

NITM Mathematical Bi-monthly

August-September 2024



Department of Mathematics,
National Institute of Technology Meghalaya
Bijni Complex, Laitumkhrah, Shillong-793003, India

“All the truths of mathematics are linked to each other, and all means of discovering them are equally admissible.”

— **Adrien Marie Legendre**



DIRECTOR'S MESSAGE

Dear Students, Faculty, and Readers,

I am immensely pleased to introduce the inaugural edition of the Department of Mathematics' bimonthly magazine. This magazine represents a significant step forward in creating a platform where the department can showcase our students and faculty members' intellectual curiosity, talent, and dedication.

Mathematics is not just a subject confined to classrooms and textbooks; it is a dynamic and evolving field with the power to shape the world around us. I am proud of the department's commitment to fostering academic excellence and a spirit of innovation.

This magazine is a testament to that pursuit of knowledge. It will serve as a medium for not only disseminating new ideas and research but also for encouraging discussions, collaborations, and creativity within our vibrant mathematical community. I encourage each of you—students and faculty alike—to contribute actively to the growth of this magazine and make it a reflection of our collective brilliance.

As we move forward, let us continue to strive for academic distinction, intellectual curiosity, and a passion for solving the complex problems that mathematics presents. The journey is as important as the destination. I believe that together, we will continue to make strides toward a brighter future for the department and the world of mathematics.

I congratulate the editorial team on their hard work in bringing this publication to life, and I look forward to seeing the magazine evolve in the years to come.

With best wishes,
Prof. Pinakeswar Mahanta
Director, NITM

HoD's Message

As the Head of the Department of Mathematics (MA), it is truly an honor for me to write for the inaugural issue of our departmental magazine. This platform allows our faculty, staff, and students to showcase their achievements, express their opinions, and explore new mathematical concepts. I believe that this magazine will become an essential channel for sharing knowledge, ideas, and research insights that will inspire us all.

The Department of Mathematics, which started functioning in June 2012, currently offers 2-year M.Sc. and PhD programs. M.Sc. students are selected based on their ranking through CCMN and the institution mode, while PhD students are selected through interviews based on their GATE/NET scores. In addition to our core programs, the department also plays a vital role as a supporting pillar for various B.Tech and M.Tech programs within the institute.

The creation of this magazine stems from a collective desire to share our thoughts, accomplishments, and aspirations. Working together as a team to ensure its successful publication brings immense delight. I feel privileged to be part of this process and am filled with joy in nurturing our students, contributing to society, and fostering academic excellence.

My team and I remain dedicated to the holistic development of our students within the institute. I extend my best wishes to all MA family members and sincerely hope that this tradition of the departmental magazine continues for generations to come, fostering happiness, unity, and intellectual growth.

**Warm regards,
Dr. Adarsha Kumar Jena
Assistant Professor, HoD, MA**

Editor's Message

The only way to learn mathematics is to do mathematics. — Paul R. Halmos.

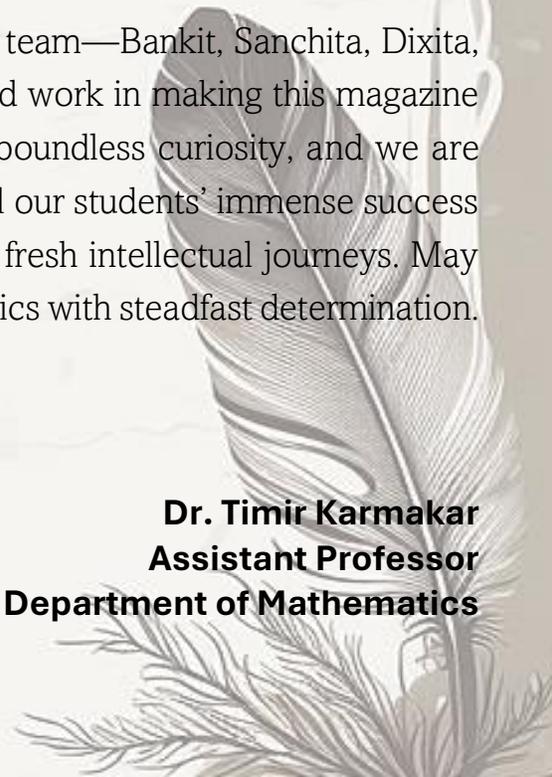
This profound statement not only serves as a guiding principle but also emphasizes the importance of active engagement in mathematics. It brings me great joy to inform you that starting from this month in 2024, the Department of Mathematics at the National Institute of Technology Meghalaya is introducing its very own publication, the “*NITM Mathematical Bi-monthly*.”

