BVPs. This representation is less convenient when dealing with non linear problems or even unknown in the case of the Helmholtz equation. However, these limitations can be circumvented by introducing some iterative schemes. In this presentation we aim to provide an insight on these algorithms alongside some proof of concept results obtained in FUGAKU and CINECA.

**Classification** : 65N75, 68W10, 65N55

**Format** : Online Talk on Zoom

**Author(s)** : Jorge Morón-Vidal (University Carlos III of Madrid)

## [00861] Using elastic waves to measure mechanical stress

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @E812

**Type** : Contributed Talk

**Abstract** : In principle, elastic waves could be used to assess the stress in a material, as the higher the stress, the faster the wave will propagate. However, the speed also depends on material parameters, which is why there are no robust (non-invasive) measurement techniques. In this talk we show how to overcome these challenges by using universal relationships between stress and wave speeds. This has led to robust measurements with either bulk waves [2] or surface waves [3].

Universal relationships in continuum mechanics are those that hold for any type of material, or constitutive choice [1]. To measure stress, it would be ideal to have a relationship between the wave speed and the stress that holds for any elastic material. However, there is only one such universal relationship:  $\rho v_{12}^2 - \rho v_{21}^2 = \sigma_{11} - \sigma_{22}$ , where  $\sigma_{ij}$  are the components of the Cauchy stress tensor, and  $v_{12}$  ( $v_{21}$ ) is the speed of a shear wave propagating in the  $x_1$  ( $x_2$ ) direction that is polarised in the  $x_2$  ( $x_1$ ) direction. Inspired by this identity we propose, and experimentally validate, several new ultrasonic methods.

[1] Truesdell, Clifford, and Walter Noll. "The non-linear field theories of mechanics." The non-linear field theories of mechanics. Springer, Berlin, Heidelberg, 1992. 1-579.

[2] Li, Guo-Yang, Artur L. Gower, and Michel Destrade. "An ultrasonic method to measure stress without calibration: The angled shear wave method." The Journal of the Acoustical Society of America 148.6 (2020): 3963-3970.

[3] Li, Guo-Yang, et al. "Non-destructive mapping of stress and strain in soft thin films through sound waves." Communications Physics 5.1 (2022): 1-7.

**Classification** : 74J05, 74B10, 74B15, 74J25

**Format** : Talk at Waseda University

**Author(s)** : Art Gower (University of Sheffield) Michel Destrade (University of Galway) Guo-yang Li (Harvard Medical School and Wellman Center for Photomedicine)

## [00864] Stabilization of time-periodic flows

**Session Time & Room** : 5C (Aug.25, 13:20-15:00) @A207

**Type** : Contributed Talk

**Abstract** : At first, I shall explain the stability and stabilizability of an ODE around a periodic trajectory. A characterization of the stability of ODEs around a periodic trajectory using the Poincare map and Floquet theory will be discussed. Then, I shall explain the extension of the idea to the parabolic type of PDEs. In particular, as an application, the stabilization of the incompressible Navier-Stokes equation around a time-periodic trajectory will be discussed.

**Classification** : 93B52, 93D15, 35B10, 34H15, 76D55

**Format** : Talk at Waseda University

**Author(s)** : Debanjana Mitra (Department of Mathematics, IIT Bombay )

## [00865] A novel hybrid microphysical–rheological multiscale constitutive model of ferroelectrics

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @E812

**Type** : Contributed Talk

**Abstract** : For describing mutually coupled dissipative processes in ferroelectrics, in particular ferroelectric domain switching and viscoelasticity, a hybrid micromechanical - rheological constitutive model is developed and embedded in the framework of a multiscale modeling approach. The mathematical theory is consistent against the background of rational thermodynamics and deals with two types of internal variables. The advanced modeling approach is applied to identify novel energy harvesting cycles exploiting dissipative effects, resulting in a major electric work output.

**Classification** : 74M25, 74F05, 74M05, 74N30, 74Q15

**Format** : Talk at Waseda University

**Author(s)** : Andreas Warkentin (University of Kassel)Andreas Ricoeur (University of Kassel)

## **[00872] Stability Estimates in Bayesian D-Optimal Experimental Design**

**Session Time & Room** : 3D (Aug.23, 15:30-17:10) @E501

**Type** : Contributed Talk

**Abstract** : We studied stability properties of the expected utility function in Bayesian optimal experimental design. We proved a convergence rate of the expected utility with respect to a likelihood perturbation. This rate is uniform over the design space. As an example we have non-linear Bayesian inverse problems with Gaussian likelihood satisfying general assumptions. Theoretical convergence rates are demonstrated numerically in three different examples.

**Classification** : 62K05, 62F15, 35R30, Bayesian Inverse Problems

**Format** : Talk at Waseda University

**Author(s)** : Tapio Helin (Lappeenranta University of Technology)Duc-Lam Duong (Lappeenranta University of Technology)Jose Rodrigo Rojo Garcia (Lappeenranta University of Technology)

## **[00875] Deep learning based reduced ensemble Kalman inversion for microscopic parameter estimation**

**Session Time & Room** : 2C (Aug.22, 13:20-15:00) @G710

**Type** : Contributed Talk

**Abstract** : In the scope of nonlinear multiscale problems, estimating the macroscopic distribution of the microscopic geometrical parameters given macroscopic measurements is of interest. In general, inverse estimation is challenging due to the need of derivatives of the complex forward model and the high cost of the forward solver. We introduce derivative-free ensemble Kalman inversion and deep-learning based model reduction to tackle the aforementioned challenges, and assess the performance of the proposed method on a hyper-elastic problem.

**Classification** : 35R30, 65N21, 74G75, 65N75, 62F86

**Format** : Talk at Waseda University

**Author(s)** : Yankun Hong (Eindhoven University of Technology)Harshit Bansal (Eindhoven University of Technology)Karen Veroy (Eindhoven University of Technology)

## **[00878] Large-amplitude problem of BGK model**

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @D101

**Type** : Contributed Talk

**Abstract** : BGK equation is a relaxation model of the Boltzmann equation for simulation of various kinetic flow problems. In this work, we study asymptotic stability of the BGK model when the initial data is not necessarily close to global equilibrium pointwisely. Main difficulty of the BGK equation comes from the highly nonlinear structure of the relaxation operator. To overcome this issue, we derive refined control of macroscopic fields to guarantee the system enters quadratic nonlinear regime.

**Classification** : 76P05, 35B35, 35B40, 82C40

**Format** : Talk at Waseda University

**Author(s)** : Gichan Bae (Seoul National University)Gyounghun Ko (POSTECH)donghyun lee (POSTECH)Seokbae Yun (Sungkyunkwan University)



## [00880] Disturbance rejection based modified repetitive control design for stabilization of Takagi–Sugeno fuzzy systems

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @G802

**Type** : Contributed Talk

**Abstract** : In this talk, the aim is to obtain a disturbance rejection based repetitive control design for the stabilization of Takagi–Sugeno fuzzy systems in presence of aperiodic disturbances. By employing Lyapunov approach, a new set of conditions is derived in the form of linear matrix inequalities to obtain the control gains for ensuring the robust stabilization of the addressed fuzzy systems. Further, numerical simulations are provided to verify the supremacy of the designed control scheme.

**Classification** : 37N35, 93B51, 93D15, 93D25, 93C42

**Format** : Talk at Waseda University

**Author(s)** : Antony Crispin Sweet Charles Selvaraj (Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore)

## [00883] Convergence of the Eberlein diagonalization method

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @E603

**Type** : Contributed Talk

**Abstract** : The Eberlein method is a Jacobi-type process for solving the eigenvalue problem of an arbitrary matrix. In each iteration two transformations are applied on the underlying matrix, a plane rotation and a non-unitary elementary transformation. In this talk we present the method under the broad class of generalized serial pivot strategies. We provide the proof of the global convergence and give several numerical examples.

**Classification** : 65F15

**Format** : Talk at Waseda University

**Author(s)** : Erna Begovic (University of Zagreb) Ana Perkovic (University of Zagreb)

## [00884] Time-Frequency Analysis of Functional Datasets

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @F311

**Type** : Contributed Talk

**Abstract** : We introduce an operator valued Short-Time Fourier Transform for certain classes of operators with operator window, and show that the transform acts in an analogous way to the STFT for functions. This object reflects the time-frequency behaviour for datasets of functional data in both an intra- and inter-functional manner, showing the function-wise time-frequency distribution and cross correlation of time-frequency concentration between datapoints, hence combining desirable aspects of existing basis selection methods for functional data science.

**Classification** : 46-XX, 62R10

**Format** : Talk at Waseda University

**Author(s)** : Monika Dörfler (University of Vienna) Franz Luef (Norwegian University of Science and Technology (NTNU)) Henry McNulty (Norwegian University of Science and Technology (NTNU)) Eirik Skrettingland (NA)

## [00885] Hybrid nanofluid of Heimenz flow over electromagnetic surface: Enhancement in thermal energy

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @D505

**Type** : Industrial Contributed Talk

**Abstract** : Over decades, the Hiemenz flow for heat transfer mechanism has gained a lot of significant consideration from engineers and researchers owing to the optimal rates of heat transfer, pressure and mass deposition near stagnation point in high speed flows. The stagnation region flows, initiated by Hiemenz [1], are very frequent and extensively adopted for modeling in considerable fields, such as

micro cooling systems, extrusions with a die, continuous casting, jet impingements, and-so-forth.

The novel and advanced concepts of nanofluids offer fascinating heat transfer characteristics compared to conventional heat transfer fluids. Applications of nanofluids in industries such as heat exchanging devices, cool automobile engines and welding equipment and to cool high heat-flux devices such as high power microwave tubes and high-power laser diode arrays. Hybrid nanofluids can also effectively be used for a wide variety of industries, ranging from transportation to energy production and in electronics systems like microprocessors, drug distributors to check the chemical reactions of drugs in blood, as coolants and heat exchangers for better heat transfer, as lubricators, in nuclear reactors for thermal emission and absorption, solar concentrators for absorbing much of the solar radiation, and many more.

The objective of this study to improve the heat transfer rate by solving Hiemenz flow of hybrid nanofluid over an electromagnetic surface.

**Classification** : 76-10, Heat transfer

**Format** : Online Talk on Zoom

**Author(s)** : Islam Zari (University of Peshawar)Karlygash Dosmagulova (Ghent University, Belgium)Chinwendu Emilian MADUBUEZE (Federal university of Agriculture Makurdi Nigeria )

## [00889] Multiple-Relaxation Runge Kutta Methods for Conservative Dynamical Systems

**Session Time & Room** : 2E (Aug.22, 17:40-19:20) @E505

**Type** : Contributed Talk

**Abstract** : Relaxation Runge-Kutta methods, which are a slight modification of the RK methods, have been introduced to preserve invariants of initial-value problems. So far, this approach has been applied to preserve only one nonlinear functional in the numerical solution of a problem. In this talk, I will present the generalization of the relaxation approach for RK methods to preserve multiple nonlinear invariants of a dynamical system. The significance of preserving multiple invariants and its impact on long-term error growth will be illustrated via several numerical examples.

**Classification** : 65L04, 65L20, 65M06, 65M12, 65M22

**Format** : Talk at Waseda University

**Author(s)** : Abhijit Biswas (King Abdullah University of Science and Technology (KAUST))David Isaac Ketcheson (King Abdullah University of Science and Technology (KAUST))

## [00892] Predicting response to pediatric leukemia with flow cytometry data

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @A601

**Type** : Contributed Talk

**Abstract** : 15% of children with B-cell acute lymphoblastic leukemia fail to achieve response or long-term remission. With new treatments being developed to provide an alternative for this subset of patients, an improved risk classification at diagnosis can help to plan and prepare for this eventuality. Flow cytometry is currently used to characterize the leukemic clone but it has no prognosis value. In this work we use flow cytometry data at diagnosis from 250 pediatric patients from hospitals in Spain to find features associated with response by means of an array of computational methods.

**Classification** : 92Bxx

**Author(s)** : Alvaro Martínez-Rubio (University of Cadiz)Salvador Chulián (University of Cádiz)Ana Niño-López (Department of Mathematics, Universidad de Cádiz)Víctor Manuel Pérez-García (University of Castilla-La Mancha)María Rosa (University of Cadiz)

## [00894] ODE models relating irrigation to kidney bean yield

**Session Time & Room** : 3D (Aug.23, 15:30-17:10) @A511

**Type** : Industrial Contributed Talk

**Abstract** : Chippewa Valley Bean, located in Wisconsin, USA, is the world's largest processor of dark red kidney beans and works with farmers over several states. Current trends in farming are pressuring producers to generate higher yields with fewer resources, particularly water resources. This project describes our work creating ODE models that describe the relationship between irrigation inputs, soil parameters, and kidney bean yields that CVB can use to advise farmers for productive yet sustainable practices.

**Classification** : 92-10

**Format** : Talk at Waseda University

**Author(s)** : Tyler Skorczewski (University of Wisconsin Stout) Keith Wojciechowski (University of Wisconsin Stout)

## [00899] Unlocking the Secrets of Locking

**Session Time & Room** : 4C (Aug.24, 13:20-15:00) @E711

**Type** : Contributed Talk

**Abstract** : For nearly incompressible linear elastic materials, such as rubber, finite element methods sometimes exhibit suboptimal convergence rates for the energy and/or stresses. This type of behavior, termed "locking", is still not completely understood. This talk reviews the concept of locking and recent results that show that conforming high order finite elements provide optimal convergence for both the energy and stresses with respect to the mesh size and polynomial degree. Robust preconditioners will also be presented.

**Classification** : 65N30, 74S05, 65N35

**Format** : Talk at Waseda University

**Author(s)** : Charles Parker (University of Oxford) Mark Ainsworth (Brown University)

## [00901] Effect of porous layer fitted on a floating bridge in mitigating waveload

**Session Time & Room** : 3D (Aug.23, 15:30-17:10) @E820

**Type** : Contributed Talk

**Abstract** : Scattering of oblique water waves by a floating bridge with porous wall fitted on its vertical sides is studied. Significant changes are noticed in wave reflection due to changes in porosity. It is observed that as the porosity increases, the values of the reflection coefficient decrease. The behavior of various parameters, such as depth, porous wall width, porosity and angle of incidence, on the reflection coefficient are also carried out.

**Classification** : 76B07, 76B15, 35P10, 76S05, 76B55

**Format** : Online Talk on Zoom

**Author(s)** : Shilpi Jain (IIT Guwahati) Swaroop Nandan Bora (Indian Institute of Technology Guwahati)

## [00902] Influence of the statistical parameters of random particulate materials on wave propagation

**Session Time & Room** : 5C (Aug.25, 13:20-15:00) @G302

**Type** : Contributed Talk

**Abstract** : Current models predicting the effective properties of random particulate materials neglect the correlation between the particles positions by using the hole correction approximation. A recent method which predicts more than one effective wavenumber is adapted in order to take into account

these correlations. The method is validated against Monte-Carlo simulations and the influence of the correlations is demonstrated with computed effective wavenumbers.

**Classification** : 74A40, 78A48, 82D30

**Format** : Talk at Waseda University

**Author(s)** : Kevish Kumar Napal (University of Sheffield)ARTUR LEWIS GOWER (University of Sheffield)Paulo Sergio Piva (The University of Sheffield)Aristeidis Karnezis (The University of Sheffield)

## **[00903] Port-Hamiltonian form and stochastic Galerkin method for ordinary differential equations**

**Session Time & Room** : 2E (Aug.22, 17:40-19:20) @E505

**Type** : Contributed Talk

**Abstract** : We consider systems of ordinary differential equations (ODEs) including random variables. Based on a polynomial chaos expansion, a stochastic Galerkin approach yields a larger deterministic system of ODEs. We investigate port-Hamiltonian formulations of the original systems and the Galerkin systems. A structure-preserving stochastic Galerkin projection is constructed, which produces a larger port-Hamiltonian system. Furthermore, the associated Hamiltonian functions are compared. We present results of numerical computations using a test example.

**Classification** : 65L05, 34F05, uncertainty quantification

**Format** : Talk at Waseda University

**Author(s)** : Roland Pulch (University of Greifswald)

## **[00904] Quadrature Methods and Error Estimates for Particles in Stokes Flow**

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @E820

**Type** : Contributed Talk

**Abstract** : For axisymmetric particles in Stokes flow, boundary integral methods can be utilized for numerical evaluation of flow velocity on and outside particle surfaces. Precomputation yields a highly efficient and accurate quadrature by expansion (QBX) method for singular integrals when evaluating on-surface. For evaluation close to the particle surface (nearly singular integrals), a line interpolation method aided by quadrature error estimates is introduced and compared to QBX in terms of both accuracy and efficiency.

**Classification** : 65Rxx, 65Dxx, 41Axx, 76-XX

**Format** : Talk at Waseda University

**Author(s)** : Pritpal Matharu (KTH Royal Institute of Technology)Anna-Karin Tornberg (KTH Royal Institute of Technology)

## **[00909] Lipschitz stability of an inverse problem for Tumor Growth Model**

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @G809

**Type** : Contributed Talk

**Abstract** : We address an inverse problem of recovering a space-dependent semilinear coefficient in the Cahn–Hilliard type system modeling tumor growth described by a system of partial differential equations

with Dirichlet boundary condition using boundary-type measurement. First, we establish a new higher-order weighted Carleman estimate for the given system and then a suitable regularity of solutions

for this nonlinear system is derived. Finally, we prove Lipschitz type stability for the tumor growth model.

**Classification** : 35R30, 35K15

**Format** : Talk at Waseda University

**Author(s)** : Barani Balan Natesan (Central University of Tamil Nadu)

## **[00912] Simulation-based Bayesian optimization over categorical covariates**

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @A206

**Type** : Contributed Talk

**Abstract** : Optimizing black-box functions of categorical variables has important applications, including the design of biological sequences with specific properties. Bayesian optimization is widely used in this type of problem. It involves adjusting a probabilistic machine learning model of the objective and using an acquisition function to guide the optimization process. We propose a new algorithm to sequentially optimize the acquisition function inspired in simulated annealing. We address convergence issues and demonstrate its effectiveness on RNA-sequence optimization.

**Classification** : 90C27, 62F15, 60J20

**Format** : Talk at Waseda University

**Author(s)** : Roi Naveiro (CUNEF University)

## **[00921] Inverse Coefficient Problem - Coupling Fourth and Second Order Equations**

**Session Time & Room** : 4C (Aug.24, 13:20-15:00) @G502

**Type** : Contributed Talk

**Abstract** : In this paper, the recovery of the diffusion coefficient from the final time-measured data is carried out using the quasi-solution approach. The inverse coefficient problem is formulated as a minimization problem using an objective functional. The existence of the minimizer is proved, then the necessary optimality condition is derived, and by using that condition, the stability results are proved. To illustrate the efficiency of this method, numerical results are investigated using the conjugate gradient method.

**Classification** : 35G16, 35R30, 49K35, 49K20

**Format** : Talk at Waseda University

**Author(s)** : NAVANEETHA KRISHNAN M (CENTRAL UNIVERSITY OF TAMIL NADU, THIRUVARUR - 610005)

## **[00922] Matrix Factorization for Change Detection in HyperSpectral Images**

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @G304

**Type** : Contributed Talk

**Abstract** : When hyperspectral images are analyzed, a big amount of data needs to be processed and therefore, specific matrix factorization algorithms are used to express the original problem in suitable subspaces. We show some recent results derived also by using spatial and spectral functions to compute a lower rank approximation of the original matrix and to measure the reconstruction error between the input image and the approximate one, with applications to the task of change-detection.

**Classification** : 15A23

**Format** : Talk at Waseda University

**Author(s)** : Antonella Falini (Università degli studi di Bari Aldo Moro) Francesca Mazzia (Università degli studi di Bari Aldo Moro, Italy)

## [00927] Bone marrow stem cells and exosomes control doxorubicin-induced CRCC: A mathematical model

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @A601

**Type** : Contributed Talk

**Abstract** : Doxorubicin (DOX), a widely used chemotherapeutic agent, can cause neurodegeneration in the brain, which leads to cancer-related cognitive changes (CRCC). In fact, CRCC is a deteriorating condition which adversely affects the day-to-day life of cancer survivors. Recent studies reported that bone marrow mesenchymal stem cells (BMSCs) and exosome may significantly affect the CRCC conditions in a combination therapy (DOX+Exosome). In this study, we investigate the interaction among intracellular signaling (NF $\kappa$ B-Bcl-2-BAX), DOX, exosome, and IL-6.

**Classification** : 92B05

**Format** : Talk at Waseda University

**Author(s)** : hyunchul Kim (Konkuk University)Donggu Lee (Konkuk University)Haneol Cho (Konkuk university)Junho Lee (Konkuk University)Yangjin Kim (Konkuk University)

## [00929] On the continuum limit of epidemic models on graphs

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @G710

**Type** : Contributed Talk

**Abstract** : We consider an epidemic model defined on graphs and study the asymptotic behavior of the solutions as the number of vertices in the graph diverges. By relying on the theory of (graphons) we provide a characterization of the limit and establish convergence results. We also present approximation results for both deterministic and random discretizations. The analysis applies to dense and sparse graphs, including power-law networks. Extensive numerical results illustrate and assess the analytical findings.

**Classification** : 35Q92, 05C99, 92D30, 65M22, 35R02

**Format** : Talk at Waseda University

**Author(s)** : blanca ayuso de dios (universita milano-bicocca)Simone Dovetta (Politecnico di Torino)Laura Spinolo (IMATI-CNR, Pavia)

## [00930] Analysis and numerical approximation of energy-variational solutions to the Ericksen--Leslie equations

**Session Time & Room** : 5B (Aug.25, 10:40-12:20) @E703

**Type** : Contributed Talk

**Abstract** : The Ericksen--Leslie equations are used to model liquid crystals in their nematic phase. We define the concept of energy-variational solutions for the Ericksen--Leslie equations in three spatial dimensions. This solution concept satisfies the weak-strong uniqueness property. We construct an energy-variational solution with the help of an implementable, structure-inheriting space-time discretization. Computational studies are performed in order to provide some evidence of the applicability of the proposed algorithm.

**Classification** : 65M60, 35A35, 35Q35, 76A15

**Format** : Talk at Waseda University

**Author(s)** : Maximilian Elias Vincenzo Reiter (Technische Universität Berlin)

## [00931] The vaginal microbiota and its association with Chlamydia infection

**Session Time & Room** : 4C (Aug.24, 13:20-15:00) @A601

**Type** : Contributed Talk

**Abstract** : Chlamydia trachomatis is the most common bacterial sexually transmitted infection in the U.S. While genital chlamydia infection can beget devastating pathologies, it is unclear why some women are more likely to develop severe infections but others are asymptomatic or remain uninfected after exposure to C. trachomatis. We use mice as a model organism, seek to evaluate the potential impact of the time of day of pathogen exposure on the genital tract microbiome in chlamydia infection.

**Classification** : 92B05, 92C70

**Format** : Online Talk on Zoom

**Author(s)** : Lihong Zhao (University of California Merced)Lihong Zhao (University of California Merced)

## [00934] Slab LU, a sparse direct solver for heterogeneous architectures

**Session Time & Room** : 1E (Aug.21, 17:40-19:20) @E704

**Type** : Contributed Talk

**Abstract** : This talk describes a scalable sparse direct solver for linear systems that arise from the discretization of elliptic PDEs in 2D or 3D. The scheme uses a decomposition of the domain into thin subdomains, or "slabs". The general framework is easier to optimize for modern heterogeneous architectures than

than traditional multi-frontal schemes. Crucial to the scalability, are novel randomized algorithms that recover structure from matrix-free samples and reduce the dimensionality of large dense matrices.

**Classification** : 65M70, 65M55, 65M22, 65M06

**Format** : Talk at Waseda University

**Author(s)** : Anna Yesypenko (University of Texas at Austin)Per-Gunnar Martinsson (University of Texas at Austin)

## [00937] Asymptotic and numerical approaches to degeneracies in Stefan problems

**Session Time & Room** : 5C (Aug.25, 13:20-15:00) @G502

**Type** : Contributed Talk

**Abstract** : This talk discusses how asymptotic analysis and numerics can be combined to devise computational schemes to moving boundary (Stefan) problems more accurately; in particular, this relates to degenerate situations where the solution domain is initially of zero extent, or where a domain that was initially present disappears completely. A further subtlety concerns whether a new domain starts to form instantaneously or after some delay time.

**Classification** : 35K40, 35K65, 35K60

**Format** : Talk at Waseda University

**Author(s)** : Michael Vynnycky (University of Limerick)Sarah Mitchell (University of Limerick)

## [00939] Learning Dynamical Systems from Invariant Measures

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @G709

**Type** : Contributed Talk

**Abstract** : Standard data-driven techniques for learning dynamical systems struggle when observational data has been sampled slowly and state derivatives cannot be accurately estimated. To address this challenge, we assume that the available measurements reliably describe the asymptotic statistics of the dynamical process in question, and we instead treat invariant measures as inference

data. We reformulate the velocity learning as a PDE constrained optimization and present several numerical examples to demonstrate the effectiveness of the proposed approach.

**Classification** : 37Mxx, 37Axx

**Format** : Online Talk on Zoom

**Author(s)** : Jonah Botvinick-Greenhouse (Cornell University)Yunan Yang (ETH Zürich)

## **[00943] Similarity solutions for cylindrical shock wave in self-gravitating non-ideal gas with axial magnetic field: Isothermal flow**

**Session Time & Room** : 3D (Aug.23, 15:30-17:10) @G601

**Type** : Contributed Talk

**Abstract** : The solution using the Lie group of symmetry method for the problem of propagating magnetogasdynamic strong cylindrical shock wave in a self-gravitating non-ideal gas with the axial magnetic field for isothermal flow. Numerical computations were performed for power law and exponential law shock paths, to see the behaviour of flow variables. The study provides how the variations in the various parameter taken in this study affect the propagation of shock and the flow behind it.

**Classification** : 35L45, 58J45, 35L67, 35Q35, 76L05, Fluid Mechanics

**Format** : Talk at Waseda University

**Author(s)** : Nandita . (Dept. of Applied Mathematics & Scientific Computing, IIT Roorkee, Roorkee,India 247667)

## **[00944] Modelling of healthcare-acquired infection spread in regional healthcare systems**

**Session Time & Room** : 5B (Aug.25, 10:40-12:20) @A201

**Type** : Contributed Talk

**Abstract** : A network-compartmental model for simulation of healthcare-associated infection spread in healthcare systems is presented. The model accounts for transmission of the pathogen by inter-hospital patient transfers and colonized patients' readmission. Estimates for basic reproduction number per hospital-community pairs are calculated for multidrug-resistant Enterobacteriaceae for selected German regions. Inter-hospital transfer network is created from anonymized German health-insurance datasets. By numerical simulations, we examine interventions to reduce spread of the pathogen within the healthcare network.

**Classification** : 92D30, 62P10

**Format** : Talk at Waseda University

**Author(s)** : Konrad Sakowski (Institute of Applied Mathematics and Mechanics, University of Warsaw)Monika Joanna Piotrowska (Institute of Applied Mathematics and Mechanics, University of Warsaw)Agata Lonc (Institute of Applied Mathematics and Mechanics, University of Warsaw)Johannes Horn (Institute for Medical Epidemiology, Biometrics, and Informatics, Interdisciplinary Center for Health Sciences, Medical Faculty of the Martin Luther University Halle-Wittenberg, Halle (Saale))Rafael Mikolajczyk (Institute for Medical Epidemiology, Biometrics, and Informatics, Interdisciplinary Center for Health Sciences, Medical Faculty of the Martin Luther University Halle-Wittenberg, Halle (Saale))André Karch (Institute of Epidemiology and Social Medicine, University of Münster)Paweł Brachaczek (University of Warsaw)Mirjam Kretzschmar (University Medical Center Utrecht, Utrecht University)



## [00947] Statistical analysis of neonatal mortality predictors in Ghana

**Session Time & Room** : 4D (Aug.24, 15:30-17:10) @E504

**Type** : Contributed Talk

**Abstract** : In this study, we identify and investigate the main factors influencing newborn mortality in the Ghanaian locality and predict the occurrence of future infant mortality based on the 2017 Demographic and Health Survey data using logistic regression. Our work shows that the child's weight and sex have a strong correlation with its survival. The study reveals that mortality is more than 50% greater in underweight children and also, 62.7% infant deaths happen in infant males.

**Classification** : 62Pxx, 92-11, 92-08, Bio Statistics

**Format** : Online Talk on Zoom

**Author(s)** : Elizabeth Dufie Amankwah (Kwame Nkrumah University of Science and Technology)Juliet Amegble Richardson (Kwame Nkrumah University of Science and Technology)Solomon Kyei Mensah (Kwame Nkrumah University of Science and Technology)

## [00954] Dynamic Modeling and Optimization of Mixed Hydrogen-Natural Gas Flow in Pipeline Networks

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @D501

**Type** : Contributed Talk

**Abstract** : We present a dynamic model for the mixing and transport of hydrogen-natural gas blends in a pipeline network. The dynamic model is derived by lumping the partial differential equations to yield a differential algebraic system. The derived system accommodates spatio-temporally heterogeneous gas injections, and is more complex and numerically ill-conditioned than the case of a single gas. Multiple reformulations for the nonlinear and non-smooth equations of mixing are compared using standard optimization solvers.

**Classification** : 90-10, 37N40, 90C30, Dynamic and Nonlinear Programming

**Format** : Talk at Waseda University

**Author(s)** : Saif Kazi (Los Alamos National Laboratory)Anatoly Zlotnik (Los Alamos National Laboratory)Karthik Sundar (Los Alamos National Laboratory)Shriram Srinivasan (Los Alamos National Laboratory)

## [00956] Inner Structure of Attractors for a Nonlocal Chafee-Infante Problem

**Session Time & Room** : 1C (Aug.21, 13:20-15:00) @G501

**Type** : Contributed Talk

**Abstract** : The structure of the global attractor for the multivalued semiflow generated by a nonlocal reaction-diffusion

equation in which we cannot guarantee the uniqueness of the Cauchy problem is studied. The existence and

properties of stationary points are analysed. Also, the study of the stability and connections between them

are carried out, establishing that the semiflow is a dynamic gradient. As a consequence, the attractor consists of the stationary points and their heteroclinic connections.

**Classification** : 35B40, 35B41, 35B51, 35K55, 35K57

**Format** : Online Talk on Zoom

**Author(s)** : RUBEN CABALLERO (UNIVERSIDAD MIGUEL HERNANDEZ DE ELCHE)

## [00958] Existence results and numerical approximation for a quasilinear elliptic system

**Session Time & Room** : 2C (Aug.22, 13:20-15:00) @G601

**Type** : Contributed Talk

**Abstract** : We analyse, in the context of anisotropic Sobolev spaces, the existence and the numerical simulation of a capacity solution to a coupled nonlinear elliptic system. We consider the case of a non-uniformly elliptic problem with a quadratic growth in the gradient. The system may be regarded as a generalization of the so-called thermistor problem.

**Classification** : 35J47, 35J70, 47H05, 46E35, 65N12

**Format** : Online Talk on Zoom

**Author(s)** : Hajar Talbi (Moulay Ismail University)Mohamed Rhoudaf (Moulay Ismail University)Francisco Ortegón Gallego (Universidad de Cádiz)

## [00962] Discontinuous Galerkin method for a high order nonlocal conservation law

**Session Time & Room** : 3D (Aug.23, 15:30-17:10) @E604

**Type** : Contributed Talk

**Abstract** : We consider a Direct Discontinuous Galerkin (DDG) method for solving a time dependent partial differential equation with convection-diffusion terms and a fractional operator of order  $\alpha$  in  $(1,2)$ . This equation was introduced to describe dunes morphodynamics and was then used for signal processing. For the DDG method, suitable numerical fluxes are introduced. We prove nonlinear stability estimates along with convergence results. Numerical experiments are given to illustrate behaviors of solutions and to verify convergence order.

**Classification** : 65M12, 65M60, 26A33

**Author(s)** : Afaf Bouharguane (Université de Bordeaux/INRIA)Afaf Bouharguane (University of Bordeaux)Nour Seloula (University of Caen)

## [00964] The Valuation of Real Options for Risky Barrier to Entry with Hybrid Stochastic and Local Volatility and Stochastic Investment Costs

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @D505

**Type** : Contributed Talk

**Abstract** : Real options are sorts of investment choices which support agents in making better decisions in management strategic cases as well as reducing uncertainty in investment simultaneously. In this paper, we present the new model for investors to handle uncertain environments in investment flexibly: First, we adopt a hybrid stochastic and local volatility model to efficiently describe the external uncertain environment affecting the value of the project in decision making cases, and we set up the investment cost as geometric Brownian motion to illustrate the value of the opportunity costs which arise from things given up by choosing to invest in complex decision making circumstances. We derive partial differential equations for the value of real options and then use asymptotic analysis to obtain analytical solutions for that of the real options. In addition, we analyze the price accuracy of the approximated formulas compared to the solutions obtained from Monte-Carlo simulation. Finally, we investigate the effects of various parameters related to stochastic volatility on real options numerically to observe economic implications.

**Classification** : 91G20

**Format** : Talk at Waseda University

**Author(s)** : Donghyun Kim (Pusan National University)Yong Hyun Shin (Sookmyung Women's University)Ji-Hun Yoon (Pusan National University)

## [00968] Modelling pathogen spreading in a network of hospitals

**Session Time & Room** : 1E (Aug.21, 17:40-19:20) @G401

**Type** : Contributed Talk

**Abstract** : I will introduce an ODE model describing the spread of multidrug-resistant bacteria in a hospital network. I will present the mathematical properties of the model solutions, including the global stability of steady states. Based on simulations for real-life data, I will describe how the parameters affect the process dynamics at both network and hospital levels. Finally, the relations to other types of models describing similar processes will be discussed.

**Classification** : 34Axx, 34Cxx, 34D23, 92D30

**Format** : Talk at Waseda University

**Author(s)** : Agata Lonc (University of Warsaw)Monika Joanna Piotrowska (Institute of Applied Mathematics and Mechanics, University of Waw)Aleksandra Puchalska (Institute of Applied Mathematics and Mechanics, University of Warsaw)

## [00971] Quantify the classicality of quantum states

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @D404

**Type** : Contributed Talk

**Abstract** : In this talk, I will first introduce classicality and quantumness in a given quantum state. As quantumness speeds up quantum algorithms, gauging the "non-quantumness" or so-called "classicality" becomes an important task. Next, I will demonstrate using descent flow on smooth manifolds to resolve the issue. Finally, I will exhibit several numerical experiments to clarify whether our proposed method is reliable and applicable.

**Classification** : 81P50, 15B10, 53Z99

**Format** : Talk at Waseda University

**Author(s)** : BingZe Lu (Mathematics, National Cheng Kung University)YuChen Shu (Mathematics, National Cheng Kung University)Matthew M. Lin (National Cheng Kung University)

## [00972] Reducing Communication in Federated Learning with Variance Reduction Methods

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @D408

**Type** : Contributed Talk

**Abstract** : In Federated Learning  $\text{FL}$ , inter-client heterogeneity and partial participation of clients at each communication cause client sampling error. We control this client sampling error by developing a novel single-loop variance reduction algorithm. While sampling a small number of clients, the proposed FL algorithms require provably fewer or at least equivalent communication rounds compared to any existing method, for finding first and even second-order stationary points in the general nonconvex setting, and under the PL condition.

**Classification** : 90Cxx, 68Wxx, 68Txx

**Author(s)** : Kazusato Oko (The University of Tokyo, AIP RIKEN)Shunta Akiyama (The University of Tokyo)Tomoya Murata (The University of Tokyo, NTT DATA Mathematical Systems Inc.)Taiji Suzuki (The University of Tokyo, AIP RIKEN)

## [00973] Inverse source problem for a seventh-order Korteweg–de Vries equation

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @G809

**Type** : Contributed Talk

**Abstract** : In this talk, we establish the boundary stability result concerning the inverse source problem for a seventh-order Korteweg–de Vries (KdV) equation. Initially, we derive a new boundary Carleman estimate for the given system using the Dirichlet–Neumann type boundary conditions. We finally

obtain a Lipschitz-type boundary stability estimate of a seventh-order KdV equation using the regularity results of the nonlinear KdV equation and the Bukhgeim-Klibanov method.

**Classification** : 35R30, 35Q53

**Format** : Online Talk on Zoom

**Author(s)** : Arivazhagan Anbu (SRM Institute of Science and Technology, Tiruchirappalli )Arivazhagan Anbu (Indian Institute of Technology Gandhinagar)

## [00976] A Multi-phase Model for Silicon Carbide Production

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @G501

**Type** : Contributed Talk

**Abstract** : We present a multi-phase model to study the reduction of quartz to silicon carbide in a laboratory-scale reactor. We model the transport of gases and solids, and the kinetics of the reactions involved in the reduction process. Through the analysis of the model, we aim to gain a better understanding of the underlying mechanisms driving the reduction of quartz and to identify key parameters that can be controlled to optimize the production of silicon carbide.

**Classification** : 35B30, 35E15, 35Q49, 35R37

**Format** : Talk at Waseda University

**Author(s)** : Brady Metherall (University of Oxford)

## [00978] Real-Time Krylov Theory for Quantum Computing Algorithms

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @D404

**Type** : Contributed Talk

**Abstract** : Here we describe the variational quantum phase estimation (VQPE) method, a compact and efficient real-time subspace algorithm to extract eigenvalues using quantum hardware. We theoretically and numerically explore a generalized Krylov scheme where the Krylov subspace is constructed through a parametrized real-time evolution, applicable to the VQPE algorithm as well as others. We discuss its application to fundamental problems in quantum computation such as electronic structure predictions for strongly correlated systems.

**Classification** : 81-08, 81-10

**Format** : Talk at Waseda University

**Author(s)** : Katherine Klymko Yizhi Shen (Massachusetts Institute of Technology )Norm Tubman (NASA)

## [00979] Optimal radio channel assignment to transmitters in a network by graph labeling approach

**Session Time & Room** : 5C (Aug.25, 13:20-15:00) @G302

**Type** : Contributed Talk

**Abstract** : An optimal radio channel assignment to transmitters in a network is modelled by graph labeling approach. A radio labeling of a graph  $G$  is a mapping  $f : V(G) \rightarrow \{0, 1, 2, \dots\}$  satisfying  $|f(u) - f(v)| \geq \text{diam}(G) + 1 - d(u, v)$  for all  $u, v \in V(G)$ . The radio number  $rn(G)$  of  $G$  is the smallest number  $k$  such that  $G$  has radio labeling  $f$  with  $\max\{f(v) : v \in V(G)\} = k$ . We present our recent results on optimal radio labelings of graphs.

**Classification** : 05C78, 05C15, 05C12

**Format** : Talk at Waseda University

**Author(s)** : Devsi Dudabhai Bantva (Lukhdhirji Engineering College, Morbi)

## [00983] Effective time step analysis of numerical schemes for gradient flows

**Session Time & Room** : 3D (Aug.23, 15:30-17:10) @E604

**Type** : Contributed Talk

**Abstract** : A gradient flow has an important role in PDEs and it has a variety of applications including biological fields. In this talk, we briefly introduce the unconditionally stable numerical schemes for type of gradient flows and analyze them by comparing the real and its rescaled time steps, which has been a critical issue in this field. Some numerical simulations are performed to confirm our result.

**Classification** : 65M12

**Format** : Talk at Waseda University

**Author(s)** : Seunggyu Lee (Korea University)

Woon-Jae Hwang (Korea University)

## [00985] A Routing Protocol for Enhancing the QoS in Vehicular Ad hoc Networks

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @E804

**Type** : Industrial Contributed Talk

**Abstract** : The vehicle ad hoc network (VANET) provides various services for safe driving to the driver. The main problem with VANET is routing, since it has much more variation in network topology and node density than conventional mobile ad hoc networks (MANET). In this paper, we propose a QoS routing protocol based on link state information for VANET. The proposed protocol provides an optimal path using link quality and link stability.

**Classification** : 68M10, 68M18, 68M15

**Author(s)** : Jin-Woo Kim (Duksung Women's University)Jaehee Kim (Duksung Women's University)

## [00986] Approximation results for Gradient Descent trained Shallow Neural Networks

**Session Time & Room** : 1C (Aug.21, 13:20-15:00) @F310

**Type** : Contributed Talk

**Abstract** : Neural networks show strong performance for function approximation, but provable guarantees typically rely on hand-picked weights and are therefore not fully practical. The aim for a small number of weights in approximation is opposed to over-parametrization by very wide or even infinitely wide networks in contemporary optimization results. The talk reconciles approximation and optimization results and provides approximation bounds that are guaranteed for gradient descent trained neural networks.

**Classification** : 41A46, 65K10, 68T07

**Author(s)** : Gerrit Welper (University of Central Florida)Russell Gentile (n/a)

## [00987] Role of applied mathematics on optimum MR damper location for LQG controlled framed structure

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @G402

**Type** : Industrial Contributed Talk

**Abstract** :

This work addresses a Linear Quadratic Gaussian Design (LQG) based semi-active control algorithm for vibration reduction of building structures. The controlled damper force required by the structure has been calculated from an MR damper. A building frame has been selected to illustrate the performance of the proposed algorithm. Four different earthquake acceleration data has been used as input vibration data to the numerical frame

**Classification** : 34H10, 34H15, 34H20, 70H03, 70H20

**Format** : Talk at Waseda University

**Author(s)** : MANIKANDAN RAJASEKARAN (DEPARTMENT OF APPLIED MATHEMATICS BHARATHIYAR UNIVERSITY COIMBATORE TAMIL NADU INDIA)PAYEL CHAUDRI (IIT KHARAGPUR)SAKTHIVEL R (PROFESSOR DEPARTMENT OF APPLIED MATHEMATICS BHARATHIYAR UNIVERSITY COIMBATORE TAMIL NADU INDIA)

## [00991] Applied mathematics applications in ocean engineering

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @G601

**Type** : Industrial Contributed Talk

**Abstract** : A novel controller technique using nonlinear quadratic regulatory framework is proposed, the

algorithm perform the parameterization of the nonlinear model of the system such that the linearized model remains transversal everywhere to nonlinear model leading to control of original model. By transversality, linearized and nonlinear solutions intersect at only grid points on time axis without using Taylor-like expansions and shown its applicability in SWT

**Classification** : 37D10

**Format** : Talk at Waseda University

**Author(s)** : MANIKANDAN RAJASEKARAN (UGC-DR DS KOTHARI POST DOCTORAL FELLOW DEPARTMENT OF APPLIED MATHEMATICS BHARATHIYAR UNIVERSITY COIMBATORE TAMIL NADU INDIA)SATARUPA DEY (Assistant Professor and Head Department of Botany Shyampur Siddheswari Mahavidyalaya (Affiliated to University of Calcutta) West Bengal India)SAKTHIVEL R (DEPARTMENT OF APPLIED MATHEMATICS BHARATHIYAR UNIVERSITY COIMBATORE TAMIL NADU INDIA)

## [00993] The effect of extended coupling in transport system

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @D404

**Type** : Contributed Talk

**Abstract** : Totally Asymmetric Simple Exclusion Process is a stochastic model to recognize the nature of non-equilibrium transport systems. Inspired by the vehicular traffic phenomena, we have actuated a new kind of coupling rule on transport dynamics. The impact of the designed dynamics on system properties has been analyzed over phase diagrams, phase transitions, finite size effect, and shock position. The calculated numerical results from mean-field theory are verified through the ground of Monte Carlo simulation.

**Classification** : 82C26, 82C70, 65C05, 60G10

**Format** : Talk at Waseda University

**Author(s)** : Tamizhazhagan S (National Institute of Technology Tiruchirappalli.)Atul Kumar Verma (NIT Trichy, India )

## [00995] Convergence of a Normal Map-Based Prox-SGD Method for Stochastic Composite Optimization

**Session Time & Room** : 1E (Aug.21, 17:40-19:20) @F309

**Type** : Contributed Talk

**Abstract** : In this talk, we present a novel stochastic normal map-based algorithm (nor-SGD) for nonconvex composite-type optimization problems and discuss its asymptotic convergence properties. We first analyze the global convergence behavior of nor-SGD and show that every accumulation point of the generated sequence of iterates is a stationary point almost surely and in an expectation sense. The obtained results hold under standard assumptions and extend the more limited convergence guarantees of nonconvex prox-SGD. In addition, based on the Kurdyka-Lojasiewicz (KL) framework and utilizing an adaptive time window mechanism, we establish almost sure convergence of the iterates and derive convergence rates that depend on the KL exponent and the step size dynamics. The

techniques studied in this work can be potentially applied to other families of stochastic and simulation-based algorithms.

**Classification** : 90C06, 90C15, 90C26

**Format** : Talk at Waseda University

**Author(s)** : Andre Milzarek (The Chinese University of Hong Kong, Shenzhen)Junwen Qiu (The Chinese University of Hong Kong, Shenzhen)

## [00996] A Decentralized Approach for Dynamic Graph Clustering

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @G709

**Type** : Contributed Talk

**Abstract** : Interconnected networks characterized by interacting agents can be represented by weighted graphs, with the weight indicating their connection strength. Graph clustering arises naturally in these networks to assist decision making and co-ordination. Among the clustering methods, spectral clustering has emerged as a powerful tool but suffers from slow convergence for large dynamic graphs. Thus, we propose a fast incremental approach for dynamic graphs as an extension of its equivalent decentralized approach based on wave propagation.

**Classification** : 37Mxx, 05Cxx, 65Fxx

**Format** : Talk at Waseda University

**Author(s)** : Hongyu Zhu (Raytheon Technologies Research Center)Hongyu Zhu (Raytheon Technologies Research Center)Tuhin Sahai (Raytheon Technologies Research Center)

## [00997] A Normal Map-Based Perspective on Second Order Theory for Composite Problems: Second Order Conditions, Metric Regularity, and Nonsingularity

**Session Time & Room** : 2C (Aug.22, 13:20-15:00) @F312

**Type** : Contributed Talk

**Abstract** : Strong metric subregularity and strong metric regularity of the natural residual and the normal map are of particular importance in the convergence analysis of first-order and second-order algorithms for composite-type optimization problems. In this talk, we characterize the strong metric subregularity of the natural residual and the normal map for a general class of nonsmooth nonconvex composite functions and establish the equivalence between these conditions, the strong metric subregularity of the subdifferential, and the quadratic growth condition. Furthermore, if the nonsmooth part of the objective function has a strictly decomposable structure, then strong metric regularity of the subdifferential is shown to be equivalent to strong metric regularity of natural residual and the normal map and to a counterpart of the so-called strong second-order sufficient conditions. Finally, we provide a link of these conditions to nonsingularity of the generalized Jacobians of the normal map and natural residual.

**Classification** : 47Nxx, 47Nxx, 47Nxx, 47Nxx, 47Nxx, Variational Analysis

**Format** : Online Talk on Zoom

**Author(s)** : Wenqing Ouyang (The Chinese University of HongKong(Shenzhen))Andre Manfred Milzarek (The Chinese University of Hong Kong, Shenzhen)

## [00998] An Optimal Consumption-Portfolio Strategy and Housing Choice Problem with a Loan-to-Value Ratio

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @A510

**Type** : Contributed Talk

**Abstract** : This paper promotes a housing choice problem with a loan-to-value ratio by an extended dynamic programming approach. Before purchasing a house, an individual agent rents a house to live in. After purchasing a house, the agent owns a house and uses it as collateral for borrowing. One main contribution is that the loan-to-value ratio has positive effects on an individual agent's decisions both before and after the time of purchasing a house. We find that an individual agent with a higher loan-to-

value ratio delays the time to buy a house and purchases a larger house. We provide closed-form solutions for each optimal policy. We also demonstrate the solutions numerically and discuss the economic implications.

**Classification** : 91G10

**Format** : Talk at Waseda University

**Author(s)** : Qi Li (Pusan National University)Seryoong Ahn (Pukyong National University)Ji-Hun Yoon (Pusan National University)

## **[00999] High-order energy stable schemes for the phase-field model by the Convex Splitting Runge-Kutta methods**

**Session Time & Room** : 2C (Aug.22, 13:20-15:00) @E702

**Type** : Contributed Talk

**Abstract** : The Convex Splitting Runge-Kutta method is a high-order energy stable scheme for gradient flow which is a combination of the well-known convex splitting method and the multi-stage Runge-Kutta method. In this talk, we will discuss the applications and challenges of CSRK via extensive examples of the phase-field model.

**Classification** : 65M06, 65M12, 65M70, Phase-field model, Convex splitting method, Runge-Kutta method

**Format** : Talk at Waseda University

**Author(s)** : Jaemin Shin (Chungbuk National University)Hyun Geun Lee (Kwangwoon University)June-Yub Lee (Ewha Womans University)

## **[01001] Recent developments on low-discrepancy point sets for Markov chain quasi-Monte Carlo**

**Session Time & Room** : 5B (Aug.25, 10:40-12:20) @E505

**Type** : Contributed Talk

**Abstract** : We consider the problem of estimating expectations by using Markov chain Monte Carlo methods and improving the accuracy by replacing IID uniform random points with quasi-Monte Carlo (QMC) points. In this talk, we present short-period Tausworthe generators for Markov chain QMC optimized in terms of the  $t$ -value, which is a criterion of uniformity widely used in the study of QMC methods. In addition, we show the effectiveness in some numerical examples using Gibbs sampling.

**Classification** : 65C10, 11K45, 65C05

**Format** : Talk at Waseda University

**Author(s)** : Shin Harase (Ritsumeikan University)

## **[01004] An Error Estimate for an Implicit-Upwind Finite Volume Scheme for Boussinesq Model**

**Session Time & Room** : 2E (Aug.22, 17:40-19:20) @E702

**Type** : Contributed Talk

**Abstract** : This study contains an error estimate for a Finite Volume Method-based Implicit-Upwind scheme for the d-dimensional( $d=2$  or  $3$ ) Boussinesq Model, which describes several buoyancy-driven Hydrodynamic phenomena such as natural-convection in a cavity and Marsigli Flow. For each time level, the  $L^2$ - norms of the error for the temperature and velocity components are found to be of order  $(h + k)$ , where  $h$  is the spatial grid size and  $k$  is the time step size.

**Classification** : 65M08, 65M15, 65N08, 65N15

**Format** : Talk at Waseda University

**Author(s)** : Chitranjan Pandey (Indian Institute of Technology Kanpur, India)B.V. Rathish Kumar (Indian Institute of Technology Kanpur, India)



## [01005] Nonlinear Disturbance Observer-Based Control Design for Markovian Jump Systems

**Session Time & Room** : 2C (Aug.22, 13:20-15:00) @E702

**Type** : Contributed Talk

**Abstract** : This paper addresses the anti-disturbance control problem for time-delayed Markovian jump nonlinear systems with modeled and unmodeled disturbances. Specifically, the modeled disturbance is generated by a nonlinear exogenous system and estimated using a nonlinear disturbance observer. A mode-dependent asymmetric Lyapunov-Krasovskii functional is used to derive sufficient conditions for the existence of the proposed controller and disturbance observer. A numerical example is included to demonstrate the efficacy of the theoretical results developed.

**Classification** : 93D05, 93D15, 93E15, LYAPUNOV STABILITY; SYSTEMS AND CONTROL THEORY

**Format** : Online Talk on Zoom

**Author(s)** : KAVIARASAN BOOMIPALAGAN (CHUNGBUK NATIONAL UNIVERSITY)OH-MIN KWON (CHUNGBUK NATIONAL UNIVERSITY)

## [01006] VMS-based Stabilized FE Analysis of Time-dependent Coupled Unified Stokes-Brinkman-Transport Model

**Session Time & Room** : 3D (Aug.23, 15:30-17:10) @E604

**Type** : Contributed Talk

**Abstract** : We present a Variational Multi-Scale (VMS)-based stabilized FE analysis for completely unified unsteady Stokes-Brinkman model with standard continuity and Beavers-Joseph-Saffman interface conditions, strongly coupled with transient transport equation. The fluids' viscosities depend on the solute concentration. A simplified algebraic subgrid multiscale approach with time-dependent sub-scales is employed. A fully-implicit Euler scheme is used for time-discretization. We analyse the stability and convergence properties of the method. Appropriate numerical experiments are conducted to verify the method's credibility.

**Classification** : 65M12, 65M22, 65M60

**Format** : Online Talk on Zoom

**Author(s)** : Manisha Chowdhury (Indian Institute of Technology Jodhpur)B.V. Rathish Kumar (Indian Institute of Technology Kanpur)

## [01007] Stability & Accuracy of Free-Parameter Multistep Methods for 1st & 2nd-order IVPs

**Session Time & Room** : 2E (Aug.22, 17:40-19:20) @E505

**Type** : Contributed Talk

**Abstract** : Dahlquist's First Stability Barrier limits the order of stable  $k$ -step multistep methods, allowing us to add free parameters. Within the parameter domain where a  $k$ -step family of methods is stable, we explore the parameters' effect on error and stability domains. For first-order IVP's, we investigate explicit methods for  $k=2,3$  and implicit methods for  $k=3,4$ , generalizing Adams & BDF methods. For second-order IVP's, we analyze explicit and implicit methods for  $k=3,4$ , generalizing Störmer & Cowell methods.

**Classification** : 65L06, 65L07, 65L20

**Author(s)** : Michelle Ghrist (Gonzaga University)Ben Lombardi (Gonzaga University)Alana Marie Dillinger (Twin Cities in Motion)

## [01008] EID estimator-based Control Design for Singular Polynomial Fuzzy Systems

**Session Time & Room** : 2D (Aug.22, 15:30-17:10) @A201

**Type** : Contributed Talk

**Abstract** : This paper studied the disturbance rejection problem for singular polynomial fuzzy system based on equivalent-input-disturbance-estimator-based control approach. The proposed approach is used to compensate the influences of unknown lumped disturbance. To cope the robust stability problems, the augmented closed-loop system is constructed that includes dynamics of the system, observer, and low-pass filter. Lyapunov stability theory is used to develop stability conditions for the resulting system. Finally, numerical examples are provided to validate the theoretical result.

**Classification** : 93D09, 93D15, 93D25, Robust stability, Lyapunov stability theory, Stabilization of systems by feedback

**Format** : Online Talk on Zoom

**Author(s)** : Selvaraj Palanisamy (Chungbuk National University)Kwon Oh-Min (Chungbuk National University)

## [01009] A phase transition of various retention rules from multivariate analysis for big datasets.

**Session Time & Room** : 3D (Aug.23, 15:30-17:10) @E501

**Type** : Industrial Contributed Talk

**Abstract** : Estimating the number of significant components(factors, resp.) from principal component analysis(explanatory factor analysis, resp.) in datasets of finance/biology is essential. However, statistical software's default estimation method behaves pathologically for big datasets. We analyze the phase transition of the default rule as to the intra-class correlation of various data-generation models, and introduce a more acceptable estimation by random matrix theory for large sample correlation matrices. We also compare our rule to retention rules proposed to date.

**Classification** : 60F15, 62H25

**Format** : Online Talk on Zoom

**Author(s)** : Atina Husnaqilati (Mathematics Department, Universitas Gadjah Mada)  
Yohji Akama (Mathematical Institute, Tohoku University)

## [01010] Superconvergent Scheme for a System of Green Fredholm Integral Equations

**Session Time & Room** : 1E (Aug.21, 17:40-19:20) @G401

**Type** : Contributed Talk

**Abstract** : In this study, we consider a system of second kind linear Fredholm integral equations with Green's type kernel function. We propose a piecewise polynomial based Galerkin and iterated Galerkin methods to solve the integral model. We carry out the convergence and error analysis for the proposed methods and establish the superconvergence results for iterated Galerkin method. The theoretical results are supported by numerical tests.

**Classification** : 34A12, 45F15

**Format** : Talk at Waseda University

**Author(s)** : Rakesh Kumar (Indian Institute of Technology, Kanpur (India))Kapil Kant (Indian Institute of Technology, Kanpur (India))B.V. Rathish Kumar (Indian Institute of Technology, Kanpur (India))

## [01012] Uncertainty and disturbance estimator design for interval type-2 fuzzy systems

**Session Time & Room** : 2C (Aug.22, 13:20-15:00) @E702

**Type** : Contributed Talk

**Abstract** : This article investigates the uncertainty and disturbance estimator-based control problem for the interval type-2 fuzzy systems. By designing the appropriate filter, the proposed control designs can estimate system uncertainties and external disturbances accurately. By using the Lyapunov-Krasovskii stability theorem, the required stability conditions and the control gain matrices for the system under consideration are obtained. Finally, an illustrative example is demonstrated to verify the feasibility of the proposed control method.

