ANNUAL RESEARCH SESSION

2025

EMPOWERING SOCIETY THROUGH SCIENTIFIC RESEARCH AND INNOVATION

Abstracts of the Proceedings of

ARS – FOS – 2025

Faculty of Science

Eastern University, Sri Lanka

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of

Annual Research Session
Faculty of Science
ARS-FOS-2025

"Empowering Society Through Scientific Research and Innovation"

15th of October 2025
Faculty of Science
Eastern University, Sri Lanka

Annual Research Session, Faculty of Science 2025 (ARS-FOS-2025)

ARS-FOS-2025, 15th of October 2025

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Annual Research Session, Faculty of Science 2025 (ARS-FOS-2025)

The Annual Research Session-2025 of the Faculty of Science (ARS-FOS-2025) is held on 15th October 2025, under the theme of ***"Empowering Society Through Scientific Research and Innovation"*****,** focusing on research tracks that are dedicated to Biological Sciences, Chemical Sciences, Environmental Sciences, Computer Science, Physical Sciences and Technology and Innovation. The ARS-FOS-2025 provides opportunities for the undergraduate and postgraduate students, and academics to disseminate their research findings particularly that address the challenges in the community using the innovative scientific knowledge and approaches. The conference is poised to provide students and academicians a professional environment to deliberate on their research experiences and receive constructive and timely feedback from participating scholars and stakeholders. Moreover, through this exercise it is expected to disseminate findings to related public and private organizations in the region, and open avenues towards community wellbeing.

Message from the Vice-Chancellor

Prof. P. Peratheepan

Vice-Chancellor
Eastern University, Sri Lanka

It is with great pleasure that I extend my warmest greetings to all participants of the Annual Research Session (ARS) – Faculty of Science, Eastern University, Sri Lanka, 2025, held under the inspiring theme *"Empowering Society Through Scientific Research and Innovation."*

The ARS serves as a vibrant platform for our students, academics, and researchers to share their knowledge, exchange ideas, and present innovative findings that contribute to addressing contemporary challenges. I am delighted to note that this year's sessions encompass a wide range of disciplines, including **Biological Sciences, Chemical Sciences, Mathematical Sciences, Computer Science, Physical Science, and Technology and Innovation**. These diverse tracks truly reflect the interdisciplinary nature of modern research and its role in fostering a deeper understanding of science for societal advancement.

In today's rapidly changing world, research is the driving force behind progress and transformation. It is our collective responsibility as a university community to ensure that the knowledge we generate leads to meaningful applications that enhance human life, preserve our environment, and contribute to sustainable national development.

I extend my heartfelt appreciation to **Dr. M.C.M. Iqbal**, Retired Associate Research Professor at the National Institute of Fundamental Studies, Sri Lanka, for gracing this occasion as the **Keynote Speaker** and sharing his invaluable insights that will undoubtedly inspire our academic community.

My sincere gratitude is also extended to Dean, Faculty of Science, Chairman of the ARS 2025 Prof. S. Arasaretnam, and the organizing committee, all subcommittees and other staff members of the faculty for their tireless efforts in bringing this event to fruition.

May this research session continue to ignite curiosity, promote collaboration, and strengthen the pursuit of scientific excellence that empowers society through innovation and discovery.
I wish the Annual Research Session – 2025, Faculty of Science, Eastern University, Sri Lanka, every success.

Message from the Dean

Mrs. T. Pio Jude Navinthan

Dean, Faculty of Science
Eastern University, Sri Lanka

It gives me great pleasure and honour to extend my heartfelt congratulations on the Faculty's Annual Research Session, ARS-FOS-2025, organized under the theme "Empowering Society Through Scientific Research and Innovation."

This year's theme speaks directly to our responsibility as scholars: to generate knowledge that addresses real societal needs and to transform scientific discoveries into innovations that improve lives. I am proud that our Faculty is committed to research excellence, interdisciplinary collaboration, and community engagement, all of which are essential for translating ideas into impact.

I wish to express my sincere gratitude to our distinguished keynote speaker, Dr. M. C. M. Iqbal, Associate Research Professor, National Institute of Fundamental Studies, Sri Lanka, for kindly accepting our invitation to share his expertise. My warm thanks also go to Prof. P. Peratheepan, Vice-Chancellor, for his guidance and support in aligning this event with the University's research vision. I would also like to convey my special thanks to Prof. S. Arasaretnam, Chair of ARS-FOS-2025, for his leadership and commitment.

I wish to extend my deep appreciation to our sponsors for their generous support, which has greatly contributed to the successful organization of this event. Their partnership demonstrates the vital connection between academia, industry, and society in fostering innovation and research development.

I would like to commend the Organizing Committee members, reviewers, session chairs, students, and all supporting staff for their dedication in making this event possible. My heartfelt appreciation is also extended to the researchers and presenters whose work enriches our academic community and contributes to societal progress.

Looking ahead, I encourage all faculty and students to strengthen interdisciplinary research, build partnerships with industry and community organizations, and pursue innovations that are socially relevant and scalable. May ideas flourish and lives be transformed.

Wishing everyone a successful and inspiring ARS-FOS-2025.

Message from the Chairperson

Prof. S. Arasaretnam

Chairperson, Annual Research Session-2025
Faculty of Science
Eastern University, Sri Lanka

It is my great pleasure to welcome you all to the Annual Research Session, organized by the Faculty of Science, Eastern University, Sri Lanka (ARS-FOS-2025). This event celebrates the creativity, dedication, and commitment of our budding undergraduate researchers.

In line with the Faculty's vision and mission, we continue to promote multidisciplinary research, industry partnerships, and community-oriented studies. By pursuing research that extends beyond theoretical boundaries and contributes to national development, we aspire to make a lasting impact on society.

This session serves not only as a platform for our young scientists to present their initial research findings, but also as a valuable opportunity to exchange ideas, foster collaborations, and inspire one another. Importantly, it marks their first step into the wider world of research. I warmly congratulate our students for their tireless efforts and commitment, and I extend my deepest gratitude to their supervisors for their invaluable guidance and mentorship in nurturing these inquisitive minds.

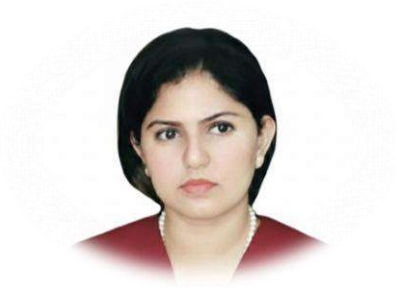
The Annual Research Session is further enriched by the keynote address of Dr. M. C. M. Iqbal, Associate Research Professor at the National Institute of Fundamental Studies, Sri Lanka. His address offers participants an excellent opportunity to gain fresh perspectives and valuable insights into the latest advancements in research.

I wish to express my sincere appreciation to the Dean of the Faculty of Science, the faculty members, the organizing committee, the reviewers, and the sponsors for their dedicated efforts in making this event a success. I am also deeply grateful to the Secretary of ARS-FOS-2025, Dr. R. M. T. B. Ranathunge, and the Editor-in-Chief, Dr. (Mrs.) B. S. W. Karunarathna, for their unwavering commitment and invaluable contributions. My heartfelt thanks are also extended to the session chairs and participants for their active engagement and meaningful contributions.

I am confident that the Annual Research Session 2025 will serve as a catalyst for promoting a vibrant research culture and inspiring our young scientists to pursue excellence in their chosen fields.

I wish the event every success and look forward to its continued growth in the years ahead.

Message from the Editor-in-Chief



Dr. (Mrs.) B. S. W. Karunarathna

Editor-in-Chief, ARS-FOS-2025
Faculty of Science, Eastern University, Sri Lanka

On behalf of the Editorial Committee, I am pleased to present the *Annual Research Session of the Faculty of Science 2025 (ARS-FOS-2025)*, held under the theme "Empowering Society Through Scientific Research and Innovation." The theme affirms our shared commitment to produce reliable knowledge and to translate it into solutions that enhance human well-being and advance a sustainable future. Research and innovation are central to a better future. From living systems to materials and matter, and from rigorous modelling to technological invention, they turn evidence into solutions for health, sustainability, and inclusive growth. This programme encourages participants to link fundamental discovery with clear pathways to measurable societal benefit.

ARS-FOS-2025 welcomes young researchers, including our undergraduates and early-career scientists, together with established academics, practitioners, and industry partners. By bringing these communities together, the Session creates a clear path from discovery to impact: rigorous methods, transparent reporting, constructive dialogue, and practical routes for application in policy, industry, and community settings. We place special emphasis on effective dissemination, ensuring that the work presented here is accessible, citable, and actionable.

