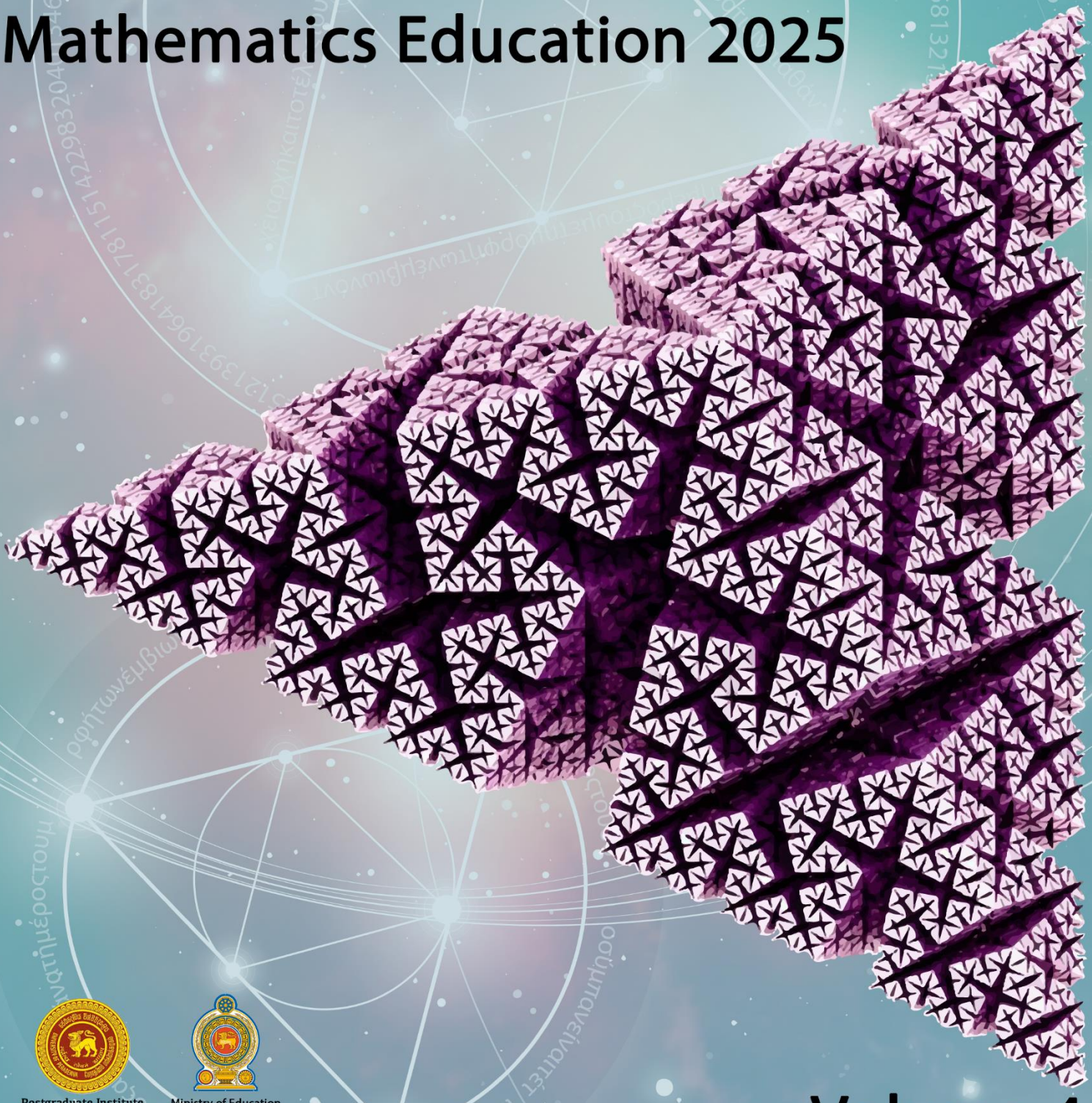
ICMME

*Mathematics for a Better World*

# Proceedings

## International Conference on Mathematics and Mathematics Education 2025



Postgraduate Institute of Science
University of Peradeniya

Ministry of Education
Sri Lanka

## Volume 4

**POSTGRADUATE INSTITUTE OF SCIENCE**

**UNIVERSITY OF PERADENIYA**

**SRI LANKA**

# PROCEEDINGS

## INTERNATIONAL CONFERENCE ON MATHEMATICS AND MATHEMATICS EDUCATION

4th and 5th of July, 2025

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## Message from the Director, Postgraduate Institute of Science


The Postgraduate Institute of Science (PGIS), University of Peradeniya, is proud to host the International Conference on Mathematics & Mathematics Education (ICMME 2025), scheduled to be held on the 4th and 5th of July 2025 at the PGIS premises.

As a premier institution for postgraduate education in pure and applied sciences in Sri Lanka, the PGIS has long been committed to fostering academic excellence and promoting impactful scientific dialogue. Over the years, we have consistently facilitated platforms for scholars, researchers, and practitioners to engage in meaningful exchange across diverse disciplines.

ICMME 2025, organized in collaboration with the Ministry of Education, Sri Lanka, represents a significant initiative in this tradition. The conference aims to bring together leading mathematicians, educators, and researchers from around the globe to share knowledge, explore innovations, and address contemporary challenges in Mathematics and Mathematics Education. We believe this gathering will not only contribute to academic enrichment but also support national and regional development goals in STEM education.

I take this opportunity to thank the Chairperson, Secretary, and all members of the organizing committee of ICMEE 2025 for their dedication and hard work in bringing this important event to fruition.

I wish all participants a productive and inspiring conference experience.

**Prof. B.M.N.W.B. Balasooriya**
*Director, Postgraduate Institute of Science*
*University of Peradeniya*

**ICMME 2025**

**Message from the Chairperson**

As the Chairperson of the Conference and also the Chairperson of the Board of Study in Mathematics, it is with great pleasure and a deep sense of pride that I welcome you to the **International Conference on Mathematics and Mathematics Education (ICMME) 2025.**

Since the inception of ICMME in 2019, this biennial event, jointly organized by the Postgraduate Institute of Science (PGIS), University of Peradeniya, and the Ministry of Education of Sri Lanka, has served as a vibrant platform for scholars, educators, and practitioners from around the world to share their insights, innovations, and research in the vast domains of mathematics and mathematics education.

Marking its fourth milestone, ICMME 2025 is held under the theme *"Mathematics for a Better World,"* reflecting our continued commitment to fostering interdisciplinary dialogue and addressing real-world challenges through analytical thinking in mathematics. In an era marked by rapid technological changes, environmental concerns, and evolving educational landscapes, the role of mathematics both as a foundational science and a tool for societal advancement has never been more critical.

This proceedings volume captures the scholarly contributions presented at ICMME 2025, showcasing the richness and diversity of contemporary mathematical research, educational methodologies, and collaborative efforts.

I take this opportunity to express my sincere gratitude to the Vice Chancellor of the University of Peradeniya, the Dean of the Faculty of Science, the Director of the PGIS, the Secretary of ICMME 2025, the Editor-in-Chief, the members of the Organizing Committee, and the members of the Boards of Study in Mathematics and Science Education for their dedication and tireless work in making this event a success.

My heartfelt appreciation also goes to our keynote speaker, plenary speakers, invited speakers, resource persons of the pre-conference workshops, session chairs, reviewers, sponsors, and all participants whose contributions have enriched ICMME 2025.

Finally, I extend my congratulations to all presenters and wish them every success. Through ICMME, let us continue to build connections across disciplines and borders, inspiring one another as we collectively advance the frontiers of mathematics and mathematics education.

**Thank you and best wishes!**

**Dr. T.H.K.R. De Silva**
*Chairperson/ICMME 2025*
*Chairperson/Board of Study in Mathematics*
*Postgraduate Institute of Science,*
*Sri Lanka*

**ICMME 2025**

**Message from the Chairperson – Board of Study in Science Education**

It is my great pleasure, as the Chairperson of the Board of Study in Science Education, to share this message on the Fourth International Conference on Mathematics and Mathematics Education (ICMME) 2025, scheduled to be held on the 4th and 5th of July 2025, at the Postgraduate Institute of Science (PGIS), University of Peradeniya. This conference is primarily organized by the Board of Study in Mathematics, PGIS, and we, at the Board of Study in Science Education, are delighted to be part of this collaborative endeavor. ICMME 2025 provides an excellent forum for both mathematicians and mathematics educators to present their research, initiate meaningful collaborations, and explore new avenues for enhancing academic and professional opportunities.

Mathematics is a major discipline that directly contributes to a country's economic growth, innovation, and national well-being. Therefore, enhancing mathematical understanding through initiatives like this conference is vital for sustainable development and building a skilled, forward-thinking society. Acknowledging this national need, the Postgraduate Institute of Science offers postgraduate programs in Science Education, with Mathematics Education being a major area of focus. The ICMME, first held in 2019, has since evolved into a significant platform for researchers and educators to exchange ideas, present their findings, and foster valuable partnerships.

I am honored to be part of the dedicated team supporting the fourth edition of this impactful conference. I extend my heartfelt appreciation to the Organizing Committee, led by Dr. T.H.K.R. De Silva, Chairperson of ICMME 2025, for their commitment and hard work in bringing this event to life.

Wishing all participants a fruitful and intellectually enriching experience at ICMME 2025!

**Prof. W.A. Priyanka P. de Silva**
*Chairperson, Board of Study in Science Education*
*Postgraduate Institute of Science*
*Sri Lanka*

**ICMME 2025**

**Message from the Editor-in-Chief**

Dear Esteemed Colleagues, Researchers, and Participants,

It is with great pleasure and deep appreciation that I welcome you to the ICMME 2025, hosted this year at the Postgraduate Institute of Science (PGIS), University of Peradeniya. As the Editor-in-Chief, I am honoured to serve a community that continues to push the boundaries of knowledge, innovation, and collaboration.

The members of the Editorial Committee have worked tirelessly to ensure that ICMME 2025 reflects the highest standards of academic rigor and relevance. From keynote addresses and panel discussions to technical sessions, the diversity and depth of contributions promise to inspire meaningful dialogue and lasting impact.

On behalf of the Editorial Committee, I extend my sincere thanks to all authors, reviewers, speakers, sponsors, and attendees for your invaluable contributions. Your dedication makes this event not only possible but also truly exceptional.

I am privileged to be an academic in profession to use this as a vehicle to serve as the Editor-in-Chief of this conference to uplift mathematics education in schools and other academic institutes. I firmly believe that elevating and sustaining quality of education is paramount important to the development of any society, and it lies mainly on innovative research.

I am pleased and very happy to inform you that we received a total of 57 research papers under two thematic areas: Mathematics and Mathematics Education from local and foreign authors. After going through a strict and stringent review process, 51 research papers were accepted for presentations at the conference.

I encourage you to engage actively, network widely, and explore new ideas that will shape the future of mathematics and mathematics education.

**Prof. W.B. Daundasekera**
*Editor-in-Chief*
*ICMME 2025*

## ICMME 2025

## A Brief Biography of Professor Suzanne Lenhart

Suzanne Lenhart is a Chancellor's professor in the Department of Mathematics at the University of Tennessee, Knoxville. She was a part-time research staff member at Oak Ridge National Laboratory for 22 years. She is a recognized expert in optimal control and ordinary and partial differential equations, with modeling applications to populations, natural resources, invasive species, and diseases.

She was the President of the Association for Women in Mathematics in 2001-2003. She received fellow awards from SIAM, AMS, AWM, and AAAS. She was the Associate Director for Education and Outreach of the National Institute for Mathematical and Biological Synthesis for12 years.

## The Abstract of the Keynote Speech of Professor Suzanne Lenhart

### Natural System Management: A Mathematician's Perspective

Mathematical modeling can represent the dynamics of a variety of natural systems. Specific management features can be included directly into the model framework, and outcomes can suggest the need for external actions further affecting the environment. In one example, optimal control techniques to design harvest rates of anchovy stock will be illustrated in a food chain model for the Turkish coast of the Black Sea. In another example, we consider the potential impact of climate change on Loggerhead Sea turtle populations.

## ICMME 2025

## A Brief Biography of Professor Ratnasingham Shivaji

Ratnasingham Shivaji joined the University of North Carolina at Greensboro (UNCG) as Head in the Department of Mathematics and Statistics in July 2011 and served in this position until July 2019. Since January 2012, he is also serving as H. Barton Excellence Professor. Prior to joining UNCG, he served for twenty-six years at Mississippi State University (MSU), where he was honored as a W.L. Giles Distinguished Professor. He received his Ph.D. in Mathematics from Heriot-Watt University in Edinburgh, Scotland in 1981 and his B.S (first-class honors and special degree in mathematics) from the University of Peradeniya, Sri Lanka in 1977. Shivaji's area of specialization is partial differential equations, and in particular, nonlinear elliptic boundary value problems. His research work has applications in combustion theory, chemical reactor theory, and population dynamics, and has been funded by the National Science Foundation and the Simon's Foundation. Currently, he is serving as the PI on an NSF Math Ecology grant. To date, he has authored one hundred ninety research papers. He was honored as a Fellow of the American Mathematical Society (AMS) for research contributions, mentoring, and leadership. He is the recipient of the 2020 Mathematical Association of America (MAA) Southeastern Section Award for Distinguished University Teaching of Mathematics and the 2024 Conference of Southern Graduate Schools Outstanding Mentor Award.