This publication is a collective endeavour by our students and faculty members, designed to ignite a love for mathematics and offer a stage for students to share their insights. Magazines transform the creative potential of our students into tangible contributions, allowing them to identify and showcase their talents through writing. Through this magazine, we aspire to highlight contributions, departmental events, achievements, and the scholarly work of both faculty and students. I encourage all students to participate by submitting interesting mathematical problems, engaging puzzles, stories, and intriguing facts about mathematicians.

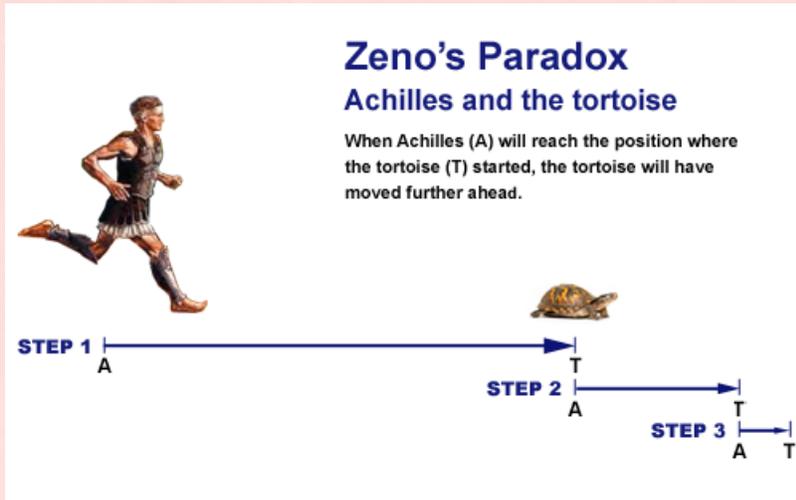
I want to express my deepest appreciation to the editorial team—Bankit, Sanchita, Dixita, and Dibyasman—for their tremendous dedication and hard work in making this magazine a reality in such a brief period. Our minds are filled with boundless curiosity, and we are continually striving to explore beyond the known. I wish all our students' immense success as they delve into the magazine's contents and set out on fresh intellectual journeys. May this initiative inspire us all to deepen our grasp of mathematics with steadfast determination.

Thank you, and best wishes.

Dr. Timir Karmakar
Assistant Professor
Department of Mathematics



Here's a mind-bender: "I am a liar." If you think it's true, then it must be false, but if you think it's false, it must be true. Now that's a *paradox!*



Zeno argues that a runner will never reach the finish line of a straight race because they must first run to the midpoint, then to the midpoint of that distance, and so on.

Paradox



The barber is a man in town who shaves all those, and only those, men in town who do not shave themselves.

Does the barber shave himself?

Featured articles

The Role of Mathematical Statistics in Modern Data Science

Bankitdor M Nongrum (Research Scholar, P22MA008)

In the age of information, data has emerged as one of the most valuable assets for organizations worldwide. From businesses to healthcare, education to social sciences, the ability to extract meaningful insights from vast amounts of data has become crucial. At the heart of this transformative process lies the field of mathematical statistics, which provides the foundational principles and methodologies necessary for effective data analysis.

Understanding Mathematical Statistics

Mathematical statistics is a branch of mathematics that focuses on the collection, analysis, interpretation, and presentation of data. It encompasses various concepts, including probability theory, statistical inference, hypothesis testing, and regression analysis. These tools enable statisticians and data scientists to model uncertainty, make predictions, and derive conclusions from data.

The Importance of Data-Driven Decision Making

In today's fast-paced world, organizations rely heavily on data-driven decision-making. This approach allows them to base their strategies on empirical evidence rather than intuition. Mathematical statistics plays a pivotal role in this process by providing the necessary framework for analyzing data and drawing actionable insights. For instance, businesses can use statistical techniques to identify trends in consumer behavior, optimize marketing strategies, and improve operational efficiencies.

Key Statistical Methods in Data Science

Several statistical methods have become staples in the toolkit of data scientists:

1. **Descriptive Statistics:** This involves summarizing and organizing data through measures such as mean, median, mode, variance, and standard deviation. These basic statistics provide a clear picture of the data's characteristics and help identify patterns.
2. **Inferential Statistics:** This branch allows data scientists to make predictions and inferences about a population based on a sample. Techniques such as confidence intervals and hypothesis testing enable researchers to draw conclusions and assess the validity of their findings.
3. **Regression Analysis:** Regression is a powerful statistical method used to understand relationships between variables. Linear regression, logistic regression, and polynomial regression help data scientists model and predict outcomes based on historical data.
4. **Machine Learning:** While often viewed as a separate field, machine learning heavily relies on statistical principles. Techniques like support vector machines, decision trees, and neural networks incorporate statistical concepts to identify patterns and make predictions.