I extend my sincere thanks to our reviewers for their careful evaluation of extended abstracts and full papers. Your expert feedback has strengthened the quality and integrity of these proceedings. I also thank the Editorial Committee of ARS-FOS-2025 for coordinating submissions, guiding authors, and managing the review process efficiently and fairly.

May these proceedings inspire continued constructive feedback, respectful debate, and enduring collaboration.

Brief Biography of the Keynote Speaker

Dr. M. Iqbal

Associate Research Professor,
National Institute of Fundamental Studies, Sri Lanka.

Dr. M. Iqbal is a pioneering Sri Lankan scholar in agriculture and environmental sciences whose career spans university teaching, nationally significant research, and science leadership. Educated at Kingswood College, Kandy, he entered the University of Peradeniya in 1976 to read for a B.Sc. in Agriculture, graduating in 1980. Soon after, he joined the then Batticaloa University College as an Assistant Lecturer in Agronomy, becoming part of the founding academic staff who helped establish what is today the Eastern University, Sri Lanka. His postgraduate formation includes an M.Phil. at the Swiss Federal Institute of Technology (ETH Zürich) and a Ph.D. at the University of Göttingen, Germany, supported by Rotary International, training that set the stage for a rigorous and internationally engaged research profile.

Following his doctorate, Dr. Iqbal undertook post-doctoral fellowships funded by the German Academic Exchange Service (DAAD) and the European Union's Erasmus Mundus programme, broadening his collaborative footprint across Europe. He later served at the Institute of Fundamental Studies (IFS), Kandy, contributing to national research priorities until his retirement in 2022. Throughout his career, he has been repeatedly recognized for scholarly excellence, receiving Presidential Awards for research publications on more than ten occasions. His publication record—over 50 peer-reviewed journal articles, 45+ conference proceedings papers, 70+ published abstracts, and several book chapters, reflects both depth and breadth across his fields of expertise. He has also shaped scholarly communication as a member of the editorial board of the *Ceylon Journal of Science* and as a current board member of *Tropical Agricultural Research*, while frequently serving as a reviewer for national and international journals.

A dedicated mentor, Dr. Iqbal has supervised numerous undergraduate final-year research projects and guided many postgraduate scholars through Master's, M.Phil., and Ph.D. programmes, building capacity for Sri Lanka's next generation of scientists. His national service includes technical assignments for NASTEC and the Climate Change Secretariat in preparing Sri Lanka's Second National Communication on Climate Change to the UNFCCC. Within the Sri Lanka Association for the Advancement of Science (SLAAS), he has served as Chair of the General Research Committee and contributed to the Ethics, Science Popularization, and GRC committees, roles that underscore his commitment to ethical, impactful, and publicly engaged science.

Collectively, Dr. Iqbal's academic leadership, sustained research productivity, and service to national scientific institutions have left a durable imprint on Sri Lanka's research ecosystem and on the many students and colleagues he has inspired.

Keynote Speech

Our Quest for Knowledge and its Dilemmas

Dr. M. Iqbal
Associate Research Professor,
National Institute of Fundamental Studies, Sri Lanka.

The scientific method has led to the technological marvels we enjoy today. The origins of the scientific method, paradoxically, can be traced back to the humanities. This development began with the Greeks, who were unhappy with knowledge derived from religious authority. The Greeks sought Universal Truths, the fundamental laws of nature, to understand natural processes. They used logical reasoning, discussions and arguments with other philosophers to arrive at the truth. Their observations of the environment were solely based on their senses. Therefore, philosophy was the first step in liberating humans from the prevailing religious autocracy to seek knowledge.

There are essentially two means to acquire knowledge: using reasoning, or from sensory experience. These formed the basis of Rationalism and Empiricism the two schools of thought in Western philosophy. They differ in the role of sensory experience in acquiring knowledge. Rationalism says knowledge is acquired independent of our senses, while Empiricism asserts sensory experience is the ultimate source of knowledge. The philosophical arguments in these two fields eventually contributed to the development of the scientific method. Both rationalism and empiricism utilize skepticism as a foundation, which is also the basis of scientific reasoning.

The scientific method revolves around a cycle of proposing hypotheses making observations, conducting experiments, and acceptance or rejection of hypotheses. The physical sciences explain the behavior of space-time and matter. With a good understanding of how matter behaves you can manipulate the physical world in all sorts of extraordinary ways.

This scientific method, however, had limitations. It was not applicable to historical sciences like astronomy, geology and biological evolution. These sciences are based on historical evidence that cannot be reconstructed since time flows only in one direction. Similarly, the neurosciences cannot be explained by the traditional scientific method since consciousness is not observable. You can't look inside someone's head and see their feelings and experiences. Although science deals with unobservable phenomena, it is able to explain what we can observe. What's unique about consciousness is that the thing we're trying to explain is unobservable. That's one way of saying a radically new approach to science is called for when the datum we're trying to account for is itself unobservable.

The last century has witnessed an explosive growth in science driven by key breakthroughs in the physical and chemical sciences such as the concept of the atom and discovery of the DNA structure. The phenomenal growth in molecular biology combined with chemical and physical sciences have provided explanations and solutions in agriculture and medicine.

We are now confronted with ethical dilemmas from our technologies. There is a growing consensus that ethics should be integral to scientific discussions. However, the tradition has

been that science comes first and then the ethics. Science decides what is in the societies interest and what counts as progress. This ends up with society agreeing to the scientific programs. Looking back, we now have some technologies over which we do not have adequate control, Run-away technologies where we have apparently lost control such as Climate Change, and Plastic pollution, and finally the dilemma with Dual-use technologies. While science is primarily used to benefit humanity, it can be misused in certain types of research to do harm as well as for good. This presents scientists and others with an ethical problem known as the dual-use dilemma.

Since the discovery of fire, stone tools and the wheel we humans have continuously invented everything within our sight of vision. Our quest to improve ourselves and control the environment around us has led to a relentless evolution of knowledge, ideas and creative inventions. Humanity now depends on our intelligence and biological systems which both are fundamental to two central technologies that is going to present us with the good, the bad and the ugly in the sciences: Artificial intelligence and Synthetic biology.

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ANNUAL RESEARCH SESSION-2025
FACULTY OF SCIENCE
EASTERN UNIVERSITY, SRI LANKA

Technical Session Schedule – ARS-FOS-2025 (15.10.2025)

TECHNICAL SESSION 01

Track 01 - Biological Sciences (11.00am)

Location: Board Room, EUSL
Chairperson: Senior Prof. P. Vinobaba, Faculty of Science
Pannel Member: Prof. K. Prasannath, Faculty of Agriculture
Zoom link: https://tinyurl.com/ARS-Session-1

Time	Abstract ID	Abstract title and authors name
11.00 am – 11.15 am	ARS-FOS-S1-01	*Phytochemical Screening, Chromatographic Profiling, and Bioactivity Evaluation of Gardenia fosbergii Fruit Extract*
11.15 am – 11. 30 am	ARS-FOS-S1-02	*Prevalence of Obesity, and Its Association with the Breakfast Habits in Young Adults in Modera, Colombo, Sri Lanka*
11.30 am – 11.45 am	ARS-FOS-S1-03	*Allelopathic effects of Eichhornia crassipes leaf extracts on germination and early growth of rice and two weed species under in vitro conditions*
11.45 am – 12.00 pm	ARS-FOS-S1-04	*Characterization of non-Candida Fungal Isolates from Oral Specimens of Cancer Patients and Healthy Individuals*
12.00 pm – 12.15 pm	ARS-FOS-S1-05	*Analysis of diversity, dominance and composition of beach seine catches in selected landing sites in Chenkalady fisheries inspector division*
12.15 am – 12.30 pm	ARS-FOS-S1-06	*Prevalence and Distribution of Ticks Among Cattle in the Selected Areas in Batticaloa District, Sri Lanka*

Track 02 - Chemical Sciences (01.15pm)

Location: Board Room, EUSL
Chairperson: Prof. M. Sithambaresan, Faculty of Science
Pannel Member: Dr. Sithy Iqba, Retired Professor,
Open University of Sri Lanka, Colombo (OUSL).
Zoom link: https://tinyurl.com/ARS-Session-1

Time	***Abstract ID***	***Abstract title and authors name***
1.15 pm – 1.30 pm	*ARS-FOS-S2-01*	*Comparison of absorption capacity of retinal and retinal-opsin complex (rhodopsin) using density functional theory*
1.30 pm – 1.45 pm	*ARS-FOS-S2-02*	*Alternative mechanism of methamphetamine addicti via direct activation of mu opioid receptor by Hydroxyamphetamine*
1.45 am – 2.00 pm	*ARS-FOS-S2-03*	*Development and Characterization of Biodegradable Polymer Film Made from Sweet Potato Starch for Food Packaging*
2.00 pm – 2.15 pm	*ARS-FOS-S2-04*	*Synthesis and Characterization of an Azo Functionalized Cr(III) Ion Imprinted Polymeric Resin for the Selective and Competitive Adsorption of Cr(III) Ions*

