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*Organizes*

# M-SPEC 2K26

**Proceeding of National Conference**

*on*

**An Impact of AI on Science Education  
and Society**

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## **FOREWORD**

**“An Impact of AI on Science Education and Society (M-SPEC 2K26)”** spearheaded by VMI, serves as an important meeting platform for researchers working in artificial intelligence. It brings together experts to present state-of-the-art research and discuss recent advances in the field.

This premier national conference unites scientists and engineers engaged in developments across materials science, nanotechnology, semiconductor devices, environmental and analytical chemistry, IoT, smart systems, and biomedical applications. Its central aim is to explore global trends in AI while encouraging cross-disciplinary collaboration to drive innovation.

The conference provides delegates opportunities to exchange ideas, build partnerships, and identify collaborative research directions. Selected high-quality papers will be published in peer-reviewed journals. The technical programme includes keynote addresses, plenary sessions, invited talks, and presentations addressing emerging challenges, novel concepts, and breakthroughs in AI.

The event also serves as a regional platform for academicians and students nationwide to present research achievements, exchange ideas, and build lasting collaborations.

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Chairman-VMI

It is a privilege to present the proceedings of **M-SPEC 2K26**. Artificial Intelligence is rapidly becoming part of everyday life, transforming how we work, travel, communicate, and solve complex problems. Yet we are only beginning to understand its full impact on business, society, and culture.

**M-SPEC 2K26** highlights innovative practices and new ideas across science, technology, business, and interdisciplinary fields. It focuses on addressing global societal challenges and promoting cross-disciplinary research through AI-driven solutions. Rapid advances in artificial intelligence continue to influence areas such as materials science, semiconductor technology, autonomous systems, medical diagnostics, and advanced manufacturing. These developments create both opportunities and new questions, reinforcing the need to share ideas and deepen awareness in this evolving field.

As AI transitions from theory to real-world applications, **M-SPEC 2K26** presents a dynamic landscape of opportunities. The enthusiastic response to the call for papers from across the country reflects the growing interest in this domain. We trust these proceedings will serve as a valuable resource for researchers, industry professionals, policymakers, and readers interested in contemporary AI research.

We extend our sincere appreciation to the reviewers for maintaining the high quality of the manuscripts included in these proceedings. We also thank the organizing team for their dedication in bringing this event to fruition.

-Chairman



26.2.2026

**Thiru R. MUTHUVEL**  
Trustee -VMI

It is both an honour and a pleasure to welcome you to **M-SPEC 2026**. We are delighted to host this distinguished national gathering at Vanetra Muthayammal Institutions.

VMI is a research-driven institution dedicated to nurturing curiosity, innovation, and translational research. Our faculty continue to advance knowledge across scientific disciplines and artificial intelligence. Guided by a shared vision of collaboration and academic exchange, we are proud to host M-SPEC 2K26.

The theme, “**An Impact of AI on Science Education and Society,**” reflects evolving challenges and opportunities in next-generation technologies. The conference sessions extend beyond academic discussion to bridge the gap between academia and industry through panel discussions, keynote lectures, invited talks, and industry exhibits. This collaborative platform encourages meaningful exchange and collective progress.

We trust the conference programme will be intellectually stimulating and inspire future research. We encourage scholars and practitioners to continue contributing to AI research and promoting knowledge exchange.

We hope your participation will be both professionally rewarding and personally memorable. May you build new collaborations and reconnect with colleagues during your time here.

I extend sincere appreciation to our sponsors and organizing committee whose dedication has been central to the success of this event.

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-Trustee



26.2.2026

**Tmt. C. MANJU**  
Secretary -VMI

Vanetra Muthayammal Institutions is recognized for its commitment to excellence in science and technology research. **M-SPEC 2K26** is a double-blind peer-reviewed national conference aimed at advancing real-world AI applications, including semiconductor technologies and intelligent diagnostic systems.

This conference serves as a platform for in-depth discussions on Artificial Intelligence in materials science, nanotechnology, semiconductor devices, environmental and analytical chemistry, IoT, smart systems, security, privacy, and trustworthy AI. It seeks to strengthen theoretical foundations while promoting innovative and interdisciplinary research contributions.

We are delighted to publish the proceedings of M-SPEC 2K26. The diverse topics covered in this volume will benefit academicians, researchers, and readers interested in science and technology. These proceedings provide accessible, content-rich knowledge for those exploring advancements in AI.

I congratulate all contributing authors and appreciate the editorial board for their diligent efforts in publishing this volume.

Wishing this event great success!

-Secretary



26.2.2026

**Dr. S.P. VIJEIKUMAR**

Principal

It gives me great pleasure to extend a warm welcome to the 2026 National Conference on “**An Impact of AI on Science Education and Society (M-SPEC 2K26).**” This flagship event brings together leading researchers, academicians, and industry professionals to share innovative ideas, practical experiences, and cutting-edge research. The conference is organized by the Academy of Sciences, Vanetra Muthayammal College of arts and Science (Autonomous), VMCAS, Rasipuram.

VMCAS is committed to excellence in teaching, research, and the practical application of knowledge to support socio-economic development and the welfare of society. M-SPEC 2K26 stands as a result of the tireless efforts of the Organizing Committee, who carefully managed every aspect of the event — from the call for papers and peer review process to guest invitations and participant arrangements. I congratulate the team for delivering such a well-organized and successful conference.

This conference has been made possible through the generous support of our sponsors. I sincerely thank all sponsors, supporters, and VMI for entrusting the Academy of Sciences with the responsibility of hosting this event.

We hope the presented papers and invited talks provide valuable insight into current trends and emerging research directions in technology and science.



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26.2.2026

**Dr. P. GOWRISANKAR**  
CoE&Dean – Academy of Sciences

It is with great pleasure that I present this introduction to the Book of Abstracts for this National Conference hosted by the Academy of Sciences. This conference brings together professionals, researchers, engineers, and experts in Artificial Intelligence and related scientific disciplines to exchange knowledge, research findings, and practical developments relevant to the 21st century. The Book of Abstracts provides a concise overview of the valuable contributions presented at the conference.

The Faculty of Sciences at VMI offers programmes across six departments: Chemistry, Physics, Electronics and Communication, Mathematics, Statistics, and Internet of Things. Academic offerings include undergraduate, postgraduate, M.Phil., and doctoral programmes. Alongside teaching, the faculty is actively engaged in meaningful research, innovation, and industry-relevant initiatives. We continually strive to strengthen innovation and entrepreneurial growth across all academic activities.

I thank the Organizing Committee for their dedication in conducting this important conference. I also extend my appreciation to faculty members, sponsors, participants, and contributing authors. This Book of Abstracts serves as a prelude to the conference proceedings. I wish everyone productive discussions and enriching deliberations.



*Dr. P. Gowrisankar*  
26.2.26

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OP - 01

**A Theoretical Framework for Fuzzy Metric Graphs****\*Maiyurapriya R and Amsaveni D****Department of Mathematics, Sri Sarada College for Women (Autonomous), Salem-16.****Abstract**

Fuzzy graph theory provides an effective mathematical framework for representing systems in which relationships are not precisely defined but involve uncertainty and it has found applications in artificial intelligence, data mining, image processing, communication networks and decision-making processes. A classical graph captures only the connectivity between vertices, whereas a metric graph assigns positive real lengths to edges. However, metric graphs assume that edge lengths are precise, which may not reflect real-world situations where travel time, cost or measurements are inherently uncertain. To address this limitation, in this paper we introduce the concept of fuzzy metric graphs by integrating fuzzy graphs with metric graphs, illustrate the concept with an example, and establish several fundamental results and theorems related to them.

**Keywords:** Fuzzy Graph, Metric Graph, Fuzzy Metric Graph.**E-Mail:** [rmaiurapriya2019@gmail.com](mailto:rmaiurapriya2019@gmail.com)

OP-02

**Green Synthesis of 2D MXene Using LiCl****\*Shyamala A and Kathiravan M**

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**Abstract**

Two-dimensional (2D) MXene have emerged as an important class of advanced nanomaterials due to their exceptional electrical conductivity, hydrophilicity, and tunable surface chemistry, making them highly suitable for applications in energy storage, catalysis, sensing, and environmental remediation. Conventional synthesis of MXenes typically involves the use of hazardous hydrofluoric acid (HF), which poses significant environmental and safety concerns. In this study, a green and safer synthesis approach for the preparation of 2D MXene using lithium chloride (LiCl) is proposed as an eco-friendly alternative. The LiCl-assisted etching method enables selective removal of the 'A' layer from MAX phase precursors while minimizing toxic by-products and reducing environmental impact. The process involves controlled chemical treatment, washing, and delamination steps that promote the formation of few-layered MXene nanosheets with improved structural stability. Characterization techniques such as X-ray diffraction (XRD), scanning electron microscopy (SEM), and Fourier transform infrared spectroscopy (FTIR) confirm successful exfoliation and formation of layered structures. The synthesized MXene exhibits enhanced surface area and active functional groups, contributing to improve electrochemical and adsorption performance. The green synthesis route not only enhances material efficiency but also aligns with sustainable chemistry principles by reducing chemical hazards and energy consumption. This work demonstrates that LiCl-mediated synthesis provides a cost-effective, scalable, and environmentally benign pathway for producing high-quality 2D MXenes. The developed approach opens new possibilities for sustainable nanomaterial production and supports future research toward eco-friendly applications in advanced functional materials.

**Keywords:** MXene, Green synthesis

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OP - 03

**Photocatalytic degradation of RhodamineB dye: MWCNT, ZrO<sub>2</sub>/MWCNT and Y-ZrO<sub>2</sub>/MWCNT hybrid composites as potential photocatalysts**

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**Abstract**

Developing a low cost and eco-friendly material is significant for removing persistent organic dyes from polluted water. These dyes are stable and difficult to break down, so an effective photocatalyst with a suitable band gap is needed. In this work, MWCNT, ZrO<sub>2</sub>/MWCNT and Y-ZrO<sub>2</sub>/MWCNT hybrid composites were prepared by a ultrasonic assisted hydrothermal method to investigate their photocatalytic efficiency toward organic dye degradation. The structural, optical and morphological properties of the prepared samples were examined using XRD, FTIR, UV-Visible spectroscopy, SEM and TEM. These analyses confirmed the formation of the composites and reveals information about the crystallinity, morphology features and light absorption nature. The photocatalytic activity was evaluated by degrading Rhodamine B dye under UV light irradiation and different experimental conditions were tested to understand the performance of the materials. Among all the samples, the Y-ZrO<sub>2</sub>/MWCNT hybrid composite showed the highest degradation efficiency. This improved activity can be attributed to the synergistic effect of yttrium doping and MWCNT, which enhances charge separation and reduces recombination of electron and hole pairs. Better crystallinity, an appropriate band gap and fewer structural defects also played a role in improving the photocatalytic performance. The maximum degradation efficiency obtained was 87.1% for ZrO<sub>2</sub>/MWCNT and 95.6% for Y-ZrO<sub>2</sub>/MWCNT hybrid composite. These results clearly show that yttrium doping improves the photocatalytic performance of the composite material.

**Keywords:** Hydrothermal synthesis, Photocatalysis, Y-ZrO<sub>2</sub>/MWCNT and RhB.

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OP – 04

**Green Nanotechnology Approach for the Preparation of Nickel Oxide Nanoparticles and their Wastewater Treatment Efficiency****\*Selvam K<sup>1</sup>, Kasthuri A<sup>1</sup> and Ramesh P<sup>2</sup>**

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**Abstract**

Nickel oxide (NiO) nanoparticles have gained significant attention as promising transition metal oxide nanomaterials due to their unique physicochemical properties, including high surface to volume ratio, chemical stability, and excellent catalytic performance, making them suitable for environmental remediation applications. In the present study, NiO nanoparticles were synthesized through an eco-friendly and cost-effective green synthesis approach aimed at minimizing the use of hazardous chemicals and reducing environmental impact. The preparation involved forming a precursor solution followed by controlled thermal treatment and calcination to obtain fine, crystalline NiO nanopowder. The synthesized nanoparticles were applied as photocatalysts for the degradation of hazardous organic dyes commonly present in industrial wastewater, such as Methylene Blue, Eosin Yellow and Rhodamine B. The efficiency of the photocatalytic process was evaluated by optimizing operational parameters including catalyst loading, dye concentration, and irradiation time. Characterization studies using UV, XRD, FTIR and SEM confirmed the successful formation of nanoscale NiO particles with uniform morphology, high crystallinity, and enhanced surface reactivity, which contributed to improved light absorption and effective charge transfer during catalytic activity. The results demonstrated significant dye degradation efficiency within a short duration, highlighting the strong interaction between NiO nanoparticles and pollutant molecules. Overall, this work establishes that green-synthesized NiO nanoparticles are efficient, sustainable, and economically viable materials for wastewater treatment, offering great potential for large-scale environmental cleanup and supporting the development of green nanotechnology solutions for pollution control and water purification.

**Keywords:** Kalanchoe pinnata, NiO NP, Green synthesis, Photodegradation

**OP- 05****Sustainability in the AI era: Beyond silicon****\*Shyamala A and Srinivasa K**

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**Abstract**

The rapid expansion of Artificial Intelligence (AI) has transformed industries, economies, and daily life, but its environmental implications extend far beyond the silicon chips that power modern computation. This paper explores the concept of sustainability in the AI era by examining the ecological footprint of data centres, energy consumption in model training, electronic waste, and the socio-environmental impacts of resource extraction for hardware production. Moving beyond a technology-centric view, the study emphasizes the integration of green computing practices, renewable energy adoption, circular economy models, and responsible AI design to ensure long-term environmental balance. It also highlights the importance of interdisciplinary collaboration between scientists, policymakers, educators, and industry leaders to create energy-efficient algorithms, low-carbon infrastructure, and ethical supply chains. In addition, the role of chemistry and material science in developing biodegradable components, alternative cooling systems, and sustainable storage devices is discussed as a pathway toward reducing the environmental burden of AI technologies. The paper further examines how AI itself can become a tool for sustainability through climate modelling, smart agriculture, waste management, and resource optimization. By aligning technological advancement with ecological responsibility, the research proposes a holistic framework that redefines progress in the digital age. The study concludes that sustainable AI is not merely a technical challenge but a collective responsibility that demands innovation, awareness, and policy support to ensure a resilient and environmentally conscious future.

**Keywords:** AI, smart agriculture**Email:** [shyamalavelu14@gmail.com](mailto:shyamalavelu14@gmail.com)

OP - 06

**Integral Solutions and Number-Theoretic Properties of a Non-Homogeneous Ternary  
Cubic Diophantine Equation**

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**Abstract**

This paper investigates a class of non-homogeneous ternary cubic Diophantine equations and focuses on the existence of non-zero integral solutions. By employing suitable algebraic transformations and systematic factorization techniques, the equation is reduced to simpler equivalent forms that facilitate the construction of distinct families of integer solutions. Three independent approaches are developed to generate parametric solutions, ensuring that the resulting values satisfy the required integrality conditions.

In addition to establishing these solution patterns, several interesting numerical relationships are derived among the obtained solutions. These relationships reveal connections with various classical figurate numbers, highlighting the interplay between cubic Diophantine equations and number-theoretic structures. The study not only demonstrates effective strategies for solving such equations but also provides insight into the structural properties underlying ternary cubic forms.

**Keywords:** Integral solutions, Figurate numbers, Cubic equation with three unknowns.

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OP - 07

**Impact of Lifestyle Factors on Diabetes Status by Using Statistical Model and Machine Learning Approaches**

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**Abstract**

Diabetes Mellitus plays a significant role in public health and is greatly influenced by various lifestyle factors. This study integrates Artificial Intelligence (AI) technologies, specifically unsupervised and supervised Machine Learning methods, to investigate the relationship between lifestyle factors and blood sugar levels (glycaemic status). This cross-sectional dataset includes 2,503 participants. The lifestyle factors in the dataset were classified into three groups using the K-means clustering method. This clustering was based on factors such as waist circumference, Body Mass Index (BMI), physical activity level, dietary intake, and smoking status.

Descriptive statistics and correlation tests were conducted to examine the differences between groups and the risk factors associated with HbA1c levels. To identify risk factors between groups, odds Ratios were used in logistic regression analysis. Additionally, prevalence was calculated to estimate the disease frequency in each group to find the progression of glycaemic severity. Subsequently, ensemble machine learning methods such as Random Forest, XG-Boost, and Gradient Boosting were used to evaluate predictive performance.

This study demonstrates that integrating artificial intelligence (AI)-based clustering methods and predictive models provides a useful framework for lifestyle-based risk stratification and early detection of diabetes. Furthermore, the combination of statistical inference and machine learning helps to gain a deeper understanding of complex lifestyle-disease relationships and supports targeted public health interventions.

**Key Words:** XG\_ Boost, Random Forest, Gradient Boosting, Odds Ratio and Prevalence

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OP - 08

**Design and Performance Analysis of an IoT-Enabled Pressure Sensing System for Precision Irrigation****Ananthi R<sup>1\*</sup> and Thirumoorthy P<sup>2</sup>**<sup>1</sup>Department of Electronics, Periyar University, Salem.<sup>2</sup>Department of Electronics and Communication, Government Arts College, Dharmapuri.**Abstract**

The integration of pressure sensors with the Internet of Things (IoT) is transforming modern agriculture through intelligent monitoring and automated resource management. This paper presents an IoT-enabled pressure sensing system designed specifically for agricultural applications, including irrigation management, water distribution monitoring, and pump performance supervision. The proposed system utilizes a high-precision pressure sensor interfaced with a microcontroller and wireless communication module to continuously measure water pressure within irrigation pipelines. The collected data is transmitted to a cloud-based platform for real-time analysis and visualization through a user-friendly dashboard. By detecting pressure fluctuations, the system can identify leakages, blockages, or pump failures, thereby minimizing water wastage and preventing crop stress. Automated alert mechanisms notify farmers when abnormal pressure conditions occur, enabling immediate corrective action. The implementation of this system enhances irrigation efficiency, reduces operational costs, promotes sustainable water usage, and increases agricultural productivity.

**Keywords:** IoT, Pressure Sensor, Smart Irrigation, Precision Farming, Irrigation Monitoring.**Email:** [ananthi5311@gmail.com](mailto:ananthi5311@gmail.com)

**OP - 09****Comparative Analysis of Multiple Sequence Alignment Algorithms in Phylogenetic Tree Construction: An AI-Inspired Computational Approach.****Sharatha Shree K**

Department of Statistics, Periyar University – Salem.

**Abstract**

Phylogenetic tree construction is a fundamental method for understanding evolutionary relationships among organisms using molecular sequence data. In this study, protein sequences of DNA topoisomerase (ATP-hydrolyzing) subunit B (gyrB) from eight *Bacillus* species were retrieved from the NCBI database and analyzed using MEGA software. Multiple Sequence Alignment (MSA) was performed using three different algorithms: Carrillo–Lipman, Feng–Doolittle, and Gibbs Sampling. Phylogenetic trees were constructed using the Neighbor- Joining method with Poisson correction and 1000 bootstrap replicates to assess statistical reliability.

Comparative analysis revealed consistent clustering patterns across all alignment approaches, demonstrating robustness in evolutionary inference. Notably, the Gibbs Sampling method, based on probabilistic modeling and Bayesian inference, represents an AI-inspired computational approach that iteratively optimizes alignment accuracy under uncertainty. Probabilistic models form the mathematical foundation of artificial intelligence, enabling pattern recognition and decision-making through likelihood estimation. This study highlights the growing intersection between bioinformatics and artificial intelligence, where computational and probabilistic methods enhance evolutionary analysis, improve scalability for large genomic datasets, and contribute to advancements in microbial classification and biomedical research. The integration of AI-driven techniques in phylogenetics represents a significant step toward intelligent biological data analysis.

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OP - 10

**Hybrid Machine Learning Approach for Cardiovascular Disease Risk Prediction: An Artificial Intelligence Perspective.****S. Govindaraj**

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**Abstract**

Cardiovascular diseases (CVDs) remain one of the leading causes of death worldwide, making early and accurate risk prediction essential for effective prevention and management. Traditional machine learning models often struggle to capture the complex relationships among demographic, clinical, and lifestyle risk factors associated with heart disease. This study presents a hybrid machine learning framework for cardiovascular risk prediction to address this challenge. The proposed approach integrates Logistic Regression (LR), Support Vector Machine (SVM), and Artificial Neural Network (ANN) models to improve prediction accuracy and reliability. To enhance model performance, a hybrid feature selection method combining ReliefF and Elastic Net was applied to identify the most significant risk factors, including age, systolic blood pressure, smoking status, stress level, physical activity, family history, sleep duration, gender, and fasting blood sugar. The models were trained and evaluated using standard performance metrics such as accuracy, precision, recall, F1-score, and ROC–AUC. Experimental results demonstrate that the hybrid soft voting ensemble outperforms individual models, achieving an accuracy of approximately 88% and a high ROC–AUC score. The proposed AI-driven framework supports early diagnosis, improves clinical decision-making, and contributes to proactive risk management and better public health outcomes.

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OP - 11

**Automated Railway Safety Monitoring System****\*Jeyaprakash V, and Vimala A**

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**Abstract**

Railway transportation is one of the most important modes of transport for passengers and goods. Safety in railway systems is very essential because even a small crack or misalignment in the track can lead to major accidents. Manual inspection of railway tracks is time-consuming and may not detect faults at an early stage. To improve safety and efficiency, an automatic Train Track Fault Alert System with automatic train control is proposed. Railway accidents mainly occur due to track cracks, structural damage, and misalignment. Existing manual inspection methods are not sufficient for continuous monitoring of long railway tracks. Delay in detecting faults increases the risk of derailment and passenger injuries. Therefore, a real-time automated system is required to detect track faults, send alerts, and automatically control train movement to prevent accidents.

The system uses crack detection sensors and vibration sensors installed along the railway track to continuously monitor track conditions. The sensor data is processed using a microcontroller or IoT module. When a fault is detected, an alert message is sent to the railway control room using wireless communication. At the same time, a signal is transmitted to the approaching train. Based on the severity of the fault, the train automatically slows down and stops before reaching the damaged track section.

**Keywords:** Railway Safety, Track Fault Detection, IoT, Automatic Train Control, Crack Detection, Vibration Sensor.

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OP-12

**IOT Based Gas Leakage Monitoring System****\*Narendharan R and Dhatchainamurthi L**

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**Abstract**

The Smart Gas Leakage Control System is designed to enhance safety in domestic and industrial environments where liquefied petroleum gas (LPG) or other combustible gases are used. Gas leakage is a major cause of fire accidents, explosions, and health hazards. With the advancement of embedded systems and IoT technologies, automated gas monitoring and control systems have become essential for ensuring human safety and preventing property damage. Gas leakage incidents often go unnoticed until they reach a dangerous level, leading to severe accidents and loss of life. Traditional detection methods depend on human intervention and lack real-time response mechanisms. There is a need for a reliable, automatic system that can detect gas leakage early and take immediate preventive action without human involvement.

The proposed system uses a gas sensor to continuously monitor the presence of combustible gases in the surrounding environment. A microcontroller processes the sensor data and compares it with predefined safety thresholds. When gas leakage is detected, the system activates a buzzer or alarm to alert occupants and automatically controls a solenoid valve to shut off the gas supply. Additionally, optional communication modules can be used to send alert notifications to users.

**Keywords:** Smart Gas Leakage Control System, Gas Leakage Detection, Gas Sensor,

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OP -13

**Photo Degradation Activity and Characterization of Phyto-Mediated Synthesis of Cuprous Oxide Nanoparticles from Kalanchoe Pinnata Leaf Extract.****\*Mohanlal R<sup>1</sup>, Kasthuri A<sup>1</sup>, Ramesh P<sup>2</sup>**

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**Abstract**

In this study, the photodegradation activities of phyto-mediated synthesis of cuprous oxide nanoparticles (Cu<sub>2</sub>O NPs) against various organic dyes like methylene blue (MB), methyl orange (MO), and eosin yellow (EY) were studied. The cuprous oxide nanoparticles were prepared by using leaf extract of the known herb Kalanchoe pinnata. Its properties, like shape, structure, and bonding nature, were also studied. X- Ray Diffraction (XRD) spectrum results showed that the average size of the prepared cuprous oxide nanoparticle was about 14.9 nm. Fourier Transform Infra-red (FTIR) analysis reveals the bonding nature of Cu<sub>2</sub>O NPs and also proves the presence of metal oxide bonds. The band gap of Cu<sub>2</sub>O NPs was about 4.49 eV on the basis of optical transmission at 389 nm using UV-visible spectroscopy. The photodegradation investigation against MB, MO, and EY under sunlight up to 180 minutes. The phyto-mediated synthesized Cu<sub>2</sub>O NPs show good and decent degradation for all three dyes. Based on the studies, the prepared Cu<sub>2</sub>O NPs are efficient at degrading organic dyes under sunlight as a source and are an environmentally friendly application.

**Keywords:** Kalanchoe pinnata, Cuprous oxide nanoparticles, Phyto-mediated synthesis, Photodegradation.

OP - 14

**Secure ATM Vibe Alert System****\*Sowmiya S and Prabusankarlal K.M.**

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**Abstract**

Automated Teller Machines (ATMs) play a vital role in modern banking by providing 24/7 access to financial services. Despite strong physical structures, ATMs are frequently targeted by criminals attempting theft through drilling, hammering, gas cutting, or forceful attacks. Such incidents cause major financial losses and damage to banking infrastructure. Therefore, an intelligent and real-time security system is necessary to detect unauthorized physical activities and prevent ATM break-ins effectively. Traditional ATM security systems such as CCTV cameras and security guards mainly provide surveillance but do not immediately prevent theft. In many cases, alerts are delayed, allowing criminals to escape before action is taken. Hence, there is a need for an automated system that can instantly detect unusual vibrations or shocks and immediately notify authorities to minimize damage and financial loss. The Secure ATM Vibe Alert System uses a vibration sensor installed inside the ATM structure to monitor physical disturbances continuously. The sensor detects unusual vibrations caused by drilling or force. When the vibration level exceeds a predefined threshold, the signal is sent to a microcontroller (Arduino). The controller processes the signal and activates a buzzer alarm to alert nearby people. Additionally, a GSM module sends real-time alert messages to bank officials or security personnel for quick response. The system effectively detects abnormal vibrations and generates instant alerts. It ensures real-time monitoring and quick preventive action against ATM theft attempts. The Secure ATM Vibe Alert System is a reliable, cost-effective, and efficient security solution. By integrating sensor technology and embedded systems, it enhances ATM protection, reduces financial risks, and improves overall banking security infrastructure.