## The Abstract of the Plenary Speech of Professor Ratnasingham Shivaji

### Analysis of Classes of Landscape Ecological Models

In this presentation we will analyze positive solutions to classes of steady-state reaction diffusion models designed to explore the effects of habitat fragmentation, density dependent emigration, logistic growth, and Allee effect growth. We establish existence, nonexistence, and multiplicity results in response to a parameter proportional to the patch size, depending on the growth choice and the emigration pattern. Our existence and multiplicity results are established via method of sub-super solutions and the study of certain eigenvalue problems.

## ICMME 2025

## A Brief Biography of Professor Oi-Lam Ng

Dr. Oi-Lam Ng is an Associate Professor in the Department of Curriculum and Instruction, and Programme Coordinator for the Bachelor of Education in Mathematics and Mathematics Education at The Chinese University of Hong Kong. She holds a PhD in Mathematics Education from Simon Fraser University, following her early career as a high-school mathematics teacher in Vancouver, Canada. Dr. Ng's research focuses on technology-enhanced mathematics education, computational thinking, and constructionist learning. She explores how digital innovations—such as 3D printing, programmable electronics, and dynamic mathematics environments—reshape mathematical discourse and learning experiences. Her work is deeply influenced by Papert's "Learning-by-Making" philosophy, advocating for hands-on, technology-driven learning approaches. She has contributed significantly to the study of multimodal mathematics learning, examining how students engage with mathematical concepts through verbal and non-verbal communication in technology-rich environments. Her research also investigates the intersection of computational thinking and mathematics, exploring how programming-based activities enhance problem-solving and conceptual understanding.

## The Abstract of the Plenary Speech of Professor Oi-Lam Ng

### Mathematics in the Digital Age: How Computational Thinking Drives Transformative Learning

This lecture explores three key dimensions of integrating computational thinking (CT) into mathematics education. "What": I begin by stating that, in an increasingly digital world, manual calculations and procedural tasks are increasingly automated, making problem-solving, reasoning, and digital/AI literacy more critical than rote learning or procedural fluency. In turn, what is valued in mathematics education must shift toward prioritizing thinking skills, as demonstrated in my empirical research on CT integration in mathematics education. "How": I present task designs from research that position mathematics learning as analyzing problems, designing computational solutions, and interpreting algorithmic outputs. This shift requires moving beyond paper-and-pencil methods to computational environments where students engage in programming-based explorations. "For Whom": I end with discussing equitable access to computationally enriched mathematics education. Through knowledge transfer initiatives, I highlight strategies to support learners with low digital literacy, fostering inclusive participation in CT-based learning. By framing CT as both a catalyst for change upon mathematics curriculum and instruction, this lecture informs future research on preparing students to engage critically and computationally in mathematical practice in an AI-driven world.

**ICMME 2025**

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# Mathematics

***Abstract No. 01*** ***Mathematics***

# A CASE STUDY ON REPLACEMENT THEORY TO ESTIMATE THE ECONOMIC LIFETIME OF AN OFFSET PRINTING MACHINE

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Replacement Theory, which is a branch of Operations Research, deals with determining the optimal time to replace equipment, assets, or components to minimize their operational and maintenance costs, and maximize operational efficiency. For industries that depend on machine intensive processes, identifying the optimal time to replace the machine is essential to maintain cost-effective operations. This study proposes a mathematical model to find the economic life of an offset printing machine which enables efficient cost management. In this study, Heidelberg SM74-4 offset printing machine is considered as a case study to demonstrate the model. The factors considered in the development of the model are operational costs, maintenance costs, depreciation, electricity consumption, and bank loan payments. In this study, to make it more realistic, the present value of money is also incorporated into the model. The objective function of the model is the Average Total Cost (ATC) which is calculated using the sum of all related expenditures, including maintenance and operating costs of the machine. To determine the time to replace the machine, the ATC is calculated for each year, when the machine is in operation. This yearly calculation terminates when the ATC, which is a unimodal function, reaches its critical point. The critical point is proven to be the most economical point to replace the machine. This study has a great impact on the printing and manufacturing industries in addition to its theoretical achievements. It determines the optimum replacement time for the Heidelberg SM74-4 by considering factors such as maintenance, energy, and loan payments. The findings show that the economic life of the machine ends after 17 years, even though it was in operation for 20 years. This extended time period shows the machine's durability but also highlights increased costs and declining efficiency over time. While the model offers a practical framework for making decisions on replacements, it does not currently account for factors like inflation and market fluctuations. Future improvements could enhance its relevance and adaptability. In conclusion, this data-driven approach supports timely and cost-effective decision-making, improving operational efficiency and financial outcomes in machinery-dependent industries.

**Keywords:** Average total cost, Machine replacement, Offset printing, Operational efficiency, Replacement theory

***Abstract No. 04*** ***Mathematics***

# ANT COLONY OPTIMIZATION ALGORITHM TO SOLVE DETERMINISTIC MULTI-OBJECTIVE ASSIGNMENT PROBLEM

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This study proposes a metaheuristic algorithm known as the Ant Colony Optimization Algorithm (ACOA) to solve the deterministic Multi-Objective Assignment Problem (MOAP). MOAP consists of several objectives to be optimized simultaneously. ACOA is one of the most prominent biologically inspired algorithms to solve optimization problems. Multi-Objective Ant Colony Optimization Algorithm (MOACOA), which is based on the ACOA, is a probabilistic approach for finding the optimal path of the MOAP. The proposed algorithm is parameterized by the number of ant colonies and the number of pheromone trails. In this study, MOACOA is applied to solve a MOAP, where the assignment costs are randomly generated following the Uniform distribution. Initially, for the first row of each of the Assignment Cost Matrix (ACM) corresponding to the objective function, the transition probabilities with equal weights are determined by applying the MOACOA. Then, under the pheromone update rule, the optimal assignment for the first row of each ACM is determined by comparing the cumulative probability solution set and the generated random set. The optimal solution for the first row of each of the ACMs is recorded, and afterward, the row and the column of each of the ACMs corresponding to the selected path are excluded. This process is repeated for the rest of the rows of each of the ACMs and the optimal solution with respect to each row is recorded. This process terminates when the proposed iterative technique converges to the optimal solution of the MOAP. The proposed algorithm is coded in Python programming language and the efficiency of the algorithm is compared with an existing method known as Technique for an Order of Preference by Similarity to Ideal Solution (TOPSIS). The proposed MOACOA is proven to be capable of solving large-scale MOAP in less computational time compared to the TOPSIS method.

**Keywords**: Ant Colony Optimization, Assignment problem, Cost Matrix, Multi-objective

***Abstract No. 05*** ***Mathematics***

# COMPUTING $h$- FUNCTION OF THE COMPLEMENT OF A SLIT VIA PARALLEL-SLIT MAPPING AND VALIDATION VIA DIFFERENT CONFORMAL MAPPING

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In potential theory, *h-function* is a concept intimately connected to Brownian motion and serves as a method for depicting the geometry of a domain. Consider a particle released from a fixed location $z_0$ in a region Ω and permitted to move randomly throughout Ω, exhibiting Brownian motion, until it first encounters the boundary. The distance from the starting point $z_0$ at the time of impact is recorded. Also, the process with millions of Brownian particles that were discharged from the same point $z_0$ is repeated. This information is formally expressed as a function known as the *h-function* of the given region Ω with respect to the specified basepoint $z_0$. The *h-function* is an increasing function and takes only the values in the interval $[0,1]$. This study forms the *h-function* of a simply connected region Ω formed by deleting a slit from the complex plane when the basepoint $z_0$ is fixed along the line of the slit, by two different methods. The first method starts with *parallel-slit mapping*, which is in terms of the prime function. This map transforms the interior of the unit disc $D_\zeta$ to the region Ω. A *Cayley-type map* is used to transform the region $D_\zeta$ to the lower half-plane and the boundary of the disc to the real line. A function $W(\zeta)$ is formulated whose imaginary part is harmonic, and the $\mathrm{Im}[W(\zeta)]$ evaluated at $\zeta_0$ produces the *h-function* of the region Ω, where $\zeta_0$ is the preimage of the basepoint $z_0$. The second method is used to cross-check the formed *h-function*. In this method, a sequence of conformal maps whose composition transforms the given region Ω to the half-plane is used instead of the prime function. Subsequently, the intersection between the boundary of the region Ω and the closed ball of radius $r$ centered at $z_0$ and its image in the half-plane is traced. Both methods produce the same *h-function*.

**Keywords**: Cayley-type map, *h-function*, Parallel-slit mapping

***Abstract No. 08*** ***Mathematics***

# SOME RESULTS RELATED TO A NEW TYPE OF CONNECTEDNESS IN TOPOLOGICAL SPACES

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General topology facilitates the study of important qualitative properties of spaces and maps, such as continuity, connectedness, and compactness. New forms of continuity and compactness have recently been introduced in topology; they are referred to as $F$-continuous and $F$-compact, respectively. An open subset $A$ of the topological space $(X, \tau)$ is called $F$-open if $\bar{A} \backslash A$ is finite. A map $k: (X, \tau) \to (Y, \sigma)$ is $F$-continuous, if $k^{-1}(U)$ is $F$-open in $X$ for every open set $U$ in $Y$. Similarly, a topological space $(X, \tau)$ is $F$-compact if and only if any open cover of $X$ has a finite subcover of $F$-open sets. This study focuses on some recent findings concerning the new concept called $F$-connectedness. A topological space $(X, \tau)$ is called $F$-connected, if it cannot be written as the union of two disjoint $F$-open sets. Initially, this study proves that a surjective $F$-continuous image of an $F$-connected space is connected. In general, the continuous image of a connected space is connected, however in $F$-setting, surjectivity should be needed. Subsequently, the following is proved: If $(X, \tau)$ is a $F$-connected space, and $(Y, \sigma)$ is a $F$-homeomorphism of$(X, \tau)$, then the latter space is $F$-connected. Next, the study proves that if $A, B$ are two subsets of a topological space such that $A \subseteq B \subseteq \bar{A}$ and $A$ is $F$-connected, then $B$ is also $F$-connected. Finally, it is proved that the finite union of a family of $F$-connected sets is also $F$-connected, provided that the intersection of the family is non-empty. In the future, it is intended to extend this study to investigate $F$-separation axioms. Also, this study expects to extend the results obtained to bitopological or tritopological environments.

**Keywords**: $F$-connectedness, $F$-continuous, $F$-homeomorphism, $F$-open, Topological spaces

***Abstract No. 13*** ***Mathematics***

# PERFORMANCE COMPARISON OF CLASSICAL AND QUANTUM K-NEAREST NEIGHBOUR ALGORITHMS

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Quantum machine learning (QML) algorithms do not always outperform their classical counterparts. In the present study, the performances of Classical K-Nearest Neighbour (CKNN) and Quantum K-Nearest Neighbour (QKNN) algorithms for different data sets and distance functions are compared. Three data sets, different in size and dimensionality (number of variables), and three distance functions commonly used for CKNN and QKNN algorithms were considered. Iris data set has the smallest size with 150 observations and the lowest dimensionality, German credit data set has 1000 data and has medium dimensionality, and MNIST data set has 70,000 data and high dimensionality. The Euclidean, Mahalanobis, and Manhattan distance functions were considered due to their quantum counterparts having high compatibility with QML algorithms. Python libraries such as NumPy and Matplotlib on IBM Qiskit and Google Colab were employed for data analysis. For the Iris data set, CKNN achieved 100% accuracy for K=3 to 10 (Euclidean & Manhattan); 90% to 93.33% (Mahalanobis), and QKNN achieved 100% accuracy over all K values (1 to 10), and distance functions. For the German Credit data set, CKNN achieved 80% accuracy for K=1, 2 (Euclidean & Manhattan); stable but fluctuating with Mahalanobis and QKNN up to 75.76% accuracy for K= 6 (Euclidean & Manhattan), but more stable with Mahalanobis. For the MNIST data set, CKNN recorded moderate accuracy (~83%) for Euclidean & Manhattan; poor performance with Mahalanobis (<33%) and QKNN achieved 50% accuracy for Euclidean & Manhattan and failed with Mahalanobis (0-10%). QKNN demonstrated high accuracy levels for low-dimensional data sets but faced accuracy challenges for high-dimensional data due to Google Colab's hardware limitations and simulated quantum noise. CKNN maintained a stable accuracy level through varying data dimensions and sizes, making it a reliable choice for machine learning tasks. QKNN shows promise, but its use depends on advancements in quantum computing.

**Keywords**: Classification, Distance Functions, Google Colab and IBM Qiskit, KNN Algorithms, Machine Learning

***Abstract No. 15*** ***Mathematics***

# A NON-LINEAR OPTIMIZATION MODEL FOR COST-EFFECTIVE AND SPACE-EFFICIENT ARCHITECTURAL LAYOUT DESIGN: A CASE STUDY OF A SINGLE-STORY RESIDENTIAL BUILDING

**H.M.H.M.G.T.M. Herath* and W.B. Daundasekera**

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Reducing construction costs while optimizing usable space according to client's preferences is essential for achieving economical and functional building designs. Architectural layout design optimization (ALDO) addresses this challenge by refining building layouts to achieve an optimal balance between cost efficiency, functionality, and spatial usability while satisfying predefined constraints. This research focuses on optimizing a building layout by developing a Non-linear Optimization model. The objectives are to minimize total construction cost and maximize the usable area while adhering to dimensional constraints, such as width, length, and total area. The case study focuses on a residential building located in the Central Province, Sri Lanka. Construction costs are calculated using the Building Schedule of Rates (BSR) Central Province–2024, while dimensional constraints for rooms are based on the Planning and Development Regulations issued by the Minister of Urban Development and Housing (MUDH). Data and background information for the study were gathered through BSR, MUDH, literature review, and consultation with a building architect. The case study is conducted on a rectangular land with dimensions $18 \times 9$ m$^2$ ($60 \times 30$ feet$^2$). The formulated model is solved using Excel Solver and compared with the manual design; the optimized results demonstrate high flexibility, allowing adjustments to better meet client preferences while effectively addressing the objectives. Results were exhibited using 3D graphs in OriginPro, highlighting the impact of design weights on cost and usable area, and offering insights to support informed decisions by clients and stakeholders. The study assumes fixed material and labor rates based on BSR–2024, a uniform wall height of 3 meters, and a single-story residential layout with rectangular-shaped rooms. The limitations of the study are, excluding structural elements, aesthetic considerations, and multi-story design aspects. This study highlights the effectiveness of ALDO and suggests future work on multi-story layouts, structural and aesthetic integration, and the inclusion of additional design preferences.

