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Book of Abstracts

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Plenary Talk 1 / **30**

Opening remarks - NMC

National Mathematical Centre

Technical session 1 / **31**

EXISTENCE OF SOLUTION OF IMPULSIVE QUANTUM STOCHASTIC DIFFERENTIAL INCLUSIONS USING NON FIXED POINT APPROACH

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We observed that Impulsive Quantum Stochastic Differential Inclusion (IQSDI) may not have solution even if it is Lipschitz continuous because of the limiting condition imposed on the impulsive term t_k. We impose an extra regularity condition on t_k and establish solution using minimal selection theorem. QSDI in this work is in the framework of Hudson and Parthasarathy developed quantum stochastic calculus on Boson Fock space

Technical session 2 / **33**

A SYSTEMATIC LITERATURE REVIEW OF MACHINE LEARNING FOR MALWARE: METHODS, ALGORITHMS, PERFORMANCE, LIMITATIONS AND FUTURE RESEARCH DIRECTION

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Malware detection is a crucial component of cybersecurity, with various techniques utilized to combat the constantly evolving landscape of malicious software. This work aims to conduct a systematic literature review (SLR) of different machine-learning models used by various authors to evaluate their effectiveness in combating malware. The objective of this work is to synthesizes the knowledge from these studies to better understand various malware detection topics and identify new research issues for possible future research directions. The systematic literature review (SLR) was conducted to review the state-of-the-art studies on Windows and Android malware detection. The results of this study indicate that machine learning algorithms have become increasingly prevalent in malware detection, which has recently gained popularity. The integration of supervised models with deep learning techniques has demonstrated a promising potential for enhancing the efficacy of malware detection and provides insights into how to improve malware detection systems.

Technical session 1 / 34

Deep Learning Platform Comparisons & A Predictive Model for Real-Time Offline Application.

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This paper explores predictive modelling, a mathematical technique used to analyse data patterns for forecasting future events or outcomes. Predictive modelling is a crucial component of predictive analytics, a data analytics discipline that employs machine learning and data mining methods to forecast activity, behaviour, and trends using both current and historical data. Initially, the paper focuses on comparing available computing platforms for deep learning. Subsequently, it delves into predicting the torque required for an exoskeleton system, enabling wearers to effortlessly lift objects. This prediction is based on input from sensors embedded in the exoskeleton and utilises available features in an offline real-time setting. The results demonstrate the effective prediction of torque based on historical data. Furthermore, the paper discusses various offline applications of the proposed system. The
successful prediction of torque opens up avenues for exploring diverse offline uses of the technology.

Technical session 1 / 35

A Trigonometrically-Fitted Four Step Method for solving Oscillatory Second Order Ordinary Differential Equations

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A continuous implicit trigonometrically-fitted four-step method (CITFFM) for solving oscillatory second order ordinary differential equations (ODEs) is developed in this paper. The CITFSM is generated by collocation and interpolation techniques through the use of a combination of power series and trigonometric function as approximate basis equation. For implementation purpose, an implicit discrete scheme is obtained from the CITSSM by choosing some numerical values to obtain constant coefficients for the method. The main predictors needed for the implementation of the implicit discrete scheme are designed to be of the same order with the method. Stability and other properties of method are ascertained, and accuracy and efficiency of the method are confirmed by solving linear and nonlinear initial value oscillatory problems of ODEs. The superiority of the method is shown

by comparing the absolute errors of the method with some methods cited in the reviewed literature, and it was seen that the new method is more accurate.

Technical session 3 / **37**

SENSITIVITY ANALYSES OF VACCINATION, TREATMENT AND DISEASE RELAPSE ON THE TRANSMISSION DYNAMICS OF TUBERCULOSIS

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It is estimated that one-third of the world's population are infected with latent Tuberculosis (TB). This research presents an exhaustive deterministic model for the transmission and control dynamics of TB. This model incorporates significant parameters such as vaccination, treatment, disease relapse after recovery, vaccination wane, progression rate from latent to active TB, among others. The model was shown to possess a positive and bounded solution region. Furthermore, by employing the next generation matrix approach and the Routh Hurwitz Stability criteria, it was obtained that there exists a locally stable disease-free equilibrium point for the model whenever the effective reproduction number, R_e, is less than unity and a unique endemic equilibrium point whenever $R_e > 1$. Sensitivity analysis of R_e was performed using the forward index sensitivity approach. It was obtained that the recruitment rate into the susceptible population and the disease transmission rate have a unitary sensitivity indices. Rates of loss of immunity after vaccination and progression from latent to active TB exhibit a direct variation with R_e while vaccination, treatment, natural and disease induced death rates exhibit an indirect variation with R_e. Numerical simulation was performed on the model by implementing the fourth order Runge Kutta numerical computation method on MATLAB subroutine. Every parameter sensitive to R_e was varied and the effects of these parameters on the spread and eradication of TB was discussed.

Technical session 3 / **39**

A Framework for Implementing ERP Systems in Higher Educational Institutions

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Higher educational institutions face challenges in managing resources effectively, impacting their competitiveness and sustainability. Higher educational institutions are critical for societal development, relying on effective management of resources for success. However, many Nigerian tertiary institutions still use traditional administrative systems, leading to inefficiencies and resource wastage. This study proposes a framework for implementing an Enterprise Resource Planning (ERP) system in higher education institutions to improve resource management. The framework integrates core processes into a single system, enhancing transparency, optimizing resource use, minimizing waste, and improving employee motivation. The framework aims to streamline administrative processes, reduce paperwork, and optimise resource utilisation. It provides a roadmap for enhancing competitiveness and sustainability. An Object Process Methodology (OPM) was adopted in this study. Data was collected using a descriptive case study to identify resource custodians and entities in Nigerian tertiary institutions. The various entities identified were classified as objects and processes. Using

SWOT (Strength, Weaknesses, Opportunities, Threats) analysis, the strengths and problems of the existing system and possible opportunities to leverage upon for improvement were identified. These served as benchmarks for the proposed ERP system for tertiary Institutions. From the research findings, it can be inferred that an ERP system is crucial for modernizing higher educational institutions in Nigeria and achieving efficiency in resource management.