**Classification** : 93D05, 93D09, 93D15, Lyapunov Stability, Systems and Control Theory, Fuzzy Systems

**Format** : Online Talk on Zoom

**Author(s)** : KAVIKUMAR RAMASAMY (CHUNGBUK NATIONAL UNIVERSITY) KWON OH-MIN (CHUNGBUK NATIONAL UNIVERSITY)

## [01013] Satellite Data Assimilation through Community Land Model to improve Rice Crop Dynamics

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @D402

**Type** : Industrial Contributed Talk

**Abstract** : The aim of the proposed talk is to discuss evaluation of existing form of Dynamic Generalized Vegetation Model (DGVM) of Community Land Model (CLM) in terms of its biogeophysics and processes for major agro-ecosystems such as in rice-rice crop rotation in India. Development of new crop-specific growth modules to bring out new version of DGVM suitable for Indian sub-tropics will be explored. This will be followed by its evaluation with respect to surface fluxes. The new modelling system will represent explicit crop growth processes in a terrestrial ecosystem model operable in a stand-alone mode or embedded in a climate model equipped with satellite remote sensing-based data assimilation for large-area prediction of intra-seasonal and inter-annual variability of crop phenology, growth, yield and fluxes of energy, moisture and carbon in the rice based systems at regional scale.

**Classification** : 76-10, 93-10, 68-XX

**Format** : Talk at Waseda University

**Author(s)** : Mahesh Kumar (Sardar Vallabhbhai National Institute of Technology, Surat, India) Ranjan Kumar Jana (Sardar Vallabhbhai National Institute of Technology, Surat, India)

## [01014] Fault detection asynchronous filter design for Markovian jump fuzzy systems under cyber attacks

**Session Time & Room** : 2C (Aug.22, 13:20-15:00) @E702

**Type** : Contributed Talk

**Abstract** : This work is concerned with the issue of fault detection asynchronous filter design for a class of discrete-time

Markovian jump fuzzy systems with cyber attacks. Precisely, the cyber attacks phenomenon in the network environment satisfies the Bernoulli distribution. Finally, the applicability and usefulness of the proposed filter design method is verified through a practical example.

**Classification** : 93D05, 93D09, 93D20, Lyapunov Stability of control systems

**Format** : Online Talk on Zoom

**Author(s)** : Sakthivel Ramalingam (Chungbuk National University) Oh-Min Kwon (Chungbuk National University)

## [01015] VMSFE Analysis of Transient MHD-NS Flow

**Session Time & Room** : 2E (Aug.22, 17:40-19:20) @E702

**Type** : Contributed Talk

**Abstract** : In this work, a thorough investigation of the transient magnetohydrodynamic Navier-Stokes (MHD-NS) equations is carried out applying variational multiscale stabilized finite element (VMSFE) technique. The convergence characteristics of VMSFE scheme (Apriori Estimate) has been derived in this study. The VMSFE method's credibility is established by numerical experiments on multiply driven cavity flow. The flow pattern is traced for various Hartmann, Reynolds, and magnetic force inclination angle values.

**Classification** : 65L60, 65K15

**Format** : Talk at Waseda University

**Author(s)** : Anil Rathi (Indian Institute of Technology, Kanpur (India))B.V. Rathish Kumar (Indian Institute of Technology, Kanpur (India))Dipak Kumar Sahoo (Indian Institute of Technology, Kanpur)

## [01016] Approximate formula for indefinite convolutions by the DE-Sinc method

**Session Time & Room** : 4C (Aug.24, 13:20-15:00) @E704

**Type** : Contributed Talk

**Abstract** : Approximate formula for indefinite convolutions by means of the Sinc approximation has been proposed by Stenger. The formula is based on his Sinc indefinite integration formula combined with the single-exponential transformation. Recently, the Sinc indefinite integration formula was improved by replacing the single-exponential transformation with the double-exponential transformation. Based on the improved formula, this study proposes a new approximate formula for indefinite convolutions.

**Classification** : 65D05, 65D15, 65D30, 65D32

**Format** : Online Talk on Zoom

**Author(s)** : Tomoaki Okayama (Hiroshima City University)

## [01018] VMS Stabilized FEA of M-NS Equations For Nano Thermal Fluid

**Session Time & Room** : 5B (Aug.25, 10:40-12:20) @E703

**Type** : Contributed Talk

**Abstract** : In this paper, we present a variable multiscale stabilised finite element method for NS equations with thermal transport for hybrid nano fluid flow. In particular algebraic approach of approximating the subscales has been considered and then the stabilization parameters are derived using Fourier analysis. Following that, we have derived an apriori error estimates. Also we have analysed the flow, velocity, pressure and temperature distribution over the bench mark problems viz. Multiply driven cavity flow.

**Classification** : 65M60, 65M15, 65M22

**Author(s)** : Dipak Kumar Sahoo (Indian Institute of Technology, Kanpur)B. V. Rathish Kumar (Indian Institute of Technology, Kanpur)Anil Rathi (Indian Institute of Technology, Kanpur)

## [01019] Particle Swarm Optimization Based Reliable Control Algorithm for Wireless Networks

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @E804

**Type :** Contributed Talk

**Abstract :** This paper deals with the fault-tolerant control problem for Wireless networks based on the particle swarm optimization method. To cope the stability and fault-tolerants simultaneously, a novel fault-tolerant control algorithm is developed. The required conditions of the addressed system are developed with the aid of Lyapunov stability theory. Precisely, the particle swarm optimization algorithm is implemented to optimize the fuzzy controller. Finally, simulation results are provided to demonstrate the effectiveness of the obtained results.

**Classification :** 68M07, 68M12, 68M15

**Format :** Online Talk on Zoom

**Author(s) :** Ponnarasi Loganathan (Bharathiar University)Pankajavalli PB (Bharathiar University)

## **[01021] A mixed finite element approach to a non-isothermal flow vegetation model**

**Session Time & Room :** 2D (Aug.22, 15:30-17:10) @D404

**Type :** Contributed Talk

**Abstract :** We consider a vegetation root-soil model which couples Richards PDE in the soil domain and saturated flow in the roots domain. Scenarios when the flow depends on soil temperature is included. A mixed finite element method is applied to obtain numerical solutions, and the well-posedness for its weak formulation and error estimates are studied. We provide numerical examples using tomography data of root domains and study convergence errors to validate our theoretical results.

**Classification :** 76Sxx, 65Mxx

**Format :** Talk at Waseda University

**Author(s) :** Malgorzata Peszynska (Oregon State University)Nachuan Zhang (Oregon State University)

## **[01025] EXISTENCE OF OPTIMAL CONTROL FOR TIME VARYING STOCHASTIC DIFFERENTIAL EQUATIONS**

**Session Time & Room :** 1E (Aug.21, 17:40-19:20) @F401

**Type :** Contributed Talk

**Abstract :** The work deals with the control problem for linear stochastic time varying system driven by square integrable stochastic process with zero mean and continuous sample paths. The cost functional is considered to be quadratic in the system state and the control. The completion of squares technique is used to establish the existence of optimal control under the family of non-adapted admissible control.

**Classification :** 49N05, 49N10, 93C05, 93C40

**Format :** Online Talk on Zoom

**Author(s) :** Murugan Suvinthra (Bharathiar University)

## **[01027] A Discussion on Numerical Methods to Solve Structural Engineering Problems**

**Session Time & Room :** 5C (Aug.25, 13:20-15:00) @E812

**Type :** Contributed Talk

**Abstract :** A number of numerical methods are developed by researchers to solve the linear/nonlinear, ordinary differential equations (ODEs) / partial differential equations (PDEs) developed for structural analysis such as vibration/bending/buckling/wave-propagation analysis in plates. The present talk is focused on a discussion of numerical approaches and their accuracy and convergence for plate vibrations i.e., linear PDE which can be extended as semi-analytic approaches to solving the nonlinear PDE during critical vibration analysis of plates.

**Classification :** 74H15, 74S25, 74G15

**Format :** Talk at Waseda University

**Author(s) :** Rahul Saini (H N B Garhwal Central University, Srinagar, Uttarakhand, India )

## [01032] Memory event-triggered finite-time fault control for neural networks system

**Session Time & Room** : 1E (Aug.21, 17:40-19:20) @F401

**Type** : Contributed Talk

**Abstract** : By wielding METS, this topic explores finite-time issue for neural networks comprise to actuator failures and deception attack. By engaging Lyapunov function and integral inequality technique, sufficient conditions in the structure of linear matrix inequality assures the asymptotic mean-square finite-time boundedness of the considered model. Ultimately, the capability of the proposed control design is demonstrated through two numerical examples.

**Classification** : 93-XX

**Format** : Online Talk on Zoom

**Author(s)** : Karthick SA (National Tsing Hua University)Bor-Sen Chen (National Tsing Hua University)

## [01033] Convective instabilities in vertical porous media

**Session Time & Room** : 5C (Aug.25, 13:20-15:00) @D101

**Type** : Contributed Talk

**Abstract** : Stability of natural convection in vertical porous slabs is of significant importance due to its applications in several natural and industrial settings – building insulation involving an unventilated air gap and for breathing walls is one of them. In this talk, we will discuss natural convection in a vertical porous slab with a differential temperature between the vertical walls. We show that a temperature-dependent thermal diffusivity/dynamic viscosity plays an important on the convective stability.

**Classification** : 76E06, 76S99, 76R50

**Author(s)** : Satyajit Pramanik (Indian Institute of Technology Guwahati)

## [01034] Machine Learning for Two-stage Robust Optimization

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @A201

**Type** : Contributed Talk

**Abstract** : When dealing with problems under uncertainty, two-stage robust optimization is one of the key approaches: you obtain an optimal robust solution, and adapt to the real scenario. However, these problems are one of the hardest optimization problem classes. To accelerate finding high-quality solutions, we propose a machine learning-based strategy. We experimentally show that with using our strategy you can train based on small problems, and apply them to bigger problems, while still getting good results.

**Classification** : 90C17, 90C90

**Format** : Talk at Waseda University

**Author(s)** : Esther Julien (Delft University of Technology)Krzysztof Postek (Delft University of Technology)Ilker Birbil (University of Amsterdam)

## [01035] Reinforcement learning-based routing strategy in IoT applications using MDC

**Session Time & Room** : 2E (Aug.22, 17:40-19:20) @E803

**Type** : Contributed Talk

**Abstract** : WSNs and IoT devices consume more power for data transmission. To reduce energy consumption, most of the traditional learning methodologies need enormous volumes of data and feature engineering, thus raising the learning complexity. A reliable reinforcement learning-based MDC model for effective routing is proposed to lower the learning complexity. Furthermore, the Q-Learning methodology is used to enhance learning along the shortest path. Combining these techniques can improve network stability while also enhancing routing performance significantly.

**Classification** : 68T01, 68T07, 68T35, Reinforcement learning, Machine Learning

**Format** : Talk at Waseda University

**Author(s)** : Muralitharan Krishnan (Sungkyunkwan University)Yongdo Lim (Sungkyunkwan University)

## **[01038] Study of transitional stresses in rotating disc of materials with different Poisson Ratio under varying temperature**

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @F312

**Type** : Contributed Talk

**Abstract** : The present paper is devoted to a study of stress distribution in rotating disc of different materials with variable Poisson ratio. Seth's transition theory is applied to the problems of elastic-plastic stresses in a rotating disc. Yield criteria and the associated flow rule are not taken into consideration for this study that forms the bases for the development of many researchers investigation. The obtained results allied in the direction of rotating disc made of an incompressible materials required higher angular speed for initial yielding as compared to disc made of gold, nickel and cast iron. At the internal surface of the compressible materials however, the circumferential stresses are showing higher values as compared to incompressible materials i.e. gold, nickel and cast iron required maximum circumferential stresses as compared to rubber material (incompressible). Also rotating disc required maximum stresses for the fully plastic state as compared to the initial yielding state.

**Classification** : 74A10, 74B05, 74B10, 74B15, 74C05

**Format** : Online Talk on Zoom

**Author(s)** : Jatinder Kaur (Chandigarh University Mohali , Chandigarh )Sonia - (Chandigarh University Mohali , Chandigarh )Nikita Madaan (Chandigarh University)

## **[01039] A model of cerebrospinal fluid flow in the cranial subarachnoid space**

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @D404

**Type** : Contributed Talk

**Abstract** : Cerebrospinal fluid fills the subarachnoid space (SAS), which covers the spinal cord and the brain. During the cardiac cycle, it pulsates due to time-varying brain displacements. In this work, we study oscillating and steady streaming flow in cranial SAS in order to understand the mixing processes and waste clearance. We develop a theoretical model of the flow using lubrication theory. The model suggests that steady streaming plays an important role in mixing.

**Classification** : 76Z05

**Format** : Talk at Waseda University

**Author(s)** : Mariia Dvoriashyna (University of Oxford)Alain Goriely (University of Oxford)

## **[01041] Dynamical Behaviours of a Stochastic Leptospirosis Model with Saturated Incidence Rate**

**Session Time & Room** : 1E (Aug.21, 17:40-19:20) @G402

**Type** : Contributed Talk

**Abstract** : Leptospirosis is a zoonotic bacterial disease that is endemic and having high incidence rate in tropical and subtropical regions especially after flooding or heavy rainfall. The objective is to investigate the asymptotic behaviour of a stochastic Leptospirosis model with saturated incidence rate in terms of basic reproduction number using Lyapunov functions. As a first step, a biologically well-posed model perturbed by multiplicative Gaussian noise will be proposed. The existence of a stationary distribution and the ergodicity of solutions of the proposed model will also be established.

**Classification** : 34D05, 34K50, 60H10, 60J65

**Format** : Talk at Waseda University

**Author(s)** : SELSHA S (Research Scholar, Govt College Chittur)

## [01042] Preconditioners of Reduced Dimension for Vector Field Problems

**Session Time & Room** : 2D (Aug.22, 15:30-17:10) @E505

**Type** : Contributed Talk

**Abstract** : When designing preconditioners based on domain decomposition methods, the coarse space plays a key role. In order to keep the scalability, the coarse space of low computational complexity is essential. We introduce a new coarse space of reduced dimension for vector field problems. Numerical results for the problems in three dimensions are also presented.

**Classification** : 65F08, 65F10, 65N30, 65N55

**Format** : Talk at Waseda University

**Author(s)** : Duk-Soon Oh (Chungnam National University)

## [01044] Nonlinear SPDE models of particle systems

**Session Time & Room** : 3D (Aug.23, 15:30-17:10) @E502

**Type** : Contributed Talk

**Abstract** : Interacting particle systems provide flexible and powerful models that are useful in many application areas. However, particle systems with large numbers of particles are very complex. Therefore, a common strategy is to derive effective equations that describe the time evolution of the empirical particle density.

Our aim is to consider non-Gaussian models that provide approximation of the Dean-Kawasaki equation. This is the joint work with Kremp and Perkowski.

**Classification** : 60H15, 35Q83, 65M08

**Format** : Talk at Waseda University

**Author(s)** : Ana Djurdjevac (Freie Universität Berlin)

## [01045] Advances on intimate partner femicide applying machine learning techniques and algorithms

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @E803

**Type** : Contributed Talk

**Abstract** : Intimate partner femicide (IPF) is female's leading cause of violent death worldwide. The accuracy of existing risk assessment instruments for IPF developed by conventional statistics is not completely competitive. In this study, machine learning techniques and algorithms for classification were used to discriminate between lethal or non-lethal violence against women by intimate partners and to detect which variables discern them the most. The obtained evidenced-based knowledge could assist professionals in predicting and preventing lethality.

**Classification** : 68Txx

**Author(s)** : Esperanza Garcia-Vergara (Universidad Loyola Andalucía)Carlos Fresneda-Portillo (Universidad Loyola Andalucía (Spain))

## [01046] Flow past a mounted wedge: The three fold structure

**Session Time & Room** : 2C (Aug.22, 13:20-15:00) @D401

**Type** : Contributed Talk

**Abstract** : This talk is concerned with the simulation of flow past a wedge mounted on a wall for channel Reynolds number  $Re_c = 6873$  in accelerated flow medium. All three stages of vortex shedding for the accelerated flow, leading to the exceedingly intricate three-fold structure has been captured very accurately. Transition to turbulence have also been resolved which is indicated by the existence of coherent structures.



**Classification** : 76D05, 76D17, 65M06

**Format** : Talk at Waseda University

**Author(s)** : Jiten C Kalita (Indian Institute of Technology Guwahati)

## **[01047] Large Deviations for Two-Dimensional Stochastic Tidal Dynamics Equations driven by Levy Noise**

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @G703

**Type** : Contributed Talk

**Abstract** :

The objective is to establish a Wentzell-Freidlin type large deviation principle (LDP) for solution of stochastic tidal dynamics equations driven by Levy Noise. The LDP is equivalent to the Laplace principle in a Polish space. The solution space of the considered equation is Polish. Hence Laplace principle will be established for the stochastic tidal dynamics equations using weak convergence approach for non-negative functionals of a general Poisson random measure and Brownian motion.

**Classification** : 35Q35, 60H15, 60G65, 60F10

**Format** : Talk at Waseda University

**Author(s)** : HASEENA A (Assistant Professor, Government College Chittur)

## **[01048] Analysis of a Poisson–Nernst–Planck–Fermi model for ion transport in biological channels and nanopores**

**Session Time & Room** : 1D (Aug.21, 15:30-17:10) @A208

**Type** : Contributed Talk

**Abstract** : We analyse a Poisson-Nernst-Planck-Fermi model to describe the evolution of a mixture of finite size ions in liquid electrolytes, which move through biological membranes or nanopores. The global-in-time existence of bounded weak solutions and the weak-strong uniqueness result are proved, via entropy and relative entropy, respectively. Furthermore, an implicit Euler finite-volume scheme for the model is analysed and some simulations are shown.

**Classification** : 35-XX, Mathematical and numerical analysis of cross-diffusion system via entropy and relative entropy

**Format** : Online Talk on Zoom

**Author(s)** : Annamaria Massimini (TU Wien)Ansgar Jüngel (TU Wien)

## **[01051] Moderate Deviations for Shell Model of Turbulence**

**Session Time & Room** : 3D (Aug.23, 15:30-17:10) @E501

**Type** : Contributed Talk

**Abstract** : This work establishes the central limit theorem and moderate deviation principle for stochastic shell model of turbulence driven by multiplicative noise. The method of weak convergence introduced by Budhiraja and Dupuis has been followed in order to establish our results. The equivalence of Laplace principle and large deviation principle under Polish spaces contributes to reduce the complexity.

**Classification** : 60F05, 60H15

**Format** : Online Talk on Zoom

**Author(s)** : Sridevi C.S. (Bharathiar University, Coimbatore, Tamil nadu)

## [01052] Large systems of linear equations in particle transport problems

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @E603

**Type** : Contributed Talk

**Abstract** : This work discusses solutions of large linear systems of algebraic equations relevant to establish a solution to the discrete ordinates approximation of the two-dimensional linear Boltzmann equation. Direct and iterative methods are investigated, along with domain decomposition techniques and parallel implementation. The type of the quadrature scheme describing the directions and the class of problems to be solved, neutron or radiation problems, directly affect the final choice of the numerical algorithm.

**Classification** : 65F22, 65F05, 65F10, 65MXX

**Format** : Talk at Waseda University

**Author(s)** : Rudnei Dias da Cunha (Universidade Federal do Rio Grande do Sul)Liliane Basso Barichello (Universidade Federal do Rio Grande do Sul)

## [01053] Radial Basis for Solving high-dimensional PDEs in Option Pricing

**Session Time & Room** : 1C (Aug.21, 13:20-15:00) @

**Type** : Contributed Talk

**Abstract** : A Radial Basis Function is used to solve the partial differential equations arising for option pricing problems in very high dimension. For such problems, classical grid-based finite-difference approaches fail to give any numerical solution as the memory requirements grow exponentially with the number of dimensions. Our numerical results are compared to both analytical solutions as well as Monte Carlo Simulations to demonstrate the efficiency of the proposed radial basis approximation.

**Classification** : 65D12, 35R10, 91G20

**Author(s)** : Désiré Yannick TANGMAN (University of Mauritius)

## [01056] Statistical methodology for functional meta-analysis of sex-based disparities in neurological diseases

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @E501

**Type** : Industrial Contributed Talk

**Abstract** : Sex-based differences in diverse health scenarios and diseases have been acknowledged for many years but still not thorough-fully analysed. We propose a statistical methodology combining transcriptomics data from different spurces which allows to unveil those disparities at the level of differentially expressed genes and differentially enriched functions. The methodology uses linear models, meta-analysing the results through the logFC, and has been successfully applied to various diseases such as Multiple Sclerosis, Alzheimer's and Parkinson's diseases.

**Classification** : 62-xx, 62Pxx, 92-04, 92-08, 92-10

**Format** : Talk at Waseda University

**Author(s)** : Marta R. Hidalgo (CIPF)Francisco Garcia-Garcia (CIPF)Borja Gomez-Cabañes (CIPF)Carla Perpiña-Clerigues (CIPF)Irene Soler-Saez (CIPF)Fernando Gordillo-González (CIPF)Gonzalo Anton-Bernat (Universitat de València)Adolfo López-Cerdan (BioBam )Rubén Grillo-Risco (CIPF)Jose Francisco Català-Senent (INCLIVA)

## [01059] EVENT-TRIGGERED CONTROL FOR PARABOLIC PARTIAL DIFFERENTIAL EQUATIONS WITH CYBER-ATTACKS

**Session Time & Room** : 2D (Aug.22, 15:30-17:10) @A201

**Type** : Contributed Talk

**Abstract** : An event-triggered control for parabolic-type partial differential equations subject to disturbances and cyber-attacks is addressed in this talk. To attenuate the disturbances an  $H_\infty$  performance is considered. By designing an appropriate Lyapunov-Krasovskii functional the stabilization conditions for the considered parabolic type partial differential equations are obtained in the form of linear matrix inequalities. Finally, a numerical example is provided to verify the efficiency of the derived theoretical results.

**Classification** : 93D05, 93D09, 93D15, Lyapunov Stability, event-triggered control

**Format** : Online Talk on Zoom

**Author(s)** : Parivallal Arumugam (Sungkyunkwan University)

## [01061] Computation of control for fractional nonlinear systems using Tikhonov regularization

**Session Time & Room** : 5C (Aug.25, 13:20-15:00) @A207

**Type** : Contributed Talk

**Abstract** : Determining the control steering the dynamical system is equally important as it is to examine the controllability of a control system. This study computes the control for the approximately controllable nonlinear system governed by Caputo derivatives. By using operator theoretic formulations, the problem of computing the control gets converted into an ill-posed problem which is solved for stable approximations using Tikhonov regularization. An example is presented demonstrating the error and truncated control graphs using MATHEMATICA.

**Classification** : 93B05, 93C10, 47A52, 34K37

**Format** : Talk at Waseda University

**Author(s)** : Lavina Sahijwani (Indian Institute of Technology Roorkee, India)N. Sukavanam (Indian Institute of Technology Roorkee, India)D. N. Pandey (Indian Institute of Technology Roorkee, India)

## [01067] Stoneley wave propagation at the interface between two initially stressed medium with interface energy

**Session Time & Room** : 5C (Aug.25, 13:20-15:00) @E812

**Type** : Contributed Talk

**Abstract** : The present study investigates the propagation of Stoneley waves at interface of two distinct imperfectly bonded solid half-spaces considering strain and kinetic energies localized at interface. Gurtin–Murdoch (1975) and Eremeyev (2016) approaches are used to derive interface strain energy density, stress tensor, kinetic energy density accounting for non-perfect interface. Comparative analysis of dispersion curves is done numerically and presented through graphs. The findings have applications in geosciences for non-destructive characterization of thin inter-phases between solids.

**Classification** : 74H10, 74B05

**Format** : Online Talk on Zoom

**Author(s)** : Arindam Nath (Department of Mathematics, School of Sciences, NIT Andhra Pradesh, India)Sudarshan Dhua (Department of Mathematics, School of Sciences, NIT Andhra Pradesh, India)

## [01068] Reverse engineering controller area network using the Pearson correlation coefficient

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @E505

**Type** : Industrial Contributed Talk

**Abstract** : Controller Area Network (CAN) is a communication bus widely adopted in road vehicles. However, car manufacturers adopt proprietary CAN message sets, complicating message decoding by third-party applications, e.g., for indirectly detecting adverse road-weather conditions. This talk presents an algorithm for reverse engineering CAN messages based on the Pearson correlation coefficient between CAN messages from an annotated and interpolated dataset. The proposed algorithm was experimentally validated with data collected from different vehicle brands.

**Classification** : 62P30, 68P20, 62-04

**Format** : Talk at Waseda University

**Author(s)** : David Rocha (Instituto de Telecomunicacoes, Universidade de Aveiro)João Almeida (Instituto de Telecomunicações, Universidade de Aveiro)José Fonseca (Instituto de Telecomunicações, Universidade de Aveiro)Joaquim Ferreira (Instituto de Telecomunicações, Universidade de Aveiro)

## [01069] Global existence and stability of three species predator-prey system with prey-taxis

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @G702

**Type** : Contributed Talk

**Abstract** : In this paper, we study the initial-boundary value problem of a three species predator-prey system with prey-taxis which describes the indirect prey interactions through a shared predator in a bounded domain  $\Omega \subset \mathbb{R}^n$  ( $n \geq 1$ ) with smooth boundary and homogeneous Neumann boundary conditions. The model parameters are assumed to be positive constants. We first prove the global existence of classical solutions under suitable assumptions on the prey-taxis coefficients  $\chi_1, \chi_2$  and  $d$ . Moreover, we establish the global stability of the prey-only state and coexistence steady states by using Lyapunov functionals and LaSalle's invariance principle.

**Classification** : 35A01, 35B35, Partial differential equations and Mathematical Biology ( To prove Global existence and stability for chemotaxis systems and predator-prey systems )

**Format** : Talk at Waseda University

**Author(s)** : GURUSAMY ARUMUGAM (The Hong Kong Polytechnic University )

## [01073] About reaction-diffusion systems with exponential growth: Numerical study

**Session Time & Room** : 4D (Aug.24, 15:30-17:10) @G602

**Type** : Contributed Talk

**Abstract** : The modeling and mathematical analysis of concrete phenomena are of great interest to better understand our environment and its evolution. Several analogies between chemistry and biological systems have led researchers to introduce mathematical models of "reaction-diffusion", whose objective is to follow the evolution of the quantities interacting during the process. In this talk, we are interested in reaction-diffusion systems with exponential growth, modeling an irreversible chemical reaction.

Since the 80's, considerable efforts have been devoted to the study of these systems. We provide a general overview of the different theoretical results obtained, as well as our investigation from a numerical point of view on open cases.

**Classification** : 35K57, 35K58, 80A25, 80A19

**Author(s)** : Rajae Malek (Moulay Ismail University, Meknes, Morocco)

## [01075] Implementation of Mathematical Proof and Argumentation Learning Activities in Langsa

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @D514

**Type** : Industrial Contributed Talk

**Abstract** : This study aims to implement learning designs for mastering mathematical proof and argumentation abilities in pre-service mathematics teachers enrolling in one public university in Langsa City, Aceh, Indonesia. Learning activities consist of four core stages, i.e., proofreading, writing resumes, exercises in proving, then reflection and evaluation. The results demonstrated an increase in students' mathematical proof and argumentation abilities from mediocre to excellent.

**Classification** : 97Dxx, 97Hxx, 97Ixx, 97Exx

**Format** : Talk at Waseda University

**Author(s)** : Iden Rainal Ihsan (Universitas Samudra)Natanael Karjanto (Sungkyunkwan University)Guntur Maulana Muhammad (Universitas Samudra)

## [01078] DNN-based hybrid ensemble learning strategy for XSS detection and defense

**Session Time & Room** : 2E (Aug.22, 17:40-19:20) @E803

**Type** : Contributed Talk

**Abstract** : Due to the high level of intelligence displayed by attackers, existing web-based security applications have failed. When attackers make changes to an organization's data, it is one of the most dangerous attacks (XSS). Combining ML and DL frameworks is proposed as a way to detect and defend against XSS assaults with high accuracy and efficiency. Using this representation, a new method is developed for integrating stacking ensembles into web-based software, which is called "hybrid stacking".

**Classification** : 68T01, 68T05, 68T07, Machine Learning, Deep Learning

**Format** : Online Talk on Zoom

**Author(s)** : Seethalakshmi Perumal (MIT Campus, Anna University - Chennai)

## [01079] Higher order numerical scheme to approximation generalized Caputo fractional derivatives and its application

**Session Time & Room** : 2C (Aug.22, 13:20-15:00) @G710

**Type** : Contributed Talk

**Abstract** : In this paper, a high-order numerical scheme is established to approximate the generalized Caputo fractional derivative using Lagrange interpolation formula. Order of convergence for this scheme is obtained as  $(4 - \alpha)$ , where  $\alpha \in (0, 1)$  is the order of generalized Caputo fractional derivative. The local truncation error of the approximation is also obtained. Further, the developed scheme is used to solve the generalized fractional advection-diffusion equation. Stability and convergence are also discussed for the difference scheme. In the last, numerical examples are discussed to illustrate the theoretical results.

**Classification** : 35R11, 26A33, 65R10

**Format** : Online Talk on Zoom

**Author(s)** : Sarita kumari (Indian Institute of technology (Banaras Hindu University))Dr. Rajesh Kumar Pandey (Indian Institute of Technology (BHU) Varanasi)

## [01080] About Thermistor Problem: numerical study using Discrete Duality Finite Volume

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @G602

**Type** : Contributed Talk

**Abstract** : We propose a DDFV for a coupled nonlinear parabolic-elliptic equations. The system is known as a generalization of the Thermistor problem which models a temperature dependent electrical resistor.

We first establish some a priori estimates satisfied by the sequences of approximate solutions. Then, it yields the compactness of these sequences. Passing to the limit in the numerical scheme, we finally obtain that the limit of the sequence of approximate solutions is a weak solution to the problem under study.

**Classification** : 35M30, 35K92, 35J46, 65N08

**Author(s)** : Manar Lahrache (Moulay Ismail University, Faculty of Science, Meknes, Morocco)

## [01082] Analysis of traffic flow models by triangulation of min-plus matrices

**Session Time & Room** : 2E (Aug.22, 17:40-19:20) @G305

**Type** : Contributed Talk

**Abstract** : Cellular automata model for traffic flow can be described in terms of min-plus linear systems. In this talk, we focus on the triangulation of a min-plus matrix, which is defined based on the roots of characteristic polynomial and the algebraic eigenvectors associated with the roots. It plays an important role in the analysis of the asymptotic behavior of the model. Further the algebraic eigenvectors are shown to give us preferable initial states.

**Classification** : 15A80, 37B15, 76A30

**Format** : Talk at Waseda University

**Author(s)** : Yuki Nishida (Tokyo University of Science) Sennosuke Watanabe (The University of Fukuchiyama) Yoshihide Watanabe (Doshisha University)

## [01083] The existence and the numerical approximation to a nonlinear coupled system in anisotropic Orlicz-Sobolev spaces

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @G601

**Type** : Contributed Talk

**Abstract** : We study the existence of a capacity solution for a nonlinear elliptic coupled system in anisotropic Orlicz-Sobolev spaces. The unknowns are the temperature inside a semiconductor material, and the electric potential. This system may be considered as a generalization of the steady-state thermistor problem. The numerical solution is also analyzed by means of the least squares method in combination with a conjugate gradient technique.

**Classification** : 35J70, 35J66, 35K61, 46E30, 65N22

**Format** : Online Talk on Zoom

**Author(s)** : Hakima Ouyahya (Moulay Ismail University)

## [01090] A high order approximation scheme for non-linear time fractional reaction-diffusion equation

**Session Time & Room** : 3D (Aug.23, 15:30-17:10) @G402

**Type :** Contributed Talk

**Abstract :** We discuss a high order numerical scheme for the non-linear time fractional reaction-diffusion equation of order  $\alpha \in (0, 1)$ . A cubic approximation and compact finite difference schemes are used to approximate the time-fractional and spatial derivatives respectively. The numerical scheme achieves convergence rate of order  $4-\alpha$  in the temporal direction and 4 in the spatial direction. Further, numerical experimentation is performed to demonstrate the authenticity of the proposed numerical scheme.

**Classification :** 26A33, 35R11, 35A35

**Format :** Online Talk on Zoom

**Author(s) :** Rajesh Kumar Pandey (Indian Institute of Technology (BHU) Varanasi) Deeksha Singh (Indian Institute of Technology (BHU) Varanasi)

## **[01091] Nonlinear effects of neighborhood influence over college education, and social mobility**

**Session Time & Room :** 3C (Aug.23, 13:20-15:00) @G402

**Type :** Industrial Contributed Talk

**Abstract :** This contagion-effect model studies the impact of environmental factors on upward social mobility, where the educational environment is measured by the proportion of college-educated individuals, and social mobility is measured by a change in the proportion of people in different income classes. The dynamics of the educational environment are modeled using a modified version of the invasion/extinction ecological model of Richard Levins. In addition, the model adapts a version of a SIR-type model to capture the nonlinear effects of the influence of the environment. The educational environment influences the educational choices of poor people, becoming effective only after a threshold point is reached. The growth rate in influence is modeled using a monotonically increasing saturation function, which includes a delay parameter referred to as handling time, that measures the speed of influence generated by educated, successful individuals. The simulations indicate that poor individuals choose to become educated at a rate that primarily depends on the density of educated people acting as role models in the local environment. (This research has been peer-reviewed, accepted, and published by the Socio-Economic Planning Sciences Journal under the name "Neighborhood effects, college education, and social mobility," and all the authors are aware of the submission. This research is expected to contribute to studying the nonlinear dynamical effects of changing environments over socio-economic outcomes).

**Classification :** 34-11, 37N40, 92B05

**Author(s) :** Cesar Montalvo (University of Virginia)

## **[01094] Variational iteration Method for Shallow Water Waves**

**Session Time & Room :** 4E (Aug.24, 17:40-19:20) @D401

**Type :** Contributed Talk

**Abstract :** Variational iteration method, VIM, is employed to solve analytic solutions of shallow water wave equations. For its linearized models we compute a periodic numerical example, and a symbolic one with unprescribed initial conditions and parameters. Both examples are found their explicit exact solutions by VIM. Then we turn to some nonlinear models and obtain their highly accurate approximate solutions. We concluded that VIM is very effective for shallow water wave problems and other nonlinear PDEs.

**Classification :** 76M30, 35F55, 35C05, 35C10, shallow water wave

**Format :** Talk at Waseda University

**Author(s) :** Tzon-Tzer Lu (Department of Applied Mathematics, National Sun Yat-sen University)

## [01096] Stability modulation by a reaction in Navier-Stokes flow

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @E817

**Type** : Contributed Talk

**Abstract** : Channel/pipe flows mathematically modeled by the Navier-Stokes equation can be stabilized or destabilized by a slight viscosity stratification. We perform linear stability analysis (LSA) and non-linear simulation (NLS) for such flow, where a reaction changes the viscosity. The analysis involves a WENO-based diffuse-interface method for NLS and the Chebyshev spectral method for LSA. This talk will discuss how varying parameters representing the physical forces present in the system can control flow instabilities.

**Classification** : 76Vxx, 80Axx, 35Qxx, 65Mxx, Navier-stokes equation, Reaction effects in flows, Chemically reacting flows, Finite volume methods for initial value and initial-boundary value problems involving PDEs

**Format** : Talk at Waseda University

**Author(s)** : Manoranjan Mishra (Indian Institute of Technology Ropar, India)Surya Narayan Maharana (Indian Institute of Technology Ropar)

## [01097] Versal deformations as a tool of matrix analysis

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @G304

**Type** : Contributed Talk

**Abstract** : Reductions of matrices or matrix pencils to canonical forms are unstable operations: both the corresponding canonical forms and the reduction transformations depend discontinuously on the entries of an original matrix or pencil. This issue complicates the use of canonical forms for numerical purposes. Therefore V.I. Arnold introduced a notion of versal deformations. We will discuss versal deformations and their use in codimension computations, investigation of possible changes in eigenstructures, and reduction to structured perturbations.

**Classification** : 15A63, 15A21

**Format** : Talk at Waseda University

**Author(s)** : Andrii Dmytryshyn (Örebro University)Andrii Dmytryshyn (Örebro University)

## [01101] Supersonic Pre-Transitional Disturbances in Boundary Layers on Porous Surfaces

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @E817

**Type** : Contributed Talk

**Abstract** : The effect of wall permeability on the response of pre-transitional supersonic boundary layers subject to low-amplitude, free-stream vortical disturbances is investigated via asymptotic methods and numerically. Equally-spaced cylindrical pores couple the pressure and wall-normal velocity fluctuations when the spanwise diffusion is negligible, thereby reducing the growth of low-frequency laminar streaks and Görtler vortices on concave porous walls. Highly-oblique Tollmien-Schlichting waves that develop further downstream are instead enhanced. This finding is confirmed by a triple-deck analysis.

**Classification** : 76N20, 76N25, 35C20

**Format** : Talk at Waseda University

**Author(s)** : Ludovico Fossà (The University of Sheffield)Pierre Ricco (The University of Sheffield)



## [01102] Independent Study in Designing Mathematics Learning Using GeoGebra AR

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @D502

**Type** : Industrial Contributed Talk

**Abstract** : This research examines the implementation of one program from the Indonesian Ministry of Education, Culture, Research, and Technology, i.e., independent studies, in the Department of Mathematics Education at a public university in Langsa, Aceh, Indonesia. The activities focused on compiling learning designs that apply the GeoGebra Augmented Reality (AR) to geometrical concepts in secondary schools by adopting the ADDIE Model. The aim is for pre-service mathematics teachers to explore learning activities independently in mastering Technological Pedagogical Content Knowledge (TPACK) when teaching mathematics. Our findings suggest the implementation of such an independent study because of its advantages and program improvisation as a form of program development.

**Classification** : 97Gxx, 97Hxx, 97Uxx

**Format** : Online Talk on Zoom

**Author(s)** : Guntur Maulana Muhammad (Universitas Samudra)Natanael Karjanto (Sungkyunkwan University)Iden Rainal Ihsan (Universitas Samudra)

## [01103] Mechanoelectric effects in cardiac function

**Session Time & Room** : 3D (Aug.23, 15:30-17:10) @A511

**Type** : Contributed Talk

**Abstract** : To date the role of the different mechanoelectric feedback (MEF) mechanisms is not clear in the cardiac function. Using a multiscale (from cellular to organ level) 3D-0D closed loop fluid-electromechanical framework implemented in the Cardiac Arrhythmia Research Package (CARP) software, we perform computer simulations to explore the effect of two MEF mechanisms in healthy cardiac function and under the Left Bundle Branch Block pathology.

**Classification** : 92-10, 92Bxx

**Format** : Talk at Waseda University

**Author(s)** : Argyrios Petras (RICAM-Johann Radon Institute for Computational and Applied Mathematics)Matthias AF Gsell (Medical University of Graz)Christoph M Augustin (Medical University of Graz)Jairo J Rodriguez Padilla (Centre Inria d'Université Côte d'Azur)Alexander Jung (Medical University of Graz)Marina Strocchi (King's College London)Frits Prinzen (Maastricht University)Steven Niederer (King's College London)Gernot Plank (Medical University of Graz)Edward J Vigmond (Liryc, Electrophysiology and Heart Modeling Institute)

## [01104] Generation of *hp*-FEM Massive Databases for Deep Learning Inversion

**Session Time & Room** : 2D (Aug.22, 15:30-17:10) @E506

**Type** : Contributed Talk

**Abstract** : Deep Neural Networks are employed in many geophysical applications to characterize the Earth's subsurface. However, they often need to solve hundreds of thousands of complex and expensive forward problems to produce the training dataset.

This work presents a robust approach to producing massive databases at a reduced computational cost. In particular, we build a single *hp*-adapted mesh that accurately solves many FEM problems for any combination of parameters within a given range.

**Classification** : 65N30, Finite Element Method, Deep Neural Networks, Goal-Oriented Adaptivity

**Format** : Talk at Waseda University

**Author(s)** : Julen Alvarez-Aramberri (University of the Basque Country (UPV/EHU))Vincent Darrigrand (CNRS-IRIT, Toulouse)Felipe Vinicio Caro (Basque Center for Applied Mathematics

(BCAM), University of the Basque Country (UPV/EHU))David Pardo (University of the Basque Country (UPV-EHU), Basque Center for Applied Mathematics (BCAM), Ikerbasque)

## [01105] SIPG Method for boundary control problems governed by parabolic PDEs

**Session Time & Room** : 5C (Aug.25, 13:20-15:00) @E703

**Type** : Contributed Talk

**Abstract** : We present a posteriori error analysis of adaptive finite element approximations for parabolic boundary control problems with bilateral box constraints that act on a Neumann boundary. The discretization is followed by using the symmetric interior penalty Galerkin (SIPG) technique. Both reliable and efficient residual-based error estimators are deduced. The implementation of these error estimators serves as a guide for the adaptive mesh refinement process. The numerical experiment shows the effectiveness of the derived estimators.

**Classification** : 65M60, 65M15

**Format** : Talk at Waseda University

**Author(s)** : Ram Manohar (Indian Institute of Technology Kanpur)Rathish Kumar Venkatesulu Bayya (Indian Institute of Technology Kanpur)Kedarnath Buda (Indian Institute of Technology Kanpur)Rajen Kumar Sinha (Indian Institute of Technology Guwahati)

## [01106] An alternative approach to generating the Covid-19 dynamics

**Session Time & Room** : 5B (Aug.25, 10:40-12:20) @A201

**Type** : Contributed Talk

**Abstract** : The dynamics of the mysterious Covid-19 spread are interesting for further exploration and investigation. We propose a generating dynamic operator of cumulative case functions to recover all the dynamics of the SEIR model. This approach can also provide estimates of unrecorded cases based on the dynamics of the Covid-19 test, IFR, CFR, and recorded cases. This approach directly measures daily transmission indicators, which can be used effectively for day-to-day epidemic control.

**Classification** : 92D30, 92B05, 92D25

**Format** : Online Talk on Zoom

**Author(s)** : Muhammad Fakhruddin (Bina Nusantara University)Kamal Khairudin Sukandar (Institut Teknologi Bandung)Andy Leonardo Louismono (Institut Teknologi Bandung)Metra Volisa (Institut Teknologi Bandung)Rudy Kusdiantara (Institut Teknologi Bandung)Muhammad Fakhruddin (The Republic of Indonesia Defense University)Nuning Nuraini (Institut Teknologi Bandung)Edy Soewono (Institut Teknologi Bandung)

## [01110] Patient-specific simulation of veno-venous Extra Corporeal Membrane Oxygenation (ECMO)

**Session Time & Room** : 1C (Aug.21, 13:20-15:00) @D515

**Type** : Contributed Talk

**Abstract** : Veno-Venous ECMO is a well-established procedure used in Intensive Care Units for patients with pulmonary failure. The patient blood is drained via a cannula in the inferior vena cava, oxygenated and reinserted via another cannula in the superior vena cava. Still, its efficacy is very limited, mainly due to recirculation between the two cannulas. In this talk we present a patient-specific, CFD-based computational model to assess the efficacy of the procedure and quantify recirculation.

**Classification** : 92C50, 92C35, 65ZXX, 92CXX

**Format** : Talk at Waseda University

**Author(s)** : Massimiliano Leoni (RICAM)Johannes Szasz (Kepler University Klinikum)Jens Meier (Kepler University Klinikum)Luca Gerardo Giorda (Johannes Kepler University Linz)

## [01114] Modeling Covid-19 Cases and Vaccination Interplay through Time-Varying Copula Approach

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @F312

**Type** : Contributed Talk

**Abstract** : Currently, the Indonesian government has made various efforts to reduce the number of Covid-19 cases, one of which is through administering vaccines. This study aims to model the interplay between the number of Covid-19 cases and the number of citizens who have been vaccinated, especially in term of the temporal relationship, using the time-varying copula approach.

**Classification** : 60Exx, 62Hxx, 62Pxx, Multivariate Modeling, Copula Modeling

**Format** : Online Talk on Zoom

**Author(s)** : Atina Ahdika (Universitas Islam Indonesia)

## [01117] Non-Linear Study of Interaction of Viscous Fingering Instability and Chemical Reaction

**Session Time & Room** : 1E (Aug.21, 17:40-19:20) @E704

**Type** : Contributed Talk

**Abstract** : We investigate a chemically reactive front  $A+B \rightarrow C$  involving the radial miscible displacement in porous media. It is a non-linear phenomenon that is mathematically modeled by Darcy's law coupled with convection-reaction-diffusion equations. A chemical reaction may result in a change in the viscosity profile, which may lead to the interfacial instability known as viscous fingering, which occurs when a low-viscosity fluid displaces a high-viscosity fluid in a porous medium. The instability enhances the fluid mixing.

**Classification** : 76Exx, 76Sxx, 76Vxx

**Format** : Talk at Waseda University

**Author(s)** : Priya Verma (Indian Institute of Technology Ropar) Manoranjan Mishra (Indian Institute of Technology Ropar)

## [01118] Finite Element Analysis of a Non-equilibrium Model for Hybrid Nano-Fluid

**Session Time & Room** : 4C (Aug.24, 13:20-15:00) @E711

**Type** : Contributed Talk

**Abstract** : A theoretical and computational finite element study of modified Navier-Stokes Equations coupled with energy conservation governing the flow and heat transfer in complex domain with hybrid nanofluid is carried out. The apriori error estimates providing the convergence analysis for the finite element scheme is derived in the  $H^1$ -norm. The effect of hybrid nano-particle's volume fraction, Rayleigh Number, Prandtl Number, Darcy number, porosity are analyzed to trace the physics related to flow and heat transfer.

**Classification** : 65N30, 80A05, 76R99, Finite element analysis and numerical computations with its application to hybrid nano-fluid

**Format** : Online Talk on Zoom

**Author(s)** : SANGITA DEY (Ph.D Student of Indian Institute of Technology Kanpur) Rathish Kumar Venkatesulu Bayya (Indian Institute of Technology Kanpur)

## [01119] Miscible Flows Based On Darcy-Stokes-Brinkman Model: Existence and Uniqueness

**Session Time & Room** : 4D (Aug.24, 15:30-17:10) @D401

**Type** : Contributed Talk

**Abstract** : Flows in a porous or vuggy medium are encountered in several physical phenomena, including oil recovery. A vast literature use the unsteady Brinkman and continuity equations for numerical modeling of such flow systems. We couple these equations with a convection-diffusion equation for the solute concentration to take the miscibility of fluids into account. For the first time, we show the well-posedness of this problem by employing regularized Galerkin method and hemivariational inequalities.

**Classification** : 76Dxx, 76Sxx, 35Qxx, 35Dxx

**Format** : Talk at Waseda University

**Author(s)** : Sahil Kundu (Indian Institute of Technology Ropar,Ropar, India)Manoranjan Mishra (Indian Institute of Technology Ropar, India)Surya Narayan Maharana (Indian Institute of Technology Ropar)

## [01123] Parameterized Douglas-Rachford dynamical systems for generalized DC programming

**Session Time & Room** : 4D (Aug.24, 15:30-17:10) @D408

**Type** : Contributed Talk

**Abstract** : In this work, we consider the difference of convex functions (DC) programming problems which are the backbone of nonconvex programming and global optimization. The classical problem contains the difference between two proper convex and lower semicontinuous functions. This paper deals with the generalized DC programming problem, which deals with the minimization of three convex functions. We propose a novel parametrized Douglas Rachford dynamical system to solve the problem and study its convergence behavior in the Hilbert space. Moreover, we also conduct numerical experiments to support our theoretical findings.

**Classification** : 90C26, 90C30

**Format** : Online Talk on Zoom

**Author(s)** : Avinash Dixit (Kirori Mal College, University of Delhi, Delhi)Pankaj Gautam (NTNU )Tanmoy Som (IIT (BHU), Varanasi)

## [01125] Generalized Optimization Algorithms for $M$ -Estimation of Complex Simulation Models

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @E503

**Type** : Contributed Talk

**Abstract** : We provide a new optimization algorithm for simulation-based models with highly irregular objective functions, like those of network or agent-based models. The approximate inexact Newton method (AINM) is based on approximating the first two derivatives of the function through a polynomial regression. We provide new general results concerning approximate Newton methods, we extensively discuss the theoretical and computational aspects of the AINM, and support the theory by Monte Carlo experiments and two applications.

**Classification** : 90Cxx, 62F10, 62J05

**Format** : Talk at Waseda University

**Author(s)** : Raffaello Seri (Università degli Studi dell'Insubria)Mario Martinoli (Scuola Superiore Sant'Anna Pisa)Fulvio Corsi (Università di Pisa)

## [01133] Surface wave propagation in coated poro-elastic layer due to point source

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @F312

**Type** : Contributed Talk

**Abstract** : The impact of an internal energy source on an anisotropic fluid-saturated poro-elastic layer over a non-homogeneous semi-infinite medium is presented. The poroelastic layer is coated with a thin elastic layer. The Fourier transform and Green's function techniques are applied to analyse the velocity profile of Love-type wave propagation. Error analysis between phase velocity with and without damping has been shown. It is found that the dispersiveness is caused by the non-homogeneity of the semi-infinite medium.

**Classification** : 74-10, 74B10, 74H05, 74H45, 74J15

**Format** : Online Talk on Zoom

**Author(s)** : Dipendu Pramanik (Department of Mathematics, Indian Institute of Technology Indore)Santanu Manna (Department of Mathematics, Indian Institute of Technology Indore)

## [01134] A propagating edge wave on a crack plate

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @F312

**Type** : Contributed Talk

**Abstract** : The study analyzes the characteristics of the bending edge wave on a semi-infinite Kirchhoff plate having a stationary crack on the plate and supported by an elastic foundation. The non-local elasticity theory is used to investigate the effect of non-local stress on the propagation of edge waves on the crack plate. Due to the presence of the crack, the stress intensity factor related to the edge wave propagation will be discussed via numerical analysis.

**Classification** : 74-10, 74J15, 74K20, Surface waves in elastic plate

**Format** : Online Talk on Zoom

**Author(s)** : Rahul Som (Department of Mathematics, Indian Institute of Technology Indore, India )Santanu Manna (Assistant Professor, Indian Institute of Technology Indore)

## [01135] Computational framework for design, optimization, and control of sintering process

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @E605

**Type** : Contributed Talk

**Abstract** : Optimization and control of sintering, which is governed by macroscopic coupled electro-thermo-mechanical model, is critical for additive manufacturing. To reduce time in making process design decisions, we present a hybridized model-based and data-driven computational framework. In particular, we demonstrate an inverse estimation strategy combining offline-online efficient data assimilation and surrogate modeling. We test the performance of the proposed method in accelerating the estimation of sintering process parameters and hard-to-measure material properties like viscosity.

**Classification** : 65M32, 65F55, 74H15, 60-08, 74D99

**Author(s)** : Rahul Dhopeswar (TU Eindhoven)Harshit Bansal (TU Eindhoven)Karen Veroy (TU Eindhoven)

## [01137] Stability and Dispersion analysis for Rayleigh-type waves in non-local media

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @D102

**Type** : Contributed Talk

**Abstract** : We present the non-local elastic behavior of Rayleigh-type surface waves in a layered media comprising an inhomogeneous medium and a fiber-reinforced layer. The dispersion equation is derived using an approximate asymptotic displacement solution of the governing wave equation. Using the Finite Difference Scheme, the stability conditions are determined for the equations of group velocity and phase velocity. The effects of various defining parameters on propagation are discussed and graphically depicted.

**Classification** : 74-10, 74B10, 74H05, 74H45, 74J15

**Format** : Online Talk on Zoom

**Author(s)** : Manasa Bhat (Department of Mathematics, Indian Institute of Technology Indore.) Santanu Manna (Department of Mathematics, Indian Institute of Technology Indore)

## [01139] Adaptive sampling and transfer learning techniques for solution of PDEs

**Session Time & Room** : 2E (Aug.22, 17:40-19:20) @G402

**Type** : Contributed Talk

**Abstract** : An adaptive sampling technique applied to the deep Galerkin method (DGM), and separately a transfer learning algorithm also applied to DGM is examined, aimed to improve, and speed up the training of the deep neural network when learning the solution of partial differential equations (PDEs). The proposed algorithms improve the DGM method. The adaptive sampling scheme implementation is natural and efficient. Tests applied to selected PDEs discussing the robustness of our methods are presented.

**Classification** : 35-04, 65-04, Deep learning for the solution of PDEs

**Format** : Online Talk on Zoom

**Author(s)** : Andreas Aristotelous (The University of Akron)

## [01141] On tensor-based training of neural networks

**Session Time & Room** : 5B (Aug.25, 10:40-12:20) @E802

**Type** : Contributed Talk

**Abstract** : In this work by resorting to the continuous ‘model’ of a shallow neural network, we present a novel training approach, that is based on a suitable approximate solution of a Fredholm integral equation of the first kind. Here, we concentrate on least-squares collocation, functional tensor networks and alternating ridge regression. Application of the algorithm to some supervised learning tasks is on par with other state-of-the-art approaches.

**Classification** : 65R20

**Format** : Talk at Waseda University

**Author(s)** : Patrick Gelß ( Zuse Institute Berlin) Aizhan Issagali ( Freie Universität Berlin) Ralf Kornhuber (Freie Universität Berlin)

## [01142] Thermodynamically Consistent Finite Volume Schemes for Electrolyte Simulations

**Session Time & Room** : 2E (Aug.22, 17:40-19:20) @E702

**Type** : Contributed Talk

**Abstract** : In order to account for finite ion sizes and solvation effects, the classical Nernst-Planck-Poisson system describing ion transport in electrolytes needs to be enhanced by cross-diffusion - like terms. For this situation, we present a space discretization scheme which adapts the classical

Scharfetter-Gummel exponential fitting upwind flux for the Voronoi box finite volume method. Numerical examples use the Julia package VoronoiFVM.jl which takes advantage of automatic differentiation to handle the strong nonlinearities of the system.

**Classification** : 65M08, 65M12, 78A57, 65N08, 35Q81

**Format** : Talk at Waseda University

**Author(s)** : Jürgen Fuhrmann (Weierstrass Institute for Applied Analysis and Stochastics)Benoit Gaudeul (Univ. Paris Saclay)

## **[01146] Steady-State Analysis of a Single Server Queueing System Subject to Differentiated Vacations and N-Policy**

**Session Time & Room** : 2C (Aug.22, 13:20-15:00) @E501

**Type** : Contributed Talk

**Abstract** : An M/M/1 queueing system subject to differentiated vacations and N-policy is studied. When there are no customers, the server takes a vacation and returns to the system if N or more customers are found. Still, if the number of customers in the system is less than “N,” the server takes another vacation type. The explicit expression for steady-state probabilities of the system size is obtained. The exact solutions for some performance measures are also derived.

**Classification** : 60K25, 68M20, 90B22, Queueing theory

**Format** : Online Talk on Zoom

**Author(s)** : SURANGA SAMPATH MIYANAWATHURA IHALA GAMAGE (Wayamba University of Sri Lanka)

## **[01150] Optimizing Tool Assignment Using Smart Lockers**

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @E811

**Type** : Industrial Contributed Talk

**Abstract** : A logistics operator adopted smart lockers to distribute 150 commercial tools such as tablets and scanners to employees, working in 3 shifts. The lockers gather significant data like tools deficiencies, breakdowns, usage time, punctuality. The assignment policy to deliver tools must minimize downtime using two figure of merit, one classifying employees according to their ability to handle tools, and another measuring the frequency of deficiencies and breakdowns. The proposal is inspired in genetic algorithms.

**Classification** : 68T20, 90B06

**Format** : Talk at Waseda University

**Author(s)** : Jose Alberto Fonseca (Instituto de Telecomunicações - Universidade de Aveiro)Joaquim Ferreira (Instituto de Telecomunicacoes, Universidade de Aveiro)Ricardo Bandeira (Microio,Lda)Fernanda Coutinho (Instituto Superior de Engenharia de Coimbra - IPP)

## **[01151] Structure-Preserving Neural Networks for Hamiltonian Systems**

**Session Time & Room** : 3D (Aug.23, 15:30-17:10) @E606

**Type** : Contributed Talk

**Abstract** : When solving Hamiltonian systems using numerical integrators, preserving the symplectic structure is crucial. We analyze whether the same is true if neural networks (NN) are used. In order to include the symplectic structure in the NN's topology we formulate a generalized framework for two well-known NN topologies and discover a novel topology outperforming all others. We find that symplectic NNs generalize better and give more accurate long-term predictions than physics-unaware NNs.

**Classification** : 65Lxx, 68T07, 85-08

**Format** : Talk at Waseda University

**Author(s)** : Philipp Horn (Eindhoven University of Technology)Barry Koren (Eindhoven University of Technology)Veronica Saz Ulibarrena (Leiden University)Simon Portegies Zwart (Leiden University)

## [01153] Analysis of driver's behavior and average flow on traffic dynamics

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @E503

**Type** : Contributed Talk

**Abstract** : In this work, a new lattice model is proposed by considering the driver's behavior (timid or aggressive) and downstream average flow on traffic dynamics. The stability condition is determined through stability analysis. Nonlinear analysis forms the modified Korteweg-de Vries (mKdV) equation to describe traffic density wave propagation near the critical point. Theoretical results are verified with numerical simulations, and it is concluded that driver behavior and average flow can stabilize traffic flow dynamics.