**Keywords**: Architectural layout design optimization, Building layout, Constraints, Excel Solver, Non-linear optimization

***Abstract No. 16*** ***Mathematics***

# A NOVEL MIXED INTEGER LINEAR PROGRAMMING MODEL TO SOLVE MULTIPLE TRIP VEHICLE ROUTING PROBLEM

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The complexity of the development of mathematical models for vehicle routing problems increases with the addition of more variables and constraints. In this study, a mathematical model was developed for a multiple-trip vehicle routing problem by relaxing the constraints of the single-trip model. The novelty has brought to the study through a simple three-index formulation developed for the multiple-trip vehicle routing problem, with a fewer number of constraints. The model was developed using the mixed integer linear programming (MILP) technique considering a heterogeneous fleet of vehicles, time window, pickups, capacity constraints and single deport. Three-index formulation without a trip index and a new integer variable for the number of trips assigned to a vehicle in a given time unit are introduced into the model. Since most of the past studies considered the number of vehicles available for the routing plane with a separate index, this study reduces complexity and facilitates an easy-solving approach. Hence, it reduces the difficulty of determining vehicle utilization rates and provides managerial implications through identifying under-utilized resources. The model was tested and solved using a real-world data set from a small-scale enterprise in Sri Lanka by applying the Branch and Cut algorithm. Time and distance matrices and vehicle capacities were fed to the model. The output of the experimental analysis showed a clear reduction in the distance traveled and the number of vehicles used compared with the method adopted by the enterprise. It shows that the proposed method can be applied to real-world cases to reduce transportation costs and the complexity of vehicle scheduling. This study contributes to the existing knowledge gap through the proposed mathematical model.

**Keywords**: Mixed integer linear programming, Multiple trips, Optimization

***Abstract No. 21*** ***Mathematics***

# AN UPPER BOUND FOR STAR CHROMATIC INDEX OF SIMPLE CONNECTED SUB-CUBIC GRAPHS

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This study explores the star chromatic index $\chi'_{st}(G)$ of any simple connected sub-cubic graph $G$, which is a significant parameter in graph theory that measures the minimum number of colours needed to colour the edges of a graph such that no path or cycle of length 4 is bi-coloured. The idea of star edge colouring was introduced by Liu and Deng in 2008, motivated by its vertex version, and since then, it has been studied extensively by many authors. Computing the star chromatic index for a graph can be a challenging problem, and finding an algorithm for it is an active area of research in graph theory. Numerous studies have been conducted introducing upper bounds for the star chromatic index, and the best known upper bound is 7. The primary objective of this study is to establish a better upper bound for the star chromatic index of simple connected sub-cubic graphs, partially answering to the conjecture posed by Dvorak et al. in 2013. The method of colouring introduced in this study is based on categorizing any simple connected sub-cubic graph with respect to its connectivity. Subsequently, it is decomposed into a matching (possibly with paths of length 2) and a collection of disjoint paths and cycles such that every vertex is contained in some path or cycle in the collection. Showing $\chi'_{st}(G) = 6$ for the 3-regular graph of 10 vertices, where all the non-adjacent edges in the matching and in the collection are at a distance 2 from each other was a major result, and it was extended to prove that $\chi'_{st}(G) \leq 6$ for any simple connected sub-cubic graph.

**Keywords**: Matching, Simple sub-cubic graphs, Star chromatic index, Star edge colouring

***Abstract No. 22*** ***Mathematics***

# $Z$-SETS IN LARGE SCALE GEOMETRY

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This study introduces an analogous version of the $Z$-set in large-scale geometry, inspired by its foundational role in infinite-dimensional topology. A closed subset $A \subseteq X$ is called $Z$-set of $X$, if there exist arbitrary small maps from $X$ into $X\backslash A$; that is, for every open cover $U$ of $X$, there exists a map from $X$ into $X\backslash A$ which is $U$-close to the identity. Although the $Z$-set does not seem very appealing, it is the most central concept in infinite-dimensional topology. Extending this idea to large-scale geometry, we define Coarse $Z$-sets by analyzing their behavior under arbitrarily small maps of $X$ into $X\backslash A$ and examining their structural properties in a global context. A subset $A \subseteq X$ is called Coarse $Z$-set if there exists a function from $X$ into $X\backslash A$ that is "close" to identity map in the sense of large-scale geometry. Characterized by maps that are "close" to the identity, the Coarse $Z$-set can be thought of as a small set in a larger space; removing it does not change the overall structure of the original space. This study demonstrates that if a subset is a Coarse $Z$-set, the associated function is a quasi-isometry, guaranteeing coarse equivalence between the space and its complement. This equivalence preserves asymptotic dimensions, as expressed by $\mathrm{asdim}(X) = \mathrm{asdim}(X \setminus A)$. Furthermore, Coarse $Z$-sets are invariant under coarse equivalence, showcasing their robustness in large-scale geometry.

**Keywords**: Asymptotic dimension, Coarse equivalence, Coarse $Z$-set, Infinite-dimensional topology, Large-scale geometry, Quasi-isometry

***Abstract No. 23*** ***Mathematics***

# OPTIMIZING INVESTMENT PORTFOLIOS USING QUADRATIC MODELLING FOR RISK AND RETURN MANAGEMENT

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The economic crises of recent years have underscored the critical role of diversification in investment portfolios to ensure stability and optimal returns in unpredictable and volatile markets. Traditional portfolio management techniques often fall short in effectively balancing risk and return, particularly during periods of financial uncertainty. As financial markets become increasingly complex, there is a growing need for advanced mathematical optimization techniques that can efficiently allocate assets while minimizing exposure to risk. This study explores the applicability of quadratic programming (QP) as a competitive portfolio optimization method, emphasizing its capability to reduce risk while maintaining adequate returns across a diversified range of asset classes. The study formulated and implemented a QP model for a case study to analyze and compare the proposed method with an existing optimization method. A comparative analysis evaluates the computational efficiency, feasibility, and performance of using QP in dynamic financial environments. The results demonstrate that QP enhances portfolio allocation strategies, ensuring better sector diversification and risk-adjusted returns. Furthermore, the research highlights the scalability and adaptability of QP in managing investment portfolios of varying complexity and size, making it a valuable technique for financial decision-making. The findings establish QP as a tool in modern portfolio management, offering a structured, data-driven approach for risk minimization, enhanced diversification, and long-term financial stability. Also, this study reinforces the potential of QP as a computationally efficient, flexible, and robust optimization technique, addressing the limitations of traditional portfolio selection methods and paving the way for more sophisticated financial strategies in fluctuating market conditions.

**Keywords**: Diversification, Optimization, Portfolio management**,** Quadratic programming, Risk management

***Abstract No. 26*** ***Mathematics***

# GENERALIZED CLIQUE COMPLEXES

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Networks are essential for modelling and analyzing complex systems in fields such as biology, social sciences, and finance, offering insights into the interactions and relationships within these systems. Despite their widespread use, classical graph-theoretic tools have inherent limitations, as they primarily focus on local properties, such as node degrees, paths, and direct connections between edges. This localized perspective is inadequate to capture global structural features such as complex connectivity patterns, holes, cycles, and higher-dimensional voids, which are crucial for understanding the overall network behaviour. Topological approaches in network analysis extend classical graph-theoretic methods by incorporating concepts from algebraic topology, enabling the study of higher-dimensional and global network features. Clique complex construction assigns a simplicial complex to a graph by taking complete graphs spanned by vertices as simplices. This approach enables the study of connectivity and other geometric features of the graph. This study generalizes the clique complex construction by using the notion of $k$-plex, an almost complete graph that spans $n$ vertices. A $k$-plex is a subgraph on $n$ vertices in which each vertex is at least of degree $n-k$. Also, this study proves that the assignment of a graph to its generalized $k$-clique complex is a functor from the category of graphs to the category of simplicial complexes. $k$-generalized clique complexes offer a more flexible representation of higher-dimensional interactions. Once the generalized $k$- clique complex is established, homology can be computed in the usual manner. The generalized $k$-clique complex construction ignores smaller holes and its higher dimensional counterparts, and depending on the choice of $k$, one has the choice of determining the size of the hole to be ignored. This approach will give a different perspective on network analysis and its applications.

**Keywords**: Clique Complex, $k$-plex, Persistent Homology, Simplicial Complex

***Abstract No. 27*** ***Mathematics***

# STUDY ON PARTICLE SHAPE ON MICROPOLAR NANOFLUIDS OVER AN EXPONENTIALLY STRETCHING SHEET IN A POROUS MEDIUM USING OPTIMAL HOMOTOPY ANALYSIS METHOD

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This study explores the impact of nanoparticle geometry on micropolar nanofluid flow over an exponentially stretching sheet in a porous medium, incorporating the micro-rotation profile. Using the fourth-order Runge-Kutta Integration Method, Murugesan and Kumar (2019) analyzed this flow system without considering micro-rotation effects. This study extends their work by employing the Optimal Homotopy Analysis Method (OHAM) to analyze the hydromagnetic behaviour of nanofluids by considering the micro-rotation profile. Three nanoparticle shapes: cylindrical, spherical, and lamina, are considered, using silver nanoparticles suspended in water as the base fluid. The governing partial differential equations (PDEs) are transformed into a dimensionless system of ordinary differential equations (ODEs) via similarity transformations, and solved using OHAM. The Mathematica package BVPH 2.0, developed by Liao, is utilized for numerical computations. A key advantage of OHAM lies in its flexibility in selecting the initial approximation and auxiliary linear operator, enabling the transformation of a nonlinear system into an infinite series of linear sub-problems. The study examines fluid velocity, temperature distribution, micro-rotation, and concentration profiles to evaluate heat and mass transport characteristics. A tenth-order approximation solution is obtained to demonstrate error analysis, reinforcing OHAM as a robust and reliable method for solving nonlinear fluid dynamics problems. The obtained results confirm the accuracy and efficiency of OHAM, yielding higher-order approximations with minimal errors.

**Keywords**: Exponentially stretching sheet, Geometrical shape, Homotopy analysis method, Micropolar nanofluid, Porous medium

***Abstract No. 30*** ***Mathematics***

# AN OPTIMIZATION MODEL FOR NON-PHARMACEUTICAL INTERVENTION TO CONTROL THE OUTBREAK OF COVID-19 EPIDEMIC IN SRI LANKA

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COVID-19 became a global pandemic in the latter part of the year 2019 which impacted immensely on the general public not only by infection but also by creating social and economic chaos among the communities. Until an appropriate curative remedy or vaccine is found, the World Health Organization (WHO) proposed to implement certain non-pharmaceutical interventions (NPIs) to mitigate its spread. Policymakers resort to implement strict NPI strategies without a proper understanding on the impact of the implementation, especially the mental condition of the people due to travel restrictions and continuous lockdowns. The purpose of this study is to analyse the situation carefully and propose an optimization model that combines social constraints, with the objective of minimizing frustration among the general public when implementing certain strict NPIs. In order to get the support from the citizens for the implementation of NPI in their respective districts, while minimizing the mental stress, public opinion was incorporated into the optimization model. In the proposed model, the opinion of the general public is incorporated in the objective function as penalties and the objective function attempts to minimize the total penalty. Penalties are the coefficients in the objective function in the scale from 0 to 10. The developed Mixed Integer Linear Programming optimization model is solved using the Optimization Programming Language solver and hence, determined the optimal values of the non-zero binary decision variables in the objective function. By optimizing these limitations, the model was able to determine the best weekly NPI schedule for every district that reduces the overall level of public discontent.

**Keywords**: COVID-19, Mixed Integer Linear Programming, Non-pharmaceutical intervention, Optimization model

***Abstract No. 31*** ***Mathematics***

# A MODEL BASED ON CUSTOMER SATISFACTION TO PREDICT ROUTE-WISE LOGISTIC COSTS FOR BAKERY PRODUCT SUPPLY CHAINS

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Efficient logistics management is crucial for bakery product supply chains due to the perishability of the products and the need for timely delivery. Traditional logistics cost prediction models often fail to incorporate customer satisfaction factors and to utilize them for long-term business success and competitive advantage. This study introduces a customer satisfaction-based model for predicting route-wise logistics costs by integrating customer-centric variables with operational metrics. The proposed model considers key cost components such as transportation, warehousing, inventory management, regulatory compliance, and environmental sustainability. It utilizes five types of data: route-wise expected logistics costs, actual logistics costs, profitability, and customer complaint data. Actual costs are taken as the previous time (Week/Month/Year), average route cost and expected logistics costs are determined by removing additional fuel costs, claim costs, etc. The model ensures that customer satisfaction is a core component by analyzing route-specific customer complaints over time and converting them into a satisfaction index. Route-wise cost variability and cost performance index (CPI) were used to construct the predictive model by considering the best performance of cost considering CPI = 1 in the logistic cost predictions. Data analysis was conducted using Microsoft Excel to inform future logistics cost prediction decisions by developing optimistic and pessimistic models from the company owner's perspective, thereby ensuring the model's stability. A case study was conducted and the mean accuracy of the results generated by the MATLAB software was compared with the actual logistic costs, and it was 96.08% for pessimistic cost predictions and 97.13% for optimistic cost predictions. This study presents a reliable logistic cost prediction model, assuming constant demand, and offers valuable insights for future decision-making in cost management and optimization within the bakery product supply chain.