Track 03 - Technology and Innovation (02.15pm)

Location: Board Room, EUSL
Chairperson: Prof. (Mrs.) C.G. Devadason, Faculty of Science
Pannel Member: Dr. (Mrs.) Dulangana Hunupolagama,
Faculty of Technology
Zoom link: https://tinyurl.com/ARS-Session-1

Time	*Abstract ID*	*Abstract title and authors name*
2.15 pm – 2.30 pm	*ARS-FOS-S5-01*	*Development and Evaluation of Reduced Graphene Oxide-Reinforced Rubber Composites for Heavy-Duty Tire Applications*
2.30 pm – 2.45 pm	*ARS-FOS-S5-02*	*Toward Sustainable Rubber Composites: Preliminary Insights into Pinus-Derived Biochar as a Reinforcing Filler*

TECHNICAL SESSION 02

Track 04 - Mathematical Science (11.00am)

Location: Staff Development Centre, EUSL
Chairperson: Senior Prof. S. Thirukkanesh, Faculty of Science
Pannel Member: Dr T. Sritharan,
University of Colombo School of Computing (UCSC)
Zoom link: https://tinyurl.com/ARS-Session-2

Time	Abstract ID	Abstract title and authors name
11.00 am – 11.15 am	ARS-FOS-S3-01	*Exact solution of a scalar second-order ordinary differential equation possessing linearizing properties*
11.15 am – 11. 30 am	ARS-FOS-S3-02	*Neutrosophic simply b-separation axioms in neutrosophic topological spaces*
11.30 am – 11.45 am	ARS-FOS-S3-03	*Properties of fuzzy β-open sets in fuzzy topological spaces*
11.45 am – 12.00 pm	ARS-FOS-S3-04	*Different types of (m,n)-open sets in bi-generalised topological spaces*
12.00 pm – 12.15 pm	ARS-FOS-S3-05	*Study on a new type of continuity and compactness in topological spaces*
12.15 pm – 12.30 pm	ARS-FOS-S3-06	*Integrability of a nonlinear third-order ordinary differential equation via differential invariants*
1.15 pm – 1.30 pm	ARS-FOS-S3-07	*Nonlinear analyticity and Cauchy Riemann type structures in multicomplex spaces.*
1.30 pm – 1.45 pm	ARS-FOS-S3-08	*Optimizing Exam Scheduling Time Using Assembly Line Balancing Technique*
1.45 pm – 2.00 pm	ARS-FOS-S3-09	*α(gg)*- Continuous Function in Topological Spaces*
2.00 pm – 2.15 pm	ARS-FOS-S3-10	*Three-Dimensional Generalization of Cauchy–Riemann Type Equation*

Track 05 - Physical Science (02.15pm)

Location: Staff Development Centre, EUSL
Chair Person: Associate Professor. Queenie. Y. Soundararajah, Faculty of Science
Pannel Member: Dr. M.J.M. Jafeen, South Eastern University of Sri Lanka
Zoom link: https://tinyurl.com/ARS-Session-2

Time	*Abstract ID*	*Abstract title and authors name*
2.15 pm – 2.30 pm	*ARS-FOS-S4-01*	*An eco-friendly kesterite (Cu_2SnZnS_4) absorber for photovoltaic applications*
2.30 pm – 2.45 pm	*ARS-FOS-S4-02*	*Development of an Eco-Friendly Evaporative Cooling Tile Using Natural Clay*
2.45 pm – 3.00 pm	*ARS-FOS-S4-03*	*Synthesis, preliminary characterization and antimicrobial properties of Cu(II) and Fe(III) salicylaldehyde – phenylhydrazone complexes in the presence and absence of 1,10-phenanthroline as a co-ligand*
3.00 pm – 3.15 pm	*ARS-FOS-S4-04*	*Isomerization study of lycopene using density functional theory*
3.15 pm – 3.30 pm	*ARS-FOS-S4-05*	*Development of a Low-frequency Piezoelectric Sound Energy Harvester using a Single-coiled Acoustic Metamaterial Cavity*

CONCLUDING REMARKS (3.30pm)

Location: Board Room, EUSL
By: Dr. K. Premakumar,
Retired Senior Lecturer, Faculty of Agriculture, EUSL
Zoom link: https://tinyurl.com/ARS-Session-1

Phytochemical Screening, Chromatographic Profiling, and Bioactivity Evaluation of *Gardenia fosbergii* Fruit Extract.

V.G. Hewagamage[1*], J.E. Rajakulendran[1] and U. Mathiventhan[2]

Abstract. The present study aimed to assess the phytochemical screening, chromatographic profiling, and bioactivity evaluation of sequentially extracted chloroform, petroleum ether, carbon tetrachloride, and methanol fractions of the fruit of *Gardenia fosbergii* (Rubiaceae). The phytochemical analysis of fruit fractions obtained from four solvents was carried out to determine the bioactive compounds such as alkaloids, flavonoids, terpenoids, steroids, and phenolics. TLC profiling was carried out using various solvent systems of varying polarity for all sequential extractions for different phytochemicals, while column chromatography facilitated the isolation and purification of these compounds, thereby laying the groundwork for further structural characterization. Biological assays demonstrated significant antimicrobial and insecticidal activity, supporting the potential therapeutic application of *G. fosbergii*. Antimicrobial activity was carried out for all the extractions at 500 mg/ml and 1000 mg/ml test concentrations against *Escherichia coli*, *Staphylococcus aureus*, *Pseudomonas aeruginosa,* and *Candida sp*. by disc diffusion method. All four extractions' inhibition was highest (23.33 mm) for *Pseudomonas aeruginosa* and lowest (8.00 mm) for *Candida sp*., DMSO did not cause inhibition of the test pathogen. Insecticidal activity was conducted using Culex quinquefasciatus larvae against 0.25 – 2 mg/ml concentrations. The susceptibility of larvae to fractions was in the order: Pet–Ether> Chloroform > Methanol > Carbon tetrachloride. Results were subjected to one-way ANOVA and followed by Tukey's test ($P < 0.05$).

Keywords: *Gardenia fosbergii, Phytochemical analysis, Thin-layer chromatography, Antimicrobial activity, Insecticidal activity*

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Prevalence of Obesity, and its Association with the Breakfast Habits in Young Adults in Modera, Colombo, Sri Lanka

G.D.D.K. Gunasena[1*], R. Jeyandran[1] and D.N. Wanigasekara[2]

Abstract. The dietary patterns of young people and adults are changing rapidly due to the busy lifestyles worldwide. In Sri Lanka, particularly in highly populated areas, there is a remarkable trend in consuming ready-to-eat meals, skipping breakfast, and so on. Such unhealthy dietary practices are often associated with obesity. This study aimed to determine the prevalence of overweight and obesity, and to investigate their associations with dietary patterns, particularly breakfast habits, among adults in Modera, Sri Lanka. A cross-sectional study was conducted among 300 adults (age ≥30 years), both male (168 males) and female (132 females), residing in Modera, Colombo. Data were collected using a modified, interviewer-administered WHO STEP wise questionnaire, including anthropometric measurements and dietary and lifestyle assessments. Statistical analyses were conducted using SPSS 14.0. Waist circumference above 91cm is considered one of the risk factors, and BMI >30 is generally taken as obesity. The results revealed that among participants, the waist circumference margin was elevated in 44.8% of the participants. Further, 44.3 % were overweight and 22.0 % were obese. There was a clear correlation between skipping breakfast and higher BMI and waist circumference. 38.3 % of the participants did not take breakfast every day, and 61.7 % of participants had breakfast daily. Results further showed that what they included in the breakfast affected the obesity issues. Participants with normal BMI were consuming breakfast regularly, also they were consuming vegetables and fruits regularly. Participants who consumed calorie-dense snacks instead of breakfast showed higher obesity rates. Participants who consumed starch products were high in BMI, and their waist circumference was also high. 42.1 % of the participants never consumed cereals. The results of the study underscore a high prevalence of overweight and obesity among the adult population in Modera. Skipping breakfast, as well as irregular breakfast patterns and low dietary quality, were significant risk factors.