**Classification** : 65P40, 65K05, Traffic flow

**Author(s)** : Nikita Madaan (Chandigarh University)Nikita Madaan (Thapar Institute of Engineering and Technology)Sonia - (Chandigarh University)

## [01156] Row completion of polynomial matrices

**Session Time & Room** : 1E (Aug.21, 17:40-19:20) @G304

**Type** : Contributed Talk

**Abstract** : Perturbation problems arise frequently in applications, as in structural changes of the dynamics of a system or in pole placement problems in control theory.

Perturbation problems of matrices are closely related to completion problems. We present a solution to the row-completion problem of a polynomial matrix, prescribing the eigenstructure of the resulting matrix and maintaining the degree.

**Classification** : 15A22, 15A83

**Author(s)** : Agustzane Amparan (Universidad del País Vasco, UPV/EHU)Itziar Baragaña (Universidad del País Vasco, UPV/EHU)Silvia Marcaida (Universidad del País Vasco, UPV/EHU)Alicia Roca (Universitat Politècnica de València )

## [01157] The boundary domain integral method for boundary value problems with variable coefficients

**Session Time & Room** : 1E (Aug.21, 17:40-19:20) @F309

**Type** : Contributed Talk

**Abstract** : The boundary domain integral equation method is an important tool to formulate (in terms of integral operators) boundary value problems with variable coefficients. Although the theory of boundary domain integral equations has been largely developed, there is a lack of results in numerical implementations.

The aim of this talk is to enumerate the different boundary domain formulations for several boundary conditions and present discretizations of the integral equation systems and comparisons between the numerical behavior of the approximated solutions.

**Classification** : 31B10, 65Rxx, boundary domain integral methods

**Author(s)** : Nahuel Domingo Caruso (National University of Rosario - CIFASIS-CONICET)Carlos Fresneda-Portillo (Universidad Loyola Andalucía (Spain))

## [01160] A mathematical study of cancer and radiotherapy towards personalized medicine

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @A601



**Type :** Contributed Talk

**Abstract :** We present a mathematical model that describes the growth of a tumor mass, considering the interaction between the microenvironment abiotic factors and the epigenetic composition of the cancer cell population. We show the dynamics of its effects on radiotherapy treatment.

Results reveal the predictive and diagnostic value of the use of mathematical models as an aid to the medical image in outlining patient-specific therapeutic protocols and optimizing the effectiveness and relapse control.

**Classification :** 92B05, 65M60

**Format :** Online Talk on Zoom

**Author(s) :** Giulia Chiari (Politecnico di Torino)

## **[01163] An infinite class of shocks for compressible Euler**

**Session Time & Room :** 5B (Aug.25, 10:40-12:20) @G401

**Type :** Contributed Talk

**Abstract :** We consider the two dimensional compressible Euler equations with azimuthal symmetry and construct an infinite class of shocks by establishing shock formation for a new Hölder family of so-called pre-shocks for all nonnegative integers. Moreover, a precise description of the dominant Riemann variable in the Hölder space is given in the form of a fractional series expansion.

**Classification :** 35L67, 35Q31, 76N15, 76L05

**Format :** Talk at Waseda University

**Author(s) :** Calum Rickard (University of California, Davis)Sameer Iyer (University of California, Davis)Steve Shkoller (University of California, Davis)Vlad Vicol (New York University)

## **[01164] Infection spreading in tissue as a delayed reaction diffusion wave**

**Session Time & Room :** 5D (Aug.25, 15:30-17:10) @D515

**Type :** Contributed Talk

**Abstract :** In this work, we have discussed the stationary solution of a delayed reaction diffusion system for the concentrations of uninfected cells, infected cells, and virus cells. We have also discussed the existence of waves for the corresponding monotone system and found the minimal wave speed of the system. We have observed that when the death rates of uninfected and infected cells were the same, the virus propagation gradually decreases, but when the death rates are different, the wave propagation initially increases and then decreases. It is also observed that as the time delay increases the initial oscillations also increases. Next, we convert the system into a single diffusion equation using a quasi-stationary approximation, study the existence of the wave, and find the analytical expression for the minimal wave speed. We have also performed comprehensive simulations to compare and validate the results for both cases.

**Classification :** 93C10, 93C43, 35AXX

**Format :** Talk at Waseda University

**Author(s) :** Moitri Sen (National Institute of Technology Patna)Saddam Hussain (National Institute of Technology Patna)Vitaly Volpert (Institut Camille Jordan, UMR 5208 CNRS, University Lyon 1)

## **[01169] Physical properties of seed maize versus open market maize**

**Session Time & Room :** 1C (Aug.21, 13:20-15:00) @

**Type :** Contributed Talk

**Abstract :** Accurate kernel dimensions are crucial to designing efficient screen cleaners in maize processing. Reported dimensions in literature are determined for individual varieties. Unfortunately, the open maize market in Ghana contains a mixture of varieties, making literature-reported dimensions impractical for efficient screen designs. We present a comparative analysis of individual variety and open market maize dimensions using Analysis of Variance (ANOVA) and Least Significant Difference

(LSD) tests to inform on efficiency of maize screen-cleaning systems.

**Classification** : 00A06, 00A69, 00A79, 62B99, 62C99

**Author(s)** : Martin Apraku Amankwah (Sunyani Technical University)Komla Agbeko Dzisi (Kwame Nkrumah University of Science & Technology, Kumasi)Ahmad Addo (Kwame Nkrumah University of Science & Technology, Kumasi)

## **[01171] The role of the autoregulation mechanism in hypertension and hypotension in humans**

**Session Time & Room** : 1C (Aug.21, 13:20-15:00) @D515

**Type** : Contributed Talk

**Abstract** : We present a nonlinear model for the propagation of the pressure and flow velocity waves in the human cardiovascular system, including deep learning tools with available physiological data. This model is used for understanding the system-level dynamics of the pressure and flow rates. This time-domain analysis is best to describe time-dependent controls, collectively known as the autoregulation mechanism. We discuss an application of our model to the study of the hypertension and hypotension.

**Classification** : 92C35, 76Z05, 68T07, 49N90

**Author(s)** : Radu C Cascaval (University of Colorado Colorado Springs)

## **[01172] Spatio-structural partial differential equation (PDE) modelling for single-cell cancer data**

**Session Time & Room** : 2D (Aug.22, 15:30-17:10) @E709

**Type** : Contributed Talk

**Abstract** : Melanoma routinely develops resistance to targeted therapies, leading to unfavourable prognosis for patients. We introduce a novel approach to modelling single-cell RNA-seq data obtained from melanoma tumours, using partial differential equations (PDEs) to represent the tumour as a spatio-structural population. We show how non-spatial data can be used to predict spatially heterogeneous distributions of cell types, within the tumour, and explore combination therapies and treatment strategies to overcome traditional patterns of resistance.

**Classification** : 35Q92, 37N25, 62P10, 92-10, 35G20, Mathematical Oncology, PDEs

**Author(s)** : Arran Hodgkinson (Queen's University Belfast)Arran Hodgkinson (Queen's University Belfast)Dumitru Trucu (University of Dundee)Matthieu Lacroix (Institut de Recherche en Cancerologie de Montpellier)Laurent Le Cam (Institut de Recherche en Cancerologie de Montpellier)Ovidiu Radulescu (Universite de Montpellier)

## **[01173] Turing Patterns as a Model for Brain Folding**

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @D514

**Type** : Contributed Talk

**Abstract** : Folding patterns of every human brain are unique with no consensus among neurobiologists regarding the mechanism for folding pattern formation. We present a Turing reaction-diffusion model that uses an activator and inhibitor, and incorporates parameters that influence genetic control, brain growth, and domain scale. Our results study static and dynamic domain growth, and we investigate domain shape to compare results to brain diseases with excessive folding or lack of folding such as polymicrogyria and lissencephaly.

**Classification** : 92C15, 92B05, 92-10, 37N25, 35B36, Turing Pattern Formation, Brain Development, PDEs, Modeling, Dynamical Systems

**Format** : Talk at Waseda University

**Author(s)** : Monica K. Hurdal (Florida State University)

## [01179] Applications of a Tiled Monte Carlo Algorithm to the Computation of Matrix Functions

**Session Time & Room** : 5B (Aug.25, 10:40-12:20) @E603

**Type** : Contributed Talk

**Abstract** : We extend our prior work on Monte Carlo algorithms for solving large linear systems to compute other matrix functions such as exponential and logarithm. Our recent algorithm that computes with matrix tiles is shown to guarantee convergence for sufficiently large tiles. We compute matrix functions by summing a polynomial approximation (e.g. Taylor, Chebyshev). We investigate the convergence conditions for each function and optimize the algorithm by adjusting the parameters.

**Classification** : 65F60, 65C05

**Format** : Talk at Waseda University

**Author(s)** : Hyeji Choi (Stony Brook University)

## [01182] Optimizing the manufacturing process of a cutting machine in iron industry

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @D501

**Type** : Contributed Talk

**Abstract** : In this talk we discuss a multi-criteria optimization framework designed for the cooperation with a prominent company, leader in the production of automatic machines employed in iron manufacturing. The optimized machine process counts several steps, starting by cutting the bars at specified lengths and moving them into two temporary buffers. Afterwards, bars are relocated through pliers to parallel depots through a lengthwise movement and gathered by order to facilitate the subsequent transfer to downstream steps.

**Classification** : 90-08, 90-10, 90-04

**Format** : Talk at Waseda University

**Author(s)** : Andrea Pizzuti (Università Politecnica delle Marche)Fabrizio Marinelli (Università Politecnica delle Marche)

## [01183] Development of algebraic preconditioners based on multiscale domain decomposition methods

**Session Time & Room** : 2D (Aug.22, 15:30-17:10) @E505

**Type** : Contributed Talk

**Abstract** : This work presents a new algebraic formulation for the Multiscale Robin Coupled Method - MRCM. This domain decomposition method generalizes other mixed multiscale methods by imposing Robin-type boundary conditions on the local problems. The MRCM is flexible and accurate, obtaining near-optimal scalability up to billions of unknowns in high-performance simulations. We propose a new algebraic formulation, allowing the construction of multiscale-based preconditioners for solving non-symmetric linear systems with Krylov subspace methods, such as GMRES.

**Classification** : 65F08, 65N55, 65N08, 76S05

**Format** : Talk at Waseda University

**Author(s)** : Fabricio Simeoni de Sousa (University of Sao Paulo)Franciane F. Rocha (Wikki Brazil)Luca Meacci (Università degli Studi di Firenze)Rafael T. Guiraldello (Piri Technologies LLC)Roberto F. Ausas (University of Sao Paulo)Gustavo C. Buscaglia (University of Sao Paulo)Felipe Pereira (The University of Texas at Dallas)

## [01187] Dynamic, data-driven neurodegeneration: Modelling clearance and proteopathy in Alzheimer's disease

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @A601

**Type** : Contributed Talk

**Abstract** : The clinical research community has raised the alarm on the importance of studying the role of clearance in Alzheimer's disease. We heed this alarm by developing and analysing the first network reaction-diffusion dynamical system coupling clearance and proteopathy. Analytical insights, and computational results on high-resolution brain graphs constructed from human data, demonstrate the connections between clearance and neurodegeneration. Our results suggest clearance deficits may play an important role in the onset and trajectory of Alzheimer's.

**Classification** : 92-10, 37N25

**Author(s)** : Georgia Staf Brennan (University of Oxford)Alain Goriely (University of Oxford)Marie Rognes (Simula Research Laboratory)Travis Thompson (Texas Tech University)Hadrien Oliveri (University of Oxford)

## [01192] Application of MUSIC Algorithm in Microwave Imaging Without Switching Device

**Session Time & Room** : 1E (Aug.21, 17:40-19:20) @D405

**Type** : Contributed Talk

**Abstract** : Although the MULTiple Signal Classification (MUSIC) algorithm has demonstrated suitability as a microwave imaging technique for identifying unknown anomalies, there is a fundamental limit that it requires a switching device to be used which permits a dipole antenna for signal transmission and reception. In this contribution, we design a MUSIC-type imaging function and explore its mathematical structure. Considering the investigated structure, we confirm that the imaging performance is highly dependent on the antenna arrangement and suggest an optimal antenna arrangement to improve the imaging performance. Simulation results with real-data are displayed to support the theoretical result.

**Classification** : 78A46

**Format** : Talk at Waseda University

**Author(s)** : Won-Kwang Park (Kookmin University)

## [01193] Cost-effectiveness and Public Health Impact of HPV Vaccination Strategies with consideration of cross-immunity in Japan

**Session Time & Room** : 2C (Aug.22, 13:20-15:00) @G304

**Type** : Contributed Talk

**Abstract** : We assessed the epidemiological and economic impact of potential health advantages of the HPV vaccination in Japan among girls and boys of ages 12–16. An age-structured mathematical model of HPV transmission was constructed. Compared to halted vaccination, girls-only vaccination programs with either 4vHPV or 9vHPV are cost-effective, but gender-neutral vaccination programs are less so. Adding boys to an existing successful girls-only program is not cost-effective since men are protected by herd immunity.

**Classification** : 92B05

**Format** : Talk at Waseda University

**Author(s)** : Wongyeong Choi (Soongsil University)Eunha Shim (Soongsil University)

## [01196] Deep Solvers in Shape Optimization

**Session Time & Room** : 3D (Aug.23, 15:30-17:10) @E811

**Type** : Contributed Talk

**Abstract** :

We introduce a novel mesh-free method for computing the shape derivative in PDE-constrained shape optimization problems. Our approach is based on a probabilistic deep solver, which can be shown to converge for a wide class of semilinear PDEs, and a suitable representation of the shape gradient. In contrast to finite element, volume and difference methods, our approach does not require a discretization of the domain's interior. We also present examples for performance illustration.

**Classification** : 68T07, 65N99

**Format** : Talk at Waseda University

**Author(s)** : Maximilian Würschmidt (Trier University) Frank Seifried (Trier University) Luka Schlegel (Trier University) Volker Schulz (Trier University)

## [01201] How differential geometry and extremum seeking systems reveal the decades- long mystery of optimized flight of soaring birds

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @A511

**Type** : Contributed Talk

**Abstract** : The optimized flight physics of soaring birds such as albatrosses have always been fascinating to biologists, physicists, mathematicians, and engineers. How can soaring birds fly in that effective way without spending almost any energy? The decades-long literature of the problem has not been successful in providing frameworks that can work in real time similar to the birds themselves. Recently, a breakthrough took place in providing a simple, real time extremum seeking method that characterizes this phenomenon and implements it in real time. Mathematical analysts using differential geometric methods have been successful in supporting these new results.

**Classification** : 92-10, 93-10, 93B05, 53Z05

**Format** : Talk at Waseda University

**Author(s)** : Sameh Eisa (University of Cincinnati )

## [01203] Existence and regularity results for nonlinear elliptic equations with degenerate coercivity

**Session Time & Room** : 5B (Aug.25, 10:40-12:20) @G502

**Type** : Contributed Talk

**Abstract** : In this research we drive the existence and regularity results for solutions of some nonlinear degenerate Dirichlet problems containing two lower order terms, the first is a nonlinear convection term satisfying an optimal growth conditions and without any hypothesis of coercivity and the second is a zero order perturbation term, which called the hardy potential, that creates an obstruction to the existence of a solution. Not also that for right hand side, it is assumed that to be an  $L^m$ -function with  $m \geq 1$ .

**Classification** : 35J60, 35K65, 35J70

**Format** : Online Talk on Zoom

**Author(s)** : Fessel Achhoud (MISI Laboratory Hassan First University of Settat) Abdelkader Bouajaja (MISI Laboratory Hassan First University of Settat)

## [01207] Optimal analysis of ecological-economic model with fishing tax and tourist entry-fee

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @A508

**Type** : Industrial Contributed Talk

**Abstract** : A market-based fishing strategy in a multi-species fishery with a fair taxation policy may provide long-term sustainable growth. Fishery-based ecotourism with an entry fee for the tourist may further contribute to the financial improvement of the local people. Here we have proposed and analyzed a harvesting model that integrates fishery and fishery-based ecotourism with the open market economy theory. We determine the optimal fishing tax and entry fee that maximizes the social benefit.

**Classification** : 91B76, 92B05, 91B55, 92D25, 92D40

**Author(s)** : Nandadulal Bairagi (Jadavpur University) Santaanu Bhattacharya (Jadavpur University)

## [01216] Neural network in option pricing

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @D505

**Type** : Contributed Talk

**Abstract** : Black-Scholes model is the universally accepted model for computing option prices. While it is robust and easy to use, it has many flaws. Moreover, it failed spectacularly in 1987 during the wall street crash. This has led to proliferation of many extensions to the Black-Scholes model. Most extensions focus on relaxing the constant volatility assumption by incorporating randomness in the volatility. Whilst it provides slightly better estimation to option prices, it is computationally expensive to implement. Moreover, most of these models do not have closed-form solutions

With advancement in computational techniques, neural network has been increasingly used to price options. Not only, does it outperform conventional stochastic volatility models, it does not require assumption on the statistical characteristics of assets and volatility distribution. A typical neural network consists of three layers: input, hidden, and output. It uses a supervised learning method based on the generalisation of the least mean square error (LMS) algorithm. A gradient descent method is used to minimise the cost function, which is the mean square difference between the target and actual net output. More advanced neural networks (deep learning architectures), such as a Recurrent Neural Network (RNN) and its variant Long Short-Term Memory (LSTM), are useful for taking care of the time-series nature of financial data. The general architecture of the convolutional neural network-based LSTM model includes an input layer, one or more convolutional layers, long short-term memory layer(s), dense layer(s), and an output layer. In this research, we will attempt to predict Strait Times Index (STI) which is one of the most regularly traded options in Singapore Exchange (SGX).

After pre-processing and cleaning the data, the input (stock price, time to maturity and volatility and output (option prices) , variables will be extracted for training and testing the models. Various hyperparameters (optimizers, learning rate, hidden layers, activation functions, etc.) will be optimised to generate the best model for the prediction of the option pricing. A comparison of the accuracy of the prediction of option pricing will be performed for three models, namely convolutional neural network-based LSTM, Multilayer Perceptron neural network N and the Black Scholes option pricing model. Different metrics (root mean squared error, mean absolute error, and mean absolute percentage error) will be used to compare the performance of the models.

**Classification** : 91G15, 91G20

**Format** : Talk at Waseda University

**Author(s)** : Abby Chee Hong Tan (Universiti Brunei Darussalam)

# [01223] Descent hybrid four-term conjugate gradient methods for unconstrained optimization

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @A206

**Type** : Industrial Contributed Talk

**Abstract** : Conjugate gradient method (CGM) is widely acclaimed to be efficient for solving large-scale unconstrained optimization problems. This study proposes new modified schemes that contain four terms based on the linear combination of the update parameters of classical or early methods depending on the popular two- and three-term CGMs. Hybridized methods have been found to exhibit better performance than the classical methods (Stanimirovic et al., 2018). Several other methods in this category can be found in (Adeleke et al., 2018; Osinuga and Olofin, 2018; Stanimirovic et al., 2018).

In continuation of the previous results, we propose hybrid methods for the solution of large-scale unconstrained optimization problems as motivated and inspired by (Alhawarat et al., 2021, Yao et al., 2020, Stanimirovic et al., 2018). Modified methods are defined using appropriate combinations of the search directions and included parameters. In this case, our methods are hybridizations of HS and DY methods. In addition, we propose a class of Dai-Liao CGMs developed using new search directions developed using different values of included parameter.

Under some certain assumptions, descent and convergence properties were established with the underlying strong Wolfe line search. The results of the new schemes showed superior performance over the existing ones in the sense of performance profiles of Dolan and Moré (2002).

**Keywords**: unconstrained optimization, strong Wolfe line search, descent property, global convergence.

**AMS subject classification**. 49J52, 49J53, 90C30

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**Classification** : 90C30, 65K05, 90C26, Nonlinear Optimization

**Format** : Online Talk on Zoom

**Author(s)** : Idowu Ademola Osinuga (Federal University of Agriculture, Abeokuta, Nigeria )Moses Oluwasegun Olubiyi (Federal University of Agriculture, Abeokuta)Semiu Akinpelu Ayinde (Babcock University, Ilishan-Remo)

## [01224] Collision-induced amplitude dynamics of nD solitons in a perturbed saturable nonlinear medium

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @G501

**Type** : Contributed Talk

**Abstract** : We study the amplitude dynamics of two-dimensional (2D) fast solitons in an interaction under a framework of coupled (2+1)D nonlinear Schrodinger equations with a saturable nonlinearity and weak perturbation. We derive a theoretical expression for the collision-induced amplitude dynamics in a fast collision of two 2D solitons. Our perturbative approach is mainly based on the analysis of the collision-induced change in the envelope of the perturbed 2D soliton. The theoretical results are validated by numerical simulations with the coupled perturbed nonlinear Schrodinger equations with saturable nonlinearity.

**Classification** : 35C08, 35Q51, 35Q60, 78A10, 78M10

**Format** : Online Talk on Zoom

**Author(s)** : Quan Minh Nguyen (International University, Vietnam National University Ho Chi Minh City)Toan Thanh Huynh (Department of Mathematics, University of Medicine and Pharmacy at Ho Chi Minh City, Vietnam)

## [01226] Health Care: Robotic Dog for Navigation of a Rehabilitation Robot

**Session Time & Room** : 5B (Aug.25, 10:40-12:20) @E603

**Type** : Contributed Talk

**Abstract** : One of the more recent technological advancements is assistive robots, which can improve patient-centered care in the health sector. This paper presents a unique set of continuous nonlinear control laws derived from a Lyapunov-based control scheme for navigation of an assistive robot and a rehabilitation wheelchair robot together modeled as a new autonomous robotic dog and rehabilitation wheelchair system. The computer simulations also present a qualitative analysis of the effectiveness of the control laws.

**Classification** : 70B15, 93C85, 93D05, 93C10

**Author(s)** : Bibhya Nand Sharma (The University of the South Pacific )Sandeep Kumar (The University of the South Pacific )

## [01232] A MESH-LESS, RAY-BASED DEEP NEURAL NETWORK METHOD FOR THE HELMHOLTZ EQUATION WITH HIGH FREQUENCY

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @E605

**Type** : Contributed Talk

**Abstract** : We develop a mesh-less, ray-based deep neural network method to solve the Helmholtz equation with high frequency. This method does not use an adaptive mesh refinement method, nor does it design a numerical scheme using some specially designed basis function to calculate the numerical solution, but it has the advantages of easy implementation and no mesh. We have carried out various numerical examples to prove the accuracy and efficiency of the proposed numerical method.

**Classification** : 65K05

**Format** : Online Talk on Zoom

**Author(s)** : andy L yang (DutchFork High school)



## [01233] A Study of the Spectra-Cutoff Imaging Method of Multiple Scattering in Isotropic Point-Like Discrete Random Media

**Session Time & Room** : 2C (Aug.22, 13:20-15:00) @G601

**Type** : Contributed Talk

**Abstract** : Imaging in random media is an important and interesting subject of inverse problems, relevant to a wide range of physical and engineering contexts, such as seismic imaging, remote sensing, medical imaging, wireless communications, and nondestructive testing.

In this talk, we show that imaging becomes difficult to perform in random media when multiple scattering is too strong to cause image distortion arising from the underlying interactions of multiply scattered waves at resonance frequencies.

The Foldy-Lax-Lippmann-Schwinger, (FLLS), formalism, which is employed for the multiply scattered waves, in the frequency domain, in the case of an ensemble of randomly distributed point-like scatterers. The scattering matrix representing the (FLLS) formalism is a non-Hermitian Euclidean random matrix.

According to the eigenvalue distribution of the scattering matrix, we present our approach to restore the distorted images by cutting off the sharp frequency responses in the resonance regime due to strong multiple scattering.

Finally, we show the use of this approach for imaging in discrete random media with numerical simulations and also discuss the limitations and future research direction.

**Classification** : 35J05, 35P15, 35P25, 47B06, 78A46

**Format** : Talk at Waseda University

**Author(s)** : Ray-Hon Sun (Stanford University (while working on this research))

## [01239] Convergence analysis of the discrete consensus-based optimization algorithm

**Session Time & Room** : 2E (Aug.22, 17:40-19:20) @G709

**Type** : Contributed Talk

**Abstract** : We study stochastic convergence of the discrete Consensus-Based Optimization, called CBO algorithm, in almost-sure sense and in expectation. CBO is a mathematical toy example for non-gradient multi-point optimizer which tries to find the global minimum point of a given cost function. The convergence analysis guarantees the termination of the optimization process. The main result is a joint work with Seung-Yeal Ha, Shi Jin, and Doheon Kim.

**Classification** : 37M99, 65p99

**Format** : Talk at Waseda University

**Author(s)** : Dongnam Ko (The Catholic University of Korea)

## [01240] Machine Learning based Optimization Algorithm for Stress Prediction

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @E804

**Type** : Contributed Talk

**Abstract** : In this work, an efficient optimization algorithm is developed to predict the stress of a person. The algorithm uses sensor data which are extracted from person's physiological parameters. The proposed work uses various techniques for smoothing the data and to identify the features from the extracted data. Different experiments are done by considering various output metrics. Based on the comparison with the existing classification algorithms, the proposed algorithm identifies the stress prediction with high accuracy.

**Classification** : 68M18, 68M20, 65-04

**Format** : Talk at Waseda University

**Author(s)** : Pankajavalli Palanisamy Balamani (Bharathiar University)

## [01241] Crossing Sea States in Layered and Stratified Fluids

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @D403

**Type** : Contributed Talk

**Abstract** : Crossing sea states are common phenomena in the oceans, and have been suggested as one possible generation mechanism for rogue waves. Modeling studies are conducted for (a) a two-layer fluid with long wave-short wave resonance, and (b) the triad resonance in a continuously stratified fluid with constant buoyancy frequency. Modulation instability will be enhanced. There is a preferred inclination of oblique wave propagation for a maximum growth rate, suggesting the occurrence of rogue waves.

**Classification** : 76E30, 35Q35, 76-10

**Format** : Talk at Waseda University

**Author(s)** : Qing Pan (The University of Hong Kong)

## [01247] Gradient-push algorithm for distributed optimization with event-triggered communications

**Session Time & Room** : 2C (Aug.22, 13:20-15:00) @F312

**Type** : Contributed Talk

**Abstract** : Decentralized optimization problems consist of multiple agents connected by a network. The agents have each local cost function, and the goal is to minimize the sum of the functions cooperatively. In this work, we propose a gradient-push algorithm involving event-triggered communication on a directed network. The convergence of the algorithm is established under suitable decays and summability conditions on a stepsize and triggering threshold.

**Classification** : 47Nxx, 65Kxx, Decentralized Optimization

**Format** : Talk at Waseda University

**Author(s)** : jimyeong kim (Sungkyunkwan University)Woocheol Choi (Sungkyunkwan Univeristiy)

## [01248] Reduction of Computational Cost with Optimal Accurate Approximation for Boundary Layer Originated Two Dimensional Coupled System of Convection Diffusion Reaction Problems

**Session Time & Room** : 2D (Aug.22, 15:30-17:10) @E702

**Type** : Contributed Talk

**Abstract** : In this talk, I will consider a generalized form of a coupled system of time dependent convection diffusion reaction problems having arbitrary small diffusion terms, which lead to boundary layers. The numerical approximations of these problems require adaptive mesh generation for uniformly convergent approximation. In the present talk, I will provide an algorithm which will reduce the computational cost of the system solver by converting the system of discrete equations to a tridiagonal matrix form. This approach together with an adaptive mesh generation technique will preserve the optimal convergence accuracy. This convergence is proved to be independent of diffusion terms magnitude.

**Classification** : 65M06, 65M50, 65N50, Computational Cost Reduction, Error Analysis, Adaptive Mesh Generation, Coupled System of Time Dependent PDEs, Two Dimension

**Format** : Online Talk on Zoom

**Author(s)** : Pratibhamoy Das (Indian Institute of Technology Patna)Pratibhamoy Das (Indian Institute of Technology Patna)Shridhar Kumar (Indian Institute of Technology Patna)

## [01251] Integral Equations Techniques for Floating Flexible Membrane

**Session Time & Room** : 1C (Aug.21, 13:20-15:00) @F311

**Type** : Contributed Talk

**Abstract** : Scattering of obliquely incident gravity waves by a horizontal floating flexible porous membrane in the water of finite depth having a variable bottom bed is analyzed. A coupled eigenfunction expansion - boundary element method is used for the solution purpose. The effect of sinusoidally varying bottom topography, membrane porosity and heading angle of the incident wave on the Bragg resonance is analyzed.

**Classification** : 45B05, 76B15, Integral Equations

**Format** : Talk at Waseda University

**Author(s)** : SANTANU KOLEY (Birla Institute of Technology and Science - Pilani, Hyderabad Campus)

## [01254] Fast SVD-Preconditioned Eigensolver for 3D Phononic Crystals

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @E603

**Type** : Contributed Talk

**Abstract** : In this talk, a Fast Linear Elastic Eigenvalue Problem Solver (FLEEPS) is developed to calculate band structures of 3D isotropic phononic crystals. FLEEPS is an iterative eigensolver of quasi-linear complexity to compute the smallest few eigenvalues of the linear elastic eigenvalue problem. The weighted SVD-preconditioned CG method in FLEEPS convergences faster than the AMG-preconditioned CG method by more than 60 times. Band structure calculations of several 3D isotropic phononic crystals demonstrate the strengths of FLEEPS.

**Classification** : 65F15, 74E10, 74E15

**Format** : Talk at Waseda University

**Author(s)** : Tiexiang Li (Southeast University)Heng Tian (Sichuan University of Science and Engineering)Xing-Long Lyu (Southeast University)Wen-Wei Lin (National Yang Ming Chiao Tung University)

## [01271] Localized and degenerate controls for the incompressible Navier--Stokes system

**Session Time & Room** : 2E (Aug.22, 17:40-19:20) @F412

**Type** : Contributed Talk

**Abstract** : This talk concerns the global approximate controllability of incompressible Newtonian fluids driven by a physically localized and degenerate interior control. By introducing transported Fourier modes as building blocks, we act on the planar Navier--Stokes system via four scalar controls that depend only on time and appear as coefficients in an effectively constructed driving force supported in a given subdomain. The four unknown parameters can be computed by merely solving a linear transport controllability problem.

**Classification** : 35Q30, 35Q49, 76B75, 93B05, 93B18

**Format** : Talk at Waseda University

**Author(s)** : Manuel Rissel (New York University Shanghai)Vahagn Nersesyan (New York University Shanghai)

## [01286] Radiation effect of ND–Ni nanocomposite, water-filled multiport cavity

**Session Time & Room** : 2D (Aug.22, 15:30-17:10) @D404

**Type** : Contributed Talk

**Abstract** : The control of the thermal radiation influence on free convection of a multiple-port open cavity packed with water supported nanocomposite nanofluid is investigated numerically . One inlet port and two outlet ports are situated on the perpendicular walls. The remaining cavity walls are adiabatic. The heated thin baffle is located inside the cavity. The cavity is crammed with the water-supported nanodiamond–nickel nanocomposite. The governing Navier–stokes equations are written in the term of vorticity stream function transport. An ADI scheme-based finite difference process is used for discretization of the governing equations. The results are discussed graphically with the various parameters of radiation parameter, Reynolds number, Rayleigh number, solid volume fraction, widths of the opening, and locations of baffle position. It reveals that the average heat transfer rate reduces with the baffle placed far from the inlet.

**Classification** : 76Sxx, 76Rxx, 76Mxx

**Format** : Talk at Waseda University

**Author(s)** : muthtamilselvan murugan (Bharathiar university)

## [01288] A WENO-Based Scheme for Simulating Miscible Viscous-Fingering Instability in Highly Convection-Dominated Regimes

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @E703

**Type** : Contributed Talk

**Abstract** : We develop a Diffuse interface numerical method that simulates the miscible Viscous-Fingering instability in highly convection-dominated regimes (Péclet number  $> 10000$ ). The developed finite volume scheme uses a two-point flux approximation (TPFA) for Darcy law and a fifth-order Weighted Essentially Non-Oscillatory(WENO) approximation for the convection term of the transport equation. The details of the numerical scheme and simulation results that agree excellently with existing numerical or experimental data will be discussed in this talk.

**Classification** : 65Mxx, 35Qxx, 76Dxx, 76Sxx, 76Rxx

**Author(s)** : Surya Narayan Maharana (Indian Institute of Technology Ropar)Manoranjan Mishra (Indian Institute of Technology Ropar, India)

## [01299] Mathematical modelling of peristaltic driven two-layered catheterized oesophagus

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @D514

**Type** : Contributed Talk

**Abstract** : An analytical mathematical model for two-layered catheterized oesophagus is presented in the wave-frame. We take due care to conserve the fluids separately. A linear relationship between pressure and flow rate is discovered for catheterized oesophagus. Pressure and flow rate rise in the presence of a catheter with thinner peripheral layer. So it can be suggested that no patient should be fed anything directly through mouth once a catheter has been inserted into the oesophagus.

**Classification** : 92C10, 92-10, 35G20, 35G60, 92C35, Biomechanics

**Format** : Talk at Waseda University

**Author(s)** : ANUPAM KUMAR PANDEY (Indian Institute of Technology (BHU), Varanasi)Sanjay Kumar Pandey (Indian Institute of Technology (BHU), Varanasi)

## [01303] Partially Mixed Cooperative Strategies in Evolutionary Games on Networks

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @D502

**Type** : Contributed Talk

**Abstract** : Cooperation is fundamental for the development of human societies. Different approaches have been proposed to explain the emergence of cooperation or partial cooperation in populations of individuals playing classical types of games. In this talk, we analyze the emergence of a new kind of cooperation, where we have a set of full cooperators and one of the partial ones, for the classical games. We prove conditions for Nash equilibria to be asymptotically stable.

**Classification** : 91CXX

**Format** : Online Talk on Zoom

**Author(s)** : Jean Carlo Moraes (Universidade Federal do Rio Grande do Sul)

## [01309] Deep Learning Methods for BSDEs/PDEs in Finance

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @E506

**Type** : Contributed Talk

**Abstract** : In this work we present both a multistep deep learning method with automatic differentiation for the resolution of nonlinear PDEs and BSDEs and an adaptation of the Deep BSDE method for Quadratic BSDE and HJB equations. An approximation error result and error rate is proved for the schemes when using a class of networks with sparse weights. Applications to finance including CVA, portfolio optimisation under exponential utility and options pricing will be presented.

**Classification** : 65Cxx, 65Nxx, 60Hxx, 91Gxx, 68T07

**Format** : Talk at Waseda University

**Author(s)** : Daniel Bussell (UCL)

## [01333] Development of Dynamical Systems-Inspired Metrics to Evaluate Immunotherapy Efficacy

**Session Time & Room** : 1C (Aug.21, 13:20-15:00) @

**Type** : Industrial Contributed Talk

**Abstract** : Immunotherapy emerged as the new paradigm to treat cancer patients. Computational tools that complement clinical practice are increasingly being used. Standardization of these tools is crucial for their adaptation and widespread implementation. This work contributes in this direction by developing new metrics inspired from dynamical systems and enriching a modular platform that predicts therapeutic issues of combination therapies in immune-oncology, and reduce the burden on clinical trials.

**Classification** : 92C32, 92C42, Quantitative Systems Pharmacology

**Author(s)** : Fahima Nekka (Université de Montréal)Didier Zugaj (Syneos Health)Frédérique Fenneteau (Université de Montréal)Miriam Schirru (Université de Montréal)Hamza Charef (Université de Montréal)Khalil-Elmehdi Ismaili (Université de Montréal)Pierre-Olivier Tremblay (Syneos Health)

## [01340] Mathematical finance without probability

**Session Time & Room** : 1C (Aug.21, 13:20-15:00) @D514

**Type** : Contributed Talk

**Abstract** : We present a non-probabilistic, pathwise approach to continuous-time finance based on causal functional calculus. We introduce a definition of self-financing, free from any integration concept and show that the value of a self-financing portfolio is a pathwise integral and that generic domain of functional calculus is inherently arbitrage-free. We then consider the problem of hedging a path-dependent payoff across a generic set of scenarios. We apply the transition principle of Isaacs in differential games and obtain a verification theorem for the optimal solution, which is characterised by

a fully non-linear path-dependent equation. For the Asian option, we obtain explicit solution.

**Classification** : 91G99, 91-10, Mathematical finance in continuous-time, model uncertainty

**Format** : Talk at Waseda University

**Author(s)** : Henry Chiu (Imperial College London)

## **[01345] Novel Lyapunov-type Inequality Involving Riesz Fractional Derivative**

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @G401

**Type** : Contributed Talk

**Abstract** : In this work, we obtained necessary condition for the existence of solutions to a fractional boundary value problem involving Riesz fractional derivative, which is defined as a two-sided fractional operator. The approach proposed in this work is based on the reduction of the problem considered to a singular integral equation, then we derive the Lyapunov-type inequalities in a weighted Lebesgue space.

**Classification** : 34B10, 34B16, 34B18

**Format** : Talk at Waseda University

**Author(s)** : Rabah Khaldi (Badji Mokhtar Annaba University)Assia Guezane Laakoud (Badji Mokhtar Annaba University)

## **[01348] Existence and nonexistence of solutions of thin-film equations with variable exponent spaces**

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @G404

**Type** : Contributed Talk

**Abstract** : This works aims at presenting a thin film problem involving variable exponent sources in a bounded domain. Which deals with the existence and nonexistence of solutions under subcritical initial energy. Also determine the global existence of solutions, exponential decay and finite time blow-up of solutions under specific conditions for the proposed model.

**Classification** : 35B44, 35D30, 35K70

**Format** : Talk at Waseda University

**Author(s)** : GNANAVEL Soundararajan (Central University of Kerala)GNANAVEL SUNDARARAJAN (Central University of Kerala)

## **[01358] Compartment Models for Ideas on Social Media Networks**

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @D505

**Type** : Contributed Talk

**Abstract** : The concept of virality and the structure of social media networks lend themselves to the use of SIR-like compartment models to study the spread of ideas between users on these platforms. This talk introduces the USBA - Unexposed, Sending, Bored, and Acclimated - family of discrete compartment models as a means of simulating how ideas reach and affect users and change the network structure, leading to the formation of echo chambers and polarization in sentiment.

**Classification** : 91D30, 91D10, 34C60, Internet Studies

**Format** : Online Talk on Zoom

**Author(s)** : Adam Mark Furman (University of Oxford Mathematical Institute)

## [01362] Nanoparticle Shape Effect On a Sodium–Alginate Based Cu–nanofluid Under a Transverse Magnetic Field

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @D404

**Type** : Contributed Talk

**Abstract** : Sodium-alginate based nanofluids represent a new generation of fluids with improved performances in terms of heat transfer. This work examines the influence of the nanoparticle shape on a non-Newtonian viscoplastic Cu–nanofluid pertaining to this category. In particular, a stretching/shrinking sheet subjected to a transverse magnetic field is considered. The proposed Cu–nanofluid consists of four different nanoparticles having different shapes, namely bricks, cylinders, platelets, and blades dispersed in a mixture of sodium alginate with Prandtl number  $Pr = 6.45$ . Suitable similarity transformations are employed to reduce non-linear PDEs into a system of ODEs and these equations and related boundary conditions are solved numerically by means of a Runge–Kutta–Fehlberg method. Moreover, analytical solutions are obtained through the application of a MAPLE built-in differential equation solver "Dsolve". The behavior of prominent parameters against velocity and temperature is analyzed. It is found that the temperature increases for all shapes of nanoparticles with the viscoplastic parameter and the Eckert number.

**Classification** : 80A05, Nanofluid

**Format** : Talk at Waseda University

**Author(s)** : ABID HUSSANAN (University of Education, Lahore, Pakistan)

## [01364] Time-Delay Systems: An Overview

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @A601

**Type** : Contributed Talk

**Abstract** : Time-delay naturally arises in many real-world systems, due to the fact that the instantaneous rate of change of such systems does not only depend on their current time but rather on their previous history as well. Hence, time-delays are ubiquitous, their introduction often leads to suppression of oscillations, multistability and chaotic motion in the dynamical systems. This talk presents some models with different kinds of time-delays such as discrete, distributed and combination of both discrete and distributed time-delays with special emphasis on the reason of incorporating such delays into the system

**Classification** : 92-10, 34D20

**Format** : Talk at Waseda University

**Author(s)** : Bootan Rahman (University of Kurdistan Hewler (UKH))

## [01365] Non symmetric discontinuous Galerkin method for fractional differential equations

**Session Time & Room** : 3D (Aug.23, 15:30-17:10) @E604

**Type** : Contributed Talk

**Abstract** : We study discontinuous Galerkin method for non-autonomous TF-ADR initial boundary value problems (IBVPs) with time fractional derivative of Caputo type. Recently, many efforts have been made to develop effective numerical methods for solving time-fractional problems. One of the typical direct numerical methods is the L1-Scheme, which can be viewed as a piecewise linear approximation to the fractional derivative. We used the classical L1-schemes for time discretization and discontinuous Galerkin method for space variable. Error bounds are established in the discrete energy norm. Finally, the convergence result is verified numerically.

**Classification** : 65M12, 65M15, 65M60

**Format** : Talk at Waseda University

**Author(s)** : GAUTAM SINGH (NIT TIRUCHIRAPPALLI)

## [01371] A mixed element scheme of Helmholtz transmission eigenvalue problem for anisotropic media

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @E603

**Type** : Contributed Talk

**Abstract** : In this paper, we study the Helmholtz transmission eigenvalue problem for inhomogeneous anisotropic media in two and three dimension. Starting with a nonlinear fourth order formulation established by Cakoni, Colton and Haddar in 2009, by introducing some auxiliary variables, we present an equivalent mixed formulation for this problem, followed up with the finite element discretization. Using the proposed scheme, we rigorously show that the optimal convergence rate for the transmission eigenvalues both on convex and nonconvex domains can be expected. Moreover, by this scheme, we will obtain a sparse generalized eigenvalue problem whose size is so demanding even with a coarse mesh that its smallest few real eigenvalues fail to be solved by the shift and invert method. We partially overcome this critical issue by deflating the almost all of the  $\infty$  eigenvalue of huge multiplicity, resulting in a drastic reduction of the matrix size without deteriorating the sparsity. Extensive numerical examples are reported to demonstrate the effectiveness and efficiency of the proposed scheme.

**Classification** : 65F15, 65M60, 65N25, 78M10

**Format** : Talk at Waseda University

**Author(s)** : Qing Liu (School of Mathematics, Southeast University)Tiexiang Li (School of Mathematics, Southeast University)Shuo Zhang (Academy of Mathematics and System Sciences, Chinese Academy of Sciences)

## [01384] Adaptive coupling method for multi-domain time integration for lithium-ion battery simulations

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @E702

**Type** : Contributed Talk

**Abstract** : The multiphysics and multiscale problem of simulating lithium-ion batteries at microscale is approached with a multi-domain time integration technique. The sub-domains of the electrolyte and the solid phase are simulated independently and coupled at certain interval. We obtain the adaptive coupling interval based on the error estimate evaluated on the Butler-Volmer current density flux at the interface between the electrolyte and solid domains. The results are presented to discuss the computational benefits of such schemes.

**Classification** : 65M22, 65M12, 65Y99, 65Z05

**Format** : Online Talk on Zoom

**Author(s)** : Ali ASAD (CMAP, Ecole Polytechnique)Romain de Loubens (TotalEnergies One Tech)Laurent François (ONERA, DMPE)Laurent Séries (CMAP, Ecole Polytechnique)Marc Massot (CMAP, Ecole Polytechnique)

## [01389] Exponential Behavior of Nonlinear Stochastic Partial Functional Equations Driven by Poisson Jumps and Rosenblatt Process

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @G702

**Type** : Contributed Talk

**Abstract** : In this paper, we discuss the asymptotic behavior of mild solutions of nonlinear stochastic partial functional

equations driven by Poisson jumps and the Rosenblatt process in a Hilbert space. The Rosenblatt process is the simplest non-Gaussian Hermite process. It has continuous non-differentiable paths and is self-similar with stationary increments. It is Murray Rosenblatt who first conceived of it. The results are obtained by using the Banach

fixed point theorem and the theory of resolvent operator developed by Grimmer. Finally, an example is provided



to illustrate the effectiveness of the obtained results.

**Classification** : 35R60, 60H15, Stochastic Differential Equations

**Format** : Talk at Waseda University

**Author(s)** : Anguraj Annamalai (PSG College of Arts & Science, Coimbatore, Tamil Nadu, India)

## [01390] Neural Operator for Multidisciplinary Engineering Design

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @G501

**Type** : Contributed Talk

**Abstract** : Deep learning surrogate models have shown promise in solving PDEs, which enable many-query computations in science and engineering. In this talk, I will first introduce a geometry-aware Fourier neural operator (Geo-FNO) to solve PDEs on arbitrary geometries, inspired by adaptive mesh motion and spectral methods. Furthermore, we study the cost-accuracy trade-off of different deep learning-based surrogate models, following traditional numerical error analysis. Finally, we demonstrate our approach on challenging engineering design problems.

**Classification** : 35C99, 65M99, 65Z05, 68T07

**Format** : Talk at Waseda University

**Author(s)** : Daniel Zhengyu Huang (Caltech)Andrew M. Stuart (Caltech)Elizabeth Qian ( Georgia Tech)Maarten de Hoop (Rice University)

## [01391] Defect reconstruction in waveguides using resonant frequencies

**Session Time & Room** : 1E (Aug.21, 17:40-19:20) @D405

**Type** : Contributed Talk

**Abstract** : This talk aims at introducing a new multi-frequency method to reconstruct width defects in waveguides. Different inverse methods already exist, but those methods are not using some frequencies, called resonant frequencies, where propagation equations are known to be ill-conditioned. Since waves seem very sensible to defects at these particular frequencies, we exploit them instead. Given partial wavefield measurements, we reconstruct slowly varying width defects in a stable way and provide numerical comparisons with existing methods.

**Classification** : 78A46, 35B34

**Format** : Talk at Waseda University

**Author(s)** : Angèle Niclas (CMAP - École Polytechnique )

## [01392] Solving a fractional pantograph delay equation

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @G401

**Type** : Contributed Talk

**Abstract** : We study a pantograph delay equation involving a fractional derivative. Our approach relies basically on the reduction of the considered problem to an equivalent integral equation, then by using fixed point theorems, we prove the existence results. We also discussed the fractional Ambartsumian differential equation, that describes in the classical case the absorption of light by the interstellar matter.

**Classification** : 34B05, 26A33, 34A30

**Format** : Online Talk on Zoom

**Author(s)** : Assia Guezane Laakoud (Badji Mokhtar Annaba University)Rabah Khaldi (Badji Mokhtar Annaba University)

## [01393] Generalized Mittag-Leffler Functions and Its Rational Approximations with Real Distinct Poles

**Session Time & Room** : 1E (Aug.21, 17:40-19:20) @G402

**Type** : Contributed Talk

**Abstract** : Mittag-Leffler functions are indispensable in the theory of fractional calculus and many other applications in engineering. However, their computational complexities have made them difficult to deal with numerically. A real distinct pole rational approximation of the two-parameter Mittag-Leffler function is proposed. Under some mild conditions, this approximation is proven and empirically shown to be L-Acceptable. These approximations are especially useful in developing efficient and accurate numerical schemes for partial differential equations of fractional order. Some applications are presented, such as complementary error function and solution of fractional differential equations.

**Classification** : 33B10, 41A20, 65L05

**Author(s)** : Olaniyi Samuel Iyiola (Clarkson University)

## [01416] Autonomous controllers for a Swarm of UAVs

**Session Time & Room** : 1E (Aug.21, 17:40-19:20) @F401

**Type** : Contributed Talk

**Abstract** :

Self-organization patterns emerge in biological swarms' due to collective interactions from their individuals. This paper presents a set of novel autonomous controllers of the individuals of a swarm of planar unmanned aerial vehicles for the MPC problem. The stabilizing continuous nonlinear controllers of the UAVs gives rise to diverse pattern formation due to the communication that occurs amongst an individual and its neighbors. The controllers' effectiveness is illustrated through computer and numerical simulations.

**Classification** : 93-XX, 93-10, 93Dxx, 93D05

**Author(s)** : Sandeep Ameet Kumar (School of Information Technology, Engineering, Mathematics and Physics, The University of the South Pacific)

## [01418] Non-linear Particle Swarm Optimization Algorithm for Non-linear Fixed-charge Transportation Problems

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @D505

**Type** : Industrial Contributed Talk

**Abstract** : The non-linear fixed-charge transportation problems are one of the challenging NP-hard problems. Hence, a new non-linear particle swarm optimization algorithm (NPSO) with new inertia weight and acceleration coefficients have been introduced that not only explores the search space but also maintains the feasibility condition of the transportation problem. The performance of the proposed NPSO is compared with its existing variants. Also, some benchmarks problems from the literature have been solved and the results are compared.

**Classification** : 90B06, 90C30, 90C90, 90C06

**Format** : Talk at Waseda University

**Author(s)** : Shivani Saini (Dr B R Ambedkar National Institute of Technology Jalandhar (INDIA))Deepika Rani (Dr B R Ambedkar National Institute of Technology Jalandhar (INDIA))

## [01420] A stochastic solution to inverse problems in thermo-fluid problems

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @D401

**Type :** Contributed Talk

**Abstract :** Inverse problems find their applications in various thermo-fluid systems. The present work aims to develop a computational framework using fast Bayesian inference, which leads to forward uncertainty propagation in various thermo-fluid models and solves the corresponding inverse problems. The framework leverages the polynomial chaos expansions (PCEs) to generate a computationally efficient and statistically equivalent surrogate model of the computationally expensive forward model and dimensionality reduction based on Karhunen-Loeve (K-L) expansion.

**Classification :** 76M21, 80A23, 86A22

**Format :** Online Talk on Zoom

**Author(s) :** SUFIA KHATOON (Indian Institute of Technology Delhi)

## **[01434] Pointwise adaptive finite element method for the elliptic obstacle problem**

**Session Time & Room :** 1C (Aug.21, 13:20-15:00) @D514

**Type :** Contributed Talk

**Abstract :** In this talk, I will discuss pointwise a posteriori error analysis of a finite element method for the obstacle problem. The reliability and the efficiency of the proposed a posteriori error estimator will be discussed. In the analysis, sign property of Lagrange multipliers, Green's function estimates and the barrier functions play a crucial role. The construction of the barrier functions is based on appropriate corrections of the conforming part of the solution obtained via an enriching operator. The use of the continuous maximum principle guarantees the validity of the analysis without mesh restrictions but shape regularity. Numerical results will be presented to illustrate the performance of a posteriori error estimator.

**Classification :** 65N15, 65N30

**Format :** Talk at Waseda University

**Author(s) :** Kamana Porwal (Indian Institute of Technology Delhi, New Delhi)

## **[01435] Automatic generation of terrain maps using sequences of satellite images**

**Session Time & Room :** 3C (Aug.23, 13:20-15:00) @E504

**Type :** Contributed Talk

**Abstract :** In this work, we propose an unsupervised methodology for analyzing temporal sequences of satellite images. Images decompose into disjoint tiles, and we embed sequences of tiles into multidimensional time series. The proposed embedding captures valuable information about the terrain and its evolution. It allows the partitioning of the ground into different types of terrain and understanding of the relationship between them. The proposed methodology shows promising results when analyzing a region of Navarre, Spain.

**Classification :** 62H35

**Format :** Talk at Waseda University

**Author(s) :** Aritz Pérez (Basque Center for Applied Mathematics) Carlos Echegoyen (Public University of Navarre) Guzmán Santafé (Public University of Navarre) Unai Pérez (Public University of Navarre) María Dolores Ugarte (Public University of Navarre)

## **[01452] Some Statistical Properties and Maximum Likelihood Estimation of Parameters of Bivariate Modified Weibull Distribution with its Real-Life Applications**

**Session Time & Room :** 3E (Aug.23, 17:40-19:20) @E504

**Type :** Contributed Talk

**Abstract :** Real-life data sets with ties arise quite commonly in medicine, industry, reliability and survival analysis. We attempt to model such types of data sets using bivariate distributions with singular components. For this purpose, we consider mainly two types of approaches, namely the "Minimization approach" and the "Maximization approach." Using the minimization approach the bivariate modified Weibull (BMW) distribution is derived. Due to five parameters, the BMW is a more general and flexible distribution. It reduces to the Marshall-Olkin bivariate exponential (MOBE) and Marshall-Olkin bivariate Weibull (MOBW) distributions under certain parameter restrictions. Some distributional, modal and aging properties of BMW will be discussed. The copula associated with BMW distribution is given. Finally, we will discuss the maximum likelihood estimation of parameters of BMW distribution via the EM algorithm. We will give some numerical results of a real-life data set with ties.

**Classification :** 62Nxx, Mainly to developed models to analyze real life bivariate data sets where the ties occur naturally in the data sets. The data may be censored . Such type of models are known as Bivariate distributions with singular component.

**Format :** Talk at Waseda University

**Author(s) :** Sanjay Kumar (Ph.D. Student, Department of Mathematics & Statistics, Indian Institute of Technology Kanpur)Debasis Kundu (Professor, Department of Mathematics & Statistics, Indian Institute of Technology Kanpur)Sharmishtha Mitra (Professor, Department of Mathematics & Statistics, Indian Institute of Technology Kanpur)

## [01463] Chemical Signalling and Pattern Formation in Predator-Prey Models

**Session Time & Room :** 4C (Aug.24, 13:20-15:00) @A601

**Type :** Contributed Talk

**Abstract :** Random movement of species is well documented to put forward Turing instability in predator-prey models . On the other hand recent studies suggest that directed movement of species known as direct taxis leads to stabilization of steady state and no patterns emerge. However the importance of chemical cues in predator-prey interactions is still a topic of contention among ecologists. Source of chemicals to which prey species respond often originate as cues released by the predators which lead to directed movement of prey individuals opposite to the concentration of chemicals. This movement of prey individuals opposite to the gradient of chemical is known as indirect predator taxis. This talk will introduce an advection-reaction-diffusion mathematical model to understand the impact of chemical induced anti-predation defense in a special class of predator-prey system. The reaction part considers Schoener's model of intraguild-predation which has no periodic solution. We will discuss uniqueness and existence of classical solutions, linear stability analysis results and conditions for the pattern formation. We will show that random diffusion forces constant steady state to be stable and only directed movement of prey individuals has ability to destabilizes the constant steady state and spatio-temporal patterns emerge. We numerically show emergence of spatio-temporal patterning that depicts the tendency to spatio-temporal separation between prey and predators.

**Classification :** 92B05, Mathematical Biology, Partial Differential Equations

**Format :** Online Talk on Zoom

**Author(s) :** Purnedu Mishra (Norwegian University of Life Sciences Norway)Prof. Darius Wrzosek (Norwegian University of Life Sciences)

## [01472] The Arithmetic Mean iterative methods for solving brain glioma growth models

**Session Time & Room :** 1C (Aug.21, 13:20-15:00) @F310

**Type :** Contributed Talk

**Abstract :** Brain tumour is the uncontrolled growth of normal brain cells and most malignant form is known as glioma. In this work, the formulation and implementation of the Arithmetic Mean iterative methods for solving glioma growth models are presented. Numerical results and convergence analysis are included to verify the performance of the proposed methods.

**Classification :** 41A55, 45A05, 45B05, 65D32, 65F10

**Format** : Talk at Waseda University

**Author(s)** : Mohana Sundaram Muthuvalu (Universiti Teknologi PETRONAS)Jumat Sulaiman (Universiti Malaysia Sabah)Elayaraja Aruchunan (Universiti Malaya)Majid Ali (Universiti Sains Malaysia)Ramoshweu Solomon Lebelo (Vaal University of Technology)

## **[01477] Optimization of a submerged piezoelectric device using an ANN Model**

**Session Time & Room** : 3D (Aug.23, 15:30-17:10) @E811

**Type** : Contributed Talk

**Abstract** : The design of a submerged piezoelectric wave energy converter (PWEC) device has been analyzed to optimize the power generated by the PWEC device. An artificial neural network (ANN) is adopted to optimize the geometric parameters of the device. First, a numerical model is introduced using the boundary element methodology (BEM). The input database for the modeling of the ANN model is generated using the Latin Hypercube Sampling method, and the output database for the modeling of the ANN model is simulated using the numerical model based on BEM. Four hundred samples are used to model the ANN with data taken in a 70:30 ratio for training and validation of the model. The prediction of the optimal parameter values for the design of the PWEC device is carried out using a database containing 3000 sample points generated randomly using the LHS method. The developed ANN model shows a good agreement between the training accuracy and the validation accuracy. Also, the model forecast provides a range for the geometric parameters of the PWEC device to optimize power generation.