**Keywords:** ATM Theft Alarm, Vibration Sensor, Automatic Door Lock, Embedded System,

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OP - 15

**Lanthanum Doped Graphitic Carbon Nitride Synthesis and Characterization for Methyl Orange Dye Degradation****Saranya S, Sethupathi N, Kalaiyarasi C, Mahalingam P**

Department of Physics, PGP College of Engineering and Technology, Namakkal – 637207.

**Abstract**

Lanthanum doped graphitic carbon nitride (La/g-C<sub>3</sub>N<sub>4</sub>) was synthesized with the application of melamine (MCN) and urea (UCN) by hydrothermal and calcination method. XRD, FTIR, SEM, EDX, UV-DRS and BET analysis using to investigate the properties of synthesized La/g-C<sub>3</sub>N<sub>4</sub>. A photocatalytic property of the material was investigated by degradation of Methyl orange (MO) dye under dark and UV light irradiation. Both samples are exposing, graphitic stacking structure in XRD and typical chemical structure in FTIR spectrum. Morphological study confirms nanostructure formation and precursor not influence to change the morphology. The BET characterization shows synthesized materials have enhanced surface area with pore volume for efficient photocatalytic application. EDX stated that, the La/g-C<sub>3</sub>N<sub>4</sub> have C, N, O and La elements and lanthanum doping narrows the bandgap energy of material. MCN and UCN have nearly similar photocatalytic degradation of MO dye and catalyst not efficiently degrades the dye under dark condition. The degradation reaction major active species was confirmed using of different scavengers and degradation reaction follows first order kinetic. MO dye degradation catalytic activity of La/g-C<sub>3</sub>N<sub>4</sub> influenced by pH, reaction time, concentration of catalyst and dye.

**Keywords:** Nanomaterial, La doping, Methyl Orange, MCN**Email:** [saranyaphy1992@gmail.com](mailto:saranyaphy1992@gmail.com)

OP - 16

**Synthesis and Characterization of Sandwich Structure NiWO<sub>4</sub> /rGO/NiWO<sub>4</sub>  
Composite with Efficient Electrochemical Properties for Supercapacitor Application**

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<sup>2</sup>Department of Physics, Muthayammal College of Arts and Science, Rasipuram, Namakkal 637408, Tamil Nadu, India.

**Abstract**

NiWO<sub>4</sub>/rGO/NiWO<sub>4</sub> sandwich composite were synthesized with the utilization of jet nebulized spray pyrolysis technique at optimum conditions followed by calcinating the material under nitrogen atmosphere at 450°C for 2hrs. Modified Hummer's method availed to prepare graphene oxide and it placed as interlayer between the metal oxide layers. XRD result confirms reduction of graphene oxide and crystalline structure. Morphological study shows formation of nanosized metal oxide particle that was successfully anchored on surface of reduced graphene oxide. Electrochemical performances were characterized by CV and EIS techniques. NiWO<sub>4</sub>/rGO/NiWO<sub>4</sub> sandwich structure composite shows superior specific capacitance 222 F/g at 5mV/s and EIS study produced charge transfer resistance of synthesized composite (3.4 Ω). Sandwich structure composites were found to have higher active sites, good electrical conductivity and possess a synergistic effect for supercapacitor application with good electrochemical performance also, composite exhibit excellent cycle life. These properties suggesting that sandwich structure NiWO<sub>4</sub>/rGO/NiWO<sub>4</sub> composite is a good electrode material for supercapacitor with excellent electrochemical performance. Furthermore, composite exhibit notable microbial activity against pathogenic species of gram-Positive staphylococcus bacteria.

**Keywords:** JNS, NiWO<sub>4</sub>/rGO/NiWO<sub>4</sub>, Supercapacitor

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OP -17

**Nanotech Innovations: Building the Next-Gen Mini-Machines****Aruna S<sup>1</sup>, Rasikapriya A<sup>2</sup>, Uvarani P and Vimala B<sup>4</sup>**

Department of physics, Muthayammal Engineering College, Rasipuram – 637408.

**Abstract**

A basic definition of Nanotechnology is the study manipulation and manufacture of extremely minute machines or devices. These devices are so small to the point of manipulating the atoms themselves to form materials. By this Nanotechnology we can make computers billions of times more full than today's and new medical capabilities that will heal and cure in cases that are now viewed as utterly hopelessly. If we know about exactly how many dopant atoms are in a single transistor and exactly where each individual dopant atom is located and placed roughly the right number in roughly the right place, we can make a working transistor .

Self replication make a effective route to truly low cost manufacturing. Artificial systems able to make a wide range of nonbiological products like diamond under programmatic control are likely to be more brittle and less adaptable in their response to changes in their environment than biological systems. At the same time they should be simpler and easier to design . Everything requires the computer is a major reason why people should research and develop Nanotechnology.

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OP -18

**Microwave Combustion Synthesis and Third Order Nonlinear Optical Traits and Optical Limiting behaviour of Gd<sup>3+</sup> Ion Doped ZnAl<sub>2</sub>O<sub>4</sub> Nanoparticles**

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**Abstract**

Zinc aluminate (ZnAl<sub>2</sub>O<sub>4</sub>) nanoparticles doped with Gadolinium (Gd<sup>3+</sup>) ions were synthesized using the microwave combustion technique with varying doping concentrations (x = 0, 0.1, 0.3, and 0.5). X-ray diffraction analysis confirmed the formation of a cubic crystalline structure. The crystallite size of Gd<sup>3+</sup> substituted ZnAl<sub>2</sub>O<sub>4</sub> nanoparticles ranged from 9 to 12 nm. Fourier transform infrared spectroscopy revealed characteristic metal–oxygen stretching vibrations. The optical band gap decreased from 5.50 to 3.62 eV with increasing Gd<sup>3+</sup> concentration due to the formation of intermediate energy levels, evaluated using the Kubelka–Munk function. High-resolution scanning electron microscopy images showed nanocluster grain morphology, and energy dispersive X-ray analysis confirmed the presence of Zn<sup>2+</sup>, Gd<sup>3+</sup>, Al<sup>3+</sup>, and O<sup>2-</sup> elements. Magnetic studies indicated diamagnetic behaviour for pure ZnAl<sub>2</sub>O<sub>4</sub> and superparamagnetic behaviour for Gd<sup>3+</sup> doped samples. Nonlinear optical parameters such as nonlinear refractive index (10<sup>-8</sup> cm<sup>2</sup>/W), nonlinear absorption coefficient (10<sup>-4</sup> cm/W), and third-order nonlinear susceptibility (10<sup>-6</sup> esu) were determined using the Z-scan technique. Optical limiting analysis demonstrated strong limiting behaviour, suggesting the potential application of Gd<sup>3+</sup> doped ZnAl<sub>2</sub>O<sub>4</sub> nanoparticles in optical switching and optical power limiting devices.

**Keywords:** Zinc aluminate; Microwave combustion; Z-scan; Third-order nonlinear optics; Optical limiting behaviour.

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OP – 19

**Heterostructured C-CeO<sub>2</sub>/g-C<sub>3</sub>N<sub>4</sub> nanocomposite for degradation of Amoxicillin under  
sunlight irradiation**

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<sup>b</sup> Department of Physics, Sri Sarada College for Women (Autonomous), Salem 636 016, Tamil Nadu, India.

**Abstract**

In this work, C-CeO<sub>2</sub>/g-C<sub>3</sub>N<sub>4</sub> heterojunction nanocomposite was synthesized via a facile hydrothermal method. XRD, FESEM, and HRTEM analyses were employed to investigate the crystalline structure and morphology of the as-synthesized photocatalysts. FT-IR spectra of C-CeO<sub>2</sub>/g-C<sub>3</sub>N<sub>4</sub> exhibits strong interaction between C-CeO<sub>2</sub> and g-C<sub>3</sub>N<sub>4</sub>, which implies the enhanced photogenerated charge carrier transfer. The photocatalytic experiment of the CeO<sub>2</sub>/g-C<sub>3</sub>N<sub>4</sub> heterojunction nanocomposite reveals superior photocatalytic activity and significant reusability. After 150 mins of sunlight irradiation, 87.5% of Amoxicillin were degraded by C-CeO<sub>2</sub>/g-C<sub>3</sub>N<sub>4</sub> nanocomposite, which is approximately 1.78 times higher than the photocatalytic activity of C-CeO<sub>2</sub>. In addition, the disintegration of Amoxicillin into non-toxic secondary compound was studied through total organic carbon (TOC) and high-performance liquid chromatography (HPLC) analysis. Thus, the synthesized C-CeO<sub>2</sub>/g-C<sub>3</sub>N<sub>4</sub> heterojunction nanocomposite is an ideal material for industrial wastewater remediation.

**Keywords:** Heterojunction; Photodegradation; charge carrier; Sunlight; Wastewater

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OP - 20

**Schiff Bases: Synthesis, Structural Characteristics and Applications****Saranya M<sup>1</sup> and PrabhuR<sup>2</sup>**

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**Abstract**

Schiff bases are a significant class of organic compounds characterized by the azomethine ( $>C=N-$ ) functional group, typically formed through the condensation of primary amines with aldehydes or ketones. Due to their structural flexibility and strong chelating ability, Schiff bases are widely utilized in coordination, inorganic, and bioinorganic chemistry. They readily form stable complexes with various metal ions, enhancing their chemical and biological significance.

In the present study, Schiff bases derived from aromatic aldehydes and both aliphatic and aromatic amines were synthesized using conventional reflux and magnetic stirring methods. Their corresponding metal complexes were also prepared. The synthesized compounds were characterized by melting point determination, UV–Visible spectroscopy, and infrared spectroscopy. Spectral analyses confirmed the formation of the azomethine group and indicated coordination of the metal ions through nitrogen and/or oxygen donor atoms, demonstrating bidentate ligand behavior. The biological activities of the metal complexes were evaluated, including antioxidant, antibacterial, and antifungal properties, while their electrochemical behavior was investigated using cyclic voltammetry. The results revealed that metal coordination enhances biological activity, likely due to increased lipophilicity and metal–ligand synergistic effects.

**Keywords:** Schiff base metal complexes, Antioxidant activity, Antimicrobial activity, Catalytic applications, Electrochemical behavior.

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OP –21

**Multifaceted Applications of Nanotechnology in Modern Medicine****Aarthi P, Dhivyadharshini P and Tamilmani P**

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**Abstract**

The integration of nanotechnology into clinical practice nanomedicine has catalyzed a transformative shift in the prevention, diagnosis, and treatment of complex diseases. By engineering materials at the nanoscale, researchers have unlocked the ability to interact with biological systems at the molecular level, overcoming physiological barriers that impede conventional therapies. This abstract synthesizes the diverse applications of nanotechnology, ranging from precision oncology to cardiovascular intervention and antimicrobial resistance.

In this, the core of this revolution lies in targeted delivery systems and specialized therapeutic modalities. In oncology, engineered nanoparticles deliver chemotherapeutic agents directly to tumor cells, simultaneously enhancing efficacy and sparing healthy tissues from systemic toxicity. This precision is further extended to cardiovascular health, where nanomaterial-based stents reduce restenosis, and nanoparticles deliver drugs directly to atherosclerotic plaques. Beyond delivery, nanotechnology introduces dynamic treatment options such as photodynamic therapy, using light-activated reactive oxygen species, and hyperthermia therapy, utilizing magnetic nanoparticles to generate localized heat to destroy malignant cells.

Furthermore, nanotechnology is redefining the management of infectious diseases and diagnostics. Nano-antibiotics and antiviral nanoparticles are being deployed to overcome drug-resistance mechanisms and inhibit viral replication. Simultaneously, the development of high-sensitivity nanosensors allows for the early detection of biomarkers associated with heart attacks and other critical conditions, facilitating rapid clinical intervention. This multi-dimensional approach underscores nanotechnology's role as a cornerstone of 21st-century personalized medicine, offering a pathway to highly specific, minimally invasive healthcare.

**Keywords:** Nanomedicine, Targeted Delivery Systems and Specialized Therapeutic Modalities, Nanomaterial-Based Stents, Photodynamic Therapy, Hyperthermia Therapy, Nano-Antibiotics

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OP - 22

## AI-Enabled Embedded System for Intelligent Renewable Energy and Smart Energy Storage Management

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### Abstract

The increasing demand for sustainable power generation has accelerated the adoption of renewable energy sources such as solar and wind. However, the intermittent and unpredictable nature of these sources creates significant challenges in maintaining power stability and efficient energy storage. This paper presents the design and development of an AI-enabled embedded system for intelligent renewable energy management integrated with advanced energy storage control.

The proposed system utilizes environmental sensors, voltage and current monitoring modules, and a microcontroller-based embedded platform to collect real-time data from renewable energy sources and battery units. Artificial Intelligence algorithms are implemented to analyse power generation patterns, forecast load demand, and optimize charging and discharging cycles of the battery storage system.

The embedded architecture ensures low power consumption, real-time processing, and seamless communication with cloud-based monitoring platforms for remote supervision. Additionally, the system incorporates protection mechanisms against overcharging, deep discharge, and thermal instability, thereby extending battery lifespan and ensuring operational safety.

Experimental evaluation demonstrates improved energy utilization, reduced dependency on conventional grid supply, and enhanced reliability of renewable energy systems. The proposed AI-driven embedded solution offers a scalable and cost-effective approach for smart micro grids, residential solar installations, and hybrid renewable energy applications, contributing toward sustainable and intelligent energy management.

**Keywords:** Energy Storage System (ESS), Embedded System, Artificial Intelligence (AI), Machine Learning, Smart Grid, Microcontroller, Battery Management System (BMS).

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OP - 23

**Ai-Enhanced Nonlinear Ordinary Differential Equations Modeling Framework for  
Hormonal Imbalance In Polycystic Ovary Syndrome (PCOS)**

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**Abstract**

Hormonal imbalance is a condition in which there is too much or too little of one or more hormones in the bloodstream, disrupting the body's normal physiological functions. Polycystic Ovary Syndrome (PCOS) is a complex endocrine–metabolic disorder characterized by hormonal imbalance, insulin resistance, hyperandrogenism, and disrupted follicular dynamics. This study proposes an AI-enhanced nonlinear ordinary differential equation (ODE) modeling framework to analyze the hormonal regulatory mechanisms underlying PCOS. The model integrates key physiological variables including luteinizing hormone (LH), follicle-stimulating hormone (FSH), insulin (I), androgen (A), and follicular mass (F), capturing their nonlinear feedback interactions through coupled differential equations. This hybrid AI–mathematical framework improves predictive accuracy, enables early detection of hormonal instability, and supports targeted therapeutic simulations. The proposed framework provides a rigorous nonlinear dynamical systems perspective on PCOS progression and demonstrates how AI-assisted ODE modeling can enhance precision medicine in reproductive endocrinology.

**Keywords:** Polycystic Ovary Syndrome (PCOS), Nonlinear Ordinary Differential Equations, Artificial Intelligence, Hormonal Dynamics, Stability Analysis, Bifurcation Theory, Mathematical Modeling, Precision Medicine.

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OP - 24

## Synthesis of Bipyridine Derivatives Compounds, Its Anti-Cancer Activities and Molecular Docking Studies

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### Abstract

Synthesize organic compounds like heterocyclic compounds and their biological evaluation has been done. Studies like in vitro biological studies are the initial step to innovate the new drug. Background: Substituted bipyridine-based compounds with diverse pharmacological activities like anticancer, anti-inflammatory, antimicrobial, antiviral, and antioxidant hold a significant scaffold in the pharmaceutical industry because of their biological activities. These derivatives were synthesized and tested for their inhibitory and cytotoxicity activity against glutathione S-transferase (GST), and hepatocellular carcinoma (HepG2). These bipyridine-based compounds were found to inhibit these enzymes with IC50 values ranging from 2.07 to 4.15  $\mu\text{M}$  for GST. The bipyridine-based compounds were tested in a range of 12.5–100  $\mu\text{M}$  concentrations against the HepG2 cell line. Among these derivatives studied, synthesized compounds was the most effective substance on HepG2 cells. Also, Trifluoromethanesulfonyl symmetrical and unsymmetrical 2,2'-bipyridines were good inhibitors for both enzymes. The time- and dose-dependent cytotoxicity determined supports bipyridine-based compounds' potential as chemotherapeutic candidates for HepG2 cells. Trifluoromethanesulfonylsymmetrical and unsymmetrical 2,2'-bipyridines derivatives possess good anticancer activity. Furthermore, the molecular docking results indicated that the bipyridine-based compounds predicted strong binding and stability at the active site of enzymes and the cancer line. DFT studies were performed on the synthesized compounds using M06-2X/6-31+G(d,p) level of theory. The bipyridine-based compounds may enable the development of more selective and effective structures as enzyme inhibitors and anticancer drugs in the future.

**Keywords:** glutathione S-transferase, hepatocellular carcinoma, structural characterization, Molecular docking, Anticancer activity, DFT study.

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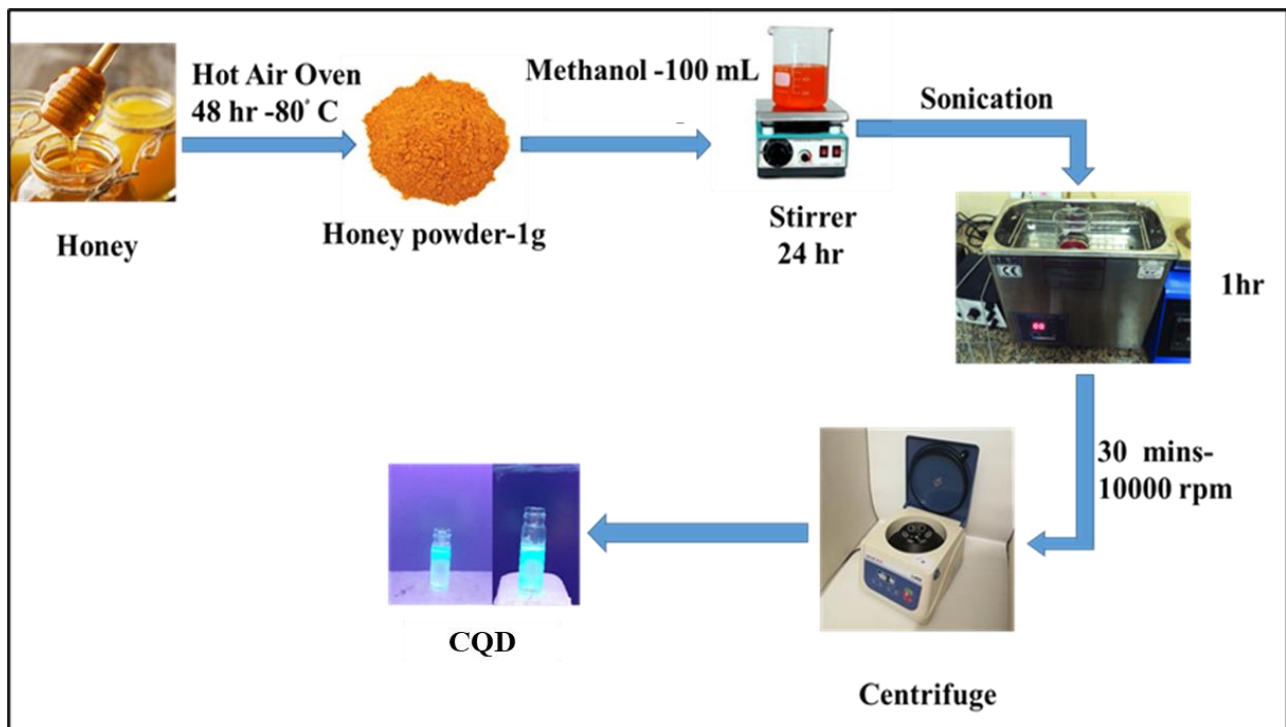
OP - 25

**Honey derived Carbon Quantum Dots used for Sensing of Ascorbic Acid****Suganya Karuppannan & Sakhivel Pachagounder**

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**Abstract**

A simple low-cost green synthesis of carbon quantum dots (CQDs) from honey by the ultrasonication technique. The FT-IR spectroscopy used to confirm the functional groups present in CQDs. The XRD and UV-Vis spectroscopy analysis indicate that the structural and Optical properties of the materials. The Fluorescent emission properties of CQDs confirmed by were Photoluminescence (PL) spectroscopy. The electrochemical studies was conducted for the sensing of ascorbic acid using cyclic voltammetry (CV) measurements.



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OP - 26

**Deepfake Image and Video Detection Using Hybrid Deep Learning Techniques****Balaji V<sup>1</sup>, Deebesh P<sup>1</sup> and \*Mani A<sup>2</sup>**

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**Abstract**

The rapid growth of Generative Artificial Intelligence has enabled the creation of highly realistic fake images and videos, known as deepfakes. While useful in media applications, deepfakes pose serious risks such as misinformation, identity theft, and cybercrime. This paper proposes a hybrid deep learning framework combining Convolutional Neural Networks (CNN) and Transformer-based models to detect manipulated visual content. The system analyses spatial and temporal features to identify visual artifacts and inconsistencies. Experimental evaluation on benchmark datasets demonstrates improved detection accuracy compared to single-model approaches. The proposed method supports reliable media authentication and strengthens digital security systems.

**Keywords:** Deepfake Detection, Generative AI, CNN, Transformer Models, Computer Vision

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OP - 27

**AI-Driven Text Classification Model for Detecting False News Content****Archana T<sup>1</sup>, Abitha P<sup>1</sup>, Divya Krithi S<sup>1</sup> and \*Mani A<sup>2</sup>**

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**Abstract**

Misinformation has spread quickly across digital media platforms, creating serious social, political, and economic problems. The enormous amount of information produced every day makes manual verification of online news content time-consuming and unfeasible. In this paper, a framework for detecting fake news using Natural Language Processing (NLP) and Artificial Intelligence (AI) is presented. The suggested method uses inputs like news article content, headlines, author details, and optional social media metadata to categorize information as either real or fake. It approaches fake news identification as a supervised text classification problem.

Tokenization, stop-word removal, normalization, and lemmatization are among the extensive text preprocessing techniques that follow the methodical data collection from benchmark datasets like LIAR, Fake News Net, and Kaggle Fake News datasets. Both conventional methods like Term Frequency–Inverse Document Frequency (TF-IDF) and n-grams and sophisticated representation techniques like Word2Vec, GloVe, FastText, and transformer-based embeddings like BERT and RoBERTa are used for feature extraction.

The system assesses deep learning architectures like LSTM, CNN, and BERT-based classifiers in addition to a variety of machine learning models like Random Forest, Naïve Bayes, Support Vector Machines, and Logistic Regression. Standard evaluation metrics such as accuracy, precision, recall, F1-score, ROC-AUC, and confusion matrix analysis are used to evaluate performance.

**Keywords:**

Fake News Detection, Natural Language Processing, Machine Learning, Deep Learning

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OP - 28

**Controlling Misinformation in Generative Language Models****Kavina M<sup>1</sup>, Harshini R<sup>1</sup>, Kabinaya M<sup>1</sup>, Vidhya Varsha H<sup>2</sup> and \*Mani A<sup>3</sup>**

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**Abstract**

Large Language Models (LLMs) have achieved remarkable performance in natural language generation, yet they frequently produce factually incorrect or fabricated information, commonly known as hallucination. This issue limits their reliability in critical domains such as healthcare, education, and legal systems. This paper proposes a hybrid framework that integrates Retrieval-Augmented Generation (RAG), knowledge grounding, and a post-generation fact-verification module to improve factual accuracy. A confidence scoring mechanism is also introduced to assess response reliability. Experimental evaluation demonstrates that the proposed approach significantly reduces hallucination rates while preserving linguistic quality and coherence in generated outputs.

**Keywords:** Large Language Models, Hallucination Reduction, Retrieval-Augmented Generation

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OP - 29

**Machine learning tool for finding a Malware and Ransomware****Brindha S<sup>1</sup>, Anitha C S<sup>1</sup>, Aishwarya K<sup>1</sup>, Bavanitha S<sup>1</sup> and \*Mani A<sup>2</sup>**

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**Abstract**

Malware and ransomware are continuously changing and becoming more advanced. Attackers regularly modify their techniques to avoid detection. Traditional security systems mostly rely on signature-based detection, which means they compare files against known malware patterns. These systems work well for old and known attacks, but they often fail to detect new, modified, or zero-day malware. Because of this limitation, there is a strong need for smarter and more adaptive detection machines and deep learning models (such as CNN and LSTM). Supervised models help classify known malware patterns efficiently, while deep learning models automatically learn complex behaviors techniques. To solve this problem, this research proposes an intelligent machine learning-based detection system for identifying malware and ransomware. The main goal of the system is to detect threats in real time, with high accuracy, while keeping false alarms (false positives) as low as possible. This ensures that harmful files are detected quickly without wrongly blocking legitimate software.

A key contribution of this work is a new hybrid adaptive learning technique. This technique combines behavior-aware feature fusion, which merges static and dynamic behaviors, with online incremental model updating, where the model continuously learns from new malware samples. This approach helps the system handle concept drift, meaning it can adapt when malware behavior changes over time. Finally, experiments conducted using standard benchmark datasets show that the proposed system achieves better detection accuracy, stronger robustness, and improved adaptability compared to traditional methods. Overall, the framework provides an effective and reliable solution for protecting systems against modern and evolving malware and ransomware threats.