Keywords: *Breakfast Habits, BMI, Dietary Habits, Obesity*

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Allelopathic effects of *Eichhornia crassipes* leaf extracts on germination and early growth of rice and two weed species under in vitro conditions

N. Kirushananth*, W.M.D.M.Weerasekara and U. Mathiventhan

Abstract. Allelopathy refers to the biological phenomenon where plants release chemicals known as allelochemicals into the environment, which can influence the growth, survival, or reproduction of other organisms nearby, typically other plants. *Eichhornia crassipes* is an invasive aquatic plant that invades agricultural and aquatic ecosystems. The objective of the research work was to evaluate the allelopathic effect and phytochemical study of the *E. crassipes* aqueous and ethanolic leaf extracts against different germination parameters of rice (*Oryza sativa*), weedy rice (*Oryza sativa f. spontanea)* and Saramolla grass (*Ischaemum rugosum)* weed seeds. The experiment was carried out in petri dishes with ten selected seeds that were treated separately with different concentrations of plant extracts, such as 250 ppm, 500 ppm, and 1000 ppm. The control treatment was treated with sterile distilled water. The germination parameters, such as seed germination percentage, plumule length, and radicle length, were studied. The results reveal that the germination percentage of rice seed (58%) is inhibited by 1000 ppm ethanolic extract, but the germination percentage of rice showed some stimulant effect for the aqueous extract. The length of both baby shoots (P) and embryonic roots (R) of rice was inhibited (P- 0.92± 0.159, R-2.60±0.351) by ethanolic (1000 ppm) leaf extract, compared to the control treatment (P-2.26± 0.271, R-6.18± 0.357). Germination percentage of weedy rice (12%) was also inhibited by aqueous (1000 ppm) extract, and germination of *I. rugosum* was inhibited by both ethanolic extracts (2%) and aqueous extract (2%). When considering each extract, the ethanolic extract showed the strongest inhibition effect on seed germination and early growth compared to the aqueous extract. The inhibitory effect was increased with the increase in extract concentration ($p > 0.05$) of three seeds, such as rice, weedy rice, and *I. rugosum*. Inhibitory effects also varied with different types of extracts (aqueous and ethanol). It is evident from the data that allelochemicals present in *E. crassipes* might inhibit the process of seed germination. These findings will help to develop an eco-friendly weedicide.

Keywords: *allelopathic effect, aqueous extract, Eichhornia crassipes, ethanolic extract, germination parameters*

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Characterization of non-Candida Fungal Isolates from Oral Specimens of Cancer Patients and Healthy Individuals

D.N. Wanigasekara[1*], S.S. Wickramasingha[1], W.M.D.G.B. Wijayaratne[1] and M.T. Napagoda[2]

Abstract. The oral microbiome consists of a diverse range of microorganisms, among which fungi are often underrepresented in scientific studies. Most studies have focused on *Candida* species, especially in immunocompromised individuals. This study aimed to isolate and characterize non-*Candida* fungi from the oral cavities of cancer patients admitted and attended to the Oncology unit of National Hospital, Galle, and healthy individuals residing in the Bope-Poddala MOH area. Oral swab and rinse samples were collected from 170 cancer patients and 170 healthy individuals. Eleven fungal isolates that exhibited morphological features inconsistent with *Candida* were selected from specimens cultured on Candida Chrome Agar (CCA); three from cancer patients and eight from healthy individuals. These isolates were further purified and sub-cultured on Sabouraud Dextrose Agar and Rice Agar for morphological examination. Microscopic analyses included Gram staining, potassium hydroxide (KOH) preparation, and germ tube tests. All eleven isolates exhibited the presence of hyphae, with no germ tube formation or budding cells, indicating filamentous fungal morphology. These findings suggest that non-*Candida* filamentous fungi are present in the oral cavities of both immunocompromised and healthy individuals. The study highlights the importance of expanding the scope of oral fungal research beyond *Candida* species to better understand the diversity and potential clinical significance of these organisms in the human oral microbiota.

Keywords: *Filamentous fungi, non-Candida fungi, oral microbiome*

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Analysis of diversity, dominance and composition of beach seine catches in selected landing sites in Chenkalady fisheries inspector division

M. Himasha Farwin* and A.J.M. Harris

Abstract. Beach seine fishing is a traditional and commonly practiced method along the Eastern coast of Sri Lanka, particularly in the Batticaloa District. However, detailed scientific studies on the catch composition of beach seine fisheries in this region are limited, creating a significant knowledge gap that hinders proper assessment of diversity, species dominance, and sustainable fisheries management practices. Past researches have concentrated on other coastal regions, resulting in a significant data gap for Batticaloa's beach seine fisheries. To address this gap, the present study investigated fish species composition, diversity, and dominance in beach seine catches at ten landing sites across three sub-fishing areas- Kaluvankeni, Punnaikuda, and Savukkadi, within the Chenkalady Fisheries Inspector (FI) division during the active fishing season from June to November 2025. Data were collected by investigating eight beach seine operations at each site, identifying all fish species using a standard taxonomic field guide, and analyzing the type and weight of the species. A total of 114 species were recorded at Kaluvankeni, 106 at Punnaikuda, and 128 at Savukkadi. The Spotted Sardinella (*Amblygaster sirm*, family Clupeidae) dominated catches at Kaluvankeni, while the Indian Anchovy (*Stolephorus indicus*, family Engraulidae) was dominant at Savukkadi. Shannon-Wiener species diversity indices were highest at Savukkadi (2.46), followed by Kaluvankeni (2.15) and Punnaikuda (1.95), while dominance indices were lowest at Savukkadi (0.16), suggesting a more even distribution of species and less dominance by a few species. These findings highlight the high fish diversity of species in the Chenkalady FI Division and emphasize the importance of site-specific data for effective fisheries management and conservation strategies in coastal Sri Lanka.

Keywords: *Batticaloa District, Beach Seine, Species Diversity*

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Prevalence and Distribution of Ticks Among Cattle in the Selected Areas in Batticaloa District, Sri Lanka

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Abstract. Tick infestations pose a significant challenge in cattle management, with their effects influenced by various factors, including age, gender, vegetation, feeding habits, health conditions, predilection sites, and severity of infection. Despite the lack of published studies on this subject in the Batticaloa District, the present study aimed to assess the prevalence of tick species among cattle in the region. The research focused on assessing tick infestations in cattle across three selected sites within the Batticaloa District: Karadiyanaru, Vantharumoolai, and the Cattle Farm at the Faculty of Agriculture, Eastern University, Sri Lanka, and the study was carried out over seven months period from June to December 2024. A total of 587 ticks were collected from the selected sixteen cattle by hand picking. Morphological identification revealed six tick genera: *Boophilus* sp., *Haemaphysalis* sp., *Rhipicephalus* sp., *Amblyomma* sp., *Hyalomma* sp., and *Dermacentor* sp. The analysis based on host gender indicated a higher prevalence of tick infestation in female cattle (62.86 %) compared to males (37.14 %). Age-wise, adult cattle exhibited the highest infestation rate (60.14 %). Female ticks were found to be more abundant than male ticks. Among anatomical predilection sites, the dewlap was the most affected area, accounting for 32.37 % of the total infestations. Geographically, Karadiyanaru recorded the highest prevalence rate (41.23 %), followed by the cattle farm (35.43 %) and Vantharumoolai (23.34 %). Effective tick management strategies should include regular mass inspections, proper sanitary practices, and farmer education on infection control and prevention. Further studies are recommended to assess the economic impact of tick infestations on cattle farming in the Batticaloa District and their potential role in zoonotic disease transmission. This study highlights the necessity for comprehensive veterinary interventions to improve cattle health and mitigate the impact of tick infestations on livestock production.

Keywords: *Batticaloa District, Cattle, Tick infestation*

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Comparison of Absorption Capacity of Retinal and Retinal-Opsin Complex (Rhodopsin) using Density Functional Theory

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Abstract. Retinal is a light-sensitive molecule found in vertebrate eyes and light-harvesting systems of microbes. Its ability to absorb light and change shape makes it essential for biological processes. This study explores photoabsorption properties of retinal isomers and their protein complexes using Time Dependent Density Functional Theory with ωB97XD/631-G (d) level of theory. Absorption maxima and molar absorptivity of all-trans, 9-cis, 11-cis, and 13-cis were analyzed in the free state and in complex with opsin protein. In free-form, absorption maxima revealed distinct shifts associated with the extent of π-conjugation in the retinal backbone. 11-cis, involved in vertebrate vision, expressed the shortest λ_{max} at 385.63 nm, reflecting limited conjugation. Whereas, all-trans, which plays a central role in microbial photoreception, showed the highest λ_{max} at 424.13 nm corresponding to fully extended conjugation. Molar absorptivities followed a similar trend, with 11-cis showing the highest among unbound isomers, indicating its sensitivity to photons. Upon opsin binding, all isomers exhibited a significant red-shift in absorption, which is expressed as 540.93 nm (all-trans), 506.85 nm (9-cis), 508.81 nm (11-cis), and 508.51 nm (13-cis). All-trans rhodopsin showed the highest value, highlighting its adaptation for energy harvesting under extreme conditions. 11-cis binds with opsin to form native rhodopsin, showing a significant increase in molar absorptivity and red-shift in λ_{max}, which optimizes light sensitivity in dim-light conditions. 9-cis rhodopsin (isorhodopsin) showed lower absorptivity than native rhodopsin, ensuring its role as a functional backup in vision. These results illustrate how retinal isomers are evolutionarily optimized for respective roles and are in good agreement with experimental findings.