**Classification** : 68T07, 68T20, 68V99

**Format** : Talk at Waseda University

**Author(s)** : Vipin V (Birla Institute of Technology and Science Pilani, Hyderabad Campus)SANTANU KOLEY (Dept.of Mathematics, Birla Institute of Technology and Science - Pilani, Hyderabad Campus)

## **[01478] Water wave interaction with porous wave barriers placed over stepped-seabed.**

**Session Time & Room** : 1C (Aug.21, 13:20-15:00) @F311

**Type** : Contributed Talk

**Abstract** : This study examines the dispersion of water waves by inverted semicircular surface-piercing wave barriers installed on a stepped seabed. The “Boundary element method” is applied to handle the present “Boundary value problem”. In addition to this energy identity is derived to estimate the dispersion of wave energy by the pair of perforated wave barriers. In addition, the influence of porosity, geometrical configurations of pair of porous barriers, and stepped seabed on the energy dissipation are investigated. The study reveals that for smaller Keulegan-Carpenter (KC) number, the “energy dissipation” due to the perforated barriers is higher. However, the reflection coefficient shows the opposite pattern.

**Classification** : 45B05, 45G15, 45F05

**Format** : Online Talk on Zoom

**Author(s)** : SANTANU KUMAR DASH (Birla Institute of Technology and Science-Pilani, Hyderabad campus)SANTANU KOLEY (Birla Institute of Technology and Science - Pilani, Hyderabad Campus)

## **[01479] Water wave trapping by porous barriers using boundary element method.**

**Session Time & Room** : 1C (Aug.21, 13:20-15:00) @F311

**Type** : Contributed Talk

**Abstract** : This study examines the dispersion of water waves by inverted semicircular surface-piercing wave barriers installed on a stepped seabed in presence of a rigid wall in the right far-field boundary. The boundary element method is applied to handle the present boundary value problem. In addition, the energy identity is derived to estimate wave energy dispersion by the pair of perforated wave barriers.

The influence of porosity, geometrical configurations of pair of porous barriers, and stepped seabed on the energy dissipation are investigated. The study reveals that for smaller Keulegan-Carpenter (KC) number, the energy dissipation due to the perforated barriers is higher. However, the reflection coefficient shows the opposite pattern.

**Classification** : 45B05, 45G15, 45F05

**Format** : Online Talk on Zoom

**Author(s)** : KAILASH CHAND SWAMI (Birla Institute of Technology & Science-Pilani, Hyderabad Campus) SANTANU KOLEY (Birla Institute of Technology and Science - Pilani, Hyderabad Campus)

## **[01489] Mathematical modelling of hybrid wave energy converter device**

**Session Time & Room** : 1C (Aug.21, 13:20-15:00) @F311

**Type** : Contributed Talk

**Abstract** : The hydrodynamics of a hybrid wave energy converter device is investigated. For the sake of mathematical modeling, the associated boundary value problem is converted into a system of Fredholm integral equations and solved using the boundary element method. To incorporate the higher order plate boundary condition, central difference scheme is used. Primary emphasis is given to analyze the power extraction of the hybrid wave energy converter device for various incident wave parameters associated with the hybrid wave energy converter device.

**Classification** : 45B05, 76B15, 76B07

**Format** : Talk at Waseda University

**Author(s)** : KSHMA TRIVEDI (Birla Institute of Technology and Science-Pilani, Hyderabad campus) SANTANU KOLEY (Birla Institute of Technology and Science-Pilani, Hyderabad campus)

## **[01490] RANS modelling of OWC device over the sloping seabed**

**Session Time & Room** : 2C (Aug.22, 13:20-15:00) @D401

**Type** : Contributed Talk

**Abstract** : The hydrodynamics of the oscillating water column device placed over the sloping seabed under the influence of irregular incident waves is studied. Reynolds-Averaged Navier-Stokes equations (RANS) with a modified  $k - \omega$  turbulence model was used and the air-water interface was tracked using a volume-of-fluid (VOF) approach. The results demonstrate that the amplitude of the inward and outward velocities via the orifice, free surface elevations, and flow characteristics are greater for higher significant wave heights.

**Classification** : 76D05, 76D33, 76F25

**Format** : Online Talk on Zoom

**Author(s)** : AMYA RANJAN RAY (Birla Institute of Technology and Science, Pilani – Hyderabad Campus) SANTANU KOLEY (Birla Institute of Technology and Science - Pilani, Hyderabad Campus)

## **[01509] Hydromagnetic Hybrid Nanofluid Flow Over a Rotating Stretching Disk**

**Session Time & Room** : 2E (Aug.22, 17:40-19:20) @D405

**Type** : Contributed Talk

**Abstract** : The research aim in this article is to study the effect of magnetic field on the unsteady flow and heat transfer of an incompressible nanofluid due to a rotating disc. In addition, the flow is taken to be in a Darcy-Forchheimer porous medium. The governing set of highly non-linear PDEs are converted into set of highly non-linear ODEs using suitable similarity transformations. The system consisting of non-linear ODEs is numerically solved by the Spectral Quasi Linearization Method (SQLM). The solutions for the local skin friction along the radial direction, local skin friction along tangential direction, and the local heat transfer rate at the surface of the disc for different values of the suitable parameters are also obtained. The results of dimensionless velocity and temperature profiles are shown graphically where the values of local skin-friction coefficients and the heat transfer

coefficients are presented in tabular form. A statistical analysis in the form of regression analysis is also performed to estimate the skin-friction and heat transfer coefficients.

**Classification** : 76W05, 76S05

**Format** : Talk at Waseda University

**Author(s)** : Raj Nandkeolyar (Department of Mathematics, National Institute of Technology Jamshedpur, Jamshedpur) Premful Kumar (Department of Mathematics, National Institute of Technology Jamshedpur, Jamshedpur)

## **[01524] Radon measure solutions to compressible Euler equations and applications**

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @G701

**Type** : Contributed Talk

**Abstract** : We proposed a definition of Radon measure solutions to the compressible Euler equations with general constitutive relations. With this definition, we proved the Newton-Busemann law for stationary hypersonic flow passing bodies, constructed delta shock solutions to the Riemann problems of the rectilinear barotropic Euler equations, justified the interpretation of delta shocks as free pistons. This shows the possibility of treating solid-fluid interaction problems by simpler Cauchy problems with solutions in the class of Radon measures.

**Classification** : 35R06, 35Q31, 35D99

**Format** : Talk at Waseda University

**Author(s)** : Hairong Yuan (East China Normal University) Aifang Qu (Shanghai Normal University)

## **[01539] Actuator fault reconstruction-based tracking control for periodic piecewise polynomial systems**

**Session Time & Room** : 1C (Aug.21, 13:20-15:00) @G501

**Type** : Contributed Talk

**Abstract** : The problem of actuator fault reconstruction and fault-tolerant tracking control for periodic piecewise polynomial systems with time-varying delay is investigated. The observer system is configured with periodic piecewise polynomial character to concurrently reconstruct the actuator faults and states of the system. Based on these configurations, the fault-tolerant tracking control is proposed, which aids in tracking the reference system by compensating the actuator faults. Numerical example is provided to validate the competence of proposed control scheme.

**Classification** : 93CXX, 37MXX, 37N35, 34H05, 34H15

**Author(s)** : Aravinth Narayanan (Bharathiar University) Sakthivel Rathinasamy (Bharathiar University)

## **[01540] Composite Disturbance Rejection and Stabilization for Periodic Control Systems**

**Session Time & Room** : 1C (Aug.21, 13:20-15:00) @F311

**Type** : Contributed Talk

**Abstract** : The stabilization and disturbance rejection issues for periodic control systems with actuator faults and external disturbances are investigated through a proportional integral observer approach. An equivalent-input-disturbance approach is employed to estimate the external disturbances. Moreover, proportional integral observer provides more design freedom and enhances the estimation precision of equivalent-input-disturbance. A periodic time-varying control framework is proposed to guarantee robust performance of the system. The potential of the proposed control design is validated via numerical simulations.

**Classification** : 93CXX, 37MXX, 37N35, 34H05, 34H15

**Author(s)** : Sathesh Thangavel (Bharathiar University) Sakthivel Rathinasamy (Bharathiar University)

## [01542] Bipartite synchronization of complex dynamical networks under hybrid-triggered control

**Session Time & Room** : 1C (Aug.21, 13:20-15:00) @D514

**Type** : Contributed Talk

**Abstract** : The bipartite synchronization problem for multi-weighted complex dynamical networks subject to random coupling delays and external disturbances is investigated. For this, a hybrid-triggered control is incorporated, which in addition, is effective in the reduction of network resource usage guaranteeing the system's performance. And, the external disturbances are attenuated under extended passivity performance. Moreover, the conditions for ensuring the requisite synchronization of undertaken networks are derived. A numerical example is illustrated to validate the results obtained.

**Classification** : 93CXX, 37MXX, 37N35, 34H05, 34H15

**Author(s)** : Birundha Devi Nallamuthu (Bharathiar University)Sakthivel Rathinasamy (Bharathiar University)

## [01544] Unknown Input Observer-based Multiple Faults Reconstruction for Interval Type-2 Fuzzy-Model

**Session Time & Room** : 1D (Aug.21, 15:30-17:10) @A208

**Type** : Contributed Talk

**Abstract** : The prime intent of this study is to resolve the multiple faults reconstruction and state tracking issues for the interval type-2 fuzzy systems subject to actuator and sensor faults by using an active fault-tolerant tracking control law based on an unknown input observer approach. Moreover, a set of sufficient conditions namely linear matrix inequality is derived to ensure the tracking performance of the addressed system. Eventually, the derived theoretical results are verified through numerical examples.

**Classification** : 93CXX, 37MXX, 37N35, 34H05, 34H15

**Author(s)** : Anusuya Sundaram (Bharathiar University)Sakthivel Rathinasamy (Bharathiar University)

## [01546] Input-output Finite-time Stabilization for Parabolic PDE Systems with Semi-Markov Switching

**Session Time & Room** : 1D (Aug.21, 15:30-17:10) @A208

**Type** : Contributed Talk

**Abstract** : A robust reliable boundary control problem for a class of parabolic PDE systems with semi-Markov switching subject to actuator faults, randomly occurring uncertainties and nonlinearities is investigated. Particularly, randomness phenomena are characterized by stochastic variables obeying Bernoulli distribution properties. A boundary controller is developed to ensure the robust performance of the considered system. Sufficient conditions for guaranteeing the input-output finite-time stabilization of the closed-loop system are derived. Proposed method is validated through simulation outcomes.

**Classification** : 93CXX, 37MXX, 37N35, 34H05, 34H15

**Author(s)** : Abinandhitha Radhakrishnan (Bharathiar University)Sakthivel Rathinasamy (Bharathiar University)

## [01548] Quadratically Regularized Bilevel Optimal Transport

**Session Time & Room** : 2C (Aug.22, 13:20-15:00) @F411

**Type** : Contributed Talk

**Abstract** : We study the effect of an  $L^2$  regularization to an optimal control problem that is constrained by the Kantorovich problem of optimal transport. We present a class of possible applications by means of a toy problem. Using a reverse approximation argument, we discuss the approximability of solutions of the unregularized problem by a sequence of solutions of the regularized problems.



**Classification** : 49Q22, 90C08, 49J45

**Format** : Talk at Waseda University

**Author(s)** : Sebastian Hillbrecht (Technische Universität Dortmund)Christian Meyer (Technische Universität Dortmund)Paul Manns (Technische Universität Dortmund)

## **[01550] Stabilization and State Estimation of Semi-Markovian Cyber-Physical Systems via Time-Triggered Control**

**Session Time & Room** : 1D (Aug.21, 15:30-17:10) @F311

**Type** : Contributed Talk

**Abstract** : The issues of input-output finite-time stabilization and state estimation for a class of semi-Markovian switching cyber-physical systems with cyber-attacks are investigated. Primarily, immeasurable states are estimated by designing a mode-dependent observer. Further, based on the observer information, mode-dependent time-triggered controller is developed to ensure that the resultant system is input-output finite-time stable. Finally, the efficacy of proposed result is demonstrated through a numerical example.

**Classification** : 93CXX, 37MXX, 37N35, 34H05, 34H15

**Author(s)** : Panneerselvam Vellingiri (Bharathiar university)Sakthivel Rathinasamy (Bharathiar university)

## **[01551] Observer-based Nonlinear Fault-tolerant Control Design for Fractional-order Parabolic PDE Systems**

**Session Time & Room** : 2C (Aug.22, 13:20-15:00) @G710

**Type** : Contributed Talk

**Abstract** : The problem of robust stabilization for fractional-order parabolic PDE systems with nonlinear actuator faults is considered. The main aim of this work is to design an observer-based nonlinear fault-tolerant controller for obtaining the required results. Then, a set of conditions are derived with the aid of Lyapunov-based approach for the stabilization analysis. Further, the theoretical results are verified through the numerical example with graphical results.

**Classification** : 35R11, 93Dxx, 93Cxx, 37Mxx, 37N35

**Format** : Online Talk on Zoom

**Author(s)** : Sweetha Senthilrathnam (Bharathiar university)Sakthivel Rathinasamy (Bharathiar University)

## **[01564] Extended Observer-based Control for Interval-type-2 Fuzzy Systems Under Event-Triggered Scheme**

**Session Time & Room** : 1D (Aug.21, 15:30-17:10) @F311

**Type** : Contributed Talk

**Abstract** : The problems of disturbance rejection and fault tolerant control for interval-type-2-fuzzy systems are investigated by utilization of a generalized extended state observer. To be specific, the system states along with disturbances and actuator faults are simultaneously reconstructed by the implemented observer. Besides, an observer-based event-triggered scheme is implemented to mitigate the communication burden. Furthermore, the asymptotic stability criteria for the constructed system are formulated. Consequently, the theoretical declarations are authenticated by prevailing numerical simulation results.

**Classification** : 93CXX, 37MXX, 37N35, 34H05, 34H15

**Format** : Online Talk on Zoom

**Author(s)** : Shobana Nagarajan (Bharathiar University)Sakthivel Rathinasamy (Bharathiar University)

## [01573] A novel robust adaptive algorithm for time fractional diffusion wave equation on non-uniform meshes

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @E711

**Type** : Contributed Talk

**Abstract** : In this work, a novel high-order adaptive algorithm on non-uniform grid points for the Caputo fractional derivative is derived. Developed algorithm allows one to build adaptive nature where numerical scheme is adjusted according to behavior of  $\alpha$  to keep errors very small and converge to solution very fast. Analysis of numerical scheme has been established thoroughly. Moreover, a reduced order technique is implemented by using moving mesh refinement to improve accuracy at several time levels.

**Classification** : 65N06, 65N12, 65N50, 65N15

**Format** : Online Talk on Zoom

**Author(s)** : Rahul Kumar Maurya (Government Tilak P.G. College, Katni, Madhya Pradesh, India) Vineet Kumar Singh (Indian Institute of Technology (BHU), Varanasi, India)

## [01579] Boltzmann equation with generalized collisional invariants

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @D402

**Type** : Contributed Talk

**Abstract** : I demonstrate the Boltzmann equation with the generalized collision invariants. We investigate the dissipation process and transport characteristics obtained by such Boltzmann equation with the generalized collision invariants. Such results also imply the characteristics of fluids with anomalous diffusion.

**Classification** : 82Bxx, 93A16

**Format** : Talk at Waseda University

**Author(s)** : Ryosuke Yano (Tokio Marine dR. Co., Ltd.)

## [01580] Fast Summation for the Barotropic Vorticity Equations

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @D401

**Type** : Contributed Talk

**Abstract** : The barotropic vorticity equations describe the conservation of absolute vorticity for a fluid on a rotating sphere. When transformed appropriately, one can rewrite these with a Biot-Savart integral, and with a Lagrangian discretization, one can arrive at a discretized system with an update taking the form of a N-body sum. In this talk, I present a fast summation technique that reduces the asymptotic complexity of this sum from  $\mathcal{O}(N^2)$  to  $\mathcal{O}(N \log N)$  with a new spherical tree code, suitable for a wide range of problems in geophysical fluid dynamics.

**Classification** : 76M28, 76U99, 65M75, 86A08

**Format** : Talk at Waseda University

**Author(s)** : Anthony Chen (University of Michigan, Ann Arbor)

## [01582] Parameter Estimation in Mathematical Models Using Uncertainty and Sensitivity Analyses

**Session Time & Room** : 4C (Aug.24, 13:20-15:00) @G301

**Type** : Contributed Talk

**Abstract** : The accurate estimation of uncertain parameters in a mathematical model is still considered a laborious task. We propose a systematic methodology based on uncertainty and sensitivity analyses framework applied on a dynamic population balance model representing a crystallization process for the precise estimation of model parameters. For models involving many uncertain parameters, the proposed strategy can be adopted to rank parameters by their decreasing importance and then achieve

precise estimation of the more significant parameters.

**Classification** : 00A71, 81S07, 93B35, Parameter Uncertainty, Uncertainty Quantification, Sensitivity Analysis, Population Balance Models

**Format** : Online Talk on Zoom

**Author(s)** : PRIYANKA SEHRAWAT (Indian Institute of Technology Kharagpur)Priyanka Sehrawat (Indian Institute of Technology Kharagpur)Debasis Sarkar (Indian Institute of Technology Kharagpur)Jitendra Kumar (Indian Institute of Technology Ropar)

## [01588] Stable numerical schemes and adaptive algorithms for fractional diffusion-wave equation

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @E603

**Type** : Contributed Talk

**Abstract** : This work develops a stable scheme and adaptive algorithm for time-fractional mathematical models. Developed algorithm allows one to build adaptive nature where numerical scheme is adjusted according to behavior of  $\alpha$  to keep errors very small and converge to solution very fast. Analysis of numerical scheme has been established thoroughly. Moreover, a reduced order technique is implemented by using moving mesh refinement to improve accuracy at several time levels.

**Classification** : 65N06, 65N50, 65N12, 65N15

**Author(s)** : Vineet Kumar Singh (Indian Institute of Technology (BHU), Varanasi, India)Rahul Kumar Maurya (Government Tilak P.G. College, Katni, Madhya Pradesh, India)

## [01592] Optimal blood distribution using a matheuristic approach

**Session Time & Room** : 4D (Aug.24, 15:30-17:10) @D408

**Type** : Contributed Talk

**Abstract** : The problem of distribution of blood has been extensively studied, but models relating to different blood types have not been specifically considered in the literature to the best of our knowledge. This paper describes a new mathematical model for optimising blood distribution in residential areas. A Lagrangian relaxation-based matheuristic is developed to solve the problem. Hypothetical data sets were generated to mimic real blood distribution system in an urban setting. Results obtained using CPLEX solver on the AMPL platform reveal that the model described in this study is able to achieve quality results within very short times. Specifically, the number of located blood facilities is minimized for each problem instances as well as covering much of the demand points on the distribution network. We observe that the proposed system, when compared to the existing system, provides a better approach to blood distribution and is adaptable to related areas of supply chain.

**Classification** : 90C26, 90C27

**Author(s)** : Olawale Joshua Adeleke (Redeemer's University )Olawale Joshua Adeleke (Redeemer's University)Idowu Ademola Osinuga (Federal University of Agriculture, Abeokuta, Nigeria)

## [01599] Theoretical and Experimental Understanding for EMI Shielding and Supercapacitor Applications

**Session Time & Room** : 1C (Aug.21, 13:20-15:00) @

**Type** : Contributed Talk

**Abstract** : The EMI shielding performance and energy storage properties of the  $\alpha$ -MnO<sub>2</sub> SQDs are modulated by incorporating cobalt ions into crystal structure and results are verified through theoretical analysis. All the inherent properties are scrutinised using Reitveld refinement with simulated X-ray and DFT techniques. Besides cDFT/cRPA, PBE generalized GGA+U exchange correlation is used based on FM and different AFM configurations by avoiding SIE. Therefore, this theory can predict the superiority in EMI shielding and supercapacitive performance.

**Classification** : 06Fxx

**Author(s)** : Prof. Sukhen Das (Department of Physics, Jadavpur University)Dr. Dheeraj Mondal

(Department of Physics, Jadavpur University)Dr. Biplab Kumar Paul (University of Engineering and Management)

## [01601] Estimation of the Elementary Chirp Model Parameters

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @G701

**Type** : Contributed Talk

**Abstract** : We propose some estimation techniques to estimate the elementary chirp model parameters. We derive asymptotic properties of least squares estimators (LSEs) and approximate least squares estimators (ALSEs) for the one-component elementary chirp model. We propose sequential LSEs and sequential ALSEs to estimate the multiple-component elementary chirp model parameters and prove that they have the same theoretical properties as the LSEs. We illustrate the performance of the proposed sequential algorithm on a bat data.

**Classification** : 62H12, 62F12

**Format** : Talk at Waseda University

**Author(s)** : Anjali Mittal (Indian Institute of Technology Kanpur)Rhythm Grover (Indian Institute of Technology Guwahati)Debasis Kundu (Indian Institute of Technology Kanpur)Amit Mitra (Indian Institute of Technology Kanpur)

## [01607] AN INVENTORY MODEL WITH PRICE- AND STOCK-DEPENDENT DEMAND

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @D505

**Type** : Contributed Talk

**Abstract** : In this paper, we develop a multi-item inventory model with price- and stock-dependent demand and backorder. The decision variables in the model are the cycle length and the time when inventory drops to zero. The purpose of the model is minimizing the total inventory cost. Comparisons among alternative replenishment policies such as individual order, joint order or combination between these two policies are also considered. Numerical experiments and sensitivity analysis are also given.

**Classification** : 90B05, 91B06, 91B02, Inventory models

**Format** : Talk at Waseda University

**Author(s)** : Dharma Lesmono (Universitas Katolik Parahyangan)Taufik Limansyah (Universitas Katolik Parahyangan)Ignasius Sandy (Universitas Katolik Parahyangan)

## [01621] A Case Study on Multi-objective Fixed-charge Transportation Problem

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @A206

**Type** : Contributed Talk

**Abstract** : This paper investigates a case study in the field of transportation and proposes an approach for the Pareto-optimal solution of the multi-objective fixed-charge transportation problem with real life parameters represented as uncertain numbers. The model includes the knowledge and agreement as well as difference in judgements of all the experts involved. Three approaches, viz, goal programming, weighted-sum method and the fuzzy programming technique are extended using AHP, and the obtained results are analyzed and discussed.

**Classification** : 90C29, 90C70, 90B06, 90-10

**Author(s)** : Deepika Rani (Dr B R Ambedkar National Institute of Technology Jalandhar (INDIA))Shivani Saini (National Institute of Technology Jalandhar (INDIA))

## [01624] MHD free Convection of Casson fluid flow in an Inclined Square Cavity with Moving upper wall

**Session Time & Room** : 5B (Aug.25, 10:40-12:20) @D101

**Type** : Contributed Talk

**Abstract** : We have studied the natural convection of Casson fluid in a partially heated, inclined porous square cavity in the presence of external inclined magnetic field and viscous dissipation. In addition to these, it is assumed that the upper wall of the cavity is moving. We have used higher order Galerkin finite element method to solve the system of governing equations. Moreover, a comparative study for effects of various physical parameters has been done.

**Classification** : 76A05, 76D05, 76M10, 76S05, 76W05

**Format** : Online Talk on Zoom

**Author(s)** : Ram Dhan Mahla (University of Rajasthan) Sharad Sinha (University of Rajasthan Jaipur )

## [01629] Constructive approaches for the controllability of semi-linear heat and wave equations

**Session Time & Room** : 4D (Aug.24, 15:30-17:10) @G602

**Type** : Contributed Talk

**Abstract** : We addresses the controllability of the semi-linear heat equation  $\partial_t y - \partial_{xx} y + f(y) = 0$ ,  $x \in (0,1)$ . Assuming that the function  $f$  is  $C^1$  over  $\mathbb{R}$  and  $\limsup_{|r| \rightarrow \infty} \frac{|f'(r)|}{\ln^{3/2}|r|} \leq \beta$  for some  $\beta > 0$  small enough, we show that a fixed point application related to a linearized equation is contracting yielding a constructive method to approximate boundary controls for the semi-linear equation. Similar ideas are used to address the controllability for semi-linear wave type equations.

**Classification** : 35K58, 93B05

**Format** : Talk at Waseda University

**Author(s)** : Arnaud Munch (Clermont Auvergne University)

## [01630] Analysis of blood flow through multiple stenoses in a narrow artery

**Session Time & Room** : 4C (Aug.24, 13:20-15:00) @A601

**Type** : Contributed Talk

**Abstract** : A study of the effects of blood flow parameters in narrow arteries having multiple stenoses is made here, where the blood is considered as a non-Newtonian Kuang-Luo (K-L) fluid model, with no-slip conditions at the arterial wall. In fact, the main properties of K-L fluid model are that the plasma viscosity and yield stress play a very important role. These parameters make this fluid remarkably similar to blood, however, when we change these parameters the flow characteristics change significantly. We have derived a numerical expression for the blood flow characteristics such as resistance to blood flow, blood flow rate, axial velocity, and skin friction. These numerical expressions have been solved by MATLAB 2021 software and discussed graphically. Furthermore, these results have been compared with Newtonian fluid and observation made that resistance to blood flow and skin friction is decreased when blood is changed from non-Newtonian to Newtonian fluid.

**Classification** : 92B05, 92C30, 76Z05

**Format** : Talk at Waseda University

**Author(s)** : Sanjeev Kumar (Dr. Bhimrao Ambedkar University, Agra) Rashmi Sharma (Dr. Bhimrao Ambedkar University) Amendra Singh (Dr. Bhimrao Ambedkar University)

## [01634] Mimetic schemes applied to the convection diffusion equation: A numerical comparison.

**Session Time & Room** : 2D (Aug.22, 15:30-17:10) @E702

**Type** : Contributed Talk

**Abstract** : Mimetic Finite Difference Schemes (DFM) are increasingly present in the numerical resolution of transient problems [1] since they are more precise than traditional Finite Difference (DF) schemes. However, there are methods in DF that use appropriate combinations of schemes in different nodes in order to eliminate the numerical spread of the method, [2]. In these cases, DF methods are more accurate than DFM. In this work, we start from the equation of convection-diffusion of an incompressible fluid

$$\partial u / \partial t + v \cdot \nabla u = \nabla \cdot (K \nabla u), \quad (1)$$

where  $u(x, t)$  represents the unknown of the problem,  $v(x, t)$  is the velocity,  $K$  is the diffusion tensor, and DFM is defined that eliminates the numerical diffusion presented by traditional DFM schemes. To measure the effectiveness of the mimetic schemes, for different configurations of (1), they are compared with the equivalent schemes in DF with the same order of precision as the DFM; for this purpose, the second-order schemes proposed by [2, 3] are taken. Finally, different comparisons are made to verify the results obtained by the given schemes.

References:

[1] Castillo J. and Grone R.D. A matrix analysis approach to higher-order approximations for divergence and gradients satisfying a global conservation law. SIAM J. Matrix Anal. Appl., 25(1):128–142, 2003.

[2] Mehdi Dehghan. Weighted finite difference techniques for the one-dimensional advection-diffusion equation. Applied Mathematics and Computation, 147(2):307–319, 2004.

[3] Mehdi Dehghan. Quasi-implicit and two-level explicit finite-difference procedures for solving the one-dimensional advection equation. Applied Mathematics and Computation, 167(1):46–67, 2005.

**Classification** : 65M06, 65M99

**Author(s)** : Jorge Ospino (Universidad del Norte)Giovanni Calderon (Universidad Industrial de Santander)Jorge Villamizar (Universidad Industrial de Santander)

## [01641] Cut singularity of compressible Stokes flow

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @G703

**Type** : Contributed Talk

**Abstract** : In this talk we study the cut singularity governed by a compressible Stokes system. The cut is a non-Lipshitz boundary. The divergence of the leading corner singularity vector has different trace values on either sides of cut. In the consequence the pressure solution must have a jump across the streamline emanating from the cut tip. We establish a piecewise regularity of the solution by subtracting the related singular functions.

**Classification** : 35Q35, 76N10, 76F50

**Format** : Talk at Waseda University

**Author(s)** : Tae Yeob Lee (Pohang University of Science and Technology)Jae Ryong Kweon (Pohang University of Science and Technology)

## [01644] Optimal epidemic interventions and the trolley problem in heterogeneous populations

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @A511

**Type** : Contributed Talk

**Abstract** : Interventions to mitigate the spread of infectious diseases, while succeeding in their goal, have economic and social costs associated with them; this limits the duration and intensity of the interventions. We study a class of interventions which reduce the reproduction number and find the optimal strength of the intervention which minimises the number of infections by eliminating the

overshoot part of an epidemic, and avoiding a second-wave of infections. We extend the framework to a heterogeneous population and find that the optimal intervention can pose an ethical dilemma for decision and policy makers. This ethical dilemma is shown to be analogous to the trolley problem and we discuss how the problem may be avoided.

**Classification** : 92-10, 34A34

**Format** : Online Talk on Zoom

**Author(s)** : Pratyush Kumar Kollepara (La Trobe University) Rebecca Chisholm (La Trobe University) Istvan Kiss (University of Sussex) Joel Miller (La Trobe University)

## **[01648] Parameter identifiability for extensions of the Fisher-KPP model**

**Session Time & Room** : 2D (Aug.22, 15:30-17:10) @E503

**Type** : Contributed Talk

**Abstract** : The Fisher-KPP model is one of the simplest partial differential equation models exhibiting travelling wave behaviour, and has been widely used to model the growth and spread of populations in biology. When applying the model to experimental data, it is often tempting to generalize the model with additional parameters to obtain a better fit. However, this increase in model complexity also increases the difficulty of estimating the parameter values.

In this study, we use a profile likelihood approach to investigate parameter identifiability in extensions of the Fisher-KPP model on both simulated data, and experimental data from a cell invasion assay. We focus on the effects of the forms of the kinetic terms, model misspecifications, and amount of data. We also quantify the amount of data required to justify a more complex model, and explore ways to design experiments to yield data more useful for parameter identification.

**Classification** : 62fxx, 62p10, 92cxx

**Format** : Online Talk on Zoom

**Author(s)** : Yue Liu (University of Oxford) Philip K Maini (University of Oxford) Ruth E Baker (University of Oxford)

## **[01651] Coagulation equations for non-spherical clusters**

**Session Time & Room** : 1D (Aug.21, 15:30-17:10) @F311

**Type** : Contributed Talk

**Abstract** : We study the long-time asymptotics of a coagulation model describing the evolution of a system of particles characterized by volume and surface area. The aggregation mechanism takes place in two stages: collision and fusion of particles. A particularity of the system is that, for some fusion mechanisms, the particle distribution describes a system of ramified-like particles. Moreover, we prove that we are able to recover the standard coagulation equation in the case of fast fusion.

**Classification** : 45K05, 34A34, 35Q92, 35Q70

**Format** : Talk at Waseda University

**Author(s)** : Iulia Cristian (University of Bonn) Juan J. L. Velázquez (University of Bonn)

## **[01662] Shape Preserving aspects of multivariate zipper fractal functions**

**Session Time & Room** : 2E (Aug.22, 17:40-19:20) @G305

**Type** : Contributed Talk

**Abstract** : In this article, a novel class of multivariate zipper fractal functions is introduced by perturbing a classical multivariate function through free choices of base functions, scaling functions, and a binary matrix called signature. In particular, the approximation properties of multivariate Bernstein zipper fractal function are investigated along with non-negativity, and coordinate-wise monotonicity features of the germ function.

**Classification** : 28A80, 41A63, 41A29, 41A05, 41A30

**Format** : Talk at Waseda University

**Author(s)** : Deependra Kumar (Indian Institute of Technology Madras) ARYA KUMAR BEDABRATA CHAND (Indian Institute of Technology Madras) Peter Robert Massopust (Technical University of Munich(TUM) Germany)

## [01668] Order Reconstruction in Microfluidic Channels

**Session Time & Room** : 3D (Aug.23, 15:30-17:10) @G402

**Type** : Contributed Talk

**Abstract** : We analytically and numerically study Order reconstruction (OR) solutions within the Landau-de Gennes theory for nematic liquid crystals in long shallow channel geometries. OR solutions describe liquid crystal polydomains, i.e., subdomains of distinct director orientation separated by domain walls. Such solutions are of interest due to their potential applications in drug delivery technologies and optical devices for instance. We investigate OR solutions in different physical settings: nematic liquid crystals, passive and active nematodynamics, and ferronematics.

**Classification** : 34E10, 76A15, 34A99

**Format** : Online Talk on Zoom

**Author(s)** : James Dalby (University of Strathclyde)

## [01669] Generalising Quasi-Newton Updates to Higher Orders

**Session Time & Room** : 4C (Aug.24, 13:20-15:00) @A207

**Type** : Contributed Talk

**Abstract** : At the heart of all quasi-Newton methods is an update rule that enables us to gradually improve the Hessian approximation using the already available gradient evaluations. Theoretical results show that the global performance of optimization algorithms can be improved with higher-order derivatives. This motivates an investigation of generalizations of quasi-Newton update rules to obtain for example third derivatives (which are tensors) from Hessian evaluations. Our generalization is based on the observation that quasi-Newton updates are least-change updates satisfying the secant equation, with different methods using different norms to measure the size of the change. We present a full characterization for least-change updates in weighted Frobenius norms (satisfying an analogue of the secant equation) for derivatives of arbitrary order. Moreover, we establish convergence of the approximations to the true derivative under standard assumptions and explore the quality of the generated approximations in numerical experiments.

**Classification** : 90C59, 90C53

**Format** : Talk at Waseda University

**Author(s)** : Karl Welzel (University of Oxford) Raphael Hauser (University of Oxford)

## [01675] Solution of Linear Systems of Equations using a Gauss-Seidel-based Method

**Session Time & Room** : 1C (Aug.21, 13:20-15:00) @

**Type** : Contributed Talk

**Abstract** : Linear Systems of Equations (LSsEs) often arise from applications in real-life. Because of the importance of such applications, some repository, such as the SuiteSparse Matrix Collection at <http://www.cise.ufl.edu/research/sparse/matrices>, has been created to document them, and solicit assistance for solving them. The direct and indirect methods commonly applied to solve LSsEs have been complemented by other schemes so as to take care of some peculiarities in the linear systems. An adaptation based on the salient features of the Gauss-Seidel method is herein proposed for the solution of any LSEs. Exploiting one of the features led to the development of a solver for LSsEs, which has been computationally validated as accurate, efficient and robust.

**Classification** : 65F10, 65F05, Numerical linear algebra

**Format** : Online Talk on Zoom

**Author(s)** : Olabode Matthias Bamigbola (University of Ilorin) Montaz Ali (University of Witwatersand) Adebisi Ibrahim (Oduduwa University, Ile-Ife) Amos Ezech (University of Ilorin)



## [01725] Correlated random displacements computed by the Spectral Lanczos Decomposition Method and Barycentric Lagrange Treecode

**Session Time & Room** : 4C (Aug.24, 13:20-15:00) @E507

**Type** : Contributed Talk

**Abstract** : Brownian Dynamics simulations require correlated random displacements  $\{\mathbf{g}\} = \sqrt{D}\{\mathbf{z}\}$  to account for hydrodynamic interactions among solvated biomolecules and polymers, where  $D$  is the diffusion matrix based on the Rotne-Prager-Yamakawa tensor and  $\{\mathbf{z}\}$  is a normal random vector. The Spectral Lanczos Decomposition Method (SLDM) computes a sequence of approximations to  $\{\mathbf{g}\}$ , but each iteration requires a matrix-vector product  $D\{\mathbf{q}\}_k$ , where  $\{\mathbf{q}\}_k$  is the  $k$ th Lanczos vector. The present work applies the barycentric Lagrange treecode (BLTC) to accelerate the matrix-vector product, and numerical results show the performance of the SLDM-BLTC in serial and parallel calculations.

**Classification** : 65D99, 65Z05, 65F60, 76M35

**Format** : Talk at Waseda University

**Author(s)** : Lei Wang (University of Wisconsin, Milwaukee)Robert Krasny (University of Michigan, Ann Arbor)

## [01728] C0 IP Methods for Phase Field Crystal Equations

**Session Time & Room** : 5C (Aug.25, 13:20-15:00) @E703

**Type** : Contributed Talk

**Abstract** : A relatively new class of mathematical models known as phase field crystal models has emerged as a way to simulate physical processes where atomic- and microscales are tightly coupled. In this talk, we present numerical schemes for two such models which rely on a C0 interior penalty finite element method spatial discretization. We show that the numerical methods are unconditionally energy stable and unconditionally convergent and support our conclusions with a few numerical experiments.

**Classification** : 65M60, 65M12

**Format** : Talk at Waseda University

**Author(s)** : Amanda Emily Diegel (Mississippi State University)Natasha Sharma (University of Texas at El Paso)

## [01730] A family of robust chaotic S-unimodal maps based on Gaussian function

**Session Time & Room** : 1C (Aug.21, 13:20-15:00) @

**Type** : Contributed Talk

**Abstract** : we propose a new family of one-dimensional smooth maps based on the Gaussian function exhibiting robust chaos in a wide range of parameter space. We prove the existence of robust chaos in the proposed family of maps using the stability criterion and extensive numerical computation of the Lyapunov exponent and sample entropy. We also present other important properties such as the bifurcation phenomenon, invariant measure, ergodicity, entropy and other statistical properties of the proposed robust chaos map.

**Classification** : 37M05, 37M20, 37M25, 65P40

**Author(s)** : Vinod Patidar (Sir Padampat Singhanian University)

## [01734] Towards A Modeling Framework For Pediatric Sickle Cell Pain

**Session Time & Room** : 4C (Aug.24, 13:20-15:00) @A601

**Type** : Contributed Talk

**Abstract** : Sickle cell pain presents in acute episodes in pediatric patients, as opposed to the chronic pain observed in adults. This episodic nature necessitates a distinct approach from those used to model adult pain. Statistical studies have examined interactions between sleep actigraphy measurements and pain levels in pediatric populations, and we propose a dynamic model of pediatric pain that incorporates sleep effects over varying time windows. Our aim is to determine markers of future pain episodes.

**Classification** : 92-10, 37N25, 65P99, 62P10

**Format** : Talk at Waseda University

**Author(s)** : Reginald McGee (College of the Holy Cross)Angela Reynolds (Virginia Commonwealth University)Quindel Jones (Virginia Commonwealth University)Rebecca Segal (Virginia Commonwealth University)Wally Smith (Virginia Commonwealth University)Cecelia Valrie (Virginia Commonwealth University)

## [01741] A cannibalistic natural enemy pest model with different harvesting strategies

**Session Time & Room** : 5C (Aug.25, 13:20-15:00) @A201

**Type** : Contributed Talk

**Abstract** : In the present work, we discuss the dynamics of a cannibalistic predator-prey model in the presence of different harvesting schemes for the pest population and the provision of additional food to natural enemies. We present a detailed mathematical analysis and numerical evaluations to discuss the pest-free state, coexistence of species, stability, occurrence of different bifurcations, and the impact of additional food and harvesting schemes on the system's dynamics.

**Classification** : 92Dxx

**Format** : Talk at Waseda University

**Author(s)** : Jai Prakash Prakash Tripathi (Central University of Rajasthan, India)

## [01742] A signed distance function preserving scheme for mean curvature flow and related applications

**Session Time & Room** : 2D (Aug.22, 15:30-17:10) @E702

**Type** : Contributed Talk

**Abstract** : Mean curvature flow is an important research topic in geometry, applied mathematics, and the natural sciences. In this talk, we propose a scheme for solving mean curvature flow and some related problems efficiently and accurately on Cartesian grids. Our method uses the sign distance function defined in a narrowband near the moving interface to represent the evolution of the curve. We derive the equivalent evolution equations of distance function in the narrowband. The novelty of the work is to determine the equivalent evolution equation on Cartesian grids without extra conditions or constraints. The proposed method extends the differential operators appropriately so that the solutions on the narrowband are the distance function of the solution to the original mean flow solution. Furthermore, the extended solution carries the correct geometric information, such as distance and curvature, on Cartesian grids. Consequently, it is possible to adapt the existing numerical methods, for instance, finite difference or WENO scheme, that are developed on the Cartesian grids to solve PDEs on curves. The computational domain is a thin narrowband whose widths are a small constant multiple of uniform Cartesian grid spacing. Some experiments confirm that the proposed method is convergent numerically.

**Classification** : 65M06

**Author(s)** : Chia-Chieh Jay Chu (National Tsing Hua UniversityB)

## [01748] Large-scale mRNA translation and the intricate effects of competition for the finite pool of ribosomes

**Session Time & Room** : 3D (Aug.23, 15:30-17:10) @G402

**Type** : Contributed Talk

**Abstract** : We develop a mathematical network model based on balance non-linear first order ordinary differential equations to study large-scale simultaneous mRNA translation in the cell. The central feature of the model is that it is a cooperative system and this property guarantees the monotonicity of the flow. We derive that trajectories within each level set of the first integral globally converge to the fixed point. One of our findings is that raising the drop-off rate in an mRNA that is "jammed" by ribosomes can increase the network's overall protein synthesis rate.

**Classification** : 34E10, 37N25, 92-10, 93D20

**Format** : Talk at Waseda University

**Author(s)** : Aditi Jain (IIT Ropar)Michael Margaliot (Tel Aviv University)Arvind Kumar Gupta (IIT Ropar)

## [01749] Mean Field Game Partial Differential Inclusions: Analysis and Numerical Approximation

**Session Time & Room** : 5C (Aug.25, 13:20-15:00) @A201

**Type** : Contributed Talk

**Abstract** : We generalize second-order Mean Field Game PDE systems with nondifferentiable Hamiltonians to Mean Field Game Partial Differential Inclusions (MFG PDIs) by interpreting the  $p$ -partial derivative of the Hamiltonian in terms of subdifferentials of convex functions. We present conditions for the existence of unique weak solutions to stationary second-order MFG PDIs where the Hamiltonian is convex, Lipschitz, but possibly nondifferentiable. Moreover, we propose a strongly convergent monotone finite element scheme for the approximation of weak solutions.

**Classification** : 65N15, 65N30, PDIs in connection with mean field game theory

**Format** : Talk at Waseda University

**Author(s)** : Yohance Osborne (University College London)Iain Smears (University College London)

## [01754] Spectral-Cutoff for Imaging of Multiple Scattering in Isotropic Point-Like Discrete Random Media

**Session Time & Room** : 2C (Aug.22, 13:20-15:00) @G601

**Type** : Contributed Talk

**Abstract** : To image objects in the discrete random medium composed of isotropic point-like scatterers, the resonances with multiple scattering in the medium can interfere with imaging and result in poor quality of images.

To solve this problem, we present a spectral-cutoff method, which is derived based on the random matrix theory, to

filter out the undesired responses in the resonance regime to recover the damaged images. Finally, we demonstrate

this method for boosting imaging with numerical simulations.

**Classification** : 35J05, 35P15, 47B06, 78A46, 94A12

**Author(s)** : Ray-Hon Sun (Stanford University)Ray-Hon Sun (Stanford University)

## [01755] A Study of Imaging in the Existence of Resonance with Multiple Scattering

**Session Time & Room** : 2E (Aug.22, 17:40-19:20) @G502

**Type** : Contributed Talk

**Abstract** : A random medium consisting of many small bodies that can reflect or scatter the incoming waves is called multiple scattering. Imaging becomes difficult to perform in such random media because of sharp responses arising from the underlying interactions of multiply scattered waves at resonance frequencies.

In this talk, we present a study by simulating this problem with the Foldy-Lax-Lippmann-Schwinger formalism, which was employed for the multiply scattered waves, in randomly distributed isotropic point-like scatterers.

**Classification** : 35P05, 47B06, 78A46

**Author(s)** : Ray-Hon Sun (Stanford University)Ray-Hon Sun (Stanford University)

## [01762] Generalized proofs of positivity of the solutions to population models

**Session Time & Room** : 5C (Aug.25, 13:20-15:00) @D515

**Type** : Contributed Talk

**Abstract** : Dynamic models of many processes in the biological and physical sciences are governed by systems of ordinary differential equations called compartmental systems. Since the dependent variables in such models denote population size, the solutions that start from positive initial conditions remain positive for all time. In this study, two generalized proofs of positivity of the solutions to compartmental models are presented. These compartmental models can be used in many applications including epidemiology and population dynamics.

**Classification** : 92D25, 92-10

**Format** : Talk at Waseda University

**Author(s)** : AUNI ASLAH MAT DAUD (Universiti Malaysia Terengganu)

## [01789] On uniqueness of multi-bubble blow-up solutions and multi-solitons to $L^2$ -critical NLS

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @G709

**Type** : Contributed Talk

**Abstract** : This talk is concerned with the long-time behavior of solutions to the focusing  $L^2$ -critical nonlinear Schrodinger equations. Firstly, we briefly review the existence and uniqueness of multi-bubble blow-up solutions and multi-solitons in the context of NLS. Then, we introduce the uniqueness for a large energy class of multi-bubble blow-up solutions, which converge to a sum of  $K$  pseudo-conformal blow-up solutions particularly with the low rate  $(T-t)^{0+}$ . Lastly, we also discuss the uniqueness of multi-solitons which converge to a sum of  $K$  solitary waves with convergence rate  $(1/t)^{2+}$  in the energy space, and with even lower convergence rate  $(1/t)^{1/2+}$  in the pseudo-conformal space. The talk is based on the joint work with Prof. Daomin Cao and Prof. Deng Zhang, which has been published in "Archive for Rational Mechanics and Analysis" in 2023.

**Classification** : 35Q55, 35B44, 35C08

**Format** : Online Talk on Zoom

**Author(s)** : Yiming Su (Zhejiang University of Technology)

## [01790] Numerical simulation of two-layer shallow-water models: Application to Maximal Exchange at Lombok Strait

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @G710

**Type** : Industrial Contributed Talk

**Abstract** : We investigate the generation of internal waves in the Lombok Strait due to semi-diurnal tides using the momentum-conserving staggered grid (MCS) scheme. We first simulate the steady interface representing the maximum exchange flows, which has two controls located at Karangasem Narrows (KN) and Nusa Penida Sill (NPS). Next, the transport volume due to semidiurnal tides is calculated. Finally, internal wave activity near the KRI Nanggala 402 shipwreck site is analysed.

**Classification** : 35Q86, 76M20, 65Mxx, Computational Fluid Dynamics (internal waves, internal hydraulics)

**Format** : Online Talk on Zoom

**Author(s)** : Putu Veri Swastika (Udayana University) Sri Redjeki Pudjaprasetya (Bandung Institute of Technology) Nugrahanggil Subasita (Center for Applied Climate Services, Climatological Department, Agency for Meteorology Climatology and Geophysics (BMKG))

## [01797] Random dynamics of 2D stochastic Navier-Stokes equations on the whole space

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @G404

**Type** : Contributed Talk

**Abstract** : In this talk, we consider the 2D stochastic Navier-Stokes equations (SNSE) driven by a linear multiplicative white noise of It<sup>o</sup> type on the whole space. Firstly, we will discuss the existence of a unique bi-spatial  $(\mathbb{L}^2(\mathbb{R}^2), \mathbb{H}^1(\mathbb{R}^2))$ -pullback random attractor for non-autonomous SNSE with initial data in  $\mathbb{L}^2(\mathbb{R}^2)$ . Finally, we will discuss the existence of an invariant measure for 2D autonomous SNSE. Also, the uniqueness of invariant measures for  $\mathbf{f} = \mathbf{0}$  will be addressed.

**Classification** : 35B41, 35Q35, 37L55, 37N10, 35R60

**Format** : Talk at Waseda University

**Author(s)** : Kush Kinra (Indian Institute of Technology Roorkee, Roorkee) Manil T. Mohan (Indian Institute of Technology Roorkee, Roorkee)

## [01804] Spatiotemporal dynamics of a predator-prey system with fear effect

**Session Time & Room** : 1C (Aug.21, 13:20-15:00) @D514

**Type** : Contributed Talk

**Abstract** : We studied a mathematical model with fear effect due to predator population. The model is investigated from the viewpoint of stability and bifurcation analysis. We investigate how behavioral modification in prey population due to fear for predators and mutual interference among predator species can create various spatiotemporal pattern formation in population distribution. Numerical simulation demonstrates that the fear effect in a diffusive predator-prey system with mutual interference may exhibit complicated dynamics.

**Classification** : 92B05, 92B20, 65L05, 37D05, 03C45

**Format** : Online Talk on Zoom

**Author(s)** : Subhas Khajanchi (Presidency University Kolkata)

## [01805] A priori error estimates for parabolic interface problems with measure data

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @F312

**Type** : Contributed Talk

**Abstract** : This talk aims to present a priori error analysis for linear parabolic interface problems with measure data in time in a bounded convex polygonal domain in  $\mathbb{R}^2$ . Both the spatially discrete and the fully discrete approximations are analyzed. Due to the low regularity of the solution, the convergence analysis of such problems become challenging. A priori error bounds in the  $L^2(L^2(\Omega))$ -norm for both the spatially discrete and the fully discrete schemes are derived under the minimal regularity assumption the solution together with the  $L^2$ -projection operator and the duality argument. Numerical results are reported to support the theoretical analysis.

**Classification** : 49J20, 49K20, 65N15, 65N30

**Format** : Talk at Waseda University

**Author(s)** : Jhuma Sen Gupta (BITS Pilani Hyderabad)

## [01806] Well-posedness of a class of SPDE with fully monotone coefficients perturbed by Levy noise

**Session Time & Room** : 3D (Aug.23, 15:30-17:10) @E502

**Type** : Contributed Talk

**Abstract** : In this talk, we consider a class of stochastic partial differential equations with fully locally monotone coefficients in a Gelfand triplet. Under certain generic assumptions of the coefficients, we prove the existence of a probabilistic weak solution as well as the pathwise uniqueness of the solution, which implies the existence of a unique probabilistic strong solution. Finally, we allow both the diffusion and jump noise coefficients to depend on the gradient of the solution.

**Classification** : 60H15, 35R60, 35Q35

**Format** : Talk at Waseda University

**Author(s)** : Ankit Kumar (Indian Institute of Technology, Roorkee, Uttarakhand )Manil T. Mohan (Indian Institute of Technology, Roorkee, Uttarakhand)

## [01815] Time-fractional SVIR chicken-pox mathematical model with quarantine compartment

**Session Time & Room** : 4D (Aug.24, 15:30-17:10) @E711

**Type** : Contributed Talk

**Abstract** : This work considers a time-fractional SVIR chicken-pox reaction-diffusion model with nonlinear diffusion operators. The model also contains the quarantine compartment and therefore, it consists of five unknown variables. Further suitable initial and boundary conditions are also given along with the model. The existence of weak solutions proved for the proposed time-fractional model in the bounded domain with appropriate assumptions and a-priori energy estimates. The main results of the work demonstrated using the Faedo-Galerkin method and approximation problem. Finally, numerical simulations are provided to understand the evolution of the chicken-pox virus among the population.

**Classification** : 92B05, 35K57, 35A01

**Author(s)** : Shangerganesh Lingeshwaran (National Institute of Technology Goa)Hariharan Soundararajan (National Institute of Technology Goa)Manimaran Jeyaraj (Vellore Insitute of Technology)

## [01816] Optimal-control problem for a fractional order chickenpox mathematical model

**Session Time & Room** : 4D (Aug.24, 15:30-17:10) @E508

**Type** : Contributed Talk

**Abstract** : In our modern world, we are still fighting against the 19th-century varicella virus. Researchers made many studies to prevent individuals from chickenpox, but still, it is spreading because of its high transmission rate. To study and overcome this, we introduce a model of SIQVR type having a quarantine compartment. The well-posedness and the stable nature are explored. Further, the optimal-control technique is applied to control the spread of the virus. Finally, numerical simulations are performed.

**Classification** : 92B05, 49J15, 34D20, 34A08

**Format** : Online Talk on Zoom

**Author(s)** : Hariharan Soundararajan (National Institute of Technology Goa)Shangerganesh Lingeshwaran (National Institute of Technology Goa)

## [01817] Time-series medical data classification using echo state network

**Session Time & Room** : 3D (Aug.23, 15:30-17:10) @E811

**Type** : Contributed Talk

**Abstract** : Most time-series medical data classification tasks are carried out using deep recurrent neural networks. However, deep neural networks tend to consume enormous computational power. Echo state network is an efficient model for processing temporal data due to its low training cost. The reservoir maps input signals into a high-dimensional dynamical system and the readout layer extracts patterns from it. Therefore, we developed a new methodology that can classify time-series data using echo state network.

**Classification** : 68T07, 62R07, 62P10

**Format** : Talk at Waseda University

**Author(s)** : Zonglun Li (University College London)

## [01822] Domain decomposition for the Random Feature Method

**Session Time & Room** : 5C (Aug.25, 13:20-15:00) @E705

**Type** : Contributed Talk

**Abstract** : The random feature method (RFM) is a framework for solving PDEs sharing the merits of both traditional and machine learning-based algorithms. The direct method for optimization shows a high accuracy but faces acute memory and time-consuming issues with the increase of the scale of the problem. We introduced the domain decomposition into RFM and build a distributed, low-communication, and high-parallelism framework which relieves the pressure of storage and improves solving efficiency significantly in RFM.

**Classification** : 65N99, 65F20, 65-04, 65Y05

**Format** : Talk at Waseda University

**Author(s)** : Yifei Sun (Soochow University)Jingrun Chen (University of Science and Technology of China)Weinan E (Peking University)

## [01826] Environmental Feedbacks from the Warburg Effect in Pre-Metastatic Neoplasms

**Session Time & Room** : 1C (Aug.21, 13:20-15:00) @

**Type :** Contributed Talk

**Abstract :** Unusual metabolism is a hallmark of cancer known as the Warburg effect. The methodology of eco-evolutionary games can describe this effect.

We mathematically model the game between two metabolic strategies in the neoplasm: oxidative phosphorylation vs glycolysis. We show that our model results in 5 possible dynamic regimes. We conclude that lower glucose uptake rates for glycolytic cells help maintain less dangerous non-glycolytic tumors and hinder early tumor progression. This conclusion provides new treatment insights.

**Classification :** 92D25, 92D40, 91A22

**Author(s) :** Mark Steven Lovett (Dartmouth College)Erol Akçay (University of Pennsylvania)Andrew Tilman (USDA: Forestry service)Artem Kaznatcheev (Department of Mathematics and Department of Information and Computing Sciences, Utrecht University.)

## [01840] On the inviscid limit of the stochastic Navier-Stokes equation

**Session Time & Room :** 3C (Aug.23, 13:20-15:00) @G703

**Type :** Contributed Talk

**Abstract :** We study the asymptotic behavior of solutions to the two-dimensional stochastic Navier-Stokes (SNS) equation in the small viscosity limit. The SNS equation is supplemented with no-slip boundary condition, in which a strong boundary layer shall appear in the limit. Several equivalent dissipation conditions are derived to ensure the convergence holds in the energy space. One novelty of this work is that we do not assume any smallness for the noise.

**Classification :** 35Q35, 60H15, 76D10

**Format :** Talk at Waseda University

**Author(s) :** Meng Zhao (Shanghai Jiao Tong University)Ya-Guang Wang (Shanghai Jiao Tong University)

## [01844] Operational Matrix Based Numerical Scheme for Fractional Differential Equations

**Session Time & Room :** 4E (Aug.24, 17:40-19:20) @G802

**Type :** Contributed Talk

**Abstract :** Fractional calculus is active in many engineering and physics disciplines due to their non-local properties. This non integer order derivative performs well in systems where the next state depends not only on the current state but also upon all of its previous states.

Modeling such systems and determining their precise solutions are current research topics of interest. Since finding exact solutions for fractional differential equations is more challenging, developing numerical techniques is a trending research topic. In this paper, we propose the spectral collocation method based on the operational matrix of orthogonal basis polynomials to find the approximate solution of fractional differential equations. Different orthogonal and non orthogonal basis polynomials are considered for the approximation, and a comparative study is made. The operational matrix of fractional order derivatives of basis polynomials is derived as a product of matrices. This matrix together with the collocation method, is employed to transform the fractional differential equations into a set of algebraic equations, which is easier to tackle. The perturbation method is applied to show the stability of the discussed method. The solution achieved by this method is more precise than those obtained from the existing methods like the variational iteration, adomian decomposition method, and finite difference method.

**Classification :** 44Axx, 33C50, 65N35, Fractional Calculus

**Author(s) :** Ashish Awasthi (National Institute of Technology Calicut)Poojitha S (National Institute of Technology Calicut)



## **[01846] L3 approximation of the Caputo derivatives and its application to time-fractional wave equation**

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @E711

**Type** : Contributed Talk

**Abstract** : In this talk, we will discuss a new second-order L3 approximation of the Caputo fractional derivative of order  $1 < \alpha < 2$ . We have applied Lagrange's cubic interpolating polynomial to develop this approximation. A second-order difference scheme is also proposed to find the numerical solution of the time-fractional wave equation. The numerical analysis results of the proposed algorithm are provided and a comparative study is also given to show the effectiveness and accuracy of the proposed scheme.