**Keywords**: Customer satisfaction, Logistic costs, Optimistic model, Pessimistic model

***Abstract No. 34*** ***Mathematics***

# SPLITTING HOMOGENEOUS POLYNOMIALS OVER QUOTIENTS OF GROUP RINGS

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This study investigates the possibility of factoring homogeneous multivariable polynomials into linear factors over quotients of group rings. The motivation for this research stems from the observation that group determinants are homogeneous multivariable polynomials, and they can be factored into linear factors over a quotient of real group rings associated with the relevant group. This raises the natural question of whether this result can be extended to arbitrary homogeneous multivariable polynomials. It can be easily proven that any given homogeneous multivariable polynomial can factor into linear factors in some finitely generated real algebra, which may not necessarily be generated by its units. This study proved that a finitely generated real algebra is isomorphic to a quotient of a real group ring of some finitely generated group if and only if it can be generated by its units. The first isomorphism theorem, and the universal property of group rings are the main tools in proving this theorem. Based on some direct computations, it was conjectured that for a given homogeneous multivariable polynomial there exists a finitely generated real algebra generated by its units, in which the polynomial splits into linear factors.

**Keywords**: Finitely generated real algebras, Group rings, Homogeneous multivariable polynomials

***Abstract No. 36*** ***Mathematics***

# ANALYSING DIRECTED, WEIGHTED NETWORKS USING PERSISTENT HOMOLOGY

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Persistent Homology (PH) is a powerful tool in topological data analysis, which can be used to interpret the shape of data. In recent times, PH was applied to analyse the structure of complex networks, revealing information that was hitherto unknown to mainstream network analysis techniques. The current research extends the use of persistent homology to directed, weighted networks to gain valuable insights into the underlying structure and dynamics of the network. The persistent landscape was obtained, a topological summary based on PH that is more pliable to statistical analysis, of a directed weighted network. To establish the pipeline from the network to its PL, Dowker source/sink filtration was applied to the network, producing the Dowker complex, then persistence homology was computed, and the data was used as the input for PH. Various non-interacting software are already established for the individual purpose, and through this study, a single pipeline from a weighted directed network was obtained. As an application, the average persistent landscape of a dataset that represents the global trade network was input to the pipeline. The results show that the potential of persistent homology as a valuable tool for understanding the global macroeconomic network.

**Keywords**: Dowker complex, Global macroeconomic network, Persistent homology, Persistence landscape, Topological data analysis

***Abstract No. 38*** ***Mathematics***

# DOMINATING COMMON FACTOR METRIC ON RATIONAL NUMBERS

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This study introduces a novel metric on the set of positive rational numbers, derived by pulling back the symmetric difference metric on finite sets along a generalized divisor function. We first generalize the classical notion of divisibility to rational numbers via a prime factorization-based criterion. Using this definition, each rational number is associated with a finite set of its divisors, analogous to the classical set of divisors for positive integers. Subsequently, a distance function on positive rationals is defined by $d(r,s) = \sigma_0(r) + \sigma_0(s) - 2\sigma_0\big(\mathrm{dcf}(r,s)\big)$, where $\sigma_0(r)$ denotes the number of divisors of $r$ and $\mathrm{dcf}(r,s)$ is a generalized greatest common divisor. The study establishes a characterization of minimal distances and nearest neighbours in the induced metric space, reflecting the arithmetic-geometric structure of numbers in it. It was proved that, given a positive rational number, its nearest neighbours are precisely those obtained by increasing or decreasing the exponent of one of its most frequent prime factors by one. A complete description of unit spheres was provided: two positive rational numbers are at unit distance if and only if they are of the form $p^r$ and $p^{r+1}$ for some $r \in \mathbb{Z}$ and some $p \in \mathbb{P}$. These results contribute to a broader understanding of how multiplicative arithmetic properties influence interactions between rational numbers and open avenues for applications of metric space theory in multiplicative number theory.

**Keywords**: Metric spaces, Prime factorization, Rational numbers

***Abstract No. 43*** ***Mathematics***

# PROPER LUCKY LABELLING FOR MÖBIUS LADDER GRAPHS

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Proper Lucky labelling is a graph labelling concept in which adjacent vertices are assigned distinct labels, and the sums of the labels of adjacent vertices are also distinct. A graph that satisfies both of these conditions is called a Proper Lucky labelling graph. The smallest natural number needed to label the graph in this manner is known as the Proper Lucky number, denoted by $\eta_p(G)$. The Möbius ladder graph $(M_{2n})$ is a graph formed by connecting two cycles with edges in a twisted pattern, creating a non-orientable structure. This study focuses on determining the Proper Lucky number of the Möbius ladder graph and deriving a general formula for labelling this class of graphs. In Proper Lucky labelling, vertex labelling should be from the set $\{1,2,3,\ldots,k\}$ such that $k$ is the least natural number that labels the graph, and gets general formulas for vertex labelling of each graph. For that, we consider $n$ number of vertices in one cycle, and we get 2 as the Proper Lucky number for the Möbius ladder graph when $n$ is odd, otherwise, it is 4. Further, it is proved that these general formulas are valid for infinite graphs. Future studies can explore the Proper Lucky labelling of generalized Möbius like structures and other non-orientable or topologically complex graphs. Also, algorithmic approaches could be explored to compute Proper Lucky numbers for large-scale or dynamic graphs.

**Keywords**: Graph labelling, Infinite graph, Möbius ladder graph, Proper lucky labelling, Proper lucky number

***Abstract No. 46*** ***Mathematics***

# RESULTS ON VARIOUS CLOSED SETS IN BI-GENERALISED TOPOLOGICAL SPACES

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The exploration and examination of bi-generalized topological spaces are driven by the aim of investigating wider generalizations of topological spaces, which facilitates a more adaptable framework for analyzing topological properties and their interrelations. The concept of bi-generalised topological space was introduced by Boonpok in 2010. The objective of this study is to provide some new results in the sets, namely $(m,n)$-closed sets and $(m,n)$-generalised closed sets in bi-generalised topological spaces. In addition, two new types of closed sets are defined: $(m,n)$-$\alpha^*$-closed sets and $(m,n)-\beta^*$-closed sets, and some results for these new closed sets are provided. For a non-empty set $X$, the triple $(X,\mu_1,\mu_2)$ is a bi-generalised topological space, where $\mu_1$ and $\mu_2$ are generalised topologies on $X$. The members of $\mu_m$ are called $\mu_m$-open sets, $m$ =1, 2. The complement of $\mu_m$-open set is $\mu_m$-closed set. A subset $A$ of a bi-generalised topological space $(X,\mu_1,\mu_2)$ is called $(m,n)$-closed if $cl_{\mu_m}\left(cl_{\mu_n}(A)\right)=A$, where $m,n=1,2$ with $m\neq n$. Similarly, the set $A$ in $X$ is called $(m,n)$-generalised closed if $cl_{\mu_n}(A)\subseteq U$, whenever $A\subseteq U$ and $U$ is $\mu_m$-open set in $X$. In this study, firstly, it is shown that if the intersection or union of two subsets of a bi-generalised topological space is $(m,n)$-closed, then the subsets need not be $(m,n)$-closed. Next, a similar result for $(m,n)$-generalised closed sets are shown. Secondly, $(m,n)\alpha^*$-closed set is defined as follows: In a bi-generalised topological space $(X,\mu_1,\mu_2)$, a subset $A$ in $X$ is called $(m,n)\alpha^*$-closed if $int_{\mu_m}\left(cl_{\mu_n}(A)\right)\subseteq U$ for every $A\subseteq U$ and $U$ is an $(m,n)$-open set. Then, it is shown that the intersection of two $(m,n)$-$\alpha^*$ closed sets need not be $(m,n)$-$\alpha^*$closed. Also, if the intersection of two sets $A$ and $B$ is $(m,n)$-$\alpha^*$closed, then the sets $A,B$ need not be $(m,n)$-$\alpha^*$closed. Similarly, it can be shown that the union of two $(m,n)$-$\alpha^*$closed sets need not be $(m,n)$-$\alpha^*$closed. Also, it is proved that a subset $A$ in a bi-generalised topological space $(X,\mu_1,\mu_2)$ is $(m,n)$-$\alpha^*$closed if and only if $X\backslash A$ is $(m,n)$-$\alpha^*$open. Finally, another closed set is introduced, namely $(m,n)$-$\beta^*$closed as follows: A set $A$ in a bi-generalised topological space is called $(m,n)$-$\beta^*$closed if $cl_{\mu_n}\left(int_{\mu_m}(A)\right)\subseteq U$ for every $A$ contained in $U$, where $U$ is $(m,n)$-open set. Also, this study found that the intersection or union of two $(m,n)$-$\beta^*$closed sets need not be $(m,n)$-$\beta^*$closed.

**Keywords**: Bi-generalised topology, $(m,n)$-$\alpha^*$ closed, $(m,n)-\beta^*$ closed, $(m,n)$-closed set, $(m,n)$-generalised closed set

***Abstract No. 48*** ***Mathematics***

# A METHOD OF DIRECTLY DEFINING THE INVERSE MAPPING FOR SOLUTIONS OF LAMINAR BOUNDARY LAYER FLOW OVER A WEDGE

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This study developed and applied a semi-analytical method called the method of directly defining inverse mapping (MDDiM) to obtain a series solution for the laminar boundary layer flow over a wedge with a uniform surface temperature. Laminar boundary layer flow over wedge-shaped surfaces is critical in various engineering fields, including aerodynamics, heat transfer, and fluid mechanics. The governing equations are derived from the continuity and Navier-Stokes equations under the boundary layer assumptions. Using an appropriate similarity transformation, the governing equations were transformed into a system of coupled nonlinear ordinary differential equations. Traditionally, researchers have widely used perturbation and asymptotic techniques to gain analytical approximations for nonlinear problems. Unfortunately, when nonlinearity becomes strong, perturbation and asymptotic approximations of nonlinear problems often break down. Furthermore, these methods depend on any small or large physical parameters. The MDDiM overcomes these limitations by providing an extremely large degree of freedom based on the concept of homotopy, a fundamental concept in topology and differential geometry, to choose base functions, initial guesses, and inverse linear operators, allowing for the simplification of solving complicated nonlinear differential equations in many cases. The results obtained, with minimum errors, are presented graphically and discussed. Since the direct definition of the inverse operator, the series solutions were obtained using less central processing unit (CPU) time, low error, and less complicated terms. The proposed technique produces a highly accurate and reliable solution to the problems in a few iterations. All computational results were achieved using Maple 16 mathematical software.

**Keywords**: Aerodynamics problems, Heat transfer problems, Laminar boundary, Method of directly defining inverse mapping

***Abstract No. 49*** ***Mathematics***

# MODELLING CROCODILE POPULATION UNDER THE INFLUENCE OF ENVIRONMENTAL FACTORS

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Crocodilians are among the most resilient species, demonstrating remarkable survival since the Mesozoic era. The sex of a crocodile hatchling is determined by the incubation temperature of the egg, a phenomenon known as Temperature-Dependent Sex Determination (TSD). Based on thermal variations influenced by proximity to water bodies, crocodile nesting regions in river basins are categorized into three sub-regions: Region I, with the lowest incubation temperatures, producing only female hatchlings; Region II, with moderate temperatures, yielding an equal ratio of males and females; and Region III, with the highest temperatures, resulting exclusively in male hatchlings. Female crocodiles prefer to lay eggs in Region I, but due to space constraints, they may also nest in regions II and III. Considering this movement, a theoretical fraction is formulated based on the carrying capacity of Region I and the number of female crocodiles incubated in that region. Using this fraction and the TSD criteria, a dynamical model of four differential equations is developed. However, periodic flooding in large river basins alters the carrying capacities of regions I and II, while additional factors such as egg predation, seasonal food shortages, and human activities further influence crocodile populations. To account for these effects, a differential equation predicting the dynamic evolution of the carrying capacity of Region I is incorporated, assuming the total carrying capacity of regions I and II remains constant. The impact of periodic flooding and other environmental factors is modelled using a sinusoidal forcing term and a white noise component. The values of carrying capacity are obtained from this equation and, then incorporated into the system of dynamical equations describing the population of male and female crocodiles in each region. Due to data scarcity, model parameters are estimated using synthetic data derived from existing indices. Numerical simulations confirm the system's stability and accuracy, predicting an optimal male proportion of 0.09, critical for species survival.