Keywords: *Molar absorptivity, opsin, retinal, rhodopsin, Time-Dependent Density Functional Theory.*

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Alternative Mechanism of Methamphetamine Addiction via Direct Activation of Mu Opioid Receptor by 4-Hydroxyamphetamine

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Abstract. Methamphetamine (METH) is a widely abused psychostimulant, traditionally linked to dopamine transporter-mediated mechanisms of addiction, yet the potential involvement of opioid receptors, particularly the Mu opioid receptor (MOR), remains underexplored. This study investigates the role of 4-hydroxyamphetamine (4-HAMP), a major metabolite of METH, in directly activating MOR through a structure-based computational approach. Using the MOR active-state crystal structure (PDB ID: 8EF5) refined via homology modeling, 4-HAMP was optimized by density functional theory (DFT) and docked with AutoDock Vina. A 250 ns molecular dynamics (MD) simulation in NAMD evaluated the stability of the complex, while conformational dynamics were analyzed with Principal Component Analysis (PCA) and Free Energy Landscape (FEL) mapping, and binding energies calculated using MM/GBSA and absolute binding free energy (ABFE) methods. The results revealed stable interactions of 4-HAMP with Asp147, Tyr148, and Ile296, preservation of the receptor's active-state conformation, and a single deep FEL minimum supporting complex stability. The docking scores were -6.7 kcal/mol for 4-HAMP, comparable to known MOR ligands such as codeine (-6.9 kcal/mol) and tramadol (-6.99 kcal/mol), while binding energy values confirmed favorable interaction, with MM/GBSA and ABFE of -14.70 kJ/mol and -10.12 kJ/mol, respectively. These values gain relevance in the context of addiction, where repeated dosing and overdosing elevate metabolite concentrations and enhance opioid effects. Collectively, these findings provide the first evidence that a METH metabolite may directly activate MOR, uncovering an overlooked opioid component in stimulant addiction and identifying MOR-mediated pathways as potential therapeutic targets for treating methamphetamine dependence.

Keywords: *4-Hydroxyamphetamine, Computational pharmacology, GPCR activation, Methamphetamine addiction, Mu opioid receptor*

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Development and Characterization of Biodegradable Polymer Film Made from Sweet Potato Starch for Food Packaging

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Abstract. The increasing demand for sustainable materials has intensified research on biodegradable polymers as alternatives to conventional plastics. In this study, starch-glycerol biodegradable films were developed and characterized using sweet potato starch, with the aim of optimizing their properties for food packaging applications. Films were prepared at different starch-to-glycerol ratios (1:1, 1:3, 3:1, 5:1, 1:5, 7:1, and 9:1) and evaluated for thickness, moisture content, water absorption, solubility, and transparency. Chemical interactions were analyzed using FTIR spectroscopy, biodegradability was assessed through weight loss over 7, 14, and 21 days, and calcium ion absorption was determined by EDTA titration. Notably, films with 1:3 and 1:5 starch-to-glycerol ratios failed to form continuous films due to excessive glycerol content, which hindered proper plasticization. In general, increasing starch concentration reduced moisture content and improved water resistance, while higher glycerol levels increased thickness. FTIR spectra confirmed hydrogen bonding between starch and glycerol. Biodegradability tests revealed gradual weight loss over time, with starch-rich films degrading faster, leading to complete degradation within 50 days. EDTA titration indicated greater calcium ion absorption in starch-rich formulations, highlighting potential applications for mineral-enriched packaging. Overall, optimizing starch–glycerol ratios enhanced the structural and functional performance of the films, supporting their potential as eco-friendly alternatives for food packaging.

Keywords: *absorption, biodegradable, food packaging, Starch-glycerol films*

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Synthesis and Characterization of an Azo Functionalized Cr(III) Ion Imprinted Polymeric Resin for the Selective and Competitive Adsorption of Cr(III) Ions

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Abstract. Chromium is an essential trace element at low levels but becomes highly toxic at elevated concentrations. In this study, Cr(III) was selected as the target ion for imprinting to develop a novel Cr(III) ion-imprinted polymeric resin (IIP). An azo dye ligand synthesized by diazotizing 4-aminophenol and coupling it with β-naphthol, providing -OH and -N=N- groups for strong metal coordination. This ligand formed a 2:1 ligand to metal complex with Cr(III), then polymerized with resorcinol, formaldehyde, and DMF. Removal of Cr(III) created specific cavities in the resin, enabling selective recognition and adsorption of Cr(III) ions. A non-imprinted control resin (ADPR) was also synthesized under identical conditions without Cr(III) complexation. The adsorption studies showed that Cr-ADIP exhibited a significantly higher adsorption capacity (49.36 mg/g) compared to ADPR (14.70 mg/g). At lower initial Cr(III) concentrations, Cr-ADIP demonstrated remarkably high removal efficiencies, reaching up to 98.72 % at 50 mg/L**,** while ADPR only removed 58.78 % at the same concentration**.** The adsorption of Cr(III) was highly pH-dependent, with optimal performance at pH 6. Isotherm studies revealed that the adsorption behavior of Cr-ADIP followed the Langmuir isotherm model (R^2=0.9972) more closely than the Freundlich isotherm model (R^2=0.7034). The selective adsorption experiments indicated superior selectivity of Cr-ADIP for Cr(III) ions over competing ions such as Fe(III) and Cu(II), with higher separation factors. The synthesized polymer showed good reusability, maintaining high adsorption efficiency over multiple cycles. This resin provides a robust approach for the selective removal of Cr(III), contributing to sustainable industrial practices and environmental preservation

Keywords: *adsorption, isotherm, polymeric resin, selectivity*

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Exact Solution of a Scalar Second-Order Ordinary Differential Equation Possessing Linearizing Properties

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Abstract. We study the exact solution for a scalar nonlinear second-order ordinary differential equation which arises in the investigation of the first integrals in dynamics. We obtain the Lie point symmetries admitted by the equation and use a two-dimensional Lie algebra of symmetries to reduce the order of the equation in a direct manner. We demonstrate how the differential invariants of the groups of symmetries can be used to obtain simplified equations. Exact solutions are then constructed by using the solution of the reduced equations and the differential invariants. The exact solution of the underlying equation was not discussed in the previous literature. Here we make use of the algebraic properties of the equation to construct an exact solution in a simpler manner.

Keywords: *Nonlinear second-order ordinary differential equation, Lie point symmetries, Differential invariants, Exact solution*

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Neutrosophic Simply b-Separation Axioms in Neutrosophic Topological Spaces

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Abstract. The concept of fuzzy sets, later generalized through intuitionistic fuzzy sets, has significantly advanced the mathematical modeling of uncertainty and imprecision. To address the limitations of classical and fuzzy frameworks in capturing real-world complexities, neutrosophic set theory was developed, introducing a tripartite structure characterized by independent truth, falsity, and indeterminacy membership functions. This framework provides greater flexibility and precision in handling indeterminate and inconsistent information. Neutrosophic topology, an extension of this theory, establishes a robust platform for redefining classical topological concepts. Among these, neutrosophic b-open sets and their variant, neutrosophic simply b-open sets, have recently emerged as essential constructs for generalized topological investigations. These sets expand the capacity to model nuanced boundary behaviors and transitional states within topological spaces. In this work, we focus on the development of neutrosophic simply b-separation axioms**,** a new class of axioms defined within the context of neutrosophic simply b-open sets. We begin by revisiting foundational notions such as neutrosophic interior, closure, and b-open sets, which form the basis of our study. Subsequently, we define and analyze three key separation axioms: neutrosophic simply b-T_0, simply b-T_1, and simply b-T_2**,** and explore their fundamental properties. Our investigation reveals that if a neutrosophic topological space satisfies simply b-T_0, simply b-T_1, or simply b-T_2 conditions, then it also satisfies the corresponding traditional neutrosophic T_0, T_1, or T_2 separation conditions. Moreover, we demonstrate the hierarchical relationships: every neutrosophic simply b-T_2 space is also a simply b-T_1 space, and every simply b-T_1 space is also a simply b-T_0 space. This research enriches neutrosophic topology, offering nuanced tools for modeling complex systems with inherent uncertainty and partial truth values. The proposed separation axioms deepen the structural understanding of neutrosophic spaces and highlight how generalizations in topology accommodate higher degrees of indeterminacy and ambiguity.