**Classification** : 65N06

**Format** : Online Talk on Zoom

**Author(s)** : NIKHIL SRIVASTAVA (Indian Institute of Technology (BHU) Varanasi, India)

## **[01847] Non-reflective boundary conditions for the piston problem of gas dynamics**

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @E508

**Type** : Contributed Talk

**Abstract** : We consider the piston problem of gas dynamics, described by the Lagrangian formulation of the Euler equations for an ideal compressible gas. While a highly accurate numerical solution can be obtained in the interior of the domain through state-of-the-art techniques like WENO reconstruction and SSP-RK time-stepping, boundary discretization can lead to unphysical reflections. We investigate and implement several efficient boundary conditions to deal with this problem without significantly increasing the size of the computational domain.

**Classification** : 65M08, 65M22, 76N30, 35L04, 35L65

**Format** : Talk at Waseda University

**Author(s)** : Carlos Muñoz (KAUST)

## **[01848] A Higher Order Schwarz Domain Decomposition Method for Singularly Perturbed Differential Equation**

**Session Time & Room** : 2D (Aug.22, 15:30-17:10) @E702

**Type** : Contributed Talk

**Abstract** : We consider a fourth order singularly perturbed differential equation. To solve the problem, the differential equation is transformed into a coupled system of singularly perturbed differential equations. The original domain is divided into three overlapping subdomains. On the regular subdomain, a hybrid scheme is used, while a compact fourth order difference scheme is used on the two boundary layer subdomains on a uniform mesh. We demonstrate that proposed scheme is nearly fourth order uniformly convergent.

**Classification** : 65M06

**Format** : Talk at Waseda University

**Author(s)** : AAKANSHA AAKANSHA (Indian Institutes of Technology (Banaras Hindu University) Varanasi)

## **[01854] Dynamic Roughness in the Term Structure of Oil Markets Volatility**

**Session Time & Room** : 2E (Aug.22, 17:40-19:20) @A201

**Type :** Contributed Talk

**Abstract :** This paper analyses the attributes and the significance of the roughness of oil market volatility. We employ unspanned stochastic volatility models driven by rough Brownian motions that yield semi-analytic prices for futures options entailing efficient calibration applications. We calibrate option prices written on oil futures and provide empirical evidence of the dynamic nature of the roughness in oil volatility. The calibrated option-implied Hurst parameter varies over time, but rough stochastic volatility models provide a better fit to the term structure of implied oil volatility compared to classical stochastic volatility. Furthermore, including the Hurst parameter into the set of implied parameters benefits the stability of the calibrated parameters and improves pricing performance.

**Classification :** 91Gxx, 60Lxx, 60Hxx

**Format :** Talk at Waseda University

**Author(s) :** Christina Nikitopoulos (UTS)Messias Alfeus (Stellenbosch University)Ludger Overbeck (Justus-Liebig-University Giessen)

## [01861] Scattering of an Ostrovsky wave packet in a layered waveguide

**Session Time & Room :** 5D (Aug.25, 15:30-17:10) @E817

**Type :** Contributed Talk

**Abstract :** In this talk I will discuss the scattering of an Ostrovsky wave packet in a two layered waveguide with a delamination sandwiched between imperfect bonding. When the layers have different densities, the strains are described by a system of coupled Boussinesq equations. Asymptotic solutions are constructed, complemented by numerical simulations, and are used to analyse the scattering of the strain waves. These results can provide a tool to control the integrity of layered structures.

**Classification :** 74J30, 76B15, 35G25, 35G30

**Format :** Online Talk on Zoom

**Author(s) :** Jagdeep Tamber (Nottingham Trent University)

## [01883] An application to the generalized logistic growth model

**Session Time & Room :** 5B (Aug.25, 10:40-12:20) @G401

**Type :** Contributed Talk

**Abstract :** We study the bifurcation curves for a Dirichlet problem with geometrically concave nonlinearity. We give an application to the generalized logistic growth model. There are totally six qualitatively bifurcation curves.

**Classification :** 34B18, 74G35

**Format :** Talk at Waseda University

**Author(s) :** Kuo-Chih Hung (National Chin-Yi University of Technology)Kuo-Chih Hung (National Chin-Yi University of Technology)

## [01888] UAV Tracking and Targeting using YOLO with Enhanced Prior

**Session Time & Room :** 5D (Aug.25, 15:30-17:10) @D515

**Type :** Contributed Talk

**Abstract :** Unmanned Aerial Vehicles defense becomes a hot topic due to the ongoing Ukraine-Russia War and China's constant threats to Taiwan. Drones tracking and countermeasures inevitably play a crucial role in future warfare. Here, we propose a feature-enhanced Yolo network to improve the accuracy of detection and tracking for small moving objects. Multi-cores, multi-threads and field programming logic array combined with Kalman filtering are used to speed up our algorithm on edge devices such as cellphones.

**Classification :** 93C10, 93E11, 68T45

**Format :** Talk at Waseda University

**Author(s)** : Pink-Kong Huang (National Yang-Ming Chiao-Tung University)Yu-Shi Chen (National Yang-Ming Chiao-Tung University)Cho-Han Wu (Via Technologies Inc.)Chin-Tien Wu (National Yang-Ming Chiao-Tung University)

## **[01893] Existence and blow-up solutions of fractional reaction-diffusion system of SPDEs**

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @G710

**Type** : Contributed Talk

**Abstract** : In this talk, we investigate the existence and finite-time blowup solution of a reaction-diffusion system of stochastic partial differential equations (SPDEs) driven by two dimensional fractional Brownian motion. We provide sufficient conditions for the existence of a global solution. Moreover, we provide lower and upper bounds for the finite-time blowup solution of the system of SPDEs and obtain the lower and upper bounds for the probability of non-explosive solutions to our considered system

**Classification** : 35R60, 60H15, 74H35

**Format** : Online Talk on Zoom

**Author(s)** : Sankar Subramani (Periyar University, Salem, Tamilnadu.)Manil T Mohan (Indian Institute Of Technology, Roorkee)Karthikeyan Shanmugasundaram (Periyar University, Salem, Tamilnadu.)

## **[01906] Adjoint-Based Shape Optimization of Periodic Units for Compact Heat Transfer Devices**

**Session Time & Room** : 2E (Aug.22, 17:40-19:20) @D405

**Type** : Contributed Talk

**Abstract** : We present a DOLFIN/FEniCS framework for shape optimization of compact heat transfer devices consisting of periodic units. The framework relies on highly parallelized, efficient finite-element solvers for the three-dimensional periodically developed flow and heat transfer equations and their eigenvalue problems. The adjoint-based shape calculus is implemented by means of automated differentiation and operator overloading. Design constraints are incorporated through an augmented Lagrangian method. The optimized surfaces are compared with designs obtained through density-based topology optimization.

**Classification** : 80M50, 80M10, 49M41, 80M40, 76S05

**Format** : Talk at Waseda University

**Author(s)** : Geert Buckinx (VITO)Stephan Schmidt (Humboldt University Berlin)

## **[01908] Quantifying Cytoskeletal Dynamics and Remodeling from Live-imaging Microscopy Data**

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @D514

**Type** : Contributed Talk

**Abstract** : The shape of biological cells emerges from dynamic remodeling of the cell's internal scaffolding, the cytoskeleton. Hence, correct cytoskeletal regulation is crucial for the control of cell behaviour, such as cell division and migration. A main component of the cytoskeleton is actin. Interlinked actin filaments span the body of the cell and contribute to a cell's stiffness. The molecular motor myosin can induce constriction of the cell by moving actin filaments against each other. Capturing and quantifying these interactions between myosin and actin in living cells is an ongoing challenge. For example, live-imaging microscopy can be used to study the dynamic changes of actin and myosin density in deforming cells. These imaging data can be quantified using Optical Flow algorithms, which locally assign velocities of cytoskeletal movement to the data. Extended Optical Flow algorithms also quantify actin recruitment and degradation. However, these measurements on cytoskeletal dynamics may be influenced by noise in the image acquisition, by ad-hoc parameter choices in the algorithm, and by image pre-processing steps. Here, we use in silico data to understand

conditions under which Optical Flow is applicable. We found the condition to guarantee the method has a good performance is that the displacement has to be in a proper proportion as the object size. We test our methods using data on actin densities in larval epithelial cells of *Drosophila* pupae. The development of our Optical Flow method will be a starting point for identifying differences in cytoskeletal movement and remodeling under experimental perturbations. Our method will be applicable to other datasets in which flow fields are present.

**Classification** : 92-10, 92-08, 92BXX, 37CXX, 76-10

**Format** : Online Talk on Zoom

**Author(s)** : Carey Li (University of St Andrews)

## **[01913] Mathematical modeling, analysis, and simulation of the Epidemic Dynamics with Stochastic Perturbations: A case study of COVID-19 in Bogotá**

**Session Time & Room** : 5B (Aug.25, 10:40-12:20) @A201

**Type** : Contributed Talk

**Abstract** : We study the basic reproduction number for the epidemic models with stochastic perturbations in transmission rates and social behavior to analyze the dynamics of the COVID-19 pandemic in Bogotá, Colombia. We also consider the effect of vaccination as a control measure. We present the stability conditions and illustrate the simulation results for the proposed model. Finally, we present a computational experiment and validate the model by performing statistical analysis for the actual data.

**Classification** : 92D30, 92BXX, 60H30

**Format** : Talk at Waseda University

**Author(s)** : Andres Rios-Gutierrez (Universidad Nacional de Colombia)Andres Rincon-Prieto (Universidad Nacional de Colombia)VISWANATHAN ARUNACHALAM (Universidad Nacional de Colombia)

## **[01923] Primal hybrid method for quasi-linear parabolic problems**

**Session Time & Room** : 5C (Aug.25, 13:20-15:00) @E703

**Type** : Contributed Talk

**Abstract** : In this article, a second order quasi-linear parabolic initial-boundary value problem is approximated by using primal hybrid finite element method and Lagrange multipliers. Semi-discrete and backward Euler based fully discrete schemes are discussed and optimal order error estimates are established by applying modified elliptic projection. Optimal order error estimates in maximum norm are also derived. Earlier results on maximum-norm superconvergence of the gradient in piecewise linear finite-element approximations of elliptic and parabolic problems are now carried over to quasi-linear case using primal hybrid method. Finally, the results on numerical experiments confirm our theoretical findings.

**Classification** : 65M60

**Author(s)** : RAVINA SHOKEEN (The LNM Institute of Information Technology)Ajit Patel (The LNM Institute of Information Technology)Amiya Kumar Pani (BITS Goa)

## **[01924] Mixed Leader-Follower Dynamics**

**Session Time & Room** : 1E (Aug.21, 17:40-19:20) @F309

**Type** : Contributed Talk

**Abstract** : The original Leader-Follower (LF) model partitions all agents whose opinion is a number in  $[-1,1]$  to a follower group, a leader group with a positive target opinion in  $[-1,1]$

$[0,1]$  and a leader group with a negative target opinion in  $[-1,0]$ . A leader group agent has a constant degree to its target and mixes it with the average opinion of its group neighbors at each update. A follower has a constant degree to the average opinion of the opinion neighbors of each leader group and mixes it with the average opinion of its group neighbors at each update. In this paper, we consider a variant of the LF model, namely the mixed model, in which the degrees can vary over time, the opinions can be high dimensional, and the number of leader groups can be more than two. We investigate circumstances under which all agents achieve a consensus. In particular, a few leaders can dominate the whole population.

**Classification** : 37N99, 05C50, 91C20, 93D50, 94C15

**Format** : Talk at Waseda University

**Author(s)** : Hsin-Lun Li (National Sun Yat-Sen university )Hsin-Lun Li (National Sun Yat-Sen university )

## [01929] Colored noise driven autonomous stochastic resonance

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @E504

**Type** : Contributed Talk

**Abstract** : A one-dimensional linear autonomous system coupled to a generic stationary nonequilibrium fluctuating bath can exhibit a resonant response when its damped oscillation period matches some characteristic bath's relaxation time. This condition justifies invoking the stochastic resonance paradigm, even if it can be achieved more easily by tuning the system to the bath and not vice versa, as is usually the case. The simple nature of the mechanism numerically investigated here suggests number of exciting applications

**Classification** : 82C31

**Format** : Online Talk on Zoom

**Author(s)** : SHRABANI MONDAL (Jadavpur University)SHRABANI MONDAL (Jadavpur University)

## [01946] Optimal Control of Stationary Doubly Diffusive Flows on Lipschitz Domains

**Session Time & Room** : 2C (Aug.22, 13:20-15:00) @F312

**Type** : Contributed Talk

**Abstract** : Doubly diffusive flows involve coupled incompressible flow and double diffusion transport, which models physical problems like bacteria bioconvection, exothermic flows in oceanography and more. We study a distributed optimal control problem governed by doubly diffusive flows under minimal regularity on 2D and 3D bounded Lipschitz domains and establish its well-posedness. First and second-order optimality conditions are derived. Furthermore, a discretization of the control problem based on  $H(\text{div})$ -conforming discontinuous Galerkin finite elements for the state and adjoint variables and piecewise constant finite elements for the control variable is discussed. Optimal apriori error estimates are proven in suitable norms. Numerical experiments are performed using a semi-smooth Newton strategy verifying the theoretical findings.

**Classification** : 49K20, 65N30, 76S05, 76R50, 49K27

**Format** : Talk at Waseda University

**Author(s)** : Jai Tushar (Indian Institute of Technology Roorkee)Arbaz Khan (IIT Roorkee)Manil T. Mohan ( IIT Roorkee)

## **[01958] How can we make tumour predictions under mechanism uncertainty?**

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @D515

**Type** : Contributed Talk

**Abstract** : The need of quantitative tumour growth and progression predictions is pivotal for designing individualized therapies. Medical data correspond to snapshots in time of the patient's state and their collection relies on patient's clinical presentation. Current standard of care faces the following challenges: (C1) data collection is sparse in time and (C2) we lack the knowledge of the underlying biological mechanisms. To solve them, I will present a methodology that combines mechanistic modelling and machine.

**Classification** : 92-08

**Author(s)** : Haralampos Hatzikirou (Khalifa University)

## **[01964] Competitions between stage-structured species in a patchy environment**

**Session Time & Room** : 2E (Aug.22, 17:40-19:20) @A201

**Type** : Contributed Talk

**Abstract** : In this study, an ecological model with two life stages, immature and mature, and incorporating both intra- and inter-competitions between two species is explored to study invasion of species in a two-patch environment. It can be applied to exploring evolution of insects like *Drosophila* and beetles, which experience larva and adult (immature and mature life stages). The monotone dynamics in such a model provides us a property to explore its local and global dynamics. The model can also admit complex dynamics with multiple positive equilibria and limit point bifurcation when both species persist.

**Classification** : 92D25, 92D40, 37N25

**Format** : Talk at Waseda University

**Author(s)** : Chang-Yuan Cheng (National Pingtung University National Pingtung University)

## **[01966] Fekete-Szegő Inequality for Universally Prestarlike Functions By a Variational Method**

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @G401

**Type** : Contributed Talk

**Abstract** : The universally prestarlike functions of order  $\alpha \leq 1$  in the slit domain  $\Lambda = \mathbb{C} [1;\infty)$  have been recently introduced by

S. Ruscheweyh. This notion generalizes the corresponding one for functions in the unit disk  $\Delta$  (and other circular domains in  $\mathbb{C}$ ). In this paper, we obtain the Fekete-Szegő inequality for such functions by using Variational Method.

We conclude that this paper presents a new class of functions analytic in the slit domain, and closely related to the

class of starlike functions. Besides being an introduction to this field, it provides an interesting connections defined

class with well-known classes. The paper deals with several ideas and techniques used in geometric function theory.

**Classification** : 30C45

**Format** : Talk at Waseda University

**Author(s)** : Lourthu Mary Joseph (Yuvabharathi International School)

## [01973] Equilibria for Robust Routing Game of Atomic Players

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @D514

**Type** : Contributed Talk

**Abstract** : We study a routing game on edge costs given by an interval of the same length, each edge cost can be any value in the interval. Each player only knows the interval length and would select a path that is robust against the worst-case realization of edge costs. Under bottleneck-type objective with minmax-regret criterion, we prove that every robust Nash Equilibrium (NE) is an NE of the corresponding bottleneck routing game with complete information.

**Classification** : 91A35, 91A80, 91A68, 90C27

**Format** : Talk at Waseda University

**Author(s)** : Xudong Hu (Academy of Math and Systems Science, CAS)

## [01974] Solving fractional Hantavirus model: A new approach

**Session Time & Room** : 3D (Aug.23, 15:30-17:10) @G402

**Type** : Contributed Talk

**Abstract** : In the present work, fractional order Hantavirus epidemic model introduced by \cite{peixoto2006effect,hantavirus2010modeling} is integrated using new iterative method (NIM) and implicit  $\theta$ -method ( $\theta=1$ ). New iterative method has been developed by Daftardar-Gejji and H. Jafari \cite{daftardar2006iterative}. Using new iterative method and  $\theta$ -method \cite{yakit2018explicit}, we have developed a new numerical algorithm to solve fractional differential equations (FDEs) in the Hantavirus model. Dynamics of the hanta virus model is studied.

Hantavirus model of fractional order represents mouse population before and after getting influenced by Hantavirus under various conditions and its effect on birth rate and death rate of mice is studied. This model represents a Hantavirus infection in rodents and alien population. It has been observed that solution obtained by new algorithm is accurate and in good agreement when compared with solution obtained by other established algorithms. Further, effects of harvesting efforts  $E(t)$  as an optimal control on spread of Hantavirus infection is studied. It has been observed that, population of both susceptible and infected rodents minimizes when we apply optimal control.

**Classification** : 34Axx, 03-xx, 26Axx

**Format** : Talk at Waseda University

**Author(s)** : Yogita Mahesh Mahatekar (COEP Technological University)Amey Deshpande (MIT World peace University)

## [01986] Low regularity time integration of NLS via discrete Bourgain spaces

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @E604

**Type** : Contributed Talk

**Abstract** : We study a filtered Lie splitting scheme for the cubic periodic nonlinear Schrödinger equation on the torus  $\mathbb{T}^d$  with  $d \geq 1$ . This scheme overcomes the standard stability restriction  $s > \frac{d}{2}$  in Sobolev spaces  $H^s(\mathbb{T}^d)$  and now allows us to handle initial data in  $H^s$  for  $s > 0$  when  $d=1,2$  and  $s > \frac{d}{2}-1$  when  $d \geq 3$ . Moreover, we establish low regularity error estimates in discrete Bourgain spaces, and prove convergence of order  $\tau^{\frac{s}{2}}$  in  $L^2(\mathbb{T}^d)$ , where  $\tau$  denotes the time step size.

**Classification** : 65M12, 65M15, 35Q55

**Format** : Talk at Waseda University

**Author(s)** : Lun Ji (Universität Innsbruck)Alexander Ostermann (Universität Innsbruck)Frédéric Rousset (Université Paris-Saclay)Katharina Schratz (Sorbonne Université)

## [01995] Theoretical and Numerical Study of Regional Boundary Observability for Linear Time-Fractional Systems.

**Session Time & Room** : 5C (Aug.25, 13:20-15:00) @A207

**Type** : Contributed Talk

**Abstract** : The goal of this talk is to examine the regional boundary observability for time-fractional systems involving the Riemann-Liouville fractional derivative. The aim is to reconstruct the initial state of the system under considerations on a desired subregion of the evolution domains' boundary. The reconstruction problem is converted into a solvability problem with the form  $AX=b$  using an adaptation of the Hilbert uniqueness method. Some successful numerical examples were simulated and provided at the end.

**Classification** : 93B07, 93B28, 26A33, 46F12

**Format** : Online Talk on Zoom

**Author(s)** : Khalid Zguaid (Higher School of Education and Training of Agadir (ESEFA), Ibn Zohr University)Fatima Zharae El Alaoui (Moulay Ismail University)

## [01997] Robust continuation method for computing solution curves with critical points

**Session Time & Room** : 4D (Aug.24, 15:30-17:10) @E504

**Type** : Contributed Talk

**Abstract** : To better compute the solution curve of challenging problems, numerical continuation methods have proved to be a very efficient tool. However, these methods can still lead to undesired results, particularly near critical points. This paper will therefore present a robust continuation method that will include two key aspects to solve difficult problems: detection of problematic regions during the solution process and additional steps to deal with them. Numerical examples will be presented.

**Classification** : 65Y20, 65Z05, 74S05

**Format** : Online Talk on Zoom

**Author(s)** : Sophie Leger (Université de Moncton)

## [02001] GPU batched sparse solver for XGC fusion plasma collision operator

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @G305

**Type** : Contributed Talk

**Abstract** : Batched linear solvers solve many small related but independent problems. They are beneficial for GPUs, which require substantial amounts of work to operate efficiently. The XGC gyrokinetic particle-in-cell code for modeling magnetically confined fusion plasma devices employs a LAPACK CPU solver for the collision operator. We describe how Ginkgo's batched solver can be integrated into the collision operator and accelerate the simulation process. We present comparisons for the solve times on A100 GPUs with CPUs.

**Classification** : 15-04, 35-04, 76-10

**Format** : Talk at Waseda University

**Author(s)** : Paul Lin (Lawrence Berkeley National Laboratory)Aditya Kashi (Oak Ridge National Laboratory)Pratik Nayak (Karlsruhe Institute of Technology)Dhruva Kulkarni (Lawrence Berkeley National Laboratory)Aaron Scheinberg (Jubilee Development)Hartwig Anzt (University of Tennessee)



## [02003] VEM approximation for the Stokes eigenvalue problem: a priori and a posteriori error analysis

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @E705

**Type** : Contributed Talk

**Abstract** : We present a priori and a posteriori error analysis to approximate the eigenvalues and eigenfunctions

of the Stokes spectral problem. For the a priori analysis, we take advantage of the compactness of the solution operator to prove convergence of the eigenfunctions and eigenvalues. Additionally we propose a reliable and efficient a posteriori estimator in order to perform adaptive refinements that allow to recover the optimal order of convergence for non smooth eigenfunctions. We report some numerical tests

**Classification** : 65Nxx

**Format** : Talk at Waseda University

**Author(s)** : Felipe Lepe (Universidad del Bío Bío)

## [02006] Dynamics of localization patterns in some nonlocal evolution equations

**Session Time & Room** : 1C (Aug.21, 13:20-15:00) @G501

**Type** : Contributed Talk

**Abstract** : Recently, studies have been proposed to simplify biological pattern formation problems by using nonlocal evolution equations to capture the self-organization caused by complex interactions with many factors. Especially, it has been reported that linear reaction-diffusion networks reduce to some nonlocal evolution equations reproducing patterns. Also, nonlocal effects are derived to reduce the structure of the network. In this talk, we report the influence of nonlocal effects on pattern dynamics for this reduced equation.

**Classification** : 35B36, 92C15, 35K57

**Format** : Talk at Waseda University

**Author(s)** : Hiroshi Ishii (Kyoto University)

## [02011] Network models with truncated Poisson-Dirichlet process priors

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @E501

**Type** : Contributed Talk

**Abstract** : We introduce a Bayesian nonparametric network model based on the truncated Poisson-Dirichlet process prior. In our model, the sociability parameters of the nodes are sorted in descending order. This enables us to focus on the most popular nodes of the network. We will show the simulation algorithm and posterior inference method for this model. Numerical implementations will also be discussed based on simulated observations and real-world datasets.

**Classification** : 62G05, 62F15, 60G51

**Format** : Talk at Waseda University

**Author(s)** : Junyi Zhang (The Hong Kong Polytechnic University)Angelos Dassios (London School of Economics)

## [02013] An Accelerated Iteration for Finding Extremal Solutions of Discrete-Time Algebraic Riccati Equations

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @G601

**Type** : Contributed Talk

**Abstract** : Algebraic Riccati equations (AREs) have been extensively applied in linear optimal control problems and many efficient numerical methods were developed. The stabilizing (or almost stabilizing) solution has attracted the most attention among all Hermitian solutions of the ARE in the past works. Nevertheless, it is an interesting and challenging issue in finding the extremal solutions of AREs which play an important role in the applications. The contribution of this paper is twofold. Firstly, the existence of these extremal solutions is established under the framework of fixed-point iteration. Secondly, an accelerated fixed-point iteration (AFPI) based on the semigroup property is developed for computing four extremal solutions of the discrete-time algebraic Riccati equation. In addition, we prove that the convergence of the AFPI is at least  $R$ -suplinear with order  $r > 1$  under some mild assumptions. Numerical examples are shown to illustrate the feasibility and accuracy of the proposed algorithm.

**Classification** : 39B12, 39B42, 65H05, 15A24

**Author(s)** : Chun-Yueh Chiang (Center for General Education, National Formosa University) Hung-Yuan Fan (National Taiwan Normal University)

## [02022] Use of jet transport for high order methods

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @E505

**Type** : Contributed Talk

**Abstract** : The use of multivariate polynomial, called jet, in conjunction with numerical solvers, called transport, has recently become a new baseline to address computations based on high order methods. Jet transport provides more accurate, efficient, and reliable results through automatizing several crucial parts.

In this talk, I will explain these most recent results and supported by examples in areas in dynamical systems.

**Classification** : 65Pxx, 37Mxx, 37M21, Numerical integrators for dynamical systems

**Format** : Online Talk on Zoom

**Author(s)** : Joan Gimeno (University of Barcelona) Angel Jorba (University of Barcelona) Marc Jorba (Centre de Recerca Matemàtica) Narcís Miguel (PAL Robotics S.L.) Maorong Zou (University of Texas at Austin)

## [02024] Quantum asymptotic phase function on the basis of Koopman operator theory

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @D404

**Type** : Contributed Talk

**Abstract** : The asymptotic phase function is a fundamental quantity for analyzing classical limit-cycle oscillators. In this study, we define the asymptotic phase function for quantum nonlinear oscillators by using the eigenoperator of the Koopman operator associated with the fundamental oscillation frequency. In an example of a quantum van der Pol oscillator with a Kerr effect, we demonstrate that the proposed asymptotic phase appropriately yields isochronous phase values in both semiclassical and strong quantum regimes.

**Classification** : 81-XX, 34L05, 92B25, Quantum synchronization, nonlinear dynamics, Koopman operator theory

**Format** : Talk at Waseda University

**Author(s)** : Yuzuru Kato (Future University Hakodate) Hiroya Nakao (Tokyo Institute of Technology)

## [02026] Variants of the penalty method for contact problems - Formulations unifying Nitsche and penalty methods

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @G702

**Type** : Contributed Talk

**Abstract** : The penalty method is a simple yet effective computational technique of handling unilateral contact problems. In addition to its inconsistent, this method is often criticized of ill-conditioning when the penalty parameter goes to zero.

We propose here new penalty methods overcoming the conditioning issue. We also established that some of our penalty formulations are equivalent of variants of Nitsche's method, meaning that the inconsistent of these penalty methods is insignificant.

**Classification** : 35A35, 65J15, 74M15, 74B05

**Format** : Online Talk on Zoom

**Author(s)** : Ibrahima Dione (Professor at Moncton university)

## [02027] Understanding Difference Equation System Models using Telescoping Sums Method

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @G710

**Type** : Contributed Talk

**Abstract** : Difference equations frequently appear as discrete mathematical models of various biological and environmental phenomena. In this paper, the authors study the following systems:

$$\begin{aligned} x_{n+1} &= \frac{x_{n-3}}{\pm 1 \pm y_n x_{n-1} y_{n-2} x_{n-3}}, \\ y_{n+1} &= \frac{y_{n-3}}{\pm 1 \pm x_n y_{n-1} x_{n-2} y_{n-3}}, \end{aligned}$$

which were first considered by Elsayed in 2015, and results were proven using mathematical induction. This time, the authors present the solution forms of each system using telescoping sums technique. The advantages and disadvantages of the two methods are discussed. Boundedness and convergence of solutions shall be presented.

**Classification** : 39A05, 39A22, 65Q10

**Format** : Talk at Waseda University

**Author(s)** : Jerico Bravo Bacani (University of the Philippines Baguio) Julius Fergy Tiongson Rabago (Kanazawa University)

## [02032] Stable Minimization of Discrete Conformal Energy for Disk Conformal Parameterization

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @E503

**Type** : Contributed Talk

**Abstract** : Conformal energy minimization is an efficient approach to computing conformal parameterizations. In this talk, we introduce a stable minimization of discrete conformal energy (SMDCE) algorithm for conformal parameterizations of simply connected open surface. The stability of SMDCE is reflected in the guarantee of the one-to-one and onto properties of the computed parameterization and the insensitivity to the initial value. The numerical experiments indicate the stability and competitiveness with state-of-the-art algorithms in terms of efficiency.

**Classification** : 52C26, 49Q10, 68U05

**Format** : Talk at Waseda University

**Author(s)** : Zhong-Heng Tan (School of Mathematics, Southeast University) Zhenyue Zhang (Nanjing Center for Applied Mathematics)

## [02034] Relation between transaction costs and search frictions in optimal maximization

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @E505

**Type** : Contributed Talk

**Abstract** : We consider an optimal investment problem to maximize expected power-utility of random terminal wealth in a market with two types of illiquidity: transaction costs and search frictions. We suppose an investor trades only at arrival times of Poisson process, and pays proportional transaction costs for purchasing or selling stocks. We characterize a unique optimal trading strategy and provide asymptotic expansions on small transaction costs and small search frictions for boundaries of no-trade region and value function.

**Classification** : 62P05, 49N90, Financial mathematics, Stochastic analysis

**Format** : Talk at Waseda University

**Author(s)** : Tae Ung Gang (KAIST Stochastic Analysis and Application Research Center) Jin Hyuk Choi (UNIST)

## [02035] General double-sided orthogonal planes split QFT and wavelet transform on functions and distribution spaces

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @F312

**Type** : Contributed Talk

**Abstract** : We present, in our talk, an alternative version of the convolution and duality formula, and we give some results on functions and distribution spaces for the general double-sided orthogonal planes split quaternion Fourier transform. We provide the discrete representation of  $Z_2$ -periodic function for continuous quaternion Wavelet transform. Finally, we prove the Plancherel and inversion formulas for the continuous General double-sided orthogonal 2D-planes split quaternionic Wavelet transform.

**Classification** : 42C40, 42B10, 14D21

**Format** : Online Talk on Zoom

**Author(s)** : Hakim Monaim (Moulay Ismail University)

## [02037] Two-stage Bivariate Distribution Estimation based on B-spline approach

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @G701

**Type** : Contributed Talk

**Abstract** : In this work, we propose a new nonparametric model to estimate distribution functions and densities with bounded support. In addition, we study the asymptotic properties of our estimator such as asymptotic bias, variance and asymptotic normality. The method is illustrated by simulation study and an application to a real data set.

**Classification** : 62H10, 62H12, 62H05, 65C20, 60E05

**Format** : Online Talk on Zoom

**Author(s)** : Nezha Mohaoui (Moulay Ismail University)

## [02039] Intelligent Computing Models for Super-large Protein Complex Prediction

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @D408

**Type** : Contributed Talk

**Abstract** : Improved from our Fast Fourier Transform based prediction methods, recently we have designed new artificial intelligence enhanced computing models to predict the super-large protein complex structures, which can give out results from monomer sequences and show good results and

promise advances.

**Classification** : 92B20, 68T07

**Format** : Talk at Waseda University

**Author(s)** : Xinqi Gong (Renmin University of China)

## **[02040] Simulation of landslide-generated waves using non-hydrostatic numerical model**

**Session Time & Room** : 3D (Aug.23, 15:30-17:10) @E820

**Type** : Contributed Talk

**Abstract** : The reduced two-layer non-hydrostatic (NH-2LR) numerical model is developed and used to study landslide-generated waves. The NH-2LR model is validated using analytical solutions and laboratory experiments. Simulations involves landslide motions on a flat bottom as well as over a sloping beach. The effects of dispersion and non-linearity are then investigated; dispersion is important in the early generation and propagation of landslide-generated waves, whereas non-linearity has a significant influence on maximum run-up.

**Classification** : 76B15, 76M12, 35L60

**Format** : Talk at Waseda University

**Author(s)** : Sri Redjeki Pudjaprasetya (Institut Teknologi Bandung)Dede Tarwidi (Telkom University)Didit Adytia (Telkom University)

## **[02043] Almost Automorphic Solution of a Leslie-Gower Prey-Predator Model on Time Scales**

**Session Time & Room** : 5C (Aug.25, 13:20-15:00) @G401

**Type** : Contributed Talk

**Abstract** : A general non-autonomous Leslie-Gower prey-predator model on time scales with control input terms is examined. The significant property permanence is established along with the existence of almost automorphic solution of the model system. By constructing a suitable Lyapunov functional, presence of a one of a kind all-around attractive positive almost automorphic solution of the system is obtained. Two numerical examples are given to demonstrate the effectiveness of our hypothetical outcomes with simulations.

**Classification** : 34C27, 34C60, 34C25

**Format** : Online Talk on Zoom

**Author(s)** : Soniya NA (Rajiv Gandhi Institute of Petroleum Technology Jais India)

## **[02049] A Hybrid AMR Low-Rank Tensor Approach for Solving the Boltzmann Equation**

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @D402

**Type** : Contributed Talk

**Abstract** : Computational complexity grows exponentially in a grid-based approach to modeling the Boltzmann equation as dimensionality increases. Scalable low-rank tensor decomposition techniques have been developed to mitigate such issues, but challenges remain when applying real-world boundary conditions in engineering systems with complex geometries. To address these challenges, we propose a novel hybrid algorithm where quad-tree adaptive mesh refinement (AMR) is applied in real space while a low-rank approximation is used in velocity space.

**Classification** : 76P05, 35Q83, 65M50

**Author(s)** : Samuel Jun Araki (Jacobs Technology Inc. / Air Force Research Laboratory)

## [02053] An efficient preconditioner for the Riemannian trust-region method on the manifold of fixed-rank matrices

**Session Time & Room** : 5B (Aug.25, 10:40-12:20) @E603

**Type** : Contributed Talk

**Abstract** : In 2010, Vandereycken and Vandewalle proposed a preconditioner for the Riemannian trust-region (RTR) method on the manifold of symmetric positive semidefinite matrices of fixed rank. Here, we generalize their work to the manifold of fixed-rank matrices. We use the RTR method with our preconditioner to solve a stiff time-dependent PDE, the Allen--Cahn equation, on the manifold of fixed-rank matrices. Numerical experiments show the efficiency of our preconditioner. This is joint work with Bart Vandereycken.

**Classification** : 65F55, 65F45, 65F08, 65L04, 65L05

**Format** : Talk at Waseda University

**Author(s)** : Marco Sutti (National Center for Theoretical Sciences, Mathematics Division, Taipei, Taiwan)

## [02054] Low regularity ill-posedness for elastic waves and ideal compressible MHD in 3D and 2D

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @E817

**Type** : Contributed Talk

**Abstract** : We construct counterexamples to the local existence of low-regularity solutions to elastic wave equations and to the ideal compressible magnetohydrodynamics (MHD) system in three and two spatial dimensions (3D and 2D). For 3D, inspired by the recent works of Christodoulou, we generalize Lindblad's classic results on the scalar wave equation by showing that the Cauchy problems for 3D elastic waves and for 3D MHD system are ill-posed in  $H^3(\mathbb{R}^3)$  and  $H^2(\mathbb{R}^3)$ , respectively. Both elastic waves and MHD are physical systems with multiple wave-speeds. We further prove that the ill-posedness is caused by instantaneous shock formation, which is characterized by the vanishing of the inverse foliation density. In particular, when the magnetic field is absent in MHD, we also provide a desired low-regularity ill-posedness result for the 3D compressible Euler equations, and it is sharp with respect to the regularity of the fluid velocity. Our proofs for elastic waves and for MHD are based on a coalition of a carefully designed algebraic approach and a geometric approach. To trace the nonlinear interactions of various waves, we algebraically decompose the 3D elastic waves and the 3D ideal MHD equations into  $6 \times 6$  and  $7 \times 7$  non-strictly hyperbolic systems. Via detailed calculations, we reveal their hidden subtle structures. With them we give a complete description of solutions' dynamics up to the earliest singular event, when a shock forms. If time permits, we will also present the corresponding results in 2D. This talk is based on joint works with Haoyang Chen and Silu Yin.

**Classification** : 76N15, 76N30, 35L60, 35L67, 35Q35

**Format** : Talk at Waseda University

**Author(s)** : Xinliang An (National University of Singapore)Haoyang Chen (National University of Singapore)Silu Yin (Hangzhou Normal University)

## [02055] EMinv software platform for comprehensive analysis of geoscience data

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @D407

**Type** : Contributed Talk

**Abstract** : We designed and developed a new software platform, consisting of processing and inversion modular for magnetotelluric data and visualization modular for all the geoscience results. New self-improved processing and inversion algorithms were applied in this platform. This platform unified the format of data, results and models and connected data processing, interpretation and visualization, using our new rule and integrated standard. The platform is a useful tool for both production managers and scientific researchers.

**Classification** : 86-04, 86-02

**Format** : Talk at Waseda University

**Author(s)** : Kun Zhang (Chinese Academy of Geopogical Sciences)

## **[02063] Modeling Uncertainty and Optimizing Control in Philippines COVID-19 Vaccination**

**Session Time & Room** : 2C (Aug.22, 13:20-15:00) @G304

**Type** : Contributed Talk

**Abstract** : We developed a mathematical model considering vaccination in the country. We incorporated stochastic terms to capture uncertainty. Results show the importance of booster shots that increases the vaccine-induced immunity duration. We then consider the problem of distributing a limited vaccine supply over a time period considering that the country is divided into regions. Simulations showed that the strategy solved from our formulation is better at minimizing infections than a discussed alternative strategy.

**Classification** : 92D30, 37N25, 34F05, 49K15, 37H10

**Format** : Talk at Waseda University

**Author(s)** : Randy L. Caga-anan (MSU-Iligan Institute of Technology) Jayrold P. Arcede (Caraga State University) Joey Genevieve T. Martinez (MSU-Iligan Institute of Technology)

## **[02068] Variable selection aided by correlation networks**

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @D515

**Type** : Contributed Talk

**Abstract** : Variable selection is important because it can provide improved quality of results, faster times of computation and more explainable models. We present recent work in which we use data from over 100 000 cells to find a selection of morphokinetic variables guided by nonlinear correlation networks, able to capture behavioral landscapes of inflammation. Our mathematical modeling, based on logistic and decision tree models, allowed us to identify the most important variables for immune cell prediction.

**Classification** : 92-08, 92-10, 92B05, 92B15, 92C42

**Format** : Online Talk on Zoom

**Author(s)** : David G Aragonés (University of Castilla-La Mancha) Gabriel F Calvo (University of Castilla-La Mancha) Georgiana Crainiciuc (Spanish National Cardiovascular Research Center) Miguel Palomino-Segura (Spanish National Cardiovascular Research Center) Jon Sicilia (Spanish National Cardiovascular Research Center) Andres Hidalgo (Yale University)

## **[02073] Graph convolutional networks for graph signal processing**

**Session Time & Room** : 1C (Aug.21, 13:20-15:00) @F310

**Type** : Contributed Talk

**Abstract** : We propose novel graph convolution models for analyzing graph-structured time series data. Graph convolutional networks (GCNs) is a generalization of convolutional neural networks from regular grid data to irregular graph data.

The major building block of a GCN is the filter. Graph filters are designed for graph convolution in spatial and spectral domains. We also propose novel graph wavelet transform methods to be jointly used with graph convolution filters, which can further improve the results.

**Classification** : 42BXX, Machine learning, graph signal processing

**Format** : Talk at Waseda University

**Author(s)** : Jia He (Illinois Institute of Technology) Maggie Cheng (Illinois Institute of Technology)

## [02087] Best Approximation in Euclidean Space: A Supply Distribution Efficiency Model

**Session Time & Room** : 2C (Aug.22, 13:20-15:00) @F411

**Type** : Contributed Talk

**Abstract** : In this paper, we developed a mathematical model for supply distribution efficiency using inverse best approximation by considering Euclidean distance in a Euclidean space. Given a sequence  $\{S_i\}_{i=1}^k$  of closed convex subsets of a Euclidean space  $E$  and a sequence of natural numbers  $\{n_i\}_{i=1}^k$ , we determined the best location of a convex set  $S$  in  $E$  such that the Euclidean distance from  $S$  to  $S_i$  is at most  $n_i$  for each  $i \in \{1, 2, \dots, k\}$ .

**Classification** : 51K05, 41A45, 41A29

**Format** : Talk at Waseda University

**Author(s)** : Rosalio Jr Gaid Artes (Mindanao State University - Tawi-Tawi College of Technology and Oceanography)

## [02091] Stock Data has Shape: Managing Stock Portfolio via Topology-informed Machine Learning

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @E803

**Type** : Contributed Talk

**Abstract** : Given time-series data of a stocks portfolio, we generate sequences of point-cloud embeddings and use topology-based features to train a classifier on a binary classification task: determine whether or not a stock performs well on day-to-day trading. Using the trained classifier, we predict which stocks in our portfolio are projected to earn on a future trading day. We evaluate our topology-informed classifier via standard metrics and projected cumulative earnings based on a tier-structured investment scheme.

**Classification** : 68Txx, 68Uxx, Machine Learning

**Format** : Talk at Waseda University

**Author(s)** : Paul Samuel Ignacio (University of the Philippines Baguio)

## [02093] British Call Option On Stocks under Stochastic Interest Rate

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @E505

**Type** : Contributed Talk

**Abstract** : The closed form expression for the price of the British put and call options have long been established where both interest rate and volatility are assumed to be constant. In reality, these assumptions do not fully reflect the variable nature of the financial markets. In this paper, we derived a closed form expression for the arbitrage-free price of the British call option by assuming stochastic interest rate which follows the Cox-Ingersoll-Ross model and constant volatility.

**Classification** : 62P05

**Format** : Talk at Waseda University

**Author(s)** : Felipe Jr Raypan Sumalpong (Mindanao State University - Iligan Institute of Technology) Kreanne Falcasantos (Mindanao State University - Iligan Institute of Technology)

## [02100] Evaluation of Pandemic Severity using Type-2 Fuzzy Systems

**Session Time & Room** : 1C (Aug.21, 13:20-15:00) @



**Type :** Contributed Talk

**Abstract :** A type-2 fuzzy system is used to assess pandemic severity of places. To assess the situation, test positivity, vaccination status, total numbers of infected cases, active cases, recovered cases, deceased cases, population density, etc., are considered. Available imprecise data are converted into type-2 fuzzy numbers and type-2 fuzzy inference system is used. A case study on the recent COVID-19 pandemic situation is performed. The achieved results and comparison reflect usefulness and superiority of the model.

**Classification :** 03B52, 62A86, 94D05, 90C70, 90B50

**Author(s) :** Animesh Biswas (University of Kalyani)

## [02102] Network Construction Problems

**Session Time & Room :** 3C (Aug.23, 13:20-15:00) @A206

**Type :** Contributed Talk

**Abstract :** Network construction problems seek to find efficient schedules of constructing edges of a new transportation network under limited resources, with the goal of minimizing a scheduling objective which is a non-decreasing function of the times when some important pairs of nodes become connected. The talk will discuss some recent results in this area of combinatorial optimization, focusing on classification and computational complexity.

**Classification :** 90C27

**Format :** Talk at Waseda University

**Author(s) :** Igor Averbakh (University of Toronto)

## [02103] Global in Time Weak Solutions to Singular 3D Quasi-Geostrophic Systems

**Session Time & Room :** 3D (Aug.23, 15:30-17:10) @E606

**Type :** Contributed Talk

**Abstract :** Geophysicists have studied 3D Quasi-Geostrophic systems extensively. These systems describe stratified flows in the atmosphere on a large time scale and are widely used for forecasting atmospheric circulation. They couple an inviscid transport equation in  $\mathbb{R}_+ \times \Omega$  with an equation on the boundary satisfied by the trace, where  $\Omega$  is either  $2D$  torus or a bounded convex domain in  $\mathbb{R}^2$ . In this talk, we show the existence of global in time weak solutions to a family of singular 3D quasi-geostrophic systems with Ekman pumping, where the background density profile degenerates at the boundary. The proof is based on the construction of approximated models which combine the Galerkin method at the boundary and regularization processes in the bulk of the domain. The main difficulty is handling the degeneration of the background density profile at the boundary.

**Classification :** 35Q35, 76D03

**Format :** Online Talk on Zoom

**Author(s) :** Yiran Hu (University of Texas at Austin)

## [02106] Numerical solver of ordinary differential equations based on IMT-DE variable transformation

**Session Time & Room :** 2E (Aug.22, 17:40-19:20) @E505

**Type :** Contributed Talk

**Abstract :** We propose a numerical solver of initial value problems of ordinary differential equations based on the IMT-DE variable transformation, a variant of the transformation of the IMT quadrature formula. We solve the Volterra integral equation equivalent to the initial value problem by the Picard iteration, which is numerically executed by the numerical indefinite integration based on the IMT-DE transformation. This study is an example of the applications of the IMT type transformations to various computations.

**Classification :** 65L05, 65R20, 65D30

**Format** : Talk at Waseda University

**Author(s)** : Hidenori Ogata (The University of Electro-Communications)

## **[02107] Nonlinear stochastic heat equation with variable thermal conductivity**

**Session Time & Room** : 2E (Aug.22, 17:40-19:20) @G502

**Type** : Contributed Talk

**Abstract** : We consider a stochastic heat equation with variable thermal conductivity, on infinite domain, with both deterministic and stochastic source and with stochastic initial data. The stochastic source appears in the form of multiplicative generalized stochastic process. In our solving procedure we use regularized derivatives and the theory of generalized uniformly continuous semigroups of operators. We establish and prove the result concerning the existence and uniqueness of solution within certain generalized function space.

**Classification** : 35D30, 35K05, 47D99

**Format** : Talk at Waseda University

**Author(s)** : Danijela Rajter-Ciric (Faculty of Sciences, University of Novi Sad)Milos Japundzic (Novi Sad School of Business - Higher Education Institution for Applied Studies)

## **[02108] Particle dynamics model for the coarsening process of phase separation**

**Session Time & Room** : 4C (Aug.24, 13:20-15:00) @E507

**Type** : Contributed Talk

**Abstract** : The Cahn-Hilliard equation describes phase separation phenomena well.

It has been proven that this solution converges to one of the Hele-Shaw problems in the limit of one coefficient parameter to zero, which is mathematically satisfactory as an order-reduction result.

However, the computation of the Hele-Shaw problem is also problematic.

Therefore, we observed the coarsening process of phase separation phenomena and subsequently considered a particle dynamics model that roughly reproduces the process.

**Classification** : 70-10, 65N06, 65N08

**Format** : Talk at Waseda University

**Author(s)** : Daisuke Furihata (Osaka University)

## **[02111] Geometric visual model for linear derivation of elliptical orbits in 3-dimensional space**

**Session Time & Room** : 2C (Aug.22, 13:20-15:00) @F411

**Type** : Contributed Talk

**Abstract** : If visual space is defined as a 3-dimensional complex vector space, linear perspective is expressed as an L1-norm constraint with the scale. The vanishing point represents the boundary of visual space, and the L2-norm constraint indicates that visual space is a sphere. A geometric visual model that satisfies these constraints allows linear derivation of elliptical orbits. The solution is simple because it does not involve an infinite series.

**Classification** : 51K05

**Format** : Talk at Waseda University

**Author(s)** : Hiroyuki Nishimoto (Kochi University)

## [02112] Adaptive Virtual Element Methods: convergence and optimality

**Session Time & Room** : 4D (Aug.24, 15:30-17:10) @E711

**Type** : Contributed Talk

**Abstract** : We consider a Virtual Element discretization of elliptic boundary-value problems, using triangular or quadrilateral meshes with hanging nodes of arbitrary, but fixed, maximal index.

We design a two-stage adaptive algorithm, based on a stabilization-free a posteriori error estimator, which alternates data approximation and solution approximation with increasing accuracy.

We prove the convergence of the inner and outer loops, we establish the optimality of the adaptive procedure in suitable approximation classes, and we provide numerical results.

**Classification** : 65N30, 65N50

**Format** : Talk at Waseda University

**Author(s)** : Claudio Canuto (Politecnico di Torino)Lourenco Beirao da Veiga (University of Milan Bicocca)Ricardo H Nochetto (University of Maryland)Giuseppe Vacca (University of Bari)Marco Verani (Politecnico di Milano)

## [02116] Generalized Polyak Step Size for First Order Optimization with Momentum

**Session Time & Room** : 1E (Aug.21, 17:40-19:20) @F309

**Type** : Contributed Talk

**Abstract** : This paper presents a general framework to set the learning rate adaptively for first-order optimization methods with momentum, motivated by the derivation of Polyak step size. It is shown that the resulting methods are much less sensitive to the choice of momentum parameter and may avoid the oscillation of the heavy-ball method on ill-conditioned problems. These adaptive step sizes are further extended to the stochastic settings, which are attractive choices for stochastic gradient descent with momentum. Our methods are demonstrated to be more effective for stochastic gradient methods than prior adaptive step size algorithms in large-scale machine learning tasks.

**Classification** : 90C15, 65K05, 90C06

**Format** : Online Talk on Zoom

**Author(s)** : Xiaoyu Wang (Hong Kong University of Science and Technology)Mikael Johansson (KTH Royal Institute of Technology)Tong Zhang (Hong Kong University of Science and Technology)

## [02118] The finite volume method for solving the oblique derivative BVP in geodesy

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @E504

**Type** : Contributed Talk

**Abstract** : We formulate the oblique derivative boundary value problem applied in gravity field and present two approaches to its solution by the finite volume method. In the first approach, the oblique derivative in the boundary condition is decomposed into normal and two tangential components and approximated by the central scheme. In the second approach, the oblique derivative in the boundary condition is treated by the first order upwind scheme. Both approaches are tested by various experiments.

**Classification** : 65N08

**Author(s)** : Zuzana Minarechová (Slovak University of Technology)Marek Macák (Slovak University of Technology)Karol Mikula (Slovak University of Technology)Róbert Čunderlík (Slovak University of Technology)

## [02125] TNL: Numerical Library for Modern Parallel Architectures

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @E820

**Type** : Contributed Talk

**Abstract** : TNL ([www.tnl-project.org](http://www.tnl-project.org)) is a collection of building blocks that facilitate the development of efficient numerical solvers and HPC algorithms. It is implemented in C++ using modern programming paradigms in order to provide a flexible and user-friendly interface similar to, for example, the C++ Standard Template Library. TNL provides native support for modern hardware architectures such as multicore CPUs, GPUs, and distributed systems, which can be managed via a unified interface. In our presentation, we will demonstrate the main features of the library together with efficiency of the implemented algorithms and data structures.

**Classification** : 68W99, 68U01, 65N99, High-performance computing

**Format** : Talk at Waseda University

**Author(s)** : Tomáš Oberhuber (Czech Technical University in Prague)Jakub Klinkovský (Czech Technical University in Prague)Radek Fučík (Czech Technical University in Prague)

## [02138] Convergence Analysis of Leapfrog for Geodesics

**Session Time & Room** : 2E (Aug.22, 17:40-19:20) @E505

**Type** : Contributed Talk

**Abstract** : The leapfrog algorithm was proposed in Noakes'98 to find geodesics joining two given points  $x_0$  and  $x_1$  on a path-connected complete Riemannian manifold. The basic idea is to choose some junctions between  $x_0$  and  $x_1$  that can be joined by geodesics locally and then adjust these junctions. In this talk, we find the relationship between the leapfrog's convergence rate  $\tau_{i,n}$  of  $i$ -th junction with the maximal root  $\lambda_n$  of a polynomial.

**Classification** : 65L10, 65D15, 49J45, 53C22

**Format** : Online Talk on Zoom

**Author(s)** : Erchuan Zhang (University of Western Australia)Lyle Noakes (University of Western Australia)

## [02139] Normalizing Flows Based Mutual Information Estimation

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @A502

**Type** : Contributed Talk

**Abstract** : Mutual Information is a measure of mutual dependence on random quantities without specific modelling assumptions. However, estimating mutual information numerically from high-dimensional data remains a difficult problem. We propose a principled mutual information estimator based on a generalization of normalizing flows. The proposed method uses an autoregressive structure in estimating mutual information with estimating marginal and joint entropy simultaneously. Empirical results demonstrate that our proposed estimator exhibits improved bias-variance trade-offs on standard benchmark tasks.

**Classification** : 94a17, 62b10, 68t07, 68t09

**Format** : Talk at Waseda University

**Author(s)** : Haoran Ni (University of Warwick)Martin Lotz (University of Warwick)

## [02142] Self-similar hierarchy of vortices in turbulence

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @E817

**Type** : Contributed Talk

**Abstract** : By direct numerical simulations, we show that there exists the hierarchy of vortex axes in turbulence, which is self-similar in a wide range of scales, i.e., in the inertial range and a lower part of the dissipation range. This result means that the volume fraction occupied by the tubular vortices at each scale is independent of the scale.

**Classification** : 76F65, 65Z05

**Format** : Talk at Waseda University

**Author(s)** : Tomonori Tsuruhashi (The University of Tokyo)Susumu Goto (Osaka University)Sunao Oka (Osaka University)Tsuyoshi Yoneda (Hitotsubashi University)

## **[02148] A comparative study on scattering of water waves by barriers of various kinds.**

**Session Time & Room** : 3D (Aug.23, 15:30-17:10) @E820

**Type** : Contributed Talk

**Abstract** : The present study outlines the mathematical and computational details needed to compute the solutions on the scattering of surface water waves by a finite dock, thin rectangular elastic plate and circular elastic plate in finite depth water. The boundary value problem is handled for solutions analytically using a matched eigenfunction expansion . Various physical quantities associated with the scattering problems are studied for various values of wave and structural parameters. A selection of results are given to illustrate the variations of scattering coefficients and to compare with existing solutions.

**Classification** : 76B15

**Format** : Online Talk on Zoom

**Author(s)** : SOFIA SINGLA (IIITUNA, UNA)

## **[02158] Spatially coordinated collective phosphorylation filters spatiotemporal noises for precise circadian timekeeping**

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @D514

**Type** : Contributed Talk

**Abstract** :

The mammalian circadian clock is based on a self-sustaining transcriptional-translational negative feedback loop. This machinery is expected to suffer from the heterogeneous arrival time distribution of clock protein from the noisy intracellular environment at the nucleus; however, mammals exhibit robust daily rhythms of physiological and behavioral processes, including sleep and hormone secretion. We explore under which condition the circadian clock compensates for the heterogeneity by a modeling approach.

**Classification** : 92BXX, 92Cxx

**Format** : Talk at Waseda University

**Author(s)** : Seokjoo Chae Dae Wook Kim (University of Michigan)Seunggyu Lee (Korea University)Jae Kyoung Kim (KAIST)

## **[02160] Using quantum mechanics for calculation of different infinite sums**

**Session Time & Room** : 2E (Aug.22, 17:40-19:20) @D405

**Type** : Contributed Talk

**Abstract** :

Certain class of infinite sums can be calculated analytically starting from a specific quantum mechanical problem. For simplicity we illustrate the method by exploring the problem of a particle in a box. Twofold calculation of the mean value of energy for the polynomial wave function inside the well yields even argument  $p$  of Riemann zeta and related functions. This method can be applied to a wide class of exactly solvable quantum mechanical problems.

**Classification** : 81P10, 35J10, 35L05, 37N20

**Format** : Talk at Waseda University

**Author(s)** : Milica Pavkov Hrvojevic (Faculty of Sciences University of Novi Sad )Petar Mali (Faculty of Sciences University of Novi Sad)Milica Rutonjski (Faculty of Sciences University of Novi Sad)Slobodan Radosevic (Faculty of Sciences University of Novi Sad)

## [02164] Uncertainty-Aware Null Space Networks for Data-Consistent Image Reconstruction

**Session Time & Room** : 3D (Aug.23, 15:30-17:10) @E811

**Type** : Contributed Talk

**Abstract** : State-of-the-art reconstruction methods in inverse problems have been developed by incorporating latest advances in deep learning. Before learning approaches can be used in safety-critical areas like medical imaging, a model must not only provide a reconstruction, but also an estimate of its reliability. This study presents a cascaded architecture of null space networks and combines it with recent progress of uncertainty quantification in computer vision. This way, two key properties are met: data-consistency and uncertainty-awareness.

**Classification** : 68T07, 68T37, 92C50, 92C55

**Format** : Talk at Waseda University

**Author(s)** : Christoph Angermann (VASCage – Research Centre on Vascular Ageing and Stroke)Simon Goeppel (Universität Innsbruck)Markus Haltmeier (Universität Innsbruck)

## [02174] A mathematical model to predict how obesity raises the risk of diabetes

**Session Time & Room** : 4D (Aug.24, 15:30-17:10) @E711

**Type** : Contributed Talk

**Abstract** : Nowadays, obesity is a serious global issue. Obesity increases the risk of developing significant health issues like diabetes, cancer, and heart attacks. This work tries to depict the link between pancreatic damage, blood insulin levels, and blood glucose in a mathematical model. The model also illustrates how the increased obesity index raises diabetes risk. Additionally, we incorporated a delay term in the model to depict insulin production lag brought on by dysfunctional beta-cells due to obesity. We analytically analyzed both delay and non-delay models. Moreover, numerical simulations are demonstrated to support the theoretically-based analysis.