**Keywords**: Carrying capacity, Differential equations, Periodic-flooding, Temperature-dependent sex determination, White noise

***Abstract No. 50*** ***Mathematics***

# A METHODOLOGICAL APPROACH TO FLEET SIZE ESTIMATION FOR BUS TRANSPORT NETWORKS

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Accurate fleet size estimation is crucial for ensuring efficient bus operations, optimizing resource allocation, and minimizing service delays. Traditional models often assume fixed headways and fail to account for variations in travel time, layovers, and headway changes throughout the day, leading to inefficient resource allocation. This study presents a comprehensive methodology for estimating the optimal number of buses required to operate a route efficiently, considering variations in travel time, layovers, and changing headways. The proposed methodology integrates key operational parameters, including one-way travel time, layover time, round-trip cycle time, and variable headways. It follows four key steps: calculating the round-trip cycle time, estimating the base fleet requirement, adjusting for changing headways, and determining the final fleet requirement by considering peak demand and transition effects. Two scenarios were analysed, one where headway duration exceeds half the round-trip cycle time, and another with multiple headways within the same duration. A case study on bus route 100 (Panadura-Colombo, Sri Lanka) validates the model. The results show that during the initial 5-minute headway period (5:00 a.m.–6:00 a.m.), 24 buses are required. During the transition to a 3-minute headway (6:00 a.m.–6:35 a.m.), an additional 24 buses are needed due to overlapping services. From 6:35 a.m. onwards, 64 buses are required to maintain the 3-minute frequency. The proposed method enhances estimation accuracy by preventing excessive fleet allocation during off-peak hours while ensuring sufficient service capacity during peak periods. A sensitivity analysis demonstrates the robustness of the model by testing scenarios involving minor disruptions in travel time and headway intervals. Furthermore, the study acknowledges the limitations of focusing solely on service frequency, suggesting the integration of passenger demand data in future enhancements. Although the current analysis is based on a single route, the methodology is scalable to multi-route and interconnected networks. This study contributes to transit planning by offering a structured, adaptable approach for optimizing fleet sizes in variable-demand conditions. Future research could explore real-time data integration and advanced optimization techniques to enhance fleet estimation accuracy.

**Keywords**: Bus transport networks, Fleet size estimation, Headway variation, Operational efficiency, Public transit planning

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***Abstract No. 53*** ***Mathematics***

# REFINEMENT OF REGULA FALSI METHOD FOR SOLVING NON-LINEAR EQUATIONS

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Searching for roots of non-linear equations in the real domain is a common problem in science and engineering. Even though a few closed-form analytical solutions exist for algebraic equations, there is no such formula for transcendental equations, which brings numerical approximate methods to the frontline. The classical Regula Falsi method ($M_1$) is a root-finding numerical technique with linear convergence and requires checking the bracket condition at each iteration. Recently, a new root-finding technique ($M_2$) is proposed, that is superlinearly convergent with order $p = \sqrt{2}$, and it does not require checking the bracket condition. The iterations of this method are advanced by the formula : $x_{n+1} = \lambda N_{n-1} + (1-\lambda)N_n$, $0 \leq \lambda \leq 1$ for $n = 1, 2, 3, ...$, where $N_m = x_m - f(x_m)/f'(x_m)$, $m = 0, 1, 2, ...$, where $f'(x)$ is the derivative of the function defined in the non-linear equation $f(x) = 0$. In fact, due to the parameter $\lambda$, $M_2$ generates a family of root-finding techniques, all of which are superlinearly convergent. The convergence analysis of this method has also been established. However, this method fails in some cases, such as when 1) Nonlinear functions are not sufficiently smooth, 2) Nonlinear functions are not explicitly known, and 3) Derivatives have complex formulas. To alleviate those issues, each term $N_{n-1}$ and $N_n$ is replaced by the difference quotient $D_{n-1}$ and $D_n$, respectively, to obtain the following method: ($M_3$) $x_{n+1} = \lambda D_{n-1} + (1-\lambda)D_n$, for $0 \leq \lambda \leq 1$ for $n = 1, 2, 3, ...$, where $D_m = x_m - [f(x_m)\big(f(x_m) - f(x_{m-1})\big)]/(x_m - x_{m-1})$ for all $m = 1, 2, 3, ....$ The accuracy and convergence efficiency of the proposed method $M_3$ are demonstrated by several numerical test examples. While $M_3$ achieves a better accuracy comparable to both $M_1$ and $M_2$, it converges to exact roots faster than both $M_1$ and $M_2$. For example, considering the initial approximations and $x_0 = -0.4$ , $x_1 = 0.5$ for the exact root $r = 0$ of the equation $e^x \sin x + \ln(x^2 + 1) = 0$, $M_1$ requires 51 iterations to give an approximation of 0.000000000000009, $M_2$ achieves of an approximation 0.0000000000000000 within 16 iterations, while $M_3$ reaches an approximation of 0.0000000000014123 in 12 iterations.

**Keywords**: Non–linear equations, Order of Convergence, Regula Falsi Method, Roots

***Abstract No. 54*** ***Mathematics***

# SIXTH-ORDER RUNGE-KUTTA DISCRETIZATION OF THE QUADRATIC RICCATI EQUATION

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The Quadratic Riccati Differential Equation (QRDE) is a nonlinear ordinary differential equation that has many significant applications in computational sciences including optimal control theory, biological sciences, stochastic processes and physics. The initial value problem for the QRDE, frequently appearing in applications, is given by $y'(t) = p(t) + q(t)y + r(t)y^2$, $y(t_0) = \alpha \in \mathbb{R}$, where $p(t)$,$q(t)$, and $r(t)(\neq 0)$ are continuous functions defined on the interval $t_0 \leq t \leq T$. The nonlinear term $y^2$ in the QRDE often presents challenges, including lack of closed-form solutions, complex solution forms, and singularity problems. As a remedy, computational methods for the QRDE have been developed in literature. However, existing numerical methods such as Euler and Taylor series often fail to meet the numerical accuracy demanded by most applications. For example, the forward and backward Euler methods have first-order accuracy. Taylor series methods need the computation of higher-order derivatives. The classical fourth order Runge-Kutta has been utilized by File and Aga to obtain numerical solutions with an accuracy of order four. Using the fifth order Runge-Kutta method, we have recently obtained fifth order accurate solutions for the QRDE. In this study, a sixth order variant of Runge-Kutta method is applied to discretize the QRDE with a given initial condition. The stability and convergence of this method were also analyzed. Several numerical tests were carried out to illustrate the accuracy of the proposed method. Here, maximum absolute errors with respect to exact solutions on uniform grids of the domain $[t_0, T]$ with given $t_0$ and $T$ were calculated for each example. The numerical results confirm the accuracy of the derived sixth order method. For example, for a grid length $h = 0.0025$, the maximum absolute errors for the numerical tests are 9.3940e-04, 5.1002e-05, 5.3373e-08 and 7.3614e-06.

**Keywords**: Accuracy order, Initial-value problems, Quadratic Riccati equation, Runge-Kutta methods

***Abstract No. 55*** ***Mathematics***

# STUDY OF ELLIS HYBRID NANOFLUID FLOW OVER A STRETCHING CYLINDER USING THE OPTIMAL HOMOTOPY ANALYSIS METHOD

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The study of non-Newtonian fluid dynamics has attracted considerable interest due to its diverse applications in both industrial and biomedical fields. Among various non-Newtonian fluids, Ellis fluid is particularly noteworthy for its shear-thinning behaviour. In this context, researchers have examined the flow and heat transfer characteristics of an Ellis hybrid nanofluid over a stretching cylinder, incorporating the effects of magnetic fields, Darcy–Forchheimer drag, nonlinear thermal radiation, and Joule heating. This study further investigates these phenomena by accounting for the influence of buoyancy forces. The hybrid nanofluid comprising a non-Newtonian Ellis base fluid embedded with AA7072 and AA7075 nanoparticles suspended in water, offers enhanced thermal and rheological properties. To analyze the system, the governing equations for continuity, momentum, and energy are reduced to a set of nonlinear ordinary differential equations through similarity transformations. These equations are then solved using the Optimal Homotopy Analysis Method (OHAM), a semi-analytical technique that allows flexibility in selecting auxiliary linear operators and initial guesses. Graphical results, generated via the *Mathematica* software, illustrate the variations in fluid velocity and temperature profiles in response to different physical parameters. To validate the accuracy of the OHAM solutions, error comparisons are made against results obtained from the finite difference method. The analysis confirms that OHAM is a robust and effective approach for investigating complex fluid flow and heat transfer phenomena in non-Newtonian hybrid nanofluids.

**Keywords**: Buoyancy force, Ellis hybrid nanofluid, Joule heating, Optimal homotopy analysis method

***Abstract No. 56*** ***Mathematics***

# CHARACTERIZATION OF INNER TORAL POLYNOMIALS VIA FINITE BLASCHKE PRODUCTS

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A finite Blaschke product is a product of finitely many automorphisms on the unit disc. These complex-valued functions are bounded and analytic on the unit disc. An inner toral polynomial is a polynomial in $\mathbb{C}[z,w]$ such that its zero set is contained in $\mathbb{D}^2 \cup \mathbb{T}^2 \cup \mathbb{E}^2$, where $\mathbb{D}$ is the open unit disc, $\mathbb{T}$ is the unit circle, and $\mathbb{E}$ is the exterior of the closed unit disc in $\mathbb{C}$. Finite Blaschke products generate inner toral polynomials in the following way; given a finite Blaschke product $B(z)$, the numerator of $w^m - B(z)$ is an inner toral polynomial. Previous work has shown that every inner toral polynomial of the form $q(z)w^m - \alpha r(z)$, where $\alpha \in \mathbb{C} \setminus \{0\}$, $m \in \mathbb{N}$ and $r(z)$, and $q(z)$ are polynomials in $z$ with deg $(q(z)) \geq$ deg $(r(z))$, is also generated by a finite Blaschke product. This study generalizes previous results by considering inner toral polynomials generated by two finite Blaschke products. It is proved that for given two finite Blaschke products $B_1(z)$ and $B_2(w)$, the numerator of $B_1(z) - B_2(w)$ is an inner toral polynomial. Furthermore, under certain limitations, a partial converse is also proved. If $p(z,w) = \alpha r_1(z)q_2(w) - q_1(z)r_2(w)$, where $\alpha \in \mathbb{C} \setminus \{0\}$, and $r_1(z)$, $q_1(z)$, are polynomials in $z$, and $r_2(w)$, $q_2(w)$ are polynomials in $w$, with degree one is inner toral, then $p(z,w)$ can be written as the numerator of the difference of two finite Blaschke products. These findings further deepen the understanding of the relationship between finite Blaschke products and inner toral polynomials, providing new insights into the structure of distinguished varieties and their generation in multivariable complex analysis.

**Keywords**: Distinguished varieties, Finite Blaschke products, Inner toral polynomials

***Abstract No. 57*** ***Mathematics***

# GENERALIZATION OF THE SYMMETRICITY PROPERTIES OF POLYNOMIALS DEFINING DISTINGUISHED VARIETIES ON THE OPEN UNIT BIDISK

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Let $\mathbb{D}$ be the open unit disk, $\mathbb{T}$ be the unit circle, and $\mathbb{E}$ be the exterior of the closed unit disk in $\mathbb{C}$. A polynomial $p(z,w)$ is said to define a distinguished variety on $\mathbb{D}^2$, if $Z(p) = \{ (z,w) \in \mathbb{C}^2 : p(z,w) = 0 \} \subseteq \mathbb{D}^2 \cup \mathbb{T}^2 \cup \mathbb{E}^2$. For such polynomials, the zero set $Z(p)$ inside $\mathbb{D}^2$ is called a distinguished variety on $\mathbb{D}^2$. For a polynomial $p(z,w)$ with two variables having bidegree $(n,m)$, the reflection is defined by $\tilde{p}(z,w) = z^n w^m \overline{p\left(\frac{1}{\bar{z}}, \frac{1}{\bar{w}}\right)}$. A polynomial $p \in \mathbb{C}[z,w]$ is essentially $\mathbb{T}^2$ −symmetric if $p(z,w) = c\tilde{p}(z,w)$ for some $c \in \mathbb{T}$. In 2010, Greg Knese introduced the concept of symmetricity for polynomials defining distinguished varieties on $\mathbb{D}^2$ and has shown that a polynomial $p$ defining a distinguished variety on $\mathbb{D}^2$ is essentially $\mathbb{T}^2$ −symmetric. In this study, this concept of symmetricity is generalized for polynomials defining distinguished varieties on open unit polydisk $\mathbb{D}^n$, by considering polynomials with $n$ variables. A polynomial $p(z_1, z_2, \dots, z_n)$ is said to define a distinguished variety on $\mathbb{D}^n$, if $Z(p) = \{ (z_1, z_2, \dots, z_n) \in \mathbb{C}^n : p(z_1, z_2, \dots, z_n) = 0 \} \subseteq \mathbb{D}^n \cup \mathbb{T}^n \cup \mathbb{E}^n$. For such polynomials, the zero set $Z(p)$ inside $\mathbb{D}^n$ is called a distinguished variety on $\mathbb{D}^n$. For a polynomial $p(z_1, z_2, \dots, z_n)$ with $n$ variables having degree $(m_1, m_2, \dots, m_n)$, the reflection is introduced by $\tilde{p}(z_1, z_2, \dots, z_n) = z_1^{m_1} z_2^{m_2} \dots z_n^{m_n} \overline{p\left(\frac{1}{\bar{z}_1}, \frac{1}{\bar{z}_2}, \dots, \frac{1}{\bar{z}_n}\right)}$. We defined a polynomial $p \in \mathbb{C}[z_1, z_2, \dots, z_n]$ to be essentially $\mathbb{T}^n$ −symmetric if $p(z_1, z_2, \dots, z_n) = c\tilde{p}(z_1, z_2, \dots, z_n)$ for some $c \in \mathbb{T}$. This study proves that a polynomial $p$ defining a distinguished variety on $\mathbb{D}^n$ is essentially $\mathbb{T}^n$ −symmetric for any $2 \leq n < \infty$. Future studies can focus on proving properties that already exist for two variable polynomials in the case of polynomials with $n$ variables.