**Keywords:** Malware detection, Ransomware detection, Machine learning, Deep learning.

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OP - 30

**Blockchain for Secure Data Sharing****Abinow M.S.<sup>1</sup>, Balachandar V<sup>1</sup>, Dhanushkarthick S<sup>1</sup>, Dhanuja M<sup>1</sup>, C. Dhanusri <sup>1</sup> and  
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**Abstract**

Blockchain technology provides a secure and decentralized framework for data sharing across distributed networks. It uses cryptographic algorithms, consensus mechanisms, and immutable ledgers to ensure data integrity, transparency, and resistance to tampering. Unlike traditional centralized systems, blockchain eliminates intermediaries, reducing vulnerabilities and enhancing trust among participants. Smart contracts enable automated access control, ensuring that only authorized users can view or modify data. This technology is highly beneficial in sectors such as healthcare, finance, supply chain, and e-governance where secure information exchange is essential. Overall, blockchain enhances privacy, reliability, and accountability in modern digital communication systems.

**Keywords:** Blockchain, Secure Data Sharing, Decentralization, Cryptographic Security, Smart Contracts

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OP - 31

**Surface Characteristics and Electrochemical Corrosion Behavior of Anodized Aluminium  
Fabricated from Mixed Electrolyte**

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<sup>b</sup>Department of Chemistry, Loyola College, Mettala, Nmakkal-636 202. Tamil Nadu

**Abstract**

The corrosion protection of anodized coatings fabricated from sulfuric acid with and without the addition of glycerol in 3.5 wt. % NaCl aqueous solution was investigated using electrochemical methods. The nanostructure of aluminium anodized in sulfuric acid coating was modified in glycerol to enhance its corrosion resistance. Effect of electrolyte composition, concentration of additive, applied voltage, duration of anodization upon the formation and surface characteristics of anodic alumina coatings have been investigated. Anodization is also carried out with pure sulfuric acid for comparison. Optimal concentration of glycerol was found to be 3%. Under optimized anodizing conditions such as anodizing voltage, process duration and electrolyte concentration, mechanically stable, thick, crack-free anodic alumina coatings with high corrosion resistance is accomplished. Surface microstructure, surface topography, phase constitution, composition of elements present in the coatings and electrochemical corrosion behavior were evaluated by SEM, EDS, XRD and electrochemical studies. Electrochemical impedance spectroscopy analysis and Tafel studies revealed that the coating fabricated from mixed electrolyte provides improved corrosion protection to the Al alloy compared with the coating fabricated without glycerol. The improved protection provided by the coatings attributed to the viscosity nature of glycerol which enhances the corrosion resistance. These results indicated that the morphology and the corrosion resistance of anodic coating formed by mixed electrolyte are very improved if compared to single one.

**Key words:** Anodization; Aluminium; Mixed electrolyte; Glycerol; Corrosion resistance.

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OP - 32

**Review of Nanomaterial's Photocatalytic Activity For Treating Waste Water****\*Rajasulochana G<sup>1</sup> and Sivakumar P<sup>2</sup>**<sup>1</sup>Department of Chemistry, NKR Govt. Arts College for Women, Namakkal.<sup>2</sup>Department of Chemistry, Govt. Arts College, Komarapalayam, Namakkal.**Abstract**

For life to exist on Earth, water is essential. Water resources have been degraded in recent decades by a diverse range of contaminants. Surface, drinkable, and waste water can include toxins that are quite different from dyes, which can be harmful to both human health and the environment. Due to their extensive usage in both home and commercial settings, dyes of various kinds are the main pollutants in water that require immediate care. The researcher was motivated to create an environmentally friendly technique that could successfully and efficiently break down these hazardous pollutants by the poisonous effects of these dyes and their resistance to conventional water treatment techniques. In order to effectively remove dyes from wastewater, we looked at many cost-effective photocatalytic degradation techniques using metal-based nanomaterials in this research. This research provides a technique to safeguard human health and the environment. Furthermore, the understanding of how solar energy is transformed for the purpose of photocatalytic reduction of harmful metal ions and photocatalytic degradation of wastewater tainted with dyes would clear the way for future study on water treatment. Reports have also been published on the photocatalytic degradation mechanism and the factors influencing the photocatalytic activity of different photocatalysts.

**Keywords:** Photocatalytic degradation, metal-based nanomaterials, photocatalysts**Email:** [10sarvesh2010@gmail.com](mailto:10sarvesh2010@gmail.com)

OP - 33

**Synthesis, Characterization and Electrochemical Investigation Of [16]-Membered Dioxo Diaza Napthaldehyde Based Macrocyclic Ligand and its Complexes of Co(III), Ni(II), Cu(II) and Zn(II) PERCHLORATE IONS”**

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**Abstract**

A hitherto new unreported [16]-membered dioxadiazanaphthaldehyde-based macrocyclic ligand (L) 2,11-dioxo-23,30-diaza heptacyclo [30.4.0.0.4, 9.0.12, 21.0.14, 19.0.24, 29.0.34, 39]-tetraconta-12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40 pentadecaene, has been synthesised by two different synthetic routes, each involving two steps. 2-Hydroxy-1-naphthaldehyde, in the presence of potassium carbonate, was treated with  $\alpha,\alpha'$ -dibromo-o-xylene to yield the dial derivative (I). The dial derivative (I) was further made to undergo Schiff base condensation with 1,2-diaminobenzene to yield the bright yellow macrocycle (L) in good yield. In the second method, the Schiff base condensed product Naphthaloph was synthesised and allowed to undergo Williamson's condensation with  $\alpha,\alpha'$ -dibromo-o-xylene to yield the ligand (L). The neutral sixteen membered tetradentatedioxadiaza ligand(L) readily complexes with Co(III), Ni(II), Cu(II) and Zn(II) perchlorate salts in 1:1 mole ratio to yield complexes of formulae  $[\text{Co}(\text{L})\text{X}_2]\text{ClO}_4$ ,  $[\text{Ni}(\text{L})\text{X}_2]$ ,  $[\text{Cu}(\text{L})\text{X}]\text{ClO}_4$ , (X = Cl<sup>-</sup>, Br<sup>-</sup> and NO<sub>3</sub><sup>-</sup>). The complexes were also synthesised by the metal template method. The yield of the template procedure was found to be greater than that of the non-template method. The ligand and the complexes were characterised by elemental analysis, electronic spectroscopy, IR spectroscopy, Conductivity measurements, <sup>1</sup>H NMR, FAB-MS and Cyclic voltammetry studies. The [16]-membered tetradentatedioxadiazamacrocycle (L) was found to accommodate Co(III), Ni(II), Cu(II) and Zn(II) ions with ease due to the presence of flexible alkyl groups. Further studies with the inner-transition metal ions will be highly informative in understanding the coordinating capabilities of lanthanides and actinides.

**Keywords:** Schiff Base Ligand, Co(III), Ni(II) Cu(II) and Zn(II) complexes, 2-hydroxy-1-naphthaldehyde,  $\alpha,\alpha'$ -dibromo-o-xylene.

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PP - 01

**Advanced Energy Monitoring System Using IoT****Sathishkumar S, \*Harshini K, Aruna S, Narmadha J, Sowndharya R**

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**Abstract**

This paper presents the design and implementation of an IoT-based advanced energy monitoring system using ESP32 and the Blynk platform. The system measures electrical parameters such as voltage, current, power, and energy consumption in real time using appropriate sensors. The ESP32 microcontroller processes the acquired data and transmits it to the Blynk cloud through Wi-Fi for remote monitoring and visualization. Users can access energy usage data through a mobile application, enabling continuous tracking and effective energy management. Experimental results show accurate measurement and stable wireless communication. The proposed system is low-cost, scalable, and suitable for smart homes and industrial energy management applications.

**Keywords:** ESP32, Blynk, IoT, Remote Energy monitoring, smart energy system.

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PP – 02

**A Statistical Analysis of Crude Oil Prices With AI Integration****Sakthi A**

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**Abstract**

This study analyzes global crude oil price trends from 2015 to 2025 using statistical tools such as SPSS, Microsoft Excel, and Artificial Intelligence (AI) techniques. The objective is to identify patterns, volatility, and economic influences affecting oil prices over the selected period. Descriptive statistics, correlation analysis, regression modeling, and time-series trend analysis were applied. In addition, AI-based forecasting models such as Random Forest and Long Short-Term Memory (LSTM) networks were incorporated to improve prediction accuracy. The findings indicate significant volatility driven by geopolitical events, demand-supply imbalances, and the COVID-19 pandemic. Statistical and AI tools effectively identified cyclical movements and forecasting insights useful for policymakers and investors.

**Keywords:** Crude Oil Prices, Time Series Analysis, Regression, SPSS, Microsoft Excel, Artificial Intelligence, Economic Volatility, Forecasting.

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PP - 03

**Sustainable Phytofabrication of Copper Nanoparticles: A Novel Approach for Obesity Control****Chandru V and Sathya M**

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**Abstract**

The study presents an eco-friendly method for synthesizing copper nanoparticles (CuNPs) using aqueous leaf extract of *Vitex trifolia* as both reducing and stabilizing agent. This green synthesis avoids toxic chemicals, high energy usage, and hazardous by-products, offering a sustainable alternative to traditional methods. The phytochemicals in the extract, such as flavonoids, phenolics, and terpenoids, facilitate the bioreduction of copper ions and stabilization of nanoparticles. Characterization of the CuNPs via UV–Visible spectroscopy, FTIR, XRD, SEM, and EDX confirms their crystalline structure, nanoscale size, and spherical shape. The synthesized CuNPs exhibit significant anti-obesity potential, shown through pancreatic lipase inhibition and  $\alpha$ -amylase inhibition assays, indicating their ability to decrease lipid digestion and carbohydrate absorption. The study emphasizes the therapeutic potential of *Vitex trifolia*-mediated CuNPs as biocompatible candidates for anti-obesity treatment and functional nanomedicine.

**Keywords:** Copper nanoparticles, *Vitex trifolia*,  $\alpha$ -amylase**Email:** [chandrurithu9345@gmail.com](mailto:chandrurithu9345@gmail.com)

PP - 04

**Growth and Characterization of Pure and Neem Added Pottasium Di Chromate Crystals  
and Its Antibacterial Applications.**

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637408, Tamil Nadu, India.

**Abstract**

The single crystal of Pottasium dichromate was grown using slow evaporation solution growth technique at room temperature. The grown single crystal has crushed as powder and investigated through powder XRD studies and revealed that the grown crystal belongs to the triclinic system with the space group of P. Different spectroscopic and analytical techniques used for analyzing the structure and properties of the grown crystal, such as FTIR and UV-Vis. The mechanical strength of the crystal has been studied by using a Vickers' micro hardness test. The anti Bacterial characterization of pure pottasium dichromate crystal was higher for the Neem added potassium dichromate crystal. From this it concludes that the pure potassium added crystals were better for mechanical device applications due to high mechanical strength and Neem added Pottasium dichromate crystals been better for antibacterial activity. Hence the Neem added Pottasium dichromate been better for medicinal applications. It conclude for mechanically strengthens pure crystals were better to device fabrication.

**Key words:** Powder XRD, FTIR, UV-Vis and Antimicrobial activity micro hardness.

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PP - 05

**A Statistical Study on Forecasting Gold Prices Using Regression Model****Dharshini B**

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637408, Tamil Nadu, India.

**Abstract**

Gold has historically been regarded as a stable investment and a hedge against inflation, currency depreciation, and economic uncertainty. In India and across global markets, gold plays a dual role as both a cultural asset and a financial instrument. Due to its economic importance, accurate forecasting of gold prices has become essential for investors, policymakers, and financial analysts. This study presents a statistical analysis of gold price behavior and applies regression modeling techniques to forecast future price movements based on historical data and macroeconomic indicators.

**Keywords:** Statistical analysis of gold price, Regression modeling.

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PP - 06

**Design of an IoT-Based Embedded Control System for Industrial Process Automation with Blynk Interface****Vijayalakshmi P**

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**Abstract**

Industrial automation is transforming manufacturing and process industries by improving productivity, safety, and operational efficiency. This paper presents the design and implementation of an IoT-enabled embedded industrial automation system integrated with the Blynk application for real-time monitoring and control. The proposed system utilizes a microcontroller-based embedded platform interfaced with industrial sensors to monitor parameters such as temperature, pressure, vibration, and motor status.

Sensor data is processed locally within the embedded controller to ensure quick response to abnormal conditions.

To enhance reliability, the system incorporates threshold-based protection mechanisms and automated shutdown features to prevent equipment damage. The hardware prototype was evaluated in a simulated industrial environment, demonstrating stable communication, reduced manual intervention, and improved operational safety.

The proposed solution offers a cost-effective and scalable approach for small- and medium-scale industries seeking smart automation with minimal infrastructure modification.

**Keywords:** Internet of Things (IoT), Embedded Systems, Industrial Automation, Blynk

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PP - 07

**Sustainable Green and Chemistry Technology****DIVYA C**

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**Abstract**

Sustainable Green and Chemistry Technology focuses on the design development of chemical products and processes that reduce or eliminate the use and generation of hazardous substances while promoting environmental protection, economic viability, social responsibility. Rooted in the principles introduced by Paul Anastas and John C. Warner, green chemistry emphasizes pollution prevention at the source rather than treatment after formation. and This approach integrates the 12 principles of green chemistry, including waste minimization, atom economy, energy solvents, and catalysis. Sustainable green technologies aim to reduce environmental impact by optimizing resource utilization, lowering greenhouse gas emissions, and designing biodegradable and non-toxic products. Applications span pharmaceuticals, agriculture, polymers, and renewable energy systems, contributing to cleaner industrial production and circular economy models. By aligning chemical innovation with sustainability goals, green chemistry technology plays a crucial role in addressing global challenges such as climate change, resource depletion, and environmental pollution. It supports the transition toward environmentally benign manufacturing processes and sustainable development in accordance with global sustainability initiatives.

**Keywords:** Sustainable development, Greenchemistry, Pollution prevention

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**Foot Step Power Generator**

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**Abstract**

This paper presents the design and implementation of an IoT-enabled footstep power generation system using piezoelectric sensors and an ESP32 microcontroller. Mechanical energy generated from human footsteps is converted into electrical energy through piezoelectric transducers. The generated voltage is conditioned and stored using suitable power management circuits. The ESP32 processes the electrical output parameters and transmits real-time data such as generated voltage and power to a cloud platform through Wi-Fi. Energy generation data can be monitored remotely using a mobile application, enabling performance analysis and system monitoring. Experimental results demonstrate stable energy harvesting and reliable wireless data transmission. The proposed system is eco-friendly, low-cost, and suitable for installation in high foot-traffic areas such as public walkways and transportation hubs.

**Key Words:** Footstep power generator, ESP32, IoT, Piezoelectric sensor, Energy harvesting.

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### Smart Home Automation Using ESP32

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#### **Abstract**

Smart home automation is an emerging technology that enhances convenience, safety, and energy efficiency in residential environments. This project presents the design and implementation of a smart home automation system using the ESP32 microcontroller to control household electrical appliances. The system incorporates four relay modules to operate high-voltage devices such as light bulbs and a 230V ceiling fan. The ESP32, equipped with built-in Wi-Fi capability, serves as the main controller that enables wireless communication between the user and the connected appliances. The relay modules act as electrically controlled switches, allowing low-voltage signals from the ESP32 to safely control high-voltage AC loads. Through a mobile application or web-based interface, users can remotely switch appliances ON or OFF, providing improved accessibility and ease of operation. The proposed system is designed to ensure reliable performance and electrical safety by using proper isolation between the control circuit and the power circuit. Each relay channel independently controls a specific appliance, enabling flexible and efficient management of lighting and ventilation systems. The automation system reduces manual effort and helps conserve electrical energy by preventing unnecessary usage of devices. Additionally, the ESP32 platform allows future expansion, such as integration of sensors for automatic control or voice-based operation. This project demonstrates a cost-effective, scalable, and practical solution for implementing smart home automation using modern Internet of Things (IoT) technology.

**Keywords:** Internet of Things (IoT), Embedded Systems, Industrial Automation, Blynk

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**Influence of Artificial Intelligence in Material Science****Santhoshika S\***

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**Abstract**

Artificial Intelligence (AI) has emerged as a transformative force in the field of material science, significantly accelerating the discovery, design, and optimization of advanced materials. Traditional experimental approaches to material development are often time-consuming, resource-intensive, and limited by trial-and-error methodologies. The integration of AI techniques such as machine learning (ML), deep learning, and data-driven modeling has enabled researchers to predict material properties, identify novel compounds, and optimize synthesis processes with improved accuracy and efficiency.

AI-driven tools facilitate high-throughput screening of materials, simulation of atomic interactions, and analysis of large experimental datasets, thereby reducing development time and cost. In nanomaterials, AI assists in tailoring particle size, morphology, and functionality. In biomaterials, it supports biocompatibility prediction and personalized implant design. Furthermore, AI contributes to the exploration of quantum materials by modeling complex quantum interactions and discovering new quantum phases.

This paper highlights the growing influence of AI in transforming conventional material research into a data-centric and predictive discipline. The synergy between AI and material science is expected to accelerate innovation in energy storage, electronics, healthcare, and sustainable technologies, paving the way for next-generation smart materials.

**Keywords:** Artificial Intelligence, Material Science, Machine Learning, Nanomaterials

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**IOT Soil Irrigation System****Santhiya R, Varunvijey P, Naresh B, Venkatesh S**

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**Abstract**

Solar irrigation is an innovative and sustainable solution to address the growing energy and water challenges in agriculture. With increasing fuel prices and unreliable electricity supply in rural areas, solar-powered irrigation systems offer a cost-effective and eco-friendly alternative for farmers. This paper examines the design, working principles, and performance efficiency of solar irrigation systems, highlighting their potential to reduce dependence on conventional energy sources and lower carbon emissions. The integration of photovoltaic panels with water pumping systems ensures continuous and reliable water supply for agricultural activities. The study analyzes the economic and environmental benefits of solar irrigation compared to diesel and electric pump systems. It discusses installation costs, maintenance requirements, government subsidies, and long-term financial savings. Case studies from rural farming communities demonstrate improved crop productivity, reduced operational expenses, and enhanced sustainability. The research also addresses challenges such as initial investment costs, seasonal variations in solar energy availability, and the need for proper technical training. The findings suggest that solar irrigation systems significantly contribute to sustainable agricultural development and rural empowerment. Adoption of this technology supports renewable energy utilization, water conservation, and climate-resilient farming practices. The paper concludes that promoting awareness, financial support, and policy implementation can accelerate large-scale adoption of solar irrigation systems, ensuring food security and environmental protection for future generations.

**Keywords:** IOT, Soil Irrigation**Email:** [varunvijey07@gmail.com](mailto:varunvijey07@gmail.com)

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**Relationship Between Literacyrate and GDP of Indian States****Mukes Raam K**

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**Abstract:**

This study investigates the relationship between literacy rate and Gross Domestic Product (GDP) across Indian states using regression and multivariate statistical techniques supported by Artificial Intelligence (AI). Education is widely recognized as a key driver of economic development, as it enhances human capital, improves productivity, and expands employment opportunities. Considerable disparities exist among Indian states in terms of literacy levels and economic performance, necessitating a systematic statistical examination of their association.

Secondary data were obtained from Census reports and State Gross Domestic Product (GSDP) publications for 28 Indian states. Descriptive statistics, Pearson's correlation, and simple linear regression analysis were employed using SPSS software to assess the impact of literacy rate (independent variable) on GDP (dependent variable). AI-supported analytical tools were integrated to improve predictive accuracy and data interpretation.

The results reveal a significant positive correlation between literacy rate and GDP ( $p < 0.05$ ). Regression findings indicate that an increase in literacy rate leads to a measurable rise in state economic output. The study supports the human capital development theory, emphasizing that investment in education promotes sustainable economic growth and reduces regional disparities. The combined use of statistical methods and AI provides robust insights for evidence-based policymaking.

**Keywords:** Literacy Rate, GDP, GSDP, Regression Analysis, Multivariate Analysis, Economic Growth, Human Capital, Statistical Analysis, Indian States.

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**Semiconductor Materials****Kanishka G**

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**Abstract**

Semiconductor materials form the backbone of modern electronics due to their intermediate and controllable electrical conductivity. Their behaviour lies between conductors and insulators, governed by electronic structure, bandgap, and impurity levels. These materials ranging from elemental silicon to advanced compound and wide-bandgap semiconductors enable devices such as diodes, transistors, ICs, LEDs, and solar cells. Advancements in nanoscale materials, 2D semiconductors, and emerging compounds continue to broaden their applications in computing, communication, sensing, renewable energy, and high-power electronics.

**Keywords:** Energy bandgap, semiconductor materials, electrical properties, optics properties.

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**Statistical Inference and Data Analysis Using AI on Emotional Maturity, Self-Concept, Adjustment, and Academic Achievement of Twelfth Standard Students in Salem District**

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**Abstract**

The present study investigates the relationship between emotional maturity, self-concept, adjustment, and academic achievement among twelfth standard students in Salem District using statistical inference and Artificial Intelligence (AI)-based data analysis techniques. Adolescence is a crucial developmental stage where psychological factors significantly influence academic outcomes. The study adopts a descriptive survey method with a representative sample of higher secondary students selected through stratified random sampling. Standardized tools are employed to measure emotional maturity, self-concept, and adjustment levels, while academic achievement is assessed through official examination scores. Traditional statistical techniques such as mean, standard deviation, correlation, t-test, ANOVA, and multiple regression are used to examine relationships and group differences. In addition, AI-based predictive models, including linear regression and machine learning algorithms, are applied to identify key predictors of academic achievement and improve prediction accuracy.

The findings are expected to reveal significant associations among the psychological variables and academic performance. The study highlights the importance of integrating psychological assessment and AI-driven analytics in educational research to enhance student support systems and academic success strategies.

**Keywords:** Statistical Inference, Artificial Intelligence, Machine Learning, Educational Data Analysis.

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**Light Following Robot****Arulmani S, Abishek I, Boopal G and Deepak K**

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**Abstract**

A Light Following Robot is an autonomous robotic system designed to detect and move toward a light source using light-sensitive sensors. The primary objective of this project is to demonstrate the practical application of embedded systems, sensor integration, and basic robotics in creating an intelligent system capable of responding to environmental stimuli. The robot operates using light-dependent resistors (LDRs) or photodiodes that continuously monitor the intensity of light in its surroundings. These sensors provide input signals to a microcontroller, such as an Arduino, which processes the data and determines the direction of maximum light intensity. Based on this analysis, the microcontroller controls motor drivers to adjust the movement of the robot, enabling it to navigate toward the brightest light source.

**Keywords:** Arduino, light-dependent resistors, sensor integration

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**Sodium Tungstate–Catalyzed Synthesis of Functionalized 4-Phenyl-4,5-dihydro-1H-benzo[f][1,3,5]triazepin-2(3H)-one Derivatives in Ethanol****Revathi G**

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**Abstract**

A convenient and efficient method has been developed for the synthesis of functionalized 4-Phenyl-4,5-dihydro-1H-benzo[f][1,3,5]triazepin-2(3H)-one derivatives using sodium tungstate as a catalyst in ethanol under heating conditions. The reaction progress was monitored by thin-layer chromatography (TLC) to ensure completion. Upon completion, the reaction mixture was allowed to cool to room temperature, and the resulting precipitate was isolated by simple filtration. The crude product was purified by washing with water (10 mL) followed by ethanol (5 mL) to afford the desired compounds in good yields. The developed protocol offers operational simplicity, mild reaction conditions, and an environmentally benign solvent system, making it an efficient and practical approach for the synthesis of biologically relevant benzo[f][1,3,5]triazepinone derivatives.

**Keywords:** 4-Phenyl-4,5-dihydro-1H-benzo[f][1,3,5]triazepin-2(3H)-one, NMR, FTIR, Mass Spectroscopy and biological activities.

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**Morphological, Magnetic and Antibacterial Studies of Schiff Base Functionalized  
Superparamagnetic ZnO Nanoparticles**

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**Abstract**

The drug 3-[(phenylimino)methyl]-4H- chromen-4-one belongs to the schiff base compound. IR, H1 NMR and C 13 NMR confirm the structure of the schiff base 3-[(phenylimino)methyl] 4H- chromen-4-one. Superparamagnetic coated aminoethyl amino Zinc oxide nanoparticles were prepared and loaded with the drug 3-[(phenylimino)methyl]-4H- chromen-4-one. The morphology of the compound and the drug loaded Zinc oxide nanoparticles were studied by using SEM, XRD, TEM, particles size and VSM. The biological activity of the compound and the drug loaded Zinc oxide nanoparticles were studied by using gram positive and gram-negative bacteria.

**Keywords:** Zinc Oxide, Schiff base

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**IOT-Based Smart Stadium Management System****Sandhiya R**

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**Abstract**

The increasing scale of sports events demands efficient management of stadium infrastructure, crowd control, energy utilization, and security systems. Traditional stadium management methods often face challenges such as overcrowding, inefficient resource usage, delayed emergency response, and high operational costs. This paper proposes an IoT-based Smart Stadium Management System designed to enhance operational efficiency, safety, and spectator experience. The proposed system integrates IoT sensors, RFID-based smart ticketing, surveillance cameras, environmental monitoring devices, and smart energy management modules. Real-time data collected from sensors such as crowd density sensors, temperature sensors, smoke detectors, and smart meters are transmitted to a centralized cloud platform for analysis and monitoring. Advanced data analytics techniques are used to optimize seating allocation, regulate energy consumption, and detect abnormal activities. The system enables automated crowd management, smart lighting control, emergency alerts, and remote monitoring through a web-based dashboard. By implementing IoT technology, stadium authorities can improve security, reduce operational costs, and provide a safe and enhanced experience for spectators. The proposed model contributes to the development of intelligent sports infrastructure aligned with smart city initiatives.