**Classification** : 92B05, 34H05, 34D05

**Author(s)** : Parimita Roy (Thapar Institute of Engineering and Technology)Ani Jain (Thapar Institute of Engineering and Technology)

## [02175] Learning Interaction laws in particle- and agent-based systems

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @E705

**Type** : Contributed Talk

**Abstract** : We consider the following inference problem for a system of interacting particles or agents: given only observed trajectories of the agents in the system, can we learn what the laws of interactions are? We would like to do this without assuming any particular form for the interaction laws, i.e. they might be “any” function of pairwise distances, or other variables. We discuss when this problem is well-posed, construct estimators for the interaction kernels with provably good statistically and computational properties, and discuss extensions to second-order systems, more general interaction kernels, and stochastic systems. We measure empirically the performance of our techniques on various examples, including families of systems with parametric interaction kernels, and settings where the interaction kernels depend on unknown variables. We also conduct numerical experiments to study the emergent behavior of these systems. This is joint work with F. Lu, J. Feng, P. Martin, J. Miller, S. Tang and M. Zhong.

**Classification** : 70F17, 62M20, 34A55

**Format** : Talk at Waseda University

**Author(s)** : Mauro Maggioni (Johns Hopkins University)

## [02184] Oscillatory Translational Instability of Localized Spot Patterns in the Schnakenberg Reaction-Diffusion System in Defected 3D Domains

**Session Time & Room** : 1C (Aug.21, 13:20-15:00) @G501

**Type** : Contributed Talk

**Abstract** : For a two-component reaction-diffusion system in a bounded  $3D$  domain, we investigate oscillatory instabilities of  $N$ -spot equilibrium. An  $N$ -spot equilibrium consists of localized spots in which the activator concentration is exponentially small everywhere except localized regions. In the stability analysis, we consider the translation mode and obtain the eigenvalue  $\lambda$  is  $\mathcal{O}(\varepsilon^2)$ , which is the same order as the spot dynamics, while  $\tau$  is  $\mathcal{O}(\varepsilon^{-3})$ . As a result, the system which contains the behavior of  $\lambda$  and  $\tau$  falls into the  $\mathcal{O}(\varepsilon^2)$  correction. We later find that stability of these solutions is governed by a  $3N \times 3N$  nonlinear matrix eigenvalue problem. Entries of the  $3N \times 3N$  matrix involves terms calculated from certain Green's function that contains information about the domain's geometry. In the nonlinear matrix eigenvalue system, the most unstable eigenvalue decides the oscillation frequency at onset while the corresponding eigenvector determines the mode of spot oscillations. Further, we demonstrate the impact of various types of localized heterogeneity on this instability. An example of localized domain defects that we consider is to analyze the effect of perturbing the system by removing a small ball in the domain, which therefore allows a leakage of the chemical species out of the domain. Perturbation techniques is employed to compute Green's function of near-spherical and near-cubic domains to gain analytic insight into how domain geometry select the dominant mode of oscillation. We show full solutions of the 3-D Schnakenberg PDE to confirm our asymptotic results.

**Classification** : 35B36, 35B35, 35B25

**Format** : Talk at Waseda University

**Author(s)** : Siwen Deng (Macquarie University) Justin Tzou (Macquarie University)

## [02185] Vibration of anti-symmetric angle-ply layered conical shell frusta using splines

**Session Time & Room** : 1C (Aug.21, 13:20-15:00) @

**Type** : Industrial Contributed Talk

**Abstract** : Vibration of anti-symmetric angle-ply layered conical shell is studied including shear deformation using spline function approximation. The equilibrium equations are formulated in terms of displacement and rotational functions. These functions are approximated using Bickley-type splines to obtain the generalised eigenvalue problem. Parametric studies are made to analyse the effects of circumferential node number, length ratio and cone angle on the frequency parameter for number of layers and materials with ply orientations under different boundary conditions.

**Classification** : 74K25, 74-10, 74E30, 74G15, 74B05, Composite Shell structure

**Author(s)** : Viswanathan Kodakkal Kannan (Samarkand State University)

## [02188] Rare events of weak noise-driven dynamical systems

**Session Time & Room** : 3D (Aug.23, 15:30-17:10) @E501

**Type** : Contributed Talk

**Abstract** : Real-world dynamical systems can be susceptible to events with a low probability of occurrence but severe repercussions. The aim is to asymptotically quantify the likelihood of these events in dynamical systems represented by stochastic differential equations (SDEs).

First, we will go through the mathematical framework for investigating such situations. Then, we will demonstrate a numerical obstacle when using a rare events method due to diverging the tilting factor, aka Radon-Nikodym derivative. A solution will be proposed and shown using multiple scenarios.

**Classification** : 60F10, 65C20, 49M05, 49M29, 65C05

**Author(s)** : Mnerh Alqahtani (University of Hafr Al Batin)Tobias Grafke (University of Warwick)

## **[02189] Improved viscous flow between expanding or contracting permeable walls**

**Session Time & Room** : 2D (Aug.22, 15:30-17:10) @D404

**Type** : Contributed Talk

**Abstract** : Solutions to transport models of fluid in contracting/expanding porous vessels remain unknown, and the problem has been restricted to the “slow” expansion/contraction of the walls. I partially address these gaps by generating explicit solutions and improving approximations without the “slowness” dilation rate. Indeed, the homogeneous differential equation is completely solved and this exact solution may be leveraged to form more precise approximations to the flow via perturbation techniques when the Reynolds number is small.

**Classification** : 76S05, 34B15

**Format** : Online Talk on Zoom

**Author(s)** : Christopher C. Tisdell (University of New South Wales (UNSW))

## **[02191] Analysis Seismic Data in Sumatra Using Robust Sparse K-Means Clustering**

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @E501

**Type** : Contributed Talk

**Abstract** : K-means algorithm is considered to be the most important unsupervised machine learning method in clustering. It works intimately on complete and clear data but cannot handle outliers. Therefore, robust statistical algorithms are required to deal with it. This paper presents robust sparse k-means algorithm to show clustering of seismic data in Sumatra. Clustering results are displayed graphically for two, three and four clusters to see the zones formed based on the grouping results.

**Classification** : 62-11, 62-08

**Format** : Talk at Waseda University

**Author(s)** : Ulfasari Rafflesia (Univestitas Gadjah Mada, Yogyakarta)Dedi Rosadi (Univestitas Gadjah Mada, Yogyakarta)Devni Prima Sari (Universitas Negeri Padang)

## **[02197] Mean-field diffusive coupling to promote dispersal, synchronisation and stability of infectious diseases**

**Session Time & Room** : 2E (Aug.22, 17:40-19:20) @G402

**Type** : Contributed Talk

**Abstract** : The scope of mediated infectious diseases is strongly impacted by mobility of humans and mediating agents. The movement of hosts and mediators determines how spatially contagious infectious diseases are spread. Therefore, the metapopulation dynamics of mediated infectious disease model is examined in a patchy scenario where the hosts' and mediators' populations are divided into subpopulations. The network of humans and mediators are utilized to depict the patchy environment. The network patches are connected by mean field diffusive coupling. The patches of related networks synchronize and achieve bistable states as a result of dispersal.

**Classification** : 34N05

**Format** : Online Talk on Zoom

**Author(s)** : Tina Verma (Thapar Instiute of Engineering & Technology)



## [02200] Structured Distances to Nearest Singular Matrix Pencil

**Session Time & Room** : 1E (Aug.21, 17:40-19:20) @G304

**Type** : Contributed Talk

**Abstract** : We consider the structured distance to singularity for a given regular matrix pencil  $A+sE$ , where  $(A,E) \in \mathbb{S} \subseteq \mathbb{C}^{n,n}{}^2$ . This includes Hermitian, skew-Hermitian,  $s$ -even,  $s$ -odd,  $s$ -palindromic, T-palindromic, and dissipative Hamiltonian pencils. We derive explicit computable formulas for the distance to the nearest structured pencil  $(A-\Delta_A)+s(E-\Delta_E)$  such that  $A-\Delta_A$  and  $E-\Delta_E$  have a common null vector. We then obtain a family of computable lower bounds for the unstructured and structured distances to singularity.

**Classification** : 15A18, 15A22, 65K05

**Format** : Talk at Waseda University

**Author(s)** : Anshul Prajapati (Indian Institute of Technology Delhi) Punit Sharma (Indian Institute of Technology Delhi)

## [02201] Total Variation and Undecimated Wavelet Approach to Chest Radiograph Image Enhancement

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @E820

**Type** : Contributed Talk

**Abstract** : ABSTRACT

Medical images are often corrupted by white noise, blurring and contrast defects. Consequently, important medical information may be degraded or completely masked. In this talk, I will discuss recent advances in the implementation of a total variation method and an undecimated wavelet image enhancing algorithm, as well as morphological techniques such as closing, thinning and pruning combined with wavelets methods, to improve the image quality and to extract target features from chest radiographs.

**Classification** : 68U10, 44A20, 46N10, Chest radiograph image enhancement, mathematical morphology, wavelet decomposition

**Author(s)** : Anthony Y Aidoo (Eastern Connecticut State University) Gloria Agyeiwaa Botchway (University of Ghana) Matilda Acheampong Wilson (University of Ghana)

## [02215] Solving Fokker-Planck Equation in High Dimensions via Milestoning

**Session Time & Room** : 2D (Aug.22, 15:30-17:10) @E506

**Type** : Contributed Talk

**Abstract** : We propose a novel method for solving Fokker-Planck-type equations via the Feynman-Kac formula, closely related to rare events sampling. A family of trajectories is maintained between each pair of milestones while new samples are drawn based on an importance-sampling principle. We also show a probabilistic estimate of the sampling error which explains why, so-called, milestoning can significantly speed up molecular dynamics simulations.

**Classification** : 65C35, 65C30, 60H35

**Format** : Talk at Waseda University

**Author(s)** : Ziheng Chen (University of Texas at Austin) Bjorn Engquist (University of Texas at Austin)

## [02218] Self-gravitational force calculation of infinitesimally thin gaseous disks based on adaptive mesh refinement accelerated by sparse fast Fourier transform

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @E703

**Type** : Contributed Talk

**Abstract** : The central region of galaxies can be infinitesimally thin gaseous disks due to the angular momentum conservation. Dynamic of gaseous disks is significant for probing the gas flows inward/outward to the origin of galaxies. Moreover, self-gravitational force calculation should be concerned during the evolution of galaxies. We can use the sparse fast Fourier transform (sFFT) to preserve the nearly linear complexity  $\mathcal{O}(N \log N)$  for numerical calculation based on adaptive mesh refinement (AMR) in this presentation.

**Classification** : 65M80, 42A16, 42A38

**Format** : Talk at Waseda University

**Author(s)** : Chien-Chang Yen (Fu Jen Catholic University)

## [02220] Analytical approximation of phase dynamics for oscillators without polar symmetry

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @G709

**Type** : Contributed Talk

**Abstract** : Predicting and controlling oscillatory systems, despite its relevance, is still an unachieved goal. A simplification method to ease this task is phase reduction, a dimensional reduction scheme that capture the dynamics of each oscillator in just one variable -the phase-. Despite phase reduction importance, analytical results are only available for systems with polar symmetry. In this talk we show how to perform analytical phase reduction on non-symmetric oscillators.

**Classification** : 37Mxx, 37Nxx

**Format** : Talk at Waseda University

**Author(s)** : Ivan Leon (Tokyo Tech Institute of Technology) Hiroya Nakao (Tokyo Tech Institute of Technology)

## [02222] Unfolding operator in Heisenberg group and its applications

**Session Time & Room** : 3D (Aug.23, 15:30-17:10) @A511

**Type** : Contributed Talk

**Abstract** : After the development of multi-scale convergence in the 1990s, the periodic unfolding approach is one of the most effective methods for studying multi-scale problems like homogenization in the Euclidean setup.

This talk will discuss the periodic unfolding operator in the Heisenberg group. Analogous to the Euclidean unfolding operator, we prove all the required properties. We apply the unfolding operator to homogenize an optimal control problem subject to a state equation having high contrast diffusive coefficients.

**Classification** : 35Rxx

**Format** : Talk at Waseda University

**Author(s)** : Abu Sufian (TIFR- Centre for Applicable Mathematics) Akambadath Keerthiyil Nandakumaran (Indian Institute of Science, Bangalore, India)

## [02224] Numerical simulation of convective flow models in porous media using deep learning technique

**Session Time & Room** : 2D (Aug.22, 15:30-17:10) @D404

**Type** : Contributed Talk

**Abstract** : The outstanding computational ability of artificial neural networks (ANN) makes the deep learning (DL) branch more robust for solving various simple and complex convective models  $\left(2D \sim 3D\right)$  in porous media. Moreover, it is an unsupervised learning approach in the DL that uses randomly sampled spatial and boundary collocation points as training data for ANN. A loss function according to the governing and boundary conditions is formulated and enforced to minimize at the sampled collocation points through the backpropagation algorithm using suitable optimization techniques. Eventually, a fine-tuned ANN is achieved after a sufficiently large number of training processes, and the tuned ANN is used to replicate the solution quickly.

**Classification** : 76S05, 68T07

**Author(s)** : Sumant Kumar (Defence Institute of Advanced Technology, Pune)Rathish Kumar Venkatesulu Bayya (Indian Institute of Technology Kanpur)Somanchi V.S.S.N.V.G. Krishna Murthy (Defence Institute of Advanced Technology, Pune)

## [02225] On Fractional Lah-Bell Polynomials and Numbers

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @F312

**Type** : Contributed Talk

**Abstract** : In this talk, we will present a fractional generalization of the Lah-Bell polynomials and the Lah numbers associated to the fractional Poisson probability distribution. We derive the exponential generating functions in terms of the Mittag-Leffler function along with some convolution identities. These identities are the natural extension of several well-known identities available in literature. Finally, applications to compound Poisson process, Mittag-Leffler function, and the Laguerre polynomials are also presented.

**Classification** : 60E05, 05A19, 26A33, 11C08, 05A17

**Format** : Online Talk on Zoom

**Author(s)** : Ritik Soni (Central University of Punjab)Ashok Kumar Pathak (Central University of Punjab)

## [02227] A discrete-time competition model of Ricker type with reproductive delay

**Session Time & Room** : 4D (Aug.24, 15:30-17:10) @E508

**Type** : Contributed Talk

**Abstract** : We study a discrete-time competition model of Ricker type with reproductive delay. The model is examined under the assumption that species 1 and 2 have the same vital rates except that a fraction of species 1 individuals delays the initiation of reproduction. This assumption ensures that species 2 can always increase whenever species 1 can increase. This study shows that, even under this situation, species 1 can eliminate species 2 if the population is fluctuating.

**Classification** : 92B05, 37N25, 39A60, 92D40, 92D25

**Format** : Online Talk on Zoom

**Author(s)** : Ryusuke Kon (University of Miyazaki)

## [02229] Efficient numerical methods for time-fractional Black-Scholes equation arising in finance

**Session Time & Room** : 2D (Aug.22, 15:30-17:10) @E702

**Type** : Contributed Talk

**Abstract** : Two numerical schemes to solve time-fractional Black-Scholes PDE governing European options. are proposed. First, fractional derivative is discretized by L1-scheme and spatial derivatives by cubic spline method on uniform mesh. Secondly, we discretize temporal variable by L1-scheme on non-uniform mesh and spatial derivatives by NIPG method on uniform mesh. Stability, convergence and numerical results are carried out. Three European options are priced as application and impact of time-fractional derivative order on option price is shown.

**Classification** : 65M06, 65M12, 65M15

**Format** : Online Talk on Zoom

**Author(s)** : Jaspreet Kaur Anand (Indian Institute of Technology Guwahati, Guwahati, Assam)Natesan Srinivasan (Indian Institute of Technology Guwahati, Guwahati, Assam)

## [02235] Numerical simulation of dislocation multiple cross-slip

**Session Time & Room** : 4D (Aug.24, 15:30-17:10) @G602

**Type** : Contributed Talk

**Abstract** : Our contribution deals with the phenomenon in material science called multiple cross-slip of dislocations in slip planes. The numerical model is based on a mean curvature flow equation with additional forcing terms included. The curve motion in 3D space is treated using our tilting method, i.e., mapping of a 3D situation onto a single plane where the curve motion is computed. The physical forces acting on a dislocation curve are evaluated in the 3D setting.

**Classification** : 35K57, 35K65, 65N40, 65M08, 53C80

**Format** : Talk at Waseda University

**Author(s)** : Petr Pauš (Czech Technical University in Prague)Miroslav Kolář (Czech Technical University in Prague)Michal Beneš (Czech Technical University in Prague)

## [02236] An hp-version discontinuous Galerkin method for the generalized Burgers-Huxley Equations with weakly singular kernel

**Session Time & Room** : 5C (Aug.25, 13:20-15:00) @A201

**Type** : Contributed Talk

**Abstract** : We study the numerical approximation for the generalized Burgers-Huxley equations with a weakly singular kernel. Firstly, we derive an a priori error estimate for the hp-version of discontinuous Galerkin (DG) time stepping method. For the start-up singularities near  $t = 0$ , using geometrically refined time-steps and linearly increasing approximation orders, we get the exponential rates of convergence. For the fully discretized system we combine the DG time-stepping method and DG finite element discretization in space. Finally, the computational results are presented to validate our theoretical results.

**Classification** : 65N15, 65N30

**Format** : Talk at Waseda University

**Author(s)** : Sumit Mahajan (Indian Institute of Technology, Roorkee)Arbaz Khan (IIT Roorkee)

## [02238] A Generalized Multi-Parameterized Proximal Point Algorithm

**Session Time & Room** : 4D (Aug.24, 15:30-17:10) @D408

**Type** : Contributed Talk

**Abstract** : Proximal point algorithm (PPA) is an important class of methods for solving convex problems. In this article, a generalized multi-parameterized proximal point algorithm (GM-PPA) is developed to solve linearly constrained convex optimization problems. Compared with existing PPAs, the proposed method is much more general as well as flexible. Many existing PPAs reduce to our algorithm when some newly introduced parameters are fixed. Furthermore, by appropriately setting the algorithm parameters, our GM-PPA is potentially able to reduce the computation time and iteration number whereas the convergence result can still be guaranteed. Numerical experiments on synthetic problem are conducted to demonstrate the efficiency of our algorithm.

**Classification** : 90C25, 90C30

**Format** : Talk at Waseda University

**Author(s)** : Yuan Shen ( Nanjing University of Finance & Economics)

## [02242] Metaheuristic based numerical solution and statistical optimization of heat transfer through rotating heat pipe

**Session Time & Room** : 5B (Aug.25, 10:40-12:20) @D101

**Type** : Contributed Talk

**Abstract** : This study presents the numerical solution for heat transfer through a rotating heat pipe filled with hybrid nanofluid Graphene oxide-molybdenum disulphide (GO-MoS<sub>2</sub>). The developed mathematical model is solved by hybridization of “Particle Swarm Optimization” along with finite difference method. Sensitivity of different parameters on heat transfer is analysed by fitting the full quadric regression model using response surface method. The identified parameters for heat transfer enhancement are nanoparticle concentration, inlet fluid mass and temperature difference.

**Classification** : 76A20, 80M20, 65L06, 62P35, 90C31

**Format** : Talk at Waseda University

**Author(s)** : Ziya Uddin (BML Munjal University, Gurugram)Hamdy Hassan (Egypt-Japan University of Science and technology)Souad Harmand (UPHF)Wubshet Ibrahim (Ambo University)

## [02248] Remedies for entropy growth from iterative methods in CFD

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @E604

**Type** : Contributed Talk

**Abstract** : We explore the influence of iterative methods on entropy-conserving and dissipative discretizations of nonlinear conservation laws with implicit time discretizations. Newton's method can cause entropy dissipative schemes to become anti-dissipative, even with smaller iteration errors than time integration errors. We suggest various remedies and find a relaxation technique to be the most effective. Numerical experiments with dispersive wave equations demonstrate that entropy conservation produces more accurate results than non-conservative schemes, even with larger tolerances.

**Classification** : 65M12, 65N22, 65H10, 65F10

**Format** : Talk at Waseda University

**Author(s)** : Viktor Linders (Lund University)Philipp Birken (Lund University)

## [02249] An Adaptive Time Stepping Scheme for Rate-Independent Systems

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @E503

**Type** : Contributed Talk

**Abstract** : We investigate a local incremental stationary scheme for the numerical solution of rate-independent systems. The main novelty of our approach in comparison to existing methods is an adaptive choice of the step size for the update of the curve parameter. It is proven that the piecewise affine approximations generated by the algorithm converge (weakly) to a so-called parametrized balanced viscosity solution. Numerical experiments illustrate the theoretical findings and show a significant increase of the step size during sticking and in viscous jumps.

**Classification** : 65J08, 65K15, 65M12, 65M50

**Format** : Talk at Waseda University

**Author(s)** : Merlin Andreaia (TU Dortmund University)Christian Meyer (TU Dortmund University)

## [02254] Optimized first order alternating algorithms for fast and accurate low rank tensor decomposition

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @G304

**Type** : Contributed Talk

**Abstract** : CP tensor decomposition has been proven to be a powerful tool for extracting information from large high order tensor, being widely applied in many areas such as chemistry, biology and medical science. However, efficiently computing the CP tensor still remains a challenge. In this study, we propose some optimized first order alternating least square algorithms for low rank tensor decomposition. We validate and illustrate the proposed algorithms by using simulated and real multi-way data.

**Classification** : 15A72, 15A69, 65Z05

**Format** : Talk at Waseda University

**Author(s)** : HUIWEN YU (Aarhus University)Ove Christiansen (Aarhus University)

## [02266] Constructing ternary quasigroups possessing properties of parastrophic orthogonality

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @G601

**Type** : Contributed Talk

**Abstract** : A set of  $\ell$  orthogonal  $n$ -ary operations or hypercubes of order  $m$  is equivalent to an  $(\ell, m^n, \ell-n+1)$  maximum distance separable or MDS code. Consequently, the problem of constructing MDS codes can be reduced to constructing orthogonal operations. We research constructing a ternary medial quasigroup possessing parastrophic orthogonality property. A necessary and sufficient condition that the quasigroup is self-orthogonal, strongly self-orthogonal or totally parastrophically orthogonal is that each polynomial of a certain set is invertible-valued.

**Classification** : 05B15, 20N05

**Format** : Online Talk on Zoom

**Author(s)** : Fedir Sokhatsky (VasylStus Donetsk National University)Iryna Fryz (Vasyl Stus Donetsk National University)

## [02267] A Massively Parallel Performance Portable Free Space Spectral Poisson Solver for Beam and Plasma Physics Problems

**Session Time & Room** : 4D (Aug.24, 15:30-17:10) @E504

**Type** : Contributed Talk

**Abstract** : Recently, a new fast algorithm for computing volume potentials has been proposed by Vico, Greengard, and Ferrando, which provides a spectral accuracy free-space Poisson equation solver, useful for plasma and beam physics. We write a parallel performance portable implementation in the IPPL library, using the Exascale Computing Project's heFFTe and Kokkos libraries, and MPI for parallelization. A comparison with the traditional Hockney-Eastwood algorithm manifests the memory benefits of using the new algorithm, especially on GPUs.

**Classification** : 65Y05, 78A30, 35Q61, 65K05, 65N80

**Format** : Talk at Waseda University

**Author(s)** : Sonali Mayani (Paul Scherrer Institute)Antoine Cerfon (NYU)Matthias Frey (University of St. Andrews)Veronica Montanaro (Paul Scherrer Institute)Sriramkrishnan Muralikrishnan (Jülich Supercomputing Centre)Andreas Adelmann (Paul Scherrer Institute)

## [02269] Mathematical model for prioritize patient in operating room block scheduling

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @D505

**Type** : Contributed Talk

**Abstract** : We concentrate on the scheduling problem in surgical operating room that involves limited equipment and surgical specialties. Our objective is develop a feasible schedule that consider resources utilization, prioritized patients in health risk condition and availability of the surgical specialties teams. Our approach is the assignation of operating room by block using week horizon with different relative weight. A mathematical model is proposed to optimum the operating room scheduling performance.

**Classification** : 90B35

**Format** : Online Talk on Zoom

**Author(s)** : Syarifah Zyurina Nordin (Malaysia Japan International Institute of Technology (MJIT), Universiti Teknologi Malaysia)

## [02271] Enumerate All Routes on a Doughnut

**Session Time & Room** : 2C (Aug.22, 13:20-15:00) @G304

**Type** : Contributed Talk

**Abstract** : We consider a following doughnut routing problem. Given a matching  $M=(U \cap V, E)$  as a bipartite graph, two concentric circles, the cyclic ordering of the vertices in  $U$  and  $V$ , we wish to draw  $M$  with the minimum number of edge crossings so that the vertices in  $U$  (resp.  $V$ ) are on the smaller (resp. larger) circle with the given cyclic ordering.

We propose an enumerate algorithm for all optimal solutions of the problem.

**Classification** : 05C38

**Format** : Talk at Waseda University

**Author(s)** : Yasuko Matsui (Tokai University)Shin-ichi Nakano (Gunma University)

## [02276] Detection Topic of Bjorka Using LSTM with LDA

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @E811

**Type :** Contributed Talk

**Abstract :** This paper presents topic modeling for Hacker Bjorka using LSTM with LDA. The Research purpose is to analyze the public opinion of Bjorka and the topics related to him in the online community. The findings reveal that the majority of the public perception of Bjorka is positive, with accuracy of 80,26% and perplexity of -8,28. This study provides a valuable contribution to the field of computational text analysis and its applications in the online community.

**Classification :** 68T07

**Author(s) :** Muhammad Muhajir (Universitas Gadjah Mada )Dedi Rosadi (Universitas Gadjah Mada )

## **[02286] Partially Observable Stochastic Control with Memory Limitation and Mean-Field Approach**

**Session Time & Room :** 1E (Aug.21, 17:40-19:20) @F401

**Type :** Contributed Talk

**Abstract :** In this presentation, we describe the difficulties with partially observable stochastic control, POSC, and then propose memory-limited POSC, ML-POSC, to solve them. POSC does not consider memory limitation, which hampers the applications to actual controllers. Furthermore, POSC needs to solve a functional differential equation, which is intractable even numerically. In contrast, ML-POSC explicitly formulates limited memories of controllers. Additionally, ML-POSC reduces a functional differential equation to a partial differential equation by the mean-field control technique.

**Classification :** 49N30, 49N80, 49K45, 93E20

**Format :** Talk at Waseda University

**Author(s) :** Takehiro Tottori (The University of Tokyo)Tetsuya J. Kobayashi (The University of Tokyo)

## **[02289] HIV Community Transmission: A Multi-strain Modelling Approach**

**Session Time & Room :** 1E (Aug.21, 17:40-19:20) @G402

**Type :** Contributed Talk

**Abstract :** In this study, we proposed a two-strain model comprising drug-sensitive and drug-resistant strains for the dynamics of Human Immunodeficiency Virus (HIV) spread in a community. A treatment compartment is included in the modelling framework by considering drug adherence. We introduced various time delays for different phase transitions of the disease to track down the effect of its chronicity. A comprehensive stability and bifurcation analysis reveal the importance of treatment availability and drug adherence.

**Classification :** 34D05, 34D20, 92D25, 92D30

**Format :** Online Talk on Zoom

**Author(s) :** Ashish Poonia (Indian Institute of Technology Guwahati)Siddhartha Pratim Chakrabarty (Indian Institute of Technology Guwahati)

## **[02290] Bilevel programming problems**

**Session Time & Room :** 4C (Aug.24, 13:20-15:00) @A207

**Type :** Contributed Talk

**Abstract :** Most real-world optimization problems have a hierarchical structure. In mathematical optimization, hierarchical optimization problems are often known as multilevel programming problems. A particular case of multilevel problems with just two decision-makers is called a bilevel programming problem. In the formal framework of bilevel programming problems, two decision-makers are involved, a leader and a follower, at two different levels, each striving to minimize their objective functions while constrained by several interconnected constraints.

**Classification :** 90C46, 49J52, 90C99

**Author(s) :** Shivani Saini (Thapar Institute of Engineering and Technology, Patiala, Punjab)



## [02298] New semidefinite relaxations for a class of complex quadratic programming problems

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @A201

**Type** : Contributed Talk

**Abstract** : In this talk, we propose some new semidefinite relaxations for a class of nonconvex complex quadratic programming problems, widely appear in signal processing and power system. By deriving new valid constraints to the matrix variables in the lifted space, we derive some enhanced semidefinite relaxations of complex quadratic programming problems. Then, we compare the proposed semidefinite relaxations with existing ones, and show that the newly proposed semidefinite relaxations could be strictly tighter than the previous ones. Numerical results indicate that the proposed semidefinite relaxations not only provide tighter relaxation bounds but also improve some existing approximation algorithms by finding better sub-optimal solutions.

**Classification** : 90C20, 90C22, 90C35

**Format** : Talk at Waseda University

**Author(s)** : Zhibin Deng (University of Chinese Academy of Sciences)Yinzhe Xu (North China Electric Power University)Cheng Lu (North China Electric Power University)Yafeng Liu (Chinese Academy of Sciences)

## [02300] Stability of Euler implicit/explicit-SAV schemes for the Navier-Stokes equations

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @E703

**Type** : Contributed Talk

**Abstract** : In this talk, the  $H^2$  stability of two types of the first order Euler implicit/explicit-SAV schemes for the Navier-Stokes equations with finite element discretization is studied with smooth or non-smooth initial data. In the literature, the first order Euler implicit/explicit scheme for the Navier-Stokes for the initial data  $u_0$  in  $H^\alpha$  with  $\alpha = 1, 2$  and the Euler semi-implicit/explicit scheme for the initial data  $u_0$  in  $H^0$  have been proven to have  $H^2$  almost unconditional stability. In this talk, with the help of scalar auxiliary variable approach, the  $H^2$  unconditional stability of two types of the first order Euler implicit/explicit-SAV schemes for the Navier-Stokes equations for the initial data  $u_0$  in  $H^\alpha$  with  $\alpha = 0, 1, 2$  are established, which improve the classical one. Numerical experiments are presented to support the stability results. This is joint work with Teng-Yuan Chang.

**Classification** : 65Mxx, 86-08, 76Bxx

**Format** : Talk at Waseda University

**Author(s)** : Ming-Cheng Shiue (National Yang Ming Chiao Tung University)TENG-YUAN Chang (National Yang Ming Chiao Tung University)

## [02301] Weak Maximum Principle for Nonlocal Boundary Value Problems

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @F311

**Type** : Contributed Talk

**Abstract** : Throughout the last years, increased attention has been devoted to the investigation of nonlocal models in which points separated by a non-vanishing distance interact with each other. In this talk, we present a weak maximum principle for nonlocal boundary value problems and point out a possible application.

**Classification** : 47G20, Analysis of Nonlocal Models

**Format** : Talk at Waseda University

**Author(s)** : Julia Huschens (Trier University)

## [02303] Coupling Of Nonlocal Neumann Problems

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @F311

**Type** : Contributed Talk

**Abstract** : In nonlocal models points separated by a non-vanishing distance interact with each other. Therefore, domains separated by a non-vanishing distance can be coupled in these models. In this talk, we consider the nonlocal diffusion operator  $\mathcal{L}u(x) := \int_{\mathbb{R}^d} u(x) - u(y) \gamma(y, x) \, dy$  and the nonlocal Neumann operator  $\mathcal{N}u(y) := \int_{\Omega} (u(y) - u(x)) \gamma(x, y) \, dx$ . With these operators we introduce a coupled Neumann problem and we, moreover, consider parabolic nonlocal Neumann equations.

**Classification** : 47G20, Analysis of nonlocal models

**Format** : Talk at Waseda University

**Author(s)** : Michael Vu (University Trier)

## [02305] Simulating First Passage Times for Ito Diffusions

**Session Time & Room** : 2D (Aug.22, 15:30-17:10) @E506

**Type** : Contributed Talk

**Abstract** : We are interested in the mechanism of olfactory receptor neuron responses in moths. A neuron's processing of information is represented by spike trains, collections of spikes, short and precisely shaped electrical impulses. Mathematically, these can be modeled as the first passage times of solutions to certain stochastic differential equations, describing the membrane voltage, to a threshold. Classical numerical methods like the Euler-Maruyama method and the Milstein scheme approximate hitting times as a 'by-product' and are not very good if we perform them on a large interval of time. For that reason, we study an algorithm that simulates the exact discretized grid of a class of stochastic differential equations. It uses an acceptance-rejection scheme for the simulation of that grid at random time intervals; later, the whole path can be completed independently of the target process by interpolation of the Brownian or Bessel bridge. This method is very effective in the sense that it neither simulates the whole path nor focuses on a fixed time interval. We further examine the different numerical methods with the help of an example.

**Classification** : 65C30, 60H99, 92-10, First Passage Times, Exact Simulations, Applications in Neuroscience

**Format** : Talk at Waseda University

**Author(s)** : Evelyn Buckwar (Johannes Kepler University) Devika Khurana (Johannes Kepler University)

## [02311] Lipschitz Stability of Recovering the Conductivity from Internal Current Densities

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @G809

**Type** : Contributed Talk

**Abstract** : Hybrid imaging techniques have been developed recently to produce clearer images than those produced by electrical impedance tomography. We focus on the inverse problem arising in the quantitative step of many hybrid imaging methods, formulated as recovering the isotropic conductivity of an object given internal current densities generated by applying different boundary conditions to the electrostatic equation. We provide a local Lipschitz stability for the general inverse problem in both full and partial data cases.

**Classification** : 35R30, 65N21, 92C55

**Format** : Talk at Waseda University

**Author(s)** : Lingyun Qiu (Yau Mathematical Sciences Center, Tsinghua University; Yanqi Lake Beijing Institute of Mathematical Sciences and Applications) Siqin Zheng (Yau Mathematical Sciences Center, Tsinghua University)

## [02312] Fractional controllability problem of semilinear hyperbolic systems

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @F402

**Type** : Contributed Talk

**Abstract** : In this communication, we talk about the fractional controllability problem of internally controlled semilinear hyperbolic systems. In the first method, we show the controllability of the linear system using Hilbert uniqueness method HUM, and the fractional controllability problem is solved applying Schauder's fixed point theorem. Secondly, the analytics study is then attempted by employing generalized inverse methods and changed also into a fixed point problem. Hence, we give an approximate approach to find a control that brings the Riemann-Liouville fractional attained position (resp. speed) to the required position  $y_d1$  (resp. speed  $y_d2$ ). Finally, computing simulations are used to confirm the obtained results.

**Classification** : 57-XX, 26-XX, 53-XX

**Format** : Online Talk on Zoom

**Author(s)** : Mustapha Benoudi (Moulay Ismail University)

## [02315] On Adaptive Kalman Filtration

**Session Time & Room** : 3D (Aug.23, 15:30-17:10) @E504

**Type** : Contributed Talk

**Abstract** : We consider a linear partially observed system. The coefficients of this system depend on some finite - dimensional unknown parameter. We study the problems of the construction of adaptive Kalman filtration equations. The adaptive filter is constructed in two steps. First we propose a preliminary estimator using observations on a relatively small interval of observations. Then this estimator is used for construction of One-step MLE-process. Finally the last estimator allows us to construct an adaptive recurrent filter.

**Classification** : 62M05, 62M20, 62F12, 62G20

**Format** : Talk at Waseda University

**Author(s)** : Yury Kutoyants (Le Mans University )

## [02316] Spatio-temporal modeling with SPDE based GMRF

**Session Time & Room** : 3D (Aug.23, 15:30-17:10) @E504

**Type** : Contributed Talk

**Abstract** : Gaussian random fields (GRFs) are a type of geostatistical model used in spatial inference problems. In many such contexts data are available at a given spatial scale, whereas predictions are required at another scale that represents a different spatial configuration.

The GRF model of interest and the accompanying Bayesian inferential procedure use the INLA-SPDE approach. In this talk I will describe the GRF model, the inference procedure and discuss challenges in this situation.

**Classification** : 62M30, 62P12, 60G60, 60H15, 62F15, Infer spatio-temporal precipitation patten in Austria

**Format** : Talk at Waseda University

**Author(s)** : Corinna Perchtold (Johannes Kepler University, Linz) Evelyn Buckwar (Johannes Kepler University) Johan Lindström (Lund University)

## [02319] Parameter estimation of the Richards model in multi-wave epidemic cases

**Session Time & Room** : 3D (Aug.23, 15:30-17:10) @E504

**Type** : Industrial Contributed Talk

**Abstract** : The Richards model with changepoint detection can model multi-wave infectious disease transmission. Next, choose the best parameter estimation method from non-linear least squares and genetic algorithm to accurately predict COVID-19 cases in Indonesia and Japan. Genetic algorithm predictions outperform non-linear least squares. A genetic algorithm only needs a range for the initial value, while non-linear least squares need an exact value. The government and health facilities can use prediction results to prevent infectious disease epidemics.

**Classification** : 62P10, 92B15, 92B05

**Format** : Talk at Waseda University

**Author(s)** : Faihatuz Zuhairroh (Universitas Gadjah Mada )Dedi Rosadi (Universitas Gadjah Mada )Adhitya Ronnie Effendie (Universitas Gadjah Mada )

## [02321] Anisotropic perimeter approximation for topology optimization

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @F403

**Type** : Contributed Talk

**Abstract** : Perimetric type functionals are known to be difficult to handle directly within topology optimization algorithms because of their high sensitivity to topology changes. I will present a Gamma-convergence approximation of an anisotropic variant of the perimeter which is built upon the solution of an elliptic boundary value problem. I will discuss the advantages of such a construction over local approximations, and show applications to the optimal design of supports in additive manufacturing.

**Classification** : 49Q10, 49Q20, 49Q05

**Format** : Talk at Waseda University

**Author(s)** : Samuel Amstutz (Ecole polytechnique)Beniamin Bogosel (Ecole polytechnique)

## [02322] Low discrepancy point sets inspired by Sudoku hypercubes

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @G601

**Type** : Contributed Talk

**Abstract** : Monte Carlo methods are effective to avoid the "Curse of Dimensionality," while not perfect since their convergences are late.

To overcome the weakness, quasi-Monte Carlo methods have been developed.

Some of the methods use low discrepancy point sets called  $(t, m, s)$ -nets.

In this talk, I present a new construction procedure of  $(t, m, s)$ -nets from orthogonal arrays as an application of the extension of Sudoku to higher dimensions named Sudoku hypercubes.

**Classification** : 05B15, 65C05

**Format** : Talk at Waseda University

**Author(s)** : Shigetaka Taga (University of Tsukuba)

## [02325] A Hybrid Method for Solving Linear KKT Systems

**Session Time & Room** : 4D (Aug.24, 15:30-17:10) @E508

**Type** : Contributed Talk

**Abstract** : We propose an iterative method for solving linear systems arising from optimization problems with a separable objective function and dense constraints and suitable preconditioner for quick convergence. The method is implemented in Julia using Krylov.jl for the iterative solution, CUDA.jl to enable GPU capabilities, and a custom kernel for construction of the preconditioner. The method attains faster solution times than direct methods common in solvers such as Mosek and Gurobi

in theory and in practice.

**Classification** : 65F10, 15A29, 90C05, 65K05, 90C25

**Format** : Talk at Waseda University

**Author(s)** : Shaked Regev (Gridmatic)Shaked Regev (Gridmatic)

## [02326] Multi-level Wavelet Convolutional Neural Networks for Classifying Lung Cancer

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @E811

**Type** : Contributed Talk

**Abstract** : Lung cancer classification becomes significant as it can increase the survival rate. Our previous study to classify lung cancer using Recurrent Neural Networks (RNN) and Wavelet RNN intensify accuracy by 2.7%. It may increase with the computational complexity. Thus, in this research, we focus classifying lung cancer using deep learning Neural Networks that has been successfully applied in practice. A model called Multi-level Wavelet Convolutional Neural Networks. This study provides more discussion on Neural Networks and lung cancer classification.

**Classification** : 68T07

**Format** : Online Talk on Zoom

**Author(s)** : Devi Nurtiyasari (Gadjah Mada University)Dedi Rosadi (Gadjah Mada University)Abdurakhman Abdurakhman (Gadjah Mada University)

## [02329] Improve Error Prediction Using Regularization Model for Movie Recommendation System

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @E811

**Type** : Contributed Talk

**Abstract** : Currently, most applications (such as Netflix, Spotify, and the others) provide engaging facilities to improve the user's experience. These applications highly depend on the effectiveness of their recommendation systems. The goal for this paper was to improve error prediction (RMSE and MAE) using Regularization model compared with state-of-art models. The proposed technique obtains a better result than a state-of-art model with an improvement of 0.48% and 1.43% on error prediction using ML-1M dataset, respectively.

**Classification** : 68T07, 68T09, Machine Learning

**Format** : Online Talk on Zoom

**Author(s)** : Malim Muhammad (Universitas Gadjah Mada)Dedi Rosadi (Universitas Gadjah Mada)Danardono Danardono (Universitas Gadjah Mada)

## [02330] Representation Learning for Continuous Single-cell Biology with Graph Neural Networks

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @D505

**Type** : Contributed Talk

**Abstract** : Single-cell RNA sequencing provides high-resolution transcriptomics to study cellular dynamic processes, yet its high-dimensionality, sparsity, and noises undermine the performance of downstream analysis. We propose a deep learning framework based on Variational Graph AutoEncoder to learn a low-dimensional representation that preserves global information and local continuity. By applying pseudotemporal ordering to the extracted features, we show that the model accurately preserves the dynamic cell trajectories of real and synthetic scRNA-seq datasets.

**Classification** : 92B20, 68T05, Machine Learning, Bioinformatics

**Format** : Talk at Waseda University

**Author(s)** : Chengkai Yang (The University of Tokyo)

## [02332] Risk Parity Portfolio in the COVID-19 Era: Indonesia Empirical Evidence

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @A510

**Type** : Contributed Talk

**Abstract** : A Risk Parity Portfolio allocates capital thus each asset contributes the same amount of risk to the entire portfolio. In this paper, we conduct an empirical study of Risk Parity Portfolio with Gaussian Multivariate Mixture-Based Clustering based on financial ratio data. The daily closing price data of LQ45 index stocks listed on the Indonesia Stock Exchange were employed. The performance of the Risk Parity Portfolio outperformed the Tangency Portfolio in the COVID-19 era.

**Classification** : 91G10, 91G80

**Format** : Online Talk on Zoom

**Author(s)** : Rosita Kusumawati (Mathematics Department, Mathematics and Natural Sciences Faculty, Universitas Gadjah Mada)Dedi Rosadi (Mathematics Department, Mathematics and Natural Sciences Faculty, Universitas Gadjah Mada)Abdurakhman Abdurakhman (Mathematics Department, Mathematics and Natural Sciences Faculty, Universitas Gadjah Mada)

## [02334] A generalized integral equation formulation for pricing American options under regime-switching model

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @D505

**Type** : Contributed Talk

**Abstract** : In this paper, we present a generalized integral equation formulation for American put options under regime-switching model, with a goal of improving computational efficiency in mind, particularly when the number of regimes,  $n$  is large. Given that the integral equation approach is characterized with its excellent trade off between maximizing analytical tractability and minimizing numerical discretization, our achieved high efficiency is based on a newly proved theorem, which facilitates the decoupling of an originally simultaneously involved  $n$ -PDEs so that they can be solved recursively at the numerical solution stage. While some numerical examples are provided to demonstrate the implementation of the new approach and its efficiency, it is anticipated that the very same theorem can be used to reduce the computational burden if other numerical approaches are adopted.

**Classification** : 91G20, 91-10

**Format** : Talk at Waseda University

**Author(s)** : Yawen Zheng (University of Wollongong)Song-Ping Zhu (University of Wollongong)

## [02336] Within-Groups Generalized M-Estimators in One-Way Unbalanced Panel Data Model

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @E504

**Type** : Industrial Contributed Talk

**Abstract** : Within-Groups Generalized M-Estimators (WGM) is a method for determining robust estimators of outliers for panel data models. This study will conduct a simulation to compare WGM in one-way unbalanced panel data model with fixed-effects approach using different multivariate locations and scale estimators, namely S-multivariate, Minimum Volume Ellipsoid (MVE), and Minimum Covariance Determinant (MCD). Then apply it to economic growth data in Kalimantan. Based on the simulation results and applications, it is known that the WGM with the S-multivariate estimator gives a better MSE value.

**Classification** : 62J99

**Format** : Talk at Waseda University

**Author(s)** : Desi Yuniarti (Department of Mathematics, Faculty of Mathematics and Natural Science, Universitas Gadjah Mada, Yogyakarta)Dedi Rosadi (Department of Mathematics, Faculty of

Mathematics and Natural Science, Universitas Gadjah Mada, Yogyakarta)Abdurakhman Abdurakhman  
(Department of Mathematics, Faculty of Mathematics and Natural Science, Universitas Gadjah Mada,  
Yogyakarta)

## [02337] Numerical analysis for the cancer invasion system with nonlocal diffusion

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @E604

**Type** : Contributed Talk

**Abstract** : Cancer modelling is challenging in grounds of capturing the physics behind it and performing numerical simulations. In this work, we analyze the cancer invasion model with nonlocal diffusion. First, the Galerkin finite element scheme is implemented to the given system of equations for spatial discretization. Then, backward Euler scheme is applied for temporal discretization. Further, a priori error bounds and convergence estimates for the fully-discrete problem are derived. Numerical tests provided validate the theoretical studies.

**Classification** : 65M15, 65M60, 92B05

**Format** : Talk at Waseda University

**Author(s)** : Kausika Chellamuthu (Bharathiar University, Coimbatore 641046, Tamil Nadu.)

Manimaran Jeyaraj (Vellore Institute of Technology)Manimaran Jeyaraj (Vellore Institute of Technology, Chennai Campus, Chennai - 600127.)

## [02343] Construction and analysis of splitting methods for Chemical Langevin Equations

**Session Time & Room** : 3D (Aug.23, 15:30-17:10) @E502

**Type** : Contributed Talk

**Abstract** : Consider modeling the stochastic dynamics underlying different chemical systems, which is usually described by the

Gillespie Stochastic Simulation Algorithm (SSA), i.e. the Markov process arising from taking into account every

single chemical reaction event. While exact and easy to implement, this algorithm is computationally expensive for

chemical reactions involving a large number of molecular species. As an approximation, Chemical Langevin Equations

(CLEs) can work for large number of species or/and reactions. In this talk, we construct an explicit splitting method

applied to the system of CLEs for a simple example of a reversible bimolecular reaction. The drift term of this

stochastic differential equation system satisfies a local one-sided Lipschitz condition and the diffusion term involves

square root terms. We then present the main ideas of a mean-square convergence proof, as well as numerical

illustrations. The results are joint work with Youssra Souli, Johannes Kepler University, Linz.

**Classification** : 60H10, 65C30, 60H35

**Format** : Talk at Waseda University

**Author(s)** : Evelyn Buckwar (Johannes Kepler University)Youssra Souli (Johannes Kepler University)

## [02345] Performance of the Treynor Ratio in Compilation of Fuzzy Portfolios

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @A510

**Type** : Industrial Contributed Talk

**Abstract** : In investing, investors have several characteristics, namely risk averse, risk seeker, and risk indifferent. Differences in these characteristics lead to the preparation of an optimal portfolio in decision-making. This study analyzes the application of the Treynor ratio as an instrument to measure portfolio performance. Portfolio preparation uses a fuzzy approach. The process of optimizing the model by applying multiobjective. The results of this study are the portfolio Treynor index ratio formed against the characteristics for the three characteristics of investors. This is used for investor recommendations in determining investment decisions.

**Classification** : 91G10, 91G80

**Format** : Online Talk on Zoom

**Author(s)** : Padrul Jana (Universitas Gadjah Mada)Dedi Rosadi (Universitas Gadjah Mada)Epha Diana Supandi (Universitas Islam Negeri Sunan Kalijaga)

## **[02347] Reduction of High Wave Load on a Sea Wall by an Elastic Plate and a Porous Structure**

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @E820

**Type** : Contributed Talk

**Abstract** : The present study investigates the wave impact on a sea wall in the presence of an elastic plate and a finite-width porous structure within the linearized water wave theory framework. By employing eigenfunction expansion, a system of an algebraic equation is obtained and solved. The force, reflection and dissipation coefficients are plotted through graphs to investigate the effect of different system parameters.

**Classification** : 76B15

**Format** : Talk at Waseda University

**Author(s)** : GAGAN SAHOO (IIT ROPAR)SUBASH CHANDRA MARTHA (IIT Ropar)SOFIA SINGLA (IIIT UNA, UNA)

## **[02348] Multi-day Value-at-Risk estimation by GARCH and Extreme Value Theory**

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @E505

**Type** : Contributed Talk

**Abstract** : The conventional VaR models have been unable to predict huge losses by market prices because these underestimate the probability of extreme price fluctuations. To overcome this problem, McNeil and Frey introduced a two-step approach combining the GARCH model and EVT. In this study, we investigate the estimation of multi-day VaR based on a bootstrapping simulation approach with GARCH-EVT, as well as perform back-testing in order to evaluate its ability to provide appropriate multi-day VaR estimation.

**Classification** : 62P05

**Format** : Talk at Waseda University

**Author(s)** : Ichiro Nishi (Tokio Marine Holdings, Inc.)

## **[02351] THE WELL-POSEDNESS AND DISCONTINUOUS GALERKIN APPROXIMATION FOR THE NON-NEWTONIAN STOKES–DARCY–FORCHHEIMER COUPLING SYSTEM**

**Session Time & Room** : 5B (Aug.25, 10:40-12:20) @D101

**Type** : Contributed Talk

**Abstract** : We establish the well-posedness theorem and study discontinuous Galerkin (DG) approximation for the non-Newtonian Stokes--Darcy--Forchheimer system modeling the free fluid coupled with the porous medium flow with shear/velocity-dependent viscosities. The unique existence is proved by using the theory of nonlinear monotone operator. In particular, we prove a coupled inf-sup



condition to show the existence of pressure in  $L^2(\Omega_1) \times L^{\frac{3}{2}}(\Omega_2)$ . We also explore the convergence of the Picard iteration for the continuous problem. Moreover, we apply the DG method with  $\mathbb{P}_k/\mathbb{P}_{k-1}$  element for numerical discretization and obtain the well-posedness, stability, and error estimate. For the discrete problem, we also investigate the convergence of the Picard iteration. The theoretical results are confirmed by the numerical examples.

**Classification** : 76Axx, 76Sxx, 76Dxx, 65Nxx

**Format** : Talk at Waseda University

**Author(s)** : Jingyan Hu (University of Electronic Science and Technology of China)Guanyu Zhou (University of Electronic Science and Technology of China)

## [02352] Analysis of a model of Dengue fever transmission

**Session Time & Room** : 1E (Aug.21, 17:40-19:20) @G402

**Type** : Contributed Talk

**Abstract** : In our study, we consider a model formulation of a dengue fever transmission including delay terms. The next-generation matrix techniques have been used for deriving the basic reproduction number for the spread of infectious disease. Nondimensionalisation has been carried out and equilibrium points have been obtained. Then stability analysis of the delay model has been investigated. Numerical simulations have been shown for the specific parameters and the effect of the time delays has been observed.

**Classification** : 34D20, 37G15, 92D25, 92-10, 34K20

**Format** : Talk at Waseda University

**Author(s)** : Burcu Gürbüz (Johannes Gutenberg-University Mainz)Aytil Gökçe (Ordu University)Segun Isaac Oke (Ohio University, USA)Michael O. Adeniyi (Lagos State University of Science and Technology)Mayowa M. Ojo (Thermo Fisher Scientific)

## [02353] Finite volume coupled with finite element scheme for the chemotaxis-fluid model

**Session Time & Room** : 4D (Aug.24, 15:30-17:10) @D401

**Type** : Contributed Talk

**Abstract** : We propose a linear decoupled positivity-preserving scheme for the chemotaxis-fluid system modeling the mutual interaction of the swimming aerobic bacteria with the surrounding fluid flow. The scheme consists of the finite element method (FEM) for the fluid equations on a regular triangulation and an upwind finite volume method (FVM) for the chemotaxis system on two types of dual mesh. The discrete cellular density and chemical concentration can be regarded as the piecewise constant functions on the dual mesh (or equivalently, the piecewise linear functions on the triangulation in the mass-lumping sense), which are obtained by the upwind finite volume approximation satisfying the positivity-preserving and mass conservation laws.

The numerical velocity is computed by the finite element method in the triangulation and is utilized to define the upwind-type numerical flux in the dual mesh. We examine the  $M$ -property of the matrices from the discrete system and prove the well-posedness and the positivity-preserving property. By using the  $L^p$ -estimate of the discrete Laplace operators, semigroup analysis, and induction method, we establish the optimal error estimates for chemical concentration, cellular density and velocity field in  $(l^\infty(W^{1,p}), l^\infty(L^p), l^\infty(W^{1,p}))$ -norms. Several numerical examples are presented to confirm the theoretical results.

**Classification** : 76Dxx, 65Mxx, 76Mxx

**Format** : Talk at Waseda University

**Author(s)** : Ping Zeng (University of Electronic Science and Technology of China)Guanyu Zhou (University of Electronic Science and Technology of China)

## [02356] Reconstruction of Multipolar Acoustic Sources using Sparse Measurements

**Session Time & Room** : 1D (Aug.21, 15:30-17:10) @A208

**Type** : Contributed Talk

**Abstract** : In this talk, we will discuss an algorithm for reconstructing multipolar acoustic sources using sparse far-field multifrequency measurements of the scattered field. A hybrid Fourier algorithm exploiting the low rank of the structured Hankel matrix associated with the scattered field is designed. The sparse data is first linked to the Fourier coefficients of the source, then enriched using an annihilation-filter-based Hankel matrix completion approach (ALOHA), and finally inverted for sources using the inverse Fourier transform.

**Classification** : 45Qxx, 65Txx, Machine Learning

**Format** : Talk at Waseda University

**Author(s)** : Abdul Wahab (Nazarbayev University)Abdul Wahab (Nazarbayev University)

## [02358] Minimal time for boundary controllability of linear hyperbolic balance laws

**Session Time & Room** : 5C (Aug.25, 13:20-15:00) @A207

**Type** : Contributed Talk

**Abstract** : The purpose of this talk is to present our recent results on minimal control time for null and exact boundary controllability of 1-D linear hyperbolic balance laws with arbitrary internal and boundary coupling. We will show explicit and easy-to-compute formulas to completely characterize such critical quantities, which can be strictly smaller than the classical uniform lower bound. The difference between these two kinds of controllability will also be discussed.

**Classification** : 93B05, 35L04, Control of Partial Differential Equations; Boundary Controllability; Hyperbolic system involving balance laws (with source term (i.e. internal coupling)) and Conservation laws (without source term); Optimal control time

**Format** : Talk at Waseda University

**Author(s)** : Long Hu (Shandong University)Guillaume Olive (Jagiellonian University)

## [02359] A Weighted Max-Min Model for Stochastic Fuzzy Multi-Objective Supplier Selection in a Supply Chain

**Session Time & Room** : 2C (Aug.22, 13:20-15:00) @G301

**Type** : Contributed Talk

**Abstract** : This research is focused on the study of Nonsymmetrical Stochastic Fuzzy Multi-Objective Supplier Selection Linear Programming (SFMOSSLP) with objective and constraint functions containing fuzzy parameters and random variables. This study aimed to develop an algorithm to transform the SFMOSSLP into a Deterministic Single-Objective Linear Programming (DSOLP) using the weighted max-min method so it can be easy to solve using the simplex method. In the end, we showcase the algorithm's performance and discuss its practicality.

**Classification** : 03B52, 03E72, 90C05, 90C15, 60G07

**Author(s)** : Grandianus Seda Mada (Universitas Gadjah Mada)Nugraha K. F. Dethan (Universitas Timor)Julius Aloysius Nenoharan (Universitas Timor)

## [02361] A unified framework for convergence analysis of stochastic gradient algorithms with momentum: a linear two-step approach

**Session Time & Room** : 2D (Aug.22, 15:30-17:10) @E506

**Type** : Contributed Talk

**Abstract** : From the viewpoint of weak approximation, the stochastic gradient algorithm and stochastic differential equation are closely related. In this talk, we develop a systematic framework for the convergence of stochastic gradient descent with momentum by exploring the stationary distribution of a linear two-step method applied to stochastic differential equations. Then we prove the convergence of two stochastic linear two-step methods, which are associated with the stochastic heavy ball method and Nesterov's accelerated gradient method.