Technical session 4 / **40**

Information theoretic analysis of ArXiv's physics abstracts

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The abstract gives the first impression of the manuscript. How much information or complexity is contained in the abstract? In this study, the amount of information in ArXiv's physics abstracts was characterized using Shannon entropy. The variation of abstract entropy with respect to the number of authors, abstract length, and year was considered. The entropy of the abstract was found to have a linear relationship with the number of authors between 1 and 24. With authors between 1 and 24, there were significant variations and outliers in entropy values. A slight increase has been observed in abstract entropies in recent years. In the relationship between the length of the abstract and the entropy, three regimes were identified. The results obtained in this study will be helpful in making editorial decisions to improve the quality of abstracts.

Technical session 3 / **41**

SQL Injection Detection Model Using Autoencoder-Tokenization-TCN Approach

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SQL injection attacks pose a significant threat to database security, potentially leading to data breaches and unauthorized access. This paper presents a novel approach to SQL injection detection using a combination of deep learning techniques: autoencoders, tokenization, and Temporal Convolutional Networks (TCNs). The proposed method aims to accurately differentiate between legitimate SQL queries and SQL injection attempts by leveraging the temporal and structural patterns inherent in the query data. The system utilizes autoencoders to learn a compressed representation of normal queries, tokenization for converting queries into sequence data, and TCNs for capturing temporal dependencies.

Technical session 2 / **42**

STABILITY ANALYSIS OF EBOLA DYNAMICS TRANSMISSION

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Modelling HIV Superinfection with Two Unique Viral Strains

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HIV superinfection, the acquisition of a second distinct viral strain in an individual already infected, presents challenges to HIV management and vaccine development. Understanding the dynamics and implications of superinfection is crucial for advancing HIV research and developing more effective prevention and treatment strategies. While HIV superinfection is recognized, the mechanisms, factors influencing its occurrence, and its impact on disease progression remain inadequately understood. This study addresses the gaps in knowledge regarding HIV superinfection by employing mathematical modelling to analyze the dynamics of coexistence and competition between two unique viral strains within the same host. A HIV superinfection model with two unique viral strains was developed. The viral strains-free and viral strains equilibria states were obtained and found to be stable. Numerical simulations showed that in order to prevent HIV superinfection, treatment at 95% level of efficacy should begin at any time, t < 50 days, before the second strain is fully integrated in the population of primarily infected cells. We conclude that the HIV superinfection model developed in this study minimizes the rate of infection and the rate at which new viruses are produced by the second strain. The models also show that the second strain of HIV contributes to the persistence of HIV in the system, increases viral load, orchestrates the multiplication of infected cells and results in the decline of the population of healthy cells.

Technical session 1 / 44

Biomechanical Analysis of Hemodynamic Muscular Pressure on the Arterial Blood Vessel: Insights from Computational Modeling

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High blood pressure, also known as hypertension, is a common medical condition where the force of blood against the walls of the arteries is consistently too high. During the last 100 years, pathological methods have been used to explain different ways that recapitulate the unique features of muscles and how they relate to the arterial blood vessel. The mechanical characterization of pressure acting on the artery blood vessel when the muscle collapses has resulted in high blood pressure. The biomechanical environment causes behavioral changes that affect the wall of the vessel. This is due to the mechanical properties applied to the artery to obtain stress relaxation, burst pressure on the valves, and dynamics biomechanical analysis. These resulted in the non-linearity and hysteresis of the blood flow. A consistent biomechanical contract of the muscles on the artery blood vessel can

lead to high blood pressure, which can lead to death. This can be subdued by in-depth analysis using a computational technique to investigate the missing element that has resulted in physiological and biomechanical performance on the arterial blood vessel by the contracted muscles. The result shows the hemodynamic factor to be 6.6e-7 that help reduce high blood pressure. These models will help researchers and clinicians understand the complex hemodynamics and mechanics of blood flow, predicting the effects of various physiological and pathological conditions, and developing new diagnostic and treatment strategies for cardiovascular diseases.
Keywords: Hypertension; Biomechanical model; Static structural analysis; Finite element, Blood pressure flow; Muscles; Arterial

Technical session 2 / **45**

Investigating the complexity in human mobility using information theory

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ABSTRACT
Humans mobility patterns are a complex systems driven by several dynamics.The amount of information available in human mobility to different places can give insight to urban and economic development. In this study, information theory was used to analyze human mobility to six different places (retail and recreation centers, grocery stores, pharmacies, parks, transit stations, workplaces, and residential areas) in the 36 states of Nigeria over a period of three years. Our results showed that the entropy of mobility within workplace has the highest complexity. It was also found that the entropy values of mobility correlate with GDP and population of the location. Furthermore, the network analysis of entropy values was computed to determine clusters and connection in mobility across states of Nigeria

Technical session 4 / **46**

Modelling the impact of Temperature-Dependent Specific Heat Capacity of Tri-hybrid Casson Nanofluid for enhanced solar panels.

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Abstract:
The transition to solar energy is pivotal in addressing global energy challenges, offering a clean and renewable alternative to fossil fuels. However, to maximize the potential of solar power, there is critical need to enhance the efficiency and reliability of solar panels. This study focuses on modeling the influence of temperature-dependent specific heat capacity in Tri-hybrid Nanofluid to optimize

solar panel performance. The system of governing Partial Differential Equations was formulated by incorporating variable temperature-dependent specific heat capacity, magnetic field, and thermal radiation, and later transformed into a system of Ordinary Differential Equations by similarity techniques. The resulted ODEs were solved numerically using Python software. The simulation results show that the temperature profile declines as the variable specific heat capacity parameter increases. It can be concluded that temperature-dependent thermophysical properties (specific heat capacity) and radiation have a significant influence on enhancing the tri-hybrid nanofluid for improved solar panels. By addressing thermal management challenges, such as heat dissipation and temperature regulation, the results surface significant improvements in efficiency and reliability, with potential real-life applications including increased energy output and prolonged lifespan of solar panels, contributing to a more sustainable energy future.
Keywords: Modelling, Solar panels, Tri-Hybrid nanofluid, Python.