Keywords: : *Neutrosophic topological spaces, Neutrosophic simply b- open sets, Neutrosophic simply b$-T_0$ space, Neutrosophic simply b$-T_1$ space, Neutrosophic simply b $-T_2$ space*

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Properties of fuzzy β-open Sets in fuzzy Topological Spaces

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Abstract. Topology plays a vital role in various real-life applications including computer science, robotics, physics, and even economics. However, traditional topology often falls short when dealing with real-world scenarios characterized by uncertainty and imprecision. To address this, fuzzy sets were introduced, allowing partial membership in sets. Consequently, fuzzy topological spaces were developed to extend and refine classical topological concepts, making them more applicable to complex systems and imprecise data. In this paper, we investigate the structure and key properties of fuzzy β-open and fuzzy β-closed sets in fuzzy topological spaces. The main objective is to characterize these sets and explore their relationships with other types of fuzzy open sets, such as fuzzy α-open, and fuzzy semi-open sets, as well as their corresponding fuzzy closed sets, such as fuzzy α-closed and fuzzy semi-closed sets. Based on closure and interior operations, we define fuzzy β-open sets and show that all fuzzy α-open, and fuzzy semi-open sets are fuzzy β-open, the converses do not necessarily hold. Using set-theoretic and topological methods, we prove that the union of fuzzy β-open sets remains fuzzy β-open, although their intersection may not preserve this property. Similarly, fuzzy β-closed sets, defined as the complements of fuzzy β-open sets, are shown to be closed under intersection but not necessarily under union. Furthermore, we establish inclusion relationships between fuzzy β-closed sets and other fuzzy closed sets, such as fuzzy α-closed and fuzzy semi-closed sets. These findings enrich the theory of fuzzy topological spaces and provide a foundation for future work on fuzzy β-continuity, fuzzy β-compactness, and related topological concepts.

Keywords: *Fuzzy topological space, fuzzy β-open set, fuzzy α-open set, fuzzy semi-open set, fuzzy β-closed set, fuzzy α-closed set, fuzzy semi-closed set*

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Different Types of (m,n)-Open Sets in bi-Generalised Topological Spaces

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Abstract. In 2010, Boonpok introduced the concept of bi-generalized topological spaces, drawing inspiration from the theories of bi-topological spaces and generalized topological spaces. The triple (X, μ_1, μ_2) is called a bi-generalised topological space, where (X, μ_1) and (X, μ_2) are generalised topological spaces. This study aims to explain some novel properties of (m, n)-open sets, (m, n)-semi open sets, and (m, n)-pre open sets in bi-generalised topological spaces. These functions are defined as follows: In a bi-generalised topological space, a subset A is called (m, n)-open set if $A = \text{int}\mu_m(\text{int}\mu_n(A))$. If $A \subseteq \text{cl}\mu_n(\text{int}\mu_m(A))$, the set A is (m, n)-semi open. Similarly, if $A \subseteq \text{int}\mu_m(\text{cl}\mu_n(A))$, the set A is (m, n)-pre open. In this study, first, we prove that a set A is (m, n)-open if and only if A is both μ_m-open in (X, μ_m) and μ_n-open in (X, μ_n). Second, we show that if a set A is (m, n)-open, then $\text{int}\mu_m(\text{int}\mu_n(A)) = \text{int}\mu_n(\text{int}\mu_m(A))$. However, the converse of this result is not true. Third, we provide an example to illustrate that $\text{int}\mu_m(\text{int}\mu_n(A)) \neq \text{int}\mu_n(\text{int}\mu_m(A))$ in general. Fourth, we prove that the (m, n)-open sets and (n, m)-open sets are the same. Fifth, we prove that a set A is semi-open if $\text{cl}\mu_n(A) = \text{cl}\mu_n(\text{int}\mu_m(A))$. Sixth, we prove that if a set is (m, n)-pre open and μ_n-closed, then that set is μ_m-open. Finally, we show that if the intersection or union of two sets is (m, n)-semi open or (m, n)-pre open, then those sets need not be (m, n)-semi open or (m, n)-pre open. We have concluded by elucidating novel characteristics of three categories of open sets in bi-generalized topological spaces. Our future research will concentrate on (m, n)-semi regular open sets.

Keywords: *bi-generalised topological spaces, (m, n)-open sets, (m, n)-semi open sets, (m, n)-pre open sets*

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Study on a New Type of Continuity and Compactness in Topological Spaces

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Abstract. Topology can be formally defined as the study of the qualitative properties of certain objects. Furthermore, general topology aids in exploring various beneficial properties of spaces and mappings, including continuity, connectedness, and compactness. Recently, within the field of topology, new forms of continuity and compactness have been introduced, referred to as F-continuous and F-compact, respectively. This paper aims to elucidate several new findings associated with these novel concepts. First, we demonstrate that the composition of two F-continuous maps remains F-continuous. Subsequently, we present the following: If a function k is F-continuous from the topological space (X,τ) to another topological space (Y,σ), then for every x in X and for every neighborhood V of $k(x)$, there exists a neighborhood U of x such that $k(U)$ is contained within V. Next, we establish that if the function k is bijective and an F-homeomorphism, then the mapping k is closed. Moreover, we address some results on F-compactness. By demonstrating that the union of two F-compact sets is F-compact, we extend this to the general case through induction. Finally, we prove that a topological space X is F-compact if and only if any collection C of closed subsets of X possesses the finite intersection property. In conclusion, we intend to broaden our research in the future to encompass connectedness and separation axioms.

Keywords: *F- continuous, F-homemorphism, F-compact, topological spaces*

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Integrability of a Nonlinear Third-Order Ordinary Differential Equation via Differential Invariants

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Abstract. We investigate integrability properties of a nonlinear scalar third-order ordinary differential equation from Lie point symmetry viewpoint. The dynamical equation we consider arises in the study of integrals of motion of the equation. We show that the equation admits a three-dimensional Lie algebra of point symmetries which are translation and scaling. Differential invariants of the symmetry transformations are used to reduce the order of the equation in a straightforward manner. We then construct exact solution for the equation from the symmetry reduced equations. The direct symmetry based approach we pursued in this work to find the exact solution does not require the integrals of motion and we demonstrate that it is systematic and easier to apply this method and obtain solution for the underlying equation.

Keywords: *Differential invariants, Exact solution, Integrals of motion, Lie algebra, Scalar nonlinear third-order ordinary differential equation, Lie algebra*

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Nonlinear Analyticity and Cauchy Riemann Type Structures in Multicomplex Spaces.

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Abstract. This paper investigates the analytic function theory within a three-dimensional multicomplex number system. Building on the established framework for linear Cauchy-Riemann (CR)-type equations, we extend the analysis to encompass both linear and nonlinear structures. We first establish a constant modulus theorem for analytic-type functions in this space and introduce a formulation for Wirtinger-type derivatives, providing a direct test for analyticity. The central contribution of this work is the development of nonlinear CR-type equations, motivated by their role as Bäcklund transformations in PDE theory. We demonstrate that functions satisfying these nonlinear conditions are solutions to corresponding nonlinear Laplace equations, thereby generalizing a fundamental property of classical complex analysis. This research provides a coherent framework for analyzing nonlinear phenomena in higher-dimensional function theory and opens avenues for applications in mathematical physics.

Keywords: *Multicomplex Analysis, Cauchy-Riemann Equations, Wirtinger Derivatives, Harmonic Functions, Higher-Dimensional Function Theory*

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Optimizing Exam Scheduling Time Using Assembly Line Balancing Technique

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Abstract. This study investigates the innovative use of the Assembly Line Balancing Problem (ALBP) technique, which has historically been employed in industrial production, in the examinations department's operations. The goal is to model exam related tasks as an assembly line process in order to reduce the overall amount of preparation time needed to prepare national level examinations, such as A/L exams. Timetabling, paper setting, typing, proof reading, translation, moderation, printing, packing, and distribution are among some of the sequential, interdependent operations that make up the exam preparation process. Every task has a time limit to meet the deadline and satisfied certain prerequisites. This study intends to minimize the idle time, maximize overall operational efficiency, while balance task distribution among available staff by implementing ALBP principles. Standard balancing procedures are applied, dependencies are identified, and the process is modeled using an organized methodology. A Mixed Integer Linear Programming model is developed for general context of ALBP with the number of task and the number of stations under given precedence relationships with the objective of minimizing the cycle time. Later, this model applied for minimizing exam preparatory time with seven tasks and three working teams which contains 52 constraints and 21 binary variables. The non-zero binary decision variables in the objective function are identified by solving the developed Mixed Integer Linear Programming model using IBM ILOG Optimization Studio. As a result, the exam preparation time is computed within nine seconds while maintaining resource optimization with fulfilling precedence relations between tasks. According to this study, academic administration can fulfill deadlines and expedite procedures while maintaining quality by implementing ALBP. This study provides a reproducible framework for enhancing the effectiveness of education management procedures by showcasing the potential of industrial optimization techniques in non-industrial contexts. The strategy promotes more investigation into the interdisciplinary uses of operations research in government departments.