Applications Across Industries

Mathematical statistics finds applications in various sectors, showcasing its versatility and importance:

- **Healthcare:** In clinical trials, statistical methods are used to determine the efficacy of new treatments and interventions. Data analysis helps identify patient outcomes, track disease prevalence, and assess risk factors.
- **Finance:** Statistical models are essential in risk assessment, portfolio management, and fraud detection. By analyzing historical financial data, organizations can make informed decisions to maximize returns and minimize risks.
- **Marketing:** Businesses leverage statistical analysis to understand consumer preferences, segment markets, and evaluate campaign effectiveness. Predictive analytics, rooted in statistical models, helps optimize marketing strategies and allocate resources efficiently.
- **Social Sciences:** Researchers in sociology, psychology, and education utilize statistical methods to analyze survey data, conduct experiments, and understand societal trends.

Challenges and Future Directions

Despite its significance, the field of mathematical statistics faces several challenges, especially in the context of big data. High-dimensional data, often referred to as the "curse of dimensionality," can complicate statistical analyses. Moreover, the increasing complexity of data and the demand for real-time analysis require advanced statistical techniques and computational tools.

Looking ahead, the integration of mathematical statistics with emerging technologies such as artificial intelligence and machine learning will continue to evolve. As data grows in volume and

complexity, the demand for skilled statisticians and data scientists will increase, highlighting the importance of education and research in this field.

Conclusion

Mathematical statistics is the backbone of modern data science, providing the essential tools and methodologies for analyzing data and making informed decisions. As we continue to navigate an increasingly data-driven world, the role of mathematical statistics will remain vital in transforming raw data into actionable insights. By harnessing the power of statistical principles, organizations can unlock new opportunities, drive innovation, and ultimately achieve greater success.

Coffee time on exploring anisotropic porous media flows: insights into atherosclerosis and its implication

Sanchita Pramanik and Timir Karmakar

“Pour a bottle of beer. Restraining your thirst for the moment, admire its lively performance. One by one, bubbles of gas are nucleated, rise and crowd together at the surface. A foam or froth is quickly formed. Most of the liquid drains away, leaving the bubbles packed closely together in the form of elegant polyhedral cells. If you wait long enough you may see the structure change, as gas diffuses between the cells. This gradual change is punctuated by sudden local rearrangements. In most brands of beer, it is quickly overtaken by the collapse of the foam, as its individual films burst. Drink in it time, and you can feel that the foam is not quite a liquid. Paradoxically, it is very soft solid, creamy in texture if the bubbles are small. Cheers!” -

Denis Weaire and Stefan Hutzler, *The Physics of Foams*, Oxford University Press (2001).

The term "porous media" describes substances or materials that have interconnected pores or void spaces inside of a solid matrix. These voids can take on a variety of forms and combinations, as well as sizes ranging from microscopic to macroscopic. The structural component of the material is commonly referred to as the "matrix" or "frame." The pores, or voids, are filled with liquid or gas. Some examples of natural porous media are dirt, sand, rock, biological tissues, etc. The concept of "anisotropy" describes the property of having different characteristics in different direction. The term 'aniso' is derived from the Greek word, which means uneven. Anisotropic materials have direction-dependent characteristics, whereas isotropic materials have the characteristics that are same in all directions.

Anatomy of blood vessel:

Blood vessels are a complex system of channels that carry blood to and from different tissues and organs. The anatomical structure of an artery wall is presented below. The artery consists of four main parts: the endothelial glycocalyx, intima, media, and adventitia, extending from the lumen to the most external portion. The endothelial glycocalyx layer and the endothelial cell layer are the two primary innermost layers of the artery wall. A basement membrane and an internal elastic lamina comprise the intima. The media consists of two parts: smooth muscle cells and an external elastic lamina. Collagen fibers, elastic fibers, and connective tissue make up the adventitia, the outermost layer. The glycocalyx is a thin, hair-like structure that covers the surface of endothelial cells lining the luminal surface of blood vessels and protects endothelial cells from mechanical stress and prevents blood cells and platelets from adhering to the artery wall.