**Keywords:** Internet of Things, Smart Stadium, Crowd Management, RFID Ticketing,

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**PP -19****Design and Implementation of IOT-Based Smart Monitoring System Using Semiconductor Sensors and Blynk Cloud****Arulmani S**

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**Abstract**

The rapid development of semiconductor devices and Internet of Things (IoT) technology has enabled intelligent monitoring and automation systems. This paper presents the design and implementation of a smart monitoring system using semiconductor-based sensors integrated with the Blynk IoT Platform. The proposed system uses an ESP32 microcontroller to collect real-time data from temperature and humidity sensors and transmit it to the cloud via Wi-Fi connectivity. The Blynk Cloud platform provides remote monitoring, data visualization, and control features through a mobile application. The system ensures secure communication using authentication tokens and enables real-time alerts and graphical data representation. Experimental results show reliable performance, low power consumption, and efficient data transmission. This system can be effectively applied in smart agriculture, industrial monitoring, environmental sensing, and home automation. The proposed approach demonstrates how semiconductor devices combined with cloud platforms can create cost-effective and scalable smart solutions.

**Keywords:** Semiconductor Sensors, IoT, ESP32, Blynk Cloud, Remote Monitoring, Smart Systems.

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**Role of Semiconductor Technology in IOT-Based Smart Systems****Sathishkumar S**

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**Abstract**

Internet of Things (IoT) technology has brought a significant transformation in the modern technological world. It enables intelligent communication between various devices. Semiconductor technology plays a vital role in the design and implementation of IoT systems. IoT devices efficiently operate using semiconductor components such as microcontrollers, sensors, memory chips, communication integrated circuits (ICs), and power management circuits. Advancements in semiconductor manufacturing technologies have enabled the development of integrated circuits with low power consumption, high speed, and compact size. In particular, CMOS scaling technology, System-on-Chip (SoC), and advanced materials such as silicon carbide (SiC) and gallium nitride (GaN) have significantly improved performance and energy efficiency. This research paper discusses the importance of semiconductor devices in IoT architecture, their working principles, and recent advancements in semiconductor materials. It also analyzes challenges such as power consumption, heat dissipation, and miniaturization. This study highlights that semiconductor innovations will serve as the backbone for the future growth of IoT applications in smart cities, healthcare, agriculture, and industrial automation systems.

**Keywords:** Semiconductor, IoT, CMOS, SoC, Low-power devices, Intelligent systems.

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**Edge AI For Smart Agriculture Using IOT Sensors****Surya T**

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**Abstract**

Agriculture plays a vital role in ensuring food security and economic stability, yet traditional farming methods often suffer from inefficient resource utilization, delayed decision making, and crop yield uncertainties. The integration of Internet of Things (IoT) technology with Edge Artificial Intelligence (Edge AI) offers a promising solution for real-time, data-driven smart farming. This paper proposes an Edge AI-based smart agriculture system that utilizes IoT sensors to monitor critical environmental parameters such as soil moisture, temperature, humidity, pH level, and light intensity. Unlike conventional cloud-based systems, the proposed approach performs data processing and intelligent decision-making at the edge device level, thereby reducing latency, bandwidth usage, and dependency on continuous internet connectivity. Machine learning algorithms deployed on edge devices analyze sensor data to predict irrigation needs, detect crop diseases, and optimize fertilizer usage. The system enables automated irrigation control and real-time alerts, improving water efficiency and crop productivity. By integrating IoT sensing with edge intelligence, the proposed model enhances sustainability, reduces operational costs, and supports precision agriculture practices. The study demonstrates that Edge AI-based agricultural monitoring systems can significantly improve farm management efficiency while addressing connectivity challenges in rural areas.

**Keywords:** Edge AI, Internet of Things, Smart Agriculture, Precision Farming, Machine Learning, Automated Irrigation.

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**Obstacle Avoiding Robot****Surya T, Dinesh Kumar S, Gowtham A, Jeeva S**

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**Abstract**

This paper presents the design and development of an intelligent Obstacle Avoiding Robot capable of autonomous navigation in dynamic environments. The primary objective of the project is to enhance mobility and safety in robotic systems by integrating real-time obstacle detection and avoidance mechanisms. The robot is built using a microcontroller-based control system integrated with ultrasonic sensors for distance measurement and DC motors for locomotion. The system continuously monitors its surroundings, detects obstacles within a predefined range, and alters its path accordingly without human intervention. This implementation demonstrates an efficient combination of embedded systems, sensor technology, and control algorithms to achieve reliable autonomous movement. The system is specifically designed to operate in crowded areas such as hospital corridors, patient wards, emergency units, and isolation rooms. By minimizing direct human contact during supply delivery, the robot helps reduce the risk of infection transmission and improves operational efficiency, especially during critical situations like pandemics. Its compact structure and reliable navigation mechanism allow it to maneuver safely around patients, staff, and medical equipment. The robot can also be upgraded with advanced features such as IoT-based remote monitoring, camera integration for surveillance.

**Keywords:** IoT, Robot**Email:** [aj777devil@gmail.com](mailto:aj777devil@gmail.com)

**PP- 23****A Statistical Study on The Comparative Consumption Levels Of Tea and Coffee Among Students and Staffs in an Arts College at Rasipuram****Kavinapriya R**

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**Abstract**

Tea and coffee are integral parts of daily life and social culture. While tea has a long-standing traditional base, coffee consumption has grown rapidly due to urbanization and modernization. Comparative analysis helps understand shifting preferences. Statistical inference enables reliable conclusions about population behavior based on sample data, while AI enhances predictive analysis and pattern recognition. This study combines both approaches to provide a scientific comparison of consumption trends. The study uses primary data collected through structured questionnaires. A random sampling technique ensures representation. Statistical inference methods such as estimation, hypothesis testing (t-test, chi-square), ANOVA, correlation, and regression are applied. AI techniques including classification algorithms and predictive modeling are used to identify consumption patterns and forecast trends. Data analysis is performed using statistical and AI-based software tools.

**Keywords:** AI, ANOVA**Email:** [23ust002@muthayammal.in](mailto:23ust002@muthayammal.in)

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**Synthesis, Characterization and Antimicrobial Studies on metal (II) complexes of 6-phenyl-2-(4-amino antipyrinyl)-4-(4-nitro benzylidene)diamino-1, 3, 5-triazine****Ramkumar S**

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**Abstract**

Triazine based donor-p-acceptor (D-p-A) ligand 6-phenyl-2-(4-amino antipyrinyl)-4-(4-nitro benzylidene) diamino-1, 3, 5-triazine (PAAPNAT) and its copper(II) have been synthesized from 2,4diamino-6-phenyl-1, 3, 5-triazine. The structural features have been investigated from their IR, UV-Vis, <sup>1</sup>H NMR, Mass and ESR spectral studies. Spectroscopic and other analytical data of the complexes suggest square planar for copper (II) and tetrahedral geometry for other metal(II)complexes.Their fluorescence and absorbance properties have been investigated by Luminescence spectroscopy and UV-Vis spectroscopy. The ligand and its complexes were screened for anti-bacterial(*Pseudomonas aeruginosa*, *Escherichia coli*, *Staphylococcus aureus*, *Bacillus subtilis*) and antifungal (*Aspergillusniger*, *Aspergillusflavus*) activities. The metal(II)complexes are found to possess increased biological activities than that of the free ligand. Emission spectra of copper(II),exhibited more intense fluorescence in all media indicating their high photo active nature.

**Keywords:** Triazine, fluorescence, anti-bacterial etc.

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**Chitosan and Modified Derivatives as Emerging Antidiabetic Agents****Elamathi Sand Sathya M**

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**Abstract**

Diabetes mellitus is a chronic metabolic disorder. In addition to taking medication, adjusting the composition of the diet is also considered one of the effective methods to control the levels of blood glucose. Chitosan and its derivatives are natural and versatile biomaterials with health benefits. Chitosan has the potential to alleviate diabetic hyperglycemia by reducing hepatic gluconeogenesis and increasing skeletal muscle glucose uptake and utility. Scientists also focus on the glucose-lowering effect of chitosan oligosaccharide (COS). COS supplementation has the potential to alleviate abnormal glucose metabolism in diabetic rats by inhibiting gluconeogenesis and lipid peroxidation in the liver. Both high and low molecular weight chitosan feeding reduced insulin resistance by inhibiting lipid accumulation in the. COS can reduce insulin resistance but has less ability to reduce hepatic lipids in diabetic rats. A clinical trial showed that a 3-month administration of chitosan increased insulin sensitivity and decreased body weight and triglycerides in obese patients

**Keywords:** Chitosan, Chitosan oligosaccharide, Diabetes mellitus

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**Phytochemical Analysis and Biological Activities of Essential Oil and Oleoresins Derived from *Nigella Sativa* Seeds**

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**Abstract**

GC-MS analysis of black cumin essential oil identified thymoquinone as the major component, followed by p-cymene,  $\alpha$ -thujene, thymohydroquinone, and longifolene (2.0%). Oleoresins extracted using different solvents mainly contained linoleic acid. Antioxidant activity of the essential oil and oleoresins (200 ppm) was evaluated in a linseed oil system using peroxide value, thiobarbituric acid, ferric thiocyanate, ferrous ion chelation, and DPPH radical scavenging assays. The essential oil and ethyl acetate oleoresin exhibited stronger antioxidant activity than synthetic antioxidants. Total phenolic content (mg GAE/g) was highest in essential oil, followed by ethyl acetate, ethanol, and n-hexane) oleoresins. The essential oil showed significant antifungal activity, achieving up to 90% inhibition against *Fusarium moniliforme*, and demonstrated strong antibacterial activity, particularly against Gram-positive bacteria.

**Keywords:** Antioxidant, *Fusarium moniliforme*

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**An Efficient Synthesis of 3,4-dihydropyrimidinone  
Derivatives and its Biological Evaluation**

**SanthoshkumarV**

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**Abstract**

A simple efficient approach has been developed for the synthesis of 3,4-dihydropyrimidinone analogs. The Synthesis of Dihydropyrimidones (DHPMs) and their thio-analogues have become popular in the world of synthetic organic chemistry due to their activities such as antibacterial, anti-viral, anti-inflammatory, anti-hypertensive and anti-tumor. In this paper we have synthesis 3,4-dihydropyrimidinone from phosphorus pentoxide followed by aimed to synthesis 3,4-dihydropyrimidinone in a simple step process. The synthesized compound was characterized using spectroscopic methods viz., UV, IR and NMR spectra and biological activity. In summary, the synthesized 3,4-dihydropyrimidinone from natural product extract which showed over all significant antibacterial activities.

**Keywords:** Dihydropyrimidinone, biological activity.

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**Smart AI Tools and Sensor-Assisted Innovations in Advanced Analytical Techniques****Sathya M**

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**Abstract**

Artificial intelligence (AI) is a scientific and technical field focused on developing engineered systems that generate outputs such as predictions, recommendations, decisions, and content based on human-defined objectives. The integration of AI with analytical techniques has significant potential to transform decision-making and drive innovation across multiple sectors. AI enhances data detection, segmentation, and image resolution, with convolutional neural networks (CNNs) effectively analyzing complex image datasets for material characterization. Machine learning is increasingly combined with analytical methods such as gas chromatography (GC), high-performance liquid chromatography (HPLC), GC-MS, LC-MS, ultraviolet (UV) and infrared (IR) spectroscopy, mass spectrometry (MS), colorimetry, and biosensing techniques. AI-based models improve data interpretation, accuracy, and efficiency, particularly when supported by chemometric tools in UV and IR spectroscopy. Real-time AI analysis of sensor data enables rapid and actionable conclusions, benefiting fields such as environmental monitoring and pharmaceuticals. By processing complex multi-dimensional sensor data beyond the capability of conventional methods, AI enhances error reduction, process automation, and precise analysis of complex compounds. Overall, AI-driven tools and smart sensors are advancing modern analytical techniques toward faster, more accurate, and automated systems.

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**Smart Ride Schield****Mauliy C and Rubesh D**

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**Abstract**

Road accidents involving two-wheeler riders remain a significant global safety concern, often leading to severe injuries and fatalities due to delayed emergency response and lack of timely communication. To address this challenge, this paper proposes “Smart Ride Shield,” an IoT-based intelligent helmet designed to automatically detect accidents and generate real time emergency alerts. The system integrates an ESP32 microcontroller with an MPU6050 accelerometer and gyroscope sensor to continuously monitor rider motion and orientation. A robust three-layer accident detection algorithm is implemented, consisting of impact detection through sudden acceleration changes, tilt detection based on abnormal angular deviation, and no-motion detection for a defined duration to confirm rider inactivity. This multi-layer decision mechanism improves detection accuracy and minimizes false positives. Additionally, an MQ3 alcohol sensor is incorporated to monitor alcohol presence and provide immediate warning alerts to enhance rider safety and prevent unsafe driving conditions. Upon confirming an accident, the ESP32 transmits alert data via Wi-Fi to a cloud automation platform, which instantly delivers emergency notifications through a Telegram bot, including a clickable location tracking link and accident information. This automated communication system ensures rapid response from emergency contacts without requiring manual intervention. The proposed solution is cost-effective, energy-efficient, reliable, and easy to implement using readily available hardware and cloud services. Experimental testing demonstrates accurate accident detection and real-time alert delivery. The Smart Ride Shield system significantly enhances rider safety by reducing emergency response time and providing an intelligent, scalable, and practical solution for modern smart transportation safety applications.

**Keywords:** MQ3 alcohol sensor, ESP32 transmits

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**Surveillance Using ESP32-CAM with Telegram****Arulmani S, Abishek R, Inbatamilan E, Dhulasi Balan V and Aravinth S**

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Namakkal 637408, Tamil Nadu, India.

**Abstract**

This project presents a cost-effective and IoT-based smart surveillance system using the ESP32-CAM module integrated with a Telegram Bot for real-time remote monitoring and control. The ESP32-CAM, equipped with a built-in camera and Wi-Fi capability, captures images either upon user request or through motion detection. The captured images are transmitted instantly to authorized users via the Telegram application, ensuring secure and reliable communication. The system eliminates the need for complex hardware and expensive CCTV infrastructure, making it compact, energy-efficient, and easy to install. Users can remotely access live updates, receive instant alerts, and control the device from anywhere with an internet connection. This solution is suitable for home security, office surveillance, and small-scale monitoring applications. The proposed system demonstrates an affordable, scalable, and user friendly approach to modern surveillance using Internet of Things (IoT) technology.

**Keywords:** IoT, ESP32-CAM, Telegram Bot, Smart Surveillance, Remote Monitoring.

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**Green Synthesis of Tin Oxide (SnO<sub>2</sub>) Nanoparticles Using Clerodendrum phlomidis leaves  
Extracts for photocatalytic degradation of Rhodamine B dye**

**Thenmozhi S and RamkumarS**

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637408, Tamil Nadu, India.

**Abstract**

Green synthesis of tin dioxide (SnO<sub>2</sub>) nanoparticles was biosynthesized using aqueous leaf extract of Clerodendrum phlomidis as a natural reducing and stabilizing agent. The phytochemicals present in the leaf extract effectively reduced tin(II) ions and facilitated the formation of SnO<sub>2</sub> nanoparticles under controlled conditions. Green synthesis uses plant extracts containing secondary metabolites (e.g., flavonoids, phenolics, terpenoids) as reducing and capping agents to form metal/metal-oxide nanoparticles. The synthesized nanoparticles were characterized by X-ray diffraction (XRD), Fourier-transform infrared spectroscopy (FTIR), ultraviolet–visible (UV–Vis) spectroscopy, and electron microscopy (SEM/TEM) to confirm their crystalline structure, functional groups, optical properties, and morphology. The photocatalytic activity of the biosynthesized SnO<sub>2</sub> nanoparticles was evaluated through the degradation of the model pollutant Rhodamine B (RhB) dye under ultraviolet/visible light irradiation. The results demonstrated significant dye degradation efficiency, with kinetic analysis revealing pseudo-first-order behaviour, attributed to the generation of reactive oxygen species and effective charge separation at the nanoparticle surface. This green approach offers a synthesizing SnO<sub>2</sub> photocatalysts for environmental remediation of dye-contaminated wastewater.

**Keywords:** Clerodendrum phlomidis, Rhodamine B, Flavonoids, Degradation

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## **A Comparative Statistical Study on the Clinical Profile and Outcomes of Lung and Breast Cancer Patients**

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### **Abstract**

The present study focuses on statistical inference and data analysis in a comparative statistical study on the clinical profile and outcomes of lung and breast cancer patients. Cancer remains one of the leading causes of morbidity and mortality worldwide, with lung and breast cancers representing significant public health concerns. A comparative understanding of their clinical characteristics and treatment outcomes is essential for improving patient management strategies. The study adopts a retrospective and analytical research design. Clinical data were collected from hospital records of diagnosed lung and breast cancer patients. Variables such as age at diagnosis, stage of cancer, histopathological characteristics, and treatment modalities, duration of treatment, survival rate, and complications were analyzed. Statistical techniques including descriptive statistics (mean, standard deviation, and percentage analysis), inferential statistics (t-test, chi-square test), survival analysis, and regression models were employed to identify significant differences and associations between the two groups.

The findings revealed notable variations in clinical presentation, stage at diagnosis, treatment response, and survival outcomes between lung and breast cancer patients. Statistical inference indicated significant associations between stage of cancer, treatment modality, and patient survival in both groups. The study underscores the importance of early detection, tailored treatment strategies, and data-driven clinical decision-making to improve cancer outcomes.

**Keywords:** Statistical Inference, Data Analysis, Clinical Profile, Treatment Outcomes, Lung Cancer, Breast Cancer, Comparative Study, Survival Analysis.

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**Women Safety Surveillance System****Santhiya R, Yogawarshan S, Kavin S and Naveen V**

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**Abstract**

Women's safety has become a major social concern due to the increasing number of harassment and assault incidents worldwide. To address this issue, this project presents the design and development of a Women Safety Tracking Device that provides real-time monitoring, emergency alerting, and location tracking to ensure rapid assistance during critical situations. The proposed system integrates GPS, GSM, and IoT technologies to detect emergencies and transmit the victim's live location to predefined contacts and authorities. The device can be activated through a panic button or sensor-based trigger, enabling immediate communication even in remote areas. This system aims to reduce response time and improve the chances of rescue during emergencies. The developed prototype demonstrates reliable performance in real-time tracking. By leveraging modern embedded systems and wireless communication technologies, the proposed solution contributes to enhancing personal security and empowering women with a smart safety mechanism. This project highlights the potential of IoT-based safety systems in addressing societal challenges and promoting safer environments for women.

**Keywords:** Women Safety Tracking Device

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**Investigates the Impact of Doping and Temperature on Metal Oxide Thin Films Using Jet Nebulizer Spray Pyrolysis Technique**

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**Abstract**

Transition metal oxide thin films have high potential on many applications by their unique structural, optical and electrical properties. Doping and temperature of material preparation change the ambience and nature of thin films. Here we investigate, impact on calcium doped manganese oxide thin film properties by different ratio of calcium doping (Ca:Mn = 50:50, 40:60 and 30:70) and calcinating temperatures (350°C, 450°C and 550°C). Thin films fabricated by jet nebulizer spray pyrolysis technique (JNS) under optimized conditions and materials are calcinated under nitrogen atmosphere for 2 hrs. Morphology characterization reveals, nanosize spherical shape metal oxide particles are uniformly deposited over the substrate with small aggregation. Crystalline nature was improved at high calcinations temperature and particle size lies in the range of 40-70 nm. Higher ratio of doping reduces crystalline nature and particles are amalgamating to form small clusters. Manganese oxide crystal lattice incorporated by calcium metal that narrows the bandgap energy 2.5 to 2.1 eV. Fabricated calcium doped manganese oxide thin films effectively sense 6% ethanol owing to high selectivity property.

**Keywords:** Thin films, JNS technique, Sensor application, Doping and Calcinating temperature

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**Photocatalytic degradation studies of Methylene Blue dye using La-Ce/MWCNT composite****\*Dhivya A<sup>1</sup> and Loganathan A<sup>2</sup>**

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<sup>2</sup>Department of Chemistry, Thriuvalluvar Government Arts College, Rasipuram, Namakkal, Tamil Nadu – 637401

**Abstract**

The synthesis, characterization of La-Ce/MWCNT composite catalyst was studied systematically. The prepared photocatalyst La-Ce/MWCNT was tested for the degradation of Methylene Blue (MB) dye under UV and solar light irradiations. The composite was characterized using X-ray diffraction (XRD) and scanning electron microscopy (SEM), which confirmed the successful incorporation of cerium, lanthanum, in the MWCNT matrix. XRD analysis revealed distinct peaks corresponding to the monoclinic phase of CeO<sub>2</sub>, cerium oxide, and lanthanum indicating the formation of the composite. The photocatalytic activity of La-Ce/MWCNT was evaluated under both UV and visible light irradiation, showing significant dye degradation, with 92.1% degradation under UV light at a dye concentration of 30 mg/L. The results suggest that La-Ce/MWCNT is a highly efficient photocatalyst for organic pollutant degradation, offering potential applications in environmental remediation and wastewater treatment.

**Key Words:** Lanthanum, Cerium oxide, MWCNT, Photocatalysis and Elluent.

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**Role of Advanced Semiconductor Materials in Next-Generation Photovoltaic Technologies****Geetha P**

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**Abstract**

The increasing global demand for sustainable energy has intensified research into high-efficiency photovoltaic (PV) technologies. Semiconductor materials form the backbone of solar energy conversion systems due to their unique electronic band structures and tunable optoelectronic properties. While crystalline silicon dominates the commercial PV market, its theoretical efficiency limits and fabrication costs motivate the exploration of next-generation semiconductor materials. This paper presents a comprehensive review of advanced semiconductor systems including perovskites, III V compound semiconductors, organic semiconductors, and quantum dot nanostructures. The physical principles governing photovoltaic action such as photon absorption, charge carrier generation, separation, and transport are discussed in relation to material properties such as band gap, mobility, and defect density. Emphasis is placed on band gap engineering, tandem architectures, and Nano structuring techniques that significantly enhance power conversion efficiency. Current challenges including material stability, toxicity, scalability, and long-term degradation are critically analyzed. The study concludes that continued innovation in semiconductor design and interface engineering is essential for achieving cost-effective, high-performance photovoltaic systems suitable for large-scale deployment.

**Keywords:** Semiconductors, Photovoltaic's, Perovskite Solar Cells, Band gap Engineering, Tandem Cells, Quantum Dots

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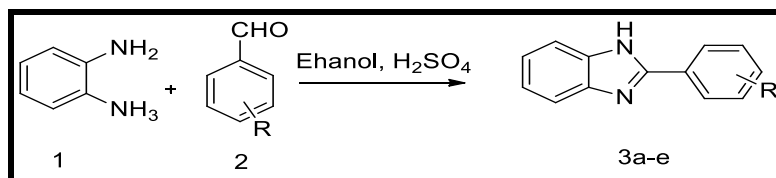
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**Sulfuric Acid–Catalyzed Synthesis and Spectral Characterization of 2-Phenyl-1H-benzo[d]imidazole Derivatives in Ethanol****\*Poovizhi A, Vinoth N and Dhivya A**

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**Abstract**

An efficient and straightforward method has been developed for the synthesis of 2-phenyl-1H-benzo[d]imidazole derivatives via the condensation of aldehydes (1 mmol) with aromatic amines (1 mmol) in ethanol using sulfuric acid as a catalyst. The reaction was carried out in a 50 ml round-bottom flask under stirring at 80°C, providing a simple and cost-effective approach to benzimidazole formation. The progress of the reaction was monitored by thin-layer chromatography (TLC) using a 1:1 mixture of ethyl acetate and n-hexane as the mobile phase. Upon completion, the reaction mixture was filtered, and the obtained precipitate was washed with water (10 ml) to afford the pure product. All synthesized compounds were structurally confirmed and characterized by spectroscopic techniques including <sup>1</sup>H NMR, <sup>13</sup>C NMR, IR, and mass spectrometry. The protocol demonstrates operational simplicity, mild conditions, and good efficiency, making it a practical method for the preparation of biologically important benzimidazole derivatives.

**Scheme 1:** Synthesis of 2-phenyl-1H-benzo[d]imidazole derivatives

**Keywords:** Aldehyde, aromatic amine, ethanol, sulfuric acid, benzimidazole.

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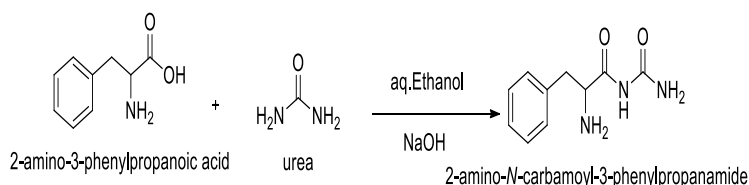
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**Aqueous Ethanol-Mediated Synthesis and Structural Confirmation of 2-Amino-N-carbamoyl-3-phenylpropanamide Using Sodium Hydroxide as Catalyst****\*Kokila M, Vinoth M and Dhivya A**

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**Abstract**

A simple and efficient synthetic protocol has been developed for the preparation of 2-amino-N-carbamoyl-3-phenylpropanamide using aqueous ethanol as a green solvent system and sodium hydroxide as a base catalyst. The reaction was carried out under mild heating conditions, enabling effective formation of the target compound with good yield and purity. The use of aqueous ethanol enhances solubility, reduces the need for hazardous organic solvents, and supports environmentally friendly reaction conditions. Upon completion of the reaction, the product was isolated by filtration and purified by washing with suitable solvents. The synthesized compound was structurally confirmed using standard analytical and spectroscopic techniques including FT-IR, <sup>1</sup>H NMR, <sup>13</sup>C NMR, and mass spectrometry. The developed method demonstrates operational simplicity, cost-effectiveness, and eco-friendly advantages, making it a practical approach for the synthesis of biologically significant amide derivatives.