Keywords: *Assembly Line Balancing Problem, IBM ILOG Optimization Studio, Mixed Integer Linear Program*

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α(gg)*- Continuous Function in Topological Spaces

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Abstract. We investigate the α(gg)*-closed sets, which serve as an alpha-generalization of the generalized star-closed sets. This novel concept enriches the framework of generalized closed sets and offers a deeper understanding of closure properties within topology. We study the α(gg)*-closed sets and explore their relationships with the existing types of closed sets such as standard closed sets, α-closed sets, regular closed sets, π-closed sets, g*-closed sets, and sets defined under various star operations, including (gs)*-closed and (gsp)*-closed sets in the literature. These results highlight the generalization strength and distinctive behavior of α(gg)*-closed sets. Then, we define and examine α(gg)*-continuous functions, characterized by the preimage of every closed set in the codomain being α(gg)*-closed in the domain. We analyze the behavior of these functions and prove that standard continuity, α-continuity, g*-continuity, and other generalized forms-such as gb-continuity, gspcontinuity, gpr-continuity, gspr-continuity, and gαr-continuity implies the α(gg)*-continuity. However, the converse is not necessarily hold, indicating that α(gg)*-continuity encompasses a broader class of functions than previously established forms. The findings presented in this study provide a unified and extended perspective on continuity in topological spaces. The introduction of α(gg)*-continuous functions opens new avenues for theoretical exploration and potential applications in generalized topological structures.

Keywords: *α(gg)*-closed sets, generalized closed sets, continuity, α(gg)*-continuity, closure operators, generalized topological spaces*

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Three-Dimensional Generalization of Cauchy–Riemann Type Equation.

Y.M.N.S Gunasekara* and T.P.J Navinthan

Abstract. A symbolic extension of complex numbers into three dimensions is developed by introducing additional imaginary units and formulating a corresponding analytic framework. This construction is motivated by the central role of the Cauchy–Riemann equations in complex analysis, where differentiability, analyticity, and harmonicity are closely linked. Extending these principles to higher dimensions provides a system in which the real and imaginary components remain harmonic while retaining an algebraic structure similar to the complex plane. Within this framework, generalized Cauchy–Riemann-type equations (CRTE) are defined for functions of three real variables. These equations guarantee that each component satisfies the three-dimensional Laplace equation, and they enable the definition of analytic-type functions. Criteria for differentiability are established, a derivative formula is derived, and a higher-dimensional analogue of the constant function theorem is proved, showing that several key properties of complex analysis naturally extend into the three-dimensional setting. The analytic structure of this system is illustrated through explicit examples. Polynomial and exponential-type functions are analysed, and methods for constructing harmonic conjugates are demonstrated. These examples confirm that the extended CRTE determine consistent relationships among function components and preserve harmonic conditions. The framework thus provides both an algebraic and analytic perspective on functions in higher dimensions, offering a foundation for future developments in multicomplex analysis. Beyond its theoretical significance, the approach has potential applications in multidimensional harmonic theory and mathematical physics, where generalized function systems play an important role.

Keywords: *Multicomplex numbers, Cauchy–Riemann type equations, harmonic conjugate, analytic function*

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An Eco-Friendly Kesterite (Cu_2SnZnS_4) Absorber for Photovoltaic Applications

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Abstract. Among the readily available options for producing effective CIGS photovoltaic systems, kesterite (Cu_2ZnSnS_4) has drawn interest and attention all around the world. Kesterite is a P-type material with fascinating optical characteristics, including a visible absorption coefficient of more than 104 cm^{-1} and a band gap ranging from 1 eV to 1.5 eV. This highly stable chalcogenide family candidate is inexpensive, non-toxic, and abundant in Earth. In recent years, the majority of researchers have been competing to produce photovoltaic systems based on kesterite. Additionally, according to Shockley-Queisser theory, kesterite has an exceptional theoretical power conversion efficiency of up to 31 %. Up till now, recent material advances for kesterite have attained an efficiency of 12 %. In this work, kesterite powder was prepared using a solution-based approach. The ball milling technique was used to produce a finely ground kesterite powder. Then, using the doctor blade procedure, the prepared kesterite paste with chloroform and diethylene glycol (stabilizer) was deposited on the ultrasonically cleaned FTO glasses and dried at 80°C for 30 minutes. In this experiment, the doctor blading method was used for depositing kesterite films as it is cost-effective and not as complex as other techniques. In order to verify the properties of the synthesized material, the UV-Vis Spectroscopy and X-ray diffraction characterization techniques were used. According to the X-ray diffraction investigations, the thin film's diffraction pattern displays the distinctive kesterite peaks, which are in good agreement with the JCPDS reference and other published values. Based on the UV-Vis spectra, it can be verified that the synthesized kesterite has an optical band gap of around 1.72eV and significant absorption in the visible region. In conclusion, the synthesized kesterite material can be used as a light-harvesting material and as an absorber for photovoltaic systems.

Keywords: *Absorber, Chalcogenide, UV-Vis Spectroscopy, Visible range, X-ray diffraction*

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Development of an Eco-Friendly Evaporative Cooling Tile using Natural Clay

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Abstract. Regions across Sri Lanka and other tropical climates experience high ambient temperatures, increasing electricity demand, and impacting indoor comfort and productivity. Conventional cooling systems are often energy-intensive, costly, and unsustainable, highlighting the need for passive alternatives that are feasible for resource-limited communities. This study examines a low-cost, natural solution: a clay tile system that cools indoor air through evaporative cooling. Three tile prototypes (0.1143 m × 0.1143 m) were fabricated from refined natural clay shaped in Expanded Polystyrene (EPS) molds and fired in a modified wood stove kiln using biomass as fuel. Tile 1 had minimal airflow channels, Tile 2 incorporated a wave-like surface to enhance water–air interaction, and Tile 3 balanced airflow openings with surface area. Experimental testing was conducted in an EPS-insulated chamber (0.2159 × 0.508 × 0.381 m^3) with a USB-powered fan drawing air through a tile fitted into a side window and a water pump circulating water over its surface to simulate evaporative conditions. Temperature and relative humidity were recorded at five-minute intervals over 70 minutes, and a reference test without tiles assessed baseline cooling. Cooling efficiency analysis indicated Tile 2 as the most effective (93.67 %), followed by Tile 3 (83.69 %) and Tile 1 (58.70 %), confirming that airflow design influences evaporative performance. The results demonstrate that clay tiles fabricated from low-cost, locally sourced natural materials provide a sustainable, passive cooling solution capable of reducing energy consumption, improving indoor comfort, and delivering economic and environmental benefits, presenting a practical strategy for sustainable building design and climate-resilient architecture.

Keywords: *Clay tile, Eco-friendly cooling, Evaporative cooling principle, Passive cooling, Tropical climate*

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Synthesis, Preliminary Characterization and Antimicrobial Properties of Cu(II) and Fe(III) Salicylaldehyde – Phenylhydrazone Complexes in the presence and absence of 1,10-Phenanthroline as a co-Ligand

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Abstract. The study investigates the physicochemical properties and antibacterial activity of Cu(II) and Fe(III) complexes derived from a Schiff base ligand, synthesized by the condensation of salicylaldehyde and phenylhydrazine, in the presence and absence of 1,10-phenanthroline as a co-ligand. The ligand and its corresponding metal complexes were synthesized under controlled reflux conditions. The preliminary characterization was done using FT-IR spectroscopy, UV–Visible spectroscopy, melting point determination, and conductivity measurements. The FT-IR spectra confirmed coordination through azomethine nitrogen and phenolic oxygen, while UV–Vis spectra revealed bathochromic shifts and new bands corresponding to metal-to-ligand charge transfer and d–d transitions. The melting points and conductivity data supported the formation of stable ionic complexes with higher thermal stability than the free ligand. Antibacterial studies were conducted using the agar disc diffusion method at varying concentrations (1000, 750, 500, and 250 ppm). The Schiff base ligand exhibited moderate antibacterial activity, whereas the metal complexes showed variable activity. The findings suggest that Schiff base-metal complexes incorporating 1,10-phenanthroline possess promising antibacterial potential likely due to improved stability, increased membrane permeability and possible DNA intercalation. These results support further investigation into metal-Schiff base-co-ligand systems as candidates for novel antimicrobial agents to combat drug-resistant infections.