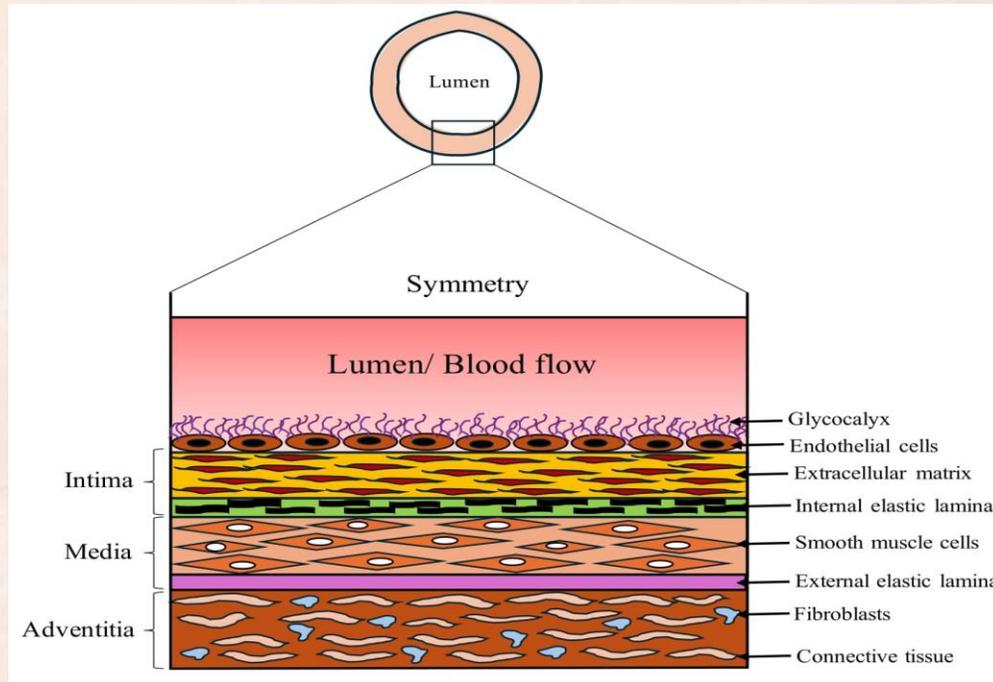


Figure: Anatomical view of the arterial wall

Formation of plaque and atherosclerosis:

Macromolecular transport, such as low-density lipoprotein (LDL) through the arterial wall, is intimately associated with various arterial diseases, such as the formation of plaques inside arteries due to abnormal accumulation of macromolecules, which often leads to atherosclerosis. The precise cause of the formation of atheromatous plaques inside the arterial walls (atherosclerosis) is unclear. However, it is believed that the accumulation of macromolecules, such as LDL, in the intima is one of the primary factors of atherosclerosis. In a vessel, low-density lipoprotein (LDL), sometimes referred to as "bad cholesterol," flows with the blood. Damage to the endothelial glycocalyx layer creates endothelial dysfunction, such as increased permeability, inflammation, or excessive cholesterol, which promotes the transport of macromolecules such as LDL from the arterial lumen to the arterial intima via the endothelial cell membrane. The initial stage of atherosclerosis is thought to be caused by endothelial dysfunction, which allows luminal high plasma cholesterol concentration, mainly low-density lipoprotein, to flow past endothelial cells and accumulate in the intima. Monocytes penetrate through the endothelial cell layer, enter the sub-endothelial area, and try to remove LDL by becoming macrophages. Aggregates of LDL cause macrophages to die and leave behind a necrotic core. Over time, the necrotic core enlarges, eventually bursts through the endothelium, and enters the blood vessel lumen, generating a thrombus. Blood platelets gathered around this, obstruct the major arterial portion, eventually leading to atherosclerosis.