Technical session 1 / **47**

Temperature oxidation of double combustible reaction and thermal ignition in a concentric cylinder with diverse boundary constraints

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Chemical species undergoing spontaneous reactions and temperature oxidation of materials are useful in explosion safety, propulsion detonation and chemical synthesis. Thus, this study considers the dynamics of temperature oxidation of a two-step exothermic combustion and thermal ignition in a concentric isothermal cylinder with diverse boundary constraints. With constant thermal reactant conductivity, a time-dependent partial derivative model is developed to give insight into the chemistry of the branch chain reaction, pre-exponential factor, Arrhenius kinetic, and critical behaviour of the system. A finite semi-discretization difference method is used to investigate the various boundary conditions' impact on the thermal distribution, stability and ignition of the homogenous species reactant. The outcomes show the momentous effects of mixed conditions on the oxidation process, ignition mechanism and thermal behaviour within a concentric cylinder. Hence, this enhances safety protocol and facilitates combustion optimization processes in thermal engineering applications.

Technical session 3 / **48**

Schrodinger Equation for Momentum Indicator in the Stock Market

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ABSTRACT

This paper is a contribution to the application of quantum finance theory. Some of the common momentum indicators include: the rate of change (or the ROC), the relative strength index (or the RSI), the moving average convergence divergence (or the MACD) and the stochastic indicator. It is

noted that many of the known methods for computing the indicators including those not mentioned here, have mainly concentrated
on the historical stock's data spanning over weeks and months, and even at that, there is no empirical basis for most of those methods as they were mere mathematical manipulations and conjecture. Using the model based on the Schrodinger equation for the harmonic oscillator, we developed a method to compute the velocity and momentum of stock prices in a stock market. This offered a proven approach that would give financial technical analysts credible computational method using daily/current stock market data that would improve their quality of advice to potential investors and interested stakeholders. Some randomly selected equities traded on the floor of the Nigeria Stock Exchange were used as our case study.

Keywords –Schrodinger equation, quantum finance, velocity indicator, momentum indicator, technical analyst.

Technical session 4 / 49

Magnetohydrodynamic Two-Phase Slip Flow and Heat Transfer of Dusty Tangent Hyperbolic Fluid over an Expansive Porous Sheet

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The relevance of flow dynamics and heat transfer in complex fluid-solid systems is essential in many manufacturing and engineering processes, such as chemical processing, thermal cooling systems, heat exchangers, etc. The current study, therefore, delves into the analysis of dusty tangent hyperbolic fluid flow mechanism and heat transfer characterized by the MHD two-phase flow phenomenon over a porous expansive sheet. A mathematical model is developed in partial derivatives to capture the physical description of the problem for both phases in the presence of thermal radiation, Joule heating, exponentially decaying heat source, Navier slip and convective heating boundary situations. A numerical technique via shooting with the Runge-Kutta Fehlberg method is employed to solve the controlling model equations. The results are presented graphically and tabularly with relevant discussion to comprehend the critical engineering parameters on the dimensionless profiles of velocity, temperature, and heat transfer phenomena. The computational results expose a decline in the hydrodynamic boundary layer but an expanded thermal boundary layer due to magnetic field influence. Improvements in the heat source and surface convection terms raise thermal distribution across the system surface.

Technical session 2 / 51

An Inventory Management for World Food Program (WFP) Beans Distribution to IDPs and Deteriorating Rate with Partial Backlogged Under Boko Haram Terrorists Caliphate in Nigeria.

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This study looks into the challenges of the critical situation faced by the World Food Program (WFP) on inventory management during humanitarian assistance under the stronghold of the Boko Haram terrorists caliphate, in Gwoza, Borno State, Nigeria. However, the EOQ model under such a man-made disaster and a terrorists region with an unavoidable task that required additional cost of military escorts transportation services on foodstuffs (Beans) and other items to the various destinations of internally displaced persons camps (IDPs Camps) that involved military assistance as a backup with a significant increase in holding/ carrying cost and the ordering cost. The safety of the humanitarian workers (WFP) and the foodstuff (Beans) consignment and other items are very important. Keeping scenario in mind, and attempt has been made to formulate a suitable EOQ model to optimise the performance of the World Food Program.

Keywords: Inventory Management, EOQ, WFP, Boko Haram Terrorists, Foodstuffs.

Technical session 3 / **52**

APPLICATION OF OPTIMAL CONTROL STRATEGIES TO DRUG-CRIME MODELING

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Abstract: The drug-crime nexus represents a persistent challenge with profound societal implications. This publication explores an innovative approach by applying optimal control strategies and cost-effectiveness analysis to model and address this complex issue. This research presented a six-dimensional compartments model for the co-dynamics of drug and its related crime. This model is governed by a system of first order nonlinear differential equation. Furthermore, two time-dependent controls were incorporated into the non-autonomous model with the aim of minimizing the population of drug addicts and drug criminals at a low cost. The solution of the optimal control model shows that the implementation of any of the controls is efficient in achieving the objective functional when compared with the absence of controls. Both the ICER and ACER methods shows that the implementation of only empowerment and enlightenment control U1 is the most cost effective strategy. Our findings demonstrate that optimal control strategies, when appropriately tailored to the specific context, can yield significant reductions in drug-related crime, making efficient use of limited resources.