Keywords: *Agar disc diffusion, Antimicrobial activity, Cu(II) Schiff base complex, Fe(III) Schiff base complex , 1,10-phenanthroline*

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Isomerization Study of Lycopene using Density Functional Theory

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Abstract. Lycopene, a carotenoid predominantly found in the all-trans configuration in fruits and vegetables, features a structurally unsaturated hydrocarbon chain containing eleven conjugated and two non-conjugated double bonds. Thermal treatment facilitates the isomerization of all-trans lycopene into various cis-configurations, the 5-cis, 9-cis, and 13-cis forms. This study utilizes Density Functional Theory calculations at the B3LYP/6-31G (d,p) level to elucidate the mechanism of isomerization and to assess the relative stabilities in both ground and excited states. The computed thermodynamic stability order, relative to the all-trans configuration, was found to be: 5-cis (-0.03 kcal·mol^{-1}) < all-trans (0.00 kcal.mol^{-1}) < 9-cis (0.90 kcal.mol^{-1}) < 13-cis (1.03 kcal.mol^{-1}). This order was consistently observed across vacuum, aqueous, and toluene environments at the ground state. Potential Energy Surface (PES) analyses of trans-to-cis isomerization in the ground state revealed that the 5-cis configuration possesses the highest rotational energy barrier, with activation energies ranked as 5-cis (73.95 kcal.mol^{-1}) > 9-cis (50.68 kcal.mol^{-1}) > 13-cis (41.27 kcal.mol^{-1}) in all evaluated phases. Consistent with previous experimental findings, 13-cis lycopene is identified as the primary cis isomer, with subsequent isomerization pathways governing the relative formation of 9-cis and 5-cis lycopene. Further PES studies examining trans-to-cis isomerization in the excited state indicated that the 9-cis (6.9 kcal.mol^{-1}) exhibits superior photochemical reactivity compared to the other two lycopene isomers, due to its lower energy barrier facilitated by conical intersections. The results of this study prove that the 5-cis lycopene isomer is thermodynamically the most stable, primarily due to its higher activation barrier against isomerization.

Keywords: *Density Functional Theory, Lycopene, Isomerization, Photoisomerization, Potential Energy Surface*

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Development of a Low-Frequency Piezoelectric Sound Energy Harvester using a Single-Coiled Acoustic Metamaterial Cavity

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Abstract. The rapid urbanization promotes concerns on noise pollution and the increasing energy demand. Instead of converting sound energy into waste energy using sound absorbers, the sound energy should be converted into utilizable energy. To address the low energy density, the sound pressure should be amplified. The objective of this study was to propose a single coiled acoustic metamaterial cavity as a modified Helmholtz resonator to enhance the sound pressure for low-frequency sound waves before transducing using piezoelectric plates. The harvester's design was validated using COMSOL Multiphysics simulation for different geometric configurations such as multiple necks, Zigzag neck, and Neck-to-Cavity Cross-Sectional Ratio. Experimental validation was performed in the frequency range of 100 Hz to 2000 Hz. A Lead Zirconate Titanate (PZT) plate was integrated at the harvester's maximum pressure point. The fundamental resonance frequency of the harvester was determined to be 300 Hz. Voltage measurements across different methods, using a cathode ray oscilloscope, a programmed millivoltmeter, a multimeter equipped with voltage doubler and rectifier circuits, and storing measurements using a capacitor, were consistent with the fundamental frequency. The discrepancies between theoretical and experimental resonance frequencies led to modifications in the Helmholtz resonance equation, where the experimental value was eleven times the theoretical value. The modified equations were verified using the LC circuit theories at the resonance, and the calculated value through the modified equation was aligned with the experimental value. In comparison to configurations without the harvester, the harvester produced a six-fold increase in voltage, resulting in a 16 dB gain and a 1.44 µW peak power output.

Keywords: *Acoustic metamaterials, COMSOL Multiphysics, Helmholtz resonator, noise pollution, and sound energy harvesting*

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Development and Evaluation of Reduced Graphene Oxide-Reinforced Rubber Composites for Heavy-Duty Tire Applications

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Abstract. This study presents the development and comprehensive evaluation of reduced graphene oxide (rGO)-reinforced rubber composites designed for use in heavy-duty vehicle tires. Graphene-based fillers, particularly rGO, are recognized for their outstanding mechanical strength, superior interfacial interactions, and their capacity to induce strain crystallization in rubber matrices, making them highly suitable for advanced tire technologies. In this work, rGO was synthesized via the chemical reduction of graphene oxide, which itself was prepared through the oxidation of graphite. Two distinct rubber matrix systems were investigated; i. A blend of natural rubber (NR), styrene-butadiene rubber (SBR), and butadiene rubber (BR), ii. Pure natural rubber. Mechanical, thermal, and electrical properties, as well as sustainability-related characteristics, were systematically evaluated as a function of rGO loading. The incorporation of rGO into the NR/SBR/BR blend resulted in significant enhancements in mechanical performance. Notably, at an rGO loading of 2.5 parts per hundred rubbers (phr), the tensile strength increased by 25.8%, and the modulus by 59.8%, relative to the unfilled composite. The composite retained 91.5% of its original tensile strength after thermal aging, and hardness improved by 5.2 units, indicating increased stiffness and reinforcement. In contrast, the NR-only system exhibited a decline in tensile strength with increasing rGO content. The swelling index of the NR/SBR/BR blend decreased by 21.2% with higher rGO content, suggesting improved crosslink density, whereas the NR-only system showed negligible change. Electrical conductivity in the NR/SBR/BR composites increased by 60.4%, 73.7%, and 94.9% at rGO loadings of 2.5, 5, and 10 phr, respectively. Thermal conductivity was enhanced by 8.2% and 14.9% at 0.5 and 2.5 phr rGO, respectively. Such improvements were not observed in the NR-only composites. The findings demonstrate that the addition of 1.2 phr rGO imparts significant multifunctional reinforcement, particularly in NR/SBR/BR blends, resulting in durable, high-performance, and sustainable rubber composites suitable for demanding heavy-duty applications.

Keywords: *electrical conductivity; reduced graphene oxide; rubber composite; tensile strength; thermal conductivity*

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Toward Sustainable Rubber Composites: Preliminary Insights into Pinus-Derived Biochar as a Reinforcing Filler

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Abstract. Carbon black (CB), the predominant reinforcing filler in the rubber industry, is derived from the incomplete combustion of heavy aromatic oils and is classified as a Group 2B carcinogen, raising health and environmental concerns. This study investigates the feasibility of biochar (BC) derived from Pinus wood as a sustainable alternative filler for natural rubber composites. We hypothesize that BC, due to its graphitic-like structure, can mimic CB's reinforcing mechanism by providing an active interface with the rubber matrix. Pinus wood obtained from local sawmills in Moratuwa, Sri Lanka, was processed into crushed biochar (CBC) and sawdust biochar (SBC). CBC was prepared by pyrolyzing 2×2 cm wood chunks at 700 °C, followed by crushing and sieving into particle sizes of 50–100, 250–500, and 1000–2000 µm. SBC was produced by sieving sawdust into the same size ranges prior to pyrolysis. Hybrid systems combining CB and BC at 0:45, 22.5:22.5, and 45:0 phr were also evaluated. CBC (250–500 µm, 45 phr) showed the highest torque difference ($\Delta M \approx 13$ Nm) with decreased T90 and increased TS2, indicating improved processability. Mechanical testing revealed that CBC enhanced tensile strength by 18 % and elongation at break by 100 % compared to CB. SBC (50–100 µm) further improved stress, strain, and elongation, while the 22.5:22.5 phr blend achieved a tensile strength of 20 N/mm², a 50 % increase, reflecting better filler dispersion. The highest cure rate index (CRI ≈ 37.8 min^{-1}) was observed for CBC (250–500 µm, 45 phr), confirming BC's active role in vulcanization. These findings demonstrate that Pinus-derived BC not only reinforces rubber effectively but also interacts synergistically with CB, offering a greener alternative to petroleum-based fillers and contributing to sustainable rubber production.

Keywords: *biochar; carbon black; carbon black replacement; natural rubber composite; sustainable fillers*

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