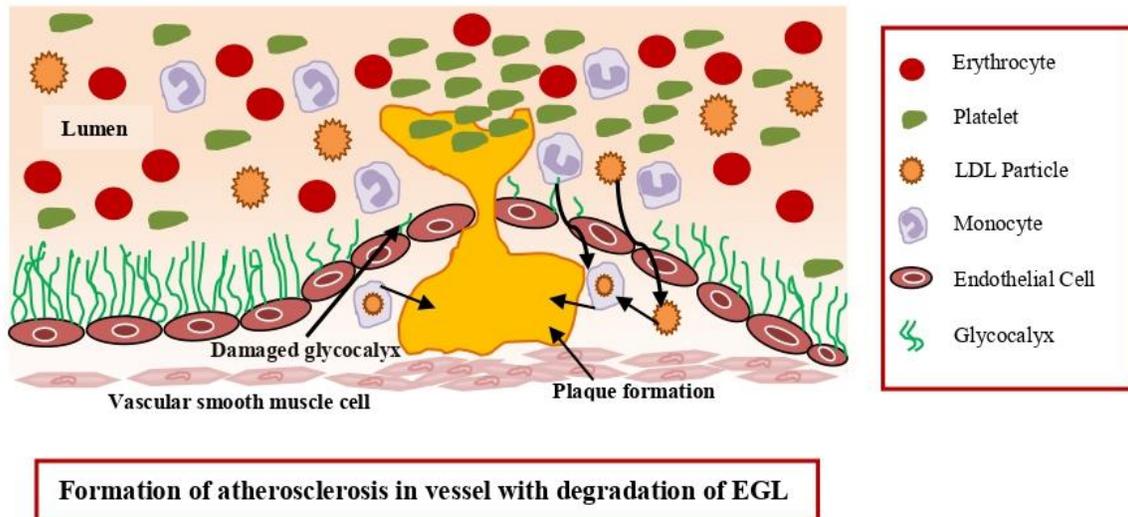


Figure: A cartoon diagram of a degraded glycocalyx forming plaque.

Due to the nature and orientation of endothelial glycocalyx, this can be considered as anisotropic porous medium. It is a very interesting fact to examine the response of the endothelial glycocalyx to the mechanical force referred to as shear stress and the impact of LDL transport on the arterial wall. Some investigation on this topic is very crucial for diagnosing and treating atherosclerotic cardiovascular diseases such as myocardial infarction, stroke, renal failure, and so on.

References

1. V. M. Subbotin, Excessive intimal hyperplasia in human coronary arteries before intimal lipid depositions is the initiation of coronary atherosclerosis and constitutes a therapeutic target, *Drug Discovery Today* 21 (2016) 1578–1595.
2. E. Jang, J. Robert, L. Rohrer, A. von Eckardstein, W. L. Lee, Transendothelial transport of lipoproteins, *Atherosclerosis* 315 (2020) 111–125.

Departmental Activities

Academic excursion and newly developed lab visit to the Permanent Campus on 30th August 2024.



Student Achievements

- 1. The thesis entitled "Phase retrieval and norm retrieval in Hilbert spaces" submitted by Ms. Suman Dowerah, under the supervision of Prof. Saikat Mukherjee, MA Department, has been accepted for the award of Doctor of Philosophy (Ph.D) on the recommendations of the Oral Defence Examination Committee (ODEC). The Viva-Voce examination was held on 24-07-24**
- 2. The thesis entitled "On Projection Based Iterative Methods to Solve Large Linear Systems" submitted by Mr. Ashif Mustafa, under the supervision of Dr. Manideepa Saha, Assoc Prof, MA Dept, has been accepted for the award of Doctor of Philosophy (Ph.D) on the recommendations of the Oral Defence Examination Committee (ODEC). The Viva-Voce examination was held on 28-08-24.**

Research Publications

1. Dbyasman Sarma and Tikaram Subedi, The probability that the product of three elements in a finite ring is zero, *Journal of Algebra and its Applications*, doi: <https://doi.org/10.1142/S0219498825503499>, 2024.
2. Sanjiv Subba and Tikaram Subedi, An extension of semi-commutative rings via reflexivity, *Analele Stiintifice Ale Universitatii Al I Ouza Din Iasi-Serie Noua Matematica*, 2024 (Accepted)
3. S. Arulmozhi, K Sukkiramathi, S. S. Santra, S. Nandi, K Vajravelu, B Kumbhakar, S. M Hussain, Stokes' second problem exact solution for hybrid nanofluid flow along an exponentially accelerating vertical surface, *ZAMM- Journal of Applied Mathematics and Mechanics*, DOI: [10.1002/zamm202400248](https://doi.org/10.1002/zamm202400248), 2024 (Accepted).

Lab developed



A WELL-EQUIPPED COMPUTER LAB IS BEING DEVELOPED FOR THE DEPARTMENT OF MATHEMATICS ON THE PERMANENT CAMPUS IN SOHRA.

Departmental News

Department of Mathematics, NIT Meghalaya warmly welcomes our newly joined Gust Faculty members, Dr. Md. Ibrahim Molla and Dr. Shivani Goel. We are excited to have them on board!



Dr. Md. Ibrahim Molla did his Ph.D. from the Ramkrishna Mission Vivekananda Educational and Research Institute, Belur in 2024. He specializes in Number Theory and is actively engaged in research within this field.



Dr. Shivani Goel did her Ph.D. from Indian Institute of Technology, Madras in 2021. She specializes in Algebraic Graph Theory and Enumerative combinatorics and is actively engaged in research within this field.

- ✓ Total 19 students have joined the two-year M.Sc. programme 2024.
- ✓ Total 03 students have joined the Ph.D. programme 2024.

Editorial Team



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