Technical session 1 / **54**

Induced Partial and Mixed synchronization in Chain-Fractance system

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A general procedure for targeting and controlling synchronization in chain-fractance configuration is designed bidirectionally and unidirectionally. The appropriate open-plus-closed-loop coupling

criterion are employed to induce mixed and partial synchronization, respectively. Transitions from anti-synchronization, amplitude death and complete synchronization were realized by varying the scaling factor embedded in the coupling function. The tunable matrix element in the matrix type coupling is also used to achieve the desired synchronization. Finally, the electronic software simulation confirm the theoretical analysis and numerical simulation.

Technical session 2 / 55

Unraveling Complex Dynamics and Active Control of a Novel Multi-equilibrium Hyperchaotic Memristive-Based Variable-Boostable System

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This paper presents a detailed exploration into the dynamics of an innovative 5D variable-boostable (V-B) system, incorporating series-based memristors. The investigation traces the transition from integer 3D-chaotic flows to 5D-integer-order hyperchaotic flows, shedding light on the system's evolution and enhanced capabilities. A thorough analysis is conducted, focusing on the system' s multi-equilibrium points and linear stability. Additionally, the behavior of the system is scrutinized through comprehensive examinations, including bifurcation diagrams, Lyapunov exponents, 0-1 chaos test, and the coexistence of attractors. Finally, active control strategies of the new system to establish global stability within the system have been achieved. The findings contribute to the understanding of the intricate dynamics exhibited by the 5D V-B
system, offering valuable insights into its potential applications and implications for future research.

Technical session 2 / 56

A Numerical Study of the effects of Fuel Injection timing on Engine Performance and Emission characteristics of Spark Ignition Direct Injection Engine

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Key words: Compressed Natural Gas (CNG),Spark Ignition Direct Injection (SIDI) Engine,Fuel Injection Timing,Engine Performance, Emission Characteristics, Gasoline

Abstract: This study numerically investigated the effects of early and late injection timings on the combustion of compressed natural gas (CNG) in SIDI engines; that is spark ignition engines where the gas is directly injected at high pressures (50 bar). The pressure and emission characteristics of early and late CNG injection were compared with a 200-bar gasoline direct injection base study at wide open throttle. This was done to further understand the comparative performance of CNG against gasoline under different injection regimes and be able to predict the effect of injection timing

on optimal performance.
The results showed the late injection of CNG increased in-cylinder pressures and flame propagation compared to the early injection due to the presence of a stratified charge and turbulence induced by the injection. This resulted in improved performance but at the cost of increased emissions caused by lack of adequate time to achieve a homogeneous mix in the engine combustion chamber. Compared to gasoline combustion, the late injection of CNG reduced CO2 emissions by 36% even though the power output was the same in both cases.
The study concluded that CNG provides reduced emissions compared to gasoline under both early and late injection conditions. Furthermore,late injection of CNG occasioned increased NOx emission and soot formation. Further investigation is required to maximize the performance and reduce the emissions from late injection.

Technical session 2 / **58**

Angular Motion and Nonlinear Conservation Laws: A Study on the Flow of Erying-Powel Hybrid Nanofluid over a Riga Plate

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This study explores the effects of rotation in a fluid flow over a magnetized surface, which has practical applications in the design and operation of induction motors, electric generators, and induction regulators. The mathematical model provides a framework for analysing and predicting the complex interaction between a Erying-Powel fluid, hybrid nanoparticles, rotation, non-linear heat and mass conservation laws. To simplify the dynamical mathematical model into a solvable system of dimensionless ordinary differential equations, a scaling transformation of the similarity form is employed. Due to the complexity of the coupled differential equations, an assume solution using the Lagrange polynomial as the basis function is employed through the use of collocation method. This approach allows us to construct a differentiation matrices, which are essential for solving the differential equations. A parametric analysis of all the pertinent parameters, such as the Eckman number and volume fraction, is accounted for through tabular and graphical illustrations.

Technical session 4 / **59**

Multivariate Statistical And Geospatial Techniques for the Assessment of Groundwater Suitability for Drinking and Irrigation Purpose in Sokoto-Rima Catchment Area, NW Nigeria

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This study aims to provide adequate primary information on physico-chemical parameters, water quality indices, probable source of ions responsible for groundwater chemistry and their spatial variability in Sokoto-Rima Catchment. A combination of hydro geochemistry, multivariate statistics, and geographical information system (GIS) approaches was employed to evaluate the groundwater quality and its sustainability for both drinking and agriculture in the Hydrological Area (HA). The results showed that the groundwater samples are mainly Ca–Na–HCO3 type. The Hierarchical Cluster analysis showed total of Four (4) clusters, which correspond with spatial 50 groundwater distribution. The component analysis showed that PC1and PC2 represents the major geochemical processes taking place, due to the presence and dissolution of some carbonate silicate and evaporate minerals in the aquifer. Correlation analysis indicates that rock weathering and leaching are the main natural drivers of GW hydrochemistry in this area. the results of PCA are validated using the cluster analysis and correlation matrix analysis. Based on the groundwater quality index (GWQI), it is found that all the groundwater samples belong to excellent to good water quality domains for human consumption. The results of irrigation water quality index including sodium adsorption ratio (SAR), permeability index (PI) and sodium percentage (Na %) suggested that most of the groundwater samples are good quality water for agricultural uses except in few locations were the KR indicated Marginal to unsuitability status. The IDW interpolation technique was used to generate the spatial distribution maps of each parameter of groundwater dataset for this study.