**Classification** : 65C30, 60H35

**Format** : Talk at Waseda University

**Author(s)** : Qian Guo (Shanghai Normal University) Fangfang Ma (Shanghai Normal University)

## [02365] Fuzzy C-Medoids Clustering on the Foreign Currency Exchange Rate Against the Indonesian Rupiah

**Session Time & Room** : 3D (Aug.23, 15:30-17:10) @E504

**Type** : Industrial Contributed Talk

**Abstract** : The exchange rate is always fluctuating, indicates the presence of heteroscedasticity. Forecasting currency exchange rate movements is necessary in order to make a correct decision. In this study, clustering was carried out using a fuzzy c-medoids algorithm with distances based on the estimated parameters of the GARCH model. The case study used is data on foreign exchange rates against the Indonesian Rupiah (IDR) for the monthly period of January 2018–October 2022.

**Classification** : 62M10

**Format** : Online Talk on Zoom

**Author(s)** : Vemmie Nastiti Lestari (Universitas Gadjah Mada) Abdurakhman Abdurakhman (Universitas Gadjah Mada) Dedi Rosadi (Universitas Gadjah Mada)

## [02367] Applying the 2 Steps SLP method to the UC-ACOPF problem

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @D408

**Type** : Contributed Talk

**Abstract** : The Unit Commitment (UC) problem is a widely used tool for the daily management of power transmission networks in modern economies. While the classical UC is a mixed-integer linear problem, when the AC Power Flow (ACPF) equations are included as constraints it becomes a mixed-integer nonlinear problem (MINLP). The 2-Step SLP method has been successfully applied to solving MINLP problems for gas networks, and here we will analyze its performance for power networks.

**Classification** : 90Cxx

**Format** : Talk at Waseda University

**Author(s)** : Dolores Gómez (Universidade de Santiago de Compostela) Alfredo Ríos-Albores (Universidade de Santiago de Compostela) Pilar Salgado (Universidade de Santiago de Compostela)

## [02369] Unique continuation results for generalized ray transforms

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @F311

**Type :** Contributed Talk

**Abstract :** We discuss unique continuation results for certain generalized ray transforms. We prove that if the generalized ray transform of a function vanishes along all lines passing through an open set in Euclidean space, and the function vanishes in that same open set, then the function vanishes identically. We give an example to show that the second assumption cannot be removed. We also consider generalized transforms on higher order objects such as vector fields, symmetric 2-tensor fields etc., and under the same hypotheses, show that a certain component vanishes. Since such ray transforms have a non-trivial kernel, this is the optimal result that one can expect.

**Classification :** 46F12, 35J40, 45Q05

**Format :** Talk at Waseda University

**Author(s) :** Divyansh Agrawal (TIFR Centre for Applicable Mathematics (CAM))Venkateswaran P. Krishnan (TIFR Centre for Applicable Mathematics (CAM))Suman Kumar Sahoo (University of Jyväskylä)

## **[02372] Stokes flow past circular cylinders in slip-patterned microchannel using BEM**

**Session Time & Room :** 5D (Aug.25, 15:30-17:10) @D101

**Type :** Contributed Talk

**Abstract :** We present Stokes flow past staggered circular cylinders in microchannel with an alternating slip and no-slip on the channel walls. We utilize Boundary Element Method (BEM) to numerically solve Stokes equation. In order to gain a deep insight of flow mechanics, we investigate the streamlines, velocity profiles, and pressure drops with varying slip-length, radius of the cylinder, and spacing between the cylinder. The findings of this study might be helpful for mixing enhancement in microchannel.

**Classification :** 76M15, 35Q30, 76B15, 65N38, 76M10

**Author(s) :** Chandra Shekhar Nishad (Pandit Deendayal Energy University Gandhinagar )

## **[02374] Embarrassingly-parallel optimization algorithms for high-dimensional optimal control**

**Session Time & Room :** 2E (Aug.22, 17:40-19:20) @F401

**Type :** Contributed Talk

**Abstract :** Developing efficient algorithms for Hamilton--Jacobi partial differential equations  $\mathcal{HJ}$  PDEs is crucial for solving high-dimensional optimal control problems in real time but notoriously tricky due to the so-called curse of dimensionality. In this talk, we present novel grid-free and embarrassingly-parallel optimization algorithms for solving a broad class of  $\mathcal{HJ}$  PDEs relevant to high-dimensional state-dependent optimal control problems. We illustrate their performance and efficiency on large-scale multi-agent path planning problems.

**Classification :** 49L12, 65K10, 90C30, 49M29, 49M37

**Format :** Talk at Waseda University

**Author(s) :** Gabriel Provencher Langlois (New York University)Jerome Darbon (Brown University)

## **[02377] Accurate approximation of layer potentials evaluated near surfaces of spherical topology**

**Session Time & Room :** 4C (Aug.24, 13:20-15:00) @E704

**Type :** Contributed Talk

**Abstract :** Layer potentials, integrals representing the solution of a PDE when solved using boundary integral methods, are notoriously difficult to accurately evaluate close to the boundary of the domain due to a rapidly varying integrand. The presented quadrature method resolves this key challenge by factoring the integrand into a smooth and a simpler nearly singular part, then efficiently expanding the smooth part in a new basis and treating the remaining nearly singular integrals analytically.

**Classification :** 65D32, 65D30, 65R20, 65N99

**Format** : Talk at Waseda University

**Author(s)** : David Krantz (KTH Royal Institute of Technology)Anna-Karin Tornberg (KTH Royal Institute of Technology)

## **[02378] Hough transform generalization for detecting fuzzy lines and fuzzy circles**

**Session Time & Room** : 1C (Aug.21, 13:20-15:00) @

**Type** : Contributed Talk

**Abstract** : In this paper, we investigate a technique, namely fuzzy Hough transform, to detect fuzzy geometrical entities like fuzzy lines and fuzzy circles. This technique identifies fuzzy lines and fuzzy circles by a voting procedure. This voting procedure is carried out in parameter space in the fuzzy set-theoretic framework. Sequentially, a concept of similarity measure between two fuzzy shapes is delineated. Moreover, we apply the proposed technique in a few authentic images to detect fuzzy lines and fuzzy circles. Also, the idea of similarity measure between two fuzzy shapes is implemented in two sample images of fuzzy shapes.

**Classification** : 03E72, 97G40

**Author(s)** : Diksha Gupta (Ajeenkya D Y Patil University, Pune)

## **[02379] Quasigroups with inverse properties and information protection**

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @G305

**Type** : Contributed Talk

**Abstract** : In connection with the computerization of almost all spheres of life, the need for information protection, and therefore for the development of new encryption methods, has grown rapidly. To quickly decipher the information, it is appropriate to use invertible functions having the property of some invertibility of elements, i.e. quasigroups with inverse properties. We investigate varieties of these quasigroups and propose methods for their constructions and applications.

**Classification** : 20N05, 08B15, 14L30

**Format** : Online Talk on Zoom

**Author(s)** : Alla Lutsenko (Vasyl' Stus Donetsk National University)

## **[02380] PDE methods for joint reconstruction-segmentation of images**

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @A502

**Type** : Contributed Talk

**Abstract** : In practical image segmentation tasks, the image must first be reconstructed from indirect/damaged/noisy observations. Traditionally, reconstruction-segmentation would be performed in sequence: first reconstruct, then segment. Joint reconstruction-segmentation performs reconstruction and segmentation simultaneously, using each to guide the other.

Past joint reconstruction-segmentation has employed relatively simple segmentation algorithms, e.g. Chan-Vese. This talk will describe how joint reconstruction-segmentation can be performed using Bhattacharyya-flow-based segmentation (Michailovich et al., 2007) and graph-PDE-based segmentation (Merkurjev et al., 2013).

**Classification** : 94A08, 35Q93, 35R02

**Format** : Talk at Waseda University

**Author(s)** : Jeremy Michael Budd (California Institute of Technology )Franca Hoffmann (California Institute of Technology )Allen Tannenbaum (Stony Brook University)Yves van Gennip (Technische Universiteit Delft)Carola-Bibiane Schönlieb (University of Cambridge)Jonas Latz (Heriot-Watt University)

## [02381] Dynamic parking pricing for smart urban transportation system

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @D502

**Type** : Contributed Talk

**Abstract** : Traffic jam is one of the critical challenges of an urban city. Researchers have reported that search for a parking space significantly contributes to this problem. By having a dynamic pricing depending on the demand, this challenge can partially be addressed by filtering customers to move to other non-demanding parking spaces or look for cost reasonable options. Furthermore, parking places will compete to maximize their profit. Hence, a game theoretic or hierarchical decision making model can best describe the scenario. Bounded by the allowed maximum parking pricing, perhaps set by the city administration, and the minimum price to stay in business, this paper models a dynamic parking pricing as a price-wise continuous multilevel decision making problem.

**Classification** : 90-XX, 90B06, 00A69

**Author(s)** : Surafel L Tilahun (Addis Ababa Science and Technology University)

## [02384] An Energy Stable Semi-implicit Scheme for the Euler System under Diffusive Scaling

**Session Time & Room** : 3D (Aug.23, 15:30-17:10) @G601

**Type** : Contributed Talk

**Abstract** : An asymptotic preserving (AP) and energy stable scheme for the barotropic Euler system under a diffusive scaling is designed and analysed. A semi-implicit upwind finite volume on a staggered grid which dissipates the mechanical energy is introduced. The proposed scheme preserves the positivity of density and is consistent with weak solutions. The results of extensive case studies are presented to substantiate the robustness and efficacy of the proposed scheme as well as the theoretical claims.

**Classification** : 35L45, 35L65, 35L67, 35L60

**Format** : Talk at Waseda University

**Author(s)** : Arun Koottungal Revi (Indian Institute of Science Education and Research Thiruvananthapuram) Mainak Kar (Indian Institute of Science Education and Research Thiruvananthapuram)

## [02389] Exploring the excess of cloud condensation nuclei and rain suppression using a minimal 3D Boussinesq model with bulk cloud microphysics

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @D408

**Type** : Contributed Talk

**Abstract** : For many decades the hypothesis that an increase in air pollution could affect the rain formation processes has been discussed with theoretical, experimental, and numerical arguments. Several studies have shown that higher pollutant concentrations can inhibit, decrease or increase precipitation. Differences between results arise partly from the complexity of the problem, which requires the consideration of processes at multiple scales. This study aims to provide a very simple numerical model that satisfactorily represents the atmospheric dynamics and cloud microphysics to explore the effect of pollution on rain formation. We adapted and extended a previously existing three-dimensional minimal model consisting of five equations describing the atmospheric dynamics and implemented a simple bulk parametrization that represents the role of cloud condensation nuclei (CCN) 's role in cloud formation processes. To explore the effect of different CCN concentrations and distributions, we used two CCN profiles, one with a single accumulation layer and one with two layers, modifying their concentrations. Our results showed that polluted scenarios resulted in rain inhibition when a single CCN layer was initially present and rain increment when two layers were present. In low-polluted environments, both CCN initial profiles generated similar precipitation and showed similar

dynamic patterns. In this talk, we will highlight the importance of the vertical distribution of CCN, not only concentration, on the formation of rain, its inhibition, or suppression. This is joint work with Olmo Guerrero Medina.

**Classification** : 86A08, 35Q86

**Format** : Talk at Waseda University

**Author(s)** : Gerardo Hernandez-Duenas (National Autonomous University of Mexico, Institute of Mathematics) Olmo Guerrero-Medina (University of California Davis)

## **[02390] Discontinuous Galerkin method for time-fractional delay differential equation**

**Session Time & Room** : 3D (Aug.23, 15:30-17:10) @G402

**Type** : Contributed Talk

**Abstract** : In this article, we analyze the discontinuous Galerkin method for time-fractional partial differential equation with delay term  $u(\theta(t))$ , where  $\theta(t)=t-\tau(t)<t$ . The well-posedness of the fully discrete scheme for a fractional delay system is investigated. Also, we show the optimal order of convergence in the energy norm. Some numerical results are provided to support theoretical results.

**Classification** : 26A33, 35D30, 65M60, 34K37

**Format** : Talk at Waseda University

**Author(s)** : Raksha Devi (Department of Mathematics, Indian Institute of Technology, Roorkee ) Dwijendra N. Pandey (Department of Mathematics, Indian Institute of Technology, Roorkee )

## **[02391] Null controllability of semilinear differential inclusion with nonlocal condition**

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @G402

**Type** : Contributed Talk

**Abstract** : We discuss the null controllability of semilinear differential inclusion with the nonlocal condition using  $L^p([0, a], U)$  control, where  $U$  may be a separable Hilbert space or uniformly convex Banach space. Undoubtedly, exact controllability is much more beneficial than null controllability. But, null controllability plays its role in a system where exact controllability does not hold. Differential inclusion can properly define partial differential equations involving jump discontinuous functions.

**Classification** : 34G10

**Format** : Talk at Waseda University

**Author(s)** : BHOLANATH KUMBHAKAR (DEPARTMENT OF MATHEMATICS, INDIAN INSTITUTE OF TECHNOLOGY ROORKEE) DWIJENDRA NARAIN PANDEY (DEPARTMENT OF MATHEMATICS, INDIAN INSTITUTE OF TECHNOLOGY ROORKEE)

## [02393] Effect of adding reactions on the chemical reaction network sensitivity

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @G802

**Type** : Contributed Talk

**Abstract** : Biological functions arise from the complex dynamics of reaction networks comprising numerous reactions and chemicals. However, network information is often inaccurate and diverse across species. Previously, we developed the "Structural Sensitivity Analysis", which enables the responses of reaction systems to parameter perturbations to be determined solely from network topology. In this study, we investigate how small alterations to network structure affect system behavior. The results can be classified into five distinct cases based on topology.

**Classification** : 37N25

**Author(s)** : Atsuki Hishida Atsuki Hishida (Kyoto University)Atsushi Mochizuki (Kyoto University)

## [02394] Gaussian distributions on Riemannian symmetric spaces of non-positive curvature

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @F402

**Type** : Contributed Talk

**Abstract** : Learning from data that live in Riemannian manifolds has become central to many applications, ranging from radar signal processing to neuroscience. In this talk, we present a generalisation of Gaussian distributions to Riemannian symmetric spaces of non-positive curvature, which include hyperbolic spaces, as well as spaces of real, complex and quaternion positive definite matrices, and spaces of structured Toeplitz or block-Toeplitz positive definite matrices and discuss applications to geometric statistics on such spaces.

**Classification** : 53C22, 53B20, 53B50, 53C80, 53C35, Geometric statistics, probability on manifolds

**Format** : Talk at Waseda University

**Author(s)** : Cyrus Mostajeran (Nanyang Technological University)Salem Said (Université Grenoble-Alpes)

## [02398] Mixed-precision Paterson--Stockmeyer method for evaluating matrix polynomials

**Session Time & Room** : 2D (Aug.22, 15:30-17:10) @E503

**Type** : Contributed Talk

**Abstract** : The Paterson--Stockmeyer method is an evaluation scheme for matrix polynomials with scalar coefficients that arise in many state-of-the-art algorithms based on polynomial or rational approximants, for example, those for computing transcendental matrix functions. We derive a mixed-precision version of the Paterson--Stockmeyer method that can be faster and use less memory than its fixed-precision counterpart while delivering the same level of accuracy.

**Classification** : 65G50, 65F45, 65F60

**Format** : Talk at Waseda University

**Author(s)** : Nicholas J. Higham (The University of Manchester)Xiaobo Liu (The University of Manchester)



## [02400] A generalized structural bifurcation analysis of chemical reaction networks

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @G401

**Type** : Contributed Talk

**Abstract** : Chemical reactions link metabolites and form complex networks in living cells. We have previously developed “structural bifurcation analysis,” by which bifurcation properties of reaction systems are determined solely from network topologies. In this work, we establish a precise formalization connecting our analysis to conventional methods based on Jacobian matrices. The formalization increases applicability of the analysis, e.g. determining multistationarity, without assuming the full-rankedness of stoichiometric matrices or eliminations of equations/chemicals.

**Classification** : 34Hxx, 92Bxx, 34D10

**Format** : Talk at Waseda University

**Author(s)** : Yong-Jin Huang (Division of Biological Sciences, Graduate School of Science, Kyoto University) Takashi Okada (Division of Biological Sciences, Graduate School of Science, Kyoto University) Atsushi Mochizuki (Institute for Life and Medical Sciences, Kyoto University)

## [02401] A low-degree normalized B-spline-like representation for Hermite osculatory interpolation problems

**Session Time & Room** : 1C (Aug.21, 13:20-15:00) @F310

**Type** : Contributed Talk

**Abstract** : This talk deals with Hermite's osculatory interpolating splines. For a partition of a real interval

endowed with a refinement consisting in dividing each subinterval into two small subintervals, we consider a space of smooth splines with super-smoothness at the vertices of the initial partition, and of the lowest possible degree. A normalized B-spline-like representation for the considered spline space is provided. In addition, several quasi-interpolation operators based on blossoming and control polynomials have also been developed. Some numerical tests are presented and compared with some recent works to illustrate the performance of the proposed approach.

**Classification** : 41A15

**Author(s)** : Mohamed BOUSHABI (Abdelmalek Essaadi University, LaSAD, ENS, 93030 Tetouan, Morocco) Salah Eddargani ( University of Rome Tor Vergata Rome) María José Ibáñez (University of Granada) Abdellah Lamnii (Abdelmalek Essaadi University, LaSAD, ENS, 93030 Tetouan, Morocco)

## [02405] STABILITY OF NON-ISOTHERMAL POISEUILLE FLOW IN FLUID OVERLYING POROUS DOMAIN

**Session Time & Room** : 5C (Aug.25, 13:20-15:00) @D101

**Type** : Contributed Talk

**Abstract** : The linear stability analysis of thermal convection of Poiseuille flow in an anisotropic and inhomogeneous porous domain underlying fluid domain is investigated. The impact of depth ratio, anisotropy, inhomogeneity, Darcy number, Reynolds number and Prandtl number is inspected. An increase((decrease)) in anisotropy((inhomogeneity)) parameter follows unimodal((porous)) to bimodal((fluid and porous)) characteristic of neutral curves. Energy budget analysis is carried out to classify type of instability. Secondary flow patterns are analysed to validate the least stable mode.

**Classification** : 76E17, 76E06, 76T99, 80A19, 76S05

**Format** : Talk at Waseda University

**Author(s)** : Anjali Anjali (Department of Mathematics, Indian Institute of Technology Roorkee) Premananda Bera (Department of Mathematics, Indian Institute of Technology Roorkee) Arshan Khan (Department of Mathematics, Indian Institute of Technology Roorkee)

## [02407] Scattering of water waves by two horizontal porous plates over a pair of trenches

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @E820

**Type** : Contributed Talk

**Abstract** : The scattering of water waves by two non-uniform horizontal porous plates in the presence of a pair of trenches is modeled using Darcy's law for flow past a porous plate. The eigenfunction expansions in conjunction with the matching conditions gives rise to an overdetermined system of linear equations, which is solved to obtain the numerical values of physical quantities such as reflection, transmission, dissipation coefficients and force. Different graphs are plotted to visualize the effect of different system parameters. This study highlights two horizontal porous plates over uneven bottom topography will play a vital role in constructing an effective breakwater reducing high wave impact.

**Classification** : 76B15

**Format** : Talk at Waseda University

**Author(s)** : Sunita Choudhary (Indian Institute Technology, Ropar)S. C. Martha (Indian Institute Technology, Ropar)

## [02409] Effect of Permeability on Couette Flow in Fluid-Porous System

**Session Time & Room** : 5C (Aug.25, 13:20-15:00) @D101

**Type** : Contributed Talk

**Abstract** : A horizontal fluid layer overlying a porous layer is considered in which the plane Couette flow is induced due to uniform movement of upper plate and convection arises due to maintenance of temperature difference between the upper and lower plate. Fluid considered is Newtonian and incompressible which satisfies Boussinesq approximation. The porous layer is modelled by Darcy's law. The classical linear stability analysis is implemented to study the impact of media permeability for heavy oils.

**Classification** : 76E06, 76E17, 76T99, 76F10, 76S05

**Format** : Talk at Waseda University

**Author(s)** : Nandita Barman (Department of Mathematics)Premananda Bera (Department of Mathematics)

## [02412] Randomized algorithms of AND-OR tree calculation regarding query complexity

**Session Time & Room** : 4C (Aug.24, 13:20-15:00) @G301

**Type** : Contributed Talk

**Abstract** : We discuss the randomized algorithm of AND-OR tree calculation. It is known that for any nontrivial balanced AND-OR tree, there is a unique randomized input (eigen-distribution) which achieves the distributional complexity. In contrast, the dual problem has the opposite result; the optimal randomized algorithm is not unique. We extend the study on randomized algorithms to unbalanced cases and see that uniqueness still fails in most of the cases.

**Classification** : 03D15, 68Q17, 68W20

**Format** : Talk at Waseda University

**Author(s)** : Fuki Ito (Tokyo Metropolitan University)Fuki Ito (Tokyo Metropolitan University)

## [02414] Quadratic Lie algebras algorithms applied over oscillator algebras

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @G305

**Type** : Contributed Talk

**Abstract** : Quadratic Lie algebras appear in Mathematics and Physics. Main examples are oscillator and generalized oscillator which are related to space-time models and determine some Lie groups with Lorentz metrics or Lorentzian cones. This variety of algebras with bilinear invariant forms can be built using double extensions from a metric vector space via derivations. In this talk we will see an overview of how all these concepts can be algorithmically obtained. Available in our Github repository.

**Classification** : 17B05, 15A63, 17B40, 17B81

**Format** : Talk at Waseda University

**Author(s)** : Jorge Roldán-López (Universidad de La Rioja)Pilar Benito (Universidad de La Rioja)

## [02415] Propagation of epistemic uncertainty though a multi-layerd geometrically exact beam

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @D408

**Type** : Contributed Talk

**Abstract** : Uncertainty is ever-present in engineering. In this work, we demonstrate the effect of parameter uncertainty on a carbon spring prosthetic foot. The prosthesis is built with multiple layers of carbon fibre laminate. This layered structure is accounted for via homogenisation of the material parameters in the geometrically exact beam model of the prosthesis. Homogenising the material parameters introduces additional uncertainty. The resulting uncertain deformation envelopes and stored energy envelopes are examined.

**Classification** : 90C70, 70E55, 74-XX

**Format** : Talk at Waseda University

**Author(s)** : Eduard Sebastian Scheiterer (Institute of Applied Dynamics - Friedrich-Alexander Universität Erlangen-Nürnberg)Sigrid Leyendecker (Institute of Applied Dynamics - Friedrich-Alexander Universität Erlangen-Nürnberg)

## [02417] State equation for oscillator chains

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @E504

**Type** : Contributed Talk

**Abstract** : We present a linear state equation between kinetic temperature and mass density that has been widely verified in boundary-driven one-dimensional nonequilibrium systems. We show that this relation holds even more universally and in particular when standard relations between purely mechanical and thermodynamic quantities do not apply. We investigate special situations in which phase transitions occur and the relation fails, as common in statistical mechanics. We also provide a theoretical explanation of how this happens.

**Classification** : 82C05, 70-10

**Format** : Talk at Waseda University

**Author(s)** : Vincenzo Di Florio (Politecnico di Torino)Lamberto Rondoni (Politecnico di Torino)Claudio Giberti ( University of Modena and Reggio Emilia)Hong Zhao (Xiamen University)

## [02418] A two-stage method for an industrial NP-hard bin packing problem

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @D505

**Type :** Industrial Contributed Talk

**Abstract :** Our industrial problem consists of building batch annealings from a sample of steel coils. We have to consider all the rules/constraints related to the characteristics of coils and constraints related to technology. The objective is to ensure the annealing of coils at the minimum cost.

This problem is a simultaneous NP-hard bin packing type. A two-stage method is developed in this paper to address this problem: stage one refers to a smart enumeration of all possible and feasible bins. Then, the second stage will consist of finding the optimal solution for an ILP.

**Classification :** 90B30, 90C10

**Format :** Talk at Waseda University

**Author(s) :** Abdelghani Bouras (Industrial Engineering Department, College of Engineering, Al FaisalUniversity)

## **[02420] Nonparametric Bivariate Density Estimation for Missing Censored Lifetimes**

**Session Time & Room :** 3E (Aug.23, 17:40-19:20) @E504

**Type :** Contributed Talk

**Abstract :** Estimation of the joint density of two censored lifetimes is a classical problem in survival analysis, but only recently the theory and methodology of efficient nonparametric estimation have been developed. A familiar complication in survival analysis is that in real data censored lifetimes and indicators of censoring may be missing. For the model of missing completely at random, an efficient bivariate density estimator is proposed, and a practical example is presented.

**Classification :** 62N02, 62G05, 62G07, Missing data, survival analysis and censoring, nonparametric estimation

**Format :** Online Talk on Zoom

**Author(s) :** Lirit Fuksman (The University of Texas at Dallas)

## **[02424] Nonlinear fractional elliptic systems : Theory and Numerics**

**Session Time & Room :** 5B (Aug.25, 10:40-12:20) @G502

**Type :** Contributed Talk

**Abstract :** In this talk, we focus on a class of elliptic systems with gradient source terms, governed by the fractional Laplacian  $(-\Delta)^s$  of order  $s$

**Classification :** 35J66, 35K57, 65N30, 35-00, 65-00

**Format :** Online Talk on Zoom

**Author(s) :** Maha Daoud (Hassan II University of Casablanca)

## **[02429] Differential geometry with extreme eigenvalues in the positive semidefinite cone**

**Session Time & Room :** 4E (Aug.24, 17:40-19:20) @G305

**Type :** Contributed Talk

**Abstract :** Geometric data in convex cones appear in a wide range of applications. Of particular interest is the space of symmetric positive definite (SPD) matrices and a variety of associated geometries that have been successfully exploited in medical imaging, neuroscience, and machine learning. In this talk, I will explore the Hilbert and Thompson geometries associated with SPD matrices and show that they offer a natural route to statistics based on extreme eigenvalues with promising computational properties.

**Classification :** 15B48, 53C22, 53B20, 53B50, 53C80

**Format :** Talk at Waseda University

**Author(s) :** Nathaël Da Costa (Nanyang Technological University)Cyrus Mostajeran (Nanyang Technological University)Rodolphe Sepulchre (University of Cambridge)Graham van Goffrier (University College London)

## [02430] Hessian geometric derivation of macroscopic thermodynamic uncertainty relations (TUR)

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @D404

**Type** : Contributed Talk

**Abstract** : The recently developed Hessian geometry of force and flux spaces in chemical reaction networks provides a geometric derivation of TUR. The relations are obtained from a comparison of two Riemannian metric tensors - one characterizes the pseudo entropy production and the other the current fluctuations. This geometry yields a characterization of the error term as the norm of a linear subspace component of the flux vector and thus characterizes the fluxes where TUR become equalities.

**Classification** : 82Cxx, 53Zxx, 80Axx

**Format** : Talk at Waseda University

**Author(s)** : Dimitri Loutchko (The University of Tokyo)Tetsuya J Kobayashi (The University of Tokyo)

## [02432] Dispersion relation reconstruction for 2D Photonic Crystals based on polynomial interpolation

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @E820

**Type** : Contributed Talk

**Abstract** : A natural way to compute photonic dispersion relation is to restrict the parameters to the edges of the irreducible Brillouin zone (IBZ), which has been formalized as a dangerous simplification. We propose a novel method based on polynomial interpolation to approximate band functions in the whole IBZ. The importance of IBZ interiors, the need to reduce computational cost and our analysis of the regularity of band functions illustrate the necessity and feasibility of our method.

**Classification** : 78M22, 26B30, 32A10, 65M60, 41A10

**Format** : Talk at Waseda University

**Author(s)** : Yueqi Wang (University of Hong Kong)Guanglian Li (University of Hong Kong)

## [02433] Response Surface Methodology-Based Model Updating Using FRF Curvature

**Session Time & Room** : 2E (Aug.22, 17:40-19:20) @D405

**Type** : Contributed Talk

**Abstract** : We propose a Response Surface Methodology (RSM) based model updating approach using Frequency Response Function (FRF) curvature as the response for optimization. The optimization algorithm is based on a multi-objective function that is solved using MATLAB. The updated model is then used for identifying structural damage. The proposed approach is validated through numerical simulations on a simply supported beam and an experimental study on a free-free aluminum beam. The results demonstrate that the RSM-based model updating approach can accurately identify the location and severity of damage in structures.

**Classification** : 82M20, 90C29

**Format** : Online Talk on Zoom

**Author(s)** : Nur Raihana Sukri (Malaysia-Japan International Institute of Technology, Universiti Teknologi Malaysia)Syarifah Zyurina Nordin (Malaysia Japan International Institute of Technology (MJIT), Universiti Teknologi Malaysia)Nurulakmar Abu Husain (Malaysia Japan International Institute of Technology, Universiti Teknologi Malaysia)

## [02434] Multiobjective Mesh Optimization Algorithms for Quadrilateral Meshes

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @E709

**Type** : Contributed Talk

**Abstract** : Accurate numerical PDE solutions require good quality computational meshes on the corresponding geometric domains. Both explicitly and implicitly tangled meshes are problematic for finite element simulations as are meshes with low quality elements. In this talk, we will present our multiobjective optimization methods for mesh untangling and quality improvement of quadrilateral meshes. The objective functions are developed by combining separate objective functions using “no articulation of preferences”. Encouraging results from numerical experiments will be presented.

**Classification** : 65N50, 65N30, 65K10

**Format** : Talk at Waseda University

**Author(s)** : Moein Moradi (University of Kansas)Suzanne Michelle Shontz (University of Kansas)

## [02436] Subordinated Stochastic Processes and Applications

**Session Time & Room** : 2E (Aug.22, 17:40-19:20) @F412

**Type** : Contributed Talk

**Abstract** : A Subordinated stochastic process is obtained by time changing a parent process  $X_t$  with a positive non-decreasing stochastic process  $T_t$ . The process  $T_t$  is called the directing process or the random clock.

Subordinated processes demonstrate interesting probabilistic properties and have applications in finance,

economics, statistical physics, anomalous diffusion and fractional calculus. Also scaling limits of continuous time

random walk depending on the conditions on mean waiting times and second moments conditions on jumps

converges weakly to different subordinated stochastic process. The aim of this talk is to discuss the concept of subordinated processes and their connections to different fields.

**Classification** : 60G10, 60G18, 60G20, 62M10, 60G51

**Format** : Talk at Waseda University

**Author(s)** : Arun Kumar (Department of Mathematics, Indian Institute of Technology Ropar, Rupnagar, Punjab, India 140001)

## [02442] Geopolitical and Demographic Possible Factor affecting COVID-19 Spread level with OPLSDA approach

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @E504

**Type** : Industrial Contributed Talk

**Abstract** : COVID-19 continuing challenges to health and socio-economic crisis. Geopolitical and demographic may possible affecting COVID-19 spread and this research focus on COVID-19 spread level classification. The method used is Orthogonal Projections to Latent Structures Discriminant Analysis (OPLS-DA), OPLS-DA projects predictor that have the best correlation with responses so that they can separate predictor variables from variables that are not correlated. OPLS-DA effectively identifies sources of variability between classes to produce good classification results with an accuracy rate 84.44%. The results also explain how predictor variables can affect the level of spread of COVID-19.

**Classification** : 62H30, 68U01, Classification and Discriminant Analysis for Outlier and High-dimensional data

**Format** : Online Talk on Zoom

**Author(s)** : Noviana Pratiwi (Gadjah Mada University)Dedi Rosadi (Gadjah Mada University)Abdurakhman Abdurakhman (Gadjah Mada University)

## [02443] Enhanced charge-based algorithm and its application in reliability-redundancy allocation problems

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @A201

**Type** : Contributed Talk

**Abstract** : Reliability-redundancy allocation problems (RRAP) require selecting components with diverse choices and redundancy levels that maximize profit within constraints. The nonlinearity and non-smoothness in RRAP have defeated many traditional mathematical approaches. Therefore, in this paper, a new version of the charge-based artificial electric field algorithm (AEFA) is proposed, incorporating a novel Coulomb's constant and bounds. This restructuring improves the adaptability of AEFA on RRAPs. The suggested algorithm outperforms other existing algorithms on seven RRAPs.

**Classification** : 90C15, 90B25, 90C29, 90C06, 90C26

**Author(s)** : Dikshit Chauhan (Dr B R Ambedkar National Institute of Technology Jalandhar)Anupam Yadav (Dr B R Ambedkar National Institute of Technology Jalandhar)

## [02444] Pricing American XVA with stochastic default intensity

**Session Time & Room** : 2D (Aug.22, 15:30-17:10) @E709

**Type** : Contributed Talk

**Abstract** : We derive a PDE model for American derivatives' pricing including the valuation adjustment (XVA),

assuming mean-reverting default risk for the counterparty, and constant default risk for the self-party. There are two nonlinear source terms, one from the American constraint and one from the XVA, handled by a double-penalty iteration.

We also derive asymptotic approximations to the XVA price and to the free boundary.

We present numerical experiments to study the accuracy and effectiveness of the 2D PDE and asymptotic approximations.

**Classification** : 65Mxx, 65Nxx, 91Gxx

**Format** : Talk at Waseda University

**Author(s)** : Christina Christara (University of Toronto)Yuwei Chen (University of Toronto)

## [02449] Recent Advances in Fast Finite Difference Schemes for PDE Problems

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @G306

**Type** : Contributed Talk

**Abstract** : In this talk, a fast finite difference scheme is discussed to a hidden-memory variable-order time-fractional diffusion equation. To reduce the computational cost and memory, a modified exponential-sum-approximation method is utilized to discretize the hidden-memory variable-order fractional derivative. We then develop different techniques from the analysis of L1 methods to prove the convergence for the corresponding fast fully discrete scheme. Numerical experiments are presented to substantiate the theoretical results.

**Classification** : 34A08, 26A33, 65D15, 65D40

**Format** : Talk at Waseda University

**Author(s)** : Lu-Yao Sun (University of Macau)

## [02452] Fifth-order WENO Schemes with Z-type Nonlinear Weights for Hyperbolic Conservation Laws

**Session Time & Room** : 2E (Aug.22, 17:40-19:20) @E702

**Type :** Contributed Talk

**Abstract :** In this talk, we propose the variant Z-type nonlinear weights in the fifth-order weighted essentially non-oscillatory (WENO) finite difference scheme for hyperbolic conservation laws. We take new smoothness indicators and follow the form of Z-type nonlinear weights introduced by Borges et al., leading to fifth order accuracy in smooth regions and sharper approximations around discontinuities. Finally, numerical examples are presented to demonstrate the advantages of the proposed WENO schemes in shock-capturing.

**Classification :** 65M06

**Author(s) :** Jiayi Gu (Pohang University of Science and Technology)Xinjuan Chen (Jimei University)Jae-Hun Jung (Pohang University of Science and Technology)

## **[02453] Allee effects, Evolutionary game, and Ideal free strategies in Partial Migration Population**

**Session Time & Room :** 2D (Aug.22, 15:30-17:10) @E503

**Type :** Contributed Talk

**Abstract :** Allee effect is a density-dependent phenomenon in which population growth or individual components of fitness increase as population density increases. Understanding the density-dependent effect is vital to elucidate how populations evolve and to investigate evolutionary stability. Partial migration, where a proportion of a population migrates while other individuals remain resident, is widespread across most migratory lineages. However, the mechanism is still poorly understood in most taxa, especially those experiencing positive density-dependent effects. In this talk we discuss the evolutionary stability of partial migration population with the only migrant population experiencing Allee effects. Using the Evolutionary Game Theoretic (EGT) approach, we show the existence and uniqueness of a evolutionary stable strategy (ESS). We also show that the ESS is the only Ideal Free distribution (IFD) that arises in the context of a partially migrating population.

**Classification :** 39A60, 92D25, 91A22

**Format :** Talk at Waseda University

**Author(s) :** Yogesh Trivedi (Bits-Pilani, K.K Birla Goa Campus)Ram Singh (Bits-Pilani, K.K Birla Goa Campus)Anushaya Mohapatra (Bits-Pilani, K.K Birla Goa Campus)

## **[02454] Cellular gradient flow structure connects single-cell-level rules and population-level dynamics**

**Session Time & Room :** 1C (Aug.21, 13:20-15:00) @D515

**Type :** Contributed Talk

**Abstract :** In multicellular systems, single-cell behaviors should be coordinated consistently with the overall population dynamics and biological functions. We show that the generalized gradient flow modeling of the cellular population dynamics naturally connects them and reproduces well-known properties of cells. We also demonstrate the gradient flow structure in a standard model of the T-cell immune response. This theoretical framework works as a basis for understanding multicellular dynamics and functions.

**Classification :** 92C37, 92D25, 49S05

**Format :** Talk at Waseda University

**Author(s) :** Shuhei A Horiguchi (The University of Tokyo)Tetsuya J Kobayashi (The University of Tokyo)

## **[02457] Optimizing Bunkering Management Strategy to Support Green Shipping Using Artificial Bee Colony Algorithm (ABC)**

**Session Time & Room :** 3E (Aug.23, 17:40-19:20) @D505



**Type :** Contributed Talk

**Abstract :** Sea transportation has been considered as more eco-friendly transportation compared to other transportation. However, maritime logistic has produced a lot of carbon emissions. Therefore, this research is performed for optimizing the development of bunkering management strategies. It will focus on choosing a fuel with an affordable price and producing fewer carbon emissions. The problem can be formulated as the MINLP to minimize the total cost and can be solved by ABC algorithm as an optimization method.

**Classification :** 90Bxx, 90Cxx, 90-08

**Format :** Online Talk on Zoom

**Author(s) :** Nurul Fajr Romadhona (Sepuluh Nopember Institute of Technology)Sena Safarina (Sepuluh Nopember Institute of Technology)Oktaviani Turbaningsih (University of Tasmania)

## [02459] Functional ODE observers for DAE control systems

**Session Time & Room :** 2E (Aug.22, 17:40-19:20) @D515

**Type :** Contributed Talk

**Abstract :** Many control systems have essential features, which can only be expressed if system dynamics is described by simultaneous differential and algebraic equations (DAEs). For example, the classical state space models, governed only by ordinary differential equations (ODEs), cannot adequately treat impulses that occur in electrical circuits. This talk is devoted to the problem of designing functional observers for linear DAEs. A new and milder sufficient condition for functional observers is proved.

**Classification :** 93B53, 93B07, 93A10, 93C99, 93D05

**Format :** Talk at Waseda University

**Author(s) :** Nutan Kumar Tomar (Indian Institute of Technology Patna)Juhi Jaiswal (Indian Institute of Technology Madras)Pabitra Kumar Tunga (Indian Institute of Technology Patna)

## [02467] Existence of unique blow-up solutions to fully fractional thermostat models

**Session Time & Room :** 3E (Aug.23, 17:40-19:20) @G401

**Type :** Contributed Talk

**Abstract :** A thermostat is a device that detects the temperature of a physical system and takes the requisite actions to maintain the system's temperature at a predetermined set point. This paper deals with a fully fractional thermostat model involving Riemann-Liouville fractional derivatives. By choosing an appropriate weighted Banach space of continuous functions, we employ the Banach contraction principle to establish the existence and uniqueness result. An example is presented to validate our theoretical finding.

**Classification :** 26A33, 34A08, 34K10, 34K37, 65L10, Fractional differential equations, Riemann-Liouville fractional derivative, Thermostat model, Banach contraction principle, Product rectangle rule, Numerical simulation.

**Format :** Online Talk on Zoom

**Author(s) :** KIRAN KUMAR SAHA (Indian Institute of Technology Roorkee)NAGARAJAN SUKAVANAM (Indian Institute of Technology Roorkee)

## [02468] Intuitionistic fuzzy proximal twin svm with fuzzy hyperplane

**Session Time & Room :** 3C (Aug.23, 13:20-15:00) @D501

**Type :** Contributed Talk

**Abstract :** Twin support vector machine (TWSVM) is a contemporary machine learning technique for classification and regression problems. However, TWSVM is sensitive to noises as it ignores the positioning of the input data samples and hence fails to distinguish between support vector and noises. To overcome this issue, we propose a novel Intuitionistic fuzzy proximal twin svm with fuzzy

hyperplane (IFTPSVM-FH). Instead of addressing two quadratic programming problems like in TWSVM, two non-parallel classifiers are obtained by solving two systems of linear equations which makes the model more efficient. The two major features of the proposed approach are that it gives an intuitionistic fuzzy number based on the relevance to each data vector and that the parameters for the hyperplane, such as the components of the normal vector and the bias term, are fuzzified variables. With the use of fuzzy variables, the proposed fuzzy hyperplane effectively captures the ambiguous character of real-world categorization tasks by representing vagueness in the training data. The proposed approach uses local neighbourhood information among the data points and also uses both membership and non-membership weights to reduce the effect of noise and outliers. By incorporating nonlinear kernel functions into the feature space, the method can be used to detect complex patterns or non-linearity in the dataset. We have applied our method on real-world classification tasks and concluded that it performs incredibly well in comparison to other approaches. In order to demonstrate the practical application of the proposed model, we use it for the predict the trends of the stock market.

**Classification** : 90-08, 90C30, 90C25

**Format** : Online Talk on Zoom

**Author(s)** : Yash Arora (IIT Roorkee)Shiv Kumar Gupta (IIT Roorkee)

## [02472] Geometry and mechanics of shape-programmable systems

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @E803

**Type** : Contributed Talk

**Abstract** : Modern responsive materials such as liquid crystal elastomers (LCEs) can be pre-programmed to undergo spatially inhomogeneous deformations in response to external stimuli such as heat and light. Shape-programming of LCEs has been the subject of intense research in recent years, resulting in the discovery of patterning designs and techniques that allow flat 2D sheets to assume target geometries upon activation. In this talk, we present recent mathematical, computational and experimental advances in shape-programming of LCEs.

**Classification** : 74-04, 74-10, 74S05, 74M05, 74G65

**Format** : Talk at Waseda University

**Author(s)** : Daniel Duffy (University of Cambridge)Cyrus Mostajeran (Nanyang Technological University)John Simeon Biggins (University of Cambridge)Timothy J White (University of Colorado Boulder)Mark Warner (University of Cambridge)

## [02473] Applications of Bures-Wasserstein geometry of HPD matrices to signal detection

**Session Time & Room** : 2C (Aug.22, 13:20-15:00) @F411

**Type** : Contributed Talk

**Abstract** : Autocovariance matrices can describe characteristic of time series data. If the data follow the stationary process, the corresponding autocovariance matrix is Hermitian positive definite (HPD). In this talk, we introduce Riemannian geometry of the HPD matrix spaces equipped with the Bures-Wasserstein (BW) metric and propose a detection method by utilizing the geodesic distance to define BW mean and median of HPD matrices. Robustness of the proposed mean and median will also be analyzed.

**Classification** : 53B20, 60G35, 32M15

**Format** : Talk at Waseda University

**Author(s)** : Yusuke Ono (Keio University)Linyu Peng (Keio University)

## [02477] Effect of contact angle hysteresis in a novel microfluidic system

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @D402

**Type** : Contributed Talk

**Abstract** : We present a reduced ODE model, derived from a continuum framework, for fluid flow and solute transport in a novel microfluidic system with applications for drug discovery. While the flow is gravity-driven, our analysis highlights the importance of capillary effects, exploring how contact angle hysteresis and meniscus shape modify the flow. We show how our model can be used to identify optimal parameter regimes for advective solute transport, which informs device operation and design.

**Classification** : 76-10, 76D45, 92-10

**Format** : Talk at Waseda University

**Author(s)** : Barnum Swannell (University of Oxford) Sarah Waters (University of Oxford) James Oliver (University of Oxford) Daniela Ortiz Franyuti (Roche Innovation Center) Olivier Frey (InSphero) Michal Rudnik (InSphero)

## [02480] Conservative Timesteppers for Fluid Mechanics via Finite Elements in Time

**Session Time & Room** : 5C (Aug.25, 13:20-15:00) @E703

**Type** : Contributed Talk

**Abstract** : Finite-element-in-time—FET—formulations can be carefully constructed to preserve key structures in time-dependent PDEs, such as energy and helicity dissipation, material conservation, and Hamiltonians. Furthermore, with appropriate trial and test spaces, FET formulations can be solved one timestep at a time, like classical timesteppers.

We propose a general auxiliary space concept that connects these ideas, using FET to derive timesteppers up to arbitrary order in time that preserve these structures. We discuss potential future applications of this idea.

**Classification** : 65M60, 76D05, 65P10, 76W05, 65M22

**Format** : Talk at Waseda University

**Author(s)** : Boris Duncan Andrews (University of Oxford) Patrick Emmet Farrell (University of Oxford) Wayne Arter (United Kingdom Atomic Energy Authority)

## [02483] Existence and uniqueness of traveling wave solutions for competition-diffusion systems

**Session Time & Room** : 5C (Aug.25, 13:20-15:00) @G502

**Type** : Contributed Talk

**Abstract** : In this talk, we will consider the existence and uniqueness of traveling wave solutions for a class of competition-diffusion models. We find a necessary and sufficient condition for the existence of non-decreasing traveling wave solutions connecting trivial and positive equilibria. Moreover, with the help of the asymptotic behaviors of such solutions at positive infinity, we also prove that traveling wave solutions are unique up to translations.

**Classification** : 35K40, 35K57, 35B35

**Format** : Talk at Waseda University

**Author(s)** : Jian-Jhong Lin (National Taipei University of Technology)

## [02487] Asset Forecasting Using Geometric Brownian Motion and Variance Gamma Models

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @E505

**Type** : Contributed Talk

**Abstract** : The basic assumption in the Black-Scholes-Merton model is log returns assets normally distributed. In reality, asset price movements are so fluctuating that the data is not normally distributed. This paper proposes a way to forecast using the variance gamma (VG) model. The VG model has three parameters to control volatility, skewness, and kurtosis. We compare results with the geometric Brownian motion (GBM) model. The accuracy of the model used the mean absolute percentage error (MAPE).

**Classification** : 62P20

**Format** : Online Talk on Zoom

**Author(s)** : Abdul Hoyyi (Gadjah Mada University)Abdurakhman Abdurakhman (Gadjah Mada University)Dedi Rosadi (Gadjah Mada University)

## [02489] $L^p$ -estimates for Maxwell's equations in heterogeneous materials

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @G601

**Type** : Contributed Talk

**Abstract** : Estimates for the time-harmonic Maxwell's equations in heterogeneous materials are concerned.

The materials contain two constituents. One high-conductivity constituent of small size is embedded in each period so that it is disconnected. The other of low-conductivity constituent contains the rest of the material. The contrast ratios of the conductivity and the magnetic permeability in one constituent

to the other can be very high. Here  $L^p$ -estimates for the electromagnetic fields uniform in contrast ratios are presented.

**Classification** : 35J70, 35J25, 35J75

**Format** : Talk at Waseda University

**Author(s)** : Li-Ming Yeh (National Yang Ming Chiao Tung University)Dongwoo Sheen (Seoul National University)

## [02500] Constructing crypto-algorithms using vector-valued functions

**Session Time & Room** : 2E (Aug.22, 17:40-19:20) @G304

**Type** : Contributed Talk

**Abstract** : Binary compositions of vector-valued functions defined on an arbitrary set, including finite sets, are introduced. Some properties of the compositions are investigated. In particular, it is proved that each of them is associative. Using the obtained results, crypto-algorithms with a public key have been obtained.

**Classification** : 11T71, 94A60, 05B15, 20N05, 20N15

**Author(s)** : Fedir Sokhatsky (Vasyl' Stus Donetsk National University)

## [02503] Modelling mosquito dynamics and novel malaria vector control interventions

**Session Time & Room** : 5C (Aug.25, 13:20-15:00) @A201

**Type** : Contributed Talk

**Abstract** : We present mathematical and statistical models of mosquito behaviour and feeding cycle dynamics. We analytically derive estimates of vectorial capacity for malaria (the potential of the mosquito population to transmit malaria). We parameterise these models to data from semi-field and field studies and evaluate the impact of current and novel vector control interventions in reducing vectorial capacity. We connect these models to malaria transmission models in humans to investigate the impact of these interventions in reducing clinical malaria transmission.

**Classification** : 92D30, 92D45, 92D50, 92C60, Malaria modelling, mosquito behaviour

**Author(s)** : Nakul Chitnis (Swiss Tropical and Public Health Institute)

## [02505] Modelling capture and storage of gases in porous media

**Session Time & Room** : 2D (Aug.22, 15:30-17:10) @D404

**Type** : Contributed Talk

**Abstract** : An accurate description of reactive mass transport in porous media is of paramount importance in a multitude of environmental applications. In this talk, we will present mathematical models of gas transport in porous media for applications in contaminant removal and hydrogen storage. The models will be simplified via dimensional analysis and solved analytically in some limiting cases. Numerical solutions of the full models will also be presented. All solutions will be compared with experimental data.

**Classification** : 76S05, 80A19, 35B40, 76M50

**Format** : Talk at Waseda University

**Author(s)** : Francesc Font (Universitat Politècnica de Catalunya, CIF: Q0818003F, C. Jordi Girona, 31, 08034 Barcelona, Barcelona)Tim G. Myers (Centre de Recerca Matemàtica)Maria Agualeles (Universitat de Girona)Esther Barrabés (Universitat de Girona)

## [02506] Hydrodynamic hovering of swimming bacteria

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @D404

**Type** : Contributed Talk

**Abstract** : The 'hovering' of flagellated bacteria near a rigid surface, i.e. stable swimming at a finite separation, has been studied experimentally and computationally but remains poorly understood physically. We use boundary element simulations to confirm existing results and to reveal that an elongated, as opposed to spherical, cell body is essential for hovering. We then derive and asymptotically solve a simplified model for the swimming cell and its near-field wall interactions, thereby elucidating the dominant physics.

**Classification** : 76Z10, 92C17, 76M45

**Format** : Talk at Waseda University

**Author(s)** : Pyae Hein Htet (University of Cambridge)Debasish Das (University of Strathclyde)Eric Lauga (University of Cambridge)

## [02511] Autocratic Decision-Making based on Neutrosophic Sets for Machine Selection in the Industrial Factories

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @A201

**Type** : Industrial Contributed Talk

**Abstract** : Neutrosophic Sets address ambiguity by considering the levels of truth, falsity, and indeterminacy. This research proposes an autocratic strategy for dealing with Multi-Attribute Decision-Making problems in the neutrosophic environment. The method is adopted to handle machine

selection problems to stimulate both production level and income creation, in which executives utilize neutrosophic values to estimate the determination levels of the characteristics. Analytical examinations demonstrate that the offered approach is more efficient than the other existing methods.

**Classification** : 90B50, 65Kxx

**Format** : Talk at Waseda University

**Author(s)** : Amirhossein Nafei (National Taipei University of technology, Taipei , Taiwan )Seyed Hadi Nasseri Ojaki (Department of mathematics, University of Mazandaran, Babolsar, Iran )

## [02512] Incentive design for electric vehicles charging station management

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @D501

**Type** : Contributed Talk

**Abstract** : We propose a new bilevel optimization model to determine optimal pricing of Electric Vehicle (EV) changing stations. The goal is to define incentives to decrease the energy grid peaks while integrating the behaviour of the EV users through preference lists. The bilevel optimization model is reformulated as a single level one based on a rank pricing approach. The model is solved through a cutting plane approach. Numerical results are discussed

**Classification** : 90-10, 90c11

**Format** : Talk at Waseda University

**Author(s)** : Luce Brotcorne (INRIA)Luce Brotcorne (INRIA)Miguel Anjos (University of Edinburgh)Gaël Guilloit (INRIA)

## [02513] Models for the Interdiction Problem for the Minimum Spanning Tree

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @D502

**Type** : Contributed Talk

**Abstract** : The Minimum Spanning Tree Interdiction (MSTI) problem is a two-player game between a network operator aiming to determine a Minimum Spanning Tree (MST) and an interdictor which, constrained by a budget, changes the network topology to increase the weight of a MST. Mathematical formulations for a generalization of the MSTI problem are devised, and valid inequalities are proposed. Dominance relations between the models are studied, and computational experiments are presented to evaluate their efficiencies.

**Classification** : 90-10, 90C10, 90C46, Bilevel programming

**Format** : Talk at Waseda University

**Author(s)** : Luis Salazar-Zendeja (INRIA)Diego Cattaruzza (Centrale Lille)Martine Labbé (Université Libre de Bruxelles)Frédéric Semet (Centrale Lille)

## [02516] Stability and dynamics of multi-layer shear flow with liquid-liquid slip

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @D403

**Type** : Contributed Talk

**Abstract** : Although the presence of slippage at polymer-polymer interfaces has been widely reported in experiments and MD simulations, its effect on the stability of superposed fluid layers undergoing shear has not been adequately addressed. Therefore, we formulate a mathematical model and under the assumption of one layer being asymptotically thin we derive a novel weakly non-linear evolution equation for the interface to study the linear stability and system dynamics. A slip-induced Turing-type instability is found.

**Classification** : 76E17, 76E30, 76E05, 76D05

**Author(s)** : Anna Katsiavria (Imperial College London)Demetrios Papageorgiou (Imperial College London)

## [02517] Flocking Dynamics of Agents with Nonidentical Intrinsic Accelerations

**Session Time & Room** : 5C (Aug.25, 13:20-15:00) @A201

**Type** : Contributed Talk

**Abstract** : Collective dynamics has attracted much attention over the past decades. It depicts a group of agents represents the identical dynamics under the interaction. There have been several papers proposed to study these. In this talk, we set up a flocking model where agents in a flock can have different intrinsic accelerations. We give some theoretical results to ensure the occurrence of flocking dynamics and some numerical simulations are provided to support these.

**Classification** : 92D50, 92D25, 34D05, 93D20

**Format** : Talk at Waseda University

**Author(s)** : Yu-Hao Liang (National University of Kaohsiung)

## [02519] Intensity modulated radiotherapy planning through a fuzzy approach

**Session Time & Room** : 4C (Aug.24, 13:20-15:00) @A207

**Type** : Contributed Talk

**Abstract** : In radiotherapy treatment, is it possible to vary the radiation intensity, achieving a dose distribution with superior compliance. An individualized treatment plan comprises information on how the dose is distributed within a patient. The dose distribution problem translates into optimizing the total radiation dose applied to the patient. Fuzzy optimization is used to deal with inaccurate prescription. Interior point methods are applied to determine optimal solutions with less dose distribution in critical organs.

**Classification** : 90C51, 90C05, 90C70

**Format** : Talk at Waseda University

**Author(s)** : Aurelio Oliveira (University of Campinas)Nicole Cassimiro (University of Campinas)

## [02520] A direct method for solving a structured Sylvester equation

**Session Time & Room** : 2D (Aug.22, 15:30-17:10) @E505

**Type** : Contributed Talk

**Abstract** : In this talk, we will present a pseudospectral method for 2D advection operators. After discretizing the 2D advection operator by the Legendre-Gauss-Lobatto pseudospectral methods, we obtain a Sylvester equation. The Sylvester equation is equivalent to a block tridiagonal liner system of equations. We propose a URV approach to solve the linear system.

**Classification** : 65F05, 65N35

**Format** : Talk at Waseda University

**Author(s)** : Yung-Ta Li (Fu Jen Catholic University)

## [02521] Asymptotic tracking of a point cloud moving on Riemannian manifolds

**Session Time & Room** : 1E (Aug.21, 17:40-19:20) @G402

**Type** : Contributed Talk

**Abstract** : We present two Cucker-Smale type models for the asymptotic tracking of a point cloud moving on complete, connected, and smooth Riemannian manifolds. For each model, we provide a sufficient framework in terms of a moving target point cloud, system parameters, and initial data. In the proposed framework, we show asymptotic flocking, collision avoidance, and asymptotic tracking to a given point cloud. The main result is a joint work with Hyunjin Ahn, Seung-Yeal Ha and Jaeyoung Yoon.

**Classification** : 34D05, 34H05, 70F10, 70G60, 92D25

**Format** : Talk at Waseda University

**Author(s)** : Hyunjin Ahn (Myongji University)Junhyeok Byeon (Seoul National University)Seung-Yeal Ha (Seoul National University)Jaeyoung Yoon (Seoul National University)

## **[02528] Propagation of Rayleigh-like surface waves in multilayered nonlocal elastic media**

**Session Time & Room** : 5C (Aug.25, 13:20-15:00) @E817

**Type** : Contributed Talk

**Abstract** : Haskell matrix method is employed to derive the dispersion relation of Rayleigh-like surface waves propagating through a multilayered nonlocal elastic solid half-space. This dispersion relation is reduced for a 2-layered model to discuss the characteristics of phase speed of Rayleigh-like wave. For specific model, the effect of nonlocality on Rayleigh-like waves for 2- and 3-layered models has been depicted graphically. The particle motion remains elliptical, and influenced by the presence of nonlocality for 2-layered model.