**Keywords**: Distinguished varieties, Inner toral polynomials, Symmetricity

***Abstract No. 58*** ***Mathematics***

# AN INNOVATIVE STATISTICAL APPROACH TO RESTRICTED TRANSPORTATION PROBLEMS

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The transportation problem, which aims at minimizing the total transportation cost while delivering goods from multiple sources to various destinations, is a fundamental optimization problem. Classical methods, such as the Least Cost Method, Vogel's Approximation Method, Row Minima Method, Column Minima Method, and North-West Corner Method, are frequently used to find an initial basic feasible solution. To achieve the optimal solution, techniques like the Stepping Stone Method and the Modified Distribution Method are typically employed. This research focuses on the restricted transportation problem, which arises when certain routes are restricted due to regulatory, safety, or logistical constraints. First, the balance of the given transportation problem is examined. If it is unbalanced, a dummy row or column with zero transportation costs is added to ensure that the total supply equals the total demand. Subsequently, the arithmetic mean and the standard deviation of the cost matrix are calculated, excluding the large costs assigned to restricted routes and all zero-cost entries. Next, each valid cost is transformed into its corresponding cumulative distribution function (CDF) value of the log-normal distribution. Then, the geometric mean for each row and column is computed, excluding zero-cost values. Afterwards, the row or column is identified with the lowest geometric mean, and the maximum possible quantity is allocated to the cell with the lowest CDF value in that row or column. Thereafter, the corresponding supply and demand are updated by eliminating any fully satisfied row or column. After that, the CDF matrix is revised accordingly, and the allocation process is repeated until all supply and demand requirements are met. Finally, the total transportation cost is determined using the original cost matrix and the final allocation plan. Benchmark instances validate the effectiveness of the proposed method in minimizing transportation costs while satisfying restricted conditions. A comparative analysis is performed with traditional approaches to demonstrate the superior accuracy of this statistical approach.

**Keywords**: Geometric mean, Log-normal distribution, Optimal solution, Restricted transportation problem

***Abstract No. 59*** ***Mathematics***

# MATHEMATICAL MODELING OF THE EFFECT OF WARFARIN ON BLOOD CLOTTING IN PATIENTS WITH PROSTHETIC HEART VALVES

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Warfarin is an important anticoagulant in use to prevent thromboembolic complications in patients with prosthetic heart valves. The effectiveness of warfarin therapy is monitored using the International Normalized Ratio (INR), with a target range of 2.0–3.5, to minimize the risks of thrombosis and bleeding. However, maintaining INR within this therapeutic range is challenging due to warfarin's narrow therapeutic window, significant inter-individual variability, and complex pharmacokinetics (PK) and pharmacodynamics (PD), which depend on individual patient characteristics. This study develops a mechanistic PK/PD model to describe warfarin dynamics including absorption, distribution, metabolism, elimination, and its effects on clotting factors and INR dynamics, particularly, in patients with prosthetic heart valves. The PK component models the drug's disposition in the body, while the PD component accounts for its inhibition of vitamin K-dependent clotting factors. The formulated model is solved using Python programming and some model parameters were estimated using clinical data, while the other parameters were obtained from existing literature. The model was validated using data from an additional 12 consecutive days. Further, a sensitivity analysis was performed to identify key parameters influencing INR stability and therapeutic outcomes. Furthermore, the model demonstrates how different warfarin dosing scenarios affect INR stabilization. Regular dosing achieves therapeutic INR (2-3.5) in approximately 4.31 days. Missed doses delay stabilization to 5.04 days, increasing thrombosis risk, while extra doses stabilize INR faster in about 2.45 days with quick spikes. However, extra doses increase the risk of excessive anticoagulation and bleeding. This model serves as a valuable tool for predicting individual responses to therapy and for optimizing personalized dosing strategies, ultimately improving patient care and enhancing the safety and efficacy of anticoagulation therapy.

**Key Words:** Anticoagulant, Prosthetic heart valves, Thromboembolic complications

***Abstract No. 60*** ***Mathematics***

# TOPOLOGICAL DATA ANALYSIS OF FINANCIAL MARKET VOLATILITY: A STUDY OF PERSISTENCE DIAGRAMS

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Financial markets are known for their volatility, making it challenging to predict stock price movements using traditional methods. This study explores the application of Topological Data Analysis (TDA) to analyse financial time series data, focusing on identifying persistent topological features that correlate with periods of high volatility. To detect structural changes over time, each stock's closing price series was segmented into windows of 252 data points (equivalent to one trading year), and for each window, Takens' embedding method was applied to transform the time series into high-dimensional point clouds, which were then analysed using persistent homology to identify topological features. The most persistent features are structures as connected components (0-dimensional holes, detected via $H_0$) and loops (1-dimensional holes, detected via $H_1$), which persisted across a wide range of scales in the persistence diagram. From each diagram, the most persistent $H_1$ feature was extracted, and the overall maximum persistent point across all windows was identified along with its corresponding time series segment. The analysis was applied to major stock indices, including the S&P 500, the Dow Jones Industrial Average, Apple Inc., and Tesla. The emergence of persistent $H_1$ after high volatility indicates a return to structural regularity in the market, suggesting that after chaotic fluctuations, financial systems tend to reorganise into more stable configurations. Furthermore, computing market volatility using a rolling standard deviation supports this trend. This suggests that TDA can capture meaningful and stable market structures that arise after periods of instability, offering a novel perspective on market dynamics. Future research will focus on integrating machine learning models with TDA to enhance time series forecasting in financial markets.

**Keywords**: Financial markets, Financial time series, Market volatility, Persistence diagrams, Topological data analysis

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***Abstract No. 61*** ***Mathematics***

# A UTILITY-BASED EQUILIBRIUM FRAMEWORK FOR WEATHER INDEX INSURANCE

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Climate change and extreme weather events pose significant risks to farmers' livelihoods, increasing the need for effective risk management tools. Weather Index Insurance (WII) has emerged as a cost-effective solution, offering timely payouts based on predefined weather indices. By facilitating quicker recovery from crop losses and reducing loan default risks, WII enhances financial stability for farmers, particularly in rural areas vulnerable to climate-related disruptions. Despite the numerous advantages of WII, its uptake among farmers remains low due to high premiums and unreliable compensation. This study proposes a utility-based equilibrium model that analyses the supply, demand, and risk preferences of farmers and insurers. The model is based on mean-variance utility theory and assumes non-homogeneous farmers, whose revenues and benefit payouts follow a normal distribution. A simulation is conducted using 100 synthetic farmers, grouped by weather index exposure and assigned varying risk aversion coefficients, to explore how insurance demand responds to risk preferences and the introduction of premium subsidies. The market equilibrium is determined by farmers who purchase a positive amount of insurance, balancing aggregate demand with supply. Demand for WII increases with higher farmer risk aversion and is also influenced by the insurer's risk preferences; lower risk aversion on the insurer's side leads to greater willingness to supply, increasing overall demand. The inclusion of premium subsidies further shows that individual farmer demand is shaped not only by personal characteristics but also by the behaviour of other farmers in the market. The model assumes non-homogeneous farmers with normally distributed revenues and benefit payments, which future studies are encouraged to relax.

**Keywords**: Equilibrium model, Premium subsidies, Risk aversion coefficient, Weather index insurance

***Abstract No. 62*** ***Mathematics***

# MATHEMATICAL OPTIMIZATION AND COMPUTATIONAL GEOMETRIC PACKING ALGORITHMS FOR MAXIMIZING MATERIAL UTILIZATION IN WOOD PROCESSING

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Optimizing the use of timber resources is essential for ensuring sustainable forestry practices and maximizing wood utilization. The primary challenge in wood processing is to achieve the highest possible usable yield while minimizing waste, particularly when it comes to heartwood, which is stronger and more valuable than sapwood. The conventional wood-cutting technique, known as the plain (flat) sawn method, follows a straightforward approach but often results in significant wastage. This study specifically focuses on Jack wood, highlighting the importance of optimization tailored to the wood type. The primary objective is to reduce cutting waste and maximize usable wood by strategically positioning prioritized rectangular cuts within the heartwood. Data were collected from the State Timber Corporation (STC) in Sri Lanka, with each log of wood measured by its length and girth**.** Each timber log is assumed to be in a perfectly cylindrical shape, with no internal damage. The heartwood is assumed to occupy 70% of the timber log's radius, and its cross-sectional area was calculated accordingly. The study framework combines geometry-based optimization with spatial algorithms. The arrangement of rectangular shapes on the cross-sectional area is prioritized (3" x 4") first, then followed by prioritizing larger areas defined by lengths with widths of 28 mm, 31 mm, and 38 mm for the remaining area. An optimization model was formulated to maximize the utilization of the heartwood area under some constraints regarding total heartwood area, rectangular area, non-overlapping and rotation. Compared to plain sawn method, the optimized approach improved material utilization by up to 18% in area and 13% in volume, with a noticeable reduction in remaining usable material. The results of this study show the effectiveness of the optimized cutting method in maximizing material utilization and minimizing wastage compared to the commonly used plain-sawn method. These findings emphasize the benefit of wood-type-specific optimization in enhancing yield and reducing waste in industrial applications.

**Keywords**: Optimization, Spatial-algorithms, Sustainable forestry, Timber log, Wood utilization

***Abstract No. 64*** ***Mathematics***

# A NOVEL CRYPTOGRAPHIC SCHEME BASED ON RADIO MEAN LABELLING

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Graph theory and cryptography have long been intertwined, offering powerful techniques for securing information across disciplines such as computer science, engineering, and biology. This study introduces a novel encryption and decryption algorithm that integrates Radio mean labelling of cycle graphs with a polyalphabetic cypher, aiming to bolster cryptographic security. Graph labelling assigns labels to graph elements, facilitating efficient data representation and manipulation. A radio labelling $f$ of graph $G$ assigns positive integers to the vertices of $G$ such that $|f(u) - f(v)| \geq \text{diam}(G) + 1 - d(u, v)$, where $u, v \in V(G)$, $\text{diam}(G)$ represents the diameter of the graph, and $d(u, v)$ denotes the distance between vertices $u$ and $v$. This definition is modified as $\lceil (f(u) + f(v)) / 2 \rceil \geq \text{diam}(G) + 1 - d(u, v)$, which is called the Radio Mean Labelling (RML) of $G$. The Radio Mean number of $f$, $\text{rmn}(f)$, is the maximum number assigned to any vertex of $G$. The Radio Mean number of $G$, $\text{rmn}(G)$, is the minimum value of $\text{rmn}(f)$ taken over all RMLs of $G$. In this approach, the plaintext is transformed into cyphertext using an alternative RML method applied to odd cycle graphs, specifically $C_{2n+1}$, combined with a polyalphabetic structure. The method assigns labels sequentially to odd cycles with odd or even diameters, selecting vertices from zero at maximum distance. Each label satisfies the Radio Mean condition relative to all previous labels, shaping the cypher. Decryption is achieved by utilizing two keys: the odd cycle graph and a keyword, enabling the accurate restoration of the original message. The polyalphabetic table is constructed using a shifting value, $k$, derived from the Radio mean number of the cycle graph and the length of the keyword. This method effectively enhances data security by integrating graph-based transformations with traditional encryption techniques. Future research will focus on extending this approach by incorporating different cycle graph structures and alternative graph labelling techniques to further improve encryption strength.

**Keywords**: Cryptography, Decryption, Encryption, Radio Mean Labelling

***Abstract No. 66*** ***Mathematics***

# A MATHEMATICAL MODEL TO DESCRIBE THE BEHAVIOUR OF MITE POPULATION IN SCABIES

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Scabies is a highly contagious skin disease caused by the microscopic mite *Sarcoptes scabiei*. The female mite burrows into the skin to lay eggs, leading to intense itching, and rashes with pimple-like bumps or burrow tracks. While Nodular Scabies involves fewer mites, Crusted Scabies is a severe form characterized by thick crusts and thousands of mites. This study develops a mathematical model to examine the population dynamics of mites and the spread of rashes due to human scabies infestation. The model captures the four developmental stages of the mite: egg, larva, nymph and adult, and considers male and female mites separately. Mite mortality is influenced by natural lifespan, immune response, and medications, particularly with permethrin 5%. The model consists of sixteen parameters, where values of eleven parameters were obtained from existing literature, and the values of the other five parameters were assumed based on biological reasoning. In this model, four key assumptions are made: individuals get infectious when carrying fertilized female mites, permethrin 5% exhibits equal effectiveness against both larval and nymph stages, a uniform immune response with a constant effectiveness rate of 5% is applied across all developmental stages of the mites, and adult mites emerge in equal proportions of males and females. The model is solved both analytically and numerically, using Python, and the results were validated by comparing with the existing literature. Simulation results show that without treatment, mite populations grow rapidly, leading to Crusted Scabies. A 7-day treatment reduces mites, but does not eliminate them, while a 14- to 20-day treatment ensures complete clearance. Early and continuous treatment is crucial, as delays or early discontinuation leads to rapid regrowth. These findings are consistent with medical observations, supporting the validity of the proposed model.

**Keywords**: Life cycle, Mathematical model, Mite population, Sarcoptes scabiei, Scabies

***Abstract No. 69*** ***Mathematics***

# PRODUCT CORDIAL LABELLING OF LATTICE OF HELM GRAPHS

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Graph labelling is a widely studied concept in graph theory, involving the assignment of integers to vertices, edges, or both under specific constraints. One such labelling, cordial labelling, was introduced by Ibrahim Cahit in 1987 as a generalization of graceful and harmonious labelling. A particular variant, known as product cordial labelling, is defined for a graph $G = (V(G), E(G))$ as a function $f: V(G) \rightarrow \{0,1\}$, where each edge $uv$ receives a label determined by the product $f(u)f(v)$. The labeling must satisfy two conditions: the absolute difference between the number of vertices labeled 0 and those labeled 1 should be at most 1, and the absolute difference between the number of edges labeled 0 and those labeled 1 should also not exceed 1. If a graph can be labelled in this manner, it is classified as product cordial. The concept of product cordial labelling was introduced by R. Ponraj, M. Sivakumar, and M. Sundaram, and since then, many authors have worked on this product cordial labelling and have identified many types of graphs as product cordial. The helm graph $H_n$ is the graph obtained from an $n$-wheel graph by adjoining a pendant edge at each node of the cycle, which can be used in real world situations like controlling systems, networking, etc. This study presents that helm graphs are product cordial, and introduce the product cordial labelling for any such graph depending on whether its cycles have odd or even number of vertices. Furthermore, the product cordiality of lattices of helm graphs is studied by combining a finite number of copies of helm graphs with or without bridging edges.