Technical session 1 / 60

Unsteady Flow of Micropolar Nanofluid over a Stratified Stretching Surface with Riga Plate

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The research investigated energy and mass transport of fluids, particularly analysing the flow behavior of unsteady micro rotational Nanofluid over a Riga Plate. The influence of suction and magnetic field along with the thermophoresis and Brownian motion on the stratified flow of Micropolar nanofluids was examined. The governing equations to describe the flow scenario are given by a system of partial differential equations. Some suitable similarity variables were introduced to reduce the number of independent variables to one and thereby obtain a set of Ordinary Differential Equations (O.D.E.). The derived O.D.E. were then solved numerically and analysed using Runge-Kutta Fehberg method along with shooting technique on Maple 18.0 mathematical software. The effects of some important parameters on velocity, micro rotation, energy and concentration profiles were described graphically. The velocity profile increased with an increase in the modified Hartmann number, Grashof number and modified Grashof number parameters but decreased for increases in Unsteadiness and suction parameters. The temperature profile was enhanced with increasing values of the thermophoresis and Brownian motion parameters but diminished for increases in Prandtl number and Unsteadiness parameters. The concentration profile also increased with increasing thermophoretic values but decreased when Brownian motion parameter was increased.

Technical session 1 / 61

COMBINED EFFECTS OF STEADY VARIABLE VISCOSITY AND THERMAL CONDUCTIVITY ON ELECTRO-OSMOTIC AND MAGNETO-HYDRODYNAMIC FLOWS IN A REACTIVE FLUID

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Combined effects of steady electro-osmotic flow (EOF) and magneto-hydrodynamics (MHD) with variable viscosity and thermal conductivity of the reactive fluid flow is assumed to vary exponentially with temperature was investigated. The dimensionless variables was used to dimensionalized the governing equations of the flow using suitable physical parameter. However, steady variable viscosity and thermal conductivity momentum and energy coupled nonlinear equations were solved by Weighted Residual (Collocation) method (WRCM) using collocation method to handle the integration.The graphical results was used to study the effects of thermophysical behavior of the model. The influence of electro-osmotic and magnetic field on the fluid flow was significant as Lorentz force retarded the flow while thermal conductivity dampened the fluid flow and viscosity enhanced the temperature field due to the thickness in the thermal boundary layer as the parameter increased.
This paper concluded that variable viscosity and thermal conductivity showed an increase in the velocity and temperature profiles for steady EOF-MHD flow. This information will be useful in chemical processing industry, combustion industry and allied of engineering.
Keywords: Steady flow, Electro-osmotic; Magneto-hydrodynamic; variable viscosity; variable thermal conductivity; reactive fluid; Weighted Residual (Collocation) method (WRCM).

Technical session 3 / **62**

Review of IDS & IPS in VANET (Vehicular Ad-hoc Networks)

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ABSTRACT
Significant data collection has revolutionized our daily lives and brought about changes in various industries such as marketing, telecommunications, finance, and transportation systems. With the help of technological advancements, data collection plays a momentous role in transportation systems, particularly with regard to traffic flow signals, traffic control, and vehicular environment/networks. However, security is a major concern in this field as many aspects of these processes are sensitive and pose a huge risk of being attacked, leading to great consequences. Due to this, it is imperative to focus on the vulnerabilities that exist in Vehicular Ad-Hoc Networks (VANET) in terms of intrusion detection and prevention systems. Wireless Sensor Networks (WSNs) have also been applied in Intelligent Transportation Systems (ITSs) to address these issues. Over the last decade, this topic has received extensive research compared to that of the wired network infrastructure VANET and UAV communications against various cyber-attacks that deteriorate the integrity, confidentiality, and availability of vehicular data. Therefore, this paper aims to systematically review the related work on machine learning techniques for intrusion detection and prevention systems in VANET, UAV, and Wireless Sensor Networks.
Key words:
ML Machine Learning, DL Deep Learning, AI Artificial intelligence, RL Reinforcement Learning, ITSs Intelligent Transportation Systems, VANET vehicular ad-hoc network, UAV unmanned aerial

vehicle, DNNs Deep Neural Networks, IOV Internet of Vehicles, NN Neural Networks, CNNs Conventional Neural Networks, RNNs Recurrent Neural Networks, DDPG Deep Deterministic Policy Gradient, IDS Intrusion Detection System, IPS Intrusion Prevention System.

Technical session 1 / 63

Numerical Integration of Nonlinear FitzHugh-Nagumo Partial Differential Equations Using Second Derivative Two-step Hybrid Block Method Coupled with the Compact Difference Schemes

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In this paper, the derivation of a second derivative two-step hybrid block Method is carried out via Collocation techniques and the scheme is coupled with sixth-order compact difference schemes for the numerical solution of the nonlinear FitzHugh-Nagumo Partial Differential Equations (PDE) which is of physical relevance. The sixth-order standard compact difference schemes are used to semi-discretize the nonlinear FitzHugh PDE to a system of first-order ordinary differential equations (ODEs). Then the derived two-step hybrid block scheme proposes an approximate solution to the resulting system of ODEs. The proposed block scheme has been proven to be zero-stable, consistent, and convergent while maintaining good accuracy. The numerical results reveal that the derived block scheme is computationally efficient, when compared to the exact solution and some existing schemes solutions derived from solving FitzHugh-Nagumo PDE.

Technical session 1 / 64

Mathematical Modeling of Chemotherapy Effects on Brain Tumour Growth

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Brain tumor is an abnormal growth or mass of cells in or around the brain. It is also called a central nervous system tumor. Brain tumors can be malignant (cancerous) or benign (not cancerous). In this work we proposed a system of nonlinear differential equations that model brain tumor under treatment by chemotherapy, which considers interactions among the glial cells X(t), the cancer cells Y(t), the neurons Z(t), and the chemotherapeutic agent C(t). The chemotherapeutic agent serves as a predator acting on all the cells. We studied the stability analysis of the steady states for both cases of no treatment and continuous treatment using the Jacobian Matrix. We concluded the study with numerical simulation of the model and discussed the result obtained.

Technical session 2 / 65

RECYCLING OF MUNICIPAL SOLID WASTE: A DETERMINISTIC APPROACH.

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Effective waste management aims at minimizing garbage's detrimental effects on the environment, public health, and aesthetics, which also attempts to recover valuable resources and support sustainable development.
The Next Generation matrix was employed to calculate the reproduction number, the model equations were solved using the Differential Transformation Method (D.T.M.) and the obtained result was simulated using the Maple software. The result shows that waste management will be effective if recycling of waste is given the proper attention that it deserves. It also indicates that waste for disposal will be limited and managing waste will become easier.