Scheme 1: Synthesis of 2-amino-N-carbamoyl-3-phenylpropanamide molecule

**Keywords:** Propanoic acid, urea, ethanol, sodium hydroxide, green solvent, amide.

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**Cyclodextrin Complexation with nanoparticles in cancer Studies****Srimathi M**

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**Abstract**

The field of cancer nanotheranostics is rapidly evolving, with cyclodextrin (CD)-based nanoparticles emerging as a promising tool. CDs, serving as nanocarriers, have higher adaptability and demonstrate immense potential in delivering powerful anti-cancer drugs, leading to promising and specific therapeutic outcomes for combating various types of cancer. The unique characteristics of CDs, combined with innovative nanocomplex creation techniques such as encapsulation, enable the development of potential theranostic treatments. The different techniques administered for effective nanotheranostics applications of CD-associated complex compounds in the domain of cancer treatments. The experimentations on various loaded drugs and their complex conjugates with CDs prove effective in *in vivo* results. Various cancers can have potential nanotheranostics cures using CDs as nanoparticles along with a highly efficient process of nanocomplex development and a drug delivery system. In conclusion, nanotheranostics holds immense potential for targeted drug delivery and improved therapeutic outcomes, offering a promising avenue for revolutionizing cancer treatments through continuous research and innovative approaches.

**Keywords:** Cyclodextrin, Nano complex, Drug delivery

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**Evaluation of Green-Synthesized versus Market CuO and FeO Nanoparticles in Enhancing Rice Seedling Performance****Dhanalakshmi R and Sathya M**

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**Abstract**

The extensive application of nanoparticles (NPs) driven by industrial development has created serious environmental concerns, including loss of biodiversity, climate-related impacts, agricultural and saline soil degradation, and water pollution. Iron oxide (FeO) and copper oxide (CuO) nanoparticles are widely utilized in industries such as biomedical equipment, glass production, paint manufacturing, and semiconductor doping because of their distinctive physicochemical properties. This widespread application necessitates an assessment of their impact on plant growth and agricultural systems. In this study, we investigated the comparative effects of green-synthesized versus market-procured CuO and FeO NPs on rice seedlings. The green synthesis of CuO and FeO NPs was achieved using a plant extract from Amragandhi Haridra (*Curcuma amada*). The synthesized nanoparticles were characterized using UV-Vis spectroscopy, particle size analysis (PSA), XRD, FE-SEM with EDX, and FTIR to determine their size, morphology, functional groups, and crystalline structure.

**Keywords:** Iron oxide (FeO) and copper oxide (CuO) nanoparticles, Rice seed, *Curcuma amada*

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## Influence of Chemical Oxidation on Structural Modification of Single-Walled Carbon Nanotubes

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### Abstract

study systematically examines the effect of chemical oxidation on single-walled carbon nanotubes (SWNTs) using different oxidants. SWNTs synthesized by chemical vapor deposition (CVD) were oxidized with dilute nitric acid (2.6 M), a concentrated  $\text{H}_2\text{SO}_4/\text{HNO}_3$  mixture (3:1 v/v), and alkaline  $\text{KMnO}_4$ . Structural changes were characterized by infrared spectroscopy and transmission electron microscopy (TEM). Results show that each oxidant introduces distinct functional groups. Dilute nitric acid causes mild oxidation, forming carboxylic acid ( $-\text{COOH}$ ) groups mainly at pre-existing defect sites without significant increase over time. In contrast,  $\text{H}_2\text{SO}_4/\text{HNO}_3$  treatment creates additional defects and increases  $-\text{COOH}$  groups along the nanotube walls. Alkaline  $\text{KMnO}_4$  introduces  $-\text{OH}$ ,  $-\text{CO}$ , and  $-\text{COOH}$  groups in varying amounts. Oxidation proceeds through two stages: defect generation and defect consumption. Initially, oxidants attack the graphene structure, forming active sites such as  $-\text{OH}$  and  $-\text{CO}$ . Further oxidation then destroys the graphene framework around these sites, depending on the oxidant strength and etching capability.

**Keywords:** Carbon nano tube, Nitric Acid, Alkaline  $\text{KMnO}_4$

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**Valorization of Samanea saman Seeds: Extraction and Characterization of Seed Oil****Brindha N and Sathya M**

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**Abstract**

Samanea saman seed oil was extracted from mature seeds using the Soxhlet solvent extraction method, yielding approximately 11–12% oil under optimized conditions. The extracted oil was greenish-yellow in color and free-flowing, with a specific gravity of about 0.88 and a refractive index of nearly 1.47. The physicochemical properties showed an acid value of approximately 27 mg KOH/g, a saponification value of about 187 mg KOH/g, an iodine value of around 65.8 g I<sub>2</sub>/100 g oil, and a low peroxide value, indicating moderate unsaturation and good oxidative stability. Fatty acid analysis revealed a balanced composition of saturated and unsaturated fatty acids, with linoleic acid as the major component, followed by oleic and behenic acids. Palmitic, stearic, and eicosanoic acids were identified as the primary saturated fatty acids. Overall, Samanea saman seed oil demonstrates promising characteristics for applications in biodiesel production, soap manufacturing, cosmetics, and other industrial uses.

**Keywords:** Samanea saman, Fatty acid, linoleic acid

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**An Ai-Enhanced Statistical Time Series Study of Online Sales for Forecasting and  
Predictive Analytics**

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**Abstract**

The rapid expansion of e-commerce has generated extensive online sales data, creating opportunities for advanced statistical analysis and Artificial Intelligence (AI)-based forecasting. This study presents a comprehensive statistical investigation of online sales using time series analysis integrated with AI techniques to improve prediction accuracy and business decision-making. Descriptive statistics are employed to summarize central tendency and dispersion in sales data, while trend and seasonal components are examined through time series decomposition methods.

Stationary of the data is tested using the Augmented Dickey–Fuller (ADF) test, and autocorrelation structures are analyzed using Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF) plots. Forecasting models including Moving Average (MA), Exponential Smoothing (Holt–Winters), and Autoregressive Integrated Moving Average (ARIMA) are developed to capture temporal dynamics. Additionally, AI-based models such as Artificial Neural Networks (ANN) and machine learning regression techniques are applied to model nonlinear patterns in consumer purchasing behavior.

Model performance is evaluated using statistical accuracy measures including Mean Absolute Error (MAE), Mean Absolute Percentage Error (MAPE), and Root Mean Square Error (RMSE). Comparative results indicate that AI-enhanced models outperform traditional statistical methods in handling complex sales fluctuations. The study provides practical insights for demand forecasting, inventory optimization, and revenue management in online retail businesses

**Keywords:** Online Sales, Time Series Analysis, Artificial Intelligence (AI), ARIMA Model, Exponential Smoothing, Artificial Neural Networks (ANN), Forecasting, Predictive Analytics, ACF and PACF, MAE, RMSE, MAPE.

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**AI-Driven Time Series Analysis: A Comparative Study and Forecasting of Rural Vs Urban Electricity Consumption (2021–2025)**

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**Abstract**

The period from 2021 to 2025 marks a transformative phase in global electricity consumption patterns, driven by digitalization, decentralized energy systems, and post-pandemic economic recovery. This study presents a comparative time series analysis of rural and urban electricity consumption, highlighting structural differences in load dynamics and growth trajectories. Urban electricity demand demonstrates relatively stable, linear growth with high-frequency volatility influenced by industrial automation, smart home integration, and commercial cooling systems. In contrast, rural demand exhibits exponential and fluctuating growth, primarily driven by agricultural mechanization, rural electrification initiatives, and increasing household appliance penetration.

To model these complex and non-linear patterns, Long Short-Term Memory (LSTM) neural networks are employed, demonstrating superior predictive performance compared to conventional statistical forecasting approaches. The model integrates exogenous variables such as climatic variations and socio-economic indicators to enhance forecasting precision. Results indicate that urban consumption is approaching saturation due to energy-efficient technologies, while rural regions show a rising compound annual growth rate (CAGR), reshaping future grid demand structures.

Forecast projections through 2025 emphasize the need for AI-driven demand-side management and sector-specific infrastructure strategies. The findings underscore that adaptive, localized smart grid solutions are essential to ensure resilience, efficiency, and equitable energy distribution across diverse demographic landscapes.

**Keywords:** LSTM (Long Short-Term Memory), Electricity Demand Forecasting, Rural Electrification, Urban Load Profiling, Time Series Analysis, Deep Learning in Energy Systems, Grid Resilience, Seasonal Trend Modeling, Predictive Analytics, Smart Grid Management.

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**Hybrid AI Models for Time Series Forecasting****Valli M**

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**Abstract**

Time series forecasting plays a critical role in domains such as finance, energy, healthcare, and supply chain management, where accurate predictions directly influence strategic decision-making. Traditional statistical models such as ARIMA effectively capture linear dependencies and seasonality but often struggle with nonlinear and complex patterns. On the other hand, artificial intelligence techniques including deep learning architectures like Long Short-Term Memory (LSTM) networks excel at modeling nonlinear relationships yet may overlook statistical properties such as trend stationarity and residual structure.

Hybrid AI models integrate classical statistical approaches with machine learning and deep learning techniques to leverage the strengths of both paradigms. Typically, statistical models are used to capture linear components and seasonality, while AI models learn residual nonlinear patterns. This combined framework enhances forecasting accuracy, robustness, and generalization across diverse datasets.

This paper reviews various hybrid architectures, including ARIMA–LSTM, CNN–LSTM, and decomposition-based ensemble models, and discusses their applications in financial market prediction, energy load forecasting, and demand estimation. Comparative analysis demonstrates that hybrid approaches consistently outperform standalone statistical and deep learning models, particularly for long-horizon and highly volatile time series data. Challenges such as computational complexity, interpretability, and hyper parameter optimization are also examined. The study concludes by outlining future research directions, including explainable hybrid models and probabilistic forecasting frameworks.

**Keywords:** Hybrid forecasting; Time series analysis; Artificial intelligence; Deep learning; ARIMA–LSTM; Ensemble models; Nonlinear modeling; Forecast accuracy; Machine learning; Residual learning.

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**An AI-Based Student Performance Prediction Model Using Statistical Inference and Data Analysis Techniques**

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**Abstract**

This study proposes an AI-based student performance prediction model using statistical inference and data analysis techniques. The primary objective is to predict students' academic outcomes by integrating traditional statistical methods with artificial intelligence tools. Student-related data such as attendance records, internal assessment scores, assignment performance, study hours, and academic background are used as input variables.

Statistical inference techniques, including descriptive statistics, correlation analysis, hypothesis testing, and regression modeling, are applied to identify significant factors affecting student performance. Data analysis and predictive modeling are carried out using AI tools and machine learning regression algorithms to improve prediction accuracy and efficiency.

The proposed model enables early identification of academically at-risk students, supports data-driven educational planning, and enhances institutional decision-making. The results demonstrate that the integration of statistical inference with AI-based data analysis provides a reliable, scalable, and intelligent framework for educational analytics and student performance prediction.

**Keywords:** AI in Education, Student Performance Prediction, Statistical Inference, Data Analysis, Regression Models, Machine Learning, Predictive Analytics, Educational Data Mining, Academic Analytics, Artificial Intelligence Tools

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**Statistical Analysis of Employee Performance (Using AI Techniques)**

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**Abstract**

This study aims to analyze and predict employee performance using statistical methods integrated with Artificial Intelligence (AI) techniques. The dataset consists of employee-related variables such as experience, educational qualification, attendance, training hours, productivity scores, and appraisal ratings. Initially, descriptive statistics including mean, standard deviation, and correlation analysis were applied to understand the distribution and relationships among variables. Performance.

To enhance predictive accuracy, machine learning algorithms such as Linear Regression, Logistic Regression, Decision Trees, and Random Forest were implemented. Feature selection techniques were applied to determine the most influential performance indicators. Model performance was evaluated using accuracy, precision, recall, F1-score, and  $R^2$  metrics.

The results indicate that training hours, work experience, and attendance significantly impact employee performance levels. The AI-based predictive model demonstrated high classification accuracy, enabling effective performance evaluation and decision-making in human resource management. The study concludes that integrating statistical analysis with AI techniques improves organizational performance assessment systems and supports data-driven managerial decisions

**Keywords:** Employee Performance, Artificial Intelligence, Machine Learning, Statistical Analysis, Predictive Modeling, Random Forest, Logistic Regression, Human Resource Analytics, Feature Selection, Performance Evaluation.

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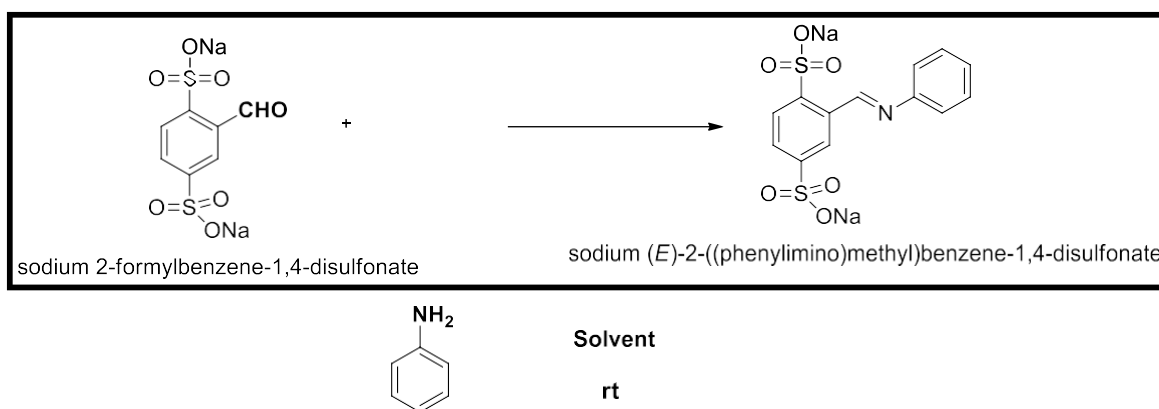
### Efficient Preparation of Schiff Base Sodium (E)-2-((Phenylimino)methyl) benzene- 1,4-disulfonate Analogues under Mild Conditions

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#### Abstract

Sodium (E)-2-((phenylimino)methyl)benzene-1,4-disulfonate derivatives were synthesized through a simple and efficient Schiff base condensation reaction between sodium 2-formylbenzene-1,4-disulfonate and various substituted anilines under mild reaction conditions. The reaction was carried out in aqueous ethanol medium at room temperature, providing good to excellent yields within short reaction time. The formation of the imine ( $-\text{CH}=\text{N}-$ ) linkage was confirmed by spectroscopic techniques including FT-IR,  $^1\text{H}$  NMR,  $^{13}\text{C}$  NMR, and UV-Visible spectroscopy, which indicated the successful conversion of aldehyde to the corresponding azomethine derivatives. The synthesized compounds exhibited good water solubility due to the presence of disulfonate groups, enhancing their potential applicability in pharmaceutical and biological fields. The developed synthetic protocol offers advantages such as operational simplicity, eco-friendly solvent system, high yield, and easy purification. These derivatives may serve as promising candidates for further investigation in antimicrobial, antioxidant, and anti-inflammatory applications.



**Keywords:** Synthesis of sodium (E)-2-((phenylimino)methyl)benzene-1,4-disulfonate derivatives

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**TADF Conducting polymers for OLED applications****VADIVU T**

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**Abstract:**

Thermally activated delayed fluorescence (TADF) polymers have emerged as a promising class of emissive materials for solution-processed organic light-emitting diodes (SP-OLEDs) due to their ability to utilize both singlet and triplet excitons for efficient light generation. Recent advances in molecular design, including main-chain donor-acceptor architectures, pendant type systems, through-space charge transfer structures, and copolymer strategies, have enabled significant improvements in their photophysical and electroluminescent properties. These polymers exhibit favourable characteristics such as high photoluminescence quantum yields, small singlet-triplet energy gaps, and efficient delayed fluorescence, leading to encouraging device performances. In addition, their polymeric nature provides important advantages, including reduced aggregation-caused quenching, excellent film-forming ability, and compatibility with low-cost solution-processing techniques. Despite these benefits, TADF polymers still face limitations compared to small-molecule emitters, particularly in achieving higher external quantum efficiencies and superior color purity with narrow emission bandwidths. Therefore, continued research focused on molecular engineering, structural optimization, and device design is essential to further enhance their performance and fully exploit their potential for next-generation, high-efficiency SP-OLED applications.

**Keywords:** TADF polymers; solution-processed OLEDs, donor–acceptor architecture, singlet–triplet energy gap ( $\Delta E_{ST}$ ), reverse intersystem crossing (RISC), delayed fluorescence, photoluminescence quantum yield, external quantum efficiency; molecular engineering.

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**Proximate Analysis and Calorific Evaluation of Coal Samples.****Mathiyazhagan M**

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**Abstract**

The present study focuses on the systematic preparation and proximate analysis of coal samples to evaluate their fuel characteristics and industrial suitability. Proper sample preparation, including air drying and oven drying, was carried out to ensure accurate analytical results. The coal sample was analyzed for inherent moisture, equilibrated moisture, ash content, and volatile matter using standard laboratory procedures. Moisture content determination plays a crucial role in assessing the handling and combustion efficiency of coal. Ash content analysis provides insight into the non-combustible residue affecting furnace performance, while volatile matter determination indicates combustion behavior and reactivity. The gross calorific value (GCV) of the coal sample was measured using a bomb calorimeter, and necessary acid corrections were applied to obtain accurate heat values. The findings of this study emphasize the importance of standardized coal testing methods for quality control, efficient energy utilization, and optimal industrial performance. Proper proximate analysis ensures better fuel management, improved combustion efficiency, and reduced environmental impact in thermal power plants and other coal-based industries. The results obtained from the proximate analysis help in determining the quality, rank, and energy potential of the coal. This study highlights the importance of standardized coal testing methods in power generation, steel manufacturing, and other industrial applications.

**Keyword:** Calorific Evaluation, GCV

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**Synthesis and Characterization of Cobalt Oxide (Co<sub>3</sub>O<sub>4</sub>)  
Nanoparticles by Co-Precipitation Method**

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**Abstract:**

Cobalt oxide (Co<sub>3</sub>O<sub>4</sub>) nanoparticles have attracted significant attention due to their remarkable physicochemical properties and wide applications in catalysis, energy storage, gas sensing, and magnetic materials. In the present study, Co<sub>3</sub>O<sub>4</sub> nanoparticles were synthesized via a simple and cost-effective co-precipitation method. An aqueous solution of cobalt precursor (such as cobalt nitrate or cobalt chloride) was reacted with a suitable precipitating agent under controlled pH, temperature, and stirring conditions to obtain cobalt hydroxide precipitate. The precipitate was filtered, washed, dried, and subsequently calcined to form crystalline Co<sub>3</sub>O<sub>4</sub> nanoparticles. The synthesized nanoparticles were characterized using various analytical techniques to evaluate their structural, morphological, and optical properties. X-ray diffraction (XRD) analysis confirmed the formation of single-phase cubic spinel structured Co<sub>3</sub>O<sub>4</sub> with good crystallinity. The average crystallite size was estimated using the Scherrer equation. Fourier Transform Infrared Spectroscopy (FTIR) verified the presence of characteristic metal–oxygen vibrations corresponding to Co–O bonds. Additional techniques such as UV–Visible spectroscopy were used to study the optical behavior of the nanoparticles. The results demonstrate that the co-precipitation method is an efficient, reproducible, and scalable approach for synthesizing high-purity Co<sub>3</sub>O<sub>4</sub> nanoparticles with controlled size and morphology. The obtained nanoparticles exhibit properties suitable for potential applications in catalysis, electrochemical devices, and environmental remediation.

**Keywords:** Cobalt oxide, Co-precipitation method, single-phase cubic spinel structure.

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**Green Synthesis of Zinc Oxide Nanoparticles Using Fruit Leaf Extract Of Psidium  
Guajava**

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**Abstract**

Green synthesis methods for nanoparticles have garnered significant attention for their sustainable potential. This research focuses on the synthesis and characterization of Zinc Oxide Nanoparticles (ZnO-NPs) using Psidium guajava leaf extract via a bio-reduction method. The study was carried out at the Physics R&D Laboratory, Muthayammal College of Arts and Science, during the 2025-26 academic period. The reaction process, involving the bio-reduction of zinc sulfate, was marked by a distinct color change from brown to light yellow. X-ray diffraction (XRD) patterns confirmed the formation of a hexagonal crystal structure with an average particle size of 20.5 nm. Furthermore, Fourier Transform Infrared (FTIR) analysis elucidated the functional groups involved in the stabilization of the nanoparticles. Optical studies indicated a band gap energy slightly larger than bulk ZnO (3.4 eV), coupled with strong absorbance in the visible region (200–1100 nm). Consequently, the synthesized ZnO-NPs demonstrate significant potential for application in solar cells, optoelectronics, spintronics, wastewater treatment, and high-performance asymmetric supercapacitors.

**Keywords:** ZnO-NPs, Psidium guajava

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**Growth and characterization of Pure and Neem added Copper Sulphate and its  
Antimicrobial Characterization.**

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**Abstract**

The single crystal of copper sulphate was grown using slow evaporation solution growth technique at room temperature. The grown single crystal has been investigated through powder XRD studies and revealed that the grown crystal belongs to the triclinic system with the space group of P1. Different spectroscopic and analytical techniques used for analyzing the structure and properties of the grown crystal, such as FTIR and UV-Vis. The mechanical strength of the crystal has been studied by using a Vickers' micro hardness test. The anti Bacterial characterization of pure Copper sulphate crystal were lower than the Neem added copper sulphate crystal. From this it conclude that the Neem added Copper sulphate was better for antibacterial activity than the pure Copper sulphate crystal. Hence the Neem added Copper sulphate been better for medicinal applications. The micro hardness is higher for pure Copper sulphate crystal conclude for device fabrication.

**Keywords:** Powder XRD, FTIR, UV-Vis, micro-hardness and antimicrobial activity.

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**Synthesis and Characterization of CoFe<sub>2</sub>O<sub>4</sub> Nanoparticles Prepared by the  
Co-precipitation Method**

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**Abstract**

Cobalt ferrite (CoFe<sub>2</sub>O<sub>4</sub>) nanoparticles were synthesized via a simple wet chemical method and systematically characterized to evaluate their structural, morphological, and optical properties. Phase identification and crystallographic analysis were carried out using X-ray diffraction (XRD), which confirmed the formation of a reverse cubic spinel structure with good crystallinity and phase purity. The diffraction peaks were well indexed to the standard spinel ferrite structure, indicating successful synthesis of cobalt ferrite nanoparticles without secondary phases. Surface morphology and particle size distribution were examined using Atomic Force Microscopy (AFM). The AFM analysis revealed relatively uniform particle distribution with slight agglomeration, and the average particle size was found to be approximately 250 nm. Optical properties were investigated using UV–Visible spectroscopy. The synthesized nanoparticles exhibit specific characteristics that make them suitable for potential biomedical applications.

**Keywords:** Cobalt ferrite, wet chemical method, spinel structure.

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**Synthesis and characterization of nickel doped cobalt oxide nanoparticles by co-precipitation method**

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**Abstract**

Nickel-doped cobalt oxide (Ni-Co<sub>3</sub>O<sub>4</sub>) nanoparticles were synthesized via a controlled co-precipitation technique to enhance the structural and optical properties of spinel Co<sub>3</sub>O<sub>4</sub>. The incorporation of Ni<sup>2+</sup> ions into the Co<sub>3</sub>O<sub>4</sub> lattice was systematically investigated using X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR), and UV-Visible spectroscopy. XRD patterns confirmed the formation of a single-phase cubic spinel structure without detectable secondary phases, indicating successful substitution of Ni<sup>2+</sup> into the Co<sub>3</sub>O<sub>4</sub> crystal lattice. The crystallite size was estimated using the Debye-Scherrer equation and found to be in the nanometre range. FTIR spectra exhibited characteristic absorption bands corresponding to tetrahedral and octahedral metal-oxygen stretching vibrations, confirming the formation of the spinel framework. UV-Visible absorption analysis revealed enhanced optical absorption behaviour, and the optical band gap energy was determined using Tauc's relation, demonstrating band gap modulation due to nickel doping. The improved structural integrity and tunable optical properties suggest that Ni-Co<sub>3</sub>O<sub>4</sub> nanoparticles are promising candidates for applications in electrochemical energy storage, photocatalysis, and sensing technologies.

**Keywords:** Nickel-doped cobalt oxide; Spinel structure; Co-precipitation synthesis; Structural characterization; XRD analysis; FTIR spectroscopy; UV-Visible spectroscopy; Optical band gap tuning; Nanostructured materials; Energy applications.

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**Design and Fabrication of a Low-Cost Air Pollution Control System Using Carbon Rod****\*KAVIYA SELVI R and LEELAVATHI P**

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**Abstract**

Air pollution has become one of the most critical environmental challenges due to rapid industrialization and urbanization. This project presents a simple and cost-effective prototype model for controlling air pollution using a carbon rod as an adsorbent material. The system is designed using a carbon rod, a 12-volt DC fan, an adaptor, and connecting wires to demonstrate the basic principle of air purification. In this setup, the 12V DC fan is used to draw polluted air into the chamber containing the carbon rod. Carbon materials possess high surface area and adsorption capacity, which enable them to trap harmful gases, particulate matter, and odor-causing pollutants from the air. When air passes over the carbon rod, contaminants get adsorbed onto its surface, thereby reducing the concentration of pollutants in the outgoing air. The adaptor supplies the required electrical power to operate the DC fan, ensuring continuous airflow through the filtration system. The project highlights the effectiveness of carbon-based materials in air purification applications due to their porous structure and chemical stability. This low-cost and portable model can be further developed using activated carbon or multiple filtration layers for enhanced efficiency. The study demonstrates a practical approach to indoor air pollution control and promotes awareness about affordable environmental protection technologies.