**Keywords**: Cordial labelling, Helm graph, Labelling, Product cordial labelling, Wheel graph

***Abstract No. 70*** ***Mathematics***

# PRODUCT CORDIAL LABELLING OF GENERALIZED HELM GRAPHS

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Graph labelling is the process of assigning integers to the vertices, edges, or both, under specific constraints. In 1987, Ibrahim Cahit introduced cordial labelling as a more flexible alternative to graceful and harmonious labellings. A specialized form, product cordial labelling, was later introduced by R. Ponraj, M. Sivakumar, and M. Sundaram in 2012, leading to further research on different classes of graphs that exhibit this property. Product cordial labelling is defined as a function $f: V(G) \to \{0,1\}$, where each edge $uv$ is assigned the label $f(u)f(v)$. A graph is said to be product cordial if the absolute difference between the number of vertices labeled 0 and 1 is at most 1, and the absolute difference between the number of edges labeled 0 and 1 does not exceed 1. This labelling method provides insights into graph structures and their combinatorial properties, making it a useful tool in network theory, coding, and other applied fields. In this study, the existence of product cordial labelling for helm graphs $H_n$, obtained by attaching a pendant edge to each vertex of the cycle in an $n$-wheel graph, is shown. A structured approach is presented for labelling these graphs based on whether the cycle has an odd or even number of vertices. Furthermore, this study extends the analysis to a generalized version of helm graphs, such as those with additional pendant attachments, and explores conditions under which these graphs maintain product cordiality. These findings contribute to the broader study of graph labellings and their applications in discrete mathematics and theoretical computer science.

**Keywords**: Cordial labelling, Helm graph, Product cordial labelling, Wheel graph

***Abstract No. 71*** ***Mathematics***

# AN OPTIMIZATION TECHNIQUE TO ASSEMBLY LINE BALANCING IN APPAREL INDUSTRY

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Balancing the assembly line in the apparel industry, which is crucial for maximizing production efficiency, requires effective assignments of machine operators (MOs) based on their skills and availability to reduce production delays. This study aims to increase the production rate by developing an optimization model as a two-phase Integer Linear Programming Model (ILPM). In the first phase, based on the MOs' efficiency, an ILPM is implemented to increase the total production rate by assigning them to operations while identifying bottleneck operations which contribute to lower the production rate. In the second phase, the total skill level of the assembly line is minimized. The predetermined bottleneck production rate is used as an indicator, ensuring that the production rate which is maximized in the first phase is kept fixed. The reassignment of the remaining MOs is based on their skill levels, while the bottleneck operations and operators are isolated in the second phase. The proposed method assigns MOs to maximize the production. Sequentially, it seeks to minimize the overall skill usage to ensure efficient utilization of operator skills. The bottleneck operation, identified in the first phase, ensures that the most efficient MOs are assigned where needed, while other operations are conducted by MOs based on a compromise solution between their skill levels and availability. This approach guarantees that the maximum production rate remains intact while optimizing operator efficiency. This proposed method offers flexibility in assigning operators with an optimum production rate and identifies the optimum number of MOs needed to perform the set of operations. Isolating bottleneck operations in the second phase minimizes their negative effect on the production efficiency and allows to reallocate resources to less critical operations. This two-phase approach compromises between production rates and skill levels, and ensures a balanced and efficient workflow. This approach can be adopted to any production line with the necessary modifications.

**Keywords**: Assembly line balancing, Bottleneck operation, Machine operator, Production rate, Two-phase integer linear programming

# Mathematics Education

***Abstract No. 03*** ***Mathematics Education***

# EXAMINING THE INTERACTION OF MOTIVATION, SELF-EFFICACY, AND ACADEMIC EMOTIONS IN SHAPING MATHEMATICS LEARNING OUTCOMES: A STUDY ON UNDERGRADUATE STUDENTS IN MANAGEMENT SCIENCE IN SRI LANKA

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This study investigates the influence of motivation components, *effort, self-efficacy, and worry*, on the mathematics learning outcomes of Sri Lankan undergraduate students in Management Science, with a sample of 384. Using a validated questionnaire, these components were measured in relation to gender and academic performance. Results show high overall motivation with 72.7% demonstrating strong effort, while self-efficacy is moderate with 47.1%. Female students scored significantly higher in motivation than males, particularly in self-efficacy and effort. Students with higher cumulative grade point averages (CGPA) exhibited stronger motivation, specifically in the range of 3.00-3.49 CGPA showing the highest scores. Significant positive correlations emerged between motivation components and academic achievement: effort ($r = .152, p < .01$), self-efficacy ($r = .175, p < .01$), and overall motivation ($r = .214, p < .01$). Moderate worry levels correlated with better performance, suggesting some anxiety may be motivational, which should be investigated further. Both male and female students demonstrated overall higher levels of motivation, while no visible differences were observed in terms of gender. The study contributes to understanding the influence of motivation on learning Mathematics.

**Keywords**: Effort, Gender, Mathematics, Self-Efficacy, Worry

***Abstract No. 09*** ***Mathematics Education***

# EFFECTS OF MATHEMATICS RECITATION SESSIONS ON COURSE SUCCESS AND ITS EQUITABLE IMPACT ON COLLEGE CALCULUS

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To combat a prevalent low success rate as college STEM majors take courses in the Calculus sequence, recitation support sessions focusing on group work and discussion were introduced at a public university. This research studies the effects of this implementation in Precalculus, Calculus I, and Calculus II courses by investigating failure rates and course success. Discussing the qualitative student-reported perceptions of recitation sessions and quantitative ordinal linear regression analysis of course outcomes helps bridge the gap between how research views these sessions versus the experiences of the impacted students. The probability of earning an F (versus a D or above) in Precalculus without recitation is 47.37%, while it is 12.28% with recitation. Calculus I students had a 17.36% probability of failing the course without recitation, and 9.91% with. Calculus II students had a 15.25% chance of failing the course without recitation and a 13.04% chance with. Students overall had lower rates of earning lower course grades. Of the students surveyed, 86% agreed that they interact with their peers during recitations. This allows greater opportunity for collaboration and a leveling of understanding throughout the lecture sections. This is reflected in the 73% of students who agreed that recitations help them understand mathematics concepts better. In recitation sessions, small learning communities of problem solvers are formed, and students can enter a safe space to practice mathematics content. Diving into the setbacks and successes of recitations offers an example of how to catalyze change in the classroom. Since the odds and probabilities of earning lower scores significantly decrease as recitations are introduced, this data indicates that students are more likely to not only pass their course but also receive higher grades. Although this study focuses on undergraduate students, the ideas for the sessions and strategies can be utilized in almost any academic environment. Showcasing researched recitation sessions and their effects could offer insight into other supplemental courses or recitation-like classroom setups.

**Keywords**: Calculus, Higher Education, Mixed Method, Peer Collaboration, Recitations

*Financial assistance from What Why How Calculus Grant (360559/9532.8) is acknowledged.*

***Abstract No. 10*** ***Mathematics Education***

# THE IMPACT OF COHORT EXPERIENCES ON STUDENTS' SENSE OF BELONGING, ACADEMIC PERFORMANCE, AND CAREER READINESS

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Mathematics is widely regarded as one of the most challenging academic disciplines, and many students struggle to complete their degrees within the typical four-year timeline in the USA. This study explores how cohort affiliation and shared experiences influence mathematics majors' sense of belonging, academic performance, and preparedness to become high school teachers. A significant number of undergraduates in mathematics in the state of California pursue the Teaching Option or the Integrated Credential Option with the goal of entering the teaching profession. Traditionally, aspiring mathematics educators in the USA complete a four-year mathematics degree followed by a one-year credential programme. However, the Integrated Credential Programme allows students to complete both their degree and credential within four years. This research focuses on the academic success of undergraduate students pursuing the Teaching and Integrated Credential Options who participated in structured cohort experiences, compared to those who did not engage in such programmes. The cohort programmes examined *Mentoring Mathematics Scholars with Success (M2S2)*, *Building Opportunities through Networks of Discoveries (BOND)*, and the *NOYCE Scholarship Programme*. Both M2S2 and NOYCE are federally funded programmes that offer financial support and cohort-based learning experiences. The NOYCE programme also provides teaching seminars, content mentoring, and opportunities to attend professional conferences. Using a mixed-methods approach, this study compares the sense of belonging and academic outcomes of students in cohort programmes with those of other mathematics majors. Data sources include institutional performance metrics (GPA and graduation rates), surveys, and interviews. The quantitative dataset includes 766 mathematics majors who entered the university between 2018 and 2024, comprising both first-time freshmen and transfer students from community colleges. Additionally, 43 survey responses and five interviews were collected and analyzed quantitatively. A pooled two-sample t-test is used to identify significant differences in outcomes between the groups. Preliminary findings indicate that students involved in cohort programmes demonstrate higher retention rates, a stronger sense of belonging, and increased career readiness in mathematics education. These insights can inform the development of academic programmes that enhance student success and effectively prepare future educators for the teaching profession.

**Keywords**: Academic performance, Cohort affiliation, Mathematics undergraduates, Preparedness for teaching, Sense of belonging

***Abstract No. 28*** ***Mathematics Education***

# STATISTICAL ANALYSIS OF ENGINEERING UNDERGRADUATES' PERFORMANCE ACROSS FORMATIVE AND SUMMATIVE ASSESSMENTS IN CALCULUS MODULE

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A collection of 199 undergraduates from the Faculty of Engineering, General Sir John Kotelawala Defence University (KDU), was selected for the study using convenience sampling. The calculus module for engineering undergraduates is designed with various essential and complex concepts for advanced engineering problems and is offered in the second academic semester. To fulfil the formative assessment category, five in-class assignments were conducted to cover all learning outcomes. For the analysis, the weighted average marks of the formative assessments were considered, and the end-semester examination was considered as the summative assessment. A descriptive analysis was performed to identify the relationship between the summative assessment marks of the calculus module and the formative assessment marks. The significant gap between the weighted average of formative and summative assessment marks suggests that end-semester examinations are considerably more challenging than continuous assessments. Shapiro-Wilk normality test results indicated that the formative assignment marks slightly differ from normality, and the end-semester examination marks are normally distributed. Pearson and Spearman Rank correlation tests were performed in the analysis. Statistically significant moderate positive correlations indicate that students who perform well in formative assessment tend to perform better in summative assessment in the calculus module. A simple linear regression model was fitted to strengthen the results, revealing that formative assessment marks significantly predict summative assessment performance ($R^2 = 0.327$). The residual analysis shows that the model's error terms are normally distributed with relatively constant variance across the range of predicted values. Although, the correlation improved slightly upon the removal of influential outliers, the fundamental relationship between the assessments remained consistent with the regression model, explaining approximately 33% of the variance in summative assessment performance.

**Keywords**: Calculus, Engineering education, Formative and summative assessment

***Abstract No. 29*** ***Mathematics Education***

# BUILDING ON PRIOR KNOWLEDGE AND MAKING CONNECTIONS: CASE OF TEACHING COMPLEX NUMBERS

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This study explores the role of mathematical connections in the teaching of complex numbers at the upper-secondary level. Drawing on the Extended Theory of Mathematical Connections (ETMC), we examine how teachers establish links between prior knowledge and new concepts to promote conceptual understanding. Through the analysis of video-recorded lessons from 10 teachers of G.C.E. (A/L) Combined Mathematics, we identify instances of Instruction-Oriented Connections (IOC), Different Representations (DR), and Part-Whole Relationships (PWR). Additionally, our findings reveal two previously unclassified types of connections: Extensional Connections (6), where new concepts are framed as extensions of prior knowledge, and Structural Connections (4), which highlight similarities in mathematical structures. Results emphasize the importance of these connections in fostering deeper comprehension and suggest their applicability across broader mathematical domains. This study contributes to the ongoing discourse on mathematical pedagogy by providing practical insights for educators to enhance student learning through purposeful connections.