**Classification** : 74J15

**Format** : Talk at Waseda University

**Author(s)** : Aarti Khurana (Panjab University Chandigarh)

## **[02529] Application of machine learning to predict dynamics of epidemiological models that incorporate human behavior**

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @D514

**Type** : Contributed Talk

**Abstract** : In this work, we present modeling, analysis and simulation of a mathematical epidemiological model which incorporates human social, behavioral, and economic interactions. We discuss an approach based in Physics-Informed Neural Network, which is capable of predicting the dynamics of a disease described by modified compartmental models that include parameters, and variables associated with the governing differential equations. Finally, human behavior is modeled stochastically and it is included in the compartmental models.

**Classification** : 92Bxx, 92-04, 92-05

**Format** : Talk at Waseda University

**Author(s)** : Alonso Gabriel Ogueda Oliva (George Mason University)Padmanabhan Seshaiyer (George Mason University)

## **[02532] Stochastic pseudo-symplectic explicit Runge-Kutta methods for Hamiltonian Systems**

**Session Time & Room** : 2D (Aug.22, 15:30-17:10) @E506

**Type** : Contributed Talk

**Abstract** : We propose a systematic approach, based on colored trees and B-series, to construct explicit Runge-Kutta pseudo-symplectic schemes for stochastic Hamiltonian systems in the sense of Stratonovich. Numerical experiments are presented to verify our theoretical analysis and illustrate the long-term accuracy of these methods. Overall, these schemes offer a good compromise between computational time and accuracy, because they are more accurate than the explicit Itô-Taylor approximation methods and less computationally expensive than the implicit symplectic schemes.

**Classification** : 65C30, 60H35

**Format** : Talk at Waseda University

**Author(s)** : cristina adela anton (MacEwan University)



## [02534] Solving a Tree Genetic Diversity Via Homogeneous Self Dual Embedding

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @F311

**Type** : Industrial Contributed Talk

**Abstract** : This research discusses another way to solve Second-Order Cone Programming of a tree genetic diversity. We propose a method based on a splitting augmented Lagrangian method (SALM) and an implementation of a homogenous self-dual (HSD) concept to a sub-problem that belongs to convex programming. Furthermore, we utilize operator splitting to review the existence of HSD. An optimal solution for tree genetic diversity can be obtained by using the modified SALM.

**Classification** : 46N10, 47N10, 90C26, 35Q49, 97M40

**Format** : Online Talk on Zoom

**Author(s)** : Alvian Alif Hidayatullah (Sepuluh Nopember Institute of Technology)Sena Safarina (Sepuluh Nopember Institute of Technology)Subchan Subchan (Sepuluh Nopember Institute of Technology)

## [02538] Probabilistic proofs for some important combinatorial identities

**Session Time & Room** : 2C (Aug.22, 13:20-15:00) @G301

**Type** : Contributed Talk

**Abstract** : Combinatorial identities involving binomial coefficients are very useful in various areas of applied mathematics, especially in discrete mathematics. Using a probabilistic approach, we present simple proofs for some important combinatorial identities involving moments of the gamma, normal, and chi-squared random variates. Some generalizations and interpretations are also given.

**Classification** : 05A19, 05A10, 33B15, 60C05, 62E15

**Format** : Online Talk on Zoom

**Author(s)** : Ashok Kumar Pathak (Central University of Punjab, Bathinda)

## [02540] Dynamics of Fractional Order Crime Transmission Model with Fear Effect and Gang-war

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @G401

**Type** : Contributed Talk

**Abstract** : Various studies present mathematical models of ordinary and fractional differential equations to reduce delinquent behavior and encourage prosocial growth. However, these models do not include the fear effect of the judiciary and of other gangs on one criminal gang, which is necessary to depict the behavioral changes of criminals. Hence, this talk will discuss a fractional-order of crime transmission model with the fear effect of the judiciary on offenders with competition effect in different gangs.

**Classification** : 26A33, 00A71, 34A08

**Format** : Talk at Waseda University

**Author(s)** : Trilok Mathur (Birla Institute of Technology and Science, Pilani)Shivi Agarwal (Birla Institute of Technology and Science, Pilani)Komal Bansal (Birla Institute of Technology and Science, Pilani)

## [02547] Split S-ROCK methods for stiff It<sup>o</sup> stochastic differential equations

**Session Time & Room** : 3D (Aug.23, 15:30-17:10) @E502

**Type** : Contributed Talk

**Abstract** : We propose explicit stochastic Runge--Kutta methods for stiff It<sup>o</sup> stochastic differential equations. The family of the methods is constructed on the basis of the Runge--Kutta--Chebyshev methods, and we utilize a Strang splitting-type approach. The derived methods achieve weak order 2, and have high computational accuracy for relatively large time-step size, as well as good stability properties. In numerical experiments, we confirm that our methods are superior to existing methods in computational accuracy.

**Classification** : 60H10, 65L05, 65L06

**Format** : Talk at Waseda University

**Author(s)** : Yoshio Komori (Kyushu Institute of Technology)David Cohen (Chalmers University of Technology)Kevin Burrage (Queensland University of Technology)

## [02548] Rayleigh-like waves in coated elastic half-space containing voids

**Session Time & Room** : 5C (Aug.25, 13:20-15:00) @E817

**Type** : Contributed Talk

**Abstract** : Secular equation for Rayleigh-like surface waves propagating through an isotropic elastic media containing voids coated with a thin isotropic elastic layer with voids is derived. The layer and the half-space are in welded contact. The effective boundary condition method has been employed to obtain an approximate secular equation of second order in terms of the dimensionless thickness of layer. An explicit formula for Rayleigh-like wave speed is derived and the results have been plotted graphically.

**Classification** : 74J15

**Format** : Online Talk on Zoom

**Author(s)** : Savkirat Kaur (Dev Samaj College for Women, Chandigarh)

## [02549] Copula for Markov Chain Model with Binomial Time Series Data

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @E503

**Type** : Contributed Talk

**Abstract** : Markov Chain Model can be constructed by the concept of time dependency and approached by the Copula. Markov Chain Model using Clayton and Joe Copula is proposed to determine the 3-sigma control limit in statistical control process for time series binomial data. In this paper, Gumbel and Frank Copula use in determining the 3-sigma control limits. We conduct simulations to see the performance of the developed methods and analyze the number of defective pieces in the jewelry manufacturing process.

**Classification** : 62-08, 62A99

**Author(s)** : Pepi Novianti (Universitas Gadjah Mada, University of Bengkulu)Gunardi Gunardi (Universitas Gadjah Mada)Dedi Rosadi (Universitas Gadjah Mada)

## [02552] The inverse elastography problem

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @E705

**Type :** Contributed Talk

**Abstract :** Optical coherence elastography (OCE) is an imaging modality that maps mechanical properties by using optical coherence tomography (OCT) to measure tissue displacement after mechanical excitation.

From OCE elastograms, quantified elasticity mapping can be accomplished using an appropriate mathematical model of the tissue.

In this talk we present a mathematical model to reconstruct the mechanical properties of an elastic medium, in the OCE imaging technique.

We formulate the inverse model problem as a PDE-constrained optimization problem, where the objective function measures the discrepancy between observations and predictions.

We will discuss different strategies for learning the space varying elasticity coefficients.

**Classification :** 65Nxx, 65N21

**Format :** Talk at Waseda University

**Author(s) :** Silvia Barbeiro (University of Coimbra)Rafael Henriques (University of Coimbra)

## **[02554] Domain-invariant subcell-based blending limiter for Lax-Wendroff Flux Reconstruction**

**Session Time & Room :** 3C (Aug.23, 13:20-15:00) @D408

**Type :** Contributed Talk

**Abstract :** Lax-Wendroff flux reconstruction (LWFR) is a single-step, arbitrarily high order, quadrature free method for solving hyperbolic conservation laws. We propose a subcell-based blending scheme for LWFR. By using MUSCL-Hancock reconstruction on the subcells and Gauss-Legendre points in flux reconstruction, we improve small-scale resolution compared to the subcell-based RKDG scheme of Henneman et al. (2020). We also propose a cost-effective correction to obtain a provably domain-invariant Lax-Wendroff scheme. Efficient Julia implementation will be discussed.

**Classification :** 76M10, 76M12, 76-04, 35L65

**Format :** Talk at Waseda University

**Author(s) :** Arpit Babbar (Tata Institute of Fundamental Research - Centre for Applicable Mathematics (Bangalore))Praveen Chandrashekar (Tata Institute of Fundamental Research - Centre for Applicable Mathematics (Bangalore))Sudarshan Kumar Kenettinkara (School of Mathematics, Indian Institute of Science Education and Research)

## **[02555] A Mean Field Game Model for Renewable Investment under Uncertainty**

**Session Time & Room :** 3D (Aug.23, 15:30-17:10) @D514

**Type :** Contributed Talk

**Abstract :** We consider a stylized model for investment into renewable power plants under long-term uncertainty. Risk-averse agents face heterogeneous weather conditions and a common noise including demand trends. The objective of each agent is to maximize profit by controlling investment at discrete time steps. We prove that the N-player game admits a Nash equilibrium that converges to the unique solution of a mean field game. The numerical experiments emphasize the impact of risk aversion and heterogeneity.

**Classification :** 91A16, 49N80, 91A80, 91A50

**Author(s) :** Célia Escribe (Ecole Polytechnique)Josselin Garnier (Ecole Polytechnique)Emmanuel Gobet (Ecole Polytechnique)

## [02560] A Composite Adaptive Finite Point Method for 2D Burgers' Equation

**Session Time & Room** : 2E (Aug.22, 17:40-19:20) @E702

**Type** : Contributed Talk

**Abstract** : This paper focuses on solving the unsteady 2D Burgers equation. We present a minimal machinery algorithm based on an operator splitting technique into different temporal levels in conjunction with an adaptive finite point method (AFPM). The advisability of the AFPM is that it efficiently adjusts itself to fit into the local properties of the exact solution, and its user-friendliness makes it easy to implement and cost-effective. Mathematical estimates like stability, consistency, and convergence analysis support the presented method.

**Classification** : 65M06, 65M12

**Author(s)** : Ashish Awasthi (National Institute of Technology Calicut)Sreelakshmi A (National Institute of Technology Calicut)Shyaman V P (National Institute of Technology Calicut)

## [02566] A spherically symmetric and steady flow describing the motion of a viscous gaseous star

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @G602

**Type** : Contributed Talk

**Abstract** : We consider a system of equations describing a spherically symmetric  $n$ -dimensional motion of a gaseous star, whose gas is viscous, heat-conducting, self-gravitating and bounded by the free-surface, and flows around a central rigid sphere. We discuss first unique existence of the solution to the corresponding stationary problem, and next do a large-time behaviour of the flow, under a certain restricted but physically plausible condition on parameters and initial data.

**Classification** : 35M33, 35Q30, 35R35, 35Q85, 76N10

**Format** : Talk at Waseda University

**Author(s)** : Morimichi Umehara (University of Miyazaki)

## [02568] A pressure-stabilized projection Lagrange--Galerkin scheme for the transient Oseen problem

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @E604

**Type** : Contributed Talk

**Abstract** : We propose and analyze a pressure-stabilized projection Lagrange--Galerkin scheme for the transient Oseen problem. The proposed scheme inherits the advantages from the projection Lagrange--Galerkin scheme: computational efficiency and essential unconditional stability. Here we also use the equal-order approximation for the velocity and pressure, and add a symmetric pressure stabilization term. This enriched pressure space enables us to obtain accurate solutions for small viscosity.

**Classification** : 65M12, 65M25, 65M60, 76D07, 76M10

**Format** : Talk at Waseda University

**Author(s)** : Shinya Uchiumi (Gakushuin University)

## [02572] LDA Hyper-parameters Regulation for Qualitative Studies in Management

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @E505

**Type** : Contributed Talk

**Abstract** : The suitability of the number of topics in management qualitative research is a complex problem. Topic models on textual data often require judgment expertise in determining suitability for management problems. One of the things to note is the determination of hyperparameter values. We have designed various hyper-parameter value conditions as an experiment and calculated the document

match probability based on the topic grouping results. Different hyperparameter values indicate different levels of probability.

**Classification** : 62P25, 68W99, 91C20

**Format** : Online Talk on Zoom

**Author(s)** : Evita Purnaningrum (Mathematics Department, Gadjah Mada University) Abdurakhman Abdurakhman (Mathematics Department, Gadjah Mada University) Nanang Susyanto (Mathematics Department, Gadjah Mada University)

## **[02573] Local convergence analysis of modified King's family for multiple roots**

**Session Time & Room** : 2C (Aug.22, 13:20-15:00) @E501

**Type** : Contributed Talk

**Abstract** : We introduce a new optimal King-like family of methods to solve nonlinear equations when the multiplicity of the root is known in advance. Local convergence of fourth order modified King's family, defined by first two steps of the new scheme is also studied. Radius of convergence balls of fourth order scheme are computed and compared with the existing methods. Comparison of these results show the superiority of our schemes over the existing ones.

**Classification** : 65A05, 65Gxx, 65H05, 65G99

**Format** : Talk at Waseda University

**Author(s)** : Saurabh Bhatia (Panjab University Chandigarh)

## **[02575] Propagation of Nonlinear Waves in Non-genuinely Nonlinear Characteristic Field**

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @G404

**Type** : Contributed Talk

**Abstract** : We consider a quasilinear hyperbolic system of partial differential equations to discuss the evolution of weakly nonlinear waves, where the evolution equation includes quadratic, cubic, and quartic nonlinear terms and the flux function admits two inflection points. We present an example from gasdynamics with analytical and numerical results demonstrating a wide range of wave phenomena, and study the interaction of expansion and compression waves evolving from a rectangular pulse.

**Classification** : 35B40, 35B65, 35C20, 35L65, 35L67

**Format** : Online Talk on Zoom

**Author(s)** : Triveni Prasad Shukla (National Institute of Technology Warangal)

## **[02580] Topological-sensitivity framework for detecting perfectly-conducting buried objects in layered media**

**Session Time & Room** : 1E (Aug.21, 17:40-19:20) @D405

**Type** : Contributed Talk

**Abstract** : Identification of the location of a scattering object from its recorded scattering signature is one of the inverse problems that finds many applications in non-destructive testing. A typical application is a detection and removal of buried land mines. The underlying problem is linked to the discovery of buried objects in a two-layered medium. We present a topological derivatives-based algorithm for detecting a perfectly conducting object in the lower layer of a two-layer unbounded 3D background medium using electromagnetic plane waves. Since the underlying problem is highly ill-posed, most of the existing methods that are qualitative turn out to be quite sensitive to unavoidable medium and measurement noises. Our focus is on designing a direct algorithm based on the topological derivative of an L2-discrepancy function. We perform a rigorous analysis of the proposed algorithm and debate its localization and stability features regarding random medium and measurement noises.

**Classification** : 78A46, 65J20, Inverse scattering, Maxwell's equations, Electromagnetic imaging, Topological derivative, Localization, Resolution analysis, Stability analysis, Medium noise, Measurement noise.

**Format** : Talk at Waseda University

**Author(s)** : Aibike Nagyz (Nazarbayev University) Abdul Wahab (Nazarbayev University)

## [02581] Well-Posedness and smoothness of geometric flows with nonlinear boundary conditions

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @G602

**Type** : Contributed Talk

**Abstract** : Geometric flows are geometric evolution equations often depicting physical phenomena. We consider a class of geometric flows of order  $2m$  in  $2\mathbb{N}$  describing evolving  $n$ -manifolds attached to fixed hypersurfaces with some nonlinear boundary conditions. We modify the theory of Maximal Regularity to accommodate quasilinear parabolic PDEs with such boundary conditions. For initial conditions in  $W_p^{2m - \frac{2m}{p}}$ ,  $p \geq \max\{2m, \frac{n}{2m}\}$  we show well-posedness and instantaneous smoothing of the solution on a maximal interval of existence.

**Classification** : 35Kxx, 35Qxx

**Format** : Talk at Waseda University

**Author(s)** : Daniel Goldberg (Technion-Israel Institute of Technology)

## [02583] Novel shock-capturing procedure for discontinuous Galerkin method for compressible flows

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @D101

**Type** : Contributed Talk

**Abstract** : In this work we develop a novel shock capturing procedure based on adaptive reformation of finite volume sub-cells for higher order discontinuous Galerkin method. For this we developed a sub-cell shock indicator based on Harten's strategy to provide enhanced shock detection using just the degrees of freedom in respective mesh element. We apply this new procedure in the current state-of-the-art entropy stable discontinuous Galerkin method and demonstrate some numerical results for 1D compressible Euler equations.

**Classification** : 76M10, 76M12, 76-10, 35L65

**Format** : Online Talk on Zoom

**Author(s)** : Kedar Shridhar Wagh (Indian Institute of Science) S. V. Raghurama Rao (Indian Institute of Science) Sashikumaar Ganesan (Indian Institute of Science)

## [02584] Malmquist Productivity Index under Fuzzy Environment

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @D408

**Type** : Contributed Talk

**Abstract** : Malmquist productivity index (MPI) is widely used to estimate the productivity change by calculating the relative performance of homogeneous organizations for different time periods using data envelopment analysis (DEA). Although in real-world applications, traditional MPI method is tedious due to ambiguous or imprecise data. Thus, traditional DEA is integrated with fuzzy. In this study, novel integrated MPI method is proposed under fuzzy environment. To show the applicability and effectiveness of the proposed model, numerical example is also discussed.

**Classification** : 90C70, 90C05, 90B50

**Author(s)** : Shivi Agarwal (Birla Institute of Technology and Science, Pilani) Trilok Mathur (Birla Institute of Technology and Science, Pilani) Swati Goyal (Birla Institute of Technology and Science, Pilani)

## [02585] Structured Dissipative mappings with their applications in Control Systems

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @D402

**Type** : Contributed Talk

**Abstract** : In this paper, we find necessary and sufficient conditions to identify pairs of matrices  $X$  and  $Y$  for which there exists  $\Delta \in \mathbb{C}^{n,n}$  such that  $\Delta + \Delta^*$  is positive semidefinite and  $\Delta X = Y$ .

Such a  $\Delta$  is called a dissipative mapping taking  $X$  to  $Y$ . The minimal-norm dissipative mapping is then used to determine the distance to asymptotic instability for dissipative-Hamiltonian systems under general structure-preserving perturbations.

**Classification** : 93Dxx, 65Fxx, 34Axx

**Format** : Talk at Waseda University

**Author(s)** : Mohit Kumar Baghel (Indian Institute of Technology Delhi) Nicolas Gillis (Université de Mons) Punit Sharma (Indian Institute of Technology Delhi)

## [02588] Synchronization in a model system of two bubbles

**Session Time & Room** : 5C (Aug.25, 13:20-15:00) @G401

**Type** : Contributed Talk

**Abstract** : We develop a model system of ODEs describing motions of bubbles interacting through the emission of sound waves of finite speed. In particular of the case of two bubbles, they fall into a state of synchronization, where the limit phase difference is 0 or  $\pi$  depending on the distance of the bubbles. We elucidate the mechanism by the analysis of the phase coupling function, and from the physical viewpoint.

**Classification** : 34E13, 35Q31, 76N30

**Format** : Talk at Waseda University

**Author(s)** : Masashi Ohnawa (Tokyo University of Marine Science and Technology)

## [02589] Two scale convergence method in Orlicz setting and application

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @G501

**Type** : Contributed Talk

**Abstract** : We discuss extension to Orlicz spaces of two scale convergence method in homogenization and application. Reiterated two scale convergence method and unfolding method is also presented in those spaces which generalize standard Sobolev spaces and capture more information. We apply above method on a number of problems including nonlinear degenerated elliptic operator with nonstandard growth.

**Classification** : 35B27, 35B40, 35J25, 35J60, 35J70

**Format** : Talk at Waseda University

**Author(s)** : Joel Fotso Tachago (The University of Bamenda) Joel Fotso Tachago (The University of Bamenda) Hubert Nnang (University of Yaoundé 1) Elvira Zappale (University of Roma 1)

## [02590] Non-Local Robust Quaternion Matrix Completion for Large-Scale Color Images and Videos Inpainting

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @A502

**Type** : Contributed Talk

**Abstract** : The image nonlocal self-similarity (NSS) prior refers to the fact that a local patch often has many nonlocal similar patches to it across the image. In this talk we apply such NSS prior to enhance the robust quaternion matrix completion (QMC) method and significantly improve the inpainting performance. A patch group based NSS prior learning scheme is proposed to learn explicit NSS models

from natural color images. The NSS-based QMC algorithm computes an optimal low-rank approximation to the high-rank color image, resulting in high PSNR and SSIM measures and particularly the better visual quality. A new joint NSS-base QMC method is also presented to solve the color video inpainting problem based quaternion tensor representation. The numerical experiments on large-scale color images and videos indicate the advantages of NSS-based QMC over the state-of-the-art methods.

**Classification** : 94A08, 68U10

**Format** : Talk at Waseda University

**Author(s)** : Zhigang Jia (Jiangsu Normal University)

## [02592] Pricing American barrier options with transaction costs

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @D505

**Type** : Contributed Talk

**Abstract** : When transaction costs in trading underlying stocks are considered, far more modelling effort is needed for pricing

options, as a unique fair price between the holder and writer no longer exists. It becomes even more complicated for

American and exotic options. In this talk, we shall discuss the valuation of American barrier options with transaction

costs and examine the impact of transaction costs on option pricing, particularly on how they affect the optimal

exercise boundary.

**Classification** : 91G20, 60G40, Mathematical finance

**Format** : Talk at Waseda University

**Author(s)** : Xiaoping Lu (University of Wollongong)

## [02595] Image recovery under non-Gaussian noise

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @A502

**Type** : Contributed Talk

**Abstract** : Cauchy noise, as a typical non-Gaussian noise, appears frequently in many important fields, such as radar, medical, and biomedical imaging. Here, we focus on image recovery under Cauchy noise. Instead of the celebrated total variation or low-rank prior, we adopt a novel deep-learning-based image denoiser prior to effectively remove Cauchy noise with blur. To preserve more detailed texture and better balance between the receptive field size and the computational cost, we apply the multi-level wavelet convolutional neural network (MWCNN) to train this denoiser.

Frequently appearing in medical imaging, Rician noise leads to an interesting nonconvex optimization problem, termed as the MAP-Rician model, which is based on the Maximum a Posteriori (MAP) estimation approach. As the MAP-Rician model is deeply rooted in Bayesian analysis, we want to understand its mathematical analysis carefully. Moreover, one needs to properly select a suitable algorithm for tackling this nonconvex problem to get the best performance. Indeed, we first present a theoretical result about the existence of a minimizer for the MAP-Rician model under mild conditions. Next, we aim to adopt an efficient boosted difference of convex functions algorithm (BDCA) to handle this challenging problem. Theoretically, using the Kurdyka-Lojasiewicz (KL) property, the convergence of the numerical algorithm can be guaranteed.

**Classification** : 94A08, 68U10

**Format** : Talk at Waseda University

**Author(s)** : Tingting WU (Nanjing University of Posts and Telecommunications)



## [02603] AN $H^1$ GALERKIN MIXED FINITE ELEMENT METHOD FOR ROSENAU EQUATION

**Session Time & Room** : 4D (Aug.24, 15:30-17:10) @E711

**Type** : Contributed Talk

**Abstract** : In this paper, by applying a splitting technique, the non-linear fourth order Rosenau equation is split into a system of coupled equations. Then, an  $H^1$  Galerkin mixed finite element method is proposed for the resultant equations after employing a suitable weak formulation. Semi-discrete and fully discrete schemes are discussed and respective optimal order error estimates are obtained without any constraints on the mesh. Finally, numerical results are computed to validate the efficacy of the method. The proposed method has advantages in respect of higher order error estimate, less requirement of regularity on exact solution and also with reduced size i.e. less than half of the size of resulting linear system over that of mentioned in Manickam et al., Numerical Methods for Partial Differential Equations, (14), (1998), pp. 695-716.

**Classification** : 65N30, 65N06, 65M60, 65M06

**Format** : Talk at Waseda University

**Author(s)** : Jones Tarcus Doss (Department of Mathematics, Anna University, Chennai)

## [02604] Particle dynamics in the KP approximation

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @E702

**Type** : Contributed Talk

**Abstract** : The Kadomtsev-Petviashvili (KP) equation is a model equation describing weakly nonlinear dispersive and small amplitude waves propagating in a quasi-two-dimensional situation. Encoded in the KP model are relations that may be used to reconstruct the velocity fields in the fluid below a given surface wave. In this talk, velocity fields associated to exact solutions of the KP equation are found, and particle trajectories are computed numerically. The solutions treated here comprise the one line-soliton solution and two-soliton solutions.

**Classification** : 65M25, 37M05

**Format** : Talk at Waseda University

**Author(s)** : Juan-Ming Yuan (Providence University)Jen-Hsu Chang (National Yang Ming Chiao Tung University)Henrik Kalisch (University of Bergen)Yusuke Shimabukuro (Math. Inst.)

## [02606] Modeling Indonesian Government Bond Yield Curve during Covid-19 Pandemic Time

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @E504

**Type** : Contributed Talk

**Abstract** : Yield curve in bond investment will provide visualization of yields of bond as the function of the time to maturities. In this study, we analyze Indonesian Government Yield Curve (IGYSC) during the pandemic Covid-19. We apply the Nelson Siegel (NS) class model and compare the performance of the optimization method of based on numerical optimization and based on heuristic optimization. All the computation are done using R software.

**Classification** : 62J02, 62P05, 65K05, 68W50, 90C20

**Format** : Talk at Waseda University

**Author(s)** : Dedi Rosadi (Universitas Gadjah Mada)Dinda Awanda Ramadhani (Universitas Gadjah Mada)Agus Sihabuddin (Universitas Gadjah Mada)

## [02608] Explorative computing for stable and consistent kinetic relaxation in lattice Boltzmann methods

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @E604

**Type** : Contributed Talk

**Abstract** : Using lattice Boltzmann methods with multiple relaxation times for robust and fast incompressible turbulent flow simulations requires tuning of the kinetic parameters. We outsource the perfect parallelizability of lattice Boltzmann methods to analyze kinetic relaxation with respect to non-linear stability and consistency based on explorative computing of artificial turbulence in three dimensions. Conclusively, numerical indication is provided, that accuracy and dissipation is adaptively balanced near the Bhatnagar–Gross–Krook single relaxation time approximated in the scale-resolving limit.

**Classification** : 65M12, 35Q20, 35Q30, 76D05

**Format** : Talk at Waseda University

**Author(s)** : Stephan Simonis (Karlsruhe Institute of Technology) Mathias J. Krause (Karlsruhe Institute of Technology)

## [02609] Reliable and efficient a posteriori error estimates for time-dependent wave equations

**Session Time & Room** : 2E (Aug.22, 17:40-19:20) @F310

**Type** : Contributed Talk

**Abstract** : I will discuss a novel equilibrated a posteriori error estimator for the space (semi) discretization of the scalar wave equation by finite elements. Specifically, I will show that the estimator provides fully-guaranteed upper bounds that are asymptotically constant-free and that it is efficient and polynomial-degree-robust, meaning that the efficiency constant does not deteriorate as the approximation order is increased. To the best of my knowledge, this work is the first to propose an estimator for the wave equation that is provably reliable and efficient in the same norm. I will present numerical examples illustrate the theory and suggest that it is sharp.

**Classification** : 35L05, 65M15, 65M20, 65M60

**Format** : Talk at Waseda University

**Author(s)** : Théophile Chaumont-Frelet (Inria)

## [02610] Discrete Tensor Product BGG Sequences: Splines and Finite Elements

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @E705

**Type** : Contributed Talk

**Abstract** : In this talk, we present a systematic discretization of the Bernstein-Gelfand-Gelfand diagrams and complexes over cubical meshes of arbitrary dimension via the use of tensor-product structures of one-dimensional piecewise-polynomial spaces, such as spline and finite element spaces. We demonstrate the construction of the Hessian, the elasticity, and div-div complexes as examples for our construction.

**Classification** : 65N99, 41A15, 41A63, 65N30

**Format** : Talk at Waseda University

**Author(s)** : Duygu Sap (University of Oxford) Kaibo Hu (University of Oxford) Guido Kanschat (Heidelberg University) Francesca Bonizzoni (Politecnico di Milano)

## [02614] Convergence of a Second-Order Scheme for Nonlocal Traffic Flow Problems

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @E506

**Type** : Contributed Talk

**Abstract** : In this work, we focus on the construction and convergence analysis of a second-order numerical scheme for traffic flow models that incorporate non-local conservation laws to capture the interaction between drivers and the surrounding density of vehicles. Specifically, we combine MUSCL-type spatial reconstruction with strong stability preserving Runge-Kutta time-stepping to devise a fully discrete second-order scheme for these equations. We show that this scheme satisfies a maximum principle and obtain bounded variation estimates. Also, the scheme is shown to admit L1- Lipschitz continuity in time. Subsequently, employing the Kolmogorov's theorem with a modification and using a Lax-Wendroff type argument, the convergence of this scheme to the entropy solution of the underlying problem is established. Numerical examples are presented to validate our theoretical analysis. Additionally, we extend our analysis to two dimensional non-local problems, for which we present a positivity preserving second-order scheme. While first-order methods are typically reliable in computational fluid dynamics, higher-order methods can provide more accurate solutions at the same computational cost, especially for problems in two or three dimensions. Our proposed scheme thus has important implications for accurately approximating traffic flow equations, and our theoretical analysis provides a solid foundation for its practical implementation.

**Classification** : 35L65, 65M12, 65M08

**Format** : Talk at Waseda University

**Author(s)** : Nikhil Manoj (Indian Institute of Science Education and Research, Thiruvananthapuram)Sudarshan Kumar K (IISER Thiruvananthapuram)GD Veerappa Gowda (Center for Applicable Mathematics, TIFR Bangalore)

## [02615] Theory of the cell motility mechanism in the absence of adhesions

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @D514

**Type** : Contributed Talk

**Abstract** : The existing paradigm of the cell motility cycle does not hold for in vivo cell movement in complex 3D environments. In physiologically relevant environments, cells frequently use pressure-driven round membrane protrusions for locomotion. The role of substrate adhesion is minimal, and it remains unknown if and how a cell can migrate without any adhesions. Here, we leverage modeling and computational tools to reveal the step-by-step cycle of locomotion for cells that use blebs as leading-edge protrusions in confined environments. We show that cells cannot effectively migrate when the cell cortex is a purely elastic material, even with asymmetric channel geometry. Cells migrate effectively if actin turnover is included with a viscoelastic description for the cortex. Lastly, we compare with previous experimental findings and identify the spatiotemporal force distribution during a motility cycle.

**Classification** : 92Bxx, 76Zxx

**Format** : Talk at Waseda University

**Author(s)** : Calina Anamaria Copos (Northeastern University)Calina Copos (Northeastern University)Wanda Strychalski (Case Western Reserve University)

## [02619] Interplay of two finite reservoirs in bidirectional system

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @G601

**Type** : Contributed Talk

**Abstract** : Motivated by the interplay of multiple species in several real world transport processes, we propose a bidirectional totally asymmetric simple exclusion process with two finite reservoirs regulating the inflow of oppositely directed particles corresponding to two different species. The system's

stationary characteristics such as densities, currents, etc., are investigated using a theoretical framework based on mean-field approximation and are supported by extensive Monte Carlo simulations. The impact of species, quantified by filling factor, has been comprehensively analyzed.

**Classification** : 35Lxx, 70Exx, 70Lxx, 37Axx

**Format** : Talk at Waseda University

**Author(s)** : Ankita Gupta (Indian Institute of Technology Ropar) Bipasha Pal (Stockholm University) Arvind Kumar Gupta (Indian Institute of Technology Ropar)

## **[02620] Power contraction of RAS with local impedance problems for the Helmholtz equation**

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @E709

**Type** : Contributed Talk

**Abstract** : The Helmholtz equation is notoriously difficult to solve, especially for the case of high wavenumber. The Restricted Additive Schwarz preconditioner with local impedance problems, often called the ORAS method, is arguably the most successful one-level parallel method for Helmholtz problems. This preconditioner can be applied on very general geometries, does not require parameter-tuning, and can even be robust to increasing wavenumber. To date, there is relatively little convergence analysis for this method. In the talk, I will present a novel analysis of the ORAS method.

**Classification** : 65N55

**Format** : Talk at Waseda University

**Author(s)** : Shihua Gong (The Chinese University of Hong Kong, Shenzhen)

## **[02621] Effect of magnetic field on natural convection through infinite plates with ramped velocity**

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @G401

**Type** : Industrial Contributed Talk

**Abstract** : In this talk, we found the analytical solution of unsteady free convective flow of an electrically conducting and viscous incompressible fluid between two infinite parallel plates when one plate moves with a ramped velocity. An applied Magnetic field has been taken into consideration. Laplace transform techniques were used to find the non-dimensional governing equations analytically. The effect of various values for magnetic field magnetic parameter, Grashof number and time parameter are demonstrated graphically.

**Classification** : 26A33, 33C65, 33C20

**Format** : Online Talk on Zoom

**Author(s)** : Sangeeta Kumari (Chandigarh University) Vanita Vatsa (Department of Mathematics, DCRUST, Murthal, INDIA)

## **[02625] Topology-Driven Shape Programmability in Tissue Morphogenesis**

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @D514

**Type** : Contributed Talk

**Abstract** : The ability of a pre-patterned and subsequently activated spontaneous strain field to drive shape transformations has gained increasing appreciation in device design, engineering, and the physics of metric shape-programmability. Many of these ideas may also hold relevance for understanding tissue morphogenesis. We show spatiotemporal patterns of active cell behaviours can be coarse-grained to yield similar spontaneous strain fields, and how topological defects in these fields can organise shape outcomes and provide robustness against natural variability.

**Classification** : 92C05, 92C15, 74M05, 92-10, 92-08

**Format** : Talk at Waseda University

**Author(s)** : Carl D Modes (Max Planck Institute of Molecular Cell Biology and Genetics)

## **[02626] Use of Origami Maths for minimizing packing & wrapping cost**

**Session Time & Room** : 4C (Aug.24, 13:20-15:00) @G301

**Type** : Contributed Talk

**Abstract** : By using the knowledge of mathematical Origami & Kirigami ( Japanese art using principles of topology, operational research & statistics) An analytical study was done to make 3D boxes, in triangular, cubical, spherical, Polihedron etc. shape with maximum volumes and minimum raw material. Boxes of different shape may be made by twisting & folding. Pop up boxes, cartons & Mobius strips can also be made by the same method to minimize the cost of packing & wrapping of manufactured products.

**Classification** : 00A05

**Format** : Talk at Waseda University

**Author(s)** : Krishna Krishna (INDIAN ORIGAMI SOCIETY)

## **[02635] Application of mathematics in large-scale agriculture projects**

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @D408

**Type** : Industrial Contributed Talk

**Abstract** : Two large-scale projects, each involving a consortium of breeding, growing and processing companies from potato industry in the Netherlands will be described, with the emphasis on the increasingly important role the mathematics is playing in these projects. Applied mathematics is required at the three major stages: design of experiments, data pre-processing, and association-regression studies. Successes and current challenges will be discussed.

**Classification** : 92F05, 65Z05, 62J02, 62J05, 62J07, mathematics for agriculture

**Format** : Talk at Waseda University

**Author(s)** : Neil Budko (Delft University of Technology)

## **[02638] A note on contribution of finite difference methods for fractional diffusion equations**

**Session Time & Room** : 2C (Aug.22, 13:20-15:00) @G710

**Type** : Contributed Talk

**Abstract** : Since the last two decades, extensive research has been carried out on the numerical solution of fractional diffusion equations, particularly in finite difference methods. The finite difference schemes play a crucial role in obtaining the solution of fractional diffusion equations. The most popular are the explicit finite difference method, implicit finite difference method, and Crank-Nicolson finite difference method. This article focuses on developing finite difference schemes for fractional diffusion equations. Also, the stability and convergence of finite difference methods will be discussed by using the matrix norm method. Moreover, it will compare methods in the sense of accuracy and rate of convergence of these schemes. The last section will be devoted to the test problems.

**Classification** : 35R11, 65M06, 65M12

**Format** : Talk at Waseda University

**Author(s)** : GUNVANT ACHUTRAO BIRAJDAR (Department of Mathematics, Institute of Chemical Technology, Mumbai)

## **[02639] ON HYPERSOFT TOPOLOGY**

**Session Time & Room** : 1C (Aug.21, 13:20-15:00) @

**Type :** Contributed Talk

**Abstract :** Hypersoft sets have acquired more importance as a generalization of soft sets and have been researched for possible extensions in many fields of Mathematics. In this paper we introduce the notion of hypersoft topological spaces using hypersoft sets and also we introduce and study the concepts of closure, interior and limit point of hypersoft sets.

**Classification :** 03E72, 06D72, 54A40, 91B06

**Author(s) :** INTHUMATHI V (Associate Professor)AMSAVENI M (Research Scholar)

## **[02640] High-Order Finite Element Schemes for Multicomponent Flow Problems**

**Session Time & Room :** 4D (Aug.24, 15:30-17:10) @E711

**Type :** Contributed Talk

**Abstract :** The Stokes–Onsager–Stefan–Maxwell (SOSM) equations model the flow of concentrated mixtures of distinct chemical species in a common thermodynamic phase. We derive a novel variational formulation of these nonlinear equations in which the species mass fluxes are treated as unknowns. This new formulation leads to a large class of high-order finite element schemes with desirable linear-algebraic properties. The schemes are provably convergent when applied to a linearization of the SOSM problem.

**Classification :** 65N30, 76T30, 35Q35

**Format :** Talk at Waseda University

**Author(s) :** Aaron Matthew Baier-Reinio (University of Oxford)Patrick Farrell (University of Oxford)

## **[02641] Reconstructing electron backscatter diffraction data using vectorized total variation flow**

**Session Time & Room :** 5D (Aug.25, 15:30-17:10) @G702

**Type :** Contributed Talk

**Abstract :** Polycrystalline materials consist of crystal grains with distinct grain orientations and crystal structure. Electron backscatter diffraction is used to record the grain orientation. This orientation data might contain noise as well as the missing regions.

We propose reconstructing the orientation data using weighted total variation flow, which is a pde obtained from solving the minimization problem. We then fill the missing region using the TV flow. This talk discusses the application of this reconstruction technique.

**Classification :** 35A15

**Author(s) :** Emmanuel Atoleya Atindama (Clarkson University)Prashant Athavale (Clarkson University)Gunay Dogan (National Institute of Standards and Technology)

## **[02647] Poincaré operators for BGG complexes**

**Session Time & Room :** 5D (Aug.25, 15:30-17:10) @F402

**Type :** Contributed Talk

**Abstract :** Poincaré integral operators give explicit potential and provide an inverse of differential operators in the sense of null-homotopy. These operators play a key role in the mathematical and numerical analysis of fluid and electromagnetic problems. Consequences include the well-posedness of the Stokes problem and the p-robustness of high-order finite element methods. In this talk, we derive such operators for the Bernstein-Gelfand-Gelfand (BGG) complexes with potential applications in elasticity and relativity. The idea is to carry over the results for the de-Rham complex by Costabel and McIntosh to these cases by homological algebra.

**Classification :** 58J10, 35N05, 58A12, 58A14, 65N30, finite element methods, Hilbert complexes, Bernstein-Gelfand-Gelfand construction, applied analysis

**Format :** Talk at Waseda University

**Author(s) :** Andreas Čap (University of Vienna)Kaibo Hu (University of Oxford)

## [02652] A multi-parametric approach for solid transportation problem under uncertainty conditions

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @A201

**Type** : Contributed Talk

**Abstract** : Since most real-life issues take place in an imprecise environment, the uncertain parameters of models based on these issues are also more realistic. In the meantime, transportation issues are no exception. Uncertainty in solid transportation problems is one of the most important issues of the economy of each country and one of the applied issues in operations research too. In this research, we present a new two-phase approach based on the parametric method for solving solid transportation problem with fuzzy objective coefficients and flexible constraints. In this method, better use of resources is done, and it achieved the maximum satisfaction level.

**Classification** : 90B50

**Author(s)** : Seyed Hadi Nasseri Ojaki (Department of Mathematics Department of applied mathematics, University of Mazandaran )Amirhossein Nafei (National Taipei University of technology, Taipei , Taiwan )Seyedeh Zehra Nasseri Ojaki (Department of Computer Engineering, Noshirvani University of Technology, Babol, Iran )

## [02653] Random generation of Phylogenetic networks

**Session Time & Room** : 1C (Aug.21, 13:20-15:00) @

**Type** : Contributed Talk

**Abstract** : Phylogenetic networks are complex structures used to represent evolutionary histories with reticulate events. Random generation of such networks is a fundamental problem in phylogenetics, as it allows for the exploration of the space of possible networks and can provide insights into the properties of the space. In this paper, we present a new algorithm for the random generation of phylogenetic networks with Boltzmann sampling. The algorithm uses a probabilistic model based on the decomposition of a network into smaller subnetworks, which are then sampled independently. The Boltzmann factor is used to control the frequency of the different subnetwork types in the generated network ensemble. We show that our algorithm is efficient, accurate and can generate diverse sets of networks with different properties. Our algorithm is expected to be useful in various applications, such as testing the performance of phylogenetic methods, exploring the space of evolutionary histories, and simulating reticulation events in biological systems.

**Classification** : 05-xx

**Author(s)** : Marefatollah Mansouri (University of Vienna )

## [02661] Practicing Responsible Computation and Innovation in HPC: A Sociotechnical Approach

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @D502

**Type** : Industrial Contributed Talk

**Abstract** : Recent advances in high performance computing (HPC) and artificial intelligence (AI) have reignited discussions for more responsible and ethical computing regarding the use and design of HPC sociotechnical ecosystems within the context of cultures and evolving societal norms. This contributed talk provides practical guidelines derived from computational and social science that scientists, educators, and practitioners alike can employ to become more aware of personal values that may unconsciously shape approaches to computation and ethics.

**Classification** : 91C99, 68-01, 68-04, 68N01, ethics, sociotechnical approach, responsible computing

**Format** : Talk at Waseda University

**Author(s)** : Elaine M. Raybourn (Sandia National Laboratories)Osni Marques (Lawrence Berkeley National Laboratory)Killian Muollo (Sandia National Laboratories)

## [02664] Numerical compression of QMC rules for integration

**Session Time & Room** : 4C (Aug.24, 13:20-15:00) @E704

**Type** : Contributed Talk

**Abstract** : We introduce an algorithm for Tchakaloff-like compression of Quasi-Monte Carlo (QMC) volume or surface integration of bivariate and trivariate compact domains.

The key tools of the algorithm are Davis-Wilhelmsen theorem on the so-called “Tchakaloff sets” for positive linear functionals on polynomial spaces, and Lawson-Hanson algorithm for NNLS.

We provide various examples, focusing, in particular, on the compression of volume and surface integration on union of balls.

**Classification** : 65D32, 65D30

**Format** : Online Talk on Zoom

**Author(s)** : Giacomo Elefante (University of Padova)Alvise Sommariva (University of Padova)Marco Vianello (University of Padova)

## [02665] Modelling metal biosorption on algae-bacteria granular biofilms

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @G809

**Type** : Contributed Talk

**Abstract** : A multiscale mathematical model describing the metals biosorption on algal-bacterial photogranules within a sequencing batch reactor is presented. The model is based on systems of mixed PDEs on a spherical free boundary domain and IDEs derived from mass conservation principles. The model is integrated numerically to examine the role of the microbial species and EPS in the adsorption process, and the effect of metal concentration and biofilm adsorption properties on metal removal.

**Classification** : 35R35, 35L45, 92-10, 92B05

**Format** : Talk at Waseda University

**Author(s)** : Fabiana Russo (Temple University)Alberto Tenore (Department of Mathematics and Applications "R. Caccioppoli", University of Naples Federico II)Maria Rosaria Mattei (Department of Mathematics and Applications "R. Caccioppoli", University of Naples Federico II)Luigi Frunzo (Department of Mathematics and Applications "R. Caccioppoli", University of Naples Federico II)

## [02666] Dynamics of biofouling in microfiltration systems

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @G809

**Type** : Contributed Talk

**Abstract** : Membrane technology is one of the most promising engineering strategies for freshwater production and wastewater treatment. The major concern results in the formation of a fouling layer leading to increasing hydraulic resistance and flux decline during membrane operations. A one-dimensional continuous model has been developed by considering a free boundary value problem describing biofouling dynamics in membrane bioreactors. Numerical results demonstrated the model accuracy in predicting biofouling effects and the implications on process management.

**Classification** : 35R35, 35L45, 92-10, 92B05

**Format** : Talk at Waseda University

**Author(s)** : Vincenzo Luongo (University of Naples Federico II)Nicholas Cogan (Florida State University)



## [02667] Coupled Active Contour Segmentation of Clue Cells from Immunofluorescence Microscopy

**Session Time & Room** : 5C (Aug.25, 13:20-15:00) @D515

**Type** : Contributed Talk

**Abstract** : Presence of clue cells is a critical criterion for diagnosis of bacterial vaginosis. We propose a coupled active contour model for segmenting the clue cells from immunofluorescence microscope images of the samples. It enables jointly segmenting the boundaries of the epithelial cell, its nucleus, and distinct bacteria. Convexification is formulated on top of the levelset framework using characteristic functions. Our approach provides a global optimal solution. Efficacy of the method is demonstrated on clinical data.

**Classification** : 92C55, 92C50, 49N99, 90C25

**Format** : Talk at Waseda University

**Author(s)** : Yongjian Yu (Axon Connected, LLC)Jue Wang (Union College)

## [02670] Glacier sliding as a viscous fluid flow modulated by cavitation

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @D401

**Type** : Contributed Talk

**Abstract** : Glacial ice slides due to lubrication by a thin film of water. Separation of ice from the bed results in water-filled cavities that modulate the stress balance, with important implications for glacier flow. We model the problem as a linearised Stokes flow over a wavy boundary. Complex variable methods are used to solve a Riemann-Hilbert problem that is coupled to a kinematic equation for cavity size. The model is used to discuss glacier friction laws.

**Classification** : 76M40, 86A40, 76D07, 76M45

**Format** : Talk at Waseda University

**Author(s)** : Ian Hewitt (University of Oxford)

## [02673] Reduced-order Modelling of Normal Elastohydrodynamic Collision of Spheres

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @D403

**Type** : Contributed Talk

**Abstract** : I present a model for the normal impact of two elastic spheres colliding in incompressible constant-viscosity Newtonian fluid. Pressure is modelled by the Reynolds lubrication equation, and sphere deformation by Hertz contact theory. Modelling the radial pressure gradient by a Pad'e approximant that is characterized by the centerline gap and curvature, and by rate of gap closing, the problem is reduced to a fourth-order system of ODEs that can be integrated numerically in time.

**Classification** : 76Txx, 74Fxx, 70Gxx

**Format** : Talk at Waseda University

**Author(s)** : John C. WELLS (Ritsumeikan University)

## [02674] General Equilibrium with Unhedgeable Fundamentals and Heterogeneous Agents

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @A508

**Type** : Contributed Talk

**Abstract** : We solve a general equilibrium model in which aggregate consumption has uninsurable growth shocks, rendering the market dynamically incomplete. Agents' stochastic discount factors depend on the history of unhedgeable shocks, agents trade assets dynamically, and the dispersion of agents' preferences impacts both the interest rate and asset prices, hence no representative agent exists.

**Classification** : 91B50

**Format** : Talk at Waseda University

**Author(s)** : Marko Hans Weber (National University of Singapore) Paolo Guasoni (Dublin City University)

## [02680] An analysis of a model of fear in disease transmission

**Session Time & Room** : 4C (Aug.24, 13:20-15:00) @A601

**Type** : Contributed Talk

**Abstract** : A model for disease transmission has been proposed that includes fear response both to disease and vaccine. It has been shown numerically that public health restrictions can create a bifurcation in the final size of the epidemic. In this talk we analyze this model to determine analytic conditions for stability and bifurcations to final disease size. We modify the model with additional terms such as adverse reactions from disease and a double-fear compartment.

**Classification** : 92-10, 92D30, 91D30, 91F99

**Format** : Talk at Waseda University

**Author(s)** : Iain Moyles (York University) Rebecca Tyson (University of British Columbia Okanagan) Avneet Kaur (University of British Columbia Okanagan)

## [02683] When to Sell an Asset? – A Distribution Builder Approach

**Session Time & Room** : 3C (Aug.23, 13:20-15:00) @A508

**Type** : Contributed Talk

**Abstract** : We revisit the question of the optimal time of an asset sale from the point of view of Sharpe's "Distribution Builder" approach: Instead of assuming the investor's risk preferences in form of a utility function, the investor provides themselves a distribution that should be attained when selling the asset at a stopping time (specified a priori). This obviously begs the question of which distributions are attainable for an investor. We connect this problem to the Skorokhod embedding problem for one-dimensional diffusions and provide explicit representation for optimal stopping times as well as their expected values. In the case that the target distribution is specified from a parametrized family (e.g., log-normal distributions), we show that optimality involves a mean-variance trade-off similar to the efficient frontier in Markowitz's approach to portfolio optimization. This is joint work with Peter Carr.

**Classification** : 91B70, 60G40

**Format** : Talk at Waseda University

**Author(s)** : Stephan Sturm (Worcester Polytechnic Institute)

## [02686] Double Conical degeneracy on band structures of periodic Schrödinger operators

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @E711

**Type** : Contributed Talk

**Abstract** : Our work investigates double Dirac cones occurring near fourfold degenerate points in the band structures of certain operators. It is known that such degeneracy originates in the symmetries of operators. Thus, we introduce a new symmetric structure-the super honeycomb structure and an innovative method to incorporate all the symmetries. Both rigorous proof and numerical simulation of the existence of double Dirac cones in the bands of Schroedinger operators with super honeycomb symmetries will be shown.

**Classification** : 68Q25, 68R10, 68U05

**Format** : Talk at Waseda University

**Author(s)** : Ying Cao (Tsinghua University)

## [02687] Semi-Markov Compartment Models

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @G306

**Type** : Contributed Talk

**Abstract** : Compartment models are a widely used class of models that are useful when considering the flow of objects or people or energy between different labelled states, referred to as compartments. Recently we have constructed a general framework for fractional order compartment models, where the governing equations involve fractional order derivatives, via the consideration of a semi-Markov stochastic process. Here we show extensions to this approach to obtain more general operators.

**Classification** : 34A08, 60K40, 92C45

**Format** : Talk at Waseda University

**Author(s)** : Christopher Angstmann (University of New South Wales) Bruce Henry (University of New South Wales)

## [02688] Analytical Solutions of Delay Differential Equations

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @G401

**Type** : Contributed Talk

**Abstract** : Delay differential equations are an interesting class of non-local equations that involve a function and its derivatives evaluated at different points in time. By introducing a new class of functions, we have been able to provide fundamental solutions for autonomous linear delay differential equations. These functions, referred to as delay functions, relate the power series solutions of ordinary differential and delay differential equations and can be easily extended to more generalised series solutions.

**Classification** : 34Kxx, 34K06, 44A10

**Format** : Talk at Waseda University

**Author(s)** : Stuart-James Malouf Burney (University of New South Wales) Christopher Angstmann (University of New South Wales) Bruce Henry (University of New South Wales) Byron Jacobs (University of Johannesburg) Zhuang Xu (University of New South Wales)

## [02689] Double Dirac Cone in Subwavelength Bandstructure

**Session Time & Room** : 4E (Aug.24, 17:40-19:20) @G501

**Type** : Contributed Talk

**Abstract** : In this talk we wish to rigorously justify the existence of the double Dirac point for the super-honeycomb lattice in the subwavelength regime. First, we will give a rigorous characterization of the symmetry conditions. Then, representing the solution by periodic layer potentials when the frequency is nonzero, we can asymptotically solve the band structure by the periodic capacitance matrix. We also study how the perturbation to the inclusions affect the band structure numerically.

**Classification** : 35C20

**Format** : Talk at Waseda University

**Author(s)** : Borui Miao (Tsinghua University) Yi Zhu (Yau Mathematical Sciences Center)

## [02692] Discovering extremal domains via shape optimization for passive tracers

**Session Time & Room** : 5D (Aug.25, 15:30-17:10) @G602

**Type** : Contributed Talk

**Abstract** : Work in passive tracers investigates how properties of a tracer distribution depend on boundary conditions and properties of the underlying fluid flow. We apply shape optimization to discover extremal domains for Poiseuille flow informed by analytic predictions of spatial moments - such as mean, effective diffusivity, skewness - derived in prior work. With this combination of asymptotic formulas and numerical study, we find and report on surprising nonlinear behavior depending on shape parameters.

**Classification** : 35Kxx, 90C90

**Format** : Talk at Waseda University

**Author(s)** : Manuchehr Aminian (California State Polytechnic University Pomona)

## **[02695] The position of the axon initial segment assembly site can be predicted from the shape of the neuron**

**Session Time & Room** : 3D (Aug.23, 15:30-17:10) @E820

**Type** : Contributed Talk

**Abstract** : A unique compartment called the axon initial segment (AIS) was found critical for the proper development of neuronal polarity. It is unclear how AIS is assembled near the proximal end of the axon during axon specification. In this study, we show that the position of the AIS assembly site is correlated with the zero set of the leading eigenfunction of the Laplace-Beltrami operator solved over the geometry of the neuron. We will then discuss the implications from this observation.

**Classification** : 92C20, 92C15

**Format** : Talk at Waseda University

**Author(s)** : Zhuang Xu (The University of New South Wales)Paul Curmi (University of New South Wales)Christoph Angstmann (University of New South Wales)

## **[02701] Pricing Multi-Asset American Options in Dynamic Programming with Sparse Grids**

**Session Time & Room** : 4C (Aug.24, 13:20-15:00) @E507

**Type** : Contributed Talk

**Abstract** : We introduce a sparse grid interpolation and quadrature scheme for pricing multi-asset American option based on dynamic programming. At each time step, we take advantage of the smoothness of the continuation value function, allowing for fast convergence of interpolation. In the multi-dimensional spatial domain, conditional expectations are estimated by sparse grid quadrature or QMC, depending on the asset models. Our algorithm is proven to have accurate error estimates, and numerical experiments demonstrate its efficiency.

**Classification** : 65D40, 65Kxx

**Format** : Talk at Waseda University

**Author(s)** : Jiefei Yang (The University of Hong Kong)Guanglian Li (The University of Hong Kong)

## **[02702] A mathematical model of cell expansion for cultivated meat production**

**Session Time & Room** : 4D (Aug.24, 15:30-17:10) @D408

**Type** : Contributed Talk

**Abstract** : Cultivated meat represents a cruelty-free alternative to conventional production methods of animal protein. However, it currently faces pressing technological challenges that curtail its commercial viability. To facilitate its industrial scale-up, we propose a mathematical model of metabolism of a stem cell expansion system, a key step in the production of lab-grown meat. We evaluate our model with numerical simulations and perform a global parameter sensitivity analysis to gain further insights about our system

**Classification** : 92-10, 92C75, 92B05

**Author(s)** : Julia Krol (Mathematical Institute, University of Oxford)Sarah Waters (Mathematical Institute, University of Oxford)Hua (Cathy) Ye (Department of Engineering, University of Oxford)Akin Odeleye (Ivy Farm Technologies)

## [02907] Robust Train Trajectory Optimization

**Session Time & Room** : 3E (Aug.23, 17:40-19:20) @G402

**Type** : Contributed Talk

**Abstract** : Varying operating conditions may produce delays in railways. We model the Robust Train Trajectory Optimization (RTTO) problem aiming to minimize the impact of model parameter uncertainty on the calculated energy-efficient trajectories, which would be drivable under any of the considered operating conditions. We analyze RTTO using the Robust Maximum Principle, reformulate the problem as a Quadratically-Constrained Quadratic Programming problem and showcase the performance of the model in a real case study.

**Classification** : 34H05, 49K35, 93-08, 90C47, 90C25

**Format** : Talk at Waseda University

**Author(s)** : Alex Cunillera (Delft University of Technology) Ramon M. Lentink (Nederlandse Spoorwegen) Niels van Oort (Delft University of Technology) Rob M. P. Goverde (Delft University of Technology)

## [02961] An analysis of boundary variations in Laplace-Steklov eigenvalue problems

**Session Time & Room** : 2E (Aug.22, 17:40-19:20) @G402

**Type** : Contributed Talk

**Abstract** : We analyze the influence of boundary perturbations on the spectrum of Laplace-Steklov eigenvalue problems. Both the differential equation and a boundary condition involve the spectral parameter. We derive Hadamard type expressions for the variation of the eigenvalues as the problem domain deforms. Consequently, we provide the convergence characteristics of the eigenvalues on the perturbed domain as its boundary approaches to that of the unperturbed one. Numerical results are obtained using a finite element formulation.

**Classification** : 35-XX, 65-XX, FEM analysis of eigenvalues in PDEs

**Format** : Talk at Waseda University

**Author(s)** : Önder Türk (Middle East Technical University) Eylem Bahadır (Gebze Technical University)