Technical session 2 / **66**

OPTIMAL ANALYSIS OF THE EFFECT OF D1 AND D2 VACCINES ON MEASLES VIRUS

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Abstract
Measles, an acute viral infectious disease caused by the measles morbillivirus, belongs to the paramyxovirus family. It spreads through direct contact and airborne transmission, primarily infecting the respiratory tract through coughs, sneezes, and nasal secretions. The prevalence of measles is a concern in African and developing countries where overpopulation and limited birth control measures exist. Outbreaks in such regions pose significant risks. In this study, a mathematical model was developed to analyze measles transmission, considering various immunization strategies, and the effectiveness of the Two-Dose vaccination D1(t) and D2(t). A control model was formulated, and the Disease-Free Equilibrium (DFE) state was determined. The basic reproduction number, denoted as R_0, was computed to assess the potential spread of the virus. Local stability analysis of the DFE was conducted using Jacobian Matrix Techniques, revealing that the DFE is locally asymptotically stable when R_0 is less than 1. The findings suggest that global eradication of measles is feasible if R_0 remains below one.

Key words: Basic Reproduction Number R_0, D1 and D2 Vaccination, Jacobian Matrix, Measles, Optimal Control, Stability

Technical session 3 / **67**

Numerical and Analytical solutions of Heat and Mass transfer of Casson nanofluid flow with convective boundary conditions.

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Abstract: Heat and mass transfer of magnetohydrodynamic (MHD) Casson fliud in the presence of nanofluid, viscous dissipation, thermal radiation and magnetics effect is investigated. The MHD flow is steady, incompressible and generated due to exponentially stretching surface and convective boundary conditions is employed. The governing nonlinear partial differential equations describing the problems are formulated and transformed to ordinary differential equations via similarity variables. Analytical method via Homotopy perturbation method (HPM) is used to obtain the solutions for flow velocity, temperature and concentration. Numerical method solution is employed to validate the analytical solution. The effects of some embedded flow parameters such as magnetic parameter, Prandtl, Brownian motion, Eckert number, Lewis number, thermal radiation and thermophoresis parameters on flow velocity, temperature and concentrations distributions are presented graphically with aid of Maple sofware and discuss in details. It is found that increase in Casson parameter results in increase in temperature and nano particle concentrations. It is also found that magnetic parameter and Biot number due thermal convective conditions yield an increase in the temperature but has reverse effect on the flow velocity.
Key words: Casson fluid, Magnetohydrodynamics(MHD), nanofluid, Homotopy perturbation method

Technical session 2 / 68

DYNAMICAL ANALYSIS OF DIPHTHERIA AND PERTUSIS CO-INFECTION WITH OPTIMAL CONTROL

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ABSTRACT
Diphtheria and Pertussis are vaccine-preventable respiratory diseases which pose as public health challenge particularly in infants and children who missed out of routine vaccination programs during Covid-19 outbreak.
This study hinges on the fact that pathogens can coexist in a host, therefore we propose a non-optimal and optimal control intervention strategy to check the transmission co-dynamics of diphtheria and pertussis. The SIR-type model was utilized and modified into 8 compartments with Vaccination at birth, Maternal derived immunity and partial quarantine as non-optimal control disease controller. The study established that the model is both epidemiologically and mathematically sound.
The next generation matrix was used to derive the co-infection of the basic reproduction number of the co-infection, after which stability analysis was done. The formulated model exhibits four equilibria points, which are; diphtheria-free equilibrium, pertussis-free equilibrium, co-infection-free equilibrium and co-infection endemic equilibrium. The sensitivity analysis was manually calculated

to know the effects and magnitude of each parameter on the basic reproduction number. Furthermore, the existence of an optimal control was established, The Hamilton and Pontryagin principles for optimal control was employed to provide insights on control input interventions such as disease awareness campaigns, vaccination programs, provision of personal protective equipment (PPE) for health workers, cocooning and intensified diagnosis efforts. The accuracy of the pertussis-diphtheria co-infection model was validated through theoretical and Numerical simulation and relevant results are graphically displayed.

Technical session 4 / 69

Optimal Control Analysis of Cyberattacks in Software-Defined Networking

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Abstract
This research explores the dynamics of cyberattacks in Software-Defined Networking (SDN) environments using optimal control theory. It aims to study the dynamics of cyberattack propagation in a complex system such as a telecoms/computer network built on the principle of SDN. The focus of the study is to formulate optimal defense strategies to ameliorate the impacts of the cyberattacks with the SDN. The study examines the mechanisms driving the spread and evolution of cyberattacks within SDN architectures using the theory of epidemiology. It considers factors such as attack vectors, propagation pathways, reproduction number, and bifurcation analysis with time delay. The study proposes a model that incorporates delay to represent the latent period, and the basic reproductive number is derived. To evaluate the impact of control measures, the model is reformulated as an optimal control problem incorporating the quarantined class of nodes and mitigation strategies. The existence of an optimal control solution is also demonstrated. Finally, numerical simulations are conducted to validate the theoretical analysis. Additionally, by using time delay as a bifurcation parameter, it is shown that a critical delay value exists for the stability of attack prevalence. If the delay surpasses this critical value, the system becomes unstable, leading to a Hopf bifurcation.