**Keywords:** Prototype model, carbon rod, multiple filtration layers, air pollution control.

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**Synthesis, Characterization, and Photocatalytic Evaluation of NiO Nanoparticles Prepared via Wet Chemical Route****\*LOKESHWARI S**

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**Abstract**

Nickel oxide (NiO) nanoparticles were synthesized by a simple wet chemical method using nickel chloride and ammonium hydroxide (NH<sub>4</sub>OH) at room temperature. The prepared nanoparticles were characterized using X-ray diffraction (XRD), Atomic Force Microscopy (AFM), and UV–Visible absorption spectroscopy to evaluate their structural, morphological, and optical properties. XRD analysis showed sharp and well-defined diffraction peaks, confirming the formation of highly crystalline NiO with good phase purity. The diffraction pattern corresponded to the cubic structure of NiO. AFM studies revealed that the nanoparticles were predominantly spherical in shape with noticeable agglomeration, which is attributed to high surface energy at the nanoscale. UV–Visible analysis indicated suitable optical absorption behavior, suggesting potential applicability in light-driven processes. The results demonstrate that the wet chemical synthesis method is a simple and effective approach for producing crystalline NiO nanoparticles. Owing to their structural stability and favorable optical properties, the synthesized NiO nanoparticles are promising candidates for photocatalytic applications, particularly in environmental remediation.

**Key words:** Nickel oxide, highly crystalline, Photocatalytic applications.

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## Synthesis and Characterization of Magnesium doped Zinc Oxide Nanoparticles by Co-precipitation Method

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### Abstract

Magnesium-doped zinc oxide ( $Zn_{1-x}Mg_xO$ ) nanostructured materials with compositions in the range of  $0 < x < 0.8$  were successfully prepared using a chemical co-precipitation technique for potential sensing device applications. This method was selected due to its simplicity, cost-effectiveness, and suitability for producing nanoscale materials. The structural properties of the synthesized samples were investigated using X-ray diffraction (XRD), which confirms the formation of a single-phase ZnO crystalline structure. No secondary phases were detected in the diffraction patterns. Optical characterization was carried out using ultraviolet-visible (UV-Vis) spectroscopy, and the results support the formation of pure ZnO with characteristic absorption behavior. Fourier-transform infrared (FTIR) spectroscopy was also employed to analyze the functional groups and bonding nature of the material. The FTIR spectra display characteristic Zn-O stretching vibrations, confirming the presence of ZnO. Additional absorption bands corresponding to atmospheric  $CO_2$  and moisture were also observed. Furthermore, the absence of any significant peak shift in the XRD patterns indicates that magnesium incorporation into the ZnO lattice is minimal. This suggests that the synthesis conditions or reaction time were insufficient to achieve the formation of a well-defined  $Zn_{1-x}Mg_xO$  nanocomposite structure.

**Keywords:** ZnO, UV-Vis Spectroscopy, X-ray Diffraction (XRD), FTIR, Magnesium Doping, Nanostructures.

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## Facile Synthesis and Functional Characterization of Reduced Graphene Oxide–Cobalt Ferrite Hybrid Nanocomposites

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### Abstract

The present investigation aims to analyze the structural, optical, magnetic, and dielectric properties of  $\text{CoFe}_2\text{O}_4/\text{GO}$  composites, which were subsequently converted into  $\text{rGO}/\text{CoFe}_2\text{O}_4$  nanocomposites. The nanocomposites were synthesized using a chemical method by varying the cobalt ferrite concentration at different levels (0.2 g, 0.5 g, 0.8 g, and 1.0 g). The structural, functional, and optical properties of the synthesized materials were characterized using X-ray diffraction (XRD), Fourier Transform Infrared (FTIR) spectroscopy, and UV–Visible spectroscopy. FTIR analysis revealed the presence of a characteristic metal–oxygen (M–O) vibration band at  $571.97\text{ cm}^{-1}$ , confirming the formation of  $\text{CoFe}_2\text{O}_4$  in the rGO matrix. The corresponding variation in peak intensity indicates effective chemical interaction between  $\text{CoFe}_2\text{O}_4$  and rGO. XRD analysis exhibited diffraction peaks corresponding to the crystalline spinel structure of cobalt ferrite, confirming the successful formation of  $\text{rGO}-\text{CoFe}_2\text{O}_4$  nanocomposites. UV–Visible studies showed an optical band gap energy of approximately 3.2 eV. The results demonstrate that varying the cobalt ferrite concentration significantly influences the structural and optical characteristics of the nanocomposites. These findings suggest that  $\text{rGO}-\text{CoFe}_2\text{O}_4$  nanocomposites are promising materials for applications in catalysis, environmental remediation, magnetic storage, and sensor technologies.

**Keywords:**  $\text{rGO}-\text{CoFe}_2\text{O}_4$  nanocomposites, spinel structure, sensor application.

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**Synthesis and Characterization of ZnO and NiO Nanocomposite by Co-precipitation****Method****\*Swetha M and Saranya M**

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**Abstract**

In this study, a ZnO–NiO nanocomposite was successfully synthesized by the co-precipitation method. The structural, functional, and optical properties of the prepared nanocomposite were systematically characterized using FTIR, XRD, and UV–Visible spectroscopy techniques. X-ray diffraction (XRD) analysis confirmed the formation of crystalline hexagonal ZnO and cubic NiO phases, indicating successful synthesis without secondary impurities. The average crystallite size was found to be in the nanometer range, confirming the nanoscale nature of the composite. Fourier Transform Infrared (FTIR) spectroscopy revealed characteristic absorption bands corresponding to Zn–O and Ni–O stretching vibrations, confirming the formation of metal–oxygen bonds. UV–Visible spectroscopy showed strong absorption in the UV region, and the calculated optical band gap demonstrated slight variation compared to pure ZnO and NiO, indicating improved optical properties due to the synergistic interaction between the two metal oxides. The results confirm that the synthesized ZnO–NiO nanocomposite possesses good crystallinity, stable chemical bonding, and enhanced optical characteristics, making it a promising material for applications in photocatalysis, gas sensing, and optoelectronic devices.

**Keywords:** ZnO–NiO nanocomposite, Co-precipitation method, XRD analysis, FTIR spectroscopy, UV–Visible spectroscopy, Crystallite size, Optical band gap, Metal oxide nanoparticles.

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**Preparation and Functional Evaluation of CoFe<sub>2</sub>O<sub>4</sub>-NiO Nanocomposites via  
Co-precipitation Method**

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**Abstract**

In this work, we report the synthesis of CoFe<sub>2</sub>O<sub>4</sub>-NiO nanocomposites using a soft chemical Co-precipitation method. The structural, morphological, and optical properties of the prepared nanocomposite were investigated using X-ray diffraction (XRD), Atomic Force Microscopy (AFM), and UV-Visible absorption spectroscopy. XRD analysis confirmed the formation of a phase-pure and well-crystalline CoFe<sub>2</sub>O<sub>4</sub>-NiO nanocomposite. AFM studies revealed nanoscale particles with relatively uniform distribution and slight agglomeration. The UV-Visible absorption spectra indicated favorable optical behavior, suggesting improved light absorption characteristics of the composite material. The synergistic combination of magnetic CoFe<sub>2</sub>O<sub>4</sub> and semiconducting NiO enhances the functional properties of the nanocomposite. Owing to its structural stability, phase purity, and promising optical features, the synthesized CoFe<sub>2</sub>O<sub>4</sub>-NiO nanocomposite is a suitable candidate for supercapacitor electrode materials and photocatalytic applications, particularly in energy storage and environmental remediation.

**Keywords:** CoFe<sub>2</sub>O<sub>4</sub>-NiO nanocomposites, pure crystalline, phase purity, electrode materials.

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## Synthesis and Characterization of Magnesium Doped Cadmium Oxide by Coprecipitation Method

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### Abstract

This study reports a facile approach for Magnesium-doped cadmium oxide (Mg.CdO) nanoparticles were successfully synthesized using a simple and cost-effective chemical precipitation method. The structural optical and morphological properties of the prepared samples were systematically investigated to evaluate the influence of Mg incorporation into the CdO lattice. (FTIR) X-ray diffraction (XRD) analysis confirmed the formation of single-phase cubic CdO structure without secondary impurities, indicating successful substitution of Mg<sup>2+</sup> ions into the Cd<sup>2+</sup> lattice sites. In order to effects and various factors of optimum pH was achieved in precipitation method finding pH level 8 to 9 homogenous in shape and regular. A slight shift in diffraction peaks and reduction in crystallite size were observed with increasing Mg concentration, confirming lattice distortion due to doping. UV–Visible spectroscopy showed a blue shift in absorption edge and a gradual increase in optical band gap with increasing Mg content, attributed to the Burstein–Moss effect and quantum confinement. Mg doping effectively modifies the structural and optical properties of CdO, making Mg. CdO a promising material for optoelectronic and transparent conducting oxide.

**Key words:** FTIR, UV, XRD.

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**Development of Multifunctional Hydroxyapatite–Polyaniline Nanocomposites for  
Advanced Biomedical and Electrochemical Applications**

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**Abstract**

Hydroxyapatite–polyaniline (HAP–PANI) composites which are nanocomposites were synthesized using the co-precipitation method. Hydroxyapatite, a biocompatible and bioactive ceramic material, was combined with polyaniline, a conducting polymer, to obtain a composite with enhanced electrical and biomedical properties. The prepared composite was dried and characterized using various analytical techniques such as X-ray diffraction (XRD) and Fourier Transform Infrared Spectroscopy (FTIR) to evaluate its structural, functional and morphological properties. The results confirmed the successful formation of homogeneous composites (HAP–PANI composites) with improved conductivity and bioactivity. The HAP–PANI composites show potential applications in bone tissue engineering, cancer therapy, biosensors, drug delivery systems, and biomedical coatings.

**Key words:** HAP–PANI Nanocomposites, Cancer therapy, Biosensor.

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**Synthesis And Characterization of Strontium nitrate and Zinc nitrate Nanocomposite by using Co-precipitation Method**

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**Abstract**

Strontium nitrate ( $\text{Sr}(\text{NO}_3)_2$ ) and zinc nitrate ( $\text{Zn}(\text{NO}_3)_2$ ) were synthesized by a simple chemical precipitation method under controlled conditions. The prepared samples were characterized using FTIR, X-ray Diffraction (XRD), and UV–Visible spectroscopy to confirm their structural and optical properties. FTIR spectra showed characteristic absorption bands of nitrate ( $\text{NO}_3^-$ ) ions, particularly strong peaks around  $1380\text{--}1450\text{ cm}^{-1}$  corresponding to asymmetric stretching vibrations, confirming the formation of metal nitrates. XRD analysis revealed sharp and intense diffraction peaks, indicating good crystallinity and phase purity of both compounds. The observed peaks matched standard reference data, and the average crystallite size was found to be in the nano meter range. UV–Visible spectra exhibited strong absorption in the ultraviolet region, and the optical band gap values were determined using Tauc plots, suggesting potential optical applications. The results confirm the successful synthesis of pure and crystalline strontium nitrate and zinc nitrate with stable structural and optical properties.

**Keywords:** Strontium nitrate, Zinc nitrate, Chemical synthesis, FTIR, XRD, UV–Visible spectroscopy, Crystallinity, Optical band gap.

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**Synthesis and Characterization of Cobalt doped Nickel Ferrite (NiFe<sub>2</sub>O<sub>4</sub>)  
Nanoparticles by Co-precipitation Method**

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**Abstract**

Ni<sub>1-x</sub>Co<sub>x</sub>Fe<sub>2</sub>O<sub>4</sub> (x = 0.2–1.0) nanoparticles were successfully synthesized by the co-precipitation method and sintered at relatively low temperature. XRD patterns confirmed the formation of a single-phase cubic spinel structure with good crystallinity, and the average crystallite size was calculated using the Debye–Scherrer equation, indicating nanocrystalline nature. FTIR spectra exhibited two characteristic absorption bands in the 400–600 cm<sup>-1</sup> range, corresponding to metal–oxygen stretching vibrations at tetrahedral (Td) and octahedral (Oh) sites, confirming the spinel framework. UV–Visible analysis revealed strong absorption in the UV region and demonstrated semiconducting behavior, with the optical band gap varying as a function of cobalt content. The results confirm that Co substitution significantly influences the structural and optical properties of nickel ferrite nanoparticles.

**Keywords:** Nickel ferrite, Cobalt substitution, Spinel ferrite, Co-precipitation method, XRD, FTIR, UV–Vis spectroscopy, Optical band gap, Nanocrystalline materials.

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**Plant-Assisted Green Fabrication of Sodium Tungstate–Nickel Chloride Nanocomposites  
Using *Strychnos potatorum***

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**Abstract**

A sustainable biogenic synthesis of sodium tungstate–nickel chloride nanocomposites was successfully achieved using seed extract of *Strychnos potatorum* as a phytochemical-mediated reducing and stabilizing agent. The bioactive constituents facilitated controlled nucleation and growth of nanocrystalline heterostructures without toxic chemical intermediates. FTIR spectral analysis revealed prominent absorption bands at  $2836.33\text{ cm}^{-1}$  (aliphatic C–H stretching),  $2332.83\text{ cm}^{-1}$  (asymmetric  $\text{CO}_2$  stretching), and  $2127.43\text{ cm}^{-1}$  ( $\text{C}\equiv\text{C}/\text{C}\equiv\text{N}$  stretching), while strong bands at  $959.95\text{ cm}^{-1}$  confirmed W–O stretching vibrations of tungstate units. The characteristic peaks at  $581.25\text{ cm}^{-1}$  and  $462.14\text{ cm}^{-1}$  correspond to Ni–O and metal–oxygen lattice vibrations, confirming nanocomposite formation. X-ray diffraction patterns exhibited well-defined diffraction peaks indicating high crystallinity and successful phase integration of sodium tungstate and nickel-based components. UV–Visible absorption spectroscopy displayed a distinct absorption maximum at  $\sim 368\text{ nm}$ , attributed to charge transfer transitions within the metal–oxygen framework. The optical band gap energy, estimated using Tauc’s plot, was found to be approximately  $3.05\text{ eV}$ , confirming the semiconducting nature of the synthesized nanocomposite. The enhanced structural and optical properties suggest strong potential for photocatalytic and water purification applications.

**Keywords:** Nanocomposite, *Strychnos potatorum*, Sodium tungstate, Nickel chloride, Water purification.

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**Insight into the Structural Evolution and Electrical Conductivity Mechanism of  
Synthesized PANI**

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**Abstract**

Polyaniline is one of the most widely studied conducting polymers due to its simple synthesis environmental stability tunable electrical conductivity and potential applications in sensors supercapacitors anticorrosion coatings and energy storage devices. PANI can be synthesized through chemical oxidative polymerization or electrochemical polymerization of aniline monomer in acidic medium. The conductivity of PANI depends on its oxidation state and doping level. In this study polyaniline was synthesized via chemical oxidative polymerization using ammonium persulfate as an oxidizing agent in hydrochloric acid medium. The obtained polymer was characterized using techniques such as Fourier Transform Infrared Spectroscopy (FTIR), UV–Visible spectroscopy. X-ray Diffraction (XRD) and Scanning Electron Microscopy (SEM) to evaluate its structural optical and morphological properties. The results confirm the successful formation of emeraldine salt form of polyaniline with good conductivity and characteristic molecular structure.

**Key words:** Conducting polymers, energy storage devices, good conductivity.

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**Preparation and Characterization of CoFe<sub>2</sub>O<sub>4</sub> and PANI nanocomposites material by using  
Gas Sensor Applications**

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**Abstract**

In the present work, PANI/CoFe<sub>2</sub>O<sub>4</sub> nanocomposites were successfully synthesized through a cost-effective and environmentally friendly co-precipitation technique. The prepared nanocomposites were characterized using X-ray diffraction (XRD), Fourier transform infrared (FTIR) spectroscopy, and Scanning Electron Microscopy (SEM). The XRD patterns displayed broad peaks at approximately 20.3° and 25.2°, indicating the amorphous and low-crystalline nature of polyaniline. In contrast, prominent diffraction peaks observed at around 35.5° and 43.2° correspond to the well-defined crystalline planes of cobalt ferrite, confirming its successful formation via the co-precipitation method. FTIR analysis further confirmed the chemical interactions and bonding between polyaniline and CoFe<sub>2</sub>O<sub>4</sub> within the nanocomposite, consistent with the structural information obtained from the XRD results. UV–Visible analysis revealed that the optical band gap of the composites decreased to 1.53 eV for PANI–cobalt ferrite compared to pure PANI (3.21 eV). The results indicate significantly enhanced optical and electrical properties of the PANI/CoFe<sub>2</sub>O<sub>4</sub> nanocomposites, making them promising materials for various advanced technological applications.

**Key words:** PANI/CoFe<sub>2</sub>O<sub>4</sub> nanocomposites, Amorphous, Enhanced optical and electrical properties.

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**Synthesis and Characterization of Cu Doped Mn Nanoparticles By Co-Precipitation****Method****\*SUVATHI P R and AZHAGARASU R**

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**Abstract**

Fourier Transform Infrared (FTIR), UV–Visible, and X-ray Diffraction (XRD) studies were carried out to understand the structural and optical properties of the copper-doped manganese nanoparticles. The XRD analysis confirmed that the synthesized nanoparticles possess a well-defined hexagonal crystal structure. The diffraction peaks were sharp and clear, indicating good crystallinity of the material. No extra or impurity peaks were detected in the pattern, which proves that the prepared samples are pure and free from unwanted phases. Using the XRD data, the average crystallite size was calculated and found to be around 14 nm after annealing at 400°C. The FTIR spectra showed characteristic absorption bands corresponding to metal–oxygen (Mn–O and Cu–O) vibrations. These vibration bands confirm the formation of manganese oxide and indicate the successful doping of copper into the host lattice. The presence of these functional groups verifies the chemical bonding and structural stability of the nanoparticles. UV–Visible spectroscopy was used to study the optical behavior of the nanoparticles. The absorption spectra revealed that copper doping influences the optical properties of manganese oxide. A noticeable change in absorption behavior suggests a modification in the band gap energy due to the presence of copper ions. This shift in optical response confirms the interaction between copper and manganese ions within the crystal structure and highlights the potential of these nanoparticles for optical and photocatalytic applications.

**Keywords:** Copper-doped manganese nanoparticles, metal–oxygen vibrations.

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**Synthesis and Characterization of Hydroxyapatite/Polyethylene glycol Nanocomposites****\*Angel T and Satheesh Kumar V**

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**Abstract**

In this study, Hydroxyapatite nanoparticles were synthesized by the wet precipitation method and subsequently combined with polyethylene glycol (PEG) to form HAP/PEG nanocomposites. The prepared samples were characterized using Fourier Transform Infrared Spectroscopy (FTIR), Ultraviolet–Visible (UV) spectroscopy, and X-Ray Diffraction (XRD) techniques. FTIR analysis confirmed the presence of phosphate ( $\text{PO}_4^{3-}$ ), hydroxyl ( $\text{OH}^-$ ), and PEG functional groups, indicating successful interaction between HAP and PEG. XRD patterns revealed the crystalline nature of hydroxyapatite with characteristic diffraction peaks corresponding to its hexagonal structure, while slight peak broadening indicated nanoscale particle size. UV–Visible spectroscopy was used to study the optical properties and absorption behaviour of the nanocomposite. The results confirm the successful formation of HAP/PEG nanocomposites with improved structural and functional properties. These nanocomposites show potential applications in bone repair, drug delivery, and biomedical implant materials.

**Keywords:** Hydroxyapatite (HAP), Polyethylene glycol, Wet precipitation method, Fourier Transform Infrared Spectroscopy, Biocompatible Materials, Biomedical applications, Bone tissue Engineering.

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**Synthesis and Characterization Studies of Pure Mg and  
Cu Doped MgO Nanoparticles by Co-Precipitation Method**

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**Abstract**

The structural, optical, and functional properties of pure magnesium oxide (MgO) and copper-doped magnesium oxide (Cu-MgO) nanoparticles were systematically analyzed using X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR), and UV-Visible spectroscopy. XRD analysis confirmed that both pure and Cu-doped MgO nanoparticles possess a well-defined crystalline nature with high phase purity. The diffraction peaks matched the standard cubic crystal structure of MgO, indicating that copper incorporation did not disturb the fundamental lattice framework. The average crystallite size of pure MgO nanoparticles was found to be approximately 6 nm, while Cu doping slightly increased the crystallite size to about 8 nm. FTIR spectroscopy further verified the chemical composition and bond formation. Prominent absorption bands corresponding to Mg-O stretching vibrations were observed in both samples, confirming the successful formation of magnesium oxide nanoparticles. In the Cu-doped sample, minor shifts in peak positions were detected, indicating interactions between copper ions and the MgO host lattice. UV-Visible spectroscopy was employed to study the optical behavior. Pure MgO nanoparticles showed a distinct absorption peak near 264 nm, whereas Cu-doped MgO exhibited a slightly shifted peak around 260 nm. Overall, the results confirm that copper incorporation alters the optical properties while maintaining the structural stability of MgO nanoparticles.

**Keywords:** Cu-doped MgO nanoparticles, optical behavior.

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## **Real-Time Distance Measurement and Object Tracking Using Arduino-Powered Sonar System**

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### **Abstract**

SonarVision is a low-cost, Arduino-powered ultrasonic radar system designed to detect and visualize obstacles in real time. The project utilizes an Arduino microcontroller, an ultrasonic sensor and a servo motor to perform distance measurement and environmental scanning. The ultrasonic sensor emits high-frequency sound waves and measures the time taken for the echo to return after striking an object. Based on the time-of-flight principle, the distance of the object is calculated and processed by the Arduino. The servo motor rotates the ultrasonic sensor across a predefined angular range, enabling two-dimensional scanning of the surrounding area. The collected distance data is transmitted to a computer and displayed using visualization software, creating a radar-like graphical interface that shows object position and range. This system demonstrates the practical implementation of SONAR (Sound Navigation and Ranging) principles in an embedded platform. Sonar Vision provides an effective and affordable solution for obstacle detection, distance measurement, and basic environmental mapping. The project has potential applications in robotics, autonomous navigation, security systems, and assistive technologies for visually impaired individuals. It highlights the integration of embedded systems, sensor technology, and real-time data processing in modern engineering applications.

**Keywords:** Arduino microcontroller, time-of-flight principle, Arduino, SONAR.

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**Design and Development of an Ultrasonic-Based Obstacle Detection and Avoidance System****\*BRUNDHA S, DHARSHINI V and DIVYA V**

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**Abstract**

An ultrasonic obstacle detector is an electronic sensing system designed to identify the presence and distance of objects using high-frequency sound waves, typically above 20 kHz. The system operates on the principle of echo ranging. It consists of an ultrasonic transmitter, receiver, control circuitry, and a processing unit. The transmitter emits short ultrasonic pulses into the surrounding environment. When these sound waves encounter an obstacle, they are reflected back toward the receiver. By measuring the time interval between transmission and reception of the echo, the system calculates the distance to the object using the known speed of sound in air. Ultrasonic obstacle detectors are widely used in robotics, autonomous vehicles, industrial automation, and assistive devices for visually impaired individuals. They offer advantages such as non-contact detection, low cost, simple implementation, and reliable performance in various lighting conditions, unlike optical sensors. These systems can detect stationary and moving objects and are effective for short- to medium-range applications. However, their performance can be influenced by environmental factors such as temperature, humidity, and the shape or texture of obstacles. Despite these limitations, ultrasonic obstacle detectors remain a practical and efficient solution for real-time object detection and collision avoidance systems.

**Keywords:** Ultrasonic sensor, Obstacle detection, Echo ranging, Time-of-flight measurement, Collision avoidance.

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**Design and Implementation of an Infrared Sensor-Based Automated Vehicle Counting System for Smart Parking Management**

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**Abstract**

The IR Sensor Based Vehicle Entry and Exit Counting System is a compact, reliable, and efficient solution developed to automatically monitor and count vehicles at entry and exit points. The system operates using infrared (IR) sensors that detect vehicle movement by sensing interruptions in infrared beams. When a vehicle passes through the monitored area, the IR sensor identifies the obstruction and sends a corresponding signal to a microcontroller. The microcontroller processes this input to determine whether the vehicle is entering or exiting and updates the total vehicle count accordingly. The updated count is then displayed on a digital screen in real time. This system eliminates the need for manual vehicle counting, reducing human error and improving accuracy. It is designed to be cost-effective, easy to install, and energy efficient, making it suitable for both small-scale and large-scale applications. The project has significant applications in parking management systems, traffic monitoring, toll plazas, and automated vehicle control environments. By providing real-time monitoring and accurate data, the system helps in efficient space utilization and traffic flow management. Overall, the IR Sensor Based Vehicle Entry and Exit Counting System offers a practical and dependable solution for modern automated monitoring requirements.

**Keywords:** IR Sensor, Vehicle Counting System, Microcontroller, Entry and Exit Monitoring, Parking Management, Traffic Monitoring, Automation, Real-Time Monitoring.