**Keywords**: Complex numbers, Conceptual understanding, G.C.E. (A/L), Mathematical connections

***Abstract No. 32*** ***Mathematics Education***

# USING KAHOOT AS A MATHEMATICS ASSESSMENT TOOL FOR JUNIOR SECONDARY LEVEL STUDENTS IN SRI LANKA

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This study focused on the effectiveness of using Kahoot as an assessment tool for assessing knowledge of "multiplying fractions" among junior secondary school students. It was observed that around 67% of the students provided incorrect answers and/or struggled to provide correct answers for questions on "fractions" at both term tests and written assessments. Hence, in this study, the lesson on "multiplying fractions" was selected for a mathematics assessment, and many scholars have recommended Kahoot as a suitable tool for game-based assessment. Educators and researchers use Thomas Malone's Theory to enhance learning through games; hence, this theory was used for this study. A mixed-method research design was adopted, and quantitative data were collected using a structured questionnaire with 5-Point Likert Scale after giving Kahoot assessment to students. Convenience sampling of the non-probability techniques was used within the cross-sectional time horizon, and all the 28 students of grade 8 in a class at Type 1C school in the Ratnapura education zone of the Sabaragamuwa Province were included in the sample. After analyzing the primary data through SPSS (Version 27), the test of reliability was given a satisfactory degree of consistency (Cronbach's Alpha = 0.750), which indicates the instrument was reliable. The findings show that students gave strong positive feedback on all the survey questions. Descriptive Statistics Tests confirmed the strong agreement of students towards Kahoot assessment, and a small standard error indicates the preciseness of the responses. Further, Median (5.000) and Interquartile Range (IQR) (0.000) were used since the data was not normally distributed and revealed no spread, which confirms strong agreement among students. Hence, additional statistical tests were not necessary to conduct, but qualitative analysis revealed more insights about the study. The qualitative data was collected through semi-structured interviews. Based on Kahoot game results, the students were divided into three groups for the interview; five students with the top scores, five students with the lowest scores, and five students from the middle range. The Thematic Analysis showed that students experienced technical issues, but did not give up their involvement, instead, Kahoot made the students' experience of assessment enjoyable and motivating rather than traditional paper-based assessments. The attractive graphics and audio features of Kahoot also built up students' curiosity for their active participation and a strong willingness to do more game-based assessments, learning through immediate feedback. These findings will encourage further research on a larger scale and a more diverse group of students to establish long-term influences for more digital assessment tools. In conclusion, this study recommends using Kahoot as an effective assessment tool for lessons on "fractions", which highlights the need for further research in this regard.

**Keywords**: Game-based learning, Kahoot, Mathematics assessment, Secondary education, Student engagement

***Abstract No. 41*** ***Mathematics Education***

# MATHEMATICAL CONCEPTS USED IN HUNTING METHODS BY VEDDAS IN SRI LANKA

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Indigenous people hold great significance as the first inhabitants, laying the foundation for the region's heritage and culture. The Veddas are the indigenous people of Sri Lanka. However, studies conducted on the application of mathematical concepts in their hunting practices are scarce. Therefore, this qualitative study was conducted to identify the mathematical concepts used in the methods of hunting. Data on hunting practices were collected through semi-structured interviews with six adult males from Dambana, Sri Lanka. Thematic analysis was conducted, and the emerging themes were the application of various mathematical concepts in hunting equipment, techniques, and factors affecting hunting. Findings revealed that the Fibonacci number pattern was used in crafting bows and arrows (3, 5, and 8), whereas the trajectory of arrows followed a path of a projectile. Relative velocity played a major role in aiming and shooting animals, which the Veddas describe by observing the animal's jumps. Additionally, several other mathematical concepts, such as estimation, length and mass measurement, friction, centrifugal force, and dynamic force, were used in hunting. It can be concluded that the Veddas incorporate mathematical concepts into their hunting practices. However, one of the limitations of this study is the small sample size. It highlights the importance of conducting further research on these mathematical concepts used by Veddas to preserve them before they become obsolete.

**Keywords**: Hunting methods, Mathematical concepts, Vedda

***Abstract No. 47*** ***Mathematics Education***

# THE EFFECT OF ACTIVITY-BASED TEACHING METHODS ON GRADE 7 STUDENTS' MATHEMATICAL ENGAGEMENT AND MOTIVATION IN WATTALA DIVISION

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This study explores how activity-based education helps Grade 7 students in the Wattala Division to participate in more mathematical activities and be more enthusiastic about mathematics. In normal situations, when teachers only deliver lectures, students do not participate actively, lose interest, and hence forget what they learned. But with Activity-Based Learning (ABL), students get actively involved through problem-based activities, collaboration, and applying mathematics to real-life situations, and so learn more successfully. This study conducted a six-week comparative study design on two groups: one through traditional lecture-based teaching and the other through ABL. In this study, the sample consists of five mathematics teachers in Wattala Division and 50 students in grade 7. Data was collected by interviewing teachers, observing teachers, and surveying students. It was learned that students who were taught through ABL were more interested and engaged, and gained more knowledge compared to students who were taught by traditional teaching methods. Teachers also found that ABL led to high student involvement and helped to develop critical thinking and problem-solving skills. Despite these self-evident benefits, this study faced challenges implementing these methods, including teacher training, inadequate resources, and adapting classrooms to interactive teaching. These challenges need to be resolved to apply ABL successfully in mathematics education. This resistance shows that there has to be a systematic transition phase when applying activity-based practices so that students can increasingly adapt in solving mathematics problems as a team and with experiential learning. This study emphasises the need for systematic teaching practices, especially student-centered and active engagement. More studies are needed to investigate the impact of ABL on student outcomes in the longer term, with different groups of students, and in different subjects. Extending this study to different learning environments will prove its effectiveness and the sustainability of it in the long term.

**Keywords**: Activity-based learning, Mathematics education, Motivational outcomes, Student engagement

***Abstract No. 51*** ***Mathematics Education***

# ENHANCING STUDENTS' INTEREST AND PARTICIPATION IN MATHEMATICS LESSON DEVELOPMENT

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Mathematics significantly improves students' problem-solving and analytical thinking skills. However, based on the experience as a teacher, many eighth-grade students show low levels of engagement and participation, which negatively affects their academic performance. This study investigates strategies to enhance student engagement in mathematics learning through interactive and student-centred methods. A quantitative research design was employed, focusing on five students in grade 8 from a selected Type 1AB school in the Rathnapura Educational Zone of Sabaragamuwa Province, Sri Lanka. Participants were selected through purposive sampling. Three intervention sessions were designed and conducted to address different aspects of students' disengagement in mathematics learning. These interventions include the use of technology integration, collaborative learning, real-world problem-solving, and differentiated instruction. Data was collected using observations for classroom activities, memos based on student reflections, and surveys. The findings indicate a positive impact of the interventions on students' engagement. Specifically, 60% of the selected students showed increased interest in interactive learning methods such as group discussions and hands-on activities. The application of real-world contexts to mathematical concepts resulted in 75% of the selected students demonstrating increased interest and finding learning more relatable. Furthermore, 95% of the students reported increased enthusiasm and reduced anxiety towards mathematics when lessons incorporated technology-based activities. Since interactive methods and technology-based activities enhanced students' interest, participation, and conceptual understanding of mathematics, this study provides practical insights for educators aiming to implement active student engagement in mathematics through innovative lesson design. Among the insights, the interactive and student-centred interventions positively influence students' engagement with mathematics. Observations and student feedback reveal that interactive learning methods, such as group discussions and hands-on activities, led to higher levels of participation. Applying mathematical concepts to real-world contexts appeared to help students grasp abstract ideas more effectively, making learning more meaningful and relatable. In conclusion, these strategies significantly enhance students' engagement, enthusiasm, and pleasure in studying mathematics. This study offers useful advice for teachers, indicating that incorporating these technology-enhanced and interactive techniques can make mathematics classes more interesting, which will ultimately boost student motivation and academic achievement.

**Keywords**: Interactive learning, Mathematics learning strategies, Technology integration

***Abstract No. 52*** ***Mathematics Education***

# STRUCTURED PROBLEM-SOLVING IN MATHEMATICS EDUCATION: ENHANCING REASONING, ACCURACY, AND CONFIDENCE AMONG BILINGUAL LEARNERS

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Problem-solving skills are crucial for students' development of foundational mathematics, such as conceptual understanding, accuracy, reasoning, and confidence. This study examines how an organised approach to problem-solving affects students' performance in a bilingual secondary school classroom in North Central Province, Sri Lanka. The objective was to determine how systematic teaching methods affect students' mathematical confidence, accuracy, and logical reasoning. Quantitative tests and qualitative information from students' interviews and classroom observations were combined in a mixed-methods methodology. Students were led through a series of processes in the structured technique, including comprehending the problem, determining known and unknown variables, choosing suitable approaches, methodically solving the problem, and confirming the result. Instructions were given bilingually in Sinhala and English to improve understanding and lessen cognitive burden. The findings showed that students' accuracy in problem-solving and logical thinking had significantly improved. About 85% of the students show more confidence when overcoming difficulties in mathematics. Furthermore, bilingual education reduces cognitive strain by roughly 40%, indicating that it promotes improved understanding of mathematical concepts and language. These results demonstrate how well-structured approaches to problem-solving can raise mathematical competency. Additionally, the study highlights how crucial bilingual education is to enhancing students' comprehension in multilingual classrooms. The information offered by this study can assist teachers in providing more effective support for bilingual students in mathematics classes.

**Keywords**: Bilingual students, Logical reasoning, Mathematics education, Structured problem-solving

***Abstract No. 68*** ***Mathematics Education***

# STATUS OF SECONDARY LEVEL MATHEMATICS EDUCATION IN SELECTED SCHOOLS IN KALMUNAI EDUCATION ZONE, SRI LANKA

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This study investigates the status of secondary-level Mathematics education in selected schools within the Ampara District of Sri Lanka, with a focus on students' performance, teaching methodologies, and the challenges faced by both students and teachers. Employing a mixed-methods approach, the sample consisted of 200 students (grades 10 and 11), 25 Mathematics teachers, and 8 trainee teachers from three selected schools in the Kalmunai Education Zone. The test assessed students' knowledge and skills in key areas of Mathematics, while the questionnaires gathered insights into students' learning experiences, teachers' teaching practices, and the availability of teaching resources. The test results revealed that a significant majority of students scored below satisfactory levels, with 36% scoring below 20%. Only 10% of the students achieved scores above 75%. The majority of the students performed below satisfactory levels, particularly struggling with Set Theory and Probability. Key challenges identified include, insufficient instructional time, a lack of modern teaching aids, and limited use of innovative teaching strategies. Students reported dissatisfaction with teachers' ability to clarify doubts, while teachers cited difficulties in syllabus completion and engaging with students effectively. These findings align with consistently low Mathematics scores in national examinations. The study recommends the integration of modern teaching aids, the provision of remedial classes for underperforming students, and enhanced professional development for teachers. Establishing well-equipped Mathematics classrooms and promoting student-centered instructional methods are essential steps toward improving secondary-level Mathematics education in the Kalmunai Education Zone.

**Keywords**: Mathematics education, Student performance, Teaching challenges, Innovative methods, Remedial teaching

***Abstract No. 73*** ***Mathematics Education***

# FACTORS AFFECTING MATHEMATICS PERFORMANCE OF GRADE 10 STUDENTS IN DIVISION 2 SCHOOLS AT HATTON EDUCATIONAL ZONE

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The General Certificate of Education (Ordinary Level) (G.C.E. (O/L)) examination is an important public examination in Sri Lanka. Mathematics plays a key role in this examination, and passing mathematics is a fundamental requirement for students to advance to advance higher level classes. Grade 10 is the foundational year for the G.C.E. (O/L), and this study aims to identify the factors influencing the mathematics performance of Grade 10 students in schools within the Hatton Division 2. The study explores how four main themes: interest for mathematics, home environment, parents' education level, and the type of school attended, affect students' performance in mathematics. Under these themes, we examined the relationship between students' performance in mathematics and the factors; private tuition attendance, homework completion, time spent on self-studying mathematics per week, parental conflict at home, paternal alcoholism, education level of both parents, the location of the school (urban or rural), and the category of the school (1AB, 1C, Type 2). The data for this study were collected from 125 students and 6 teachers from schools in the Hatton Educational Zone Division 2. A convenience sampling method was used to select schools, ensuring representation from 1AB, 1C, and Type 2 schools in both urban and rural areas. Data were gathered through a structured questionnaire and semi-structured interviews. The Chi-square test and Cramér's V rule were applied for data analysis using SPSS software. The results show that the amount of time spent on self-studying mathematics per week is strongly associated with students' mathematics performance in Grade 10. Additionally, completing assigned homework, father being an alcoholic, the relationship between parents, the education levels of both parents, the location of the school, and the type of school attended all show a moderate association with students' mathematics performance. The study also revealed that attending private tuition classes does not have a significant relationship with students' mathematics performance in Grade 10.

**Keywords**: Chi-square test, Cramér's V rule, G.C.E. (O/L), SPSS software

***Abstract No. 74*** ***Mathematics Education***

# DETERMINANTS OF MATHEMATICS ACHIEVEMENT AMONG G.C.E. (O/L) STUDENTS: A STUDY IN THE KALMUNAI EDUCATION ZONE

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This study investigates the factors influencing mathematics achievement among G.C.E. (O/L) students in the Kalmunai Education Zone, Sri Lanka. The research explores the impact of socio-economic background, school infrastructure, teacher quality, student motivation, and parental involvement on students' mathematics performance. Data was collected from 96 teachers across various schools using proportionate random sampling technique. Structured questionnaires were administered through direct distribution and collection method. Data analysis was conducted using SPSS software, employing correlation analysis and one-way ANOVA tests at $p < 0.05$ significance level. Correlation analysis revealed that student motivation is the strongest positive correlation with mathematics achievement ($r = 0.70$), and ANOVA results showed significant differences across all factor categories. The study concludes that all identified factors significantly influence mathematics achievement, with student motivation and parental involvement showing the strongest impact. A multi-faceted approach, which addresses these determinants, can substantially improve mathematics achievement in the Kalmunai Education Zone. The findings of this study highlight the complex interplay of factors that contribute to the academic achievement of students in mathematics. To improve students' performance, a multi-dimensional approach is required, focusing on enhancing socio-economic conditions, improving school infrastructure, investing in teacher quality, fostering motivation, and encouraging parental involvement.

**Keywords**: Mathematics achievement, Parental involvement, School infrastructure, Socioeconomic factors, Student motivation

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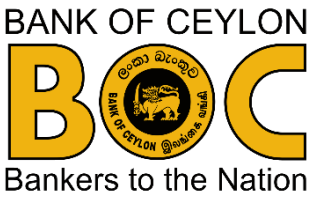


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