Technical session 2 / 70

SOLUTION OF THE FRACTIONAL BURGER-HUXLEY EQUATION OF THE CAPUTO-FABRIZIO TYPE USING THE ABOODH TRANSFORM METHOD WITH THE REDUCED DIFFERENTIAL POLYNOMIALS

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ICAWMSCS 2024
Keywords: Aboodh transform, Reduced differential polynomial, Burger-Huxley equation and Caputo-Fabrizio fractional derivative.
Abstract
The Aboodh transform method was combined with the reduced differential polynomials to solve the Fractional Burger-Huxley(FB-H) equation of the Caputo-Fabrizio type. The general Burger-Huxley equation which is a nonlinear partial differential equation that models the interplay between the reaction mechanisms, convective effects and diffusion transport observed in many biological and physical systems is analyzed. The results gotten are showcased in tabular and graphical forms to explain the performance and efficiency of the combined methods. It is discovered that the results derived are close to the exact solution of the problems illustrated. This work will thus make it simple to study nonlinear process that arise in various aspect of innovations and researches.

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Technical session 1 / **71**

Analog CMOS Circuits for Convex Quadratic Programming

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Analog circuit design for nonlinear programming has been widely studied in the literature (Dennis, 1959;
Kennedy and Chua, 1988; Tank and Hopfield, 1986; Wilson, 1986). However, recent advances in edge computing
and in model predictive control have led to a resurgence of interest in analog programming circuits (Vichik and
Borrelli, 2014; Vichik et al., 2016; Bena et al., 2023). We develop electronic circuit analogs for emulating the
solution of convex Quadratic Programming (QP) problems. Quadratic programs are prevalent in engineering
and are often encountered in applications where solutions must be determined in real time using minimal
computational resources. Such applications include among others model predictive control (MPC) problems,
economic dispatch of power, and optimal routing in large-scale integration (VLSI) to mention a few.
We model the optimality conditions associated with such convex QP problems using energy-conservative laws
governing the flow of current and voltage distribution within a piecewise linear resistive-diode network. The
quiescent operating point for the ensuing circuit characterizes the optimal solution of the source QP problem.
The proposed work entails taking advantage of the inherent parallelism in analog circuits to emulate the
behaviour of the programming circuit on a high-speed analog circuit processor known as a Field Programmable
Analog Array (FPAA) board. This provides a high-level simulation-based mechanism for accessing the feasibility
of the programming circuit and for functional verification. Then the programming circuit is realized using a very
large-scale integration technology. An analog CMOS application-specific integrated circuit (ASIC) is developed
to realize the programming circuit in a 180nm process technology (Skibik and Adegbege, 2018; Ara´ujo et al.,
2024). Finally, we show, using tools from mathematical programming and circuit theory, that the circuit
solution coincides with the solution of the original QP program. We demonstrate the viability of the proposed
programming circuit using a real-life example of an economic dispatch problem.

Technical session 1 / **72**

An optimal control intervention for the interrelated dynamics of TB transmission in humans and animals amidst seasonal flux

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Tubercuosis(TB)is a global health concern,affecting both humans and animals.This paper provides a dynamic model to anayze the complicated dynamics of tuberculosis transmission, taking into account human animal interactions and a saturated incidence rate with seasonal changes.Furthermore,the model accounts for the efficiency of measures targeted at reducing the spread of tuberculosis(TB).This study intends to give insights into the intricate interpay between TB transmission patterns,seasonal changes,and the efficacy of control measures by combining epidemiological concepts with ecological dynamics.The study uses simulation and analysis to support targeted intervention techniques and policy decisions for reducing tubercuosis transmission in a shared human-animal habitat.When both control measures are taken,the alpha parameter,which represents awareness among the general public,increases,the KEa parameter,which represents efficacy of drugs,increases, and the beta and b parameters decrease, and the population of infectious individuals decreases vj=0,R0=2269426314,when vj=0.5,ba=0.05 and βh=0.04,R0=0575348645 and when v1=1.1,v2=1.5,ba=0.05 and βh=0.001,R0=0.001144038597).It is seen that increased awareness among the general public and the efficacy of therapy will subsequently prevent cases of infection at the end of the control program. It is concluded that public awareness and the efficacy of therapy should be incorporated into the control program for an optimal control strategy for TB infection to be curtailed in the hosts.
Keywords:Seasonal variations,TB spread,diverse populations,interconnected dynamics,and combined control techniques.

Technical session 2 / 73

COMPUTATIONAL INVESTIGATION OF THE DYNAMICS OF PHYSICALLY BLOWN POLYURETHANE FOAM

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This study presents the mathematical modelling and simulation of physically blown polyurethane foam in a dedicated device considered in Tesser et al. (2003). For a given initial concentration of the physical blowing agent the final foam density was obtained via simulation. The temperature profile of the polymerization and curing process reported in the experiment of Tesser et al. (2003) was fitted to obtain the polymerization model equations and the associated model parameters. The present model considers the foam as a pseudo-homogeneous phase with the gas bubbles uniformly dispersed and the blowing agent transfer rate from the polymer liquid mixture to gas phase to be controlled by the heat generated from the chemical reactions. The foam growth behaviour of the investigated model uses Cyclopentane as the physical blowing agent. And the set of unsteady non-linear coupled differential equations describing the foam process are solved using the Euler method, while the 3D simulation was performed on the FOAM software developed in ITWM. Observations of the temperature distribution, foam conversion, density profiles and blowing agent evaporation were reported and compared with results in literature.

Technical session 2 / **74**

TRANSMISSSION DYNAMICS OF SCHISTOSOMIASIS-MALARIA DUAL INFECTION WITH OPTIMAL CONTROL

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Schistosomiasis is largely a water-snail related disease that mostly affects school aged children in developing countries. Malaria is an ancient disease that is still thriving and threatening to be a major source of death and disability due to climate change and socio-economic conditions.
This paper presents a mathematical model for Schistosomiasis-Malaria dual infection in order to investigate the relationship in their transmission. The steady state of the single infection was analyzed, existence, stability of the equilibria and the basic reproduction numbers were established. The single-infection and the dual infection models exhibited backward bifurcations. Sensitivity analysis was carried on the dual-infection model, and it was discovered that increased in Schistosomiasis infection may not implies increased in Malaria infection while the reverse is the case.
The existence of an optimal control was established, the Hamilton and Pontryagin principles for optimal control was employed to provide insights on control input interventions.