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## **Integration of Artificial Intelligence with Numerical Methods for Solving Mathematical Problems**

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### **Abstract**

The integration of Artificial Intelligence (AI) with numerical methods represents a transformative advancement in solving complex mathematical problems. Traditional numerical techniques such as finite difference methods, finite element methods, and iterative solvers have long been used to approximate solutions for differential equations, optimization problems, and large-scale linear systems. However, these methods often face limitations related to computational cost, convergence speed, and handling high-dimensional or nonlinear systems. By incorporating AI approaches particularly machine learning, deep learning, and neural networks-numerical computation can be enhanced through adaptive learning, pattern recognition, and predictive modeling. AI-driven models can approximate solutions, optimize parameters, accelerate convergence, and reduce computational complexity. This hybrid framework has demonstrated significant success in areas such as scientific computing, engineering simulations, physics-informed modeling, and real-time decision systems. The synergy between AI and numerical analysis not only improves efficiency and accuracy but also opens new pathways for solving previously intractable mathematical problems. Furthermore, the integration enables data-driven correction of numerical errors and enhances stability in highly nonlinear and chaotic systems. AI-assisted numerical frameworks also support automated model selection and parameter tuning, reducing human intervention in complex computations.

**Keywords:** Artificial Intelligence (AI), Numerical Methods, Neural Networks, Finite Difference Method (FDM), Finite Element Method (FEM), Physics-Informed Neural Networks (PINNs).

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**Numerical Methods Integrated with Artificial Intelligence****SUGANYA A**

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**Abstract**

The integration of Artificial Intelligence (AI) with classical numerical methods has emerged as a transformative approach for solving complex mathematical models arising in science and engineering. This paper presents a hybrid computational framework that combines traditional numerical techniques - such as finite difference methods, finite element analysis, and iterative solvers- with machine learning models to enhance accuracy, convergence speed, and computational efficiency. Neural networks are employed to approximate nonlinear solution spaces, predict optimal discretization parameters, and accelerate convergence in large-scale systems of equations. The proposed AI-assisted numerical scheme is evaluated on benchmark problems involving partial differential equations, nonlinear boundary value problems, and high-dimensional optimization tasks. Comparative analysis demonstrates that the hybrid approach reduces computational cost while maintaining or improving solution accuracy compared to conventional numerical solvers. Furthermore, the study investigates error estimation, stability, and generalization capabilities of AI-enhanced solvers. The results indicate that incorporating data-driven learning into numerical algorithms offers a promising direction for next-generation scientific computing, enabling adaptive, efficient, and scalable solutions to complex mathematical problems. The integration strategy also facilitates parallel implementation, making it suitable for high-performance computing environments. Sensitivity analysis confirms the robustness of the proposed method under varying initial and boundary conditions. Overall, the study highlights the potential of AI-driven numerical techniques to redefine computational mathematics and engineering simulations.

**Keywords:** Artificial Intelligence (AI), Scientific Machine Learning, Convergence Analysis, Iterative Solvers, Error Estimation, Nonlinear Boundary Value Problems.

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**Linear Algebra as The Foundation of Modern Artificial Intelligence****SELVI G**

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**Abstract**

Linear Algebra serves as the fundamental mathematical framework underlying modern Artificial Intelligence (AI). At the core of AI systems lies the representation of data in the form of vectors and matrices, enabling machines to process large volumes of structured and unstructured information efficiently. Images, text, speech, and numerical data are encoded as high dimensional vectors, allowing algorithms to detect patterns, measure similarities, and make predictions. Neural networks, which power deep learning models, rely extensively on matrix multiplication and linear transformations. Weight matrices and bias vectors systematically transform input data across multiple layers, enabling feature extraction and decision-making. The efficiency of these computations is enhanced through optimized linear algebra operations executed on GPUs and parallel computing systems. Advanced AI techniques also depend on concepts such as eigenvalues, eigenvectors, and matrix decompositions like Singular Value Decomposition (SVD) and Principal Component Analysis (PCA). These methods support dimensionality reduction, data compression, and improved model performance. Furthermore, optimization algorithms used in training AI models are grounded in vector and matrix calculus. As AI continues to evolve with innovations in generative models and large-scale machine learning systems, linear algebra remains indispensable. Its principles ensure scalability, computational efficiency, and mathematical rigor, making it the foundation upon which modern artificial intelligence is built.

**Keywords:** Linear Algebra, Artificial Intelligence, Vectors, Matrices, Neural Networks, Linear Transformations, Eigenvalues, Matrix Decomposition, Dimensionality Reduction, Deep Learning, Optimization, Machine Learning.

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**Brains Behind the Graphs AI and Graph Theory****KALAISELVI P**

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**Abstract**

Artificial Intelligence (AI) has rapidly advanced by adopting mathematical models that effectively represent and analyze complex relationships in data. Among these models, Graph Theory plays a vital role by providing a structured framework to represent interconnected systems using vertices and edges. This paper, titled “*Brains behind the Graphs: AI and Graph Theory*,” explores the synergy between Graph Theory and Artificial Intelligence in building intelligent, adaptive, and scalable systems. Graph-based representations enable AI models to capture relational information that traditional data structures fail to express efficiently. The study highlights the importance of graph algorithms and learning techniques in solving real-world problems such as recommendation systems, social network analysis, navigation, fraud detection, and knowledge representation. Special emphasis is given to Graph Neural Networks (GNNs), which combine graph-theoretic concepts with deep learning to process non-Euclidean and relational data. These models enhance learning accuracy by exploiting node connectivity and structural patterns within graphs. Furthermore, the integration of AI-based inference with graph structures supports intelligent decision-making under dynamic and uncertain conditions. By bridging mathematical rigor with data-driven intelligence, Graph Theory strengthens the foundations of modern AI technologies. The paper concludes that understanding the “brains behind the graphs” is essential for designing next-generation AI systems capable of reasoning, learning, and adapting in highly connected environments.

**Keywords:** Graph Theory, Artificial Intelligence, Graph Algorithms, Graph Neural Networks, Intelligent Systems.

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**Artificial Intelligence on Partial Differential Equations and Neural Networks (PINNS)****YASOTHA S**

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**Abstract**

Artificial Intelligence (AI) has emerged as a transformative paradigm for solving Partial Differential Equations (PDEs), which govern a wide range of physical, biological, and engineering systems. Traditional numerical methods such as finite difference, finite element, and finite volume techniques often require structured meshes and become computationally expensive in high-dimensional or inverse problem settings. In recent years, neural network-based approaches, particularly Physics-Informed Neural Networks (PINNs), have provided a mesh-free and data-efficient alternative framework. PINNs embed the underlying physical laws directly into the training process by incorporating PDE residuals, boundary conditions, and initial conditions into the loss function, enabling the neural network to learn physically consistent solutions. Leveraging automatic differentiation, these models approximate continuous solutions while maintaining differentiability across the domain. Beyond forward problems, PINNs demonstrate strong potential in solving inverse problems, parameter estimation, data assimilation, and uncertainty quantification. Despite challenges such as optimization stiffness, spectral bias, and training instability, ongoing advancements, including adaptive loss weighting, domain decomposition strategies, and neural operator learning are expanding the scalability and robustness of AI-driven PDE solvers. This integration of machine learning and computational physics represents a significant step toward next-generation scientific computing frameworks capable of addressing complex, multi-scale, and high-dimensional systems.

**Keywords:** Artificial Intelligence, Partial Differential Equations, Physics-Informed Neural Networks, Leveraging automatic differentiation

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**Graph – Theoretic Optimization Models For GPS Navigation with AI – Based Inference****KIRUTHIKA M**

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**Abstract**

Global Positioning System (GPS) navigation plays a crucial role in modern transportation, logistics, and location-based services by providing optimal routing and real-time guidance. The efficiency of GPS navigation systems largely depends on effective route optimization techniques capable of handling complex and dynamic road networks. Graph theoretic optimization models offer a strong mathematical foundation for representing transportation networks, where intersections are modelled as vertices and road segments as edges with weights such as distance, travel time, cost, or traffic density. This paper focuses on graph theoretic optimization models integrated with Artificial Intelligence (AI)–based inference to enhance GPS navigation systems. Classical graph algorithms enable the computation of shortest and optimal paths, while AI-based inference introduces adaptability by learning from historical data and real-time traffic conditions. AI techniques support intelligent decision-making by predicting congestion, identifying alternative routes, and adjusting navigation strategies dynamically. The fusion of graph theory and AI allows GPS systems to evolve from static routing mechanisms into intelligent, context-aware navigation frameworks. This integrated approach improves accuracy, efficiency, and reliability, particularly in complex urban environments where traffic patterns are highly unpredictable. Furthermore, graph-based AI models contribute to reduced travel time, fuel consumption, and overall transportation costs. The paper highlights the importance of combining mathematical optimization with AI inference for next-generation GPS navigation and emphasizes its potential applications in smart cities, autonomous vehicles, and intelligent transportation systems.

**Keywords:** Graph Theory, GPS Navigation, Optimization Models, Artificial Intelligence, AI-Based Inference, Intelligent Transportation Systems.

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**Matrix Decomposition Techniques in Artificial Intelligence****MALATHI R**

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**Abstract**

Matrix decomposition techniques form a fundamental component of the mathematical framework underlying Artificial Intelligence (AI). In AI applications, data is commonly represented as large matrices capturing relationships among features, samples, or network parameters. Efficient manipulation and interpretation of these matrices are essential for improving model performance and computational scalability. Matrix decomposition methods such as Singular Value Decomposition (SVD), Eigenvalue Decomposition (EVD), QR Decomposition, LU Decomposition, and Non-negative Matrix Factorization (NMF) provide structured approaches to transform complex matrices into simpler and more informative components. In machine learning, decomposition techniques play a crucial role in dimensionality reduction, feature extraction, and noise filtering. For instance, SVD and Principal Component Analysis (PCA) enable the identification of dominant patterns in high-dimensional datasets, thereby enhancing predictive accuracy and reducing overfitting. Eigenvalue-based methods are widely applied in spectral clustering and graph-based learning, where structural properties of data are analyzed through adjacency and Laplacian matrices. Matrix factorization is also central to recommender systems, topic modeling, image compression, and natural language processing, where latent representations improve efficiency and interpretability. Furthermore, low-rank approximations derived from decomposition methods significantly reduce memory usage and computational cost in large-scale deep learning models. This paper explores the theoretical foundations, algorithmic implementations, and practical AI applications of matrix decomposition techniques, emphasizing their role in building scalable, accurate, and robust intelligent systems.

**Keywords:** Matrix Decomposition, Singular Value Decomposition (SVD), Eigenvalue Decomposition, Matrix Factorization, Dimensionality Reduction, Artificial Intelligence, Machine Learning, Low-Rank Approximation, Spectral Clustering.

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**Graph theory Applications in AI-Driven Systems****PARVATHA R**

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**Abstract**

Graph theory provides a rigorous mathematical foundation for modeling relational, structured, and high-dimensional data in modern Artificial Intelligence (AI). This paper investigates advanced graph-theoretic frameworks that underpin AI-driven systems, with particular emphasis on spectral graph theory, Graph Neural Networks (GNNs), probabilistic graphical models, and combinatorial optimization. We examine the role of the graph Laplacian and its eigenstructure in spectral clustering, dimensionality reduction, and graph signal processing, highlighting their importance in scalable learning architectures. The study further explores message-passing mechanisms in GNNs, along with extensions to hyper graphs and multilayer networks for capturing higher-order interactions in complex systems. In addition, probabilistic graphical models—including Bayesian networks and Markov random fields—are analyzed to address uncertainty and structured inference in intelligent decision-making systems. From an optimization perspective, classical graph algorithms such as shortest path, maximum flow, and matching are revisited within the context of large-scale AI infrastructures, emphasizing computational efficiency and approximation techniques for NP-hard problems. By integrating algebraic, combinatorial, and probabilistic methodologies, this work demonstrates how graph-theoretic principles enable interpretable, scalable, and adaptive AI systems. The proposed framework not only strengthens the mathematical foundations of AI but also advances applications in social network analysis, recommendation systems, bioinformatics, and smart technological ecosystems, thereby reinforcing the transformative impact of AI on science and society.

**Keywords:** Graph Theory, Artificial Intelligence (AI), Spectral Graph Theory, Graph Laplacian, Graph Neural Networks (GNNs), Probabilistic Graphical Models, Bayesian Networks.

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**Operations Research and Artificial Intelligence: Mathematical Foundations And Real-World Applications****REKHA M**

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**Abstract**

Operations Research (OR) is a multidisciplinary field that employs advanced analytical and computational techniques to support optimal decision-making in complex systems. Originating during World War II to address military logistics and strategic planning problems, OR has evolved into a vital discipline for modern industries and public administration. It integrates applied mathematics, statistics, engineering, computer science, and increasingly, Artificial Intelligence (AI) to model, analyze, and optimize real-world systems. Core OR methodologies include linear and nonlinear programming, queuing theory, simulation, network models, and decision analysis. These techniques convert practical constraints and objectives into mathematical frameworks, enabling organizations to maximize profit, improve service levels, enhance resource utilization, and minimize operational risks. The incorporation of AI—particularly machine learning, predictive analytics, and intelligent optimization algorithms—has significantly strengthened traditional OR approaches by enabling data-driven forecasting, adaptive modelling, and real-time decision support. Applications of OR and AI span supply chain management, transportation planning, healthcare logistics, financial systems, energy management, and manufacturing operations. AI-enhanced OR models can process large-scale datasets, detect hidden patterns, and dynamically adjust strategies in uncertain and rapidly changing environments. This synergy between OR and AI fosters smarter automation, improved strategic planning, and sustainable competitive advantage.

**Keywords:** Operations Research, Artificial Intelligence, Optimization, Mathematical Modeling, Machine Learning, Decision Support Systems, Simulation.

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**Number Theory Meets Artificial Intelligence: A New Era of Computational Mathematics****SUMITHRA A**

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**Abstract**

Number Theory, a fundamental branch of pure mathematics concerned with integers, prime numbers, and modular arithmetic, has long been central to cryptography and computational mathematics. With the rapid advancement of Artificial Intelligence (AI), new opportunities have emerged to enhance the analysis and application of number theoretic concepts. This paper explores the intersection of Number Theory and AI, highlighting how machine learning algorithms and neural networks assist in solving complex mathematical problems, identifying patterns in prime distributions, and optimizing cryptographic systems. AI-driven models enable efficient large-scale computations, improve prime factorization techniques, and support automated theorem verification. Furthermore, the integration of AI strengthens cyber security frameworks by enhancing encryption methods such as RSA and detecting vulnerabilities in cryptographic protocols. The synergy between Number Theory and Artificial Intelligence represents a transformative shift in computational mathematics, enabling faster problem-solving, improved security mechanisms, and innovative research methodologies. This interdisciplinary approach not only advances theoretical mathematics but also contributes significantly to real-world applications in data security, block chain technology, and digital communication systems. The study demonstrates that combining classical mathematical foundations with modern AI techniques paves the way for a new era of intelligent computation.

**Keywords:** Number Theory, Artificial Intelligence, Machine Learning, Cryptography, Prime Numbers, RSA Algorithm, Computational Mathematics, Cyber security.

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**AI In Healthcare: Predictive Modeling and Statistical Analysis**  
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**Abstract**

Artificial Intelligence (AI) has emerged as a transformative technology in healthcare, enabling predictive analytics, personalized treatment, and enhanced decision-making. This study examines the integration of AI with rigorous mathematical and statistical methodologies to improve patient outcomes and optimize healthcare delivery. Machine learning algorithms, including regression models, classification techniques, and neural networks, are applied to large-scale medical datasets to predict disease risks, identify high-risk patient populations, and guide clinical interventions. Statistical approaches such as probability modeling, hypothesis testing, survival analysis, and multivariate analysis provide the foundational framework to validate AI predictions, ensuring reliability and accuracy in critical decision-making scenarios. The research highlights practical applications, including early detection of chronic diseases, predictive modeling for hospital resource management, and optimization of personalized treatment plans. Real-world examples demonstrate that AI systems can identify patterns in complex medical data that are often imperceptible to human clinicians, enabling timely interventions and reducing adverse outcomes. Furthermore, ethical considerations such as algorithmic bias, fairness, and transparency are addressed through mathematical fairness measures and bias-detection techniques, ensuring equitable access to AI-driven healthcare solutions. This paper emphasizes the synergy between AI technology and mathematical modeling, demonstrating that data-driven approaches can significantly enhance healthcare efficiency, accuracy, and accessibility. By bridging statistical theory with machine learning applications, AI can transform clinical practices, inform healthcare policies, and contribute to a more resilient and responsive healthcare system.

**Keywords:** Predictive Analytics, Risk Prediction Models, Disease Prediction, Prognostic Modeling, Early Diagnosis Systems, Clinical Decision Support Systems (CDSS).

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**Radon Transform and Its Application in Computed Tomography**  
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**Abstract**

The Radon Transform is a fundamental operator in integral geometry that maps a function defined on  $\mathbb{R}^2$  to its set of line integrals. Introduced by Johann Radon in 1917, this transform later became the mathematical foundation of Computed Tomography (CT). In CT imaging, the attenuation of X-rays passing through an object at multiple angles produces projection data that correspond mathematically to the Radon transform of the internal density function. The reconstruction of cross-sectional images from these projections constitutes an inverse problem, typically addressed using the Fourier Slice Theorem and algorithms such as filtered back projection and iterative reconstruction methods. This paper presents the mathematical formulation of the Radon Transform, discusses its inversion theory, and explains its direct application in CT scanning technology. Special attention is given to the ill-posed nature of the inverse problem, the role of regularization techniques, and the impact of noise and discretization in practical implementations. The pioneering contributions of Godfrey Hounsfield and Allan Cormack, recognized by the Nobel Prize in Physiology or Medicine, demonstrate the profound connection between abstract mathematical theory and modern medical imaging. This study highlights how integral transforms and harmonic analysis provide the theoretical backbone for one of the most important diagnostic tools in contemporary medicine. Furthermore, recent advances integrate computational optimization and machine learning to enhance reconstruction accuracy and reduce radiation exposure. The synergy between functional analysis, numerical methods, and high-performance computing continues to improve image resolution and stability.

**Keywords:** Radon Transform; Integral Geometry; Inverse Problems; Computed Tomography (CT); Fourier Slice Theorem; Filtered Back Projection (FBP); Iterative Reconstruction; Image Reconstruction; Regularization Techniques.

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**AI in Financial Systems: Fraud Detection Using Statistical and Mathematical Models****KEERTHANA V**

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**Abstract**

The rapid adoption of digital financial systems has significantly increased the volume and complexity of transactions, creating opportunities for fraudulent activities. Artificial Intelligence (AI) has emerged as a critical tool in detecting and preventing financial fraud, leveraging large-scale data analysis and predictive modelling. This study explores the integration of AI with statistical and mathematical methods to develop robust fraud detection systems. Machine learning algorithms such as decision trees, logistic regression, support vector machines, and neural networks are employed to identify anomalous patterns in transaction data. Statistical techniques—including probability modelling, hypothesis testing, and anomaly detection—provide the foundation for evaluating model accuracy and minimizing false positives, ensuring reliable decision-making in high-stakes financial environments. Mathematical frameworks like matrix factorization, graph-based models, and optimization algorithms are utilized to uncover hidden relationships among transactions, accounts, and user behavior. These models enable real-time monitoring and rapid response to suspicious activities, enhancing both operational efficiency and security. The study also emphasizes the ethical and societal implications of AI in financial systems, including bias mitigation, fairness, and transparency, which are addressed using quantifiable mathematical fairness metrics. Through a combination of theoretical analysis and practical case studies, this research demonstrates the significant potential of AI-driven, mathematically-grounded fraud detection systems to reduce financial losses, improve customer trust, and enhance the overall integrity of digital financial ecosystems.

**Keywords:** Artificial Intelligence (AI) in Finance, Machine Learning (ML), Deep Learning, Supervised Learning, Unsupervised Learning, Semi-Supervised Learning, Reinforcement Learning, Neural Networks, Ensemble Learning, Anomaly Detection.

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**Statistical Quality Control in AI-Assisted Labs: Ensuring Accuracy and Reliability in Stem Education****ROJA P**

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**Abstract**

Artificial Intelligence (AI) has revolutionized STEM education by enabling intelligent simulations, automated experiments, and virtual laboratories. These AI-assisted labs enhance accessibility, personalization, and efficiency, but they introduce new challenges in ensuring the accuracy, reliability, and consistency of experimental outputs. This study develops a statistical quality control (SQC) framework for AI-assisted laboratory environments, integrating classical control theory with probabilistic modeling to monitor and maintain high standards in AI-driven experiments. The proposed framework is particularly relevant for virtual physics, chemistry, and engineering labs, where reproducibility, safety, and pedagogical effectiveness are critical. By applying SQC principles to AI-assisted experiments, educators and developers can ensure consistent learning outcomes while maintaining system reliability. This study demonstrates that statistical quality control can effectively bridge the gap between AI innovation and educational rigor, providing a mathematically grounded, scalable, and socially responsible methodology. The approach not only safeguards experimental accuracy but also enhances the overall trustworthiness and adoption of AI-driven STEM education platforms. The integration of explainable AI techniques ensures transparency in automated decision-making within virtual lab environments. Ultimately, this model establishes a sustainable pathway for aligning AI-powered educational tools with rigorous statistical validation standards.

**Keywords:** Statistical Quality Control (SQC), AI-Assisted Laboratories, STEM Education, Data Accuracy, Reliability Analysis, Process Monitoring, Error Detection, Measurement Validation, Laboratory Automation.

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**Societal Impact of Ai-Based Decision Systems: A Quantitative Approach****SOWBARNIKA T**

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**Abstract**

Artificial Intelligence (AI) has become an integral component of modern decision-making systems, influencing sectors such as education, healthcare, finance, governance, and public policy. While AI offers the potential to enhance efficiency, accuracy, and accessibility, it also raises critical societal concerns including fairness, bias, accountability, and ethical transparency. This study examines the societal impact of AI-based decision systems through a quantitative lens, emphasizing the role of mathematics and statistical analysis in evaluating and optimizing these systems. The research also explores the interplay between algorithmic design and societal outcomes, highlighting real-world case studies where mathematical modelling has successfully enhanced decision-making transparency and accountability. Furthermore, the study addresses the challenges associated with large-scale implementation, including data quality, representational bias, and the trade-offs between efficiency, fairness, and interpretability. This paper demonstrates that integrating AI with rigorous mathematical and statistical frameworks is essential for understanding and mitigating the societal implications of automated decision systems. By adopting a quantitative approach, stakeholders—including policymakers, educators, and organizational leaders—can harness AI responsibly to promote equitable outcomes, improve operational effectiveness, and foster societal trust in AI technologies. In addition, the study proposes measurable fairness indices and statistical audit mechanisms to continuously evaluate algorithmic performance. Techniques such as regression analysis, Bayesian inference, and optimization modelling are employed to detect systemic disparities and quantify uncertainty.

**Keywords:** Artificial Intelligence (AI); Algorithmic Decision-Making; Societal Impact; Quantitative Analysis; Statistical Modeling; Algorithmic Bias; Fairness in AI; Causal Inference; Public Policy Analytics; Responsible AI

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**Privacy-Preserving Mathematical Models in AI Education Platforms**

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**Abstract**

Artificial Intelligence (AI) has significantly transformed STEM education through intelligent tutoring systems, adaptive assessments, and predictive analytics. However, the large-scale collection and processing of student data raise serious privacy and security concerns. Ensuring data confidentiality while maintaining predictive accuracy presents a challenging applied mathematical problem. This paper develops a rigorous mathematical framework for privacy-preserving AI models in educational platforms. The study further examines noisy stochastic gradient descent and establishes convergence conditions under privacy-induced perturbations. Using tools from convex optimization and statistical learning theory, we derive bounds on generalization error in privacy-constrained models. Additionally, mathematical formulations of secure multiparty computation and homomorphic encryption are discussed as algebraic techniques for collaborative AI training without raw data sharing. Applications are considered in modern AI-driven education systems, including large-scale language model platforms developed by Open AI and digital learning research initiatives at Stanford University. The proposed framework demonstrates that privacy preservation can be formulated as a constrained optimization problem balancing accuracy, stability, and confidentiality. Furthermore, theoretical guarantees are established for differential privacy parameters under realistic educational data distributions. The results indicate that mathematically structured privacy mechanisms can sustain robust model performance while ensuring strong data protection standards.

**Keywords:** Privacy-Preserving AI, Mathematical Models, AI Education Platforms, Data Privacy in Ed Tech, Secure Machine Learning, Federated Learning, Homomorphic Encryption, Differential Privacy, Student Data Protection, AI-Driven Learning Systems.

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**Applications of Calculus and Artificial Intelligence In Precision Medicine****DINESHKANNA S**

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**Abstract**

The integration of Artificial Intelligence with multivariable calculus and optimization theory represents a transformative frontier in personalized medicine. Traditional healthcare often relies on generalized treatment protocols; however, human physiology is a highly dynamic, continuous system governed by complex rates of change. By employing differential equations to model pharmacokinetics-the metabolic life-cycle of a drug within the human body-AI systems can transcend static dosing guidelines. These mathematical frameworks allow algorithms to continuously compute the optimal, individualized drug dosages required to maximize therapeutic efficacy while strictly minimizing toxicity over time. Furthermore, the application of constrained optimization is revolutionizing complex procedural treatments, most notably in oncology. In radiation therapy planning, AI leverages advanced calculus to solve high-dimensional optimization problems. The algorithm's objective is to calculate the precise angle, intensity, and duration of radiation beams. By mathematically defining the tumour's destruction as the primary goal and the preservation of surrounding healthy tissue as a rigid boundary constraint, the AI navigates millions of potential treatment vectors to find the safest, most effective path. Beyond treatment delivery, real-time patient data streams from wearable and diagnostic devices further refine these models through adaptive feedback control systems. Consequently, AI-powered calculus-based frameworks are paving the way for truly predictive, preventive, and precision-driven healthcare.

**Keywords:** Artificial Intelligence (AI), Personalized Medicine, Optimization Theory, Multivariable Calculus, Pharmacokinetics, Constrained Optimization, Differential Equations, Radiation Therapy Planning.