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Lead Paper 1

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Computational analysis of enzymatic processes in polymer degradation

Biodegradability of materials and material building blocks, such as polymers, monomers, polymer crosslinkers is a long lasting question related to environmental issues. The improvement of polymeric materials for biological degradation is a field of active research with many challenges. A newly developed computational model can sufficiently describe the oxidative degradation of polymer building blocks as they occur at mono oxygenase enzymes. This computational model helps to understand the properties of degradable materials and to identify potentially biodegradable building blocks for polymer chemistry.

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Plenary Talk 2: Compatibilisation Efficiency in Polycarbonate Blends –a DPD Study

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Keynote address 2: Emerging Geospatial Techniques for Modelling and Simulation of Earth Dynamics and Complex Systems

Opening Ceremony - MC: Mr. Gbolahan Ogunajo - ARO / 79

National and Great Ife anthems

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Introduction of the Guests

Opening Ceremony - MC: Mr. Gbolahan Ogunajo - ARO / 81

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Chairperson's Opening Address and Conference Opening (Declaration)

Opening Ceremony - MC: Mr. Gbolahan Ogunajo - ARO / 85

Short address by the Head of Department

Opening Ceremony - MC: Mr. Gbolahan Ogunajo - ARO / 86

Short address by the Dean of Science

Opening Ceremony - MC: Mr. Gbolahan Ogunajo - ARO / 87

Vice –Chancellor's Address

Opening Ceremony - MC: Mr. Gbolahan Ogunajo - ARO / 88

Citation of the Keynote Speake

Opening Ceremony - MC: Mr. Gbolahan Ogunajo - ARO / 89

Keynote Address 1

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Opening Ceremony - MC: Mr. Gbolahan Ogunajo - ARO / 90

Goodwill Messages

The Head of Department –Prof. M. O. Olatinwo
The Dean of Science –Prof. O. A. Adesina
The Executive Director, AFRIGIST, Professor Lazarus M. Ojigi
The Executive Director, ARCSSTE-E, Professor A. Babatunde Rabiu

Opening Ceremony - MC: Mr. Gbolahan Ogunajo - ARO / 91

Chairman Closing remarks

Opening Ceremony - MC: Mr. Gbolahan Ogunajo - ARO / 92

Vote of Thanks

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Great Ife and National anthems

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Plenary Talk 3: Mathematical Modeling: An Industrial Perspective

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Keynote address 3: United Nations African Regional Centre for Space Science and Technology Education - English, (UN-ARCSSTE-E)

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Keynote address 2

Keynote from AFRIGIST

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PLENARY Talk 4: Turbulence near absolute zero

A slightly historical perspective

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Lead Paper 4

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Plenary Talk 1: Modeling, Simulation and Complex Systems for National development

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Technical session 3b / 100

RAY TRACING ALONG THE MERIDIAN NEAR EQUATOR : A SIMULATION BY COMPUTER PROGRAMMING

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Communication using Radio waves transmission from a source, travel through a space medium to carry programmed instructions to another destination. Ray tracing is a procedure of finding the paths of energy flow of the waves. These paths depend on Launch parameters, nature of the medium as well as environment of the wave. Simulation of plane polarized Electromagnetic rays in bi-refringent Ionosphere in the presence of geomagnetic components as azimuthally symmetric third order harmonic field by computing the Associated Legendre polynomials with constants. The complex full Appleton-Hartree formula computes the real refractive index and the imaginary part as the absorption factor to consider collisions. Tracing is along the Meridian near the Equator applying geometrical Optical laws in concentric homogenous shells whose thickness is varied as control for ray reflection. Results illustrate symmetric ray paths at 6MHz and reflected in the F-layer. At vertical incidence the ray never becomes horizontal but has a cusp called the spitze at refractive index of approximately zero when the ray is considered reflected. At oblique incidence, the program performs a premature reflection resulting in the stunting ray tracing. Focusing is achieved for predetermined range by program adjusting Launch conditions. Absorption of ray is high at peak layers of the ionosphere with maximum at the D- layer. The program is versatile tool to investigate Ray Tracing.

Technical session 3b / 101

Development of an Improved Model for Out-Patient Flow Processes using Hierarchical Timed Coloured Perinets

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Patient healthcare service delivery system is pivotal to sustenance of lives of human being. Existing works modelled patient flow processes with emphasis on medical record sections and consultation rooms of hospital, thereby limiting the capability of the existing models in studying and improving the issues of outpatients'long waiting time and queue emanating from medical record section through pharmacy section. This research developed an improved model for outpatient flow processes using Hierarchical Timed Coloured Petri Nets (HTCPN) formalism. The developed HTCPN model was simulated using Coloured Petri Nets (CPN) tools to determine the average patient waiting time, operation time and resources utilization rate subject to available medical resources to experiment scenarios. The model was validated by carrying out a statistical analysis t-Test between the simulated and the measured Time of Stay (TOS) of outpatients at 5% significance level. An improved HTCPN model was developed for outpatient flow processes. This model can be adopted in hospital environment to study and improve excessive queues and delays associated with the considered hospital or other related ones.

Technical session 3b / 102

Solution of Nonlinear Brusselator Model by a Combined Sawi Transform and Homtopy Analysis Method

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The Brusselator is a theoretical model for a type of autocatalytic reaction to analyze the behaviour of the chemical systems with non-linear oscillator. Fractional-order Brusselator system of equations (Reaction-Diffusion system) were solved using Sawi Homotopy Analysis Method (SHAM) which is a combination of Sawi transform and Homotopy analysis method. Obtained results were compared with the results in the literature and it was deduced that the mean absolute error (MAE) obtained by SHAM were smaller compared to the solution in the literature. The compiled findings showed the efficacy of the implemented technique and hence recommended for solving fractional-order nonlinear partial differential equations. (within the domains of applied sciences, engineering and technology).