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**Agentic and Physical AI: Integrating Autonomous Intelligence with Embodied and Real-World AI Systems****MHOGANRAJ AS**

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**Abstract**

The rapid evolution of Artificial Intelligence is driving a profound paradigm shift: the convergence of Agentic AI and Physical AI. Historically, AI has functioned as reactive software bounded by digital constraints, dependent on constant human prompting. However, Agentic AI introduces autonomous entities capable of multi-step reasoning, goal-directed planning, and dynamic workflow orchestration with minimal human intervention. Concurrently, Physical AI embodies these advanced cognitive processes within robotic and cyber-physical systems, effectively bridging the gap between digital intelligence and tangible real-world execution. This abstract explores the transformative synergy between the "digital brain" of agentic models and the "physical body" of embodied machines. This convergence heavily relies on multimodal vision-language-action (VLA) models and low-latency edge computing. These technologies empower robots to perceive unstructured physical environments, dynamically reason about spatial relationships, and autonomously execute complex physical interventions. Unlike conventional automation—which fundamentally relies on rigid, pre-programmed instructions—these integrated systems continuously learn from operational experience and adapt their behaviors to highly unpredictable, real-time conditions. The fusion of Agentic and Physical AI establishes the critical foundation for a new economic and technological era. From intelligent manufacturing and resilient autonomous logistics to advanced, interactive healthcare robotics, this synergy allows machines to seamlessly translate high-level human intent into sophisticated physical action. Ultimately, embodied agentic systems represent the next critical frontier in artificial cognition, fundamentally redefining the boundaries of automation and unlocking unprecedented potential for intelligent machines to collaboratively understand, navigate, and manipulate the physical world around us.

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**Integrating Artificial Intelligence with Quantum Computing for Advanced Computational Modeling and Optimization****NESHIKA V**

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**Abstract**

Artificial Intelligence (AI) has emerged as a transformative force in computational science, yet classical hardware faces significant scaling bottlenecks when processing High-dimensional datasets. This work explores the integration of AI with Quantum Computing to overcome these limitations through Quantum Machine Learning (QML) and hybrid quantum-classical architectures. We develop a framework that leverages quantum phenomena, specifically superposition and entanglement, to enhance the feature space mapping of complex neural networks. The system utilizes Variation Quantum Eigen solvers (VQE) and Quantum Approximate Optimization Algorithms (QAOA) for accelerated data-driven parameters estimation and pattern recognition. Physics-Informed Neural Networks (PINNs) are adapted for quantum environments to handle noisy intermediate-scale quantum (NISQ) data, ensuring constraint-aware learning from heterogeneous sources. Stability and convergence analyses are performed to evaluate the transition from classical gradient descent to quantum-enhanced optimization landscapes. The integration of AI with quantum circuits enables predictive assessments of molecular dynamics, cryptographic resilience, and large-scale financial modeling. Ultimately, the synergy between AI and quantum computing strengthens high-performance computing capabilities, supports the development of fault-tolerant algorithms, and advances the frontier of next-generation digital intelligence.

**Keywords:** Artificial Intelligence, Quantum Computing, Quantum Machine Learning, Physics-Informed Neural Networks, Hybrid Quantum-Classical Systems, Predictive Modeling.

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**Nanotechnology Integrated with Artificial Intelligence****YOHASHINI A**

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**Abstract**

Nanotechnology, the science of manipulating matter at the nanoscale (1–100 nanometers), has emerged as a transformative field in medicine, electronics, energy, and materials science. The integration of nanotechnology with Artificial Intelligence (AI) is accelerating innovation by enabling intelligent design, real-time analysis, and predictive modeling of nanoscale systems. AI techniques such as machine learning, deep learning, and neural networks are increasingly used to analyze complex datasets generated from nanoscale experiments, simulations, and imaging tools like electron microscopy. In nanomedicine, AI-assisted nanotechnology enhances targeted drug delivery, early disease detection, and personalized treatment strategies. Smart nanoparticles can be designed using AI algorithms to optimize size, shape, and surface properties for efficient interaction with biological systems. In materials science, AI models predict the properties and behavior of nanomaterials, reducing the need for costly and time-consuming laboratory experiments. This accelerates the discovery of advanced materials with improved strength, conductivity, and sustainability. Moreover, AI-driven automation in nanoscale fabrication improves precision and quality control in semiconductor manufacturing and nanoelectronics. The combination also supports environmental monitoring through nanosensors that collect real-time data, which AI systems analyze to detect pollutants and predict environmental changes. Overall, the convergence of nanotechnology and AI represents a powerful interdisciplinary approach that enhances efficiency, accuracy, and innovation. This synergy is paving the way for intelligent nanodevices and smart systems, shaping the future of healthcare, industry, and sustainable development.

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**The Symbiotic Relationship Between Pure and Applied Mathematics****NIVETHA A**

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**Abstract**

The mathematical sciences are traditionally divided into two primary branches: pure and applied mathematics. While they often operate with different goals, they form a unified ecosystem of logic and discovery. Pure mathematics is driven by the pursuit of aesthetic beauty and internal consistency. It focuses on abstract structures—such as number theory, topology, and non-Euclidean geometry—seeking to establish universal truths through rigorous proof. In this realm, a concept is explored for its own sake, independent of any immediate physical utility.

Conversely, applied mathematics serves as the bridge between abstract theory and the physical world. It utilizes the tools developed by pure mathematicians to solve concrete problems in physics, economics, and data science. Through mathematical modeling, applied mathematicians translate natural phenomena into quantitative languages, to predict outcomes and optimize systems. The history of science is replete with instances where "useless" pure mathematics became the foundation for revolutionary technology. For example, the abstract study of prime numbers eventually became the backbone of modern RSA encryption, and Riemannian geometry provided the essential framework for Einstein's General Relativity. This synergy suggests that the distinction between the two is often a matter of time rather than substance. Together, pure and applied mathematics provide both the fundamental language of logic and the practical toolkit necessary to navigate and manipulate the complexities of the modern universe.

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**Stochastic Dynamics and The Evolution of Time Series Forecasting****SAHANA A**

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**Abstract**

Time series analysis and forecasting represent the mathematical discipline of deciphering the temporal order of data to uncover the latent mechanisms governing dynamic systems. Unlike static statistical models, time series data is defined by its chronological continuity, where each observation is potentially a function of its own history. This field focuses on decomposing complex signals into constituent elements: the underlying long-term trend, periodic seasonal fluctuations, and the stochastic "white noise" that represents inherent system volatility. The theoretical framework of forecasting has evolved from simple moving averages to sophisticated state-space models and spectral analysis. Central to this evolution is the concept of stationary—the statistical property where the mean and variance remain constant over time—which serves as a prerequisite for many classical linear models. When dealing with non-stationary real-world data, techniques such as "differencing" or power transformations are applied to stabilize the series. In recent years, the field has been revolutionized by Deep Learning, specifically Recurrent Neural Networks (RNNs), which can memorize long-term dependencies that traditional econometric models often overlook. The impact of high-fidelity forecasting is profound, ranging from the precision of "Just-in-Time" manufacturing to the critical timing of high-frequency trading in financial markets. By quantifying the uncertainty of the future through confidence intervals and probability density forecasts, researchers can mitigate the risks associated with black-swan events. Ultimately, time series analysis transforms the passage of time from a sequence of random occurrences into a structured narrative, providing the foresight necessary for strategic resilience in an era of global complexity.

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**The Strategic Framework of Operations Research and Optimization****D JESHI**

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**Abstract**

Operations Research (OR) is the discipline of applying advanced analytical methods to facilitate better decision-making within complex organizational systems. Often described as the "science of better," OR utilizes a multidisciplinary approach—combining mathematical modeling, statistics, and algorithms—to resolve conflicts in resource allocation. At its core, OR seeks to transform raw data into actionable intelligence, providing a structured framework to evaluate various strategies under conditions of uncertainty and risk. The engine driving Operations Research is mathematical optimization. This process involves the formulation of an objective function—such as minimizing operational costs or maximizing production throughput—subject to a set of real-world constraints like labor hours, budget limits, or raw material availability. Techniques such as linear programming, integer programming, and network flow analysis allow researchers to navigate vast solution spaces to identify the "optimal" choice. For instance, in logistics, optimization models determine the most efficient routes for global supply chains, significantly reducing carbon footprints and overhead costs. Beyond mere calculation, modern OR integrates simulation and stochastic modeling to account for the inherent volatility of human and natural systems. As industries transition toward data-driven paradigms, the synergy between optimization algorithms and machine learning has become paramount. This evolution allows for prescriptive analytics, where models not only predict future trends but also prescribe the specific sequence of actions required to achieve peak efficiency. Ultimately, Operations Research serves as the vital link between mathematical theory and organizational excellence, ensuring that limited resources are utilized to their fullest potential.

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**The Evolution of Operations Research and Systematic Optimization****VENKATRAMAN d**

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**Abstract**

Operations Research (OR) represents the analytical backbone of modern industrial and service systems, focusing on the application of scientific methods to complex decision-making. Emerging from military logistics during World War II, the field has evolved into a sophisticated discipline that balances mathematical rigor with practical utility. It involves the construction of models that represent the functional relationships within a system, allowing managers to predict the consequences of alternative policies. By identifying bottlenecks and redundancies, OR provides a systematic way to improve the reliability and performance of everything from healthcare delivery to telecommunications. The core of this discipline is Optimization, the mathematical process of finding the best possible solution from a set of feasible alternatives. This often involves the use of sophisticated algorithms to navigate high-dimensional spaces where manual calculation is impossible. Whether employing Heuristics for rapid approximation in real-time routing or Integer Programming for scheduling personnel, optimization ensures that every unit of input yields the maximum possible output. In the age of Big Data, these models have become increasingly dynamic, incorporating real-time data streams to adjust to market fluctuations and supply chain disruptions instantaneously. Furthermore, the integration of stochastic modeling allows OR to account for "noise" and variability, such as consumer demand spikes or equipment failure. By quantifying risk through Monte Carlo simulations and queuing theory, organizations can build resilience into their operations. Ultimately, Operations Research and Optimization do not just provide answers; they offer a strategic lens through which the inherent complexity of the modern world can be managed, refined, and mastered for the greater efficiency of society.

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**Navigating Uncertainty through Probability and Statistical Methods****Ragunath K**

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**Abstract**

Probability and statistical methods provide the fundamental mathematical framework for quantifying uncertainty and extracting meaningful insights from data. While probability theory offers a deductive approach—starting with known parameters to predict the likelihood of specific outcomes—statistics functions inductively, using observed data to infer the underlying rules of a system. Together, these disciplines form the bedrock of the modern scientific method, allowing researchers to distinguish between genuine patterns and mere coincidences in an increasingly noisy world. The core of statistical methodology lies in the transition from descriptive to inferential analysis. Probability distributions, such as the Normal, Binomial, and Poisson distributions, serve as theoretical benchmarks for real-world phenomena. By applying techniques such as hypothesis testing, regression analysis, and Bayesian inference, statisticians can validate theories with measurable confidence. For instance, in clinical trials, these methods are used to determine if a new medication's efficacy is statistically significant or simply a result of random variation. In the era of Big Data, the role of these methods has expanded into the realm of machine learning and predictive modeling. Stochastic processes and Monte Carlo simulations allow for the modeling of complex, time-dependent systems ranging from stock market fluctuations to meteorological shifts. By quantifying risk and acknowledging the inherent variability of the natural world, probability and statistics do not just provide "answers"—they provide a rigorous language for decision-making under pressure. Ultimately, these tools empower society to navigate the unknown with calculated precision and empirical integrity.

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**Molecular Mimicry and The Quantum Threshold****SIVARAM R**

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**Abstract**

While early nanotechnology focused on simple particles, the modern frontier is defined by molecular manufacturing and functional nanosystems. At the heart of this shift is the ability to exploit quantum confinement effects. When a material is restricted to the nanoscale, its electrons are "caged," leading to optical and electrical properties that do not exist in bulk form. For instance, quantum dots—nanometer-sized semiconductor crystals—can be tuned to emit specific colors of light simply by changing their size, a principle now driving the next generation of ultra-high-definition displays and biological imaging. The structural diversity of carbon-based nanomaterials remains a primary research pillar. Beyond the well-known carbon nanotubes, researchers are now perfecting graphene—a single layer of carbon atoms arranged in a hexagonal lattice. Its record-breaking electron mobility and mechanical strength make it a "wonder material" for future flexible electronics and high-performance sensors. One of the most provocative shifts in nanotechnology is its convergence with synthetic biology. Scientists are now using DNA as a structural building block (DNA origami) to "fold" genetic material into tiny boxes or motors. These programmable nanostructures can act as: Intelligent Sensors: Detecting single-molecule pollutants in water. Nanobots: Navigating the bloodstream to perform microsurgery or clear arterial blockages. Nanostructured Scaffolds: Providing the 3D framework for growing complex human organs in a laboratory setting. As we transition from passive nanostructures to active nanosystems, the focus is shifting toward autonomous assembly and self-replication. This leap requires rigorous safety protocols to manage the lifecycle of synthetic particles, ensuring that the precision of the small scale translates into a massive, positive impact on global health and energy.

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**The Quantum Leap: Advanced Synthesis and Heterogeneous Architectures****DEVAPRIYAN S**

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**Abstract**

While silicon has reigned supreme for decades, the semiconductor landscape is currently undergoing a structural transformation driven by Atomic Layer Deposition (ALD) and advanced thin-film engineering. The focus is shifting from simple miniaturization to the mastery of Charge Carrier Mobility. By precisely engineering the strain within a crystal lattice, researchers can "stretch" atoms to allow electrons to flow with significantly less resistance, reducing the heat generation that plagues modern high-performance computing. One of the most significant shifts in 2026 is the rise of UltrawideBandgap (UWBG) materials, specifically Gallium Oxide and Diamond. These materials possess a breakdown field strength far superior to even Silicon Carbide, making them the ultimate candidates for deep-space communications and extreme-environment power grids. Beyond traditional electron-based logic, the field is merging with Photonics. By integrating III-V semiconductors (like Indium Phosphide) directly onto silicon substrates—a process known as Heterogeneous Epitaxy—engineers are creating "Optical Chips." These use light instead of electricity to move data between processor cores, shattering the "Memory Wall" that currently limits AI processing speeds. Perovskite Semiconductors: Emerging as low-cost, high-efficiency alternatives for next-gen solar cells and LEDs. Spintronics: Utilizing the "spin" of an electron rather than just its charge, promising non-volatile memory that doesn't lose data when power is cut. Neuromorphic Materials: Designing semiconductors that mimic the synaptic plasticity of the human brain for low-power AI edge devices. The future of semiconductor materials is no longer about a single "winner" material, but a complex, multi-material stack where each layer is optimized for a specific physical property, from thermal management to quantum coherence.

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**The Role of Mathematical Modeling and Simulation in Modern Science**  
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**Abstract**

Mathematical modeling and simulation serve as the cornerstone of contemporary scientific inquiry, bridging the gap between theoretical frameworks and real-world application. As systems in physics, biology, and engineering grow increasingly complex, traditional analytical methods often fall short. A mathematical model translates these intricate phenomena into a formal language of equations—frequently involving ordinary or partial differential equations—allowing for a structured representation of dynamic behavior and underlying mechanisms. The advent of high-performance computing has transformed these models into actionable simulations. By employing numerical methods and computational algorithms, researchers can "run" a model under varying parameters to observe potential outcomes without the logistical or financial constraints of physical experimentation. This dual approach is vital for predictive analytics; it enables the testing of hypotheses in "in silico" environments, ranging from climate change projections and viral transmission patterns to the structural integrity of aerospace components. Furthermore, the iterative nature of modeling—comprising formulation, validation, and refinement—ensures that models evolve as new empirical data becomes available. Sensitivity analysis and uncertainty quantification remain critical components of this process, ensuring that simulations remain robust and reliable for decision-making. Ultimately, mathematical modeling and simulation do not merely replicate reality; they provide a powerful lens through which we can understand, predict, and optimize the behavior of the universe's most complex systems, fostering innovation across multidisciplinary domains.

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**Foundations of Empirical Inquiry through Probability and Statistics****NIVAS S**

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**Abstract**

Probability and statistical methods serve as the essential logical framework for interpreting the stochastic nature of the universe. While probability provides the theoretical language for describing the likelihood of events—moving from a defined model toward predicted data—statistics operates in the inverse direction, using empirical observations to construct and refine models of reality. This synergy is fundamental to the transition from raw observation to scientific knowledge, allowing for the rigorous quantification of "certainty" in an inherently uncertain world. A primary pillar of statistical methodology is the concept of sampling theory and the Central Limit Theorem, which permit researchers to make high-stakes inferences about vast populations based on relatively small, representative datasets. Through the application of p-values, confidence intervals, and effect sizes, researchers can establish the reliability of their findings. In fields as diverse as genomics and macroeconomics, these tools are used to filter through "noise" to identify meaningful correlations and causal relationships. Furthermore, the modern landscape of data science relies heavily on Stochastic Modeling and Regression Analysis to map the dependencies between variables. By accounting for variance and error, these methods provide a robust defense against human biases and anecdotal evidence. Whether predicting the trajectory of a pandemic or optimizing the parameters of a deep-learning algorithm, probability and statistics remain the primary instruments for converting numerical chaos into structured, actionable insight, ensuring that decision-making is grounded in mathematical validity rather than intuition.

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**The Nexus of Statistical Inference and Data Analysis****PRIYADHARSHINI S**

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**Abstract**

In the modern era of data-driven decision-making, the synergy between data analysis and statistical inference forms the backbone of scientific inquiry and industrial strategy. Data analysis serves as the foundational phase, employing descriptive statistics and visualization techniques to clean, transform, and explore raw datasets. Its primary objective is to uncover patterns, identify anomalies, and summarize the inherent characteristics of a sample. However, the utility of data often remains localized to the observed group unless complemented by the rigorous framework of statistical inference. Statistical inference provides the mathematical bridge required to move beyond the "known" sample to the "unknown" population. By utilizing probability theory, researchers can perform hypothesis testing, estimate confidence intervals, and execute regression modeling to quantify uncertainty. This process allows for the generalization of findings while acknowledging the margin of error, effectively transforming mere observations into actionable evidence. The integration of these two domains is critical for mitigating cognitive biases and ensuring reproducibility. Whether applying Bayesian methods to update prior beliefs or frequentist approaches to determine significance, the objective remains constant: to extract meaningful insights from noise. As datasets grow in complexity—characterized by high dimensionality and non-linear relationships—the evolution of computational statistics continues to refine these methodologies. Ultimately, the robust application of inference within data analysis ensures that conclusions are not merely anecdotal but are statistically sound and predictive of broader phenomena.

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**The Backbone of Modern Electronics: Semiconductor Physics and Materials****SELVASANJAY S**

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**Abstract**

Semiconductors are the foundational materials of the information age, defined by an electrical conductivity that falls between that of a conductor and an insulator. This unique behavior is governed by the energy band gap—the specific energy range where no electron states can exist. By manipulating this gap through a process called doping (adding trace impurities like Boron or Phosphorus), scientists can precisely control the flow of charge carriers, enabling the creation of transistors, the "on-off" switches of modern computing. While Silicon (Si) remains the industry titan due to its abundance and high-quality native oxide, the frontier of semiconductor research has shifted toward Wide Bandgap (WBG) materials. Compounds such as Silicon Carbide (SiC) and Gallium Nitride (GaN) are revolutionizing power electronics. These materials can operate at much higher voltages, temperatures, and frequencies than traditional silicon, making them indispensable for the rapid charging systems of electric vehicles and the high-speed requirements of 5G and 6G telecommunications. As we approach the physical limits of Moore's Law, the focus is turning toward two-dimensional (2D) semiconductors like Molybdenum Disulfide (MoS<sub>2</sub>). These atom-thick layers offer extraordinary electrostatic control, potentially allowing for transistors that are smaller and more energy-efficient than anything currently in production. Furthermore, Organic Semiconductors are carving out a niche in flexible electronics and foldable OLED displays. Unlike rigid inorganic crystals, these carbon-based polymers can be printed onto plastic substrates, opening the door to wearable health monitors and transparent solar cells. The future of the field lies in Heterogeneous Integration—combining these diverse materials into a single "chiplet" architecture to maximize performance while minimizing power consumption.

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**The Evolution of Advanced Materials: Design and Synthesis**  
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**Abstract**

Materials Science is the engine of industrial evolution, transforming theoretical concepts into tangible technologies. While early civilizations were defined by single materials like bronze or iron, the modern era is characterized by functional complexity. We no longer simply "find" materials; we engineer them at the Nano scale to exhibit specific, often multi-functional behaviors. The discipline revolves around the fundamental link between a material's atomic architecture and its mechanical, electrical, and thermal capabilities. By manipulating defects within a crystal lattice or controlling the grain boundaries in an alloy, engineers can dictate how a substance will endure extreme stress or conduct energy. Modern Frontiers: Smart and Sustainable Systems Current research has moved beyond static substances toward "smart" materials—those that can sense and respond to their environment. This includes: Shape-Memory Alloys: Metals that return to their original shape when heated. Piezoelectrics: Materials that convert mechanical pressure into electrical energy. Self-Healing Polymers: Synthetics capable of repairing microscopic cracks without human intervention. Furthermore, the integration of Computational Materials Science has accelerated discovery. Using density functional theory (DFT) and machine learning, researchers can simulate how a hypothetical material will perform under high-pressure or corrosive environments before physical synthesis ever begins. This digital-first approach is crucial for meeting the urgent demand for high-capacity battery electrodes and lightweight composites for aerospace, ensuring that the next generation of materials is both high-performing and environmentally benign.

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**Computational Foresight through Mathematical Modeling****T MARUDHAMUTHU**

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**Abstract**

The integration of mathematical modeling and computer-based simulation has redefined the boundaries of experimental science, providing a virtual laboratory for exploring the unreachable. At its core, mathematical modeling involves the abstraction of physical properties into quantitative relationships. Whether utilizing stochastic processes to account for randomness or deterministic equations to describe rigid laws, these models serve as a fundamental blueprint for reality. By simplifying the "noise" of the natural world into manageable variables, researchers can isolate specific drivers of change within a system. Simulation acts as the execution layer of this process, utilizing numerical integration and iterative algorithms to solve equations that are analytically intractable. This capability is particularly transformative in fields like fluid dynamics, financial forecasting, and pharmacology, where the cost of failure is high. Simulations allow for "what-if" scenario testing, providing a low-risk environment to observe how systems react to extreme conditions. This predictive power is essential for optimizing industrial processes and developing resilient infrastructure in an era of rapid global change. Furthermore, the synergy between modeling and big data has ushered in a new era of high-fidelity simulations. Modern frameworks now incorporate machine learning to refine model parameters in real-time, narrowing the gap between simulated results and empirical observations. As computational power continues to scale, mathematical modeling and simulation remain indispensable tools for decoding the complexity of the natural world, turning abstract theory into practical, life-saving insights.

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**The Dialectic of Discovery in Pure and Applied Mathematics****V JOTHIBALAJI**

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**Abstract**

The field of mathematics functions as a dual-natured discipline, oscillating between the pursuit of absolute logic and the necessity of practical utility. Pure mathematics represents the exploration of the "mathematical universe" for its own sake. It is characterized by rigorous deduction and the development of abstract structures, such as Hilbert spaces or complex manifolds. In this domain, the mathematician acts as an architect of thought, building intricate systems where the only constraint is internal consistency. While these concepts may appear detached from reality, they often reveal the deep, hidden symmetries that govern the logic of existence. Applied mathematics, by contrast, is the functional application of these abstract structures to the tangible world. It acts as the translator between raw data and theoretical insight. By employing tools like vector calculus, probability theory, and differential equations, applied mathematicians create frameworks to understand fluid dynamics, financial markets, and quantum mechanics. The beauty of this branch lies in its versatility; a single mathematical theorem derived in a vacuum can become the essential algorithm for modern artificial intelligence or the foundation for global logistics. The boundary between "pure" and "applied" is increasingly fluid. What begins as a quest for intellectual elegance in number theory or group theory frequently becomes the indispensable backbone of modern cryptography and physics. This continuous feedback loop ensures that mathematics remains both a sublime art form and the most powerful tool available for scientific advancement. Ultimately, the two branches are not separate entities but different perspectives of the same universal language.

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**Sustaining the Grid: The Synergy Of Renewable and Energy Storage****PRAGADEESH V**

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**Abstract**

The global transition to a low-carbon economy is fundamentally a challenge of synchronization. While renewable energy sources—primarily solar and wind—have seen an 80% drop in costs over the last decade, their inherent intermittency requires a radical reimagining of grid infrastructure. By 2026, the focus has shifted from mere energy generation to the sophisticated integration of renewable assets with diverse energy storage systems (ESS). The Storage Spectrum: Short to Long Duration Effective decarbonization relies on a portfolio of storage technologies tailored to different timescales: Short-Duration (0–4 hours): Lithium-ion remains the dominant technology, but Sodium-ion batteries are rapidly scaling as a cost-effective, more sustainable alternative for residential and grid-balancing applications. Long-Duration (10+ hours): For seasonal shifting, Flow Batteries (utilizing vanadium or organic chemistries) and Gravity-Based Storage are gaining traction, providing stable power when wind and solar output drops for days. Green Hydrogen: Acting as a "chemical battery," surplus renewable energy is used to power electrolysis, creating hydrogen that can be stored in salt caverns for heavy industry and long-haul transport. 2026 Trends: Smart Grids and Resilience Modern systems are moving toward Hyper-distributed Energy. The rise of Vehicle-to-Grid (V2G) technology allows electric vehicle fleets to act as mobile batteries, feeding power back into the grid during peak demand. Simultaneously, AI-driven Grid-Forming Inverters are becoming standard, providing the synthetic inertia necessary to stabilize high-renewable grids without the need for traditional spinning turbines. This convergence of storage and intelligence is transforming the grid from a passive delivery system into a resilient, bi-directional network capable of achieving net-zero